Investigation of visitor impacts at Jenolan Caves

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Abstract

A study has started of dust and carbon dioxide gas in the tourist caves at Jenolan. The study Also involves the analysis of the cave climate. The history of the problems and the techniques used are outlined.

Introduction

At Jenolan Caves an investigation is being conducted of the effects of the visitors to the caves. About one quarter of a million cave visits are made in a year, and although the impact of each visit is very small, the accumulated effects can be significant.

The particular problems being investigated are the dust and the carbon dioxide. As the cave climate is a major influence on these two problems, it is also being investigated.

Previous work

The impact of visitors on the caves has been of concern for many years. Collecting of souvenirs was prevented quite early in the history of the caves. Discontinuance of the use of candles and carbide because of the soot problem was a major reason for the early introduction of electrical lighting of the caves. The ingestion of dust and smoke through the Binoomea Cut was prevented by the installation of airtight doors. The previous damage was repaired by steam and water cleaning and track improvements were made to reduce mud and dust problems. The impact of each visitor has now been reduced to the introduction to the caves of a tiny quantity of dust, a little metabolic heat, some carbon dioxide gas and possible traces of other pollutants that have not yet been identified. If compared to wild caving, the impact is almost non-existent.

The study of dust had its origins in the cleaning programs that have been conducted in the caves in the last 20 years. Steam cleaning and then water jet cleaning have been used at Jenolan to remove thick dust deposits from the caves, with a high degree of success [1]. The physical processes that cause dust to be deposited in the caves were studied in the late seventies [2], but the size of the task was a bit larger than the department in charge of the caves was prepared to support.

The study of carbon dioxide has been made in many caves. Some in N.S.W. have concentrations greater than five per cent (5%), but in this case there was no major difficulty with carbon dioxide but some spot measurements had shown there were occasional instances of noticeable amounts.

The Jenolan Caves Trust has decided to sponsor the study, which is in line with its efforts to investigate the visitor carrying capacity of the caves.

Method

The dust study was initiated using some of the methods used fifteen years previously. The quantities of dust are very small and the logistics of collecting samples over a period of time were best accomplished by continuous collection at many sites and periodic *in situ* measurements.

A special optical densitometer that was developed in the first program of measurements was upgraded and is used to measure the transmission of light through calibrated Petri dishes which are left in the cave to collect the dust as it gravitates to the floor of the cave. Trials from the previous program had shown the robust nature of this measurement and its excellent sensitivity.

A network of the Petri dishes, placed on plastic picnic plates, has been distributed through the cave systems. The statistics of the number of visitors, the geometry of the cave and the cave climate variables will be used to analyse the processes that control the deposition of dust.

The carbon dioxide measurements are made with a non-dispersive infra-red gas analyser which was purchased as a printed circuit card and then built into a humidity proof enclosure with rechargeable batteries, a display unit and a micro-power sampling pump to enable the unit to be left in a cave while its output is recorded to find the temporal patterns of carbon dioxide concentration. The instrument measures over a range of zero to 3 per cent of carbon dioxide in air with a resolution of 0.005 percent, but only records with a resolution of 0.02 percent.

The cave climate is being determined by periodic measurements through the caves with a small aspirated psychrometer (wet and dry bulb thermometer) to measure air temperature and humidity, and intensive periods of two days to two weeks when a large number of meteorological variables are measured with up to six , eight channel data loggers with directional vane anemometers, cup anemometers, screened thermometers, barometers, micro-manometers rain gauges and water level transducers.

The technique of cave climate investigation involves developing a model of each cave system and verifying the model, modifying it as necessary until the reaction of the cave to external stimuli can be predicted with the desired degree of accuracy.

The caves at Jenolan have two major chimney systems operating, the northern caves have an upper entrance in the Elder Cave, with vigorous air flow through the Imperial and Chifley Caves. See Figure 1. In cold weather (below 10°C) the air enters the Chifley (not shown) and Imperial entrances and flows through the cave, cooling the cave and evaporating water from the walls, eventually rising and leaving the cave through the Elder Cave entrance and other small cracks. The lower parts of the cave are then very well ventilated and no carbon dioxide is detected. In warm weather, (over 20°C) the flow is in the reverse direction.

