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VOLCANIC AND METALLOGENIC EVOLUTION OF THE MOMCHILGRAD DEPRESSION (EASTERN RHODOPES)

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ABSTRACT

Preceding volcanic activity epithermal low-sulfidation quartz-gold-adularia ore mineralizations are localized within the various Paleocene and Late Eocene sedimentary rocks in the Momchilgrad depression. Hydrothermal-metasomatic deposits of montmorillonite bentonite are formed within tuffs of the Beli Plast rhyodacite and Rabovo latite-andesite complexes. Agate occurrences associate with the latite-andesites of the Rabovo complex. Volcanogenic-sedimentary clinoptilolite zeolite deposits are formed within the tuffs of the Perperek complex. Perlite deposits are localized within the extrusive bodies of the Perperek trachyrhyolite and Ustren rhyolite complex. The formation of the quartz-Au-polymetallic Zvezdel-Pcheloyad ore field spatially and genetically is related to the Zvezdel volcano (built by basaltic-andesites of the Zvezdel complex).

The Momchilgrad depression is situated in the area between the Central and Southeastern Rhodopes blocks of the Rhodopes Massif. Various breccias, conglomerates, sandstones, marlstones and limestones deposited within the depression during the Paleocene and Late Eocene.

PRIABONIAN

The metallogenic processes preceded intense volcanic activity in the depression. Epithermal low-sulfidation quartz-gold-adularia ore mineralizations (Mavroudchiev at al., 1996) formed in the southeastern parts of the depression within the Paleocene and Late Eocene sediments (Fig. 1). Linear stockwok or stratiform ore bodies (Han Krum, Sarnak, etc.) are located within the favourable for replacing rocks and tectonic zones (detachment).

These ore mineralizations seem to have preceded the volcanic activity but probably resulted from its initial stages and were genetically related to the magma reservoir. The occurrences in the southeastern parts of the Momchilgrad depression were connected with still not erupted Irantepe volcano.

The volcanic activity also began from the southeastern parts of the Momchilgrad depression. The beginning was in the Priabonian when formed the Kalabak andesite complex. The Irantepe volcano (Ivanov, 1960), having diameter of about 10 km, as well as several smaller satellite volcanoes developed (Fig. 1).

The initial stages of the volcanic activity was dominated by explosive processes. Various lapilli tuffs, agglomerates, and epiclastics deposited upon the coal-sandstone and marl-limestone units and on the metamorphic basement as well. Locally, the tuffs and epiclastics are interbedded by reef limestones indicating that volcanoes grew up in a shallow marine basin. The tuffs are cut or covered by Amph-Py andesites. Agate occurrences associate with the andesite lavas of this complex.

RUPELIAN

The Momchilgrad depression extended to the east of the Varbitsa fault near by the town of Djebel (Djebel depression; Boyanov, Goranov, 1997) where the pre-Paleogene basement and rhythmic marlstone-sandstone unit were covered by conglomerates and sandstones (Fig. 2) hosting Makedontsi epithermal low-sulfidation quartz-gold-adularia deposit.

The tuffs of the Beli Plast rhyodacite complex covered these sedimentary rocks in the whole basin. Their vents were located to the north of the considered area in the outlines of the Krushka (the village of Skalna Glava; Yanev, 1995) and Zornitsa grabens. The Kardjali coastal reef developed in the area of the towns of Kardjali and Djebel as the limestones were not affected by the wallrock-alteration of the Makedontsi deposit. It is considered that this volcanism took place either in the boundary interval Priabonian-Rupelian or in the very beginning of the Rupelian.

What was coming next is the formation of the **Rabovo latite-andesite and Madjarovo latite complexes**.

