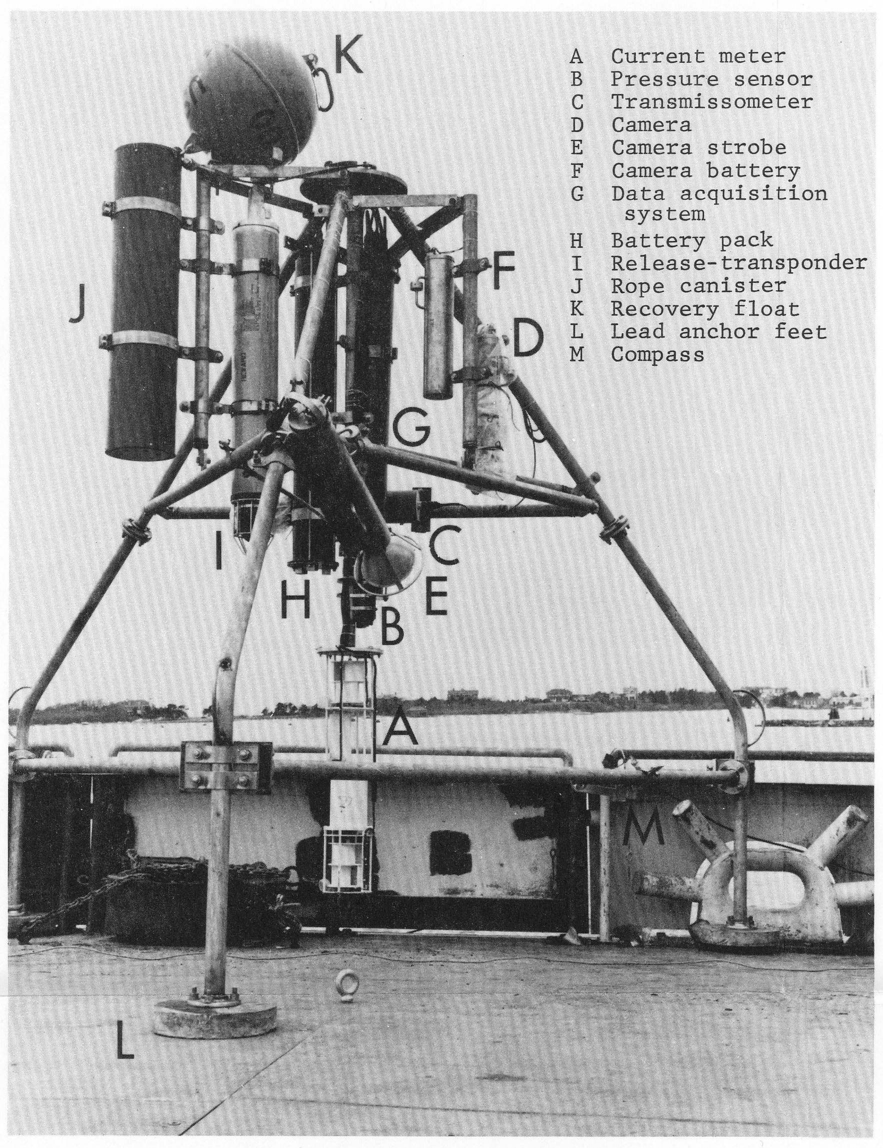

Figure 24.--Bottom tripod instrument system.

