

Study on Cave Environment Features and Preservation Methodologies

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I. Preface

Our ancestors used natural cave as prehistoric settlements, shelters and storages of harvested goods in a long time ago. Archeologists or anthropologists use caves to investigate pre-historic civilization, and geomorphologies study caves' geographical features and cave-micro landscapes. Since caves are formed in the underground, they give distinctive features compared to other natural tourism resources. With its preserved ancient mysteries and all-weather tourism features, caves have become more attractive resources and tourism materials for developers and tourists. These natural caves contribute to enhancing local community's growth and are also used for promoting local community's unique features. They are recognized as a high profit yielding tourism resources, so local community and relevant municipal

governments actively pursue cave development and actually acquire many benefits from them.

Especially, the caves that are located in Danyang and Yeongwol areas have generated high tourism relevant profits with their great advantage in location along with its high accessibility from metropolitan areas. The Hwanseon Cave in Samcheok City has seen a great success. Samcheok City actively implemented tourism-inclined projects by utilizing cave resources and also by hosting the World Cave Expo.

However, these cave developments are emphasizing local economy boost than natural environment preservation. Korea's current cave developments allow unlimited visitors, causing pollution and modifications on natural environment of caves. However, there still lack systemized efforts for natural environment preservation and restoration.

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In this regard, this study aims to investigate factors that cause cave's environment changes and seeks preventive measures to restore the cave from pollution. Then, this study will propose cave environment preservation methodologies.

II. Cave's unique environment features and factors that cause changes

Initially, the cave environment is an unpolluted underground realm unlike the ground world. Cave has well preserved natural environment where we can glimpse at the ancient history and mysteries from old civilizations and is free from air pollution or water pollution. They were the center of academic researches and scientific observations in various fields. Generally, cave environment features high humidity and steady temperatures for all around year. Only under this environment, the cave creatures can survive while keeping their unique features.

Cave starts to undergo drastic transitions from the first moment of development. The cave environment is always the world of darkness and was not influenced by the external air. This enabled maintaining steady temperature with almost no

temperature fluctuation, and the interior of cave always has high humidity. The surface water absorbed from the ground level dissolves stones and underground locks, and this process forms caves.

In sum, the cave interior is dark, humid and maintains steady temperature, so the cave dwelling creatures show high resistances to darkness, temperature and humidity. Also, the inside of cave is formed with highly specific ecological system. Under these circumstances, the cave-micro landscape and speleothem are created.

Cave's natural environment should be protected to preserve the specific ecological system within the cave.

III. Cave environment preservation methodologies

The changes in cave ecosystem and cave environment can be shown in three pollution features as of white pollution, green pollution and black pollution.

White pollution is due to the atmosphere change within the cave. The causes are the increase of carbon dioxide and temperature rise and inflow of external air through the exit (entrance) doors. In fact, the cave

temperature and humidity are critical to the existence of cave creatures and the speleothem. The followings are various methodologies to preserve the cave environment.

First, the cave humidity and temperature should be well maintained by installing artificial waterfall and watering system. Secondly, indicator plants should be planted and increased to secure more fundamental monitoring and to enable steady ground-water system. Thirdly, we should supervise and control the number of visitors and opening hours to prevent excessive crowd within a cave. Fourthly, caves should have rest years, or cave zones are opened to public in shifts to minimize environment changes. Fifth, the entrance door should be in a small scale, and if the entrance ways are naturally big, there should install double-doors to protect cave from inflow of external air. However, in this case, this should not interfere with the fluent movement of troglophile species such as bats.

The green pollution is caused by lighting system, which also results to temperature rise. Followings are some preventive measures.

First, the lighting should be maintained

within 70Lux degrees so to enable fluent touring but also to prevent rise in temperature and illumination intensity. The lighting system should use mercury or sodium based lamps to minimize heat. Secondly, the installed lighting's degree or angles should be constantly changed to prevent green pollution. Thirdly, the sensor lighting system should be installed to minimize green pollution.

The black pollution is caused by combinations of numerous factors that are stated above, and black pollution causes degradation in cave growth and cave landscape, so the pollution should be fundamentally prevented to maintain cave environment.

First, the carbon dioxide control and lighting system improvement should be sought to prevent pollution by cave inhabiting creatures. Secondly, the inflow of external air should be blocked to prevent pollutions due to airborne particulates. Thirdly, the visitors should abide by hygiene restrictions to prevent pollutions that could be caused by foreign materials carried by visitors. Also, the passageway environment should be improved. Fourth, the installment materials should be environment-friendly and antioxidant coated

to prevent pollutions. Fifth, the cave surface and ground-water should be well monitored and controlled to prevent pollutions due to ground-water.

IV. Conclusion

The recent cave environment changes are due to natural changes and artificial destruction by cave development. The former is due to earthquake or crustal movements, and the latter causes rise in cave temperature, cave water pollution and byproducts of artificial wastes. The environment changes and environment destruction cause deterioration of cave ecosystem, hindering the growth of gavernicole and other cave specific creatures. We should note that the cave development is always accompanying environment destruction. The development should be minimized, and constant monitoring and observation should be performed to preserve the environment and to keep track of any changes in the environment. This study presents cave environment preservation methodologies as following.

First, the visitors and cave development should be minimized to preserve the natural

environment.

Secondly, the temperature and humidity should be steadily maintained by installing artificial waterfalls and watering system.

Third, the tourists and visitors should be limited to minimize atmosphere fluctuations within the cave.

Fourth, the entrance way should be built in a small scale to minimize influence of external airflow.

Fifth, the lighting system should be minimized to prevent green pollution and temperature rise.

Lastly, the administrators should provide constant monitoring, supervision and maintenance with substantial and directive cares along with well-educated touring system. These features should be well executed to preserve the cave environment.