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A SURVEY ON THE EFFECT OF VISITORS ON FLUCTUATIONS OF CARBON DIOXIDE IN THE ALI SADR CAVE IN HAMADAN (BASED ON THE ALTITUDE OF THE CORRIDORS)

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ABSTRACT

Naturally, as tourists enter the cave, the climatic elements of the cave and the density of the available gases change and transform the micro-climate inside the cave dramatically. Carbon Dioxide as one of the available gas in the air plays an important role in visitors' health and also in changing Carbonate forms inside the caves To this end, the present study has investigated carbon dioxide concentration inside Ali Sadr Cave which has been measured three times a day within 30 days in experimental corridors (where visitors and tourists can visit) and the control corridors (the prohibited region). The results show that the number of visitors has a great influence on concentration of Carbon Dioxide inside the cave.

Keywords: Visitors, Carbon Dioxide concentration, Ali-Sadr Cave, small corridors, large corridors.

INTRODUCTION

When water percolates through the rocks (chalk stone, salt, and gypsum) leads to their erosion and they are dissolved in the water and cavity is formed. The cavity gradually turns into underground passages. The water constantly dissolves the rocks and the cavity grows and becomes larger. This open area is called a cave. When water percolates through limestone and other minerals, they are dissolved. So, the minerals and salts are deposited in the ceiling and the walls of the cave. And stalactites andstalagmites are formed.

The caves are defined as geomorphological processes and forms which contribute to understand the evolution of the earth. They are one of the most effective and worthy geo-sites in Geo-tourism industry. Ali Sadr Cave geo-site is one of the unique tourist attractions in the world and is a combination of scientific, rarity, aesthetic features and display geological history. It represents the phenomena which not only possesses geological value, but also are valuable in terms of paleontology and geological heritage.

Mainly, Carbon Dioxide concentration in the caves has a natural and biological origin (source), but in the cave with high visitors and geo-tourists, their inhale and exhale processes lead to Carbon Dioxide concentration in the cave. Carbon Dioxide leads to calcium dissolution. High humidity levels of calcium caused by condensation of water vapor inside the cave leads to absorption of Carbon Dioxide in the air and carbonic acid is formed and calcite is dissolved. This is called dissolution and it depends on Carbon Dioxide concentration in the cave.

Polluted air inside the cave threatens speleologists, cavers, and visitors. This problem is observed in most caves in the world. High concentration of polluted air in the cave may become a death trap for those who are not aware of the symptoms.

Unfortunately, uncontrolled presence of tourists, lack of studies on the effect of tourism on cave ecosystems and unsystematic management of installation for arrival and departure of tourists have damaged natural transformation of geomorphological forms in some touristy caves in Iran. The changes that tourists impose on the caves is the function of the number of tourists, the average time of their presence and also the cave features such as size, volume, location and the capacity of natural ventilation. Some part of basic mechanisms of the changes caused by human being inside the cave is due to the accumulation of Carbon Dioxide, temperature, evaporation, and density. These mechanisms lead to dissolution of the forms inside the cave such as stalactites and stalagmites, curtains, columns and cauliflower forms and so on. Carbon Dioxide produced due to the respiration processes of visitors causes destructive effects on the cave formations.

Ali Sadr cave as one of the most attractive caves for tourists in Iran attracts more than 100000 tourists each year. Authorities aim to increase the number of tourists up to 50%. As the tourist number increases, more changes are observed in the climate elements of the cave such as temperature, relative humidity, and etc. Carbon Dioxide as one of the available gases in the air is a threat for health if it exceeds the standard amount. In other hand, it threatens transformation of the forms inside the cave. So the present study aims to investigate the role of tourists in changing Carbon Dioxide concentration inside Ali Sadr cave based on the difference in altitude and dimension.

METHODOLOGY AND MATERIALS

In order to achieve the aims of the study, the corridors inside Ali Sadr Cave have been divided into two parts: experimental region (where visitors and tourists can visit) and the control region (the prohibited region for the public and those areas which have not hooked up to the electricity yet and are far from the tourists access). Sampling procedure was done three times a day in the morning (before tourists arrival) and at noon and at night (after tourists arrival) in different parts of the experimental and the control area. The sampling was done using a three – functional Carbone Dioxide Detector Machine AZ (77535) made in Taiwan.

