ENVIRONMENTAL MONITORING IN CAVES: PART 2

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Abstract

Some techniques of measurement and the equipment used are discussed. An instrument system developed for cave work will be demonstrated.

INSTRUMENTS AND TECHNIQUES: A DEMONSTRATION

(1) Psychrometer. The most important single instrument is an aspirated psychrometer such as the Assman model. The instrument demonstrated is smaller than commercially made models and has an electric motor to aspirate the wet and dry bulb thermometers. Commercial models are larger and cost a lot of money. They usually have a clockwork motor.

To use an Assman Psychrometer in a cave with little air movement it is often easier to leave the instrument running and retire to a safe distance downwind. When it is judged (say three minutes) that the instrument has come to equilibrium it is approached and read quickly. It is very easy to get errors of greater than 1°C from operator body heat. The measurements of dry bulb and wet bulb temperatures enable the condition of the air to be measured, and its stability and directions of heat transfer calculated.

(2) Precision barometer. This is a surveying altimeter. When used in pairs they enable fast accurate levelling when vertical section surveys are required. It is also very useful for measuring barometric pressure.

(3) Titanium tetrachloride. This can be used to detect very slow airflows in caves (Halbert & Michie, 1971). I am not sure that the release of titanium dioxide in a cave is consistent with conservation. The next method may be more desirable.

(4) The cigarette. These handy flowmeters are cheap and come in convenient packets. They have some use as flow meters in low to medium rates of horizontal air flow. The smoke from a cigarette which has one end lit rises at about 100 mm per second. If a point 100 mm above the burning tip of the cigarette is taken, the horizontal distance to the smoke rising from the tip gives the velocity in mm per second. Caution: the lighting of cigarettes in caves is likely to present a health hazard if conservationists are about.

(5) Air-tracing agents. Vanilla essence and vanillin provide a non-toxic method of marking an airstream so that is can be detected with a simple sensitive instrument - the nose. Initial experiments using vanilla-tracing have been variable. They have ranged from more spectacular than fluorescein in water to quite negative.

(6) Contact thermometer. This is an electronic instrument for measuring surface temperatures. I am not sure how useful it is as I never seem to use it.

(7) The recording system. This is an electronic system that controls a modified "Rustrak" chart recorder. The system is powered by torch batteries

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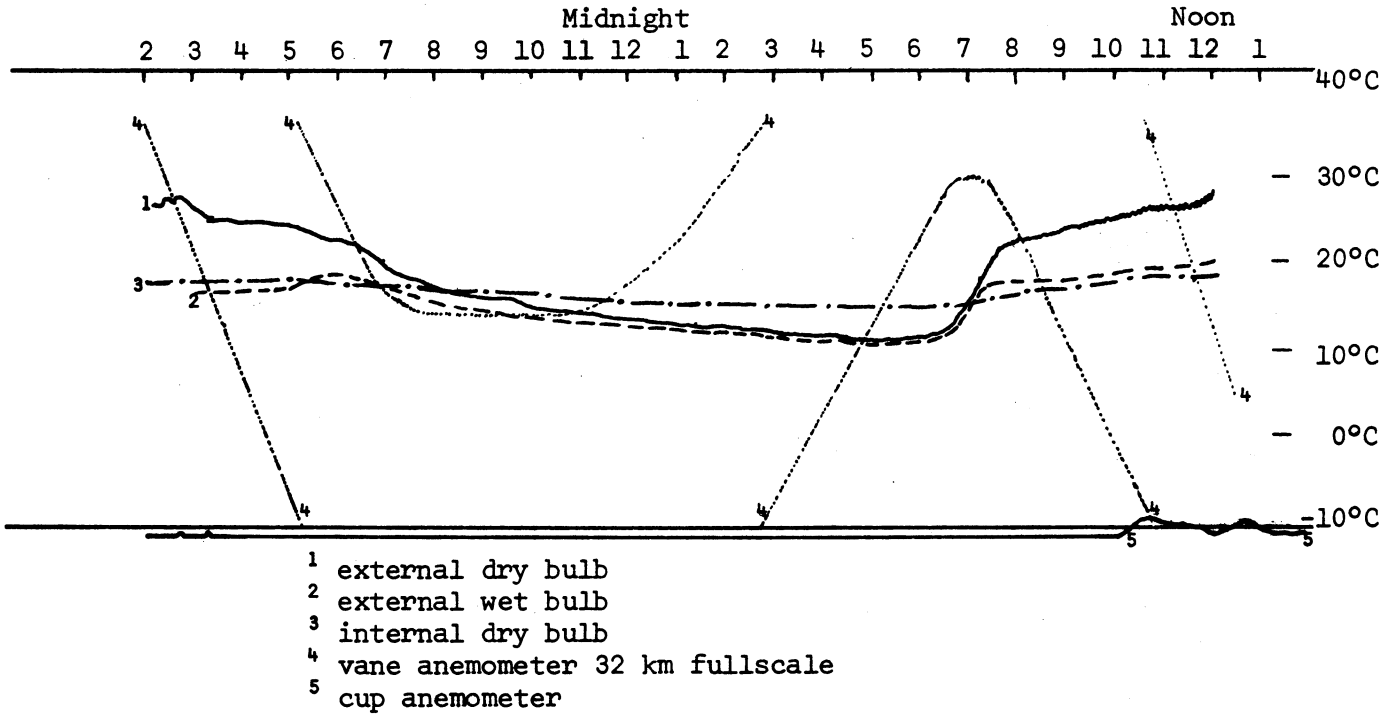

Figure 1. A recording in a chimney cave of airflow through the cave and external temperatures with internal temperature and external cup anemometer.

that can last one year. The circuitry is a mixture of analog circuits that are only operated briefly to plot a point on the chart and digital circuits using very low power. The recording system is connected to several measuring devices:

(a) The "pigeon-house" psychrometer. This consists of wet and dry bulb thermometers which are not aspirated. They are mounted in an elaborate double heat shield. This is for measuring actual air temperatures on the surface even in direct sunlight. Simple tests showed good comparisons with an Assman-type psychrometer.

(b) The cup anemometer. This rather insensitive anemometer measures the surface wind speed.

(c) Underground thermometers. These use the same elements as the pigeon-house psychrometer - selected silicon diodes.

(d) Underground vane anemometer. This resembles an engineer's vane anemometer but has two magnetic proximity detectors to sense rotation. The rotation information is fed into a bidirectional counter, the value of which is recorded. The recording of integrated flow removes much difficulty from the fluctuations of air velocity and enables more accurate measurement of heat flows.

A section of a chart which was recorded in a multi-entrance cave is shown (Fig. 1). The relation between the rate of airflow (the gradient of the vane anemometer trace) and the external dry bulb temperature can be seen.

REFERENCE

Halbert, E.J. & Michie, N.A. (1971). The use of titanium tetrachloride in the visualization of air movements in caves. *Heliotite* **9**(4):85-88.