

# GENERAL ASPECTS REGARDING THE PRESENT SITUATION OF AREAS AFFECTED BY SUBSIDENCE PRODUCED BY EXPLOITATION OF ROCK SALT BY DISSOLVING

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**Abstract:** The exploitation by dissolution has different characteristics compared to other types of exploitations, because these types of exploitations are exposed to uncontrolled dissolution phenomenon, which may occur in rapid subsidence and collapse, depending on the value of the hydraulic gradient. Study of areas affected by the exploitation of salt by dissolution was and is a constant concern of those in charge with the exploitation but has not been analysed in detail. The research was limited only to monitor the phenomena and to find solutions for eliminating the consequences than knowledge and removing the causes.

**Keywords:** uncontrolled collapse, underground holes, instability, subsidence, monitoring

## INTRODUCTION

In Romania the exploitation of salt through dissolution with probes is applied in the case of four deposits of salt, respectively Ocna Mureș, Ocnele Mari, Târgu Ocna and Cacica. The exploitation method by dissolution using probes, forms inside the mountain of salt, systems of various shapes and sizes goals, prompting the change of the magnitude and direction in which the force acts rocks. Exploitation of underground deposit (opening, preparation and abatation) inevitably entails disturbing primary state (natural) voltage rock massif. To ensure the stability of the area, both during the exploitation activity and its cessation, it must be known the direction of action and intensity of deformation processes and the displacement of rocks in mining works, depending on the type of deformation character works (opening preparation, exploitation), the pressure that can develop the outlines of works, displacement and deformation mechanism processes of rocks in space and time. After the extraction of a volume of salt from a reservoir, the state of stresses and strains of the massive salt change, resulting in destruction of surrounding rock stability, fractured rocks on the perimeter of the excavation is put in motion, the movement is transmitting in the massive on a distance that depends on their ability to fill the gap created after the operation. If the hole resulted through exploitation is very high, exceeding the possibilities of the surrounding rock to fill and stop the phenomenon of deformation of rocks, their movement can affect the land surface, causing its degradation and thus destroying the surface or underground targets.

## MATERIAL AND METHOD

The phenomena of instability manifested so far in mines in Romania have determined (in addition to expenses resulting from the removal of the effects) immobilizing large amounts of reserves through the establishment of some areas with restrictions for exploitation, thereby reducing the degree of recovery. In Romania, uncontrolled crashes of underground caverns were numerous: in the 80s collapsed the ceiling of dissolution hole from Târgu Ocna exploitation, creating a lake in the middle of the town, Lake Burlacu. In 2001, occurred the accident of gargantuan proportions in the Field II of Probes - Ocnele Mari. After this accident, this resulted in the expulsion of a volume of about 2 million m<sup>3</sup> of concentrated brine, also occurred another two accidents that led to the partial collapse of the same cavern in 2002 and 2004. The collapse of this cavern triggered processes in a chain that caused instability of another cavern from the Field I of probes (made up by joining the holes of eight probes from this field). Following decommissioning of the two fields mentioned in Ocnele Mari, a total of 200 homes were displaced (practically were created two new localities, Copăcelu and Cazanești).

## RESULTS AND DISCUSSIONS

The phenomenon of instability triggered in Field II of probes from Ocnele Mari (in 2001) has generated large-scale collapses, highlighting that the lack of complex techniques and technologies for monitoring, forecasting and prevention but also some shortcomings in carrying out and managing technological process, it led to the dissolution of pillars throughout their entire section, resulting a hole with a horizontal section of approx. 105,000 m<sup>2</sup> and a height of between 40-60 m.



a) September 2001 (first crash)



b) December 2005 (forth crash)

