HIGH ALTITUDE PHOTOGRAPHY IN CAVES

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Abstract

This paper describes equipment and techniques in photographing "inaccessible" places in caves such as the upper levels of high caverns or avens; the Gunbarrel aven at Wyanbene being an excellent example. A full description is given of constructing the lightweight equipment used. An operational run-down of taking a high level photograph and the people involved is described with problems and pitfalls discussed. Attention is given to various methods employed to aim the camera in the desired direction. The types of film used and the problems encountered in developing them are described. Finally, improvements to existing equipment and more ambitious additions are discussed.

Introduction

Following the measurement of the height of the Gunbarrel Aven in Wyanbene Cave, NSW by the Illawarra Speleological Society (ISS) using helium from a high pressure cylinder to inflate a larger than normal balloon, a lighted candle was lifted to the top of the aven. Some observers thought that the candle flame was affected by air currents during the ascent. The society later decided to equip a helium filled balloon with a large flashbulb (PF-100), that was to be fired after it had been lifted to the top of the aven, with tripod mounted cameras on the floor of the aven directed upwards to record what the flash illuminated. Photographic results of this led to the society's more ambitious project of lifting a specially constructed camera and ancillary equipment to various heights in the aven. The equipment described is designed with the wet conditions and access difficulties of the Wyanbene aven in mind. A further dampening influence on a too ambitious project is that every time the balloon and load is lofted it could be lost (i.e. cord becoming fouled, broken etc.).

Balloon

To keep the balloon weight to a minimum, 350 mm dia. by 0.0254 mm (0.001") thick polythene tube as used by dry cleaners has so far been found to be the most satisfactory. An important consideration in selecting balloon material is that it requires as little pressure as possible to inflate it (i.e. does not have to be stretched by gas pressure to size). The ends of the balloon are sealed by means of a wet cloth and a household smoothing iron; a small filling hole being left at one end. To lift 112 m of thread and a 440g payload a 6.1 m (20 ft) long balloon is required. On some ascents a second 3.05 m (10 ft) long balloon is added to:

(a) speed up the ascent.
(b) overcome the problem of water droplets collecting on the balloon which reduce its lifting capacity.
(c) speeding the balloon past cross-draughts.
(d) breaking the fall of the load should a balloon become ruptured on a high ascent.

A 40 Denier polyester thread is used to maintain the all important link between the balloon and ground party. A new thread is used for every session.

Lightweight Camera

Apart from pertinent aspects it is not the intention of this paper to delve into the workings and theory of cameras as this subject has been well documented in photographic publications. Further, with the type of photography described it is not the intention to produce portfolio type photographs but merely obtain an image that is recognisable.

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The two cameras constructed are of the single plate type for use with cut sheet film. Two major advantages steered us to this type of film:

(a) As each photo is taken it is recovered before the next photo is taken so that any loss of equipment on a 'flight' will not take all the photos with it as it would with roll film.

(b) each photo can be developed individually.

With little hope of directing the camera at high levels the wider angle of lens coverage the better; the ideal being the ultra wide angle lens. However, with most lenses likely to be used for such a project, a larger size film format can be utilised than for which the lens was originally designed with acceptable results. This in effect gives a wider coverage of the subject.

The first camera constructed was a fixed focus camera built around a single element meniscus lens with no shutter. Although this camera weighed only 30 g posed obvious difficulties in use. In spite of operational problems the first photographs of the upper levels of the Wyanbene Gunbarrel were obtained.

At a cost in weight, a second more advanced camera was constructed to suit an f3.5, 90 mm double element astigmatic lens as recovered from a Dehel folding camera of 1945 vintage. This lens was complete with an adjustable diaphragm and a between-lens leaf shutter with variable speeds including a "time" (T) setting. As the lens had a screwed barrel a mating threaded ring was fixed into the lensboard, allowing the camera to be focused. All unwanted mechanisms in the lens housing were removed. In the interests of reliability the flash contacts were replaced with a Honeywell ISX subminiature micro-switch. To trigger the shutter a Speed Graphic shutter solenoid was modified to fit into the cable release holder. The internal shutter trip mechanism had to be modified to allow it to be triggered by the solenoid with minimal power. During its first use, under wet conditions, the shutter became sluggish; it was later dismantled and clearances on pins and pivots relieved to make the shutter operate more freely.

Before manufacturing a camera body the size of film to be used and the lens to film distance at infinity needs to be determined. These dimensions can be taken off the original camera if available; if not, they can be determined with the lens and an etched glass screen. The use of a bellows type plate camera is a help. In choosing a size of sheet film to use the supply position was checked; a number of sizes are not readily available. Cutting sheet film down in size is not easy.

