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DIVING EXPLORATION OF EXTENSIONS TO LIMESTONE CAVE SYSTEMS

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This paper was presented at the 1977 Symposium for the SA Society for Underwater Science.

ABSTRACT

For many years members of the South African Spelaeological Association (SASA) have had to end their exploration of a cave system at a place where the cave passage ended in a pool of still or flowing water. Besides a few dangerous and usually futile attempts at free-diving these underwater passages, diving in this type of situation has been very limited in South Africa until a few years ago.

Most of the SCUBA diving done in fresh water caves has previously been done in large underground lakes or crater lakes such as Sinoia Cave (Rhodesia), Otjikoto Lake (SWA) and Wondergat (OFS) which require little, if any, experience in caving or cave diving techniques.

This paper describes a few caves which have been explored more fully by SCUBA DIVERS FROM SASA in the limestone belt of the Cango Valley near Oudtshoorn. Reference is made to specialised techniques and equipment used as well as the dangers, aims and Scientific Research possibilities associated with cave diving of this nature.

1. INTRODUCTION

Fresh water cave diving is a subject with many variations because there are not only many reasons for diving in a cave but also many types of cave to dive in. As a result the diving conditions vary from short, tight stream passages with zero visibility, only a few metres deep to huge underground lakes over 100 metres deep with visibility of 50 metres or more. This paper deals with the former type of diving condition, with special reference to three limestone caves in the Cango Valley, near Oudtshoorn namely Cango Cave, Efflux Cave and Conflux Cave.

Cave diving in South Africa is a fairly new branch of SCUBA diving and in the past most people who have dived in caves have been trained either as SCUBA divers or as spelaeologists, but not as both. In June, 1973 a party of divers from The Atlantic Underwater Club were invited to join The South African Speleological Association (SASA) in a trip to the Cango Valley to dive in Emerald Lake and in a water trap in the stream passage at the furthest explored extremity of Cango II or “The Wonder Cave”. Since that most successful weekend there has been an increased interest in cave diving as an integral part of spelaeology and close co-operation between SASA and The Atlantic Underwater Club has resulted in a number of people now being members of both organisations simultaneously. By November 1974 the position of Cave Diving Officer has been made in the SASA committee and to date a large number of caves have been dived in by SASA, not only in South Africa but also in SWA and Rhodesia. In addition, a set of Guidelines for Cave Diving and a Cave Diving Handbook have been drawn up by SASA. The union of spelaeology and SCUBA diving can be seen when a cave diver is diving a short underwater passage, kitted up in mining helmet and lamp, overalls, boots, SCUBA tank and mask.

The reason for SCUBA diving in water filled passages such as those found in some caves in the Cango Valley would firstly be to ascertain whether further ** “dry” cave existed

** NOTE: "dry" cave means the part of a cave system not requiring diving even if the floor has water over it.

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further on. The passage can then be surveyed by SCUBA divers, the results of which being included in the map of the rest of the cave. Once the exploration is completed SCUBA diving can, either directly or indirectly, be used for research into the archaeology, geology, biology or hydrology of the cave.

2. LIMESTONE CAVE FORMATION

If a fault occurs in a sedimentary rock such as limestone (ie. calcium carbonate), rain water combining with carbon dioxide from decaying organic matter to form a weak solution of carbonic acid, finds its way into the fault and reacts with the calcium carbonate to form soluble calcium bicarbonate.

$$CaCO_3 + CO_2 + H_2O = Ca(HCO_3)_2$$

This reaction is reversible and, when the calcium bicarbonate solution comes into contact with an atmosphere less rich in carbon dioxide, calcium carbonate is deposited in the form of calcite formation. In this way a solution cave is formed, often with a stream passage at the bottom, although a number of upper systems may exist.

For this reason, when exploring a cave system that appears to have reached an end on an upper level, the stream passage should be located and explored in the hope of breaking through again further on into the main upper system, possibly on the far side of a rocky collapse. It often happens that the stream passage reaches a water trap or totally submerged underwater passage and the only way to attempt further exploration lies in diving. As free diving in caves is expressly dangerous except for short and well explored passages, SCUBA diving equipment and techniques, specially modified for cave diving in confined spaces, should be used by specially trained cave divers.

3. EQUIPMENT REQUIRED FOR DIVING IN RESTRICTED CAVE PASSAGES

When selecting equipment to dive a waterfilled passage in a cave, the minimum of equipment should be used that will still allow a good safety factor, as the site for the cave dive may be over 1,000 metres from the cave entrance and it is a considerable task to transport diving equipment, ropes, caving equipment and emergency equipment through a cave which may require crawling or climbing over slippery rocks or mud.

