

Geologic and Stratigraphic-Geomorphologic Considerations as Premises of the Diagnosis of the Current Exploitation Conditions of the Telega Baths Anthropomorphic Saline Lake

Octavian Georgescu, Dumitru Frunzescu, Ileana-Monica Crihan,
Gheorghe Brănoiu, Ionut Lungu

Petroleum – Gas University of Ploiesti, Bd. București 39, 100680, Ploiești,
email: dfrunzescu@yahoo.com

Abstract

The present work is intended to be a summary of the geological, hydrogeological and geotechnical data referring to the environment of the anthropomorphic saline lake of the Telega Baths, as a condition for continuing its exploitation for balneotherapeutic purposes. Lake Telega Baths represents an accumulation of salt water in the hollow created by the collapse of the ceiling of a bell-shaped old salt mine, and developed in a massive salt diapir.

Key words: *Badenian, Breccia of Cosmina, Telega diapir, landslides, salt exokarst, hydrological-hydrogeological considerations on saline water, management of anthroposaline lakes.*

Introduction

From a geologic and stratigraphic point of view, the salt diapir massif of Telega belongs to the post tectogenetic molasse-like blanket of the Tarcău Unit, in the Badenian formation of the breccia of Cosmina within the Melicești syncline (outside the Tarcău Unit)

The breccia of Cosmina (Popescu Gr., 1951) is the lithostratigraphical unit constituting the direct stratigraphic support of the salt diapir of the Telega Baths; It is synonymous with “the breccia horizon of the salt with salt” (Popescu Gr., 1951; Olteanu Fl., 1951) or with the evaporitic formation (Săndulescu M. et. al., 1995). It signifies the deposit developed between the Cămpinița formation and Telega Formation. From a lithologic point of view, the breccia of Cosmina is relatively monotonous, mainly consisting of a silt clay or fine sand matrix which is blackish and buttery and contains varied clastorudites in terms of grain size and petrography. The monotone development is interrupted by the presence of the evaporitic gypsum or salt sequences, as well as by some thin marl and clay intercalations. In the study area, in the south of the Slănic syncline, the breccia of Cosmina reveals sedimentary continuity over the marl of the Cămpinița formation and begins with stromatolithic rhythmities followed by an alternating level of evaporites = gypsum and microbial carbonate blankets. Towards the east, the breccia of Cosmina is transgressive over older deposits; it contains salt massifs presenting diapiric development.

In the Melicești syncline framing the Telega diapir, the breccia of Cosmina is transgressive over the Oligo-Miocene deposits of the Tarcău nappe or over the Eocene deposits. The breccia of Cosmina is well-preserved in the northern flank of the syncline and the only profile that opens the breccia outcrops in the southern flank is on the Telega valley, in the western periclinal area of Melicești. Towards the east, the breccia of Cosmina belonging to the southern flank of the Melicești syncline disappears along a major east-west oriented fault that connects the deposits of the Telega formation with Oligo-Miocene formations. Other outcrops of the western periclinal part appear in the Lupa valley. The northern flank of the syncline opens out into the Cosmina valley and several tributaries of the Morăreasa valley.

In the Telega valley, the breccia of Cosmina forms outcrops both on the valley floor and the left flank, beginning from 200m upstream of the village school situated in the centre of Telega. Sporadic outcrops occur along a small tributary on the right, which meets the Telega valley a little downstream from the village hall. The section does not reveal the presence of the upper or lower limits of the formation, but what characterizes it is the presence of a massive salt diapir, which had once been exploited underground. On the surface, on the left side of the Telega valley and towards “La Butoi” hill, the presence of salt creates a characteristic relief with many dissolution and collapse zones over the old mine where the accumulations of rainwater and seepage led to the formation of anthropomorphic lakes=small salt lakes which were and are used as “baths” with therapeutic effects. Towards the west, the salt massif extends underground at least up to the Doftana Valley where it no longer appears in outcrops. Towards the Doftana Valley, the breccia of Cosmina disappears along the major fault that borders the southern part of the Melicești syncline. In the east of Telega towards Buștenari, the breccia of Cosmina disappears along the same major fault that was mentioned above. Along the Telega Valley, the Cosmina breccia formation opens on a distance of about 500m both downstream and upstream of the salt massif. Respectively, at the bottom and top of the salt massif, a blackish breccia outcrop occurs, having a silt - fine sand matrix in which soft clay or marl or sandstone pebbles are caught.

Geomorphological Considerations

From a regional geomorphological perspective, the studied area is part of the hills of the Prahova Subcarpathians, towards their contact with the piedmont plateau of the Câmpina terrace, on the eastern slope of the Prahova valley. The hill features of the Prahova Subcarpathians reflect the geological structure and consist of longitudinal rows of hills which correspond to the anticlinal axes with competent rocks, sandstone and sand, and separated by depressions arranged on the synclinal fillings developed over easily modeled rocks (marl and clay).

