Therefore, the changes of the alpha, mu and delta rhythms may be caused indirectly.

From this preliminary study we conclude that MEG is applicable in certain aspects of diving research which can be studied at normal pressures. Similarly, as with normobaric EEG examination, it can be used diagnostically in diving medicine. It may also be helpful to elucidate the controversial issue of whether sport diving implicitly has a risk of brain lesions,[3] a notion claimed by several MRI studies.[4,5] However, most promising seems to be its application before and after treatment of neurological DCI with hyperbaric oxygen in a recompression chamber, since MEG (combined with EEG) is a powerful, objective assessment of brain function.

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CAVE DIVING IN AUSTRALIA

David Doolette and Philip Prust

Key Words

Cave diving, deaths, history, safety, training.

Introduction

The first cave dives in Australia were probably dives in the early 1950s in Tasmania and New South Wales. Diving continues in these areas usually as an adjunct to ‘dry’ cave exploration. The majority of cave dives in Australia take place in the vicinity of Mount Gambier in South Australia and on the Nullarbor Plain. This select history of the cave diving in these latter areas tracks the development of rules, equipment and diving techniques specific to cave diving.

Beneath Mount Gambier is an aquifer in a limestone layer up to 150 m thick. This aquifer is rain fed and flows slowly from the north west to the south east where water exits at springs on the coast, primarily Ewens Ponds. Many sinkholes (cenotes) have formed by dissolution of the limestone at cracks and joints and eventual collapse of the roof of the resulting water filled cavern. Parts of these sinkholes can be dived with either direct access to the surface or with daylight visible.

In the very early 1960s divers in Mount Gambier began to dive the well-known local sinkholes; The Shaft, 10-80, The Black Hole, Kilsby’s and Piccaninnie Ponds. By the middle of this decade the word had spread about these enormous caverns filled with crystal clear water and there were many divers from Mount Gambier, Melbourne and Adelaide visiting these sinkholes, it not being unusual to find 6 car loads of divers at any sinkhole on a weekend. For the most part, these dives were conducted within sight of daylight using standard open water diving equipment and techniques. Air supply was typically a single tank with J valve without octopus or pressure gauge. Using wetsuits and usually no buoyancy vests in these deep sinkholes required that weight belts be detached and hooked onto a convenient submerged tree branch. Single, low output lights were used and there were no cave diving reels.

A very few people were exploring the dark zones of sinkholes or entering true caves and experimenting with the forerunners of modern cave diving equipment. There was some experimentation with base fed lines which worked well in the larger sinkholes and much less well in true caves. As a result of this limitation of base fed line the first cave reels were built about 1968. The need to monitor air supply was apparent to the few divers using cylinder pressure gauges. At this time perhaps only one diver was using twin cylinders in some caves. Octopus regulators or truly redundant air supplies (twin cylinders) only began to be introduced around the mid 1970s but were resisted by most divers because of the cost. Octopus regulators became accepted equipment for cave diving by 1976 and for sinkhole diving a couple of years later.

Despite the advances made by a few divers, most sinkhole diving was being conducted under the illusion that daylight was always visible and special techniques were not necessary. With inadequate gear, some divers pushed into deep water or into the dark zone, in some cases with tragic consequences. Between April 1969 and December 1974 in five separate incidents 11 divers drowned needlessly in sinkholes in the Mount Gambier area. In three of these incidents divers became lost in the caves without a guideline and in one incident a diver was entangled in fishing line used as a guideline. Three incidents involved air diving to at least 60 metres and presumably nitrogen narcosis was a factor. In all cases the divers had little or no training in cave diving techniques which likely would have saved them.

Cave Divers Association of Australia

In 1973 a group of sinkhole divers met in Mount Gambier to discuss the consequences of the sinkhole diving deaths. The private owners of The Shaft had already closed access to that site and divers feared that other sites may close or that more divers might perish. The result of this meeting was a decision to form an association to regulate cave diving in Mount Gambier. A committee was elected and charged with the task of forming the Cave Divers Association of Australia. A constitution was written and a three category testing system for sinkhole and cave diving skills was devised. The land-owners were advised of this new self-regulation system whereby only divers holding the appropriate level of qualification should be allowed access to dive sites.

