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THERAPEUTIC AND TOURISM RECOVERY OF MICROCLIMATE FROM PRAID AND TURDA SALT MINES

CAMELIA BIANCA TOMA[1], I.A. IRIMUŞ[1]

ABSTRACT. – Therapeutic and Tourism Recovery of Microclimate from Praid and Turda Salt Mines. Saliferous area Praid – Sovata – Corund is situated on the contact area of the Transylvanian Basin with neo-eruptive mountain chain of Eastern Carpathians, Calimani – Gurghiu – Harghita, and at the contact of Târnave Plateau with the orogenic alignment of Gurghiu – Harghita Mountains. The beginnings of salt exploitation in Praid dates back to the Roman era. Underground salt exploitation began in 1762, in the south-west of Salt Hill, and continues today.

The salt massif from Turda develops on the anticline Sic –Cojocna – Turda, oriented NE – SW, 2 km NE of Turda downtown. Archaeological evidence of the salt exploitation from Durgau-Turda, exist since the pre-Roman period (50 BC-106 AD). Other documents proving the exploitation in Turda date since the sixteenth and seventeenth centuries, during the Hungarian and Austrian dominions. Exploitation continued until 1932, when they were stopped because of primitive technical equipment, low efficiency and competition from other Transylvanian salt mines.

The holes resulting from exploitation were arranged and turned into treatment rooms for those affected by respiratory diseases.

The underground treatment from Praid salt mine, started by the 1960s in Doja mine, and in in 1992 at Turda Salt Mine. These underground treatments are possible due to the microclimate which was formed in the salt mines.

Keywords: *microclimate, salt, Praid, Turda, treatment.*

1. INTRODUCTION

Recognition and therapeutic use of the saline microclimate, especially in recent decades, started from a series of observations, from early nineteenth century, namely: absence of disease of chronic bronchitis and asthma to the miners of salt mines in Wieliczka (Poland), and fast healing of the disease to new employees, improvement to the disappearance of asthma in asthmatic patients, refugees during the two world wars, in Kluttert cave (Germany) developed in salt, used as shelter during the bombing (***, 1989). Therefore, treatment of respiratory diseases within the salt mines, is now recognized as effective and with reliable results to improve, statistically interpreted in the whole world.

[1] *"Babes-Bolyai" University, Faculty of Geography, 400006, Cluj-Napoca, România, emails: camelia.toma@ubbcluj.ro, irimus@geografie.ubbcluj.ro*

In Romania this type of treatment is successfully practiced, in several mines, which have stopped or still continue the production. The speleo-therapeutic potential of Romania is one of the most well represented in Europe. Such mines are: Tg. Ocna, Slanic Prahova, Praid, Ocna Dej, Cacica, Turda, but we will focus only on the exploitation of Praid and Turda microclimate. The microclimate measurements were made by the Institute of Physical Medicine, Rehabilitation and Medical Balneoclimatology.

2. SALT SITES DESCRIPTION AND BRIEF HISTORY OF THEIR EXPLOITATION

2. 1. Praid salt ore

Praid-Sovata-Corund saliferous area belongs to Praid-Sovata diapir anticline, located in the eastern diapir area of the Transylvanian Basin, at the contact with neo-eruptive mountain chain of Eastern Carpathians, Calimani-Gurghiu-Harghita, and at the contact of Târnave Plateau with the orogen alignment of Gurghiu-Harghita Mountains.

Praid Basin include "Salt Hill" diapir structure, with development in the localities Praid, Ocna de Sus and Ocna de Jos. The salt massif presents, in its surface morphology, a triangular shape, whose top, in a southerly direction, is directed to Corund village, and in North and West it merges with Sovata Basin. Salt Hill, or "Back Salt", as locals call it, has a nipple shaped, quasi-circular, and hides in his basement, the salt diapir massive, and has a maximum altitude of 571.8 m (Horvath, I., 2009).

The salt body, in the horizontal plane, has a quasi-circular shape, slightly ellipsoidal, with diameters of 1.2 and 1.4 km, and is estimated to have a burial depth of 2.6 to 2.8 km. The salt massif from Praid pierce the Mio-Pliocene blanket around and appears at the surface as diapir. This deposit belongs to the most representative salt diapirs from Europe. The volume of salt rock stuck in this diapir massif could provide the necessary of salt, of the European continent, for several hundred years (Irimus, I.A., 2006).