It has been found that a high pressure 4 litre tank with carrying handle and screw-in type demand valve is an ideal combination for short water traps. The tank is usually hand-held while diving to prevent it catching on the roof of the passage. Although only one diver usually dives at a time, there must be a standby diver and a rope tender present. The life line can either be made of polyethylene which floats or braided nylon which sinks, although nylon is the stronger of the two. The lifeline must be brightly coloured and be at least 4 millimetres in diameter. A mask without a snorkel, a neoprene vest, an underwater torch, compass and watch complete the basic diving equipment.

Flippers and weights are usually not used as the diver can push and pull himself along with his feet and hands. A spare torch, caving boots and helmet must be available to enable exploration on the far side of the water trap if necessary.

4. CAVE DIVING IN THE CANGO VALLEY

4a. CANGO II WATER TRAP

The Cango Cave system runs due west along the main Cango limestone belt and consists of Cango I which is the tourist section (800 metres long), Cango II or the “Wonder Cave” (400 metres long) and the newly discovered Cango III (approximately 2,000 metres long).

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On the 1st June, 1973 a party of five cavers, including two divers, attempted to dive a water trap in the stream passage below the end of Cango II. A water trap is defined as any place where the roof of a cave passage dips underwater but lifts again above the water further on. The purpose of the dive was to try to ascertain the extent of the underwater passage and whether access existed to a further “dry” cave further on. An attempt had previously been made to free-dive the water trap by a senior member of SASA and a small chamber with limited air space had been found, about 6 metres in. It was therefore planned that the same person would again free dive to the first chamber to act as an intermediate rope tender for a SCUBA diver, who would continue along the underwater passage at the far side of the chamber. This memorable cave dive resulted in the discovery of a further 15 metres of underwater passage at which point the passage consisted of limestone with a floor of fine silt, which quickly stirred up the naturally clear water into zero visibility. As the water flow was towards the entrance to the trap the visibility was good in front of the diver with the result that small calcite formations were seen further on in the passage before it took a gentle turn, indicating that there had been air in that section during some previous period. A direct result of this cave dive was the purchase by the Oudtshoorn Municipality of a submersible water pump to enable the water level to be dropped so that the passage floor could be dug out, enabling cavers to get through.

On 30th March, 1975, after the stream passage had been suitably enlarged, the first two people broke through into a continuation of the upper Cango Cave system which turned out to be about 2,000 metres of the most beautiful cave in South Africa, now known as Cango III.

As Cango III is sealed off from the rest of the cave, and probably from the outside World completely, it presents a unique situation for scientific research for a number of reasons. It has not yet been ascertained where the Cango stream originates or where its final destination lies. It has been explored downstream from the Cango II water trap to under Cango I and upstream well into Cango III beneath the upper system. Both ways it is likely that further exploration will require SCUBA diving. The mean water flow of 700 litres per hour and water temperature of 18 degrees Centigrade do not differ appreciably throughout the year.

If the seal on the water trap is continuously broken by dropping the water level in the stream passage by means of a pump, then the delicate balance that exists in Cango III may be affected. This could effect the formation of the calcite deposits that decorate the cave in such abundance. The ideal way to control this would be to allow only divers through the water trap to take readings of carbon dioxide in the air, air and water temperatures, humidity, atmospheric pressure, etc. The air in Cango I is badly contaminated with carbon dioxide by the many people who visit the cave and to a lesser extent, is the air in Cango II. As the humidity in the cave is very high (nearly 100%), the high concentration of carbon dioxide combines with water vapour to form carbonic acid, causing the formations to lose their original sparkle, often to re-crystallise in a dull, powdery calcium form which attract dust deposits. For this reason an excess carbon dioxide build-up should not be allowed in Cango III.

4B. ATTEMPTED LINK UP OF EFFLUX AND CONFLUX CAVES.

About 15 kilometres to the East of Cango Cave is situated Efflux Cave, also running due West along the Cango Valley limestone belt. Here 760 metres into the cave through tight crawls and one impressively large chamber is found a water trap in the stream passage.

Here on the 16th December, 1973 another important breakthrough was made by members

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of SASA when the water trap was dived by two of its members, using a four litre high pressure tank. The trap was wide but with very little roof clearance, and had a muddy floor. As it was entered with the flow of the stream going in the same direction as the diver, the opposite situation existed to that in the Cango II water trap and the visibility was zero from the start of the dive. The water trap was only about 6 metres in length and the stream passage on the far side led into a very large chamber with active calcite formations. To date the explored length of the cave has been extended by another 740 metres. A fixed guide line has been installed in the water trap by divers as well as a very simple but effective communication system, consisting of a length of hose pipe with a funnel at each end.

