

Preliminary Plans for Oceanographic Work to be
Accomplished by Ship EXPLORER en route Seattle to
Norfolk, February - March 1960 (as of 21 October 1959)

Leg A - Seattle, Washington to San Diego, California

General - Fourteen oceanographic stations are planned for this leg. The Marine Life Research Program of the Scripps Institution of Oceanography occupies each month a network of oceanographic stations from Baja California to northern California. Any stations in their area would be duplication, but by concentrating our efforts north of their area, their coverage for February can be considerably enlarged. The stations to be occupied have been planned in conjunction with Mr. Joseph Reid of Scripps. The exact track line from the area of these stations to San Diego is not yet formulated. This is being coordinated with Scripps (SIO) and the Navy Electronics Laboratory in San Diego (NEL) so that existing track lines will not be duplicated. Details of this track line will be forwarded when known.

Oceanographic stations

Seven oceanographic stations shall be occupied as described below on each of two east-west lines 180 miles long and 100 miles apart. The northern line extends from $46^{\circ}43' N$, $128^{\circ}25' W$ eastward to the shore at Cape Shoalwater. The southern line extends from $45^{\circ} 03.5' N$, $128^{\circ}25' W$ eastward to the shore at Cascade Head. The three outer stations on each line are 40 miles apart, the inner ones 20 miles apart.

At each station observations shall be made in accordance with Section 5, Hydrographic Instruction 2 (Revised) with Nansen bottles and reversing thermometers at standard depths (see Section 2-11, H.O. Pub. 607). Two water samples shall be bottled and identified for each depth. In addition, one BT shall be obtained at each station and one lowering of the velocity meter. Detailed instructions regarding the velocity meter will be forthcoming. In general, the equipment will be lowered from a specially re-designed BT winch which will carry 1000 feet of lowering-conducting cable. One lowering will be made at each oceanographic station at which a bottle cast is made throughout the trip. Readings will be made at the surface and every 25 meters to the bottom or to the 300-meter limit of the lowering cable, whichever is less. A separate log of velocity meter lowerings shall be maintained. No forms specific for this operation are available. Mr. Thomas Hickley will be in Seattle prior to sailing and will instruct ship's personnel in the operation and maintenance of this equipment.

Ten drift bottles containing consecutively numbered cards will be released at each oceanographic station. Ten bottles will also be released every two hours on the even hour during the run from station 14 to San Diego. Cards and log sheets will be furnished by the Washington Office. Bottles and stoppers shall be obtained locally. The bottles are 8 oz. soda bottles, clear glass, crown top, and 150 dozen of used bottles cost approximately \$100. Stoppers are No. 2 solid rubber stoppers costing approximately \$12 for 30 lbs. 450 dozen bottles will be needed for the entire trip. Cards shall be inserted, the bottles corked, and the card numbers, time and position logged just prior to release at each set. The shipboard preparation of the bottles, bottle releases, and the maintenance of drift bottle log will be carried out by oceanographers from the Washington Office who will be aboard.

Magnetometer

The Scripps Institution of Oceanography is lending their towed magnetometer for use throughout the trip. This has been arranged through Dr. Victor Vacquier (SIO). The magnetometer shall be towed at all times during runs between oceanographic stations. Mr. Arthur D. Raff will come aboard with the equipment at Seattle, and will remain aboard to monitor the magnetometer throughout the trip.

Bathythermograph

In addition to BT lowerings at each oceanographic station and at other specific times detailed below, one underway BT lowering shall be made every hour during the run between stations, BT's shall be read in the field, logged on Field Record of BT Data, and running profiles maintained by oceanographers from the Washington office.

Weather

It is probable that a meteorologist from the U. S. Weather Bureau may be aboard for all or part of the trip. If so, his equipment for upper-air soundings (inflation shelter, helium bottles, and reception equipment) will be brought aboard at Seattle. The inflation shelter is a 10 x 10 x 8-foot aluminum shelter that will need to be mounted where balloons released from it will not become fouled in the rigging. Further information on the USWB participation will be forwarded when plans are more definite.

Hourly weather observations will be made as required for the BT Log Sheets.

Hydrography

Underway a hydrographic watch shall be maintained at all times with the oceanographers from the Washington office assisting. A log will be maintained and soundings entered every five minutes. The time shall be logged together with positions when available and all changes in course and speed. The fathogram shall also be marked every five minutes.