Praid deposit has been exploited, with interruptions, from Roman times. The first document of salt exploitation in Praid, is from 1405, the time of Sigismund of Luxembourg. During that time, the work was made only in winter time: from November 15 till April 15. Joseph mine was opened in 1762, under the Austrian specialist Aladár Frendl, and was exploited to a depth of 55m, with ogival profile (bell mine). In the literature, the first references to the opening of the mines are those of Johann Fichtel (1780). The salt pits from Praid pass into the Vienna Royal Court property, starting with 1787, when the organized exploitation actually began. The operation of Paralela Mine begins in 1864, with trapezoidal profile, which in the end (1949) reached a depth of 90.9 m. A series of galleries and small research rooms have been executed from 1989 to identify new areas of operation. Elizabeth Gallery was made after the execution of these small rooms and galleries, and crossed the salt mountain on North-South direction, and it was used, for a long time, to drain the infiltration rain water.

G. Dozsa Mine opened between 1949 - 1950, keeping a pillar of 40 m width, away from Paralela mine. In G. Dozsa mine, three large trapezoidal rooms were operated

having the final height of 70.2 m, and a series of rooms including under the two old mines: Joseph and Paralela.

The salt rock, today, is operated under the old mines, to which was kept a safety floor of 40 m thickness, with small rooms and long rectangular pillars, in the bunk down system (the lower horizons). The salt exploitation is held, also (since 1994) in the north-east of the deposit - Telegdy mining sector – where the small rooms and square pillars method is used (Canadian way) (Horvath, I., 2001).

2. 2. Turda salt ore

Turda salt ore develops on the anticline Sic-Cojocna-Turda, oriented North-East – South-West, 2 km North-East of Turda downtown. The salt body has an elongated shape, about 4 km long, with widths ranging from 700 m to 200 m and also with a thickness ranging from 750 m to over 1000 m. Turda deposit is more complex because it basically consists of two salt massifs, which are in the eastern part of town. The first massif is situated in the Salt Valley and has a lenticular shape and the second one is in the Roman Baths area and has an ellipsoidal shape. Both massifs are united in Dumbrava synclinal area, and together form a salt deposit estimated at 38 billion tons. The salt deposit, in terms of stratigraphy, is surrounded by deposits belonging to Badenian, Sarmatian and Quaternary (Nicoleta Brişan, 2004).

Archaeological evidence of the salt exploitation from Durgau-Turda, exist since the pre-Roman period (50 BC-106 AD), and the Romans (106-274 AD) have exploited the salt from Durgau, in pyramid rooms 17-34 m deep and 10-12 m wide, but the first document that tells about the existence of a salt exploitation in Turda, is issued by the Hungarian Chancellery on the 1st of May 1271.

From existing documents dating from XIII - XVI centuries, it is shown that the salt exploitation in Turda, in that period, was located on the current location of the salt lakes, at the Salt Baths micro-basin and the South-East slope of the Salt Valley. The opening works of the “Terezia” Mine are initiated in 1960, and in short time, the “St. Anton” mine also opened, an area where the mining activity continues until the first half of the twentieth century (Mera,O., Stefanie, T., Vişinescu, V., 2010).

At the beginning, Turda Salt Mine was one of the most important mines in Transylvania, but after 1840 it started to decline due to increased competition of Ocna Mures. The construction of "Franz Joseph" gallery was completed in 1870, and was designed to facilitate the salt transport, with a length of 780 m, being extended, until the end of the century, with 137 m. The salt exploitation in “Anton” pit was abandoned in 1862, because of the presence of massive amounts of sterile inside the extracted salt, and in 1864 they started to modernize and completing the "Teresa" pit with two side rooms, "Rudolf" and "Ghizela". Exploitation continued until 1932, when it was stopped because of primitive technical equipment, low efficiency and competition from other Transylvanian salt mines (Irimuş, I. A., 2006).