Skills were tested at separate levels representing three categories of dive sites: straight sided sinkholes, sinkholes with overhangs or small tunnel sections and true caves. The practical and theory tests included buoyancy control, air management, guideline use in normal and silt-out conditions, anti-silting technique, decompression, nitrogen narcosis, and stress testing. During the first ten years of the association this system persisted and improved with better information being made available for divers to prepare themselves for examination. Since the mid 1980s the testing system has given way to a training system where intensive instruction at each of four cave diving levels is provided by the Cave Divers Association of Australia.

During the 1970s cave diving techniques in Australia developed as more diving was done in true cave sites and a fourth category covering confined or long distance cave penetration was introduced. Most Australian cave diving techniques were developed out of necessity and in isolation from the cave diving communities that were developing overseas. However, increasing frequency of visits here by overseas cave divers and overseas travel by Australian cave divers has allowed exchange of ideas. Nevertheless, much of the technical development was driven by necessity in the Australian explorations, particularly of the long caves on the Nullarbor plain which will be discussed in connection with Cocklebiddy cave.

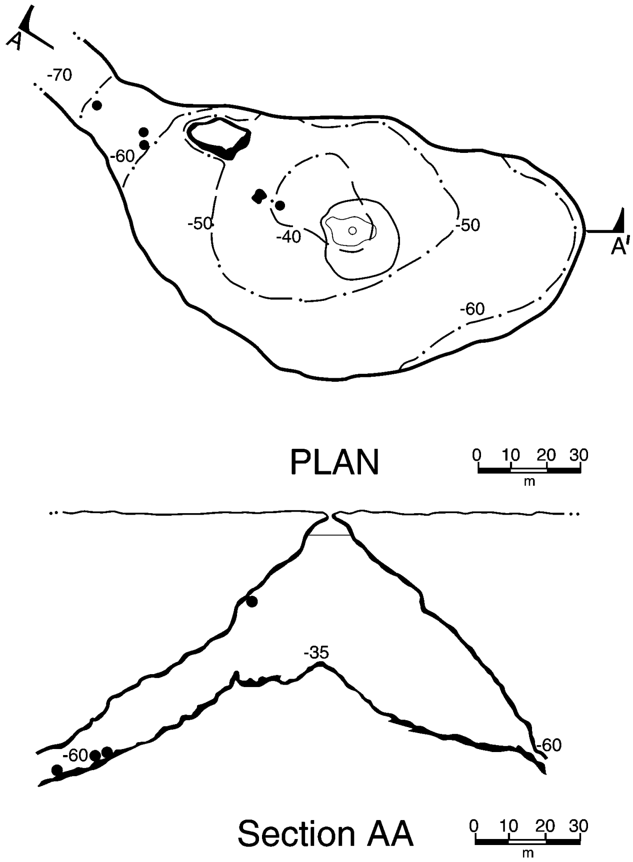

Figure 1. Cross section map of sinkhole L158 (The Shaft) near Allendale East, South Australia, redrawn from the map produced by the CDAA Research Group in 1984. The black dots are where the four bodies were found.

Three significant cave sites

THE SHAFT

On a dairy property in Allendale East is The Shaft, one of Australia's most famous and infamous sinkholes. The small entrance was exposed during ploughing in 1938. During the summer months, around noon, sunlight enters the cave through the small entrance providing a brilliant shaft of light that tracks across the debris cone. The Shaft became a popular dive site in the 1960s with much of the main cavern, in sight of the shaft, explored to considerable depth. Using a base fed line, a very few divers had explored to depths of 60 m, out of sight of the entrance light, but it was otherwise not widely known that the cave extended beyond sight of the entrance light. The low output lights of the day could not reveal the extent of the cave from this point.