The Rabovo latite-andesite complex covered larger parts of the Momchilgrad depression. In the base of its section are deposited ash- and lapilli-tuffs and epiclastics covered by vesicles-bearing lava of latite-andesite and andesite composition. They built the basic parts of the large

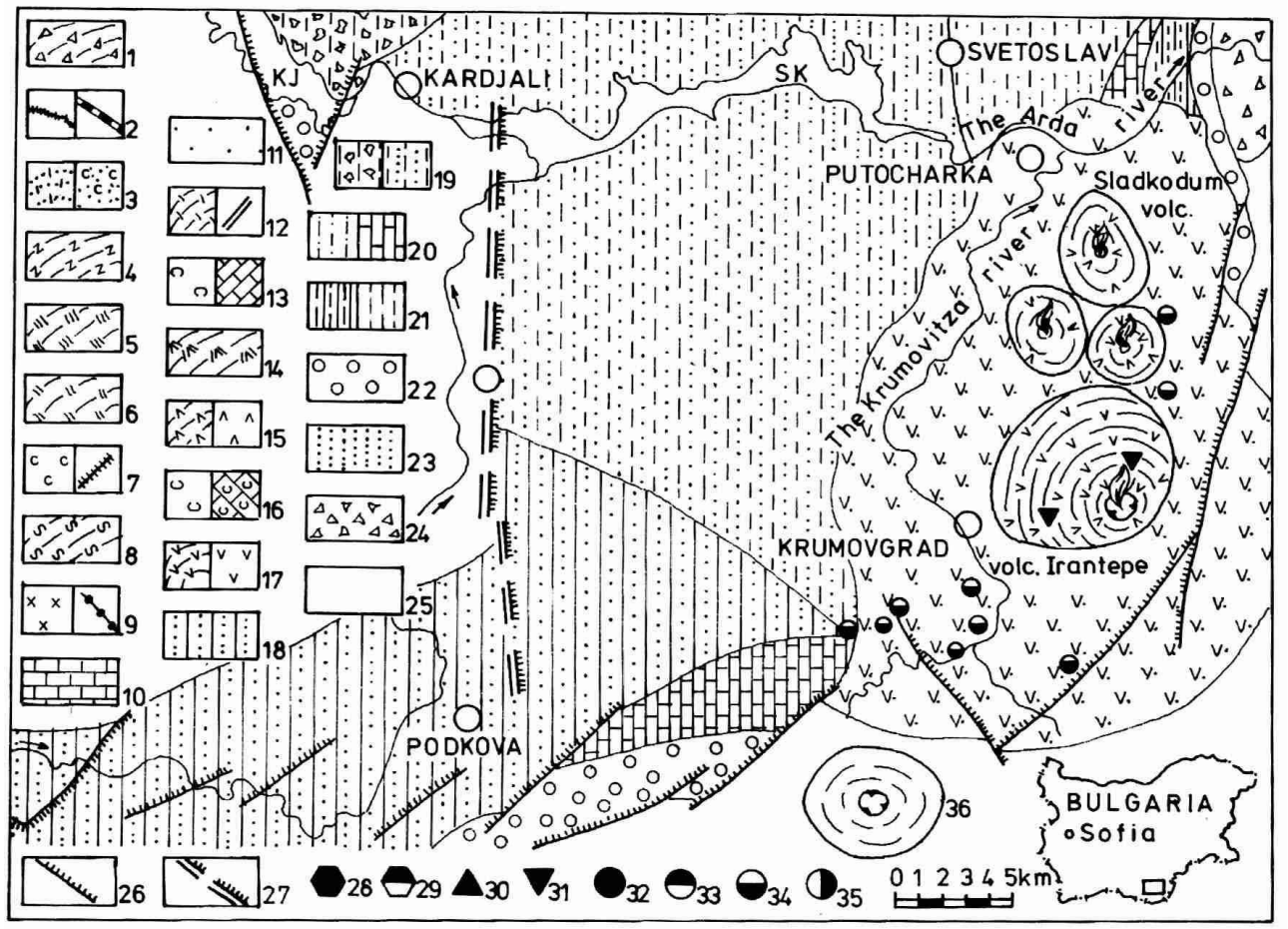

Figure 1. Formation of the Kalabak andesite complex.