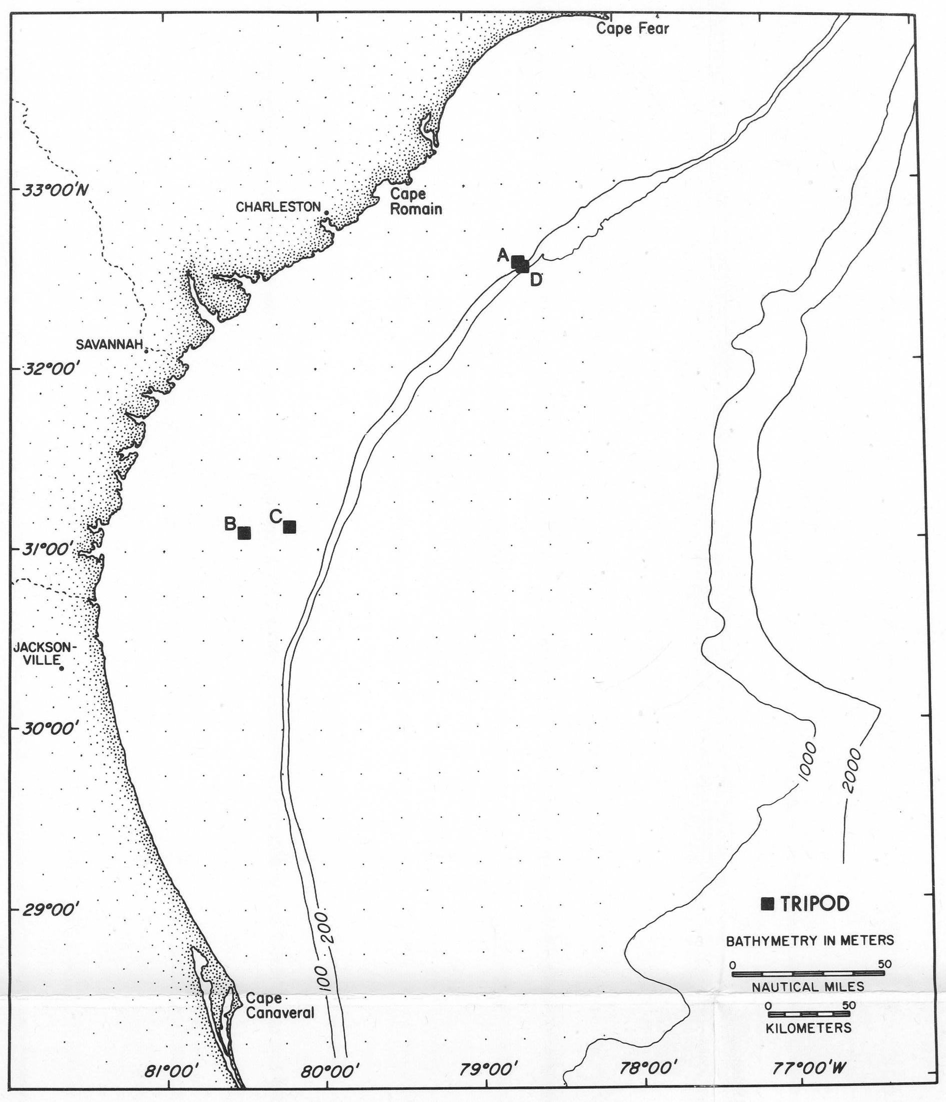

Figure 25.--Map showing station locations.

