Scripps Institution of Oceanography
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The Research Ship HORIZON

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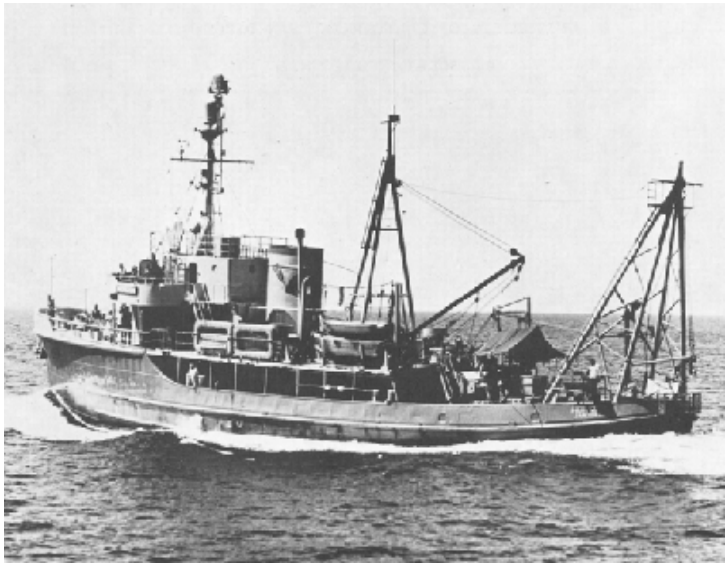
R/V HORIZON



R/V *Horizon.*
[Full Size]

"Research Vessel 'HORIZON' for sale," said the ads. "Sealed bids due December 16, 1968." Gross tonnage 505, length 143', beam 33', range 7000 miles, speed 11 knots. Built for the Navy in 1944 as ATA 180, given to the Scripps Institution of Oceanography in 1949 and converted for research. Estimated market value, fully equipped for oceanography: $500,000.

So ended at Scripps what may have been the most distinguished career of any vessel in the history of discovery. Somehow the ad made me feel like a participant in a slave auction watching the sale of the old family retainer down the river. Few other ships of exploration had sailed so far and so long or had participated in so many discoveries.

The times were ripe for discovery in 1949, just as they had been in the sixteenth and seventeenth centuries. *Horizon* was this century's equivalent of *Endeavour* or *Beagle*, or even *Golden Hind* or *Santa Maria*. Like them she was small and not above reproach. Like them she deserves some measure of fame. I am writing this footnote to history lest *Horizon* and what happened aboard her be forgotten as well as unheralded. Someone surely should do so, and I sailed on her off and on for seventeen years and owe her something. She had an unusual characteristic for a mere fabrication of metal. People liked *Horizon* and she was always, as far as I know, a happy ship.

Perhaps for that reason the charts now record Horizon Guyot in the central Pacific, from which were dredged some of the oldest rocks yet found in the ocean basins; Horizon Depth, which is the second deepest place in the ocean; Horizon Channel, in the floor of a flat plain in the Gulf of Alaska, and Horizon Bank, a drowned atoll east of the New Hebrides Islands in the southeastern Pacific. Few other ships have been so honored.

The famous oceanographic ships of the nineteenth century and the first half of the twentieth century generally made only one voyage. The *Challenger* began and ended her scientific career with one round-the-world trip, on which much of the science of oceanography is based. In those days the information collected on a single voyage was usually enough to keep all the interested scientists working for years. In fact, samples collected in 1872 by *Challenger* are still being studied today. The *Blake* and the *Discovery* did make several voyages for scientific purposes, but that was rare.

After World War II the traditions slowly began to change. The globally oriented giants, especially Russia and the United States, began to accumulate fleets of oceanographic ships. Now the same ships are used for oceanography year after year and for many cruises each year.