Oligocene: 1, 2 - Pcheloyad dyke complex - rhyolite bodies (1), rhyolite dykes (2a), and latite dykes (2b); 3 - Raven rhyolite complex - bodies (3a), tuffs and tuffaceous limestones (3b); 4 - Momchilgrad trachydacute complex; 5 - Ustren rhyolite complex; 6, 7 - Sveti-Ilia trachyrhyodacite complex - bodies (7), tuffs and tuffaceous limestones (7a), dykes (7b); 8, 9 - Zvezdel basaltic-andesite complex – basaltic-andesite epiclastites, lavas and tuffs (8), monzonitoid intrusion (9a), basaltic-andesite dykes (9b); 10 - Stomantsi rhyolite complex - tuffs and tuffaceous limestones; 11 - Djebel Sandstone Formation; 12, 13 - Perperek trachyrhyolite complex - bodies (12a), dykes (12b), tuffs and tuffaceous sandstones (13a), tuffaceous limestones (13b); 14 - Madjarovo latite complex - bodies; 15 - Rabovo latite-andesite complex - lava flows (15a), epiclastites, tuffs and tuffaceous limestones (15b); Eocene-Oligocene: 16 - Beli-Plast rhyodacite complex - tuffs and tuffaceous sandstones (16a), tuffaceous limestones (16b); Paleocene(?)-Eocene: 17 - Kalabak andesite complex - lava flows (a), epiclastites and tuffs (b); 18 - rhythmic sandstone-marlstone unit; 19 - volcano-sedimentary unit - olistostrome packet (19a) and rhythmic packet (19b); 20 - marlstone-limestone unit - marlstone packet (20a), limestone packet (20b); 21 - coal-sandstone unit - lower coal-sandstone packet (21a), sandstone-conglomerate packet (21b); 22 - breccia-conglomerate unit; 23 - Leshnikovo Formation; 24 - Biser Formation; 25 - pre-Paleogene basement; Faults: 26 - normal-slip fault; 27 - Varbitsa fossilized fault; 28 - volcanic cone or extrusion and its magma conduit (vent); Deposits and mineralisations: 29 - bentonite; 30 - perlite; 31 - agate; 32 – quartz-galena-sphalerite); 33 - quarts-Au; 34 - epithermal low-sulfidation quartz-gold-adularia; 35 - quarts-antimonite.

polyphase volcanoes Dambalak, Bivolyane, Sveti Ilia, Studen Kladenets (Ivanov, 1960, 1961) having diameters of about 8-12 km, as well as some smaller satellite monophase volcanoes with diameters up to 4-5 km (Fig. 3).

The Madjarovo complex built a volcano (4-5 km in diameter) located in the Northwestern parts of the Depression - Kartal volcano (Fig. 3). It is a not large satellite edifice of the Madjarovo volcano, developed to the east of the considered area.

Montmorillonite bentonite deposits with kaolinite and halloysite associate with the tuffs of the Beli Plast rhyodacite (Enchets) and Rabovo latite-andesite (Zimzelen, Propast, and Dobrovolets) complexes. Bentonites resulted from the argillization of the tuffs and the bentonite bodies are stratum- or lens-like shaped. According to Atanasov, Goranov (1989) they are of hydrothermal-metasomatic origin. Agate occurrences are related to the vesicles-bearing latite-andesites.