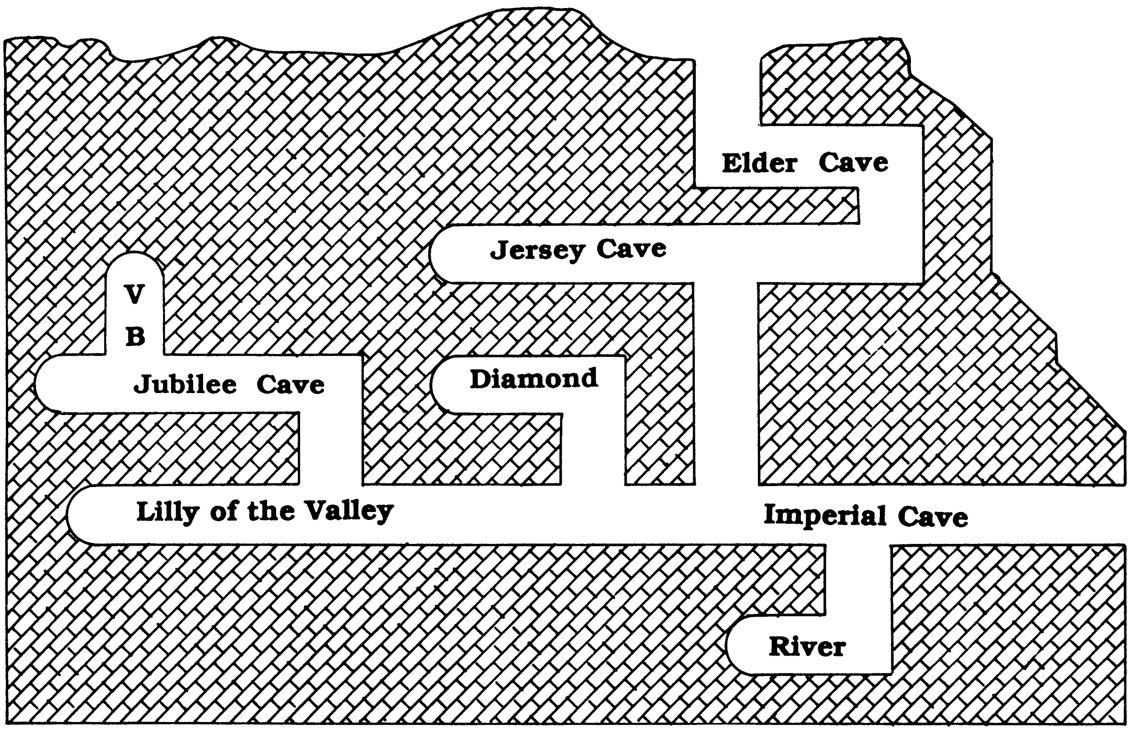

Figure 1: Simplified elevation of the northern caves. The Elder Cave assumes the role of the upper entrance, and the Imperial Cave entrance is the lower entrance.