On plotting the line surveys of Efflux I and II it was found that the furthest point of exploration, where the stream passage becomes too restricted to progress further was only about 100 metres from an underwater passage in another cave named Conflux. This has been dived in once and about five metres in a small waterfilled chamber was found with a rubble slope at the far side which appeared to be accessible, but dangerous from a diving point of view. At present plans are being made to lower the water level to enable an attempt at breaking through into a side system of Efflux cave. The likelihood of an Efflux-Conflux link-up are good as the water temperatures are identical and during heavy rains the same volume of water that is observed running into Efflux is observed coming out of the entrance to Conflux. A fluorescein test will also help to confirm this theory and is planned for the future.

5. CONCLUSION

To conclude, cave diving has become a vital tool in the exploration of caves and has become an extension to speleaology as well as an extension to SCUBA diving. The true cave diver must be concerned basically with cave research and exploration.

The scope for cave diving is wide and varied and there are many more underwater caves awaiting exploration.

6. REFERENCES

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7. ACKNOWLEDGEMENT

I would like to express my thanks to Mr J Blacquire of the SA Spelaeological Association for supplying me with some of the technical information used in this paper.

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has given him a unique insight into walking in circles. This is his 12th public walk of this nature. He has done it several times in India and also in Afghanistan, Iran, Kuwait, Thailand and Malaysia. His aim is eventually to give the British people a chance to watch him walk in circles, and at the same time to break the world record of 160 and a half hours non-stop for walking in circles.

Daily Telegraph, UK

(Editor: This story seems to be some sort of comment on Life, if I could but dare to draw conclusions!)

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APPENDIX A:

GUIDELINES FOR SCUBA DIVING IN CAVES UNDER THE AUSPICES OF THE SOUTH AFRICAN SPELAEOLOGICAL ASSOCIATION (CAPE SECTION).

Charles Maxwell - Cave Diving Officer - 16th March 1976

1. A dive leader must be approved by the committee prior to the meet. The dive leader should be given as much notice as possible to enable him to plan the dive. A dive leader should be a competent caver. The dive leader has the privilege of choosing his diving team and non-diving assistants with the co-operation of the meet leader. The meet leader has the final say in any decision.

2. The dive leader should use the following guidelines when choosing cave divers:

   (a) It is recommended that a 3rd Class Diving Certificate by held by all cave divers except under certain circumstances and at the discretion of the dive leader. An eventual cave diver's competence test should be devised, to be passed by all cave divers.

   (b) All members of the diving team should be able to handle themselves in the cave up to the point of the dive.

   (c) Diving in restricted caves should be done only by cavers experienced in tight dry caving and caving in stream passages.

   (d) It is the dive leader's privilege and/or responsibility to decide on the equipment required by each cave diver in the team and must prevent a diver from diving if his equipment is considered to be inadequate, unsuitable or faulty.

3. Whenever a cave dive is done involving SCUBA, then there must be suitable standby diver/s with adequate equipment to perform a rescue if necessary. At the dive leader's discretion a diving buddy can be considered as a standby diver.

4. When the dive leader is personally involved in a dive then he should, if he feels it is necessary, elect a deputy dive leader to take charge while he is underwater.

5. It is acceptable for one diver to dive at a time if the type of cave dive dictates this. In some cases it is dangerous for two divers to enter an underwater cave together.

6. When the circumstances permit the use of rope signals the following should be memorised by all members of the team prior to the dive:

1 PULL: **DIVER** - I AM OK. OR I AM GOING FORWARD. GIVE ME SLACK.
TENDER - ARE YOU OK? OR ACKNOWLEDGEMENT OF DIVER'S OK SIGNAL OR GOING FORWARD SIGNAL OR ASKING DIVER TO REPEAT ANY OF THE OTHER SIGNALS WHICH WERE NOT CLEARLY RECEIVED.

2 PULLS: **DIVER** - I AM COMING BACK, TAKE UP SLACK.
TENDER - ACKNOWLEDGEMENT OF DIVER'S SIGNAL OR TELLING DIVER TO COME BACK. (DIVER TO ACKNOWLEDGE).

3 PULLS: **DIVER** - PULL ME OUT SLOWLY.
TENDER - ACKNOWLEDGEMENT.

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OVER 3 PULLS: **DIVER** - RESCUE AS PREPLANNED.
TENDER - ACKNOWLEDGEMENT.

(The last signal should be a good number of pulls by the diver so that it cannot be confused with any other signal; say about 5 or 6 pulls in quick succession).

7. The use of life lines is mandatory.

8. When a diver cannot communicate with the tender and the underwater conditions permit him to wear and read an underwater watch, then he must wear one. The rope tender should always have a watch and the duration of the dive should be pre-arranged.