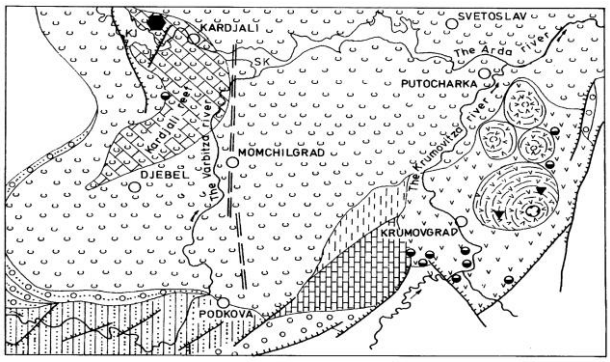

Figure 2. Formation of the Beli-Plast rhyodacite complex. For the key see Fig. 1

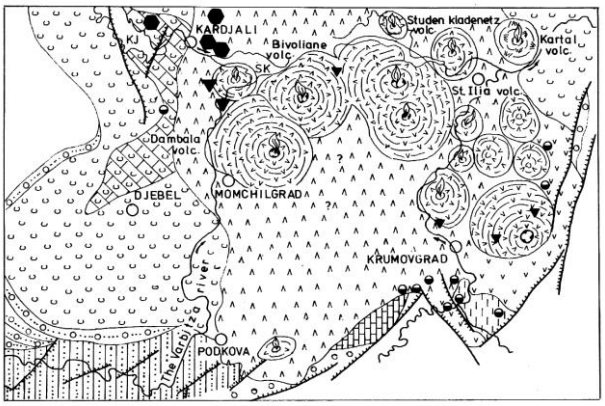

Figure 3. Fformation of the Rabovo latite-andesite and Madjarovo latite complexes. For the key see Fig. 1

Transgression continued. Breccia-conglomerates deposited in the western parts of the Momchilgrad depression (Djebel depression) on the tuffs of the Beli Plast complex and in the base of the Perperek complex.

Various tuffs belonging to the **Perperek trachyrhyolite complex** alternate upward. Several extrusions 3-4 km in size - Kogjadaa, Dyuzkaya, Yumrukkaya (Perperek volcano; Yanev et al., 1968), Hisara, Esberlik as well as an new phase of the Studen Kladenets volcano intruded the northern parts of the depression. Svetoslav reef developed in this area (to the south of the Ibredjek horst) and Sindeltsi reef - in the south parts of the depression.

Perlite deposits and occurrences are related to the rhyolite extrusions of this complex (Goranov, Popov, 1989). They form irregular bodies along the peripheries of the extrusions. Clinoptilolite zeolite deposits and occurrences of volcanogenic-sedimentary origin (Djourova, Aleksiev, 1989) are localized within the acid tuffs of the same complex (Jelezni Vrata, Belia Bair).

The marine basin deepened in the area of the Djebel depression, to the west of the Varbitsa fault (Fig. 4) where the sandstones of the **Djebel Formation deposited** (Goranov, Shilyafova, 1992). In the western parts of the this depression initially deposited epiclastics up to 20 m thick, andesite and latite in composition. They are covered by finegrained sandstones with thin and fast disappearing interbeds of conglomerates, limestones and acid tuffs (epiclastics ?). The thickness of the formation reaches up to 200 m in the central parts of the Djebel depression.

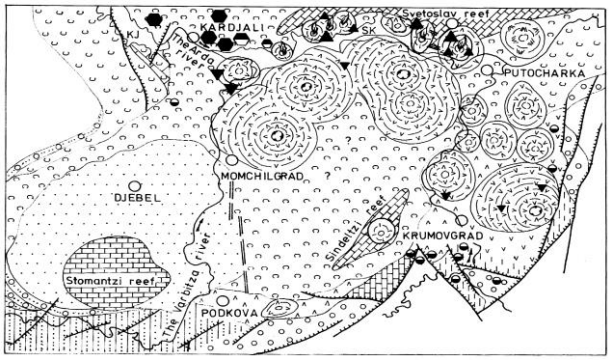

Figure 4. Formation of the Perperek trachyrhyolite complex, deposition of the Djebel Sandstone Formation and Stomantsi rhyolite complex. For the key see Fig. 1

The Djebel sandstones are covered by tuffaceous reef limestones and tuffs of the **Stomantsi rhyolite complex**. Stomantsi coastal reef developed in the southwestern parts of the Momchilgrad depression.