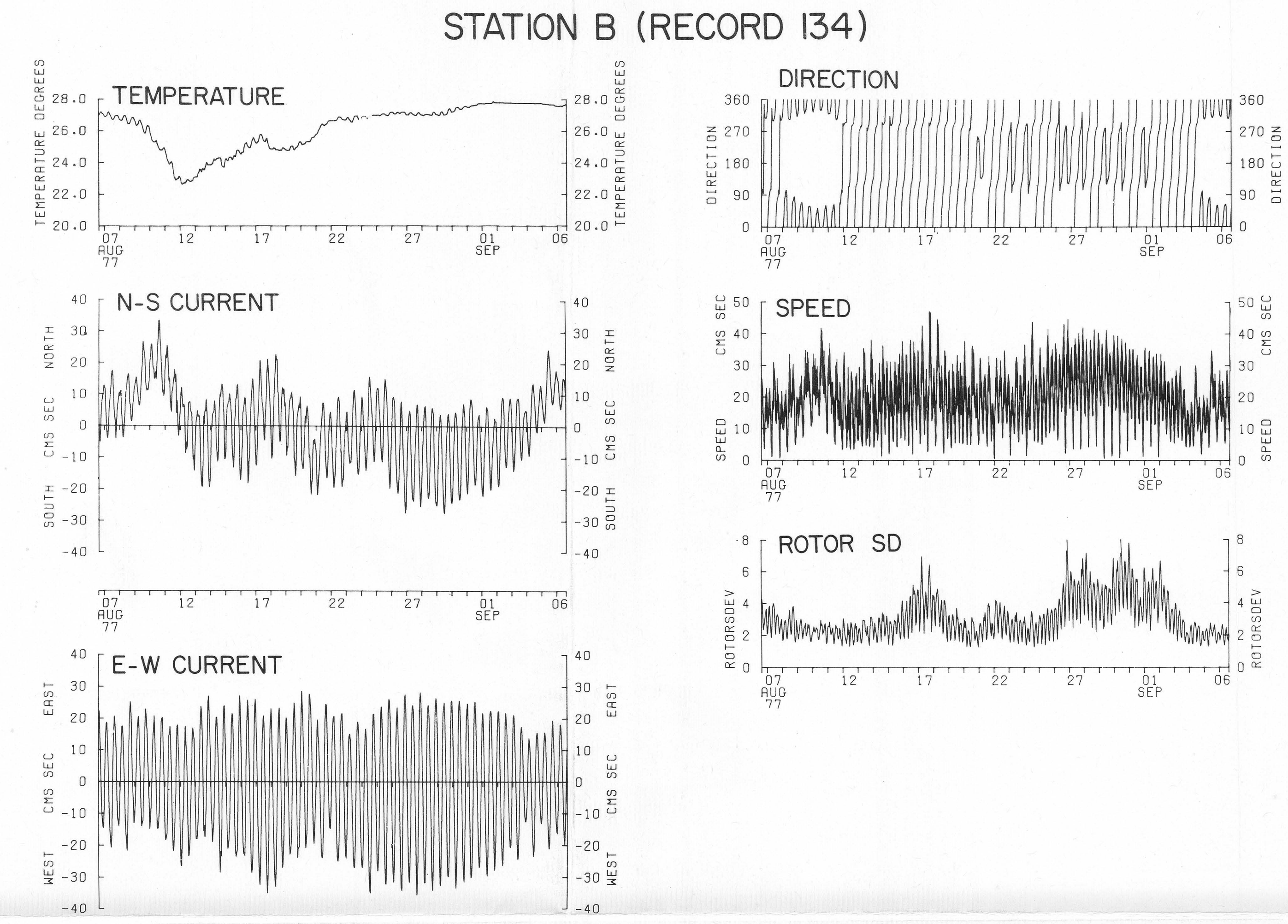

Figure 26.--Time series plot of currents, station B, record 134. Temperature is in °C. CMS SEC is centimeters per second. Rotor SD is rotor standard deviation.

