

ANALYSIS OF THE GEOTECHNIC PHENOMENON FROM OCNA MUREȘ

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1. Introduction

1.1. Activity area

Both salt deposit and town of Ocna Mures are situated on the terrace of Mures river and it covers the area between the left bank of river Mures in the north and Teleky, Hagau, Banta and Viilor hills at east, south-east and south.

Ocna Mures activity area has 42 ha as it follows:

- total ground area is 26 ha;
- total lake area is 16 ha.

Inside the activity area of Ocna Mures there are 23 wells, 17 of them are surface wells and 6 are underground wells, of which:

- an active well S118/125;
- 2 wells with technical problems: S123 and S124;
- closed wells (six underground and six surface wells).

1.2. Geology and geomorphology

Ocna Mures area is situated along the diapirs of the west coast of Transilvania delve, the salt layers have been located in the tortonien deposits. Due to salt deposits tendency to rise to the surface, cracks are made threw the impervious marl layer above and by doing so the salt comes in contact with the aquifer system of river Mures. The aquifer system is mainly situated in uncohesive alluvial layer. This alluvial layer is separated by impervious silty-clay layers.

Morphologically, the salt deposit from Ocna Mures is situated in a lowland area belonging to the alluvial plain of river Mures. Due to an increase in size of the underground caverns formations and also due to kinetic leaching, important settlements and cavings were taking place and by doing so it emphasized the lowland profile.

1.3. Hydrology

As a hydrological unit, the area of the salt diapir includes the lowland of river Mures, characterized by a intense growth in sand deposits, deposits which rest directly on salt deposit. Outside the salt deposit boundaries, these layers of sediments are covered by impervious layers of sandy-clay. Within the limits of the salt deposit, the continuity of the sediment layer was stopped due to the development of salt lakes above the deposit.

River Mures feeds and washes at the same time the aquifer and the salt lakes mentioned above. Because the the river bed is eroded into a layer of sediments, the ground water table is fed at higher levels of river Mures and the water discharge is assured during Mures low tide. The rainfall is an auxiliary source, as long as the upper impervious protection layer is missing, due to the fact the rainfall in that particular area exceeds the quantity of evaporated water.

1.4. Stratigraphy

After a review on the lithology boreholes from wells 123, 124 and 118E, the rock sterile mass has a thickness of aprox. 4m for well 123, 16m for well 124 and 356m for well 118E.

The terrace deposits for Well 123 and Well 124, are normal consolidated layers of sand and gravel of aprox. 4 to 16m. For well 123 the salt deposit can be found between 4 to 95m, followed by a layer of stiff sandy clay (marl) until 437m and between 437m to 1250m there is new salt deposit.

The review on the terrace deposits show low mechanical resistance being represented mostly by topsoil and normal consolidated sand and gravel.

2. Hystorical background

On the 22nd of December 2010, near well S123 from Ocna Mures area, judetul Alba, a dangerous event occurred with the following consequences:

- formation of a surface caving which damaged PLUS market;
- a salt lake formed;
- the diameter of the cavity cone grew from 10m to 70-90m in 12h;
- the water level rose 2-2.5m from ground level, until it spilled to lake Stefania.

3. The caving evolution

After the first measurements, the newly formed lake had a maximum of 16m in depth and an average depth of 12m, and after 2 days the new measurements had shown a maximum depth of 24.5m and an average depth of 14-16m.

On the 05.01.2011 measurement, an inflow was noticed coming from Well field roundabout and also the fact that the water level from the newly formed lake was constant in regard with the old lake from the Well field. On the 10.01.2011 measurement, the difference between the water level from the newly formed lake and the old lake was +1.4m.

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The the outcome for the increase of water level was:

- rise of the ground water table in the area near the salt deposit;
- flooding of the cellars found in the vicinity of the deposit;
- damage done to the nearby community due to water infiltration inside basements and salt water migration towards the surface;
- extreme corrosion of the steel elements and the existing structures near the deposit;
- vegetation dry-out due to high concentration of water contamination with chlorides;
- increase number of complaints from nearby citizens.