In May 1973 eight divers each equipped with a single 72 cu ft tank and low output light entered The Shaft planning to reach 250 feet (75 m) depth. No guideline was used as they believed that the entrance light would be visible. Two divers ascended relatively early from 55 m and 60 m respectively while the other divers continued deeper towards the tunnel area where the entrance light is not visible and their low output lights would be of little use in orienting themselves. From depths ranging up to at least 68 metres two divers managed to find the surface after being temporarily lost but the other four divers drowned.

Immediately following the multiple fatality the landowners closed the site to all recreational diving for several years. Later, a very small group of divers regained limited access to this site. In the early 1980s this group negotiated expanded access to the cave for a mapping project which produced maps of the cave in 1984. Care was taken not to repeat the fatalities of the past and diving was limited to a depth of 50 m. Subsequent to the mapping project negotiations with the landowners resulted in the re-opening of the site to suitably qualified divers under the guide system and the 40 m depth limit that exists today.

In the early 1990s permission was gained from the landowners to explore the deeper sections of the cave. Using trimix breathing gas and high output (400 watt) lights, a series of dives were conducted into the "tunnel" region to a depth of approximately 85 m and approximately 200 m horizontally from the entrance, giving a clearer picture of this part of the cave.

COCKLEBIDDY

Dry caving expeditions to the Nullarbor plain in the late 1960s established the existence of large underground lakes in the caves of the Nullarbor plain that may prove suitable for diving. A number of these have since proved to be spectacular dive sites including Cocklebiddy cave. In a limestone layer 90 m below the surface of the desert is the lake entrance to Cocklebiddy cave. In 1972 three divers dived 300 m into the enormous, shallow, north trending tunnel from this lake using low output lights and twin independent 72 cu ft cylinders filled only to 100 bar, the maximum the portable compressor they had could manage. What they could not know was that the cave would continue over five kilometres from this point.

In 1974 divers pushed 500 metres into this tunnel and in 1976 a team found and crossed the Rockpile, a large dry chamber formed by rock fall at 1,000 m, and dived 150 m into the second section of the water filled tunnel. In the late 1970s divers reached 500 then 1,000, then 2,000 m into the second sump. Carrying sufficient air supply for these longer dives became possible with the availability of 88 cu ft aluminium cylinders used in single and triple back mounted configurations and staging of additional cylinders. The necessary lighting was provided by the construction of home-made high output, long duration canister lights. The use of high pressure copper tubing from surface compressors allowed air cylinder to be refilled at the entrance lake rather than transported out of the cave.

In 1983, pushing a makeshift sled, consisting of cylinders and buoyancy compensators strapped to a broom handle, divers reach Toad Hall, another rock fall 2,500 m beyond the Rockpile. Crossing the 300 m, unstable rock fall at Toad Hall they found the water-filled tunnel continued.. In 1984, just weeks before a planned Australian expedition, a five member French team scooped the third sump. Using Aquazep diver propulsion units two divers reached Toad Hall and dived some 1,500 m beyond, to the terminal feeders they claimed prevented further progress. Weeks later the Australian team returned to Cocklebiddy, determined to push further than the French. Pushing three improved cylinder transport sleds, six divers transported 60 cylinders to Toad Hall. A single sled and three divers continued to the terminal feeders. One diver used a single cylinder to explore the terminal feeders and then, rather foolhardily, pushed the single tank in front of him into the narrow extension of the main feeder branch for another 250 m without finding the end. He returned with this single air supply almost exhausted.

In 1995, after a long period during which exploration was focused on the neighbouring Pannikin Plains cave, there were a number of successful, and unsuccessful, swims to Toad Hall, a large expedition returned to the third sump. Using sleds towed behind diver propulsion vehicles, a single diver was put into the third sump, for a scooter assisted dive to the end of the French line and then a streamlined swim, with twin cylinders detached from the diver, to continue the exploration of the main feeder. This expedition was successful, but only 20 m beyond the previous extent of the line the cave narrowed sufficiently to exclude even this streamlined diver.