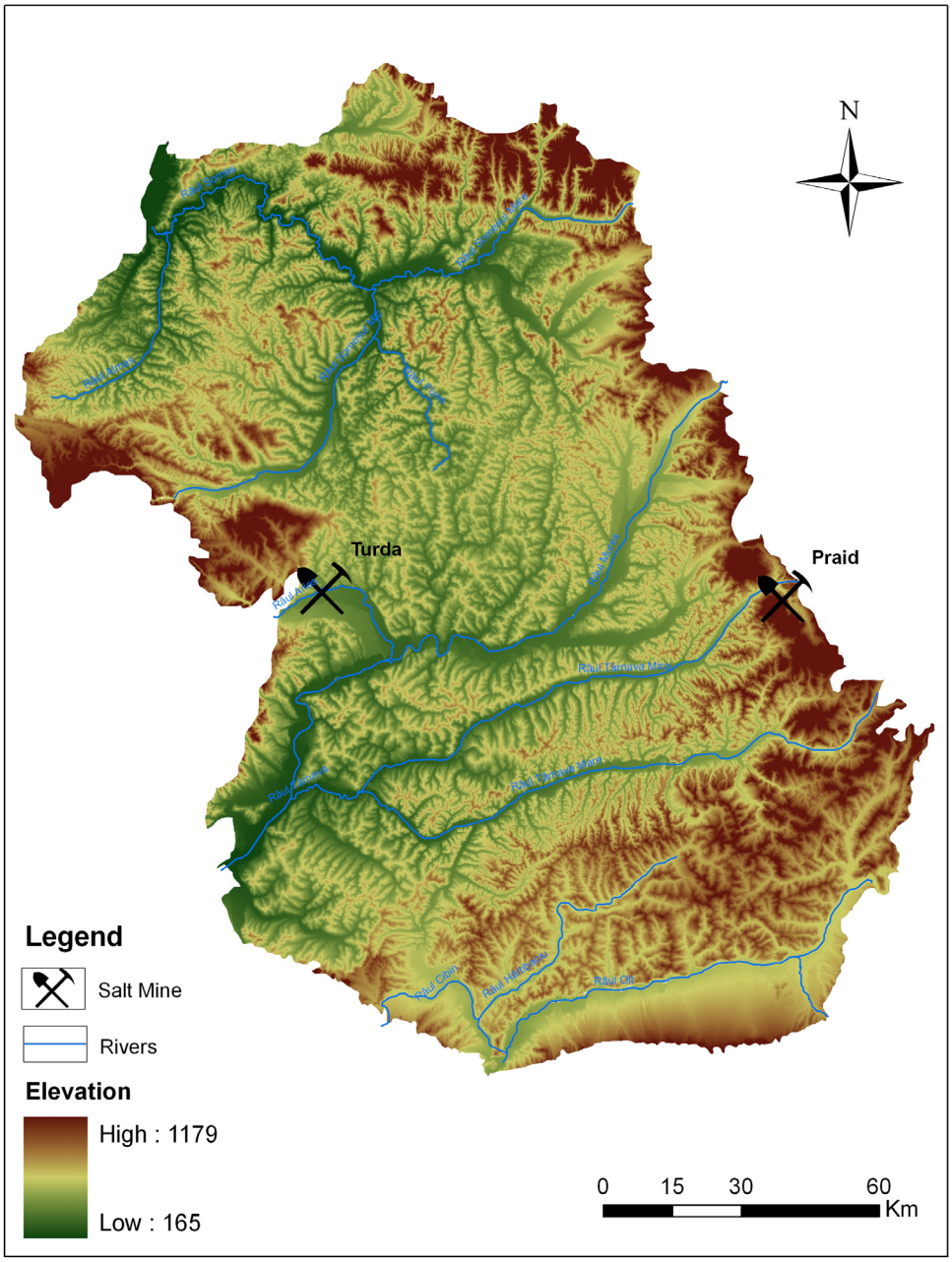

Fig. 1. The location of Praid and Turda salt mines.

3. FEATURES OF PRAID AND TURDA MICROCLIMATES

3. 1. The microclimate from Praid Salt Mine and its recovery

The microclimate from Praid Salt Mine is distinguished by the following features:

- *High degree of air purity (sterility)*, because in Praid Salt Mine the number of germs varies between 180-270 pieces/cm3. Here some certain mycological types (Mycromicetes) are present also, some of which are used to produce antibiotics (eg. like Penicillium);

- *The air temperature is constant.* In Praid Salt Mine, during cold times, temperature is 15.4 to 16.4 °C, and during summer is 15.8 °C, so maximum variation is only 0.2 ° C. The rock temperature is between 15.4 to 16.4 ° C. The determining factor is not only the temperature but rather her constant character;

- *Secondary action of relatively low temperature.* Relatively cold air, from galleries and mine rooms, like cold aerosols has a stimulating action on the "cough receptors" in the body;

- *Relatively high air humidity (vapor content).* In the current treatment rooms, relative vapor content is 71% (70% at the hall entrance), which is maintained at all times of the seasons, in this way providing a constantly fluid environment, regardless of outside conditions;

- *Favorable content of vapor condensation.* Inside Praid mine air, microscopic salt particles, in suspension have a healing effect. These crystal particles of sodium chloride (NaCl), with sizes below 5 microns (50% of them), during the inspiration, enter the lungs down to the alveolar level. Beside Ca_2+ ions, dominant in the saline air, other aerosols are present in the rich sulphate, nitrates, ammonium, Mg, K, Na, I and Brom ions. They float through microscopic drops of water and thus complete the therapeutic effect of Ca and Na particles;