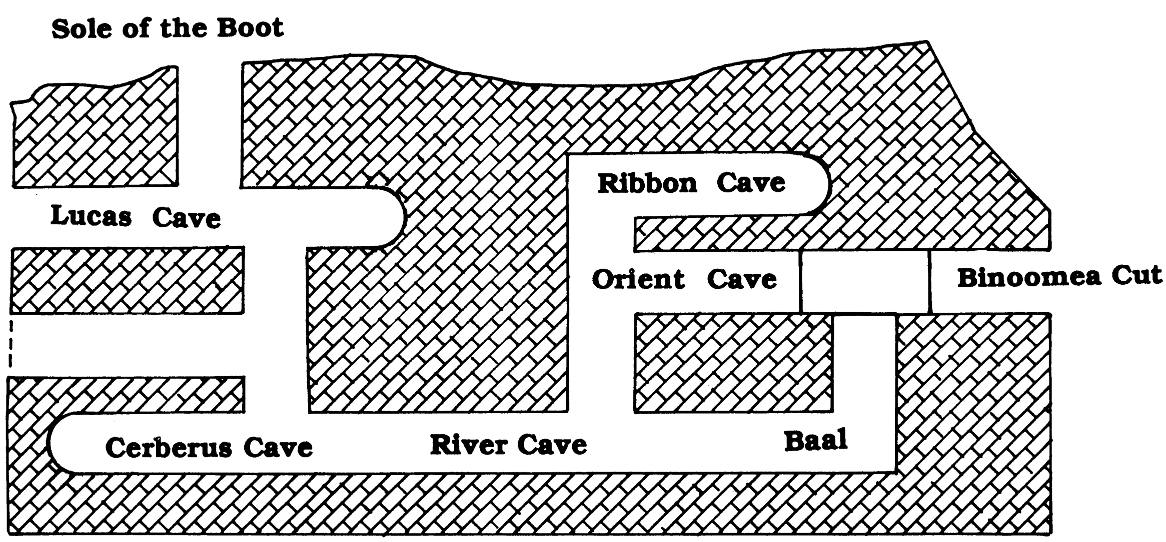

Figure 2: Simplified elevation of the southern tourist caves. The Sole of the Boot is the main upper entrance, the lower entrances are in the Lucas Cave. The Binoomea Cut would be a middle entrance, but is usually sealed by refrigerator style doors.

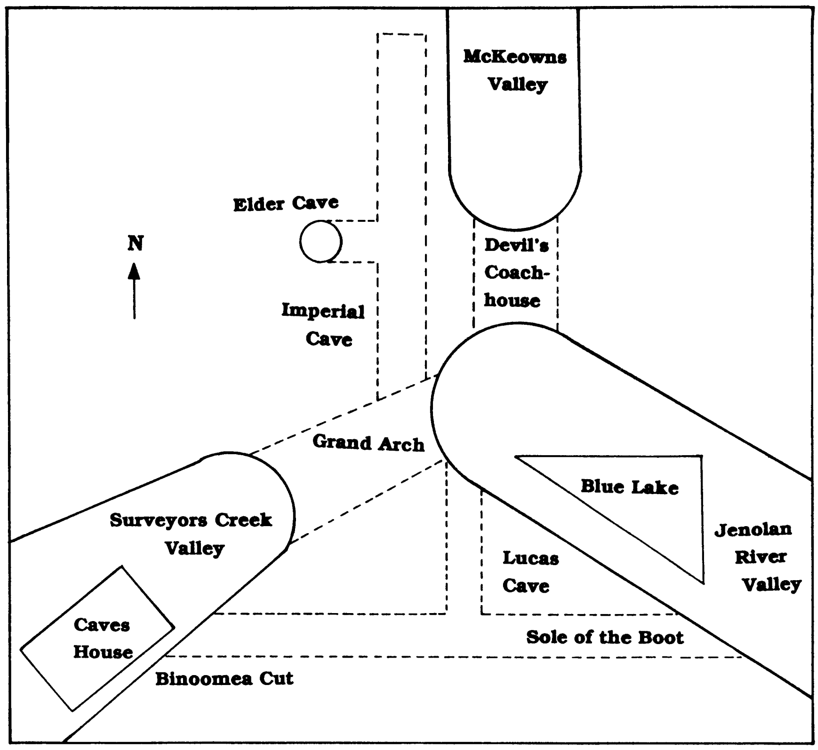

Figure 3: Simplified plan of the area showing the relationship between the valleys, the arches and the caves. The Elder Cave is on the saddle between McKeowns Valley and the valley with Caves House.

