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ON THE PLACING OF OBJECTS IN CAVES

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Cave management has advanced considerably from the days when, considering the development of a cave, the manager would first ask "Where will we get the concrete?"

Many considerations are now made, and these might even consider how the cave might be restored if the tourist use finishes.

Cave development requires detailed examination of the requirements of cave fauna, cave decorations and the commercial needs of cave tours. Changes of cave microclimate are important as are the effects of tour operations, the introduction of tour transported dust, and the control of excess carbon dioxide, and the release of both lighting and metabolic heat. Additional entrances or modification to the shape of the cave require much consideration. Expedient changes in cave shape have caused much damage in the past.

The tradition of installing concrete infrastructure should be questioned, the caves become greatly changed from their native state, and restoration is very difficult.

Use of elevated pathways has been made in many caves around the world, Jewel Cave, South Dakota, is one case. An irregular floor with sporadic manganese deposits, that had potential to splatter around the cave if disturbed, was bridged by an elevated path that easily leads the visitor through the cave.

The advantages of elevated paths are many: the floor is not destroyed, the visitors do not walk on a mud film, and the cost may well be much lower. Changes in the tour path are much easier to arrange, and if the use as a tour cave is discontinued, the recovery of the cave would be much more complete.

There are still problems with elevated floors. The amount of dust released in the cave should be less than the quantity of fugitive emissions caused by walking on earth or concrete paths. But there is still dust release by visitors and this dust should be cleaned up. Grid pathways stay clean, and prevent fallen dust from being trampled and splashed out into the cave, but they allow dust to fall through to the floor beneath, so some form of dust catcher is needed to collect this dust. Jablonsky et al [1] recommended knee high kerbing on paths to prevent splatter from paths spreading into the cave.

Materials are very important. Wood does not perform well in extreme humidity, and often releases kino to pollute cave pools. Treated wood should not be considered. With about 10% by weight of copper chromium arsenate it represents massive quantities of some very dangerous elements. In the life of a cave it is difficult to believe that none of these heavy metal poisons would not escape into the biosphere. The organic chemical treatments are just as bad.

Plastics in caves also present problems. Few plastics are free from additives such as plasticisers which obviously escape from the plastic with time. These are not biologically friendly substances. Plastics also present another problem, fire. There are occasional sources of ignition, mainly illegal smoking and electrical burnouts. The damage that such a fire would have on a cave is enormous, both biologically and aesthetically. Even the plastics of illumination wiring should be carefully considered for fire, and reliable fault protection such as core balance leakage cut-outs should always be used.

Metal structures are left as likely candidates to develop a new cave. Steel and aluminium have been used, and there is room for much work examining the long term effects of different alloys and coatings. Weathering steels may have application, but stainless steel would seem an ideal material.

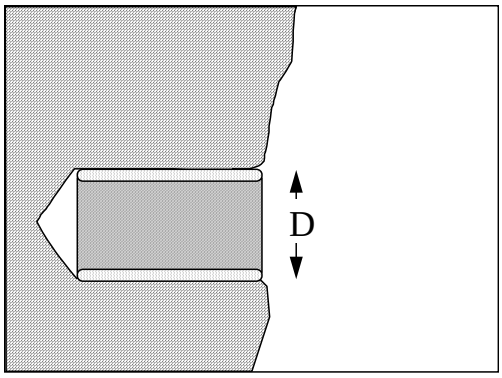
The expense of the infrastructure could be offset by the ability to rearrange it and open alternative parts of a cave to tours. With very small footprints on the ground, the elevated tracks could be moved to another side of a chamber and rearranged to make what would be effectively new tours in an old cave.

Retail facilities do not belong in caves, nor do any other avoidable facilities. From the consideration of carbon dioxide, dust and heat, the only activities in caves should be viewing the cave.

One way tracks with a different return route halve the activities on a walk in, turn around, and walk out path.

One item that *should* be placed in most caves is the permanent survey monument. Although most caves are mapped in one way or another, there are very few caves that have long-term permanent survey monuments. A map of a cave does not enable any point to be defined unless there are actual features that will not change that can be used to locate a position in the cave.

On the surface, property boundaries are able to be accurately located by survey monuments, which are archived in survey offices for reference by future surveyors. In caves, the need to protect the environment has usually resulted in temporary markers like pieces of tape to make maps, but these have little meaning to other workers and soon are lost or moved.



What is needed in caves is the use of small permanent monuments that would last 1000 years and enable any object to be exactly located at any time in the future. Not every location on a survey needs a monument, just as on the surface monuments are scattered widely. A monument must have another monument in its vicinity to define altitude, azimuth and position. There should be redundancy so the loss of any monument creates no problem, another monument can be used instead. With five or ten monuments in a small to medium sized cave, two or three monuments can be found from which to start any new mapping or locate any object.

Even if a high precision survey is not made when the monuments are placed, at any future date such a survey can be made, and any part of an old survey can be checked for errors. The aim of these surveys is to be able to produce coordinates of Northing, Easting and altitude for any point. Water levels can be recorded so that they can be referred to in 100 years time. Height of sediment banks, location of biological or anthropological specimens or information about distance to the surface all are available from a good survey. With modern equipment millimetre precision is practical. If monuments are conveniently located, the length of a growing stalactite could be monitored over centuries. This level of precision requires monuments that are better than axe marks on a wall (and are less destructive).

The proposal made here is for plugs of stainless steel (316 grade) 10mm in diameter about 20mm long, set into holes drilled 22mm into the wall. The centre of the plug is marked with a centre drill mark or a one millimetre diameter hole along the main axis.

Stamped or engraved deeply into the end face is a number or letter code distinct from any other plug in that cave. Metal monuments have the advantage of being able to be searched for with metal detectors if they become lost.

Monuments should be sited so as to be suitable for sighting with a theodolite, but placed so as to be not an aesthetic problem.

As there is no office with a long term prospects for archiving the survey data around these monuments, their location should be published in a significant journal (with paper circulation) and so be archived in several libraries. As publication of boring survey data is not popular with many journals, the data should be reduced to three coordinates and simple descriptions. The publication is much more likely if there is a useful scientific paper that carries them, for instance some observations on hibernating bats could have an appended list of the monuments that defines their position, and a reference to other papers that list survey monument positions in that cave. A monument near the cave entrance (either inside or outside) would be a good starting point. With small numbers of monuments this should not be a problem with the journals. The monuments should soon appear on current cave maps so that location becomes easier.

Practical problems will be overcome, the azimuth of the survey should be better than magnetic compass precision, and GPS is not good for azimuth determination, particularly in caves, so sightings of known trig stations or star observations may ultimately be used to refine the coordinates of the monuments.

REFERENCE

Jablonsky, P., Kraemer, S. and Yett, W. (1993b) ‘Lint in Caves’. Proceedings of the National Cave Management Symposium, Carlsbad, New Mexico, October 27 - 30 1993 pp. 73 – 81