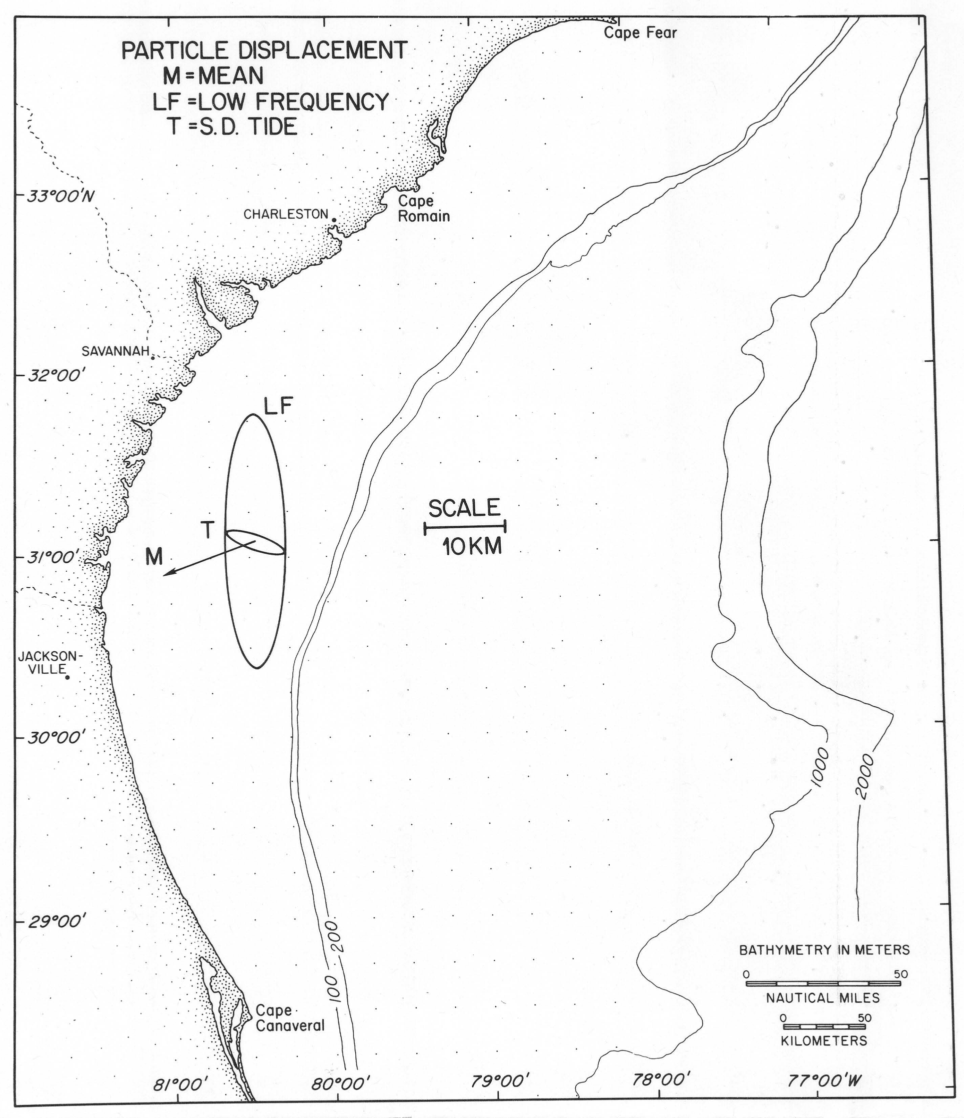

Figure 27.--Particle displacement. T = semidiurnal tide.

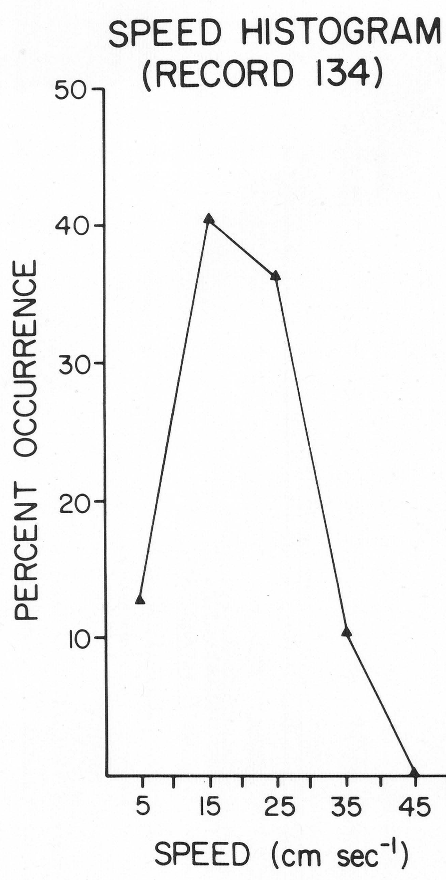

Figure 28.--Distribution of current speed, station B, record 134. Speed is in centimeters per second.

