

## CONSIDERATIONS REGARDING THE STABILITY OF LANDMARKS AND TOPOGRAPHIC MARKS PLACED IN A FIELD OF SALT PROBES

*Raluca FARCAȘ, Assist. PhD. Stud. Eng. – Technical University of Cluj-Napoca, farcasraluca19@yahoo.com*

*Tudor SĂLĂGEAN\*, Lecturer PhD. Eng. – University of Agricultural Sciences and Veterinary Medicine Cluj-Napoca, tudor.salagean@usamvcluj.ro*

*Maricel PALAMARIU, Prof. PhD. Eng. – University “1 Decembrie 1918” of Alba Iulia, mpalamariu@gmail.com*

*Sanda NAȘ, Lecturer PhD. Eng. – Technical University of Cluj-Napoca, nsanda2001@yahoo.com*

*Mircea ORTELECAN, Prof. PhD. Eng. – University of Agricultural Sciences and Veterinary Medicine Cluj-Napoca, ortelecanm@yahoo.fr*

**Abstract:** *The purpose of tracking in time the buildings in a field of salt probes is to obtain information in order to ensure the stability of the buildings, an assessment of environmental conditions to prevent various natural accidents, prevention by reducing the damage or to prevent the loss of lives and environmental degradation. Based on topographic measurements made on the topographic marks placed on land or on the topographic marks placed in the foundations of buildings, are determined the deformations and displacements that occur in the area of influence of salt extraction and the displacement directions of the marks (vertical displacements).*

**Keywords:** *deformations, displacements, salt extraction, stability, topographic marks*

### 1. Introduction

The purpose of the study is to forecast the evolution of instability phenomena from the exploitation perimeter Gura Slănic and to determine their influence on the surface area and on the existing buildings (buildings, networks, bridges), and developing the necessary measures to mitigate the effects of the instability phenomena.

The placement of buildings in the areas of influence of mining activities is done only in absolutely necessary cases [1], taking measures consisting of:

- avoiding unfavorable change of water regimes;
- capture, drainage, sewerage, regularization of water courses;
- avoiding accumulation of water through the implementation of dams;
- drilling depth 50-100-300 m, executed in areas of influence, are cemented, by this measure is avoided the massive intrusion of salt water;
- continuous monitoring of the area of influence and of the existing buildings in order to detect in its early stages the possible deformation of land and constructions.

Since in the case salt mines, there is no legislation to specify, depending on the type of construction, the maximum admissible submergences and displacements, from the speciality literature and observations made in different salt basins, including Gura Slănic, we can say that in the areas affected by exploitations, land movements are: [2], [3]

- movements due to the imbalance caused by operating without modifying the action of possible dissolution phenomena on the backs of salt, having the following phases:
  - Acceleration;
  - Constant speed;
  - Extinguishing.
- movements due to the imbalance caused by the operation, on which it overlaps the effect of the dissolving modifier on the back the salt, having the following steps:
  - Acceleration;
  - Dissolving floors and pillars;
  - Subsidence.

Moreover, the normatives and standards in the construction industry (NP-055-2001 – regarding the antiseismic design of housing construction, social-cultural, industrial and agricultural buildings, STAS 1242/61) governing the design of new buildings and presents principles for evaluating the level of protection for the existing buildings, and the determination of the intervention measures in emergency situations [4].

Târgu Ocna is located in seismic zone C. Because of this seismic zone classification and location, according to STAS 1242/61, which prohibits the construction in areas where there are gaps underground, it is recommended removal from the PUG of the lands related to the exploitation perimeter Gura Slănic - Târgu Ocna.

## 2. Additions

The aim of the topographical works is to monitor the phenomena of instability manifested on the land surface related to the salt extraction from Gura Slănic by topographic measurements realised in time.

The topographic monitoring involves measurements, analysis and interpretations. The monitoring points are coded and materialized on the ground by bornes, landmarks and topographic marks placed in the foundations of buildings, having established topographic coordinates.

The topographic measurements for levelling were performed with LEICA DNA 03, using the methodology specific for the middle geometric leveling. For measurements processing was adopted indirect measurements method.

The topographic measurements conducted on the tracking landmarks have an important role in monitoring the land surface deformations and stability of Gura Slănic field probes.

