The role of ground and underground waters in evolution of the ring structure of Jastrebac Mt.

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Abstract: Ring structure of Jastrebac Mt. represents a dome that is built from Cretaceous-Paleogenic sediments. In the central part is a granodioritic intrusion with hornfels on the border of it. Hornfels are a product of contact metamorphism. The genesis of ring structure is explained by intensive erosion and circulation of underground waters.

Key words: ring structure, hydrogeological conditions, Jastrebac Mt., erosion.

Introduction

Conventional explanation of a ring structure genesis is volcanic activity. The ring border as a rule represents a caldera rim. In central depression lava flows and pyroclastites occur. Volcanic morphology reconstructions, based on the relics of morphological forms associated to genesis were already successfully performed in Tertiary volcanic terrains of Vardar zone. Detailed information about this can be found in: Marković and Pavlović (1976), Marković (1971), Pavlović (1990). Shallow intrusion morphologically is most expressed as a cupola shaped structure, with the central part higher than its brim. Available geological documentation presents the Jasterbac ring structure as a dome. In its centre a granodioritic body has intruded. The intrusion is followed by many crescent dykes, encircling the dome centre. Central part of the structure today represents a depression, with brim defined with sharp, continuing circular crest. Existence of the ring structure is detected by analysis of satellite images and confirmed by stereoscopic investigation of aerial photos and by quantitative analysis of topographic maps. Formation of the ring, instead a cupola shaped structure in the Jasrebac Mt. area, an inversion of relief, i.e. formation of the deep depression in the ring centre and opening of intrusion, demands an explanation. Grounds of phenomena were researched in the mechanism of intrusion and in specific characteristics of geological composition and hydrogeological characteristics of formed environment.

Morphology and hydrogeological characteristics

The structure is located on the northern side of the Veliki Jastrebac, some 17 km to the south from the town of Kruševac (Serbia). Ring structure of the Jastrebac Mt. presents the Landsat satellite image (Fig.1). Structure has circular shape, slightly elongated in NNW-SSE direction. Its diameter is approx. 5,5 kilometers. Arc like ridges, connect the highest tops of the mountain. The rim altitudes vary from 800 to 1360 meters. Morphology of the structure illustrates the computer-generated block-diagram, based on data of quantitative analysis of topographic map (Fig.1). Central part of the structure is significantly lower. In vast depression is the spring of the Lomnička River. Drainage network in the middle of structure has high density. The Lomnička River tributaries have springs just below the structure rim. Assembling towards centre, the streams make a centripetal drainage pattern. The Lomnička River penetrates the brim of cen-

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tral depression NW from the Ravnište locality, where the lowest altitude of ring structure was registered (460 meters). In central depression, the river has deeply incised valley, with steep sides. Out of the structure its valley becomes wide, with gentle slopes.

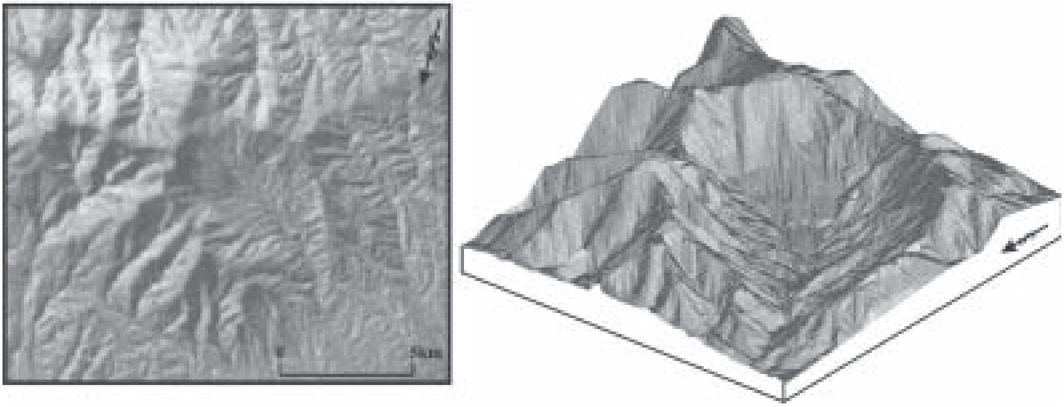

Figure 1. Satellite image (left) and block-diagram of Jastrebac Mt. ring structure (right)

