THE VELENJE MINING METHOD
INTRODUCTION

Velenje Coal Mine is a technologically highly-developed company, strongly integrated in the Slovenian energy industry and environment with its more than 135-year tradition of lignite mining. One of the thickest lignite seams in the world has spurred the development of innovative mining methods. The first beginnings of longwall faces appeared in 1947, while an extensive introduction of longwall faces began in 1952. By continuous research this method has undergone various technological improvements and is still being developed and improved. The Velenje mining method (VMM) is an internationally protected patent that has been proven to be the most effective method for extracting thick coal seams. In 2007, Velenje Coal Mine received a special reward from the Slovenian Chamber of Engineers for the innovative approach to engineering. Today, the method is producing enviable results, placing the coalmine in the global forefront of underground coalmining.

Figure 1. Longwall operation in Velenje Coal Mine.

GEOLOGICAL STRUCTURE OF THE VELENJE COAL MINE REGION

The Velenje Coal Mine region lies in a synclinal valley, which is a depression between the Smrekovec and Šoštanj fault. It is a lignite deposit, formed during the Pliocene era. The depression is meshed with local faults from different ages and runs in different directions. The present valley has been formed by subsiding and simultaneous backfilling. The coal deposit is lens-shaped, 8.3 km deep and 2.5 km wide, with a thickness of more than 170 m and a depth from 200 to 500 m. The deposit is closest to the surface on the edges and deepest in the middle. From the geomechanical point of view, the strength and rigidity of the lignite layer is much higher than the materials in the hanging wall and in the footwall of the deposit. This fact is important, both for planning excavations as well as for designing the most suitable excavation method, which needs to be adapted to the natural geological and geomechanical conditions. Also, the caving-in of the materials in the adjacent hanging wall is different from the subsiding hanging-wall layers lying above, where clay and silt layers are first plastically reshaped, while the layers situated higher up are bent and subsided to the surface, where large depression lakes have been formed as a consequence of the mining activities.
DEVELOPMENT AND CHARACTERISTICS OF THE VELENJE MINING METHOD

The Velenje longwall mining method was developed on classical coal faces equipped with friction legs and iron beams. Low performance, strenuous physical work and high production costs required an accelerated development of mining equipment and technology. At the beginning of the 1970s, Velenje Coal Mine began an intensive development of the equipment for mechanised work at longwall faces. A number of hydraulic support systems were tested. Initially, load-carrying hydraulic support systems were mainly tested. Due to their properties, the results were not very satisfactory.
Another step was to develop new, carrying and shielding, hydraulic support systems, adapted for the exploitation of coal using the Velenje mining method. A true revolution in the support system development was represented by the hydraulic support system with a conveyor sitting on a base, lemniscate-guided shield, an option of total control (prevention) of caving-in in the footline section and electro-hydraulic control system.

The entire longwall excavation process is based on the consideration of natural characteristics, provision of adequate safety and the prediction of impacts on the environment. The basic approach of mining using the Velenje mining method is that we extend the coal extraction area also above the protected area at the face. This includes exploitation of natural forces for breaking and crushing the seam. With the use of modern mining equipment, especially the hydraulic support system and advanced chain conveyors, the concept of developing the pits of Velenje Coal Mine will be based on a lower number of wider longwall faces.

According to Velenje mining method a coal face is divided in the footline section and the hanging wall section. The footline section is 4 to 5 m high and secured by the hydraulic support system which allows mechanised exploitation by using excavation machines - shearer loaders and the conveyance of coal by using efficient chain conveyors. The hanging wall section, measuring 5 to 17 m in height, is exposed to dynamic stress conditions which cause the crumbling of the coal layer; the crushed coal is then poured onto the conveyor and promptly transported to the surface.

![Figure 4. Excavation scheme of semi mechanised VMM in use 1950 - 1988.](image-url)
The allowed face height at the longwall depends on the thickness of clay insulating layers in the hanging wall, which protect the face from the inrush of running sand and water. Following the criteria of “Safe mining below water bearing strata at Velenje Coal Mine” the allowed working height is calculated according to preliminary stated variants.

The layer of clay and coal which break in the gob and in loose up the excavated, depending on the depth and the speed of face retreat. The greatest height of caving-in occurs close behind the face. The working height is determined by the analytical working of mass volume of the caved material, and is confirmed by in situ researches.

**Figure 5.** Excavation scheme of VMM in use till 1991. | **Figure 6.** State of art excavation scheme of VMM.
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TECHNICAL AND TECHNOLOGICAL PARAMETERS OF THE VELENJE MINING METHOD

By using the Velenje mining method, coal excavation can be fully mechanised, certain phases can even be automated. If natural factors of crumbling of coal in the hanging wall section are successfully integrated, the method provides a base for high productivity.

Parameters and average results of exploitation using the Velenje mining:
• face length: more than 200 m
• face height: 5 - 17 m
• face advance: up to 9 m/day
• daily production from one face: more than 16,000 t/day
• longwall face productivity: up to 70 t/m/day
• longwall face efficiency: up to 160 t/working day
• annual production: 4 million ton/year (max. 5.1 million ton in the year 1985)
### The Most Effective Method for Extracting Thick Coal Seams

<table>
<thead>
<tr>
<th>Metric</th>
<th>Description</th>
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<tbody>
<tr>
<td>33,000 ton</td>
<td>Largest daily production from coal faces (11/09/1997)</td>
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<tr>
<td>16,800 ton</td>
<td>Largest daily production from one coal face/sublevel method (28/07/2005)</td>
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<tr>
<td>10,192 ton</td>
<td>Largest daily production from one coal face, advanced with shearer cutting method (06/07/2010)</td>
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<tr>
<td>8.6 m</td>
<td>Highest daily advance with shearer cutting method (31/05/2010)</td>
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<tr>
<td>23 sections/day</td>
<td>The highest number of sections dismantled in one day from one coal face (23/06/2005)</td>
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<tr>
<td>2,320,514 ton</td>
<td>Record production from one coal face (the face operated for 236 days)</td>
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