The relief of the summits of the hills, which are oriented approximately east-west (reflecting the general direction of the structural folds), is fragmented by valleys oriented N-NW towards S-SE, their tributaries being oriented either NW-SE or E-V. In the area, the salt brook (Telega) springs from the area of the village of Melicești; and is a tributary of the Cosmina river which, in its turn, is a right side tributary of the Vărbilău valley; It has torrential behaviour, generally low flow rates, but fluctuating towards higher values when it reaches extraordinary levels in the extra-wet season. The slopes have a fragmented relief with large slopes which are more or less affected by external dynamic phenomena, erosion and landslides.

The geological substratum of the salt breccia, with salt massifs, has a specific relief, characterized by frequent landslides, salty puddles placed on dissolution funnels, dolines, poles and anthropomorphic lakes (generated in the same way as the lake of the Telega Baths, by the collapse of the ceiling of bell-shaped underground mines which were abandoned). (see figs. 1, 2, 3, 4).



Fig. 1. Upstream slope of the lake“La Butoi” – image taken on May 23rd, 2014



Fig. 2. Exokarst on salt: sinkholes, suffusion funnels, towards the top of “La Butoi” slope – image taken on May 23rd, 2014



Fig. 3. Suffusion funnels in the salt breccia – exokarst on salt: sinkholes, suffusion funnels, towards the top of the slope “La Butoi” – image taken on May 23rd, 2014



Fig. 4. Salt diapir massif with dissolution structures: sinkholes and ditches and karren on the surface of the salt

In terms of detailed geomorphology, lake Telega Baths lies in the downstream third of the southern slope of the Salty Brook (Telega), a slope whose local toponym is known as “La Butoi”. Generally, the southern slope of the Salty Brook = the slope “La Butoi” developed in the clay-marl stratigraphic context of the salt breccia with salt (breccia of Cosmina) and was affected by several generations of landslides, debritic and muddy flows or superficial gravity flows (fig. 2). The specific relief characterized by landslides (marked by cambers, detachment cirques, flow areas separated by more or less active fractures, depressions with hydrophilic vegetation and even glimee lakes) is completed by an exokarst relief specific to the salt substrate (dissolution depressions, funnels or suffusion sinkholes, and small valleys formed by the flow of torrential storm water) (figs. 3, 4). In the area of Lake Telega Baths, the bottom third of the southern slope of the Salty Brook is marked by a circumlacustrine salt border, remnants of the former bell-shaped exploitation chambers in the salt massif (debut in 1568, extended in 1865, first collapse and flood in 1866, abandoned in 1900, and followed by flooding and ceiling collapse) (figs. 5, 6).

Lake Telega Baths is bordered in the south by the ramifications of a little periclinal elevation completed by two promontories delimiting the SE and SW sides of the leased property. The depression path of the landslides from “La Butoi” slope occurs opposite the lake, beyond the summit, towards SE. In the upper part of the slope, there are two more lakes produced by collapse on salt (fig. 7).



Fig. 5. View towards the southern part of the lake – image taken on June 18th, 2010



Fig. 6. View towards the southern part of the lake – image taken on July 8th, 2010



Fig. 7. The depression area connecting the north-west headland to the north-east headland, affected by surface flows, with excessive wetness - F3 and F4 drilling site – image taken on May 23rd, 2014

The north-east promontory occurs between the path of the active slide of “La Butoi” and Lake Telega Baths, diminishing from SW to NE and ending in a saddle-shaped relief which separates Lake Telega Baths towards the west from a lake of a smaller size and polluted with slide material = Palada Lake towards the east. Towards the periclinal ending of the north-eastern promontory, the salt of the diapir massif (generally covered by a clay-silt blanket which is yellowish-gray, plastic-soft and very wet, and 0.50-2.50m in size) appears uncovered and a salt block of 3x3x4m is dislocated and detached from the pericline of the headland. The relief of this promontory towards Lake Telega Baths is steep and has 60-70° slopes towards the lake and saline springs emerging at about 2-3m above the level of the lake; to the NE side of the promontory, bordering the detachment zone of the salt olistolite and in the area of the salt springs, the slope increases to values of 70-80 degrees, marking small detachment surfaces of superficial flows in the context of a very wet to saturated substrate; towards the ramification/connection area to the other headland (NW), the slope is attenuated to values of 40-50 degrees. The depression area between the two branches (promontories) of the hill in the southern part of the lake is marked by superficial landslides in the context of excessive wetness caused by infiltrations and, mainly towards the lake, by the development of hydrophilic vegetation.

