CAVES (Karst, survey and management)

THE JENOLAN CAVE SYSTEM SURVEYING PROJECT.

PART 1 - HISTORY, ORGANISATION AND ASSESSMENT.

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ABSTRACT

The Jenolan Cave System Surveying Project is introduced and reasons are given for resurveying the cave system to a higher standard. A brief history of surveying in the Jenolan Cave System is presented and the use indicated of previous surveys in the current project. The cavers and clubs involved in the project are recorded. The survey commenced in 1987 and is now at the end of its second year, many changes in general organisation occurred between the two years and these are discussed. Some conclusions are drawn and plans for the future are presented.

INTRODUCTION

The brief - In 1986 the Jenolan Scientific Advisory Committee (Convener, Ernst Holland) established that a complete high grade survey of the Jenolan Show Caves was required. The survey was needed to allow scientific studies, notably of the geology and hydrology, to be adequately interpreted. The committee felt that the survey should be of a standard that would assist any future deliberations pertaining to the development of the caves. The proposal to survey the system was endorsed and supported (without financial commitment) by the Jenolan Caves management and staff. The authors of this paper agreed to co-ordinate the survey and negotiated special conditions that allowed the survey to be carried out at weekends while cave inspections were in progress.

A name for the game - When the surveying project commenced in 1987 a name was needed for the cave system that was to be surveyed. The accepted title of "Jenolan Show Caves" was regarded as being inelegant and restrictive. Of the cave being surveyed over half of it is not shown and is unlikely ever to be shown to the public. Equally unacceptable was a title containing the combined names of the various "caves" of the system. These are of historical origin and are associated with the necessity to limit the length of, and increase the number of tours available to the public. Thus it was proposed that the cave be called The Jenolan Cave System; its correct geomorphic name.

The name "Jenolan Cave System" is not presumptive even though there are some 300 other Jenolan Caves (Australian Karst Index, Mathews, 1985). At the time of naming, The Jenolan Cave System was conservatively estimated to be some four times longer than Mammoth Cave; the second longest cave at Jenolan at 3150 m. Further, Mammoth Cave is known to be hydrologically connected to The Jenolan Cave System through Spider Cave.

HISTORY

Trickett map and model - The first surveying in The Jenolan Cave System was by Oliver Trickett in 1897 and 1898 (Dunkley, 1986). The published result (Trickett, 1899) was a simplified plan and section of the main passages, which adequately represented the caves for the visitors and showed the relationship between the caves and the surface topography. From these surveys Trickett constructed an excellent three dimensional model of the caves which can be viewed in the Resource Centre at Jenolan Caves. Both the model and the "compass" surveys were incomplete and inadequate for scientific studies and cave development planning.

Post Trickett surveys - in the intervening 88 years considerable lengths of new cave passage had been discovered, only some of which had been surveyed. At the commencement of the project the Jenolan Caves Scientific Advisory Committee requested from speleological societies photocopies of all Jenolan maps held in their libraries; the photocopies would be paid for. Only one society responded and produced maps of some of the minor caves. Individuals were more cooperative; John Dunkley, Guy Cox, Keith Oliver and Ian Wood were especially helpful in supplying both surveys and original data. Other sources of existing surveys were the somewhat incomplete set of maps held at Jenolan Caves and the Department of Public Works archives. Where an existing survey met the required standard and its data was available, then that section of the cave system would not be resurveyed. Table 1 lists the use made of existing surveys.

ORGANISATION

The surveyors - It was believed that the project would benefit from being a truly inter-club effort. Although the clubs were not solicited for surveying teams, it was made clear that any interested club could approach the organisers or the Jenolan Caves management, supply a surveying team and be given a section of cave to survey and instructions on how to survey if necessary. The open house policy did not really work. It was obvious that teams of experienced surveyors were the most efficient and training new teams was impractical and led to a decrease in standards. At present, teams tend to be from the same club and new participants to the project are trained by their club.