Due to carbon dioxide fluctuations in different areas inside the cave, the halls and the corridors inside the cave have been divided into three parts:

1. **Low height corridors** (its ceiling height ranges between 0 to 3 meters above the ground surface and water level)
2. **Medium height corridors** (their ceiling height ranges between 3 to 7 meters above the ground surface and the water level)
3. **High corridors** (their ceiling high is above 7 meters). Considering the vast number of halls and corridors, the samples (carbon dioxide density measurements) were not extracted from the predetermined areas but the researchers moved inside the cave and measured Carbon Dioxide density at different distances and then these random measurements determined the average Carbon Dioxide density along with the time of recording. The present study has been an attempt to determine the role of the tourists in changing the Carbon Dioxide density inside Ali Sadr Cave based on measuring Carbon Dioxide density of the control and the experimental areas inside the cave and find the gap between these two areas. Because it was likely that the entered air from the entrances affected Carbon Dioxide density inside the cave, Carbon Dioxide

density was measured at a distance of 200 meters far from the cave entrance. The sampling was done within 30 full days between the dates 22.5.1393 to 20.6.1393.

RESULTS

Small Corridors

Small corridors are those sampling areas with low height (its ceiling height ranges between 0 to 3 meters above the ground surface. Table 1 shows the daily average measurements of Carbon Dioxide within 30 days in both the experimental and control areas of the small corridors inside Ali Sadr Cave. The average of the Carbon Dioxide in the experimental areas of the small corridors was 3096, 3449 and 3743 in the morning, at noon and at night respectively. At the same time, the average of the Carbon Dioxide in the control areas of the small corridors was 311, 357 and 444 respectively. The average of Carbon Dioxide in the control areas in the morning was 311. An important point is that at the same time, the average of Carbon Dioxide for the experimental areas was 3069. This difference is the result of the left Carbon Dioxide from the previous days. The average of Carbon Dioxide amount measured within 30 days in the small corridors and at night after the departure (exit) of the tourists in the experimental areas was 3743. Thus, the difference between the average of the Carbon Dioxide amount in the morning in the control areas and at night in the experimental areas, ignoring 2758 (the difference between the Carbon Dioxide density of the samples taken in the morning in the experimental and control areas of small corridors, i.e. 958 can be considered as the role of the tourism in increasing Carbon Dioxide amount inside the Ali Sadr Cave, Hamadan, within the 30 days of sampling.

Table1: The monthly average score of Carbon Dioxide amount of the samples taken from the experimental and the Control areas of the small corridors (Ali Sadr Cave, Hamadan)

No	Time of sample taking	Dimensions of corridors Areas of sample taking	Small corridors
1	Average of morning sample taking	Experimental area	3096
		Control area	311
2	Average of noon sample taking	Experimental area	3449
		Control area	357
3	Average of evening sample taking	Experimental area	3743
		Control area	444
4	Difference between control and experimental areas(morning and evening)		3432
5	The role of visitors within 30 days of sampling		958

1.1. The daily variations in Carbon Dioxide inside small corridors:

Daily variations (during the morning, noon and night) in the Carbon Dioxide amount in small corridors in the Ali Sadr Cave are illustrated in figure1. As this figure shows, in each corridor, we see 4 peaks which coincide with the holidays and the increasing number of visitors on those days. Carbon Dioxide amount of takings in the morning in small corridors exceeded 4000 and reached over 4100 in certain weekend nights.

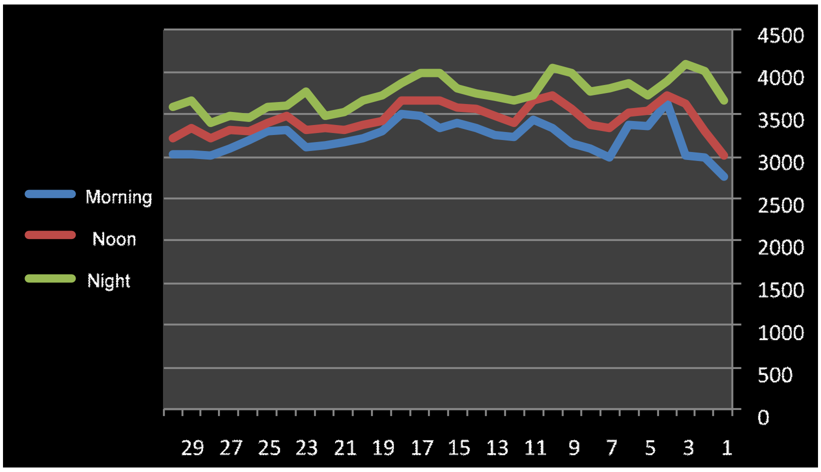

***Figure 1: Daily variations in Carbon Dioxide amount in small corridors (Ali Sadr Cave).**

Medium corridors

Medium height corridors are those corridors which their ceiling height ranges between 3 to 7 meters above the ground surface and the water level. The average scores of the Carbon Dioxide of the samples taken within 30 days in the morning, at noon and at night in the experimental points were 3156, 3384 and 3671 respectively. At the same time, the average monthly Carbon Dioxide amount in the control areas inside the cave for the samples obtained in the morning, at noon and at night were 98%, 97.6% and 97% respectively (table2).