Along with the controlled collapse process of the ceiling in the Field II, was implemented a system for micro seismic monitoring of the area, which includes Field I and the interpretation of data recorded in real-time at the micro seismic station provides important information for predicting the buckling process area [4]. In late December 2010 it took place a phenomenon of subsidence of land adjacent the supermarket "Plus", positioned immediately in south-eastern limit of the salt diapir from Ocna Mureș. This event was the intrusion of a volume of tailings underground and the expulsion of an equivalent volume of brine, which led to the formation of Lake Plus. Throughout the period of exploitation of salt from Ocna Mures have taken place land surface collapses, which generated at the surface a series of lakes filled with brine (Lake Ștefania, Lake Iosif,

Lake 1 May, Lake Minele Romane). The peculiarity of the event in December 2010, is that it is the first lake formed outside the contour diapir, all previously formed lakes being placed inside it.



Fig. 2. Field of probes - Ocna Mureș

a) the crash from December 2010

b) the fissures appeared around the crater

At Ocna Mureș, the existence of underground mining voids which are interlinked and collapse of access shafts have created favorable conditions for infiltration of groundwater in underground horizons, causing the weakening of the resistance elements (pillars, floors) and a decline of some works. The effects of this subsidence transmitted to the surface accentuated the depression of the area, which adversely affects groundwater dewatering the river Mureș. The formation of the subsidence funnels and their intersection with groundwater led to the formation of lakes with large dimensions, through which the hydraulic connection is achieved between the phreatic and the backs massive and the flooded underground voids.

The processes associated with this collapsing continues today, extending the crater and the newly created lake surface and extending the fissures around the crater, fissures that have a the tendency of evolution to several apartment buildings in the area (including former Tax Office building of Ocna Mureș) [5]. The phenomena of instability in the field of probes from Ocna Mureș, represent a major risk over the city Ocna Mures, in addition to water and soil pollution by hydrocarbons. From the existing data until now, the biggest problems that occur at the salt exploitations in the wet are Ocnele Mari (Field II - cavern Socon and Field III of probes), Ocna Mureș ( the newly formed lake Plus) and Târgu Ocna (probe S 251).

## CONCLUSIONS

The extent of the instability phenomena vary from one deposit to another, according to their specificities and permanent monitoring of influence is absolutely necessary. The main factors contributing to maintaining the overall stability or destruction of dissolved salt deposits are exploited:

- The geological and hydrogeological characteristics of the salt deposit;
- The shape, size and distribution of voids in relation to the deposit area;
- The form and dimensions of the pillars;
- The behaviour in time of the resistance elements;
- The mining method applied.

Exceeding the projected radius determine the realisations of the hydraulic links through the underground voids, reducing the pillars lift and finally collapses (situations

encountered in Ocele Mari, 2001). Along with the emergence and development of the dissolving voids created by the salt exploitation activities, due to the convergence of the voids and the deformation of the resistance elements, appear movements which can be transmitted to the surface, depending on the volume of their extent, geometry, depth or distance from the surface voids. Constant monitoring of the areas of influence is essential in order to detect the possible distortions in its infancy. Areas of influence of salt deposits are unsuitable for construction in general and for multi-storey buildings in particular. If the building's location in areas of influence is unavoidable, measures will be taken not to adversely alter water regime, measures consisting of: capture, drainage, sewage, regulating waterways, avoiding accumulation (dams). Boreholes (of any type) made in the areas of influence will be cemented to avoid the massive penetration of salt water.

Currently, since there is not the possibility to fight definitively the instability processes at the salt exploitation activities, must be expected from the beginning of the design, methods, procedures and technologies for preventing and reducing the risk. Solving the complex problems in managing the risk situations involves inputs from a wide range of diverse specialties having regard not only the phenomena of instability and damages caused, but the whole complex of circumstances that have created favorable conditions for them to occur [2]. In order to determine the degree of risk in areas affected by the exploitation through dissolving the salt is required a simulation of the stability criteria, taking into account the actual conditions of the salt deposits in Romania. Based on these simulations may establish conditions under which it may produce instability phenomena [1].

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