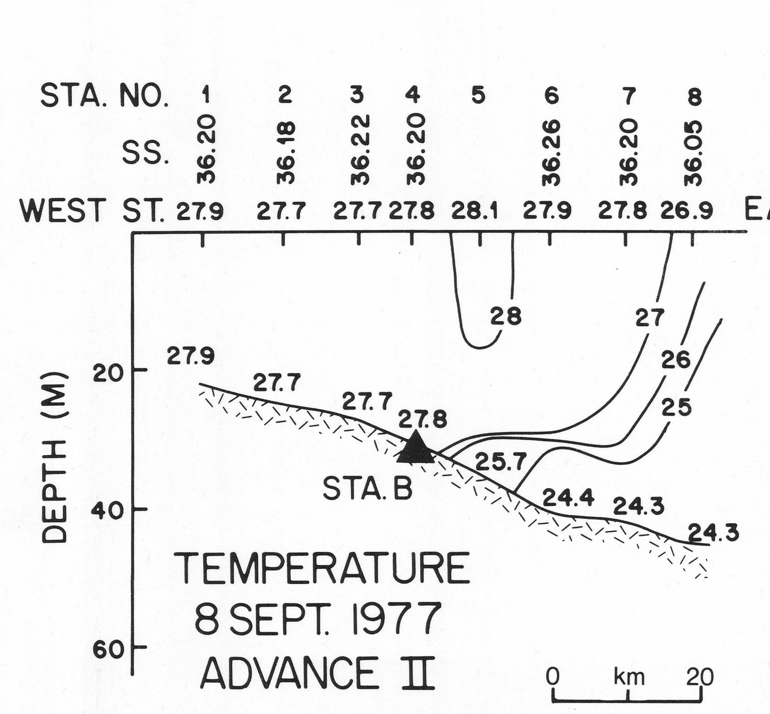

Figure 29.--A cross-shelf temperature section taken September 8, 1977 by R.V. *Advance II*. Temperature is in °C. Salinity 0/00.

CURRENTS AND SEDIMENT TRANSPORT

Long-term *in situ* observations were made on the Georgia Shelf to determine the processes responsible for bottom-sediment movement, their frequency, and direction. Information on the frequency and extent of sediment reworking by physical processes such as surface and internal waves, tides, storm-driven currents, and the Gulf Stream, as well as by epibenthic organisms is important for the engineering design of structures for use on the Continental Shelf. In addition, these data will help to predict the distribution of material deposited on the shelf (for example, drilling mud) and the fate of pollutants associated with suspended material or incorporated into the bottom sediments.

In situ observations of bottom processes are made by means of an instrument system (fig. 24) that photographs the bottom and measures bottom-current speed and direction, temperature, light transmission, and waves (bottom pressure). All instrument sensors are attached to the rigid tripod frame which sits on the bottom. During the field program, one instrument was maintained continuously at station A (fig. 25) from February-November 1978 to monitor long-term variability and seasonal changes. Measurement of the longshelf and cross-shelf variability of sediment movement was made during two shorter term deployments of longshelf (stations A and C, February-April 1977) and cross-shelf (stations A and D, July-November 1977) arrays. Data from a one-month mid-shelf pilot study (station B, August-September 1977) are discussed here.

The bottom flow at station B in the summer of 1977 can be conveniently separated into low-frequency currents (motions with periods of 2-10 days), tidal currents (periods of 12-24 hours), and high-frequency currents (periods shorter than the tides). The currents were dominated by the semidiurnal tide as shown in the time series plot of currents (fig. 26). The major axis of the tidal ellipse was oriented approximately cross-shelf with an amplitude of 25 cm/s (fig. 27). The average near-bottom current speed was 19 cm/s, and current speeds exceeded 30 cm/s approximately 10 percent of the time (fig. 28). The strongest currents tended to be in the onshore-offshore direction, reflecting the orientation of the semidiurnal tidal currents.

The mean flow computed over the entire one-month current record was 1.3 cm/s toward 251°. The low-passed (filtered to remove high frequency) currents were generally less than 10 cm/s. A southerly drift of approximately 10 cm/s occurred between August 26 and September 1 (fig. 26). Also, two periods of strong northward flow occurred between August 8 and 11, and near the end of the record. Low-frequency current fluctuations were larger in the longshelf (north-south) than in the cross-shelf direction. These low-frequency fluctuations of 5-10 cm/s probably were caused by Gulf Stream intrusions or wind stress.