The difference between the control area samples which were taken in the morning and those of experimental areas taken at night i.e. 3283(ppm) can be considered as the effect of the tourists on increasing Carbon Dioxide amount inside the medium-sized corridors inside the Ali Sadr Cave. But as was pointed out before, a significant amount of Carbon Dioxide which has been produced by visitors is accumulated inside the cave. so the difference between takings in the morning in the control and the experimental areas(points) minus those of night shows the effect of visitors in increasing Carbon

Dioxide amount inside the cave within 30 days of sampling i.e. 903(ppm).

Table2: The average monthly Carbon Dioxide amount of the sample taken in the control and experimental points of medium-sized corridors inside Ali Sadr Cave (Hamadan)

No	Time of sample taking	Dimensions of corridors / Areas of sample taking	Medium-sized corridors
1	Average of morning sample taking	Experimental area	3156
		Control area	388
2	Average of noon sample taking	Experimental area	3384
		Control area	454
3	Average of evening sample taking	Experimental area	3671
		Control area	497
4	Difference between control and experimental areas(morning and evening)		3283
5	The role of visitors within 30 days of sampling		903

2.1. The average daily variations and fluctuations of Carbon Dioxide in the medium-sized corridors:

Figure 2 shows the daily average values of the Carbon Dioxide in the medium corridors of Ali Sadr Cave. It is important to notice that as in small corridors in medium-sized corridors also we can see 4 peaks which coincide with the holidays and the increasing number of visitors on those days. So the level of Carbon Dioxide of takings in the night in medium-sized corridors was lower than that of small corridors.

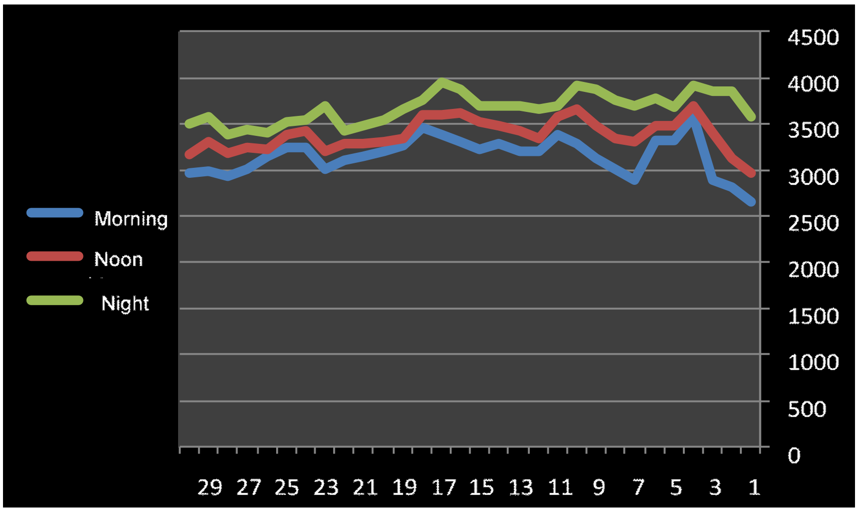

Figure 2: Diagram of changes and fluctuations of the amount of CARBON DIOXIDE in medium Corridors (Ali Sadr Cave, Hamedan)

3. Large Corridors

Large corridors are those taking points inside the cave which their ceiling high is above 7 meters. Table 3 shows the average monthly Carbon Dioxide amount taken from the control and the experimental points in the large corridors of Ali Sadr Cave. The experimental points of the large corridors which cover a limited area of the cave show lower amount of Carbon Dioxide compare to other areas due to larger space. In these corridors, the difference between the average of Carbon Dioxide amount of the samples taken during the morning in the control points and that of the samples taken at night in the experimental points is 3148 (ppm) which can be considered as the impact of the tourists excluding the amount of Carbon Dioxide concentrated before sampling.

The difference between Carbon Dioxide amount of takings in the morning in the experimental and control points minus those obtained at night i.e. 3632 shows the amount of the Carbon Dioxide produced by visitors within 30 days of sampling i.e. 987(ppm).

3.1. Daily variations and fluctuations in the Carbon Dioxide amount in the large corridors:

It is important to notice that as what was measured in small corridors and medium corridors we can also see certain peaks in large corridors which coincide with the holidays and the increasing number of visitors on those days (figure 3).

Table 3: The average monthly Carbon Dioxide amount of the samples taken from the control and experimental points in large corridors (Ali Sadr Cave, Hamadan).

