tion for the interpreter. This information, additional to that generally recorded by conventional aerial photographic procedures, is obtainable because of the fundamental differences in the manner in which materials respond to spectral energy wavelengths below and above the visible spectrum.

If a crude analogy may be permitted, the data recorded in different parts of the electromagnetic spectrum might be likened to the lines of an x-ray diffraction pattern or lines of a spectrogram. Some one or two lines of the pattern may give important information, but the entire combination of lines is commonly required to identify, recognize, or interpret a certain material. These "lines" or bits of information collected from the gamut of the electromagnetic spectrum obviously come from the visible as well as from the infrared, microwave, and other parts of the spectrum. For one interpretation problem the infrared record may provide the "strong lines" in the pattern, but for another problem these "lines" may come from conventional aerial photographs. It thus seems clear that for the photo interpretation function, conventional aerial photography is not obsolete. But it is equally clear that neither conventional aerial photography nor any other sensing record, to the exclusion of others, is necessarily the best answer to the data-gathering and interpretation procedure. On *technical grounds* conventional aerial photography remains on a firm footing for the photo interpretation as well as for the photogrammetric function. While research in new sensing systems is a natural and logical extension of photo interpretation investigations, these newer techniques cannot *solely on technical grounds* replace conventional aerial photographs. Only on *economic grounds*, when the systems approach to aerial photographic operations is considered, could conventional aerial photography become obsolete.

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Underwater Microcontouring

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Abstract: *Using vertically mounted deep-sea cameras, stereo pairs of photographs of the ocean bottom have been obtained. The camera axes were separated by a known distance sufficient to provide a three-dimensional model resulting in stereo photographs that could be used in conventional stereographic plotting instruments. A "microbathymetric chart" can thus be contoured at an interval of a few millimeters. Because the geometry of the system is known, the technique also results in an accurate determination of the height of the cameras above the bottom at the time the photographs were made. The technique holds promise as a means of quantitative evaluation of bottom roughness and as an additional parameter in bottom sediment studies.*

A new assault has been made on the unexplored regions beneath the surface of the oceans which cover two-thirds of our world.

The Coast and Geodetic Survey, using cameras developed by Edgerton, Germeshausen, and Greer, has added to its research

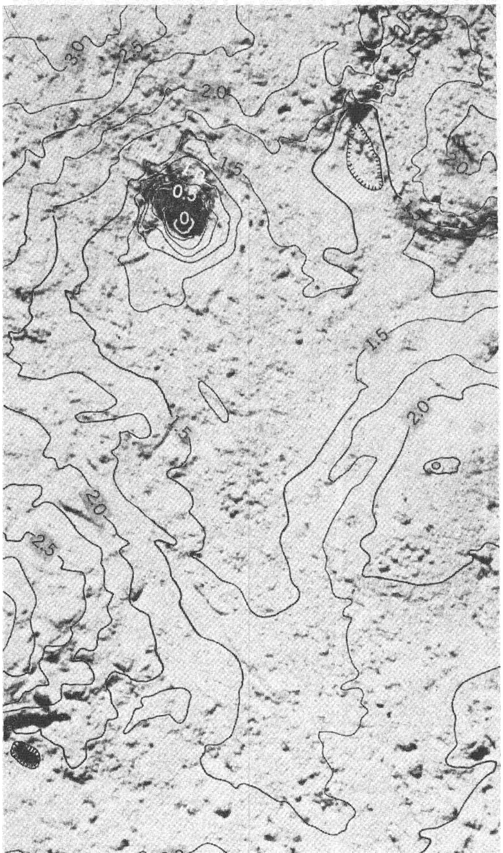

FIG. 1. Deep sea photograph with superimposed contours. This is part of a stereo pair used in the multiplex for determination of bottom configuration.

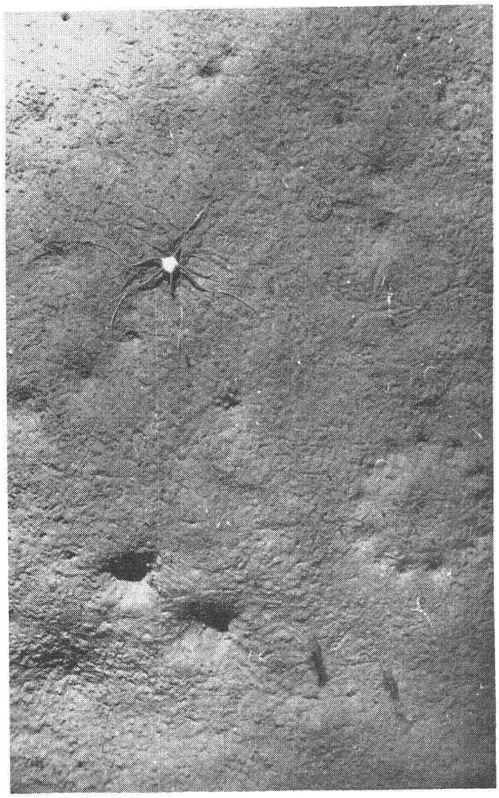

FIG. 2. Deep sea photograph showing "Brittle Star" near its "burrow."

fields the photography of the configuration of the ocean bottom. Using two 35 mm. cameras rigidly fixed on a frame to make simultaneous vertical exposures, stereo pairs have been taken at distances from the bottom ranging from 4 to 20 feet. The exposures have been printed on glass diapositives and set up in multiplex projectors. This combination of fixed-base and fixed-projection distance facilitates the determination of the base-height ratio. It has an effect similar to that of two aircraft flying at a fixed distance from each other with electronically linked cameras for simultaneous exposures.