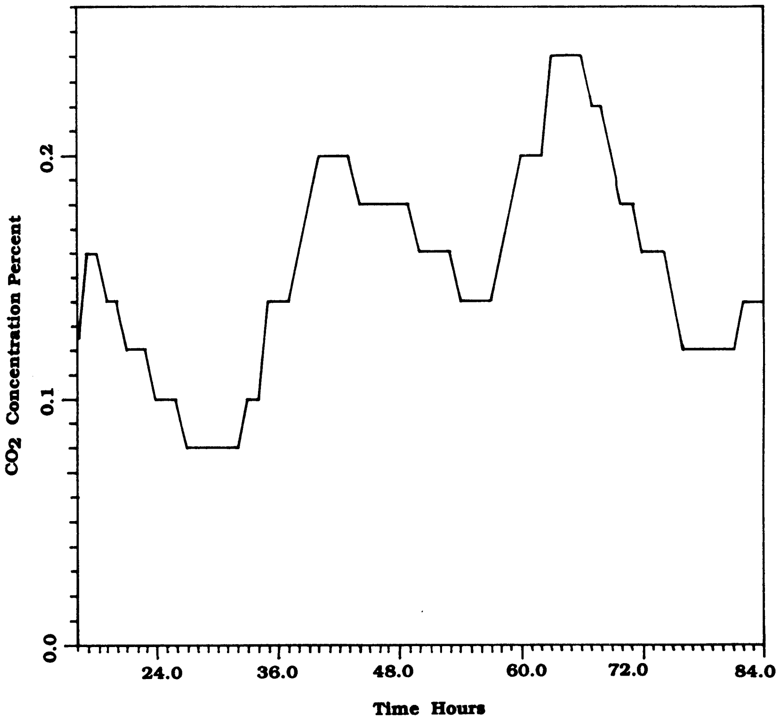

Figure 4: Record of carbon dioxide concentration in the Temple of Baal Cave over the October long weekend 1994. Time starts at midnight.

The southern caves have the Sole of the Boot as an upper entrance with vigorous air flow through the Lucas Cave through several entrances. See Figure 2. The Cerberus Cave area acts as a cold trap, cooling all winter with cold night air, but becoming stable all summer as the outside air is warmer and less dense. In summer carbon dioxide levels may rise in the low sections of both caves, but more data are needed to make these patterns clear.

The climate in the caves is dependant on the climate outside the caves, and the Jenolan River Valley, the Surveyors creek valley and the gorge at the end of McKeowns Valley have quite individual micro-climates which makes them quite distinct from the general climate in the area. The differences between the climates in the valleys and gorge give rise to the Arch Winds, strong air currents that blow through the Devil's Coachhouse and are usually blowing strongly. Figure 3 shows a simplified scheme of how the caves relate to the valleys and arches. The same effects that cause the Arch Winds also influence the circulation in the caves. Analysing the external climate of the caves may be more difficult than determining the climate inside the caves.

Results

There are only preliminary results at this stage of the project. The dust measurements from fifteen years ago showed that there were places in the caves where the dust fall in one year was extremely small. Most of the cave though, had substantial dustfall. A recent observation in Lucas Cave with an aerodynamic particle sizer showed that the air in the cave was cleaner than most clean rooms, but when people entered the dust levels rose to high levels and took nearly and hour to subside.

The carbon dioxide levels may be high in summer, readings of 0.6 percent have been made, but in winter the readings were much lower. The section of the Jubilee Cave called Victoria Bower is a small section at the top of a ladder (see VB in Figure 1). Warm air becomes trapped in this section, and after a tour party has visited, the carbon dioxide has been measured above 0.6 percent. Continuous readings in the Temple of Baal on an October holiday weekend are shown in Figure 4, the tours in the daytime caused elevation of the carbon dioxide levels which fell during the following night.

Conclusion

This is only an initial overview of the project, the work that will be done may be changed as preliminary results are analysed.

The impact of each visitor to the tourist caves has been reduced to quite a low level, but there is still the possibility to reduce it further. Massive development in the caves, such as track building, has been responsible for the low level of impact.

This type of study may be applicable to wild caves as cavers become more serious about cave preservation.

References

[1] Michie, N.A. (1978) The Dust Sampling Programme at Jenolan. *Journal of the Sydney Speleological Society,* Vol.22 No.7, pp 164 - 165.

[2] Newbould, R.L. (1974) Steam Cleaning of Orient Cave, Jenolan Caves, N.S.W. Jenolan Caves Historical and Preservation Society, Occasional Paper No 1, Published by Jenolan Caves Historical and Preservation Society, Jenolan, N.S.W., pp 24.