To calculate the height of all the marks from Gura Slănic field probe was used as starting height level the one of the landmark reference RN (DTM) of 1940 from the Station building Tg. Ocna.

For determining the vertical displacements of the tracking marks, were performed leveling measurements to obtain the height ( $H^N$ ) for each mark.

The vertical displacement is a parameter that can be determined directly by leveling topographical measures.

The relative vertical displacements ( $\Delta S$ ) are determined with the relation:

$$\Delta S = H_i - H_{i-1} \quad (1)$$

The absolute vertical displacements ( $S$ ) are determined with the relation:

$$S = H_i - H_0 \quad (2)$$

where:

$H_i$  – the height at the current measurement;

$H_{i-1}$  – the height at the previous measurement;

$H_0$  – the height at the basis measurement.

The results of processing the leveling measurements performed on the topographic marks are shown in table 1.

Table 1. Displacements of the landmarks

Landmark	$\Delta S$ [mm] 2009-2010	$\Delta S$ [mm] 2010-2011	$\Delta S$ [mm] 2011-2012	$\Delta S$ [mm] 2012-2013	$\Delta S$ [mm] 2013-2014
P1	-11,4	4,3	-4,3	-4,9	-0,3
P2	-7,5	-12,7	8,4	-13,4	-7,9
P3	-4,9	-3,1	-4,4	-4,9	-5,3
P4	-8,5	-6,2	-7,6	-10,4	-10,2
P5	-10,4	-8,7	-8,7	-11,3	-11,5
P6	-13,6	-6,0	-9,8	-11,7	-12,7
P7	-6,3	-7,9	-10,7	-14,5	-11,4
P8	-4,1	1,1	3,5	-8,2	-6,4
P9					0,0
P10	-1,9	-2,3	-0,4	-7,2	-7,8
P11		-1,7	-1,2	-6,6	-8,0
P12		-0,9	-1,9	-8,7	-7,4
P13	-6,0	-2,1	0,4	-7,8	-8,3
P14		-1,8	8,1	-7,6	-9,5
P15	-1,0	-1,5	3,8	2,1	-15,1
P16	-1,7	-0,9	4,8	3,3	-14,2
P17	-1,5	-1,4	3,7	4,5	-22,2
P18	-1,2	-1,7	4,1	3,8	-14,2
P19	0,0				0,0
P20	-7,3	-10,9	-3,2	6,0	-7,7
P21	-5,9	-1,2	0,9	-7,7	-6,5

In the building area, the values of the submergences recorded during 2010-2011 on the landmarks are between (-10.9 ÷ +4.3 mm).

For the period 2011-2012, the landmarks for stability tracking recorded values of submergences between (-10.7 ÷ +8.4 mm).

For the period 2012-2013, the landmarks for stability tracking recorded values of submergences between (-14.5 ÷ +6.0 mm).

For the period 2013-2014, the landmarks for stability tracking recorded values of submergences between (-22.2 ÷ +0.0 mm).

In the analyzed period 2013-2014, all the tracking landmarks recorded negative submergences in time.

In the variation diagram can be seen how each landmark evolved in terms of immersion recorded during a certain measurement (fig. 1).