A new violent manifestation of the volcanic activity followed**. Zvezdel basaltic-andesite complex** formed. Zvezdel stratovolcano - the largest volcano in the depression, having diameter of about 15 km, developed. Two new phases of the Dambalak and Sveti Ilia volcanoes generated, as the diameters of the bodies are 8-12 km. They are associated by nearly 20 satellite and parasitic volcanic edifices (Fig. 5).

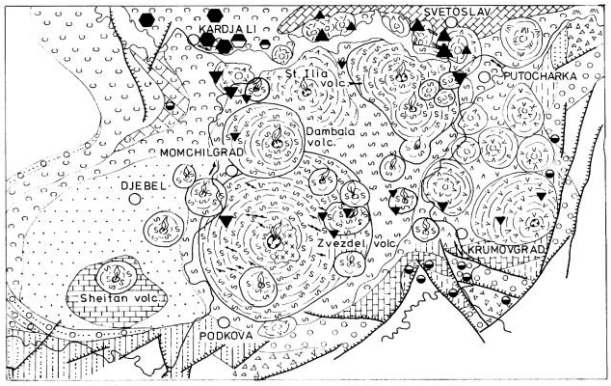

Figure 5. Formation of the Zvezdel basaltic-andesite complex. For the key see Fig. 1

The basal levels of the Zvezdel complex are occupied by pyro- and epiclastics. Effusive facies, represented by lava flows and bodies of andesite and basaltic-andesite composition, prevails upward as andesite varieties are more typical of the lower parts of the section while the upper ones are dominated by basaltic-andesites. The Zvezdel volcano is intruded by numerous basaltic-andesite dykes of the Pcheloyad dyke swarm (Galenit tensional zone; Ivanov, 1960). Zvezdel monzonitoid intrusion and its satellite Metlichka

intrusion are emplaced in the central parts of the Zvezdel volcano.

Some **agate** occurrences associate with the effusive products of the Zvezdel complex.

Several extrusions of the **Ustren rhyolite complex**, up to 3-4 km in diameter, erupted in the westernmost parts of the depression - Ustren, Schupenata Planina, Jaltika, Zli Vrah (Fig.6).

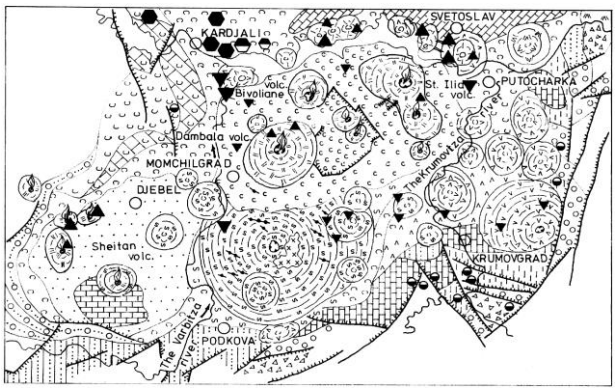

Figure 6. Formation of the Sveti Ilya trachyrhyodacite complex. For the key see Fig. 1

Magmatic **perlite** deposits are localized in these rhyolite bodies (Goranov et al., 1960). The largest perlite deposit is ocated in the Schupenata Planina extrusion cut by a subequatorial fault of current activity, fact giving the name of the rhyolite body (meaning broken mountain).

The **Sveti Ilia trachyrhyodacite** complex was generated next (Fig. 6). Mainly ash- and lapilli-tuffs as well as reef limestones initially deposited. Over them flowed reddish-violet flow-banded trachyrhyodacite lava. 10-12 km sized extrusives emplaced at Sveti Ilia, Dambalak and Bivolyane volcanoes. Several smaller parasitic extrusive bodies erupted on the slopes of these volcanoes. Radially oriented trachyrhyodacite dykes cut the Sveti Ilia volcano.

The **Nanovitsa caldera** originated between the mentioned volcanic edifices probably close to the end of this stage. It has irregular geometry and encloses an area of about 50 km^2. The caldera subsidence resulted from the roof collapse over an underlying magma reservoir that might have been common for the three volcanoes

Some **perlite** occurrences associate with the rhyodacites of the Sveti Ilia complex.