The inner sides of the Jastrebac Mt. ring structure, just below the rim, are very steep. Going towards to bottom of depression, slopes become more moderate. The outer slopes of the structure are gentle. Their radial, centrifugal drainage pattern is typical for an area of young uplifting. In the area of Veliki Jastrebac, where the ring structure has been detected, the climate is alpine, with cool summer and very cold winter. On the basis of five-year observation, an average sum of precipitation per year is registered (1041 mm in ring structure area, in the pluvial station of Izvorište (SAVIĆ, 1996)). For stations that are radially disposed around Jastrebac Mt., significantly lower amount of precipitations are registered, for the same period of observation. According to data of Republical hydro meteorological institute of Serbia, those sums are between 539 mm/year (Prokuplje), 601 mm/year (Kruševac) and 636 mm/year (Blace).

GEOLOGICAL COMPOSITION AND HYDROGEOLOGICAL CATEGORIES OF THE TERRAIN

Structure in general represents the dome composed from Cretaceous to Paleogene sandstones, conglomerates and shales (Fig. 2). In the dome centre a granodiorite body is intruded. Along the edge of the intrusion hornfels rocks occurrences as a product of a metamorphism were registered. Many crescent dykes, encircling the dome, follow intrusion (RAKIĆ ET AL., 1974). South-western intrusive border makes young regional fault striking in NW-SE direction. Along this rupture granodiorite contacts Lower Paleozoic schists. Granodiorite intrusion in Upper Cretaceous and Paleogene sediments took place in the Eocene and Oligocene boundary. According to its shape, the granodioritic body is laccolite. Coarse grained and fine-grained fractions of granodiorite are distinguished. Coarse-grained fraction makes the central part of intrusive body. It is located in the middle of the ring structure, with the lowest altitude. Fine-grained granodiorite makes a narrow belt at the periphery of laccolite. At the intrusive contact with the older units metamorphic rocks appear. Metamorphic process has produced from pelitic sediments hornfels rocks. Low-crystalline schists of Lower Paleozoic have suffered contact metamorphosis only in the narrow zone around granodiorite. Geological composition of ring structure has termed the formation of various types of aquifers. The type of aquifer that would be formed is under direct dependence of porosity type of lithological members that participate in geological composition of the researched area. According to dominate porosity type and formed type of aquifer within it, there are three hydrogeological categories of terrains.

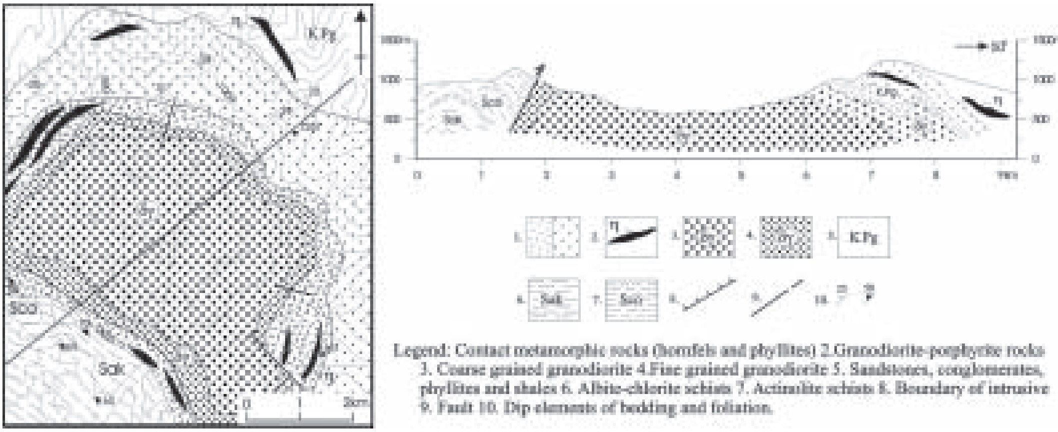

Figure 2. Geological map (Rakić et al., 1974) and cross-section

The first hydrogeological category of terrain makes rocks with intergranular porosity. Disintegrated granodiorites, deluvial and proluvial sediments, as well as alluvial sediments fall in this category. Granodiorite, when is exposed to atmospheric water, is highly liable to disintegration. The process of surface alteration, turns the compact and wholesome rock into the lax and incoherent rock. We must emphasize that disintegration of coarse-grained fraction as compared with fine-grained fraction is more intensive. Disintegrated granodiorites can be in situ for a long period of time. Depth of disintegration of granodiorite is in range of meters to decameters. For that environment is characteristic intergranular porosity. Numerous types of compact aquifers are formed in here. Most of them are slightly munificence. Disintegrated granodiorites are most often transported by deluvial and/or proluvial processes from his original place of genesis. On the inner side of ring structure, especially on the places with gentle slopes, wide deluvial and proluvial sediments have been formed. They are characteristic for compact type of aquifers and poorly munificent.

