TIME-LAPSE PHOTOGRAPHY

FOR GEOLOGIC RESEARCH

By

Robert K. Fahnestock

Approved for publication by
Director, U.s. Geological Survey

U.S. Geological Survey
Colorado State University
Fort Collins, Colorado

January 1961

CER61RKF6

TIME-LAPSE PHOTOGRAPHY FOR GEOLOGIC RESEARCH

by

Robert K. Fahnestock

Approved for publication by
Director, U.S. Geological Survey

U.S. Geological Survey
Colorado State University
Fort Collins, Colorado

January 1961 CER61RKF6

TIME-LAPSE PHOTOGRAPHY FOR
GEOLOGIC RESEARCH

Robert K. Fahnestock

U.S. Geological Survey
c/o Civil Engineering Department
Colorado State University
Fort Collins, Colorado

ABSTRACT

Developments in photographic equipment have made it possible to design a wide variety of time-lapse equipment to photograph and measure geologic processes. New films, exposure controls and techniques promise better photography under diverse light conditions. Application of photogrammetry to time-lapse analysis will allow measurement of rate of change of distance, elevation, and direction.

TIME-LAPSE PHOTOGRAPHY FOR GEOLOGIC RESEARCH

Robert K. Fahnestock

U.S. Geological Survey
c/o Civil Engineering Department
Colorado State University
Fort Collins, Colorado

Many events occur too slowly for accurate observation by the human eye. The time-lapse camera is a tireless observer that can provide a permanent record of such events. With the time element greatly compressed by time-lapse photography, geologic phenomena may be analyzed frame by frame and shots of particular events may be shown as many times as necessary to view everything to be seen. The film can even be run in reverse and an event traced back to its origin. As the geologist is primarily an observer, the additional dimension and the accuracy which time lapse can add to his observations should be welcome.

While used primarily by meteorologists and biologists, time-lapse photography has been used to study cliff recession, glaciers (Miller and Crandell, 1959), landslides, ripple and dune formation in a laboratory flume, development of model meanders, and pattern change in a glacial stream (Fahnestock, 1959). Among the many possible uses for the technique are the study of mud flows, weathering, erosion, slope development and soil creep. Time-lapse films should prove excellent geologic teaching tools.

The geologic process to be studied, and the measurements desired, determine the type of equipment that should be used. Processes that are continuous require equipment designed for continuous operation. Intermittent processes such as the passage of a flood wave may require special activating devices to permit camera operation only during periods of activity, or photography at an increased rate.

The motion picture camera is best suited to provide a continuous record of events that take place over periods which range from minutes to days. It also can be used for events requiring much longer periods; although photographs made with cameras with larger formats may provide more useful records of slow processes.

When measurements of the changes in distance, direction, elevation, and velocity are desired, a number of devices may be employed. Grid systems, reference points, and scales may be placed in the field of view of the camera for reference. From these known references, values may be read directly or interpolated with a fair degree of accuracy.

Engineers at Colorado State University are working on equipment to expose a sequence of stereo pairs to allow photogrammetric measurement of cloud formation (oral communication). For photogrammetric use, negatives on film 70 millimeters wide or even larger are desirable.

A time-lapse mechanism consists of a timing device, camera actuator, and camera. Numerous commercial mechanisms are available for time-lapse photography where weight, light, and power requirements are not critical; however, many are excessively heavy and (or) require fairly elaborate light and power systems. Because geologic work is often done in remote locations, portability and simplicity of equipment is a requisite.

A number of motors, which combine timer and camera actuator, are available for making single frame exposures with 16 millimeter cine cameras. Unfortunately for the geologist, most if not all such equipment requires 110 volt alternating current for operation. The best mechanisms for battery-operated actuating devices appear to be solenoid units or motor driven cam units. Another possibility is a pulse type camera that exposes one frame for each impulse received from the timer.

Numerous 110-volt timing devices are available, and one article (Boger, 1960) describes a device that can be constructed for a material cost of $6.50. Such devices can be battery operated with an inverter; however, the unit would be heavy and bulky because of the heavy battery drain. At least one portable battery-operated timer is available commercially (Meteorology Research, Inc.). Miller, Parshall, and Crandell (1961) have described a battery-operated timer. The major obstacle to inexpensive time-lapse mechanisms at present is the lack of a dependable, versatile, and inexpensive timer which is portable.