The north-west promontory towards the west and south sides of the lake, with attenuation towards the access road bordering the brook, is affected by the instability of the residual salty clays of the salt breccia; in correlation with the increasing gradient of the slope towards the bottom of the periclinal and the dissolution phenomena (funnels) occurring at the top, it reveals superficial gravitational flows that destroyed the three lodges of the balneological establishment of Hercules (figs. 8, 9). In the bottom periclinal area of the northwest headland of the lake, there are superficial flows/slides at the level of the silto-lutite envelope of the salt. They are also correlated with advanced stages of salt dissolution that generated dissolution grooves and suffusion funnels linked to ditches, requiring the local strengthening of the circumlacustrine terrace. The slope towards the lake of the northwest promontory has an overall inclination of 55-60 degrees and decreases to 35-40 degrees towards the depression area that makes the connection with the other (northeast) promontory. A considerable part of the slope overlooking the lake was changed/improved by anthropic intervention, in the sense of cutting 3-4 embankments with a height of 0.70-0.80m and the berm width of 0.20-0.50m (fig. 10). The thickness of the gray silty-clay envelope, superjacent to the salt in this slope, has constant values of 2.00 to 2.50m up to the top of the salt massif. To a great extent, the steep slope generated shallow landslides accentuated by the high plasticity and humidity of the clay, correlated with an almost total absence of vegetation.



Fig. 8. Overhanging dissolution holes in a horizontal plane – view towards the north-west part of the lake – image taken on July 8th, 2010



Fig. 9. View towards the north-west part of the lake (identical view photo 15) –image taken on May 23rd, 2014



Fig. 10. Embankments and berms on the western side of the lake – F1 and F2 drilling area – image taken on May 23rd, 2014

Conclusions

The northern margin of the lake (towards the Salt Brook) and the north-east one (fig. 11) (towards the small camping houses and the Palada property) reveal a more attenuated relief. The risk of overflows required several interventions that consisted in the lifting of the area by means of fillings intended to serve as an upper beach of the lacustrine establishment. The fillings made of clay and gravel reached metric dimensions and were placed above an impermeable sheet placed on the previous relief.

The frequent depressions and dissolution and suffusion funnels required the prompt correction of unevenness with fillings.

Particularly in the support area of the restaurant and treatment rooms and offices, the side towards the brook = the northern part of the trimmed platform of the lake provides examples of differential subsidence, and a concrete floor which is erected/cracked or, on the contrary, tamped. Shallow deteriorations of the slope are frequent on the brook-oriented side of the filled terrace of the restaurant and of the constructions that assure the access to the establishment.

The concrete retaining wall that marks out the platform of the restaurant towards the access road is fractured, dislocated and under pressure. This part of the slope towards the terrace of the restaurant/offices and the access road parallel to the brook required essential repairs consisting in fillings and ameliorative wooden structures overlapped by the horizontal floor of the platform.

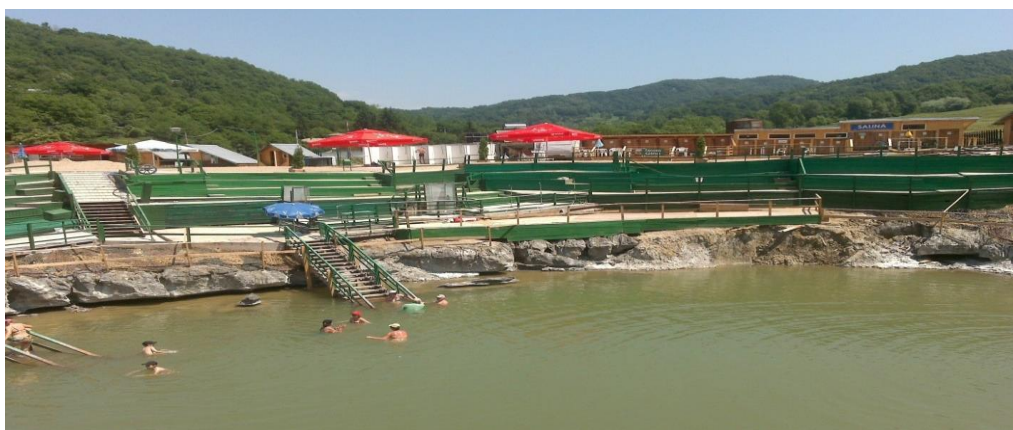


Fig. 11. View towards the north-east part of the lake – image taken on June 18th, 2010

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Considerații geologic-stratigrafice-geomorfologice ca premiză a diagnosticului condițiilor actuale de exploatare a lacului antropomorf salin de la Băile Telega

Rezumat

Lucrarea se dorește a fi o prezentare sintetică a datelor geologice, hidrogeologice, geotehnice, referitoare la ambientul lacului antropomorf salin de la Băile Telega, ca și condiție de continuare a exploatării pentru cură balneară. Lacul Băile Telega reprezintă acumulare de ape sărate în golul de prăbușire tavan al unei vechi exploatări saline în formă de clopot, dezvoltată într-un masiv de sare diapiră.