The Thurzó canal: a XVIth century aqueduct from Baia Mare (Maramureș, Romania)

Alexandru MUREȘAN(1), Traian MINGHIRAȘ(1), Dragoș CONȚIU(1) & Tudor TĂMAȘ(1,2)

(1) Montana Caving Club, Oituz 8A/15, 430202 Baia Mare, Romania, murialex@gmail.com, traian_minghiras@yahoo.com.au, dragos.contiu@gmail.com

(2) Babeş-Bolyai University, Dept. of Geology, M. Kogălniceanu 1, 400084 Cluj Napoca, Romania, tudor.tamas@ubbcluj.ro (corresponding author)

Abstract

Built between 1505 and 1515 by János and György Thurzó, the Thurzó canal was designed for the development of mining in the "Nagyverem" lode from Baia Mare. The canal supplied water for pumps used to remove minewater from the lower levels of the mines. The aqueduct was reportedly 16 km long, containing the “canal" and 26, 29 or 35 tunnels, according to different sources. Additional water was provided by three dammed reservoirs. The project was abandoned after János Thurzó’s death. The canal was put in use again in the 1st half of the XIXth century, until the beginning of the XXth century. Here we present the results of our research on the present-day Thurzó canal. In correlation with historic references and cartographic documents, we surveyed all the extent of the aqueduct and the annex reservoirs, measuring surface sectors dug in solid rock to depths of down to 7-8 m. The measured length of the canal is 11.8 km, of which a 1.48km sector was destroyed during road construction. So far 10 tunnels have been identified and all entrances are presently collapsed. Two tunnels have been reopened and surveyed in detail, while work continues at several others.

1. Introduction and historical perspective

Situated in NW Romania in Maramureș County, the city of Baia Mare is an ancient center of extraction and preparation of gold and silver ore (Fig. 1). Mining interests were the main reason for the establishment and development of the city in the XI-XIVth centuries, when the region was ruled by the Arpadian dynasty, the first kings of Hungary, who settled there German colonists (SZELLEMY 1896, BALOGH & OSZÓCZKI 2011). The first document attesting the city dates from 1327, when its name was “Zazarbánya”; in 1329, it is mentioned as “Rivulus Dominarum” (River of the Ladies), said to be included in the dower of the queens of Hungary (SZIRMAI 1809, MERUȚIU 1938).

Figure 1: Location of Baia Mare in NW Romania. The Thurzo canal was built north from the city.

Gold and silver extraction in Baia Mare during the medieval times had arguably its maximum extent in the second half of the XVth century, more precisely in the reign of Matthias Corvinus (PAULINYI 1936). The most productive area, known as “Nagyverem”, was situated at the N limit of the city, in the “Cross Hill” (Dealul Crucii (Ro), Kereszthegy (Hu), Kreuzberg (De)) (Fig. 2). The amount of ore extracted decreased significantly towards the end of the century, due to the depth reached in the extraction shafts and to the impossibility to extract the floodwater with the technology available (BRADOFKA 1896, BALOGH & OSZÓCZKI 2011). The “Thurzó canal” was built between 1505 and 1510, when part of the mines in Dealul Crucii were managed by János Thurzó de Bethlenfalva and his son György (WENZEL 1880; PAULINYI 1978). J. Thurzó was granted the use of the mines by king Ulászló the 2nd, together with a tax exemption (WENZEL 1880, PAULINYI 1936, BALOGH & OSZÓCZKI 2011) and he managed to put in place a system of minewater removal, permitting extraction to a depth of 152 m under the local base level. Water extraction was performed either with a chain pump (Bulgenkunst) (AGRICOLA 1556, *in* PAULINYI 1978) or with a flatrod system (Stangenkunst) (KOSZTKA 1869). The water needed to activate the pumps was supplied through an aqueduct (Fig. 2) connected to three dammed reservoirs (KOSZTKA 1869, BRADOFKA 1896, BALOGH & OSZÓCZKI 2011). After J. Thurzó’s death in 1508 and when the tax exemption expired, the project was abandoned and in the autumn of 1566 the crushers, the smelter and the mining equipment in the city were destroyed during a siege (BRADOFKA 1896, BALOGH & OSZÓCZKI 2011). The canal was again put in use during the 2nd half of the XIXth century (1860-1865), when using hydraulics to remove the minewater excess was considered a practical solution, this time by using a water column pumping installation (KOSZTKA 1869). The canal was reportedly in use for 70 years, until the 1st half of the XXth century (KACSÓ *et al*. 2011).

