

A Scientific Community's Response

On Tuesday, December 15, 1976, the Argo Merchant, a Liberian tanker carrying nearly 8 million gallons of Number 6 fuel oil, ran aground on Fishing Rip Shoals, about 25 miles southeast of Nantucket Island. By late afternoon, it became obvious that the ship could not free itself without help from the U.S. Coast Guard. If the weather had been calm, perhaps the ship could have been towed from the sand without major damage, but December was a particularly stormy month, even for New England waters. By Wednesday evening the 10- to 15-foot seas had not only kept ships away, but also had dug the 40-foot draft vessel deeper and deeper into the underlying sand. In the process, several major leaks in the hull had been opened. An emergency strike force team from the National Oceanic and Atmospheric Administration (NOAA) was flown in on Thursday, cooperating with the Coast Guard in monitoring the tanker's condition and the ever-increasing slick. No oceanographic ships, however, had been dispatched to the area, and thus no scientific measurements had been

taken. By Friday, large amounts of oil had escaped into surrounding waters. At this point it was obvious that a major spill was imminent.

In Woods Hole, many scientists realized the need for an immediate response to the situation - but what, how, and when? On Friday morning, 40 interested scientists from the Marine Biological Laboratory, the U.S. Geological Survey (USGS), the National Marine Fisheries Service (NMFS), and the Woods Hole Oceanographic Institution (WHOI) met to discuss the situation. After going over personal interests, prejudices, and preferences, it became obvious that we had to obtain background data about the water and sediments in the areas near the slick that might be severely affected as the oil moved in the days and weeks ahead. Future sampling could delineate the degree of spill impact only if background levels of biological populations, hydrocarbons, and suspended particulates were obtained. Furthermore, measuring the currents in the area, a program already begun by the U.S. Geological Survey, would be vital to understanding the oceanographic regime.



Tracks of Oceanus cruises 19 and 20, late December 1976, showing the locations of samples collected. Rationale for picking these sites rested primarily on observed and predicted movement of the slick.

An even greater question was the path that the oil itself might follow. If it continued to float, presumably it would follow the direction of the wind, generally toward the east in winter months. On the other hand, if it sank, it probably would move with subsurface currents in a westerly direction. If the oil did sink, how would it happen? Was some critical concentration of suspended particulates necessary, and if so, how much? Previous studies in Alaska have shown that oil sinks quickly in waters containing approximately 6 milligrams per liter of suspended sediment. Although concentrations of suspended particulates off New England generally are far lower, the oil in question and the sedimentary and oceanographic conditions were sufficiently different to complicate predictions.

It may seem unusual that such background data were not available, particularly in an area so close to a major oceanographic community. It is only recently, however, that government agencies (primarily the U.S. Bureau of Land Management) have funded large-scale oceanographic research on the U.S. Continental Shelf, and a lot of the data either were incomplete, or had not been adequately synthesized. For instance, we could not be sure in which direction the oil would move because currents in the area were poorly defined.

As reasonable as these questions and objectives seemed, they necessitated getting near the foundering vessel in order to make the required measurements. Without an available oceanographic vessel (WHOI ships, at that moment, were scattered through the Atlantic and Indian Oceans) this could have proved to be a problem. Luckily, Dr. Holger Jannasch, Chief Scientist aboard the *R/V Oceanus*, 640 kilometers away, had been appraised of the situation and had begun steaming toward Woods Hole.

On Saturday evening, a group of 10 scientists met to arrange a crisis reaction cruise on Oceanus. The ship was to arrive in Woods Hole early Monday morning, and presumably could be offloaded, onloaded, and sail to the Argo Merchant the same day. Among the scientists on the cruise were Drs. Howard Sanders and John Teal (to study benthic organisms), John Farrington (hydrocarbons), the Coast Guard's Richard Jadamec, and myself (the particulate load in the water column). Eight other scientists and technicians agreed to sail with us.