Disintegrated granodiorites either in situ or as proluvial and deluvial sediments, represents good environment for water accumulation. Influence of that water is huge for intensifying of further granodiorite degradation, which is located below the deposit. Degradation of wholesome rock enlarges the intensity of erosion, which also deepens the ring structure. Enrichment of compact type of aquifers is performed by infiltration of atmospheric water and by occasional streams, and drainage is performed by numerous, most often occasional springs and seepage springs. The second hydrogeological category of terrain presents cracky hornfels. Fissure porosity is formed in them. This porosity type is not universally expanded in contact aureole, concerning that not all hornfels are equally cracky. In hydraulically related fissure systems, the aquifers are found. Hydrogeological collectors in cracky hornfels have extreme power of accumulation, retardation and deprivation of underground waters. Suitable conditions contributed in genesis of fissure type aquifers with significant dynamic reserves of underground waters. Drainage of those aquifers is made through streams that occur on the inner side of contact aureole. Streams are located high above the bottom of depression. That water launches and transports already disintegrated granodiorites in the lower parts of ring depression. That water also contributes in stability of flow of River Lomnica, which represents the erosional basis for all courses in the ring structure.

Contact, non-cracked hornfels and fine-grained granodiorites fall into the third hydrogeological category of terrain. They are erosion resistant due to their mineralogical and structural features. Because of that, they build the top parts of the ring structure brim. These rocks have a big role in morphological development of ring structure. Infiltration of atmospheric and groundwaters in this zone is very small, so it is considered that the zone is practically, without aquifers. The biggest part of water drains on surface, and rocks represent hydrogeological basement and lateral barrier to fissure and compact types of aquifers.

EVOLUTION OF RING STRUCTURE

During Neogene's granodioritic intrusion, the overlaying sediment and metamorphic rocks were uplifted and positive structure, most probably, cupola shape, was formed. Top, cuplike of the structure has suffered the strongest tension. As a consequence a lot of joints were formed. They made a suitable predisposition for erosion. Border zone of the intrusion, created by contact metamorphism and built of hornfels rocks, is very hard and more resistant to the erosion than granodiorite. By intense erosion, on the surface and along numerous fissures, intrusive is opened in the centre of the structure. Hornfels built rim of the structure became hypsometrically higher than its centre. Since then, the moving of all ground waters and effluence of a part of underground waters from fissure aquifers started, towards the central part of the structure. With opening of the central, top part of intrusive body, erosion started even more in the centre. Coarse-grained granodiorite is less resistant than fine grained. The result was central depression deepening. Physical-chemical disintegration of granodiorite was intensified and huge deposits were formed. Circulation of water along fissures was also intensified. Environments with various types of porosity were differentiated. That way, cupola shaped circular structure gained characteristics of a ring structure. Evolution of fluvial process conditioned the penetration of River Lomnica at the lowest part of ring structure brim. Permanent streams in the inner side of the ring participate in River Lomnica's energy. River Lomnica represents erosional basis for courses within the structure. Great part in it surely had an intensive descending of Rasina valley, as a local erosional basis for Lomnica River.

CONCLUSION

Ring structure of Jastrebac Mt. represents direct morphological expression of Neogene's granodioritic intrusion in Upper Cretaceous to Paleogene sediments. By intrusion, the dome structure was formed. Top, cuplike part of the structure has suffered reinforced erosion. Erosion was the strongest in the central parts along fissures. Shallow intrusive was opened. Contact-metamorphic aureole and fine-grained granodiorite were at the rim of the intrusion. Since they were resistant rocks, they formed the ring around the central part, made of coarse-grained granodiorite. This central part suffered strong erosion and significant metamorphosis. By formation of deep depression in the middle, all the streams flow towards centre. Beside suitable geological conditions big influence for formation of such an extraordinary structure for intrusives, have microclimate and hydrogeological characteristics of the area.

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