Control

It will not be possible to use Raydist, EPI, or Shoran. For the 14 oceanographic stations and the run to San Diego, Loran coverage is available. Wherever possible, Loran shall be used in addition to standard operating procedure for dead reckoning and astronomical control. Morning and evening stars, sun lines, and noon latitudes shall be observed and a running plot of the course maintained to as high an accuracy as is possible. Since most oceanographic phenomena are highly variable in time and space, accurate positioning is not so critical as in regular hydrographic surveys, but control should be comparable to that for hydrographic runs across the Gulf of Alaska.

Sample disposition

Water samples for salinity determination and the second water sample from each station shall be turned over to the Scripps Institution of Oceanography upon arrival at San Diego.

Personnel

The following extra persons will be aboard from Seattle to San Diego:

3 oceanographers (C&GS)
Mr. Arthur Raff (SIO)
Possibly one meteorologist (USWB)

Note: After plan was typed, it was arranged with Scripps that the magnetometer and Mr. Raff would come aboard at San Diego rather than at Seattle. The PIONEER surveys and subsequent work by Scripps indicate that the magnetic work from Seattle to San Diego would not add enough new data to justify the use of the magnetometer on this leg.

Leg B - San Diego, California, to Panama Canal.

General - None of the final track for this leg is yet available, but it is being coordinated with SIO and NEL to avoid duplication of their existing tracks through the area.

Magnetometer, BT, drift bottle releases, sounding log, weather observations, and control shall be continued as on Leg A. Standard oceanographic stations shall be occupied at 100-mile intervals along the track.

Two special projects will be undertaken on this leg. The NEL deep-sea camera will come aboard at San Diego. This will be under the care of Mr. Carl Shipek (NEL) who will be aboard to Panama. Along latitude 20° N the USSR Oceanographic Ship VITYAZ found with their deep-sea camera a band of sea floor covered 80-100% with manganese nodules for a distance of about 20° of longitude. The SIO Downwind expedition gave some indication that the N-S extent of the band was not great, but the camera stations were not very close together. In correspondence with Dr. H. W. Menard (SIO) we have planned to occupy ten closely-spaced stations along each of two north-south lines. At each station we would lower the deep-sea camera and obtain a gravity core. Total time approximately 3 days. Details of actual station locations will be forwarded when they are worked out.

The second special project on this leg, planned with Dr. Menard, is a hydrographic-dredging survey of part of the Tehuantepec Ridge at about 12° N. It is questionable if sufficient cable can be obtained to dredge this ridge which crests at 1300 to 1500 fathoms. The EXPLORER's dredging winch reel now has 5000 ft (833 fms) of 3/8" cable. It can carry up to 9,000 ft (1500 fms) of this size cable or 20,000 ft (3333 fms) of 1/4-inch cable. If the dredging has to be abandoned because of insufficient cable, the hydrographic survey will still be carried out. Probably two to three days will accomplish this. Control will be as on Leg A. Dr. Menard will be aboard to help with the dredging and with the planning of the hydrographic survey. Details will be forthcoming as they develop.

Personnel

3 oceanographers (C&GS)	Mr. Arthur Raff (SIO)
Mr. Carl Shipek (NEL)	Dr. H. W. Menard (SIO)
Dr. H. B. Stewart, Jr. (C&GS)	Possibly one meteorologist (USWB)

This is a total of 7 and possibly 8 extra people for this leg.

It is realized that bunking facilities will be at best crowded. However, two of these men will leave at Panama (Menard and Shippek), and the rest of us are willing to sleep anywhere to get the work done. Probably two sittings of the ward room mess will be necessary at least on this leg. The four people from the Survey will be on a regular watch schedule and a doubling up there is possible.

Leg C - Panama to Tampa, Florida

General - From the Panama Canal to the Swan Islands (U.S.) at $83^{\circ} 57' W$, $17^{\circ} 25' N$ the track shall be a straight run with magnetometer, BTs, drift bottle releases, soundings, weather observations, and control as before. Oceanographic stations shall be occupied as before at intervals of 100 miles.

The Swan Islands cap a seamount that rises gently from general depths of 1500 fms to 1000 fms and then steeply to the surface on the southern flank of the Cayman Trough. It is not known whether this is a coral island related to the complex of cays and banks between Honduras and Jamaica or a volcanic island associated with the Cayman Trough and the Cayman Islands to the northeast. Information is not yet complete on the present state of the knowledge of this little-known U. S. possession. Pending the complete compilation of this information, a three-day reconnaissance survey around the islands is tentatively planned. This will include development of the island platform out to the 1000 fm curve, dredging of the steep slope to depths of 500 fms, sediment cores in depths of 100 fms, and a diving reconnaissance in depths of 10 fms and less. Underwater photographs of the bottom and of equipment in use (Nansen bottles, velocity meters, BT, and Phleger corer) will also be made at this time.