The quantity of brine extracted from the Probe Fields Ocna Mures from S 118/125, S 111 and S

118E in the interval of January-March 2011, was of 7500 cubic meters with the concentration of 320g/l. These quantities are found in the excess volume of existent brine of the previously mentioned field.

By pumping, the waters from the Ocna Mures Probe Field are evacuated in the canals and existent drains in the mining perimeter from the Ocna Mures town area, are diluted and end up in the Mures river. From measurements made, it results that in the January-March period of 2011, from probes S208, S209, S118E and S125 were pumped 13500 m³ of brine, with an average of 4500 m³/month.

In tabel 1 are represented the results of the monitorings from the Ocna Mures perimeter, measurements done by MINESA CLUJ.

Date	Contour surface landslide (m ²)	Surface new lake (m ²)	Elevation (m)	Elevation lake Ștefania (m)	Difference lake elevation and Ștefania lake (m)	Difference lake elevation and imposed elevation +254,0m
23.12.2010	5.400	4.800	255,693	254,623	1,070	0,623
24.12.2010	5.813	5.200	255,123	254,623	0,500	0,623
28.12.2010	6.364	5.800	255,793	254,622	1,171	0,622
05.01.2011	6.881	6.300	256,069	254,623	1,446	0,623
10.01.2011	7.150	6.600	256,104	254,706	1,398	0,706
18.01.2011	7.200	6.800	256,106	254,706	1,400	0,706
07.02.2011	7.246	6.900	256,570	254,899	1,671	0,899
21.02.2011	7315	7.000	256,800	254,940	1,860	0,940
07.03.2011	7.436	7.100	256,959	254,786	2,173	0,786
08.03.2011	7.436	7.100	256,970	254,768	2,202	0,786
22.03.2011	7.452	7.150	257,054	254,685	2,369	0,685
18.04.2011	7.507	7.100	257,016	254,544	2,472	0,544
19.04.2011	7.507	7.100	257,004	254,500	2,504	0,500
04.05.2011	7.541		256,893	254,433	2,460	0,433
06.06.2011	7.571		256,564	254,497	2,067	0,497
15.07.2011	7.600		256,594	254,660	1,934	0,660
10.08.2011	7.625		256,372	254,648	1,724	0,648
07.09.2011	7.667		256,167	254,679	1,488	0,679
19.09.2011	7.802		256,102	254,654	1,448	0,654
28.09.2011	7.849		256,133	254,644	1,489	0,644
24.10.2011	7.862		256,063	254,655	1,408	0,655
12.01.2012	7.895		255,765	254,488	1,277	0,488
13.03.2012	7.910		255,809	254,631	1,178	0,631
05.04.2012			255,510	254,358	1,152	0,358
30.05.2012	7980		255,323	254,086	1,237	0,086
16.08.2012	8.095		255,4195	254,0875	1,332	0,088

Table 1 Results of monitoring from Ocna Mures perimeter

4. Actions taken by established authorities

- during the work session from 23.12.2010 a discussion note was assembled with the involved factors and was established to continue the monitoring the landslide cone and the adjacent area, until the causes are established.
- in order to maintain a level of the lakes below the flooding levels of the structures, and to ensure the

protection of the salt structure, since the year 1960, measures were taken to maintain a constant water level in the lakes from the Ocna Mures field;

- the Ministry of the Oil and Chemical Industry has established the maintaining of the level in the lakes from the Ocna Mures field at the +254.00 m level, and by the Study S50-849/1996 elaborated by SC MINESA ICPM SA Cluj Napoca, the maintaining

of a hidrostatic level under the flooding levels of the basements of the adjacent structures and ensuring the protection of the salt structure at the maximum level maximă 253,5÷ 253,8 m;

- the Ministry of Economy, Commerce and Bussiness Environment has decided the aquisitioning of the designing services for the Feasability Study and Technical Projects per Items of the elimination works of the effects of the uncontrolled collapse of the terrain surface, the closing and the ecological works to be performed for the durable development of the mining site Salina Ocna Mureș, Alba county, approved for closure by H.G. nr. 644/2007;

- the Petrosani University has prepared a study regarding the geomining phenomenons that have influenced the occuring of the 22.12.2010 event at Ocna Mures.