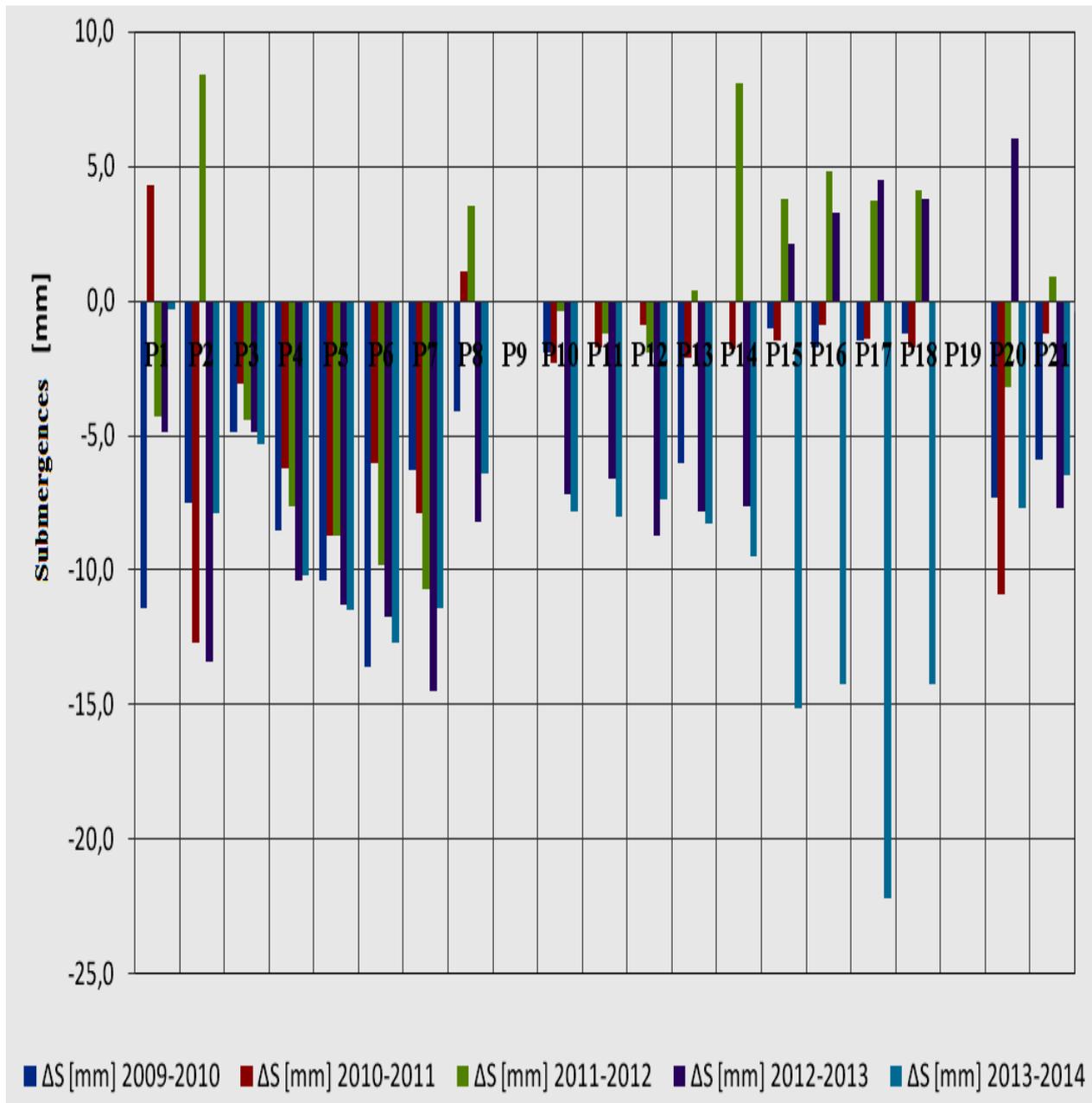


Fig.1. Variation diagram with the submergences

Based on the planimetric coordinates and on the submergences values during the period 2013-2014, were represented submergences isolines (curves of equal submergence) on the leveling route realized (Fig. 2).

The curves of equal submergence for the period 2013 - 2014, by which it can be highlighted the areas with the landmarks which recorded positive/negative values of submergences for the period 2013-2014.

In Fig. 2 is identified by the color tones the vertical displacements of the landmarks as follows: the yellow color represent the terrain liftings and the red color represent the terrain submergences, the values are given in mm.