Geologists frequently encounter photographic problems because of highly varied light conditions. These problems can, in many instances, be solved by automatic exposure controls. These controls are available on at least 57 8-millimeter motion picture cameras, 2 16-millimeter cameras and 11 35-millimeter still cameras (1961 Photography Directory). There is one light weight battery-operated unit (Flight Research's Autex) which provides automatic aperture control for many lenses. The problem of outdoor photography of large areas at night has not been solved. It may prove possible however, to utilize some automatic aperture controls to shut off the time-lapse mechanisms at dusk and resume photography at dawn.

One technique of black and white photography (Adams, 1948) utilizes under-development of negatives that have been over-exposured during the brightest part of the day to get printable negatives over a wider range of light conditions than is possible with conventional development when a fixed exposure must be used. Exposures should be set for the darkest

Figure 1 - Exposure latitude using shortened developing time. Left picture taken on Tri-X film at 1/500 sec., f 22, (3 stops under-exposed); right picture under same light conditions (7 stops over-exposed) at 1/8 sec., f 5.6. Development time was 8.25 minutes in undiluted Microdol X developer at 68°F instead of the normal 11 minutes. (Keichi Nakamoto, Colorado State University Photographer, oral communication).

period for which photos are to be taken and all brighter periods over-exposed. Figure 1 shows the exposure latitude using this technique. The shortened developing time and selection of printing paper of proper contrast will correct for this over-exposure. This technique should eliminate the necessity of automatic aperture control using black and white film in such 35 millimeter cameras as Robot and Practina, which are available with motor drives and film capacities from 30 to 200 feet. Motor driven cameras such as the Hulcher 70 millimeter and the K-24 aerial camera with a 5 x 5-inch format can be used for time-lapse purposes.

A number of types of equipment are useful in time-lapse analysis. At present, at least 5 16-millimeter and 1 35-millimeter time- and motion-study projectors are available commercially. These projectors feature variable projection speed and projection of individual frames. Some 8 millimeter projectors are also suitable for time-lapse analysis.

Figure 1 - Exposure latitude using shortened developing time. Left picture taken on Tri-X film at 1/500 sec., f 22, (3 stops underexposed); right picture under same light conditions (7 stops overexposed) at 1/8 sec., f 5.6. Development time for both pictures was 8.25 minutes instead of the normal 11 minutes in undiluted Microdol X developer at 68°F. (Keichi Nakamoto, Colorado State University Photographer, oral communication).

Devices for reading microfilm and editing movie film can be used also to study individual frames or portions of frames. Where stereophotography is of sufficient quality photogrammetric plotting equipment can be used for analysis.

Finding an inexpensive battery operated time-lapse mechanism with automatic aperture control is difficult, if not impossible, at this time. However, with the present rate of development, there is hope for the future. With components now available, the variety of the time-lapse equipment that can be produced by an individual is limited only by his finances, his mechanical ability and his ingenuity. A time-lapse mechanism with an 8 millimeter camera having automatic exposure control, can be built for less than $50.

REFERENCES

Adams, Ansel, 1948, The negative; exposure and development: Basic Photo Series No. 2. New York, Morgan and Lester, p. 9-13.

Boger, Roddy, 1960, Time lapse: Photo methods for industry, April, p. 38, 39, 100.

Downs, Bruce, 1961, Photography directory and buying guide: New York, Ziff Davis Publishing Co.

Fahnestock, R. K., 1959, Dynamics of stream braiding as shown by means of time-lapse photography: (abs.) Geol. Soc. American Bull., v. 70, p. 1599.

Miller, R. D., and Crandell, D. R., 1959, Time-lapse motion picture technique applied to the study of geological processes: Science, v. 130, no. 3378, p. 795-796.

Miller, R. D., Parshall, E. E., and Crandell, D. R., 1961, Mechanical control for time-lapse motion picture photography of certain types of geologic processes: U.S. Geol. Survey Prof. Paper ______B, p______. (In preparation).