The **Momchilgrad trachydacite** complex was generated next. Lapilli-tuffs and agglomerates are deposited in the base of its section. They are interbedded and covered by trachydacite lava in the upper parts. These products composed a new phase at the Dambalak volcano as well as some parasitic volcanic edifices on the northern slope of Zvezdel volcano (Fig. 7).

Agate occurrences are related to the Momchilgrad trachydacite complex.

The tuffs of **Raven rhyolite complex** are exposed mainly within the Nanovitsa caldera. The base of the section is occupied by tuffaceous reef limestones and the upper levels - by ash-tuffs and xenotuffs. A rhyolite extrusion few km in diameter erupted in the most southern parts of the Nanovitsa caldera (Fig. 8).

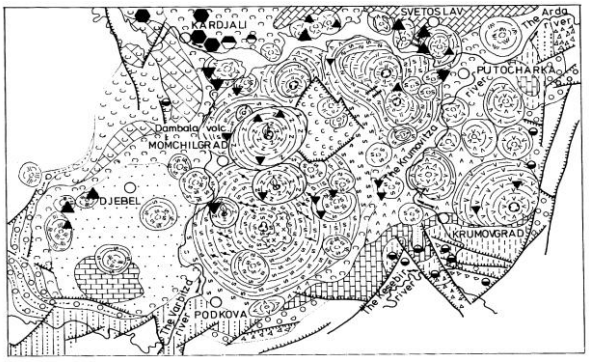

Figure 7. Stage of formation of the Momchilgrad trachydacite complex. For the key see Fig. 1

RUPELIAN-CHATIAN

The magmatic activity terminated with the emplacement of subvolcanic bodies and dykes of the **Pcheloyad dyke complex**. They are part of the Pcheloyad dyke swarm trending to WNW, about 25 km long and nearly 10 km wide. Several parasitic extrusions having diameters of 2-3 km are located on the slopes of Zvezdel volcano (Fig. 8).

The formation of the **quartz-gold-polymetallic Zvezdel-Pcheloyad ore field**, both spatially and genetically is related to the latest products of the Zvezdel volcano. The ore bodies are mainly of vein type. Stratiform metasomatic bodies are also formed within the sediments and the metamorphic basement (limestones and marbles) underlying the volcano. A horizontal zonality that is an element of the dome-like hypogenic zonality (Breskovska, Gergelchev, 1988) can be observed in the distribution of the mineral paragenesis. Quartz-galena-sphalerite deposits and mineralizations are formed in the central parts of the ore field while along the periphery these are quartz-gold-polymetallic. Polymetallic deposits of no economic significance are typical of the areas still farther from the volcano.

Chernichevo antimonite deposit as well as some polymetallic occurrences formed in the metamorphic rim of the Momchilgrad depression.