The major clubs participating in the project are Highland Caving Group, Hills Speleological Society, Sydney Speleological Society and Sydney University Speleological Society. Many other cavers, both national and inter-

TABLE 1
USES MADE OF EXISTING SURVEYS

Trickett's Map	This map together with additions made by Keith Oliver of recently explored sections has provided a base for planning the resurvey.
Lucas, Orient and Baal Dept. Public Works.	This highly accurate survey had been carried out in order to position the Binoomea Cut which enables tourist parties to access easily the Temple of Baal and the Orient Caves. It was intended to use this survey for the main traverse but the data attached to the plan could not be computed. It has been used for comparison with the resurvey.
Nettle and Arch Caves	Keith Oliver's original data and sketch of the caves were used. Survey stations could be easily relocated and left, right, up and down data added.
Ribbon Cave Ribbon	Cave was resurveyed before it was realised that Keith Oliver's original data and sketch were available. In excellent agreement with the resurvey.
Flitch of Bacon SUSS	This area was surveyed as part of the main theodolite traverse (Bonwick et al., 1988) and discrepancies were noted. The original forestry compass survey was incorrect.
Jubilee Cave SUSS	These maps were supplied by John Dunkley and again discrepancies were noticed. This time the latter survey was incorrect due to booking and proof reading errors in the forestry compass resurvey.
Barralong SUSS	John Dunkley supplied the original data and the final Barralong survey, this is being used as a base for the resurvey. It is suspected that there is a mistake in the previous plot of the data (G. Kates, pers.comm.).
Pool of Cerberus UNWSS	Data and sketch supplied by Ian Wood. Agreement with resurvey was excellent.
Imperial Riverway SAGCDG	The Imperial Riverway to the boulder pile past sump 4 and to sump 7. Agree ment was excellent with the resurvey of the airfilled sections. Data for the underwater and inaccessible air filled sections were used and adjusted by Radio Direction Finding.
Wilson's Last Cavern UNWSS	Sketch by Andrew Pavey used to check resurvey.
Imperial Cave SSS	This high accuracy survey had been carried out to position a "possible" tunnel either into the Diamond Cave passage or into Fairy Bower. It has been used for comparison with the resurvey.
Spider Cave SUSS	The survey of this cave has been published (Cox and Welch, 1984). Original data and master map were supplied by Guy Cox and have been used.

national, have also participated in the project. Appendix 1 is a list of all who have assisted in 1987 and 1988 and the names of those who are known to have contributed to the existing surveys that have been used in this project. Those who have played principal roles in the project have been singled out for special acknowledgement in the text.

Invaluable assistance has been given to the project by The Jenolan Caves management and the guiding staff, who have aided the project in many ways; directing the surveyors to little known and unrecorded parts of the system, helping with surveying and checking surveys, loaning equipment and office space and providing interest and enthusiasm for the encouragement of project members. The names of the Jenolan Caves Guides are also recorded in Appendix 1.

The survey - It was intended that, wherever possible, the underground survey should be carried out using conventional magnetic cave exploration surveying techniques for which there were a number of data reduction computer programs available. Included angle surveying techniques (theodolites) would only be used where

magnetic interference was present. A high grade surface survey would be used to link all the entrances and underground passages located by Radio Direction Finding (RDF). A detailed discussion of the surveying and computing techniques appears in The Jenolan Cave System Surveying Project - Part 2 (Bonwick et al., 1988)

Computing and drafting - When the computer data for a section of the cave was properly adjusted with loops closing, plans and projections were produced at appropriate scales. The field sketches are transferred to the master survey and then are taken into the cave to be checked and improved. The final stage is to fair draft the maps in a suitable form for publication. This demanding task is to be undertaken by Graeme Kates and Rick Pinnock.

General organisation -It was realised at the commencement of the project that the Jenolan Show Caves formed part of a very long and complex system. The length of 7200 m for the Jenolan Show Caves quoted in the Australian Karst Index (Mathews, 1985) was known to be a vast underestimate. However, even seven kilometres of cave requires considerable organisation of survey data and sketches. The organisation increases significantly with multiple parties surveying. These parties have to be coordinated so that surveys and survey station numbers would not be duplicated and be supplied with tie-in points to the master survey. In 1987 the organistion of the survey was planned; by the end of the year it was clear that a reassessment of procedures was necessary. At the beginning of 1988 a meeting of most of the regular surveyors was held to discuss and agree upon ways to improve the organisation before that year's surveying started.

Survey station labelling - Five character alphanumeric survey station labels were used. Typically the first character in the label is an alphabet character which indicates the section of the cave system. The remaining four characters are numerics. A unique series was usually allocated to each group each weekend. During 1988 clubs were allocated a numeric sequence in the Southern Caves. Table 2 shows the characters that have been allocated for the various sections of the cave; the locations are somewhat arbitrary and have been made to assist data handling and plotting.

Areas allocated - In order to simplify the organisation and to complete one section at a time it was decided to divide the system into two main sections; the caves north of the Grand Arch (the Northern caves) and the caves south of the Grand Arch (the Southern caves). The Northern caves were to be surveyed first. The initial survey of the Northern caves was finished early in 1988, it is still being checked.