R/V *Horizon* was one of the first of these, and one of the most famous. It is a rare senior oceanographer anywhere in the world who has not at least seen the ship. The same is true of the Russian *Vityaz* and *Ob*, the French *Calypso*, and the American *Atlantis* and *Vema*. Many of these research vessels were converted for ocean studies: *Calypso* was a former Royal Navy minesweeper; *Vityaz* was a German banana boat acquired in war reparation payments; *Horizon* was originally a small Navy tug.

The dramatic increase of money for oceanography made possible the change to fleets of research ships, and the fear that it might be cut off at any time kept the ships at sea collecting data as steadily as possible, which could be later analyzed at leisure and less cost. At first only the obvious results of each expedition were considered, but as the number of oceanographers grew and as new types of electronic equipment and data processing were developed, each expedition resulted in vastly more analysis and information. Just the obvious results have already revolutionized oceanography, geology, and geophysics.

Horizon did her bit. From 1949 through 1968 she made 267 cruises, spent 4,207 days at sea, and logged 610,522 miles. Of those cruises, 99 were shorter than 200 miles, for such duties as student demonstration cruises, equipment testing and installation, counting gray whales, local research, and an "inauguration parade" for University President Clark Kerr by five Scripps ships in front of the institution. Some 137 cruises were 200 to 4,000 miles long. A few of these were for geological studies, but almost all went into a long-term study of the California Current and its relation to fisheries as part of the Marine Life Research Program. Many of the longer expeditions, the ones with which I am more familiar, had geological and geophysical objectives. Of these, 19 ranged from 4,000 to 10,000 miles, in the eastern Pacific, and 12 of them, 10,000 to 50,000 miles long, ranged the world. Certainly *Horizon*'s travels are quite unmatched among ships made famous for their role in geographical discoveries.

Places and People

The names of her expeditions and ports tell a great deal about *Horizon*'s career, and about the growth of oceanography over two decades. The first Scripps expedition in the deep sea was Midpac in 1950, and *Horizon* was one of its two ships. The type of name stuck, so *Horizon* participated in Norpac and Equapac, and even in comically named Zigpac and Sixpac. Prevalent winds took over in cruise names, and so *Horizon* sailed on Chinook, in northern waters; on Doldrums, in equatorial waters; Zephyrus, with the west wind into the

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Mediterranean; Downwind, a circular cruise in the South Pacific which was reversed from its original plan to take advantage of the downwind direction of wind; and West Windrift, off the Pacific Northwest. She sailed on Northern Holiday, facetiously named for a North Pacific trip to a "holiday" or gap in information; on Shellback, Scripps' first trip across the equator; on Capricorn, which sailed south to the tropic of that name; on Vermilion Sea, to the Gulf of California; on Nova, which passed by New Zealand, New Guinea, and New Caledonia; and on Cusp, Dolphin and Dorado, Limbo and Lusiad, Hodgepodge, Inertia, Flora, and the four-ship conglomeration, Quartet. Finally someone with a sense of history applied the name Climax to the last major *Horizon* expedition for Scripps in October, 1968.

Ports of call lend an air of romance to the oceanography business that may be misleading. For oceanographers most of the excitement is in the work at sea, not the time in port. The former custom was two days in port after about a month at sea, but now the port stay is three to five days. Even for those more interested in ports, a month in the open sea in a small ship is the hard way to visit Honolulu, and it takes another month to get home. A month to reach Valparaiso or Pago Pago is more of a bargain. *Horizon* had her share of ports, including truly exotic ones.

From 1949 to 1962 she circled the Pacific like a demented cruise ship: fifteen stops at San Francisco, nine at Honolulu, three at Callao, Peru. She touched in at every marine resort in western Mexico: Acapulco, Manzanillo, Mazatlán, La Paz, Guaymas, San Felipe, Puerto Vallarta. On the other side of the Pacific she was four times at Kwajalein in the northern Marshall Islands, and at least once at Suva in the Fiji Islands, Nukalofa in Tonga, Pago Pago in American Samoa, and three times in Papeete, Tahiti — which has the only fuel in the central south Pacific. In June, 1962 she slipped from Balboa on the Pacific side of the Canal Zone to Colon on the Atlantic side, en route to around the world.