- *Low speed of air currents.* Section of the treatment and visiting rooms from Praid, varies between values of 240-250 m^2, so because of these dimensions, the human body can not see air currents, so there is no feeling of cold. Air velocity measured in the salt mine is 0.2 to 0.3 m/sec. and is independent of outside weather conditions;

- *The high content of carbon dioxide in the air.* In the air of Praid Salt Mine, the CO_2 content varies between 611-799 mg/m^3, which increased the inspired air with 1.0 to 1.5 l/min, thus accelerating lung ventilation;

- *Large negative ionizers (high number microns).* At Praid, the ionizer level varies between 413-580 ion/m^3, weight of negative ions is slightly positive in summer (natural radioactivity in saline air expressed in Ra 222 is 1.5 to 1.9 x10-13 Curie/liter, which is 2-3 times higher than in the atmosphere from surface);

- *Very low ozone in the air.* The lack of ozone (O_3 +) in the saline air, in medical terms of means higher purity, reduces smooth muscle convulsions. Low concentration of reducing material is inversely proportional to the degree of air purity;

- *The air pH is low (acidic character).* Low pH of saline air (at Praid is between 6.5 to 6.9), contribute to air disinfection and reduce bacterial flora;

- *Partial pressure of oxygen is high.* In Praid Salt Mine underground, the pressure is 734 mm Hgm/m in October, and 726 Hgm /m in June, so it is directly related to the pressure variation from the surface (Armaş I., Demian R., Verga M., Horvath I., 2004).

Given the peculiarities of Praid Salt Mine microclimate, one can state its therapeutic value for treating respiratory diseases.

In Praid Salt Mine, the underground treatment started by 1960s in Doja mine. Speleotherapy and climatic-therapy treatment, includes practically, inhaling the air from the mine, being useful for respiratory diseases (diseases as asthma, bronchitis and allergy). Treatment duration is 18 days, for adults, and 10-12 days for children, 4 hours per day spent in the salt mine. During the time spent in underground, gymnastics led by a specialist is also recommended, as well as walks and dosage exercise. Age category people that can be treated is between 2 and 60 years and they are constantly monitored by medical staff. In the treatment base, both patients with respiratory diseases and tourists who visit the exploitation rooms from Praid Salt Mine have access. Aerosol treatment of patients is done under constant supervision of medical staff. In summer season, an average of 1500 patients and from 1000 to 1500 visitors enter daily in the treatment base. In other periods, the number of patients and visitors is much less, about 100 to 300 daily.

In 1980, treatment was displaced to horizon "50", which is at a depth of 120 m from surface. This space contains operating rooms no. 657, 656 / A, 655, 653, 654, 651 and 652, a total area of 9400 sqm with a 20 m width and 14m height. Access to underground is made by bus through a coast gallery, on an incline, 1250 m long within mine. The treatment base is served by six medical staff and are arranged some first aid room, and for babies are arranged two houses, where you can change diapers and feed. For entertainment, some arrangements were made inside the mine: it was built a church (fig. 2), a playground for children with wooden toys, a gym space (fig. 3), a museum (fig. 4), a restaurant (fig. 5), a tennis table and a small library and gifts hops. The entire surface of mine has internet access (Horvath, I., 2004, 2009).

The number of people who seek this treatment is increasing and is characterized by annual return of the patients with a maximum in summer.

Fig. 2. The church from Praid Salt Mine.

Fig. 3. The gym from Praid Salt Mine.

Fig. 4. The Museum in Praid Salt Mine.

Fig. 5. The Restaurant in Praid Salt Mine.

3. 2. The microclimate of Turda Salt Mine and its recovery

The microclimate from Turda Salt Mine is distinguished by the following features:

- *The air temperature* in the cold season is between 7.2 ° C and 9.3 ° C. During summer, the temperature is between 9.2 and 10 ° C, 2 ° C. So, the temperatures are slightly higher than in winter, the difference between the average values of the temperature in the winter (9.3 ° C) and the values in the summer (10.2 ° C) is less than 1 ° C, which shows, the thermal invariation of the microclimate from one season to another;

- *Relative air humidity* ranged from 60-76% in winter season (average 67.5%) and 72-80% in the warm season (average 75.8%), in both cases being higher than outside. Differences between observation points are more evident in winter, in summer, values are more homogeneous;

- *Air currents speed* is reduced in the salt mine, is more obvious near the vents and openings for entry. Thus, in winter, values range from 0.3 to 0.4 m/s. For summer are observed differences between rooms, in the way that, the new opening, raises the velocity currents in small rooms up to 0.16 m/s, while, in Rudolf mine is maintaining a null velocity;