During the survey of the Northern caves, surveying teams were allocated passages one at a time with a view to finishing areas of the cave systematically. This was inefficient, time consuming for the organisers and lead to some duplication of surveying. As a result, teams in the Southern caves were given all the side passages in an area to survey.

TABLE 2
CAVE SECTION CHARACTER ALLOCATIONS

B	Binoomea Caves; includes Binoomea Cut, Baal, Orient and Ribbon
C	Chifley
D	Devils Coach House; includes Nettle and Arch
G	Grand Arch; including minor passages off the Grand Arch
H	Spider Cave
J	Jubilee; including Imperial Riverway
L	Lucas
M	Imperial; including Elder and Jersey
R	River; including Pool of Cerberus
S	Surface
W	Barralong; including Red and White Temples
Z	Lightswitch boxes

Familiarisation - At the commencement of the survey none of the organisers were familiar with the cave to be surveyed. Over the first year they were introduced to the cave a section at a time. This meant that they and a few others spent considerable amounts of time escorting the surveyors to their starting points. At the suggestion of Ernst Holland, before commencing the survey of the Southern caves, a familiarisation tour was carried out for all regular surveyors. During the tour, areas requiring special treatment either because they were fragile or needed exploration were pointed out. The result of the familiarisation tour meant that the organisers have been freed from their escort duties.

Tie-in points - In the Northern caves side passages were often surveyed before the main traverse and this lead to numerous problems in establishing tie-in points. The only permanent survey stations placed in the Northern caves during this project were drill holes in the concrete paths. Relocation of these holes has proved difficult as they become filled with dirt and are virtually indistinguishable from drip holes in the concrete.

The Southern caves main traverse was marked with surveyors nails. In case side passages were surveyed before the main traverse on the Southern caves survey, all lightswitch boxes were given a Dymo tag number and the red light on the box was taken as a station. The lightswitch boxes were then surveyed in during the theodolite traverse. However, it must be realised that lightswitch boxes are semi-permanent stations as one has already been moved due to upgrading of the electrical wiring.

The surface traverse has been marked with surveyors drill holes with wings or wooden pegs.

Sketches - Many of the early sketches for the Northern caves are not drawn to scale. The sketchers tended to use map symbols that they were familiar with despite being issued with a set of ASF map symbols (Mathews, 1985). Transcribing these sketches to a master map was extremely time consuming and the assistance of Vicki Bonwick in this task is gratefully acknowledged. During the survey of the Southern caves the field sketches were requested at a scale of either 1:100 or 1:200 with ASF map symbols.

In organising data and sketches, filing them by date was a mistake for rapid retrieval. Files by area are more effective.

Table 3 summarizes the changes in organisation that occurred between the Northern and Southern caves surveys.

Length of the project - With four or five survey teams working one weekend per month the project had been estimated to take a year. The project is about to enter its 17th month and is likely to take some 24 months. The organisational problems have slowed all aspects of producing the final maps but they cannot be entirely blamed for the slow progress. Maintaining the quality of the main underground and surface traverses and the quality control on the magnetic underground survey have all been time consuming. At no stage have standards been compromised in order to finish the project rapidly.

Exploration - in order for this survey to be as complete as possible all squeezes, grovels and climbs were investigated. During these investigations only a short length of new cave has been entered for the first time. The ends of "promising" passages are almost always decorated with the graffiti of previous explorers and date from the 1890's to the 1960's. Many of these passages remained concealed from the surveying teams until shown to them by Ernst Holland and other guides at Jenolan. During these investigations some myths have been destroyed and others confirmed.

The most successful exploration during the time of the project has been the connection of the Imperial Riverway with Spider Cave by SUSS. This has added an additional 2 km plus passage to The Jenolan Cave System. The assistance of Jill Rowling, Guy Cox and Mike Lake in supplying and transferring the original

TABLE 3

CHANGES IN ORGANISATION NORTHERN - SOUTHERN CAVES

	1987 Northern caves	1988 Southern caves
1.	No familiarisation tour	Familiarisation tour conducted
2.	Several groups surveying side passages in the one section	Group allocated a section and surveyed all side passages
3.	Theodolite traverse generally behind side passage surveying	Theodolite traverse generally ahead of side passage surveying
4.	Coordinates for main traverse not available until computed.	Coordinates for main traverse available in cave
5.	Main traverse stations marked with drill holes.	Main traverse stations marked with nails
6.	Light switch boxes not surveyed in	Light switch boxes surveyed in
7.	Sketches at random scales	Sketches at 1:100 or 1:200
8.	ASF survey symbols not always used	ASF survey symbols used
9.	Data and sketches filed by date	Data and sketches filed by area
10.	Sketches often needed to be redrawn photocopied reduced or enlarged before inclusion on final map.	Sketches drawn to correct scale by surveyor before inclusion on the final map.

data for Spider Cave to the projects data base is acknowledged.