At first, the oil escaping from the Argo Merchant flowed west-northwest, but within a few days it changed to a northeast direction (December 20), and later to east-southeast. Except for brief shifts in the wind, (such as December 26, when the wind blew from the east), the surface slick flowed east-southeast until all traces were lost in mid-January.

Rosette sampler is checked prior to lowering from R/V Oceanus in area of Argo Merchant spill. Water samples were collected in 30-liter bottles at various depths within the water column. In addition, probes on the bottom of the instrument monitored the temperature, salinity, depth, and light transmission within the water column.



Monday morning, December 20, arrived clear and quiet, although the forecast predicted gale conditions by the following day, giving us a narrow weather window for sampling. Preparing a ship for a cruise generally requires a full day; equipment used on the previous cruise must be offloaded, new equipment onloaded, and personnel and schedules organized. Not only did we have very few hours to arrange the cruise, but we had to organize and prepare equipment needed for a wide variety of observations and samples, and install them on the ship. Being wintertime, this equipment had to be lashed down securely to prevent it from crashing about in high seas. Nevertheless, by 3 that afternoon, the Oceanus was loaded and ready to steam to the area near the spill — but where exactly should we go?

Not knowing how long the oil would float, we assumed that it would remain near the surface and follow surface currents. Air flights monitoring the path of the oil spill showed it drifting toward the west, suggesting that our first area of interest should be directly west of the slick, the area of probable impact. Just before the Oceanus sailed, however, more recent aerial photographs showed that the slick was moving to the northeast, due to a shift in wind direction. Thus at the last moment, we changed our cruise track to an area northeast of the Argo Merchant.

By the time the *Oceanus* reached the first station, 25 miles north-northeast of the vessel, winds had increased and storm

warnings had been issued. It was only a matter of hours before we would have to run back into Nantucket Sound for shelter. By working continuously, however, we were able to occupy 2¹/₂ stations. In addition to sampling the water column for particulate load, we took six bottom sediment samples at each station. three for invertebrate animals and three for hydrocarbon analysis, the replicate samples being necessary for statistical accuracy. By 5 a.m. Tuesday, conditions deteriorated to the point where we had to stop work and steam for the relative safety of Nantucket Sound. The three-day forecast predicted continued bad weather, so we returned to Woods Hole. Although we had gathered background data relatively near the stricken vessel, our cruise had been unsuccessful because we had collected an insufficient number of samples. Moreover, the shifting winds were forcing the slick east, necessitating further sampling.

Before a second cruise could be organized, another problem presented itself — Christmas. Emergency or not, Christmas holidays are a difficult time to be away from home, particularly for a ship's crew, who often spend 80 percent of their year at sea. Fortunately, a decision to remain in port was substantiated by continued heavy winds and cold weather, which made seagoing studies impossible. Oddly, the weather during Christmas Eve and Christmas Day was calm and relatively warm, but immediately afterward it worsened, preventing the ship from leaving Woods Hole.



The shipboard laboratory. Once collected, measured quantities of the water samples (stored in graduated cylinders on the overhead rack) were filtered onto filters (seen in their holders on the bench) with 0.45 micron openings, thus trapping most of the material in suspension. At the same time, other aliquots of the water samples were treated so as to remove both dissolved and suspended hydrocarbons.

Before the Oceanus could leave, changing winds again forced a reevaluation of cruise tactics. Over the weekend, the wind shifted to the southeast for a period of about 15 hours, during which time oil from the Argo Merchant began approaching the beaches of Nantucket Island. Clearly, if such winds had persisted, the oil could have reached not only Nantucket, but also the marshes that border the southern shore of Martha's Vineyard. This possibility forced us to restructure our tasks for the second cruise; background data were needed from the shelf and nearshore waters off these islands. Muds on the bottom of the middle and outer shelves of this area could provide a potentially long-term sink for the oil; its effects on such sediments would be far more severe than in sandy bottoms, where the oil could be oxidized, or washed away. In addition, we needed to set several oceanographic current-meter buoys nearby, that would supplement other USGS buoys that were being set at the same time from another ship. Finally, and perhaps most importantly, we needed to find out whether the oil was settling from suspension. To do this we had to take water and bottom samples directly west of the stricken vessel, an area that had received considerable oil spillage during the early days of the grounding. If we found little evidence of sinking, it could be assumed that the oil was remaining in suspension and would move primarily as a result of wind transport. Since winds in winter are primarily to the east, this would mean that the oil would move seaward, thus sparing the coastal environments. Also,

