

THE STUDY OF THE GAS DYNAMIC REGIME OF A NEW OPEN SALT MINE TURDA, VALEA SĂRATĂ

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Abstract: The opening of any underground mining work requires a check and the establishment of the regime of explosive and toxic gas emissions (methane and carbon dioxide). Establishing the regime of gas emissions is necessary to clearly establish the correct choice of specific machinery in construction Ex. or not, as well as the correct sizing of the vent. The purpose of this paper is to determine the rate of methane (explosive gas) and of carbon dioxide (asphyxiants gas) in the mine workings of Valea Sărată salt mine newly opened salt mine. For the preparation of the documentation, the following elements were taken into account:

-The geological conditions of the salt deposit in the Valea Sărată mining perimeter;

-Existing records and documentation regarding previous occurrences of gas and their manifestation;

The results of quantitative and qualitative measurements in underground mining works, regarding:

-circulated air flows;

-gas concentrations: methane, its counterparts and carbon dioxide;

Establishing the release of gases in the underground atmosphere of the mining works. Based on the measurements and observations made, as well as the analysis of the previously mentioned elements, the underground mining works were included.

Keywords: salt mine, methane, carbon dioxide release, gas emission

1. Introduction

In Romania there are six salt mines which exploit the salt through underground mine workings: Praid salt mine, Tg. Ocna salt mine, Slanic Prahova salt mine, Ocnele Mari salt mine, Cacica salt mine, and Dej salt mine. these six salt pans belong to the Romanian state. At the same time, in Romania there are two private salt mines, one in Turda and the other in Dej-Nyires.

The purpose of this work is to verify the regime of methane releases (explosive gas) and carbon dioxide releases (asphyxiating gas), in the mining works within the Valea Sărată I Turda Saltworks, in order to maintain its classification.

The classification of underground mining works and the monitoring of the gas dynamic regime was carried out within two years, namely 2022 - 2023.

Based on the measurements and observations made, the analysis of the geological and mining elements taken into study, as well as the existing records and documentation regarding the previous occurrences of gas, the proposal was made to categorize the Valea Sărată I Turda Saltworks from the point of view of gas emissions. [1]

2. Geological and mining data

From an administrative point of view, the Valea Sărată I Turda perimeter is located in the outskirts of the Turda locality, Cluj county (Fig. 1).

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Access to the perimeter is via the European road E 60 and E 81 or the A3 highway up to the Turda municipality, then on the road network of the Turda municipality, up to the Turda Agricultural Research and Development Station, then on the road that connects Durgău lake and the commune Ploscoș. Also, access can be made on the railway line 300 Turda - Câmpia Turzii - Apahida - Cluj Napoca - Oradea.



Fig. 1. Location of Valea Sărată I Turda perimeter

The Turda Băi-Valea Sărată sector is, from a geological point of view, part of the area of the diapir folds in the western part of the Transylvania basin. Deposits belonging to the Neogene and the Quaternary take part in the geological composition of this sector.

The Badenian, represented by the Dej tuff at the base and limited to the upper part by the Apahida tuff. On the Salt Valley, the Badenian appears only with its upper part. The lower Badenian, represented by the Dej tuff and the white marls with globigerine, does not appear up to date.

The Upper Badenian is made up of formations with salt and gypsum - the halogen facies, over which is arranged the pelitic facies consisting of an argillaceous suite, the horizon of radiolarian schists with tuffaceous intercalations, over which follows a marl suite - the marl horizon with *Spiralis*. The succession of Badenian deposits reaches a thickness of over 1,000 m in the accumulation areas of the salt formation. The salt formation appears today in the Valea Sărată depression, and is covered on the flanks with clayey-marly deposits belonging to the pelitic facies of the Badenian, over which the Sarmatian is superimposed.

The Volhynian is present through two characteristic horizons, a lower horizon of approx. 350 m thick, bounded by the Apahida-Turda tuff at the base, the Ghiriș tuff at the top. This horizon appears well exposed during the day on the left side of the Aries river from the west of Turda, to the Valea Florilor and is present in a marly-clay facies with rare sandy-pebble intercalations. In the suite of this horizon, five layers of dacitic tuffs with variable thicknesses are found along the directives. The Flădăreni tuff with thicknesses of up to 12 m, located in succession at approx. 200 m below the Ghiriș tuff.

The Bessarabian was deposited over the Volhynian, on the left side of the Aries River; Downstream from the confluence of the Turda valley with the Aries river, a suite of deposits was separated consisting of packages of gray marls with intercalations of poorly cemented sandstones, microconglomerate sandstones with trovantes and layers of dacitic tuffs. On the left side of the Aries river it appears with thicknesses of approx. 250 m.

3. The current mining works executed at Valea Sărată

For the research of the rock salt deposit Valea Sărată I, after the execution of the research drillings, we moved on to the realization of some mining works consisting of - research well and access and research gallery.

The research well was made by mechanical digging, with the help of the pickon mounted on the mini-excavator. Along with the completion of the digging works or execution of the well equipping works by creating three compartments as follows: the personal circulation compartment equipped with ladders, the material transport compartment and the technical compartment for the installation of electrical networks, aeration columns and compressed air supply.

At the base of the well, also with the hydraulic pickon, a technical room was created in which the components of the point attack combination were brought, which after assembly or executed digging works.

Until now, all the works performed in the research well and the research gallery and contour have used non-destructive technology - dig with a combine.

The access and research gallery carried out from the surface was also executed using non-destructive technologies - 130 m, sterile excavation with combined support TH + shotcrete - in rock salt, excavation with combined point attack.

After the completion of the research works, these works will become the main works for ventilation, access and circulation.