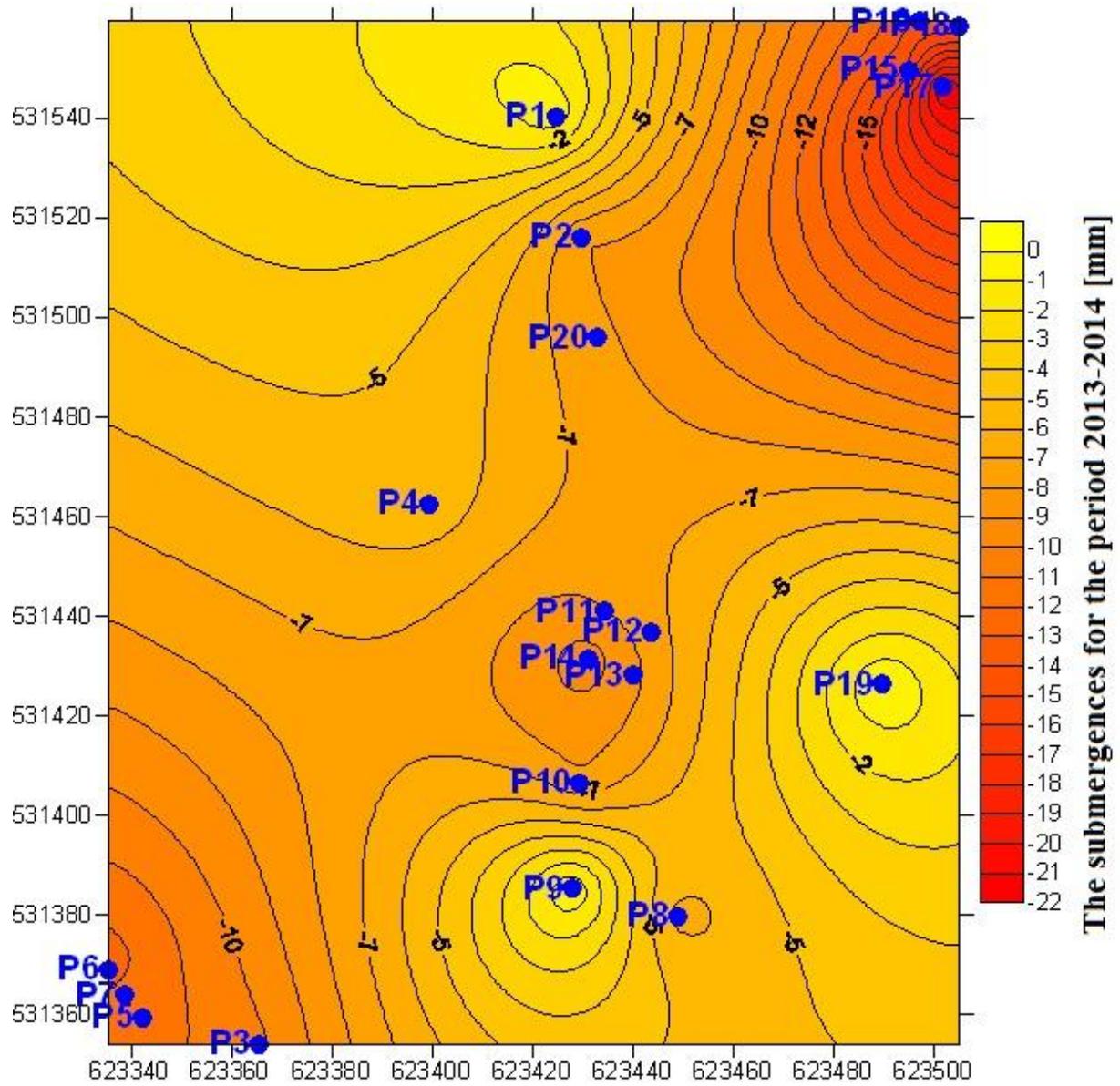


Fig. 2. Curves of equal submergence for the period 2013-2014

### 3. Conclusions

The results of measurements achieved in 2014 on the topographic marks placed on the construction foundations indicates that they are in a continuous vertical movement.

The topo-geodetic methods, by their high measurement accuracy and arrangements made to get data and estimation of results, represent a basic system in the extensive process of studying the behavior of constructions.

In topographic monitoring for tracking constructions will be given particular attention for the following:

- The vertical displacements registered on the leveling marks from the buildings area or on topographical marks.
- The surface modification that may occur as a result of the action of the natural environmental and anthropogenic factors in the tracked area.

The land under the building affect the resistance structure through foundations, causing further this additional efforts and deformations. The size of the efforts and deformations of the resistance structure is dictated primarily by the magnitude of movements but not the unevenness of such movements (lifting-lowering etc.) recorded at the point of contact between the foundation and the ground.

Determination and timely notification of the occurrence of deformations and displacements has particular importance in terms of safety of a building, while a misinterpretation of the results of observations may lead to serious accidents that result with the destruction of the studied objectives.

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