The survey has enabled exploration to become focused on areas where further connections with very close caves may be made such as Aladdin, Glass and False Frenchmans. Because of its considerable length a connection with Mammoth Cave is the most desirable, the distance between the southern end of Mammoth Cave and the northern end of Spider Cave is 500 m. Slowly the Jenolan master cave system is yielding its secrets and Henry Shannon's Hairy Diprotodon is being exposed.

Conservation - during exploration and surveying, special care has had to be taken of the particularly fragile nature of The Jenolan Cave System. Without due caution it would have been possible to destroy irreplaceable decorations and sediments and to further mark the cave with graffiti. In the early stages of the survey, teams were reluctant to investigate and survey in delicate areas and thus missed many extensions. Later a combination of specific instruction from the Jenolan Caves senior guide, taking in clean clothes, taking off clothes and padding exploration equipment, meant that all but the most fragile areas could be explored and surveyed. However, a climb to a promising lead at the top of the Temple of Baal Chamber had to be abandoned because of the risk of falling mud and calcite hitting a splendid decoration known as the Angels' Wing.

ASSESSMENT AND THE FUTURE

During the first two years of the Jenolan Cave System Surveying project much has been learnt by all participants. Two of the organisers were completely confident in their ability to survey caves in general and long caves in particular. They had surveyed and prepared maps of caves all over the World and the two most notable are the Atea Kananda at 35 km and Mamo Kananda at 55 km (James et al., 1983). The main difference in this survey is the standard at which it is being carried out and the checking that is going into the final production. There have been smaller caves and sections of cave surveyed at similiar standards but nowhere has a cave as large and as complex as The Jenolan Cave System been surveyed in this manner. The way in which the results of the project are to be published are presented in The Jenolan Cave System Surveying Project - Part 2, Techniques and Computing (Bonwick et al., 1988).

The length and depth of The Jenolan Cave System - The published length for The Jenolan Cave System must be acceptable both nationally and internationally. The cave system after its connection with Spider Cave is a contender for the honour of being the longest cave in Australia. The present longest cave is Exit Cave, Tasmania at 17 km (Mathews, 1985).

The first contentious point is whether caves on two sides of an arch are part of the same system. The consensus is that they are and there are only a few dissenting voices. The second is what length to use for the large features such as the Grand Arch and connections to the passages off it. In order to obtain a contour survey of the Grand Arch over 8 km of traverse was measured. To establish a length for this feature there are two possibilities. One is to survey from passage to passage around the circumference of the feature. The length of a feature such as the Grand Arch is the traverse line from dripline to dripline with projections to the passages leading from it. This was the method used after discussions with an international group of speleologists attending the Man's Impact on Karst conference at Jenolan, August 1988.

At the time of writing the length of The Jenolan Cave System derived from the main computer traverse (after the data has been reduced) is 14.4 km; this includes 1.8 km for Spider Cave. There is still a considerable amount of data from recent surveying to transfer to the data reduction program. The present depth of The Jenolan Cave System is 104 m but this figure will increase as the main computer traverse does not as yet include the highest point of the cave system.

What is there left to survey? - There are many extensive sections of the cave yet to be surveyed; they are:- the Spider-Imperial connection and Spider Cave extensions, part of the Lucas main traverse, Exhibition Chamber and side passages and the Barralong side passages together with the Red and White Temples.

There is only one known existing survey of the dives in the Southern caves where significant lengths of underwater passages have been explored.

These will be surveyed by the cave divers.

The future - In the future it is expected that the Jenolan Cave System Surveying Project will extend and become The Jenolan Caves Surveying Project. Hence the complete network of cave and surface traverses for Jenolan will be available on one data base.

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APPENDIX 1
ACKNOWLEDGEMENTS

The organisers of The Jenolan Caves Survey Project gratefully acknowledge the help and encouragement of the cavers listed in the table below. This list will continue to grow as more cavers participate and other contributions are brought to the attention of the organisers.

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