9. When selecting the size of diving tank or planning the maximum depth and/or duration of a dive the one third method should be the minimum one used. (ie. 1/3 in + 1/3 out + 1/3 reserve). For exploratory dives in poor conditions a larger margin of reserve air is recommended.

10. The dive leader shall be responsible for reporting to the Cave Diving Officer or Committee any new developments in cave exploration involving cave diving, so that records can be kept to assist future cave divers.

APPENDIX B

USE AND CARE OF LIFELINES

There are basically two methods of using a life line and each has it's advantages and disadvantages. The first is a line, attached to the diver's waist or wrist by means of a bowline which is controlled by a rope tender. This is useful in that the diver need not worry about handling the rope and signals can be transmitted along it for long distances, provided the line does not go round corners or become snagged in a crevice. The main disadvantage with this method is that the line is moving as the diver moves, increasing the risk of it fray-through or being pulled from the central passage into a crevice. The second method is the use of a free running reel with a handle and brake which can be made up easily using perspex and aluminium strips. The reel must be attached to the diver in case he drops it. The brake should work with a pin that is spring loaded so that when released it would shoot into a hole on the side of the reel so in an emergency where the diver drops the reel, it would automatically lock.

When a passage is being explored for the first time or when a survey is being conducted, a temporary knot should be made at the point of furthest penetration or other important feature either by the rope tender (when using Method 1 or the diver when using Method 2 to be measured later for the records. Remember that any knot in a rope reduces the breaking strain dramatically. A bowline is the best knot for attaching the rope to the diver, but even this reduces the breaking strain by about 55% in water, as the rope must be kept as thin as possible for bulk and weight reasons and the knot is the weak link, a short piece of thicker rope could be used to tie on with, attached to the thinner rope by means of an eye spliced into the end of each rope and a small stainless steel snap hook or shackle (a splice weakens the rope a great deal less than a knot).

The rope should be inspected at regular intervals for signs of wear or damage as this

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is one of the most important pieces of equipment in a cave dive. A fixed guideline or life line should not be used to pull the diver through the water unless in an emergency, as this will place unnecessary strain on the rope. When a polyethylene (floating) rope is used in a cave with an irregular roof, it may float up and get stuck, making the return trip, possibly in zero visibility, difficult. In such situations the diver should signal “take up slack” so that the rope tender will keep tension on the rope.

In some underwater passages which are dived often such as a water trap separating two “dry” sections of the cave, a permanent guide line is recommended. This should be fairly heavy rope such as an obsolete climbing rope or steel cable and should be well secured at either end. This does not mean that the diver may dive without a life line unless under certain circumstances, a short rope is attached to the diver and the other end is run along the guide line, using a snap hook. For short syphons fixed communications can easily be set up by means of a length of hose pipe with each end out of the water and a funnel stuck in each end, making a “voice tube” which is very effective, reliable and cheap.

When two divers use a life line together, the rope should be secured to the leading diver and the second diver should have a waist band with a snap hook that can be attached to the life line and run along it. An alternative is to use a “buddy line”, but this is not suitable for tight passages. The normal procedure would be to select a “lead diver” to who’s waist or wrist (depending on personal preference) the life line is tied, using a bowline knot. The second diver would have a length of rope attached to himself, leaving a length of about 2 metres. On the other end would be a snap hook or carabina which would be snapped onto the life line between the “lead diver” and the rope tender, ensuring that it could run freely back and forth along the line. This method is much less restrictive to both divers and using this method the signal is passed either from the tender or from the second diver both ways, so that both divers and tender are always kept informed. Also, if the “lead diver” discovered a side system to explore, the second diver can remain at the entrance (that might already be deep into the cave) and become the temporary rope tender. This is especially useful as rope signals do not transmit round corners and the lead diver might require someone at the entrance to the side system with a torch to enable him to retain his orientation, especially on a deep dive. Rope signals are of vital importance and should be standardised for all divers with possible modifications when required. They should be simple, few in number and memorised by all members of the diving team. When any involved messages are required a proper underwater communications system must be used (refer Section 12). The rope tender should keep tension on the rope at all times to receive signals and might need an assistant to help with coiling the rope when the diver is coming back to avoid tangles.

There are a number of ways to attach the rope but the best would be around the waist or onto the wrist. The latter way is better for signals and for being pulled out in an emergency, but must be well tied as it can (and has) slipped off a diver’s wrist during a dive. A bowline with double hitch is the best knot and must be well tied and checked before the dive starts.

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The above guidelines have purposely been left open to manipulation to suit the many variations to cave diving. It is also important that one member of the non-diving team should have a good knowledge of first aid, with special emphasis on mouth to mouth resuscitation, cardiac massage and treatment of shock.

Although these guidelines were designed for one particular diving club they may be of some use to other cave diving groups, with possible modifications.