5. Outcomes

If this lake will not be embanked, it will develop to grow due to the natural phenomenon of dissolution, endangering the inhabited area, also the marginal safety pillars and the flooring from the old Stefania mine. Not embanking the lake would lead to the development of instability phenomenons and their expansion in the entire Ocna Mures mining perimeter.

In order to avoid the natural dissolution phenomenon, it is advisable to execute 8-10 meters deep drains, from the surface, to where the salts diapir is found, which would collect the underground waters from the Mures river and from precipitation. These drains would lead to the ceasing of the dissolution towards the inhabited area of the Ocna Mures town, also to the marginal pillars of the Stefania mine. The ceasing of the dissolution will result in stopping the sinking both in the mining perimeter and in the inhabited area of Ocna Mures Town.

The registered sinking by the topographical markers placed in the mining perimeter Ocna Mures were influenced by the existence of a continuous underground water layer, constituted of very permeable alluvial formations, which lead to the natural slow dissolution phenomenon.

The sinking of the terrain, and the appearance of holes, were determined by the flow of the underground waters, directly connected to the hidrostatic level of the Mures river, also of the pluvial waters from the Banta hill. The stability of the surface was not affected by the mining activities below.

The dynamics of the sinking phenomenon is in direct correlation with the volume of precipitation which creates a fluctuation of the levels of the lakes.

The dangerous incident from 22.12.2010 happened as a direct result of the placing of the Plus store with at least 10 m inside the improper building perimeter.

The crumbling of the Plus store is due to the natural phenomenon of slow dissolution caused by the flux of fresh water from the Mures river and rain flow.

The dissolution of the back of the salt deposits made the sterile rocks, with a thickness of maximum 10.00m to behave as a beam in console. The rocks from this beam having small mechanical resistances, probably have crumbled simultaneously with its development, due to self weight. By erecting the Plus store, on top of this beam, an excess load was applied that facilitated the occurring of the dangerous incident.

6. Recommendations

In order to avoid the flooding with brine resulted from the embanking of the new lake, it is recommended a draining canal system that incorporates the whole Ocna Mures perimeter, and drains the brine from the new formed lake, also from the old lakes to the Mures river.

An intercepting drain that captures, along the Cosbuc street the underground waters from the salt massive. By a canal, that links directly to the lakes, this will contribute to the mainting of the high level, by capturing the superficial layer that exceeds this limit.

A drain east of the salt massive, along the collecting canal of the pluvial Ciortea waters, in order to partially collect the waters from the Mures river and to reduce the hidrostatic level in the influence area of the drain. This drain will junction with the intercepting drain, ensuring the first dilution of the of the collected lake waters.

A longitudinal, unloading drain will collect the volumes from the intercepting drain, also the volumes collected by the draining phenomenon, ensuring the continued dilution of the lake waters. Before unloading into the Mures river, a periodical check of the chlorine levels will be made.

Two radial drains, one at the base of the UPSOM collection hole, another one on Stefan cel Mare street, will be executed at an optimal depth for intercepting the underground water, and unloading into the the longitudinal drain. A new dilution of the collected waters is ensured, and a reduction of the hidrostatic level.

To avoid the development of the crumbling cone, and respectively of the lake in which the Plus store slid, it is recommended to embank it. The volume of the new lake is approximately 100 000 m³. It will be done with material brought from the

UPSON upfill combined with calcar with the diameter 0-40mm brought from the Poiana Aiudului quarry.

To avoid the flooding with brine resulted from the embankment of the new lake it is recommended to prepare a sistem of draining canals which incorporates the whole perimeter Ocna Mures and that drains the brine from the new lake, also from the old ones towards the Mures river.

The execution of the drainage for the neighbouring streets with the salt deposit, in order for the domestic waters not to infiltrate the underground water layer and the lakes.

Monitoring of the structures and the probes from the influence area will be carried out.

The restauration of the inoperative or destroyed markers will be done, and the plating of new ones to re-homogenize the longitudinal and transversal paths.

It will be forbidden to erect new structures in the influence area, with the exception of those who serve the exploitation, or protect the salt deposit.

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