2. Methods and purpose of the study

Although the water supply system was built 500 years ago and its purpose was known (of) locally for a long time, there is, to our knowledge, no recorded map of its extension, nor is there any survey of the tunnels. Information about the length of the canal and the number of tunnels differs between various authors: BRADOFKA (1896) mentions that the canal was 16 km long with 29 tunnels, SZELLEMY (1896) mentions a length of 25 km with 35 tunnels, while PAULINYI (1978) counts 26 tunnels. The latter seems to be closer to the present-day situation, as he cites György Thurzó's correspondence.

We have started the present work with the aim to identify the canal sections and the tunnels, to survey their present extent and to gather other relevant information available.
Surface measurements have been done with a Garmin GPSMAP 62s, tape and DistoX, and up to now two tunnels have been surveyed with a DistoX and PDA, using the Pocket Topo software. The correlation of GPS data and cartographic data was done using available GIS applications and the STEREO70 (EPSG3844) national projection system. Tunnel excavation and sampling are ongoing.

3. Results

We identified the Thurzó canal along its whole extension, starting from the main water collector at the Romană brook downstream to tunnel 10 in the Cross Hill (Fig. 2). Of the total measured length of 11.8 km, a 1.48 km sector was destroyed in the emplacement of county road DJ183 (*Imașului street*) during the construction of the Firiza Dam (1960 - 1964), the rest of 10.35 km being relatively easy to identify. Presently the canal contains 21 paved sections, 10 sections dug in bedrock and 10 tunnels (Fig. 2).
At the beginning, a short section of the canal was dug on top of sedimentary rocks (Palaeocene shales and sandstones and Holocene deposits), but for most of its length it crosses Pannonian (Upper Miocene) quartziferous andesites, lava flows and associated pyroclastic deposits (BORCOŞ *et al.* 1981).
Paved sections comprise 8098 m and have the largest extent of the aqueduct. The longest sector of this type is 1405 m long, while the shortest has 18 m. Excavations in 3 locations along the canal route have shown that the paved sections are trapezoidal, with a depth between 60 and 90 cm, base of 30 – 40 cm and the upper part between 70 cm and 1m. These canal sections are paved with andesite blocks on the sides and the bottom. KOSZTKA (1869) mentions that clay was used to fill the spaces between the andesite blocks to minimize water loss through infiltration.
Sections dug in bedrock comprise 717 m and have triangular or trapezoidal section. The depth of these sections is considerable, having to reach the level required to provide an optimum slope for the canal. Sector 4 (158 m) is the longest one surveyed, with cross-sections 7 m deep, 2-3 m wide at the base and 12-15 m at the top.
Tunnels have a total estimated length of 1574 m and their location is usually marked by the presence of a ditch dug in the hillside until stable bedrock was reached. The length of the tunnels with no present access was estimated as the crow flies either from the GPS locations of their presumed entrances, or through surface surveys connecting the locations of the entrances, marked by a little depression caused by breakdown. A length of 330 m for tunnel 10 was obtained by geo-referencing the maps with the mine in the Cross Hill (BRADOFKA 1896). The longest tunnel is no. 9 (580 m), while the shortest is no. 1 (21 m) (Fig. 2).
Three types of funnel-like depressions were identified on the ridges traversed by the tunnel, marking collapse that possibly blocks the tunnels (Fig. 3): a) on the slopes in the vicinity of the entrances, a few meters above the tunnel entrances (at most tunnels) b) in torrential valley beds above the route of the tunnels – where erosion adds up to collapse causes (tunnels 3 and 4); c) on top of the ridges crossed by the tunnels, where they represent shafts dug for tunnel ventilation or possibly for ore extraction (tunnels 3 and 6). Whatever the reason for their emplacement, they provided access for the meteoric water and accelerated weathering and subsequent collapse, as found in tunnel 6.