On that venture, *Horizon* made a planned stop at Martinique, then an improvised one at the Canary Islands to try to pick up a replacement part for a sub-bottom profiler that was to have been flown there from Texas. We tried to get the same part at Gibraltar, but again with no luck. Such is the frequent reason for unexpected port stops. Newly invented equipment is unpredictable in use. This particular component simply did not exist outside the United States and had to be flown to the ship's next possible port. *Horizon* went on to Nice, and through the Mediterranean, the Suez Canal, the Red Sea, and into the Indian Ocean. The port stops sounded like a winter

cruise: Aden; Cochin, India; Port Victoria in the Seychelles; Port Louis, Mauritius; Fremantle and Darwin, Australia; Port Moresby, New Guinea — and home across the Pacific.

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Horizon made one last grand tour during Nova Expedition of 1967. That was again in the southwest Pacific, as Capricorn had been. Again there were stops at Pago Pago and Suva, but this time also at Noumea in New Caledonia, Auckland in New Zealand, and twice at Brisbane, Australia. The second call at Brisbane was to find quiet water for storm-wrought damage and, once again, to pick up replacement parts for a sub-bottom profiler developed just before she went to sea.

Ports are formal stops where documents are exchanged, supplies are gathered, and people come aboard or depart. Thus they become prominent in the official logs. However, oceanographic ships also pause at uninhabited and isolated islands, the ones that bring the real romance to oceanography. A few days of snorkeling on the reef of a deserted atoll in the Tuamotus; a boat ride through basking sea turtles in the Revilla Gigedos; a stop at Robinson Crusoe's cave on Más a Tierra (now Isla Róbinson Crusoe), a climb on a giant stone image on Easter Island — these are not everyday pleasures, and so cherished more.

Horizon was always a great ship for the islands. I have stepped, waded, and swum ashore from a *Horizon* smallboat to many a beautiful, tropical island — named but virtually unknown to the outside world. At Ocean Island we joined in a happy Micronesian wedding. At Lifuka we saw Polynesians riding horses through the surf as in a Gauguin painting. At Nuku Hiva we walked through the silent valley of Typee, made famous by Melville when it teemed with cannibals. At Vanua Mbalavu we saw the grass walks being swept clean of leaves each dawn.

Horizon sometimes was irresistibly drawn to an island. When I was on R/V *Spencer F. Baird* on Downwind Expedition, nearing Rapa Island, our sister ship was, at one point, supposedly 250 miles east, running a sounding line. I radioed to her. After an embarrassed pause, those aboard *Horizon* admitted that she was aground on the reef at the entrance to Rapa harbor, awaiting high tide to set her free. We joined her in Rapa for part of the day.

Many of today's oceanographers first went to sea on *Horizon*. In her twenty years, 132 scientific leaders directed her work at sea, under 13 captains. Of the latter, the ones that I particularly associate with *Horizon* are Jim Faughn, Noel Ferris, and Marv Hopkins. Faughn was the captain on *Horizon*'s first long expedition, Midpac. He and Roger Revelle, the chief scientist, gave her some of that ease and style of cooperation between crew and scientists that the ship never lost. Everyone lived together and ate together, and the communication gaps and other hangups regrettably common on some research ships did not occur.

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It may have helped that the backgrounds of graduate students and sailors were not so different as they tend to be now. Like the ship herself, almost everyone aboard had been in the Navy or Marines in those days not long after World War II. Indeed, by far the highest active duty military rank of anyone aboard had been held by a graduate student. In any event, *Horizon* was a happy ship.

She stayed that way on Capricorn Expedition, with Ferris as captain and with various chief scientists. She never really changed with Marv Hopkins and the others. Ferris and Hopkins stand out in my memory because both were firm believers that a research ship is meant to be used for what the scientists want to do. The great Captain Cook wrote, as he explored the Pacific, that he hated to risk his ship surveying on a lee shore, but that the lords of the Admiralty had sent him out to survey and that was what he was going to do. Our best captains have the same philosophy.