since most spawning of marine fishes occurs in spring and summer, the oil might not have the impact upon commercial fisheries that it would have in warmer months (see page 46).

The time required for steaming to the area, occupying the stations, and installing two current-meter moorings totaled slightly more than 24 hours. If a window could be found in the generally stormy weather, we could accomplish the work and be back in port before the next storm. The weather forecast on Monday afternoon gave us some hope of finding the necessary time — winds were to moderate late that evening before increasing to near gale force early on Wednesday.

We left Woods Hole at midnight and by 3 a.m. on the 28th the weather began abating. Within a few hours, the winds were less than 10 knots, and we steamed for the first station. Although seas were by no means calm, we worked in relative comfort. The same measurements were taken as those on the first cruise. Since most of the crew was the same, the by now routine work went smoothly and quickly.

Twenty hours later, the work was complete. We ran for port with the storm on our stern. We had occupied a total of eight stations, six off Nantucket, and two near the *Argo Merchant*, and had taken more than a hundred various samples. We also had made numerous bird observations, but had seen no sign of larger sea life, such as marine mammals or sharks. Oil-coated birds were plentiful over the entire area, and patches of oil slick were common at the stations nearest the wreck.



U.S. Navy diver being questioned by partner aboard U.S. Coast Guard cutter Vigilant after dive to film conditions under Argo Merchant main slick. (Photo courtesy U.S. Navy)

However, there were no visible signs of oil in our samples, suggesting that if the oil was sinking, it was probably doing so quite slowly.

Within two weeks of the Argo Merchant's running aground, Woods Hole scientists had responded with two oceanographic cruises to assess the damage, as well as to monitor areas that might receive future impact. Since then cruises by the NMFS, USGS, and the University of Rhode Island have continued the observations and sampling. These original background samples, however, have proved most invaluable, since it is against these data that the impact of the spill must be measured. Of course, seaward movement of the oil lessened the immediate problem of the spill, but what if the winds had not been so kind? If they had been from the southeast, the oil could have reached shore within a day or two. Moreover, if the oil had sunk quickly, it could have moved westward with the bottom currents, resurfacing on beaches along the northeastern coastline of the United States.

What then was our lesson, and how can it be applied to future potential disasters? First, it must be remembered that disasters often do not move in predictable manners; at sea, they often occur during less than ideal weather conditions. One's options must be kept open, but if the time for sampling and observation is short, and the conditions adverse, one should monitor those areas in which the impact is potentially most adverse, particularly those waters closest to sites of human activity.

Second, the dearth of background data, concerning both the oceanography near the spill and how oil moves through the environment, clearly prevented a better response to the *Argo Merchant* spill. The types of data needed include insights into the following problems: How do various types of oil settle through the water column, and at what rates? What are the oceanographic/ meteorologic regimes of the area (the relative importance of currents versus winds, relating to whether the oil remains at the surface or settles)? To what extent does oil volatilize and oxidize before reaching the bottom? What is the fate and effects of oil on bottom organisms and sediments? Of more practical importance, how can we sample in a potentially impacted area without almost hopelessly fouling the ship and sampling equipment with oil? How fast can we respond to the disaster (this ultimately depends on the availability of a ship and the weather conditions)?

None of these questions were totally answered during our cruise. However, if we could have more intelligently predicted the fate of oil in the water column and on the bottom, as well as the advective regime of the environment, our cruises could have gathered more detailed and meaningful information. With increased Federal and state supported research, such data might be available before the next disaster.

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