Bottom water temperature varied between 23° and 28°C. Figure 26 shows a decrease in bottom water temperature between August 9 and 16, 1977, suggesting an intrusion of cooler water. The small temperature fluctuations at the semidiurnal tidal period indicate the presence of a weak cross-shelf temperature gradient which was advected past the tripod by the tidal current. A cross-shelf temperature section made at the end of the deployment showed a large body of warm, well-mixed 27.7°C water to the west of the instrument location, and a cooler bottom intrusion of 24.4°C water to the east (fig. 29) (collected from the research vessel *Advance II*, September 8, 1977). The 24°C water is believed to be of Gulf Stream origin. Further evidence for the presence of a front may be obtained from additional high-frequency current and temperature observations (not shown). The fluctuations in the high-passed current and temperature were largest from August 8 to 18, reaching 10-15 cm/s and 0.2°C, respectively. Internal waves associated with an intensified density stratification near the intrusion may have caused these increased high-frequency fluctuations. The high-passed-current and temperature fluctuations were otherwise typically less than 5 cm/s and 0.1°C, respectively.

Two periods of large surface wave were observed, August 16-18 and August 27-September 1, as indicated by the standard deviation of the rotor speed (fig. 26). (Because the pressure sensor failed on mooring 134, station B, no direct wave measurements were made.) During the first period, winds (measured at Savannah, Ga.) were toward the northeast, parallel to the coast. During the second period, the winds were onshore. Current speeds greater than 40 cm/s were recorded during both events, and ripples formed on the bottom. Waves are often an important mechanism for bottom reworking.

Water particle displacements caused by the mean flow, the low-frequency currents, and the tidal flow are summarized in the particle displacement plot (fig. 27). The tidal currents cause cross-shelf excursions of approximately 4 km and longshelf excursions of 1 km. The low frequency currents cause longshelf excursions of approximately 15 km and cross-shelf excursions of 4 km. The excursions for the low-frequency currents were calculated as the displacement due to a sinusoidal current having an amplitude of the standard deviation of the low-passed-current components and a typical time scale of 3 and 5 days for the long-shore and cross-shore currents, respectively. The net displacement due to the mean current was approximately 12 km for a 10-day period. The mean flow is small compared with the low-frequency current fluctuations, and thus the estimate of the mean from the relatively short data series (30 days) is probably not a good measure of the direction of the longer term net flow.

Typical bottom photographs taken during the winter of 1978 (figs. 30-33) show scour and rapid changes in the bottom topography. Bottom sediments at all stations contained less than 1 percent gravel and less than 2 percent medium silt or finer material and may therefore, be classified as rather clean medium to coarse sand.

Figures 30-32 were taken at station A. Figures 30 and 31 were taken four hours apart on February 21. The bottom was tranquil at 1737 hours, but by 2137 hours it had been disturbed. This type of reworking is often seen in the photographs from the Georgia Shelf. In one picture a fish was seen gouging the bottom (not shown), but in all other sequences the source of the disturbance could not be observed. Ripples developed on February 24, 1978 (fig. 32). The near-bottom current at this time reached 40 cm/s. During this winter deployment the bottom photographs showed more evidence of scour and ripple development than during the summer.

Figure 33 was taken at station C. Large turtles, approximately 1.5 m long, were photographed several times at station A and C during the winter of 1978.

In summary, the major processes responsible for the frequent bottom sediment movement on the Georgia Shelf were storms, waves, and bioturbation by bottom-associated macrofauna. However, all distubances of the bottom were short-lived, appearing and disappearing within a few hours to days, and did not result in major scour or undermining of the tripod structure. The observations also suggest that there was little transport of sediment in suspension, and thus movement of material over long distances did not take place.

Figure 30.--Photograph taken by tripod camera at station A (figs. 24, 25) February 21, 1978 at 1737 hours. Note tranquil bottom.

Figure 31.--Photograph taken at station A February 21, 1978 at 2137 hours. Note disturbed sediment.