From the Swan Islands the track shall run directly to the northeast tip of the Yucatan Peninsula with underway observations as before. En route the 9 fm (Rep. 1947) shoal on Banco Arrowsmith ($86^{\circ} 27' W$, $21^{\circ} 07' N$) and the 7 fm shoal (Rep. 1940) seven miles to the northeast shall be investigated for confirmation (Chart 1007). If the latter one exists, it rises abruptly from a general depth of 260 fms. The flanks shall be dredged and divers shall observe and sample the crest if possible. Prior histories of these reported shoals will be furnished by the Washington office.

Six evenly-spaced oceanographic stations shall be occupied between the Yucatan Peninsula and Cabo San Antonio, Cuba, at $86^{\circ} 32' W$, $21^{\circ} 34.5' N$; $86^{\circ} 14.5' W$, $21^{\circ} 38' N$; $85^{\circ} 56' W$, $21^{\circ} 41' N$; $85^{\circ} 39' W$, $21^{\circ} 43' N$; $85^{\circ} 21' W$, $21^{\circ} 48' N$; and $85^{\circ} 03.5' W$, $21^{\circ} 50' N$. At each station bottle casts, velocity

meter lowering, BT lowering, and bottle drops shall be as described above. In addition, 10 drift bottles shall be released at five-mile intervals between stations. The circulation in the Gulf of Mexico is still incompletely known, and the drift bottles released on this leg should add to this knowledge.

From Cabo San Antonio to $84^{\circ} 20' W$, $25^{\circ} 40' N$, the run across the western end of the Straits of Florida will include underway observations as above except that 10 drift bottles will be released every hour underway. In addition, five standard oceanographic stations evenly spaced at approximately 43-mile intervals will be occupied. Stations shall be located at $84^{\circ} 55' W$, $22^{\circ} 33' N$; $84^{\circ} 47' W$, $23^{\circ} 15' N$; $84^{\circ} 39' W$, $23^{\circ} 58.5' N$; $84^{\circ} 31' W$, $24^{\circ} 41' N$; and $84^{\circ} 23' W$, $25^{\circ} 22' N$.

This run terminates over the "drowned" barrier spit and lagoon discovered by the HYDROGRAPHER during her surveys of this area. Location of this submarine feature may be difficult, but copies of the HYDROGRAPHER's smooth sheet will aid in location by bathymetric pilotage. Both coring and dredging operations will be undertaken here in an effort to secure samples from this geologically interesting feature.

From this site to Tampa will be a straight run with underway observations as before, but with 10 drift bottles released every hour underway and one standard oceanographic station at $83^{\circ} 33' W$, $26^{\circ} 38' N$. If the track passes over any of the dome-like rises (25 feet relief over an area of about 500 acres) discovered by the HYDROGRAPHER, dredging shall be undertaken in an attempt to obtain samples to determine the origin of these features.

Personnel

3 oceanographers (C&GS)
Mr. Arthur Raff (SIO)
Dr. Harris Stewart (C&GS)
Possibly one meteorologist (USWB)

Leg D - Tampa, Florida, to Norfolk, Virginia

General - From Tampa through the Florida Keys will be a straight run with underway observations as above and standard oceanographic stations at 100-mile intervals. Drift bottle releases (10 bottles every two hours) along this portion of Leg D should delineate the counterclockwise eddy off the southwestern tip of Florida.

Standard oceanographic stations as above shall be occupied at 100-mile intervals from Tampa to the current station off Fowey Rocks. These fall at $82^{\circ} 43' W, 25^{\circ} 57' N$; at the turning point at $82^{\circ} 48' W, 24^{\circ} 18' N$; at $80^{\circ} 58' W, 24^{\circ} 13.5' N$; and at the current station at $79^{\circ} 49.5' W, 25^{\circ} 35.5' N$. Drift bottle releases shall be continued at the rate of 10 every two hours during the runs between stations, the magnetometer shall be streamed, and BTs obtained hourly under way.

At $82^{\circ} W$, dredging shall be attempted in depths of 200 to 300 fms on the Pourtales Seascarp ($24^{\circ} 15' N$). Dredging along the same seascarp shall also be attempted in the area of $81^{\circ} 30' W$ in depths of 200 to 300 fms and farther down slope in 500 fms ($24^{\circ} 02.5' N$). The rock structure of the Florida continental slope is still poorly known. Rock samples from this seascarp may shed light on this question.