4. The ventilation systems

The partial aeration of the Valea Sărată I Turda Saltworks is carried out in a reflow system with flexible aeration pipes with a diameter of 500mm.

The inclined plane is ventilated with the help of a centrifugal ventilation installation type MVR-A 800/4KB- being located on the surface, with the following technical characteristics,

- flow rate: 505 m³/min
- depression: 1800 Pa

being driven by an electric motor with the following parameters:

- power: PM = 18.5 kw
- speed: nM = 1420 rpm
- supply voltage: U = 380 V

The well was aerated with the help of a HPCHPO350 type centrifugal ventilation installation, being located on the surface, with the following technical characteristics,

- flow rate: 150 m³/min

being driven by an electric motor with the following parameters:

- power: PM = 7.5 kw
- speed: nM = 2935 rpm
- supply voltage: U = 380 V

The works related to the opening of the exploitation horizon were ventilated with the help of an installation equipped with an axial fan type AXC 1120-5/210-4 being located on the surface, with the following technical characteristics,

- flow rate: 850 m³/min

being driven by an electric motor with the following parameters:

- power: PM = 18.5 kw
- speed: nM = 1470 rpm
- supply voltage: U = 380 V

5. Specialized measurements carried out in underground mining works

In order to establish the regime of gas releases, respectively the classification category, depending on the presence of methane and carbon dioxide, during the months of October 2022 and October 2023, quantitative and qualitative measurements were carried out, both in the exhaust currents of the contaminated air from the mine, as well as in the active and inactive mining works in reserve.

The research of the presence of methane gas in the salt massif around the mining works was carried out by drilling test holes over 2 m long, in which a gas collection probe was inserted, which was sealed for 24 hours, as and stopping aeration in a 24-hour bag bottom job.

The results of the specific measurements performed are presented centrally in table 1 and 2. [1, 2, 3]

Table 1. Gas concentrations from the underground atmosphere of mining works

Nr. crt	No. station	Name of mining work	Composition of gases [% vol.]				Remarks
			O ₂	CH ₄	CO ₂	CO*	
1	A	General outlet stale air on the coastal gallery	20.8	0.0	0.14	0.0012	Total air exit from the inclined plane in the trench
2	B	Car contour gallery plan where the test holes were drilled	20.8	0.0	0.019	0.0011	In the gallery (where the probes were located approx. 35m front)
3	C	In the digging front of the inclined plane	20.8	0.0	0.10	0.0	In front of the forward combine
4	D	Bottom of the bag					End of plan
5	C	In the digging front of the inclined plane	19.7	0.0	1.21	0.0020	Ventilation off 24 hours

* The presence of carbon monoxide is due to gases emitted by internal combustion engine

Table 2. Qualitative measurements in the salt massive

Nr. crt.	No. station	Name of mining work	Rock	No. hole	Composition of gases [% vol.]			Composition of gases [% vol.]			Remarks
					Before sealing			After sealing 24 hours			
					O ₂	CH ₄	CO ₂	O ₂	CH ₄	CO ₂	
1	B	Perimeter gallery I (right side)	Salt	Front	20.8	0.0	0.1				About 35m from the interception
				F1	19.8	0.0	0.96	19.8	0.0	0.97	
				F2	19.8	0.0	0.96	19.7	0.0	0.98	
				F3	19.8	0.0	0.8	19.7	0.0	0.9	
2	B	Perimeter gallery I (left side)	Salt	Front	20.8	0.0	0.07				About 35m from the interception
				F1	19.7	0.0	0.1	19.5	0.0	1.1	
				F2	19.9	0.0	0.91	19.8	0.0	0.98	
				F3	19.8	0.0	0.80	19.80	0.0	0.88	

* the measurements were made at the level of the wells during the extraction, both at the ceiling of the work and at their base, recording the highest value.

6. Conclusions and proposals

The results of the measurements performed

The measurements and determinations carried out in the underground atmosphere highlighted the following:

A. lack of methane gas on the route of the mining works to exhaust the stale air from the salt pan, in the mining works under the depression of the main ventilation station, in the contouring works of the new panels, in the active, inactive and reserve work fronts;

B. the presence of carbon dioxide in the mining works that serve to evacuate the stale air in concentrations up to 0.1% vol.

The measurements and determinations carried out in the event of the partial aeration installations at the well being stopped and the contour and research galleries for the opening of the first exploitation horizon, highlighted:

- lack of methane gas in front of the gallery;
- the presence of carbon dioxide in concentrations between 0.04 and 0.1% by volume in the main ventilation currents;
- the presence of carbon dioxide in a concentration of 1.1% in the case of a 24-hour stoppage of the aeration installation in a work in the bottom of the bag.

The measurements and determinations made in the salt massif around the mining works highlighted:

- the lack of methane gas in the work fronts or during the demolition operation with the help of the salt advance combine, respectively in the research drillings executed in the salt massif in the inclined plane - car return niche and horizon I.

The results obtained from the measurements and determinations made in the underground atmosphere (Table 1) and in the salt massif (Table 2) around the mining works, also highlighted:

- ♣ lack of sulphide hydrogen;

♣ the presence of carbon monoxide in the atmosphere of the mining works and in the salt massif in concentrations of 0.0 - 0.0040 % vol.

♣ lack of gas pressure in the test holes executed in the salt massif;

♣ no blowouts or other phenomena of gas manifestation were reported.

At the same time in drawing No. 1 shows the orientation scheme of the aeration network and the places where measurements were made in the Valea Sărată I Turda Saltworks.

Based on the specific measurements carried out and the existing records regarding gas emissions, it is proposed to place the Valea Sărată I Turda salt mine in the:

- "NON-FIREDAMP REGIME" from the point of view of methane emissions;
- "CATEGORY I" from the point of view of carbon dioxide emissions. [3]

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