ENVIRONMENTAL GEOLOGY OF THE STRANDJA PARK, BULGARIA

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Abstract: The "Strandja" National Park is one of the unique natural-architectural reserves in SE Europe with protected endemic and relict Mediterranean and European flora and fauna. The investigated territory has been a centre of ore mining and metal processing since the Eneolithic till now. The emphasis in this work is laid on the impact of mining activities on the geological environment.

Key words: environmental geology, natural-architectural reserve, Strandja

The "Strandja" National Park is situated on an area of 116 132.6 hectares together with five reserves. Tertiary relicts have been preserved here as: *Fagus orientalis* and *Quercus polycarpa* from the forest cenoses, *Rododendreon ponticum*, *Laurocerasus officinalis*, *Ilex colchica* and many others from the shrub forest species as well as many species of protected Mediterranean and European flora. Regardless of the global paleogeographic and paleoecological changes during the Neogene and the Quaternary, the following fauna relicts have been established here: reptiles (*Boidae*, *Erycinae*, *Eryx*, *Pyphlops vermicularis*), terrestrial snails (*Zebrina*, *Chondrula*), spiders (*Tegenaria bithynae*) and others. The rare species are about 180 invertebrates, 10 underground endemic fauna species, snakes, insects, amphibians, etc.

It is typical for the investigated territory that mining and ore processing activities have been developed since the Eneolithic till now for the output of copper, gold and especially non-metallic and rock lining materials. Mining has exerted direct and indirect influence on the disturbed integrity of the natural ecosystems. Numerous ancient and contemporary small and big surface and underground mines and quarries have been preserved. At the present stage under the conditions of the economic changes in Bulgaria it is necessary to take up the responsibility of maintaining the delicate balance between man and nature.

During the time of the Eneolithic (3000 B.C.), copper, iron and gold were obtained mainly by open-pit (quarry) methods or by means of open shafts with short galleries. The ore was processed and melted and the site. The marble extracting for monument construction dates

back to Thracian times. The quarries in the Soushitsa River valley are remains from this period. About 55 ore mines for copper and iron output have been preserved in the region of the Malko Tarnovo town. These are surface and underground mines. There is also accumulated slag from the ore-melting furnaces, which had been operated since Thracian times till 1878. The old mines are not deep (several tens of meters). Almost all mines were filled with water, which was an obstacle for the ancient pitmen. Only sections with rich metal content were operated. The iron content in the region of Malko Tarnovo is 50-63 % and of copper – 3.3 %. The wastes from the mines were deposited in immediate proximity or at the Black Sea coast. They occupy vast spaces of the terrain – up to 1.5 km^2, the height being up to 3 m. The ore veins are established both in the endo- and exo-contact zones of the Upper Cretaceous – Paleogene plutons or in the ore-bearing karst. The oxidation zone is more than 10 m thick. The sizes of the ore quarries were significant – for example, there are several quarries near the town of Malko Tarnovo with sizes 150 x 100 and 115 x 60 m. Systems of old furnaces have been preserved near ancient towns have been preserved in the region of the "Strandja" Park. A whole metallurgical centre for copper output has been preserved on marbles in the western part of Malko Tarnovo. It represented a system of Etrurian or Cyprian rectangular furnaces with sizes 2.5 x 2.0 m. The chemical composition of the slag is also with high iron (more than 50 %) and copper content (3.3 %). Terrain subsidence is observed in the relief (100 x 60 m) above 13 ancient workings with inclined and lateral galleries in the Malko Tarnovo region (Georgiev, 1987). Iron slag had been established in the Zabernovo village region that was obtained from the remelting of hematite mass from Thracian times. The ore-bearing is contact-metasomatic one and contains magnetite and hematite and magnetite sands from the weathered crusts.

The output of rock lining materials in the region is significant since Thracian times till now. Marble, marble breccia, andesite, andesite breccia, tuff-breccia, latites, etc., were obtained, which were used for constructing fortresses, dolmens, sepulchres, palaces, temples, residence foundations, road covers, etc. More than 20 dolmens have been preserved on the "Strandja" Park territory, built of rocks from the local mines. Fore of them have been proclaimed to be cultural remarkable sites and date from X-VIII century B.C. (the Granichar and Belevren villages).

The same mineral resources as those obtained in ancient times are produced now in open-pit and underground mines. The whole oxidation and reduction zone is technologically exploited (Bogdanov, 1987). The deposits are of the vein type (copper-gold-polymetal) and copper-molybdenum-iron ore bodies of pocket, vein and vein-injection character. Their length

reaches up to 250-300 m and their thickness – up to 30 m. Workings for the output of placer gold have been found in the coastal zone and along the river valleys.

The processes of mining production have not only led to the mine formation but also to continuous increase, in historic plan, of the terrains with direct and indirect impact on the environment, including geomechanical, hydrological, physical-mechanical-chemical and other impacts on the geological environment. The mining activities have caused:

- decreased amount of the natural resources, changes in the natural stress-strain state of the rock complexes, pollution of the Earth's bowels, development and activation of karst processes;
- decreased reserve of surface and ground water, disturbances in the hydrological and hydrogeological regime of the water basins and the wholesome geodynamic balance in the region, aggravated water quality;
- air pollution;
- disturbances in the natural relief and creation of a new one of the technogenic type;
- entire or partial annihilation of the soil within the range of the mines and in their immediate proximity, decreased productive areas for agriculture and forestry, aggravated soil quality (grade), soil pollution, enhanced soil erosion;
- disturbed habitat conditions, migration, reduction and annihilation and reduction in the productivity and reproduction capacity of the of the flora and fauna;
- social-ecological problems for the population.

Except for the direct impact, the mining activities exert unfavourable effect by means of the related industrial branches (Table 1).

The performed complex assessment of the impact of mining on the environment and first of all – on the geological environment, is important for preserving the integrity of the unique natural-architectural "Strandja" reserve.

Table 1. Comparative assessment of the unfavourable impact of the mines, metallurgy (historical) and the related with them industrial branches

Industrial branches	Impact on								
	Geological environment	Relief	Soils	Climate	Flora and fauna	Water basins		Landscape	Man
						surface	ground		
Mining	S	S	S	M	S	S	S	S	M
Metallurgy (historical)	N	W→M	M	S	M	S	W	W	S
Power generation	N	W	S	M	S	M	W	M	M
Construction	W	W→M	M	W	W	W→M	W→M	M	M
Transport	N	W→M	W→M	M	W→M	M	W	W	M
Agriculture and forestry	S	S	S	M	S	W→M	N→M	S	W

N – no unfavourable impact

W – weak impact

M – medium strong impact

S – strong impact

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