TANK CAVE

Underneath an old water tank in a paddock near Mount Gambier is a small underground lake at the end of a low, mud filled chamber. In the mid to late 1960s a couple of divers independently dived this site with out much success. They did not push on with exploration as other similar sites had never yielded much cave. Nevertheless, they spread the word about the cave and, in the mid 1980s, it was dived again. After passing the very tight, silty entrance two divers swam approximately 100 m into the cave before trepidation at negotiating the entrance squeeze urged them to return. They later produced a beautiful map of their finds.

Three other divers, including one who had been there in the 60s, returned and, after a false start, made a 240 m dive up what is now know as the B tunnel using twin 50 cu ft cylinders. After some time, with a change of owners, the cave was closed. Subsequently, in the early 1990s the property was sold again and the present owners initially allowed access restricted to a few divers, but now all suitably qualified CDAA divers can access the site through a rigorously managed guide system. Since the early days the entrance chamber has been cleared, the squeeze widened by removal of some rock so that the cave could be entered using twin 90s or larger cylinders. The entrance is gated for security. The known extent of the cave now exceeds 8 km of passage.

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JS HALDANE, JBS HALDANE, L HILL AND A SIEBE: A BRIEF RESUME OF THEIR LIVES

Chris Acott

Key Words
Decompression illness, equipment, history, general interest, physiology.

Introduction

In the 19th century there were numerous attempts to explain the symptoms of decompression sickness which ignored Boyle's and Bert's bubble theories. These explanations included: spinal cord damage caused by cold or exhaustion; frictional tissue electricity caused by compression-or decompression-induced organ and vascular congestion. Allbutt's "System of Medicine", published in 1900, reported that decompression sickness "was attributed to the mechanical effect of pressure on the circulation". However, despite these controversial views, all the salient clinical features of decompression sickness were described between 1870-1910.[1-3]

Haldane, Hill and Siebe are names synonymous with the development of diving and diving medicine. This paper is a brief outline of the lives of the J S Haldane, J B S Haldane, Leonard Hill and Augustus Siebe.

John Scott Haldane (1860-1936)

J S Haldane was born in Edinburgh on the 3rd May 1860 and died in Oxford during the night of March 14/15th 1936. His family (whose motto was "Suffer") was affluent and influential. He studied at the University of Jena after graduating from the University of Edinburgh Medical School.[4-7]

He taught physiology at the Universities of Dundee and Oxford and was noted mainly for his work on respiratory physiology. His research demonstrated great intellectual curiosity and often involved self experimentation. He was assisted by his son (JBS Haldane) in much of his work. He developed several procedures and apparatus for the physiological study of breathing and gas exchange; these included the haemoglobinometer and the Haldane-Henderson Gas Analysis apparatus.[7]

In 1893, following self experimentation, he concluded that respiration was regulated by carbon dioxide. With a colleague he remained in an air tight box (named "the coffin") for up to 8 hours rebreathing the atmosphere and noting their reactions. "At 7 percent (oxygen concentration in air) there is usually distinct panting, accompanied by palpitations, and the face becomes a leaden blue colour. At the same time the mind becomes confused." This data were not published until 1905.[9] In 1914 the "Haldane Effect" was published. His book *Respiration* was first published in 1927.[8]

In 1895 he investigated a serious accident in which 5 London sewer workers died. He discovered "sewer gas" (hydrogen sulphide) by descending into the shaft to take samples of the air and sewerage. He recommended aerating the sewers and attaching safety ropes to all sewerage workers.[7]

In 1911 he led an expedition to Pikes Peak, Colorado, USA, to study the physiological effects of low barometric pressure.[5,6]

In 1913 he became a director of a mining research laboratory. He found that "fire damp" (a mixture of CO, CO_2 and N_2) was far more lethal than the effects of an underground explosion. As a result of his firedamp experiments he recommended: "In view of the difficulty of recognising by ordinary means the presence of poisonous amounts of this gas (carbon monoxide), I propose the plan