Basically the camera body consists of a lensboard supporting the pyramid shaped sides with a removable back; the whole being constructed of sheet balsa wood glued together with a waterproof epoxy resin. A light trap between the camera body and back is achieved by glueing velvet material to the rear of the camera body. Support brackets are glued to two opposite sides and two metal slides are fixed into the inside of the back to hold the sheet film. The thin balsa wood sheet used is not light-tight. To overcome this and to assist with waterproofing the balsa wood parts are painted with a wood sealing paint; the outside is finally painted with white enamel and the inside with a flat black enamel (i.e. as used to cut reflections from musical instruments in T.V. studios). Other refinements are additional light trappings on the removable back and supports for the rubber bands which secure the back to the camera body.

Electrical Pack

The electrical control equipment and battery pack are housed in a thin polythene bag in the interests of weight and waterproofing and consists of the following:

(a) six volt battery pack made up of four 1.5 volt 'Eveready' size N. No 904 batteries connected in series.

(b) miniature on/off switch connected in the battery supply.

(c) 2,500 μf, 25vw electrolytic capacitor to operate the camera solenoid.

(d) Light Emitting Diode (LED) indicators to assist in locating the equipment in flight and to indicate the state of the camera shutter.

(e) repetitive electronic timer as used with time lapse movies with a timing range from one second to five minutes; plug-in timing slugs being used to vary the time cycle.

(f) card relay to switch the solenoid.

Lighting

Due to the heights involved, subject illumination has to be carried aloft with the camera. For distances up to 20 m a small electronic flash unit is generally used (Hanimex TX 265). Where the subject is beyond 20 m expendible flash bulbs are used (PF-38, PF-45, PF-60, PF-100). A crude reflector is constructed on site from aluminium wire, aluminium foil and rubber bands for use with flash bulbs. A bulb holder is hung in the dome of the reflector.

Support Frame

The main frame is formed of 5 mm dia. aluminium wire in a coathanger shape with the exception that the join is made in one of the bottom corners; after twisting the ends together two prongs are left which are used to support the camera. A strong rubber band is used across the prongs to clamp them to the camera. Additional mountings for the electronic flash unit are formed of 2 mm dia. aluminium wire.

Operational Description

When all the equipment has been transported to the site, the frame and reflector are constructed and the components to be used are mounted on to the frame; the flash being mounted on the opposite end to the camera to achieve a modelling effect. After connecting the electrical wiring the completed outfit is given a test. All hands are used to unroll the balloon and to keep it off the floor while it is being filled with helium from the cylinder. During the filling process, a close inspection is made for any leaks in the balloon; any found are repaired with durex tape. When fully inflated the end of the balloon is tied off with a clove hitch using a short length of small flexible electrical wire. The position of the equipment is dependent on what photos are to be taken. With downwards or sideways photos the bracket is tied off with two ties directly to the balloon. This position is less susceptible to movement and is best if expendable flash bulbs are to be used. For upwards photos the bracket is suspended about 12 m below the balloon; being tied into the main thread rather than suspended by a separate thread from the balloon. The balloon will appear in these photographs and can be used as a scale. The electronic flash unit is usually used with this arrangement; its speed countering the spinning of the bracket. Until the thread is tied on to the bracket care is exercised to see that the balloon and load is not accidentally let go. To avoid thread tangles the thread has to be taken off the bobbin in the same manner as it was put on (not pulled off an end). The balloon is let go to the top to achieve this. On retrieving the balloon the thread is allowed to gather on the floor as it falls.

A sheet of cut film is removed from its light-tight container and loaded into the camera; all lights being extinguished during the operation. While the camera is reasonably light-tight care is taken not to direct any strong light towards it; the emergency lamp in the standard Oldham miners lamp causes no problems. The support frame is balanced by adjusting the position of the electronic package and then the shutter is cocked. After a signal from the stop-watch operator the power is switched on and the outfit let go. In places subjected to air currents no braking is applied to the thread until it is finally brought to rest. Progress is estimated by the amount of thread remaining on the floor. On high "flights" the balloon and load attains a speed of up to 5.5 ms^{-1} and at this speed, braking is started when about 10 m of thread remains on the floor. Hands are protected by gloves to avoid cuts from the fine thread. If the speed of lift and timing have been judged correctly, the camera should not operate for at least 15 seconds after it has stopped. This allows time for the load to stop spinning. As the count-down nears zero most look upwards to catch a fleeting glimpse of the upper levels as the flash goes off. At this stage the second leg of the timer is initiated and after a five second delay triggers the shutter a second time to close it; this being indicated to those below by the LED indicators. As soon as the LED's indicate that the shutter is closed the load is retrieved: minimal light being used until the unit is checked to see that the shutter is closed. All lights are once again extinguished while the exposed film is removed from the camera and replaced with an unexposed film. The exposed film is stored in a cut-film developing tank; the slots in the tank being a ready means of separating the various exposures. Two or three shots are taken from each position and stored together.