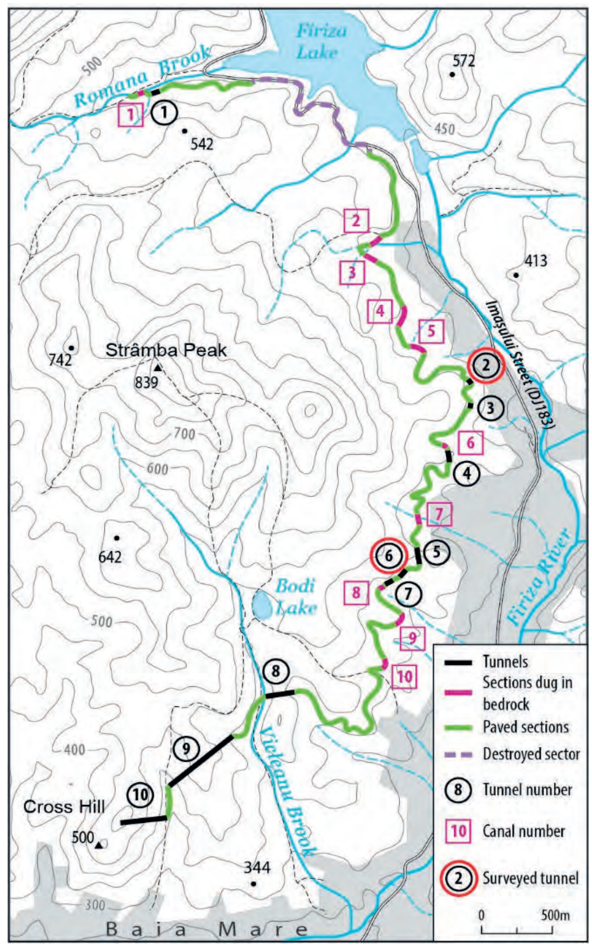

Figure 2: The extent of the Thurzó canal north of Baia Mare with the various sections shown

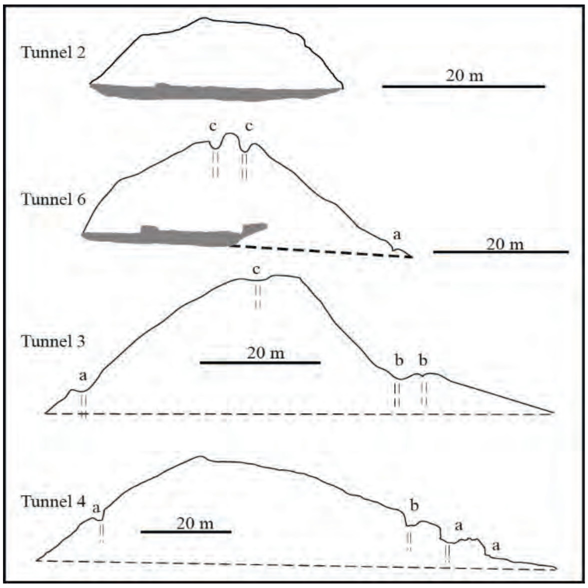

Figure 3: Profiles of tunnel sites with surveys and tunnel directions. a, b, and c mark depressions described in the text.

Tunnel 2, 27.6 m long, opens up in the N half of the canal, crossing a small ridge right after a long paved section, and is the only one that can be accessed from both ends (Fig. 4). Due to its position on the eastern slope of the hill facing the Firiza valley, and with no surface streams nearby, it was well protected from floods. It reaches a maximum depth of 11 m from the top of its foothill. The upstream entrance part was dug with rectangular section in basaltic andesites. The passage width is between 0.7-1.3 m, while the height is generally 1.7 - 1.8m, reaching up to 2.1 m (Fig. 6a). At 8 m from the entrance, a contact with stratified lava flows is reached next to the ceiling and there is a little enlargement in the upper part of the gallery. The contact between the two lithologies can be followed to the downstream end.

Tunnel 6, located in the southern half of the canal, is in a very different situation. Its total length estimated from the surface survey is of ca. 50 m, of which only 27.8 m could be surveyed (Fig. 5). The depth it reaches beneath the ridge is of ca. 20 m. Its first 8 m (sections: 1.5 x 1.5 m) are lined with andesite blocks, which make this section the only part of the tunnel safe to visit (Fig. 5, 6b, c). The bedrock consists of intensely altered andesites mineralized along vugs and fissures, with high iron sulfide content. Hydrologically, both its entrances lie in the vicinity of “bottleneck” confluences of several steep valleys, which may have contributed to its periodic flooding and accelerated weathering. Three depressions marking former mine shafts occur on the top of the ridge above, which were most likely connected to the tunnel or to its vicinity. The shafts have provided access for the meteoric water and as a result the bedrock is extremely weathered and friable, with high amounts of limonite and jarosite deposits resulted from pyrite oxidation. Ceiling collapse occurred between subsequent visits over the last 2 years, the most recent one blocking the tunnel at 27.8 m.

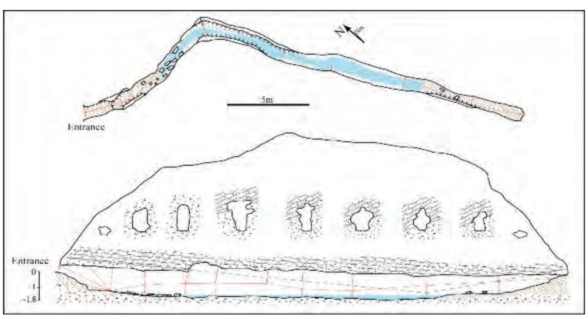

Figure 4: Survey of tunnel 2 with the contact between stratified lava flows and andesites marked in the profile.