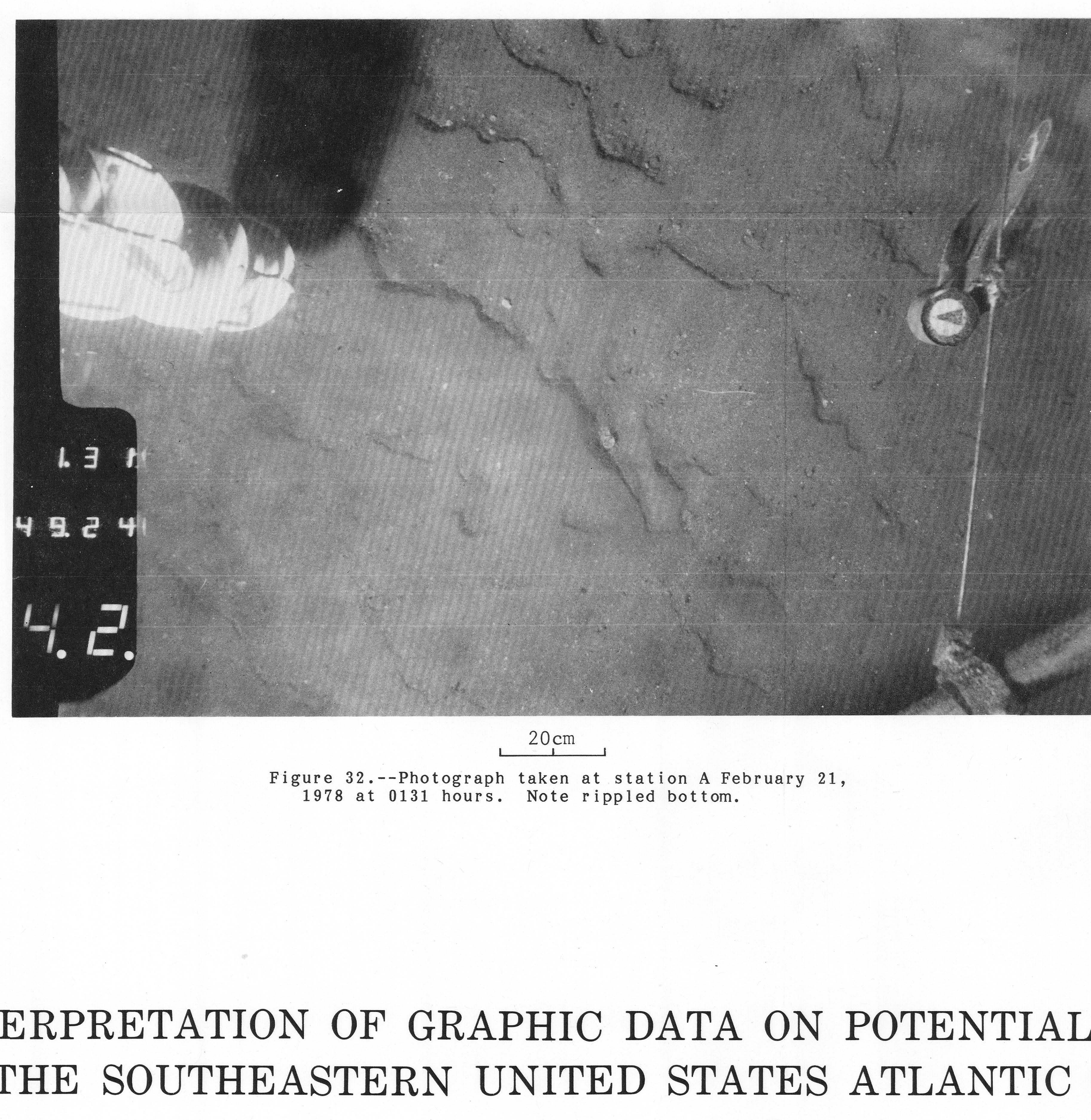

Figure 32.--Photograph taken at station A February 21, 1978 at 0131 hours. Note rippled bottom.