No	Time of sample taking	Dimensions of corridors / Areas of sample taking	large corridors
1	Average of morning sample taking	Experimental area	3129
		Control area	484
2	Average of noon sample taking	Experimental area	3332
		Control area	561
3	Average of evening sample taking	Experimental area	3632
		Control area	645
4	Difference between control and experimental areas(morning and evening)		3148
5	The role of visitors within 30 days of sampling		987

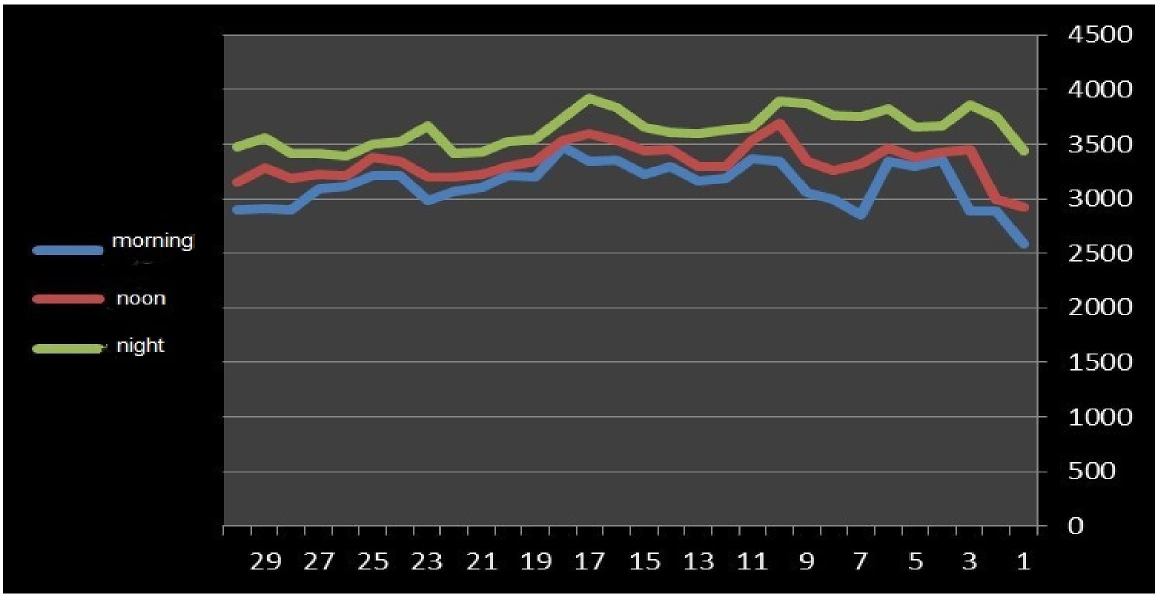

*Figure 3: the daily variations in Carbon Dioxide amount in large corridors (Ali Sadr Cave).

CONCLUSION

The caves and Karst formations have sensitive ecosystems. Human being always has been attracted by the caves beauty and this attraction has stimulated them to visit the caves and find and discover their unknown. In spite of this human being are not always cautious creatures. This interest has destroyed some parts of the caves. Ignoring the fact that animals which live in the caves threat them, destroying the caves formations have been occurred over thousands of years and this hurt their beauty and this is not compensable.

Tourists and visitors cause some changes in the climate elements of the cave, increase Carbon Dioxide concentration and cause harm to carbonate forms and in turn threaten cave ecosystem and stalactites and stalagmites.

Due to low natural ventilation and high number of visitors, along with the high humidity inside the caves, increase in Carbon Dioxide concentration inside the cave leads to the formation of a weak acid. The acid causes erosion and dissolution of calcite forms and threatens the beauty of the caves. On the other hand, concentration of Carbon Dioxide above 5000(ppm) inside the caves threatens visitors health. Thus regular assessment of Carbon Dioxide concentration inside the cave is essential. Considering the high number of visitors, Ali Sadr Cave in Hamadan needs more detailed studies.

REFERENCES

1-Tavasoli, Abas; Polluted Air in Limestone Caves and its Impact on the Speleologist, thirty-first meeting of geoscience, Geological and Mineral Exploration organization, Tehran,1391.

2- Ghobadi, Mohammad Hossein and Farmani Setareh, Mansour, Geo-tourist analysis of Geo-site of Ali Sadr Cave Using Pereira Method, Articles of the thirty-second meeting, and the first international Congress of Geoscience, Geological and Mineral Exploration organization, Hamedan, 1392.

3- Najaei,Yuosef, Ali Sadr Cave, Nazeli Press, Hamedan,1388.

4. Baldini, James U. L.;Baldini, Lisa M;McDermott Frank and Nicholas Clipson, "Carbon dioxide sources, sinks, and spatial variability in shallow temperate zone caves: Evidence from Ballynamintra Cave", Ireland. Journal of Cave and Karst Studies, v. 68, 2006, p. 1-4.