The 132 chief scientists include very junior technicians and students as well as senior scientists. Some have made reputations based on work done on this ship. Among them I recognize eight directors or assistant directors of oceanographic laboratories, several founders of businesses based on oceanography, and many oceanographers now high in scientific administration or in federal agencies. Included are five members of the National Academy of Sciences and seven Guggenheim fellows; three of these were on the ship while they held their fellowships. These scientific leaders have written or edited at least fifteen books and innumerable scientific papers, and have won many medals and awards.

Scientific Results

Scripps poured $5,362,000 into operating *Horizon*. What came of it? I relate *Horizon* especially with three fields of research: the relief of the sea floor, the undercurrents of the equatorial Pacific, and finding the lost sardine. Like the fishermen, she didn't really find the sardine, but she made more than a hundred cruises to try to find out what had happened to that fishery, including her first in 1949 and a final one in 1968. These were part of the Scripps Marine Life Research Program, a unit of the California Cooperative Oceanic Fisheries Investigation.

The Marine Life Research Program studies the ecology of the waters off California, its currents, temperatures, chemistry, and their relation to the life in the waters. It has collected the most extensive biological and oceanographic record of any part of the world ocean. It has found that the ocean has short-term variations comparable to the weather of the atmosphere. We now know that the weather of at least the northern hemisphere, and probably the entire earth, can be affected by a significant change in the surface

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temperature of the ocean. Long-range weather predictions and weather modification require an understanding of the state of the sea as well as of the air.

Such theoretical considerations as these were established on the solid base of many measurements and observations which *Horizon* helped to gather. She also gathered basic data on the distribution of sardines and anchovies and other fishes of the California Current. MLRP began originally to determine why the sardines had practically disappeared and to restore the fishery if at all possible. Restoration was not possible, but at least an understanding of the fishery was possible. Core samples from an anaerobic basin off Santa Barbara provided a continuous record of the kinds of fish that had lived in that region during the last several thousand years. Throughout that time, to most everyone's surprise, the cores showed that anchovies were the most abundant fish off California. Only for a few decades about 800 years ago and for a short period beginning about 70 years ago were sardines more abundant than anchovies. If the sediments had been studied first, no one would have been surprised when the sardines dwindled. Saddened, perhaps, but not surprised.

Most of the Pacific currents were mapped a century ago to help sailing ships transport cargoes with maximum speed and whalers to find their prey. Until 1951 it was generally assumed that *all* the major currents were known. At that time, a U. S. Fish and Wildlife Service research ship was fishing in the central Pacific and drifting west in the South Equatorial Current as expected. But abruptly the long-line fishing gear that reached a few hundred feet below the surface began to drift eastward away from the ship at a rate of several knots. This phenomenon was investigated by Townsend Cromwell, who found a persistent current running at depth along the equator.

During the International Geophysical Year in 1958, John Knauss directed *Horizon* on Dolphin Expedition to investigate the current. The ship made a north-south profile of current measurements across the equator in the central Pacific. After refueling at Tahiti, *Horizon* sailed directly along the equator eastward all the way to the Galápagos Islands. From this survey the current was revealed as a thin, enormously long ribbon of water that moved eastward at several knots, sandwiched between layers of water moving west. The top of the current at 140° west longitude, in the central Pacific, was only 70 feet beneath the surface. The high-velocity core moving at 2 to 3 knots was at about 350 feet in depth, and the bottom of the current was 1,500 feet. In contrast to the shallow depth, the current was

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about 240 miles wide, and it was traced continuously on Dolphin Expedition for 3,500 miles. Its flow was estimated as roughly 40 million tons per second. It is among the largest currents in the world. This equatorial undercurrent was named the Cromwell Current, for its discoverer who was killed in an airplane crash en route to join a Scripps expedition.