Current measurements

A current buoy, Roberts radio current meters, new FM receiving equipment, chronograph, and the cable, batteries, and other equipment for current measurements will be shipped to the EXPLORER at Tampa and shall be taken aboard there. Mr. A. J. Goodheart will be aboard on this leg to assist in the current observations with this new equipment.

At $79^{\circ} 49.5' W, 25^{\circ} 35.5' N$, 15 miles east of Fowey Rocks a mooring buoy shall be planted in approximately 250 fathoms to which shall be moored a radio current buoy. This is station 2 of profile A occupied by LT John Pillsbury during the 1885 and 1886 seasons of the C&GS Steamer BLAKE. Reoccupation of this station over 70 years later with modern equipment is expected to add to our knowledge of the Gulf Stream and to indicate the worth to be derived from reoccupying other stations in Pillsbury's classic study.

One meter shall be suspended directly from the radio buoy at 21 feet. Second and third meters with a marker buoy for additional buoyancy shall be suspended at 780 feet and at 1200 feet. The upper two meters are at depths used by Pillsbury at which he obtained mean velocities of 3.156 kts (21 feet) and 2.202 kts (780 ft). There are no known continuous in situ measurements on the Gulf Stream at depths as great as the 1200 feet of the bottom meter.

Observations of direction and velocity shall be made at each meter every half hour for at least 100 hours. A BT shall be obtained every hour at or near the station, and drift bottles shall be released at a rate of ten every hour on the hour. An attempt is being made to locate two sounding tubes which shall be secured to the lowering cable near each of the two lower meters to indicate the depth at which the observations were made.

Shelf-break reconnaissance

From the area of Fowey Rocks to Cape Hatteras the ship shall engage in reconnaissance hydrography along the 100-fm curve, as this is one of the few remaining areas along our coasts not adequately covered with continuously recording echo sounders. The track will consist of a rip-saw pattern with seven 100-mile legs at a low angle to the 100-fm curve and seven legs 10-20 miles long normal to the shelf edge. At the northern end of each long leg a standard oceanographic station shall be occupied and a bottom sediment core obtained. Drift bottles shall continue to be released 10 every two hours and hourly BTs shall be obtained between stations.

This reconnaissance survey will provide seven detailed hydrographic and magnetic profiles across the outer shelf break and an almost continuous profile along the outer shelf to reveal any uncharted submarine canyons.

Submerged capes reconnaissance

From Cape Hatteras north to Latitude 36° the bottom is delineated only by a few old reconnaissance lines with spot soundings. However, the data suggest that the spit at Cape Hatteras extends submerged some 30 miles northeastward in depths of 11 to 23 fms. It is marked on its shoreward side by a channel 3 to 5 fms deeper.

Eleven lines running from the 100-fm curve 20 miles toward shore, or to the 10-fm curve whichever is less, shall be run at 5-mile intervals between Cape Hatteras and 36° N. The magnetometer shall be streamed during this survey but no stops shall be made for oceanographic data.

Sediment profile along 36° N

Along latitude 36° N ten sediment cores shall be obtained with a Phleger corer at five-mile intervals from the 10-fm curve out to the 500-fm curve at approximately $74^{\circ} 41'$ W. Dr. Fred Phleger of the Marine Foraminifera Laboratory at Scripps has already expressed interest in analyzing such a set of cross-shelf sediment cores, and the results will aid in the interpretation of the reconnaissance hydrographic survey data.

Norfolk Canyon Dredging

If time permits, one final project will be an attempt to dredge rock samples from the walls of Norfolk Canyon at approximately $74^{\circ} 40' W$, $37^{\circ} 05' N$ in 300 fathoms. The structure and composition of the rocks underlying the Atlantic continental shelf are still poorly known, and rock samples from Norfolk Canyon would add to this knowledge.

Personnel

3 oceanographers (C&GS)
Mr. Arthur Raff (SIO)
Mr. A. J. Goodheart (C&GS)
Dr. H. B. Stewart, Jr. (C&GS)
Possibly one meteorologist (USWB)

General information

Throughout the trip it will be possible to devote some extra time to the development of bathymetric or magnetic features that the Captain in conference with others aboard may deem worthy of additional study en route.

Similarly, such features as pronounced slicks and long foam lines should be considered as "targets of opportunity" and studied when they are found.

The plans contained herein are still preliminary. Numerous refinements and some changes will undoubtedly be made, and those concerned will be informed as such changes take place.