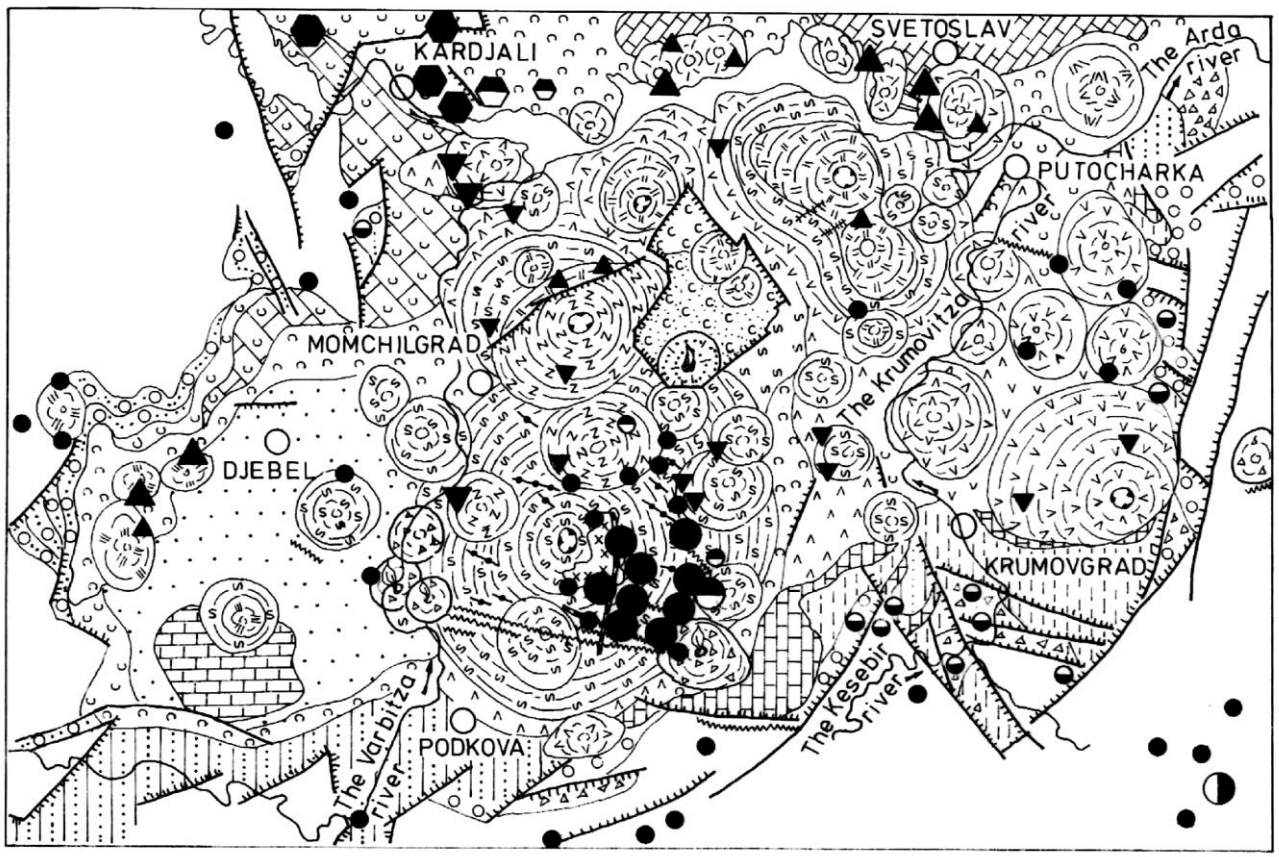

Figure 8. Stage of formation of the Raven rhyolite and Pcheloyad complexes. For the key see Fig. 1

CONCLUSIONS

The volcanic activity in the Momchilgrad depression took place in shallow marine basin as the volcanic cones are islands. Coral reefs often grew up around them as well as along the periphery of the basin. The tuffs of the Beli Plast rhyodacite and Perperek trachyrhyolite complexes deposited chiefly within the basin and are absent on the slopes of the large volcanic edifices.

A counter-clockwise migration of the magmatism can be noticed within the Momchilgrad depression (Fig. 1-8). The Irantepe, Sveti Ilia, Bivolyane, Dambalak and Zvezdel volcano successively formed. The Nanovitsa caldera, filled with the tuffs of the Sveti Ilia trachyrhyodacite and Raven rhyolite complexes, collapsed in the middle between them.

Deposits and occurrences mainly of non-metallic mineral resources (perlite and zeolites related to acid phases, agates - to intermediate phases, and bentonites) formed in the northwestern parts of the depression. Chiefly metallic ore deposits - quartz-gold-adularia (within the Paleocene and Late Eocene sediments) and quartz-gold-polymetallic (related to Zvezdel volcano) are typical of central and southeastern part of the depression.

The connection between metallic mineralization and volcanic activity from the peripheral parts and the rim of the depression is more distant and unclear. Although they probably resulted from one ore-magmatic system. Some polymetallic ore mineralizations associate with not-large, relatively isolated volcanic edifices, as for example Jaltika.

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