- *The pressure* is 1.2 mm lower to the upper level of the mine from outside, and 5-6 mm higher at the floor level of Rudolf mine from the upper corridor, reported to a altitude difference of about 60 m;

- *Thermal comfort index* expressed by equivalent effective temperature, namely, effective temperature felt by humans, based on actual temperature, humidity and air currents rate, indicating values from 7.1 to 10.4 ° TEE in the cold semester, and 9.1 to 11 ° TEE in the warm semester. These intervals, encircle Turda Salt Mine microclimate within the category of discomfort by cooling, showing a moderate cooling index;

- *Pulmonary stress* calculated on the values of water vapor pressure, size ranging between 5.6 and 7.6 mb, shows a slightly dehydrated character in all rooms inside the saline, and a balanced character in entry areas, at the vents;

- *Concentration of aerosols* particles varies between 130-250/cm3 with a rate of 80-95% particles below 3 mm, so with access to the pulmonary alveoli;

- *CO_2 concentrations* ranged from 724-840 mg/m^3, the minimum in the upper side of Rudolf mine, and maximum in table room;

- Nitrogen dioxide concentration is in all cases well below the standard of 10 mg/m^3;

- *Air pH* is around neutral point, slightly basic, indicating the absence of mineral acids in the air inside the mine (***, 1989; Mera, O., 2010).

A new company to manage and exploit tourism and therapeutic potential of old salt mine from Turda, was founded at the end of 1991, following discussions between representatives of Tourism Aries, SA Turda and Transgex S.A. Cluj companies, with those of Turda City Hall. Turda Salt Mine was open to the public in April 1992, after some small design.

Turda Salt Mine was closed in 2008 for an extensive modernization process in a PHARE 2005 project, and opened for tourists in January 2010. The salt mine is now equipped with the new treatment rooms, and the old operating rooms received a new look and enhanced functionality. Thus, in Rudolf Mine (fig. 6) rearrangements were made in order to have a concert hall, a sports field, a bowling, a minigolf (fig. 7) but also a huge gondola and an elevator. Also, on the lake from Theresa Mine (fig. 8) a dock with boats was built (fig. 9). Overall, Turda salt mine appearance has changed radically.

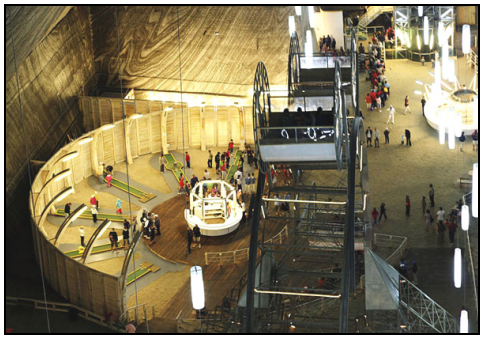

Fig. 6. Rudolf Mine, Turda Salt Mine.

Fig. 7. Minigolf in Turda Salt Mine.

Fig. 8. Terezia Mine, Turda Salt Mine.

Fig. 9. Dock with boats, the Theresa Mine, Turda Salt Mine.

4. CONCLUSIONS

Results obtained in all these years, increasing number of patients and tourists, is a guarantee that these salt mines can be used with good results for therapeutic purposes.

Favorable results of therapeutic treatments, obtained during this time, 17 years of activity in Turda Salt Mine, and 52 years of activity in Praid Salt Mine, are attributed to these specific conditions observed in these places: constant air temperature, relative air humidity, salt aerosols presence in the form of solid particles, and the lack of air- pollutants and pathogen germs.

Saline microclimates are similar, but there are some differences: air temperature, which in Praid Salt Mine is higher than in Turda Salt Mine with 4-5 degrees; temperature variation from winter to summer, in Praid Salt Mine the difference is only 0.2 °C, while in Turda Salt Mine it is 1 °C; and relative air humidity, which in Praid Salt Mine is constant, but in Turda Salt Mine it presents certain differences between winter and summer.

Thanks to these beneficial actions of microclimates on the human body, the number of patients and especially that of tourists is increasing every year, reaching mines reputation abroad. In Turda Salt Mine, the number of patients together with the number of visitors reached 64 000 in 2008, and in Praid Salt Mine, in the same year, the number of patients with that of tourists was 430 000.

It must be remembered that there are just a few therapeutic bases like these, in Transylvania, and is a good idea to use them for therapeutic and tourist purposes.

Improvement of these two mines, which are the most important in Transylvania, as an underground sanatorium, is an important objective, which allows full exploitation of the natural factors of the areas.

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