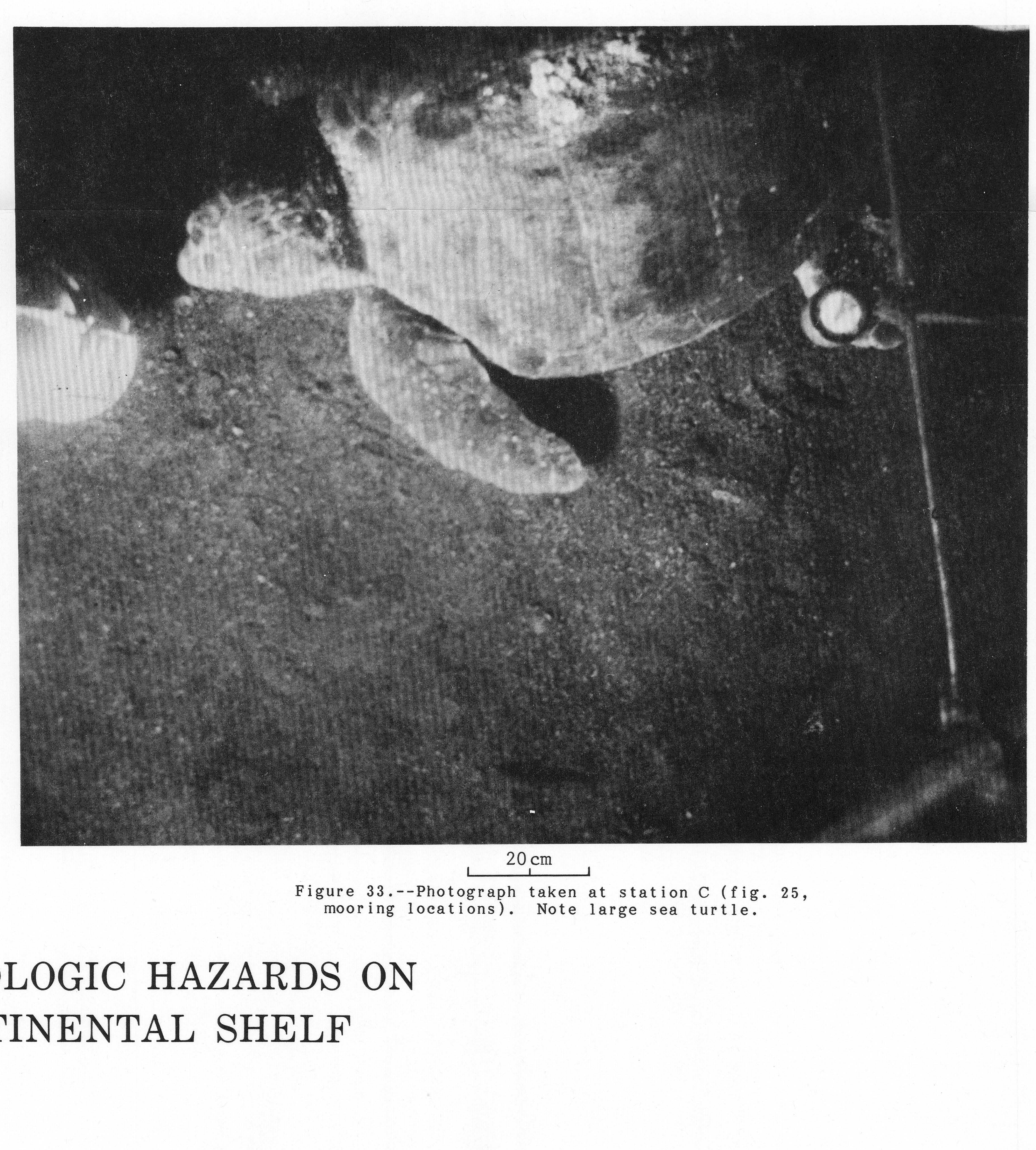

Figure 33.--Photograph taken at station C (fig. 25, mooring locations). Note large sea turtle.

INTERPRETATION OF GRAPHIC DATA ON POTENTIAL GEOLOGIC HAZARDS ON THE SOUTHEASTERN UNITED STATES ATLANTIC CONTINENTAL SHELF

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