The camera and flash can be directed as desired, although at present we have no control over the orientation of the side-facing shots. With down-facing shots the five second shutter delay allows a manually operated flash to be used to illuminate the floor before the shutter closes. This enables the photo to be oriented. A person with quick reactions is needed to fire the second flash.

Film Processing

Since most shots are underexposed, development times are pushed well beyond those recommended by the supplier. With a number of shots taken from each position only one at a time is developed so that after examination of the exposure, the development times of the rest can be adjusted to suit. Due to weight considerations, only a small electronic flash unit can be used. The resulting photos therefore, are more underexposed than those exposed by flash bulbs.

Future Improvements

Improvements that could be made in the future include:

(a) use of colour film,

(b) means of directing the camera for high-level side-facing shots,

(c) use of a reeling device and counter so that heights photographs are taken from are more accurately known, and

(d) use of hydrogen instead of the more expensive helium.

References

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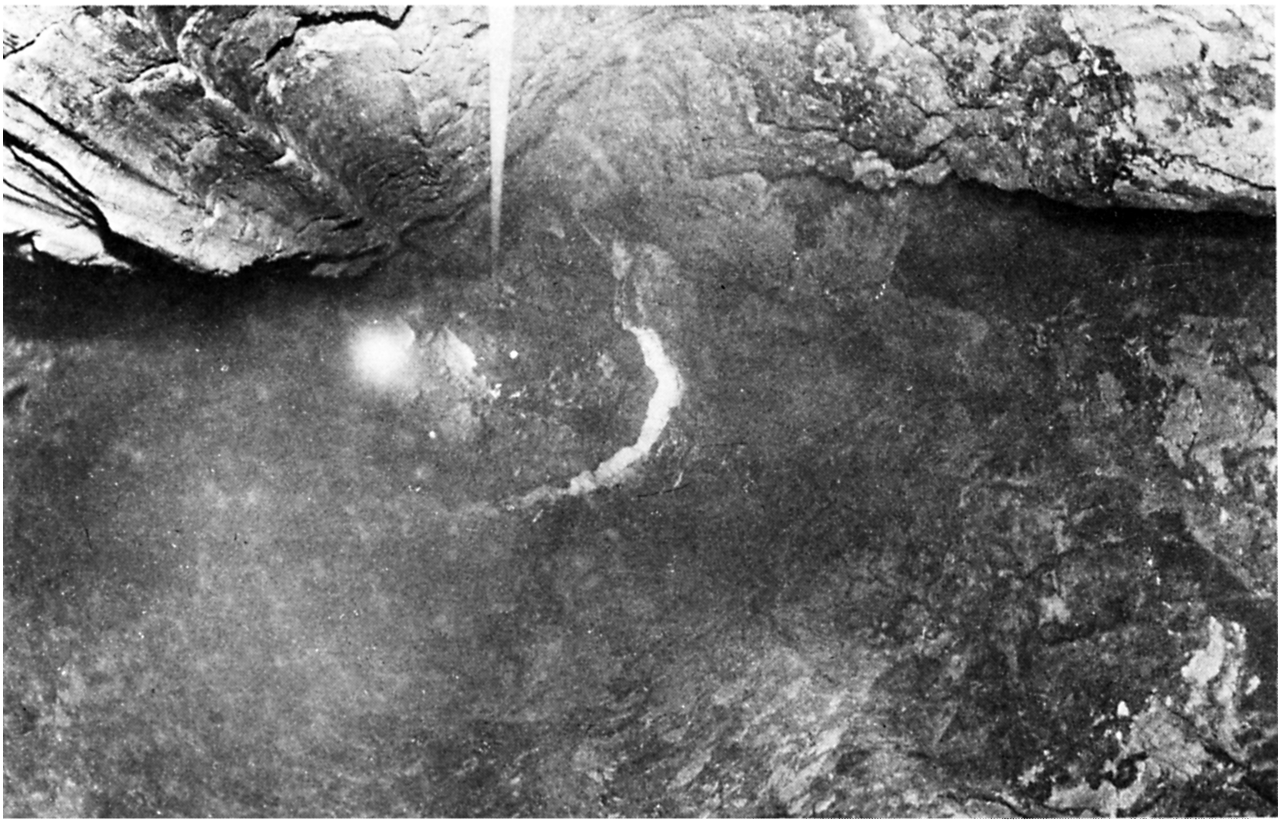

Plate 6. The Gunbarrel, Wyanbene Cave, looking down from an altitude of about 60 m. The round dots near the bottom are toy balloons tethered about 8 m. above.