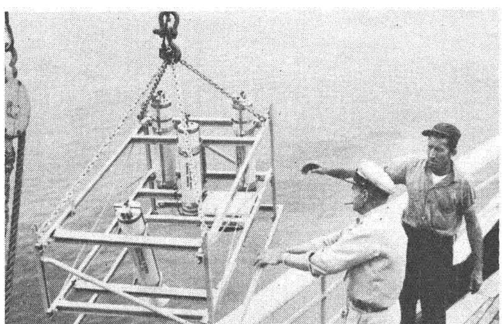

FIG. 3. Deep sea cameras and light source (original configuration) being swung over the side of the ship.

The underwater pictures have been approached from a metric analysis viewpoint. The examples shown with this paper were taken from a height of about 4 feet from the bottom. At an average projection distance of 360 mm. in the multiplex, the scale is one-third. Using a *C* factor of 600, 2 mm. contours can be drawn. The examples illustrated have 6 mm. contours to avoid crowding in the rough "terrain." The photographs were taken at a depth of 8,000 feet, at a location about 90 miles southeast of Nantucket Island along the continental slope. Color and black-and-white films were successfully used.

Basically, the Coast and Geodetic Survey's deep-sea camera consists of three major components. The first is a pair of automatic 35 mm. cameras spaced five feet apart which are loaded with 100-foot spools of film providing 500 exposures at standard frame-size (24 by 36 mm.). A data plate giving depth, time, date, position, and exposure number, as well as other desired information, is recorded on the film. These cameras have no shutters; they depend on the lack of light at great depths to prevent fogging of the film. Shallow water photography can be satisfactorily carried out at night. The specially designed Hopkins wide-angle f4.5 lens has been corrected for operation in air through a quartz window into water.

The second component is a twin-light source of 400 watt-second power with self-contained Silvercell batteries which flash every 14 seconds. The batteries also feed power to the cameras to advance the film to the next frame. This light and power source is controlled by a timer to delay the start of the unit for any given time, to allow the cameras to be lowered to the desired depth.

The third component is the pinger unit; this consists of a driver, coil, and transducer which are also battery powered. This sends a ping both up and down every second. The down pulse is reflected from the bottom and both pulses are picked up on an oscilloscope on shipboard, and the phase is compared for accurate positioning of the cameras at a predetermined distance from the bottom, as the ship drifts over an area of interest. These components are accurately positioned in a three-by-six foot metal frame and have a total weight of 325 pounds in air. They are lowered by an oceanographic winch with stainless steel cable of 4,000-pound breaking strength. A long bridle to the frame as well as the long cable gives the frame considerable stability. The height above the bottom is maintained by a man at the winch responding to information from the oscilloscope. An automatic control is being considered for this function. Using the 400 watt-second light source, the anticipation is obtaining photographs from a height of 30 feet above the bottom with a correspondingly greater coverage, this season.

Marine biologists should find the images of the brittle stars both in and out of their burrows of special interest in some of the illustrations. Other photographs have shown other marine life which would be of interest to ichthyologists—although perhaps they would prefer front, side, and top views! Approximate sizes of the few attached organisms can be determined by use of the floating dot and by shadow length. With coordination of bottom sampling with photography, keys could be made for future reference on types of bottom materials. The examples shown are in an area of fine sand, as determined from cores taken at the time of the camera lowering.

Limitations to this technique, of course, are the lack of means for positioning the photographs with anything near the accuracy of the usual mapping photography, and the limitations on light penetration through the water to obtain greater area coverage. Already new navigation systems such as those connected with satellite observations are clearing the way for better positioning, and research is being carried on to improve the light penetration under the water.

EXPLANATIONS AND REGRETS BUT NO APOLOGIES

At the time of writing this, the paged dummy for this (March) issue is ready to send to the printer. The issue is two weeks behind schedule. The fault was not with the Editor and Printer. The primary reason for the delay was very late receipt by the Editor and Printer of the complete manuscript. This loss of time was augmented and aggravated by delayed mail service, much rearrangement and repaging, snow, ice, wind, the Annual Meeting. There was a plenty of additional obstacles. The Editor and the Printer regret the delayed mailing and the effect on receipt of the issue by advertisers, members, subscribers and others.