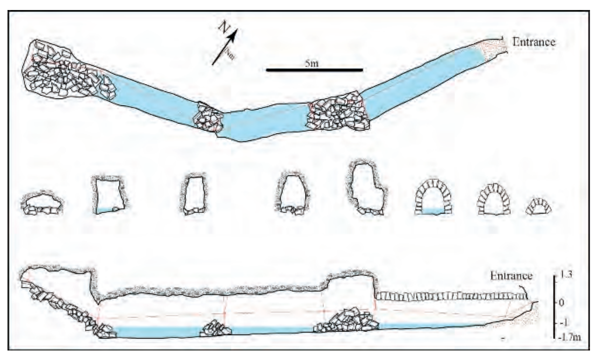

Figure 5: Survey of tunnel 6.

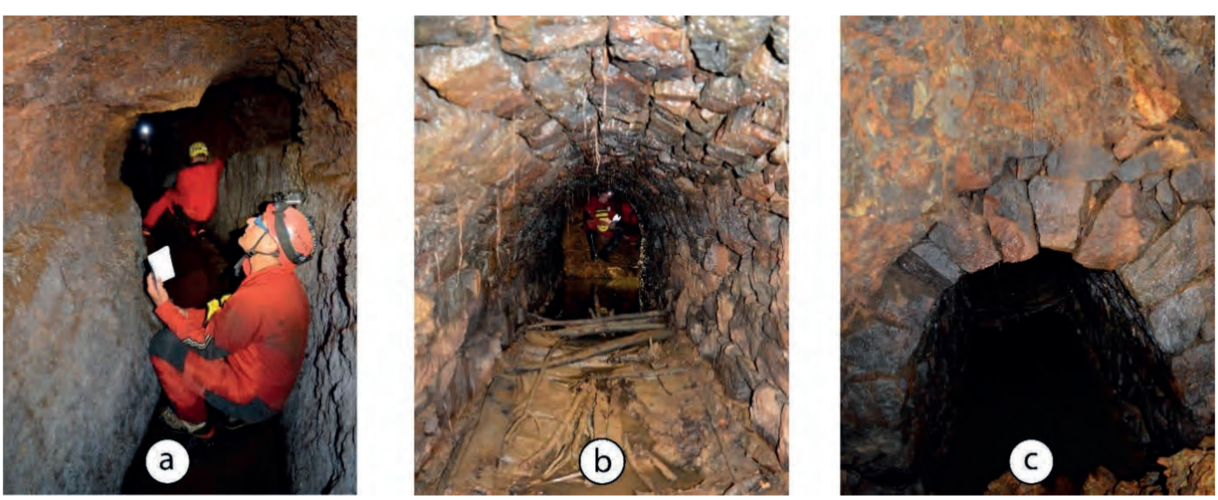

Figure 6: Types of tunnel cross-sections: a. section in tunnel 2, with enlargement in stratified lava flows; b. tunnel 6 entrance, lined with andesite blocks; c. weathered bedrock with extended limonite deposits in tunnel 6.

4. Concluding remarks and future work

This paper presents the results of our ongoing study of the Thurzó canal, a XVIth century aqueduct designed by János Thurzó to supply water for the extraction of minewater from the mines in the Cross Hill in Baia Mare, Romania. Although far from concluded, the study brings to light several characteristics of the aqueduct. Three building techniques were used, in relation to the natural obstacles encountered by the original builders. The longest part consists of paved sections, a little over 8 km long, dug along the hillsides at a constant slope angle. The rest is divided between tunnels and sections dug in bedrock – the latter usually when the height of the obstacle was below 7m. According to our data the whole extent of the Thurzó canal is 11.82 km, including the destroyed section.

The number of tunnels identified was of only 10 instead of 26 (or 29 or 35) recorded in literature. The cause of these differences may be due to both technical and historical reasons. These include road construction and possible overprinting due to re-use and considerable differences in the technologies used (i.e., sections dug through bedrock in the XIXth century may overprint on initial XVIth century tunnels). As of now, out of the 10 tunnels identified, only two are surveyed and a third (tunnel 1) has been recently discovered close to the initial water supply point, while at several others work is ongoing. Further work will definitely bring more information regarding the tools and techniques used in the construction of the canal.

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