Geographical discoveries, such as submarine mountain ranges, seem much easier to understand than the origin of currents. But the great mountain ranges discovered by scientists on *Horizon* turned out to be of a new type, and explaining their origin required fifteen years of analysis and even a revolution in scientific thought.

In planning for Midpac Expedition in 1950, it was noticed that the few soundings then available in the northeastern Pacific suggested the existence of two regions with quite different depths. It was speculated that the regions might be separated by an abrupt and steep escarpment, like the continental slope between continents and ocean basins. To determine whether this was the case, *Horizon* was deflected far to the north of a direct route on its way home from the central Pacific to San Diego.

Horizon zigzagged four times across the suspected location, and we confirmed the existence of a scarp more than a mile high and about a thousand miles long. Nothing like it was previously known on the deep-sea floor, and hardly anything comparable on land. *Horizon* returned the following year on Northern Holiday Expedition and made 18 more crossings spaced only 50 miles apart. From these, the scarp was traced as an almost straight feature at least 1,200 miles long and with a maximum relief of almost two miles. The sea floor to the north was about half a mile shallower than to the south, and the two regions were separated by a great mountainous ridge with the scarp on the south side. These enormous features were produced by crustal discontinuities of some sort, but we did not know what.

The scarp might be, as originally surmised, a boundary between deep ocean basin and some sort of crust too thick to be ocean basin and too thin to be continent. Or it might merely be the trace of an enormous vertical fault displacement like the east side of the Sierra Nevada. However, it had the outstanding characteristic that it was straight, and such faults are produced only by horizontal movement. This had been shown on the San Andreas fault in California, which, perhaps significantly, disappeared out to sea just where this great scarp reached the continent at Cape Mendocino. We called it the Mendocino Escarpment.

In planning for Northern Holiday Expedition, another boundary between regions of different depth was noticed on a line between southern California and Hawaii. It was minor and could have been disregarded, except that it resembled the topography and trend of the Mendocino Escarpment. So, on the final leg of the expedition, from Kodiak to San Diego, Harris Stewart, then a graduate student in marine geology, directed the route of *Horizon* to cross the suspect feature eight times. These outlined the shape and location of a topographic unit that separated regions with only slightly different but distinctive depths. Moreover, it changed from a great trough on the west to a simple north-facing scarp to the east. As it was unlike anything known on land, we just called it the Murray "fracture zone." It was parallel to the Mendocino "fracture zone" and it was straight, which strongly suggested horizontal faulting.

Just how straight the Murray fracture zone is was discovered in planning for Capricorn Expedition, when *Horizon* and her sister ship *Spencer F. Baird* were to sail almost directly to the northern Marshall Islands, with little time for work along the way. On a great-circle track the Murray fracture zone plotted as a straight line, right along the track

to the Marshalls. So both ships surveyed the fracture zone in only a few hours of ship time, and we found it to be at least 1,900 miles long.

By the time the ships returned home, it was known that more than one fracture zone existed, that they were roughly parallel and extremely straight, and that they could be recognized on echo-sounding records. The few echograms available, mainly collected by *Horizon*, were re-examined, and two more fracture zones, even longer than the first two, were discovered to the south. Thus, in *Horizon*'s first few years in use by Scripps was found a vast pattern in individually great fractures in the Pacific. These had not been previously known, because their mountainous nature prevented obtaining a readable depth on the older sonic sounders without recorders.

Horizon went on working in the Pacific, Atlantic, and Indian oceans, though her fraction of the total exploration effort was lessened as more and more research ships came into service. Gradually, a global pattern of fracture zones throughout the world's oceans began to emerge, but not until 1965 was a probable origin for them proposed. Then J. Tuzo Wilson of the University of Toronto proposed that fracture zones are the scars produced by the motion of large plates of oceanic crust. In this he followed a fundamental hypothesis of Harry Hess of Princeton that the oceanic crust is created in the middle of many ocean basins and spreads

quietly to the sides, drifting along with the moving deep mantle of the earth. Subsequent field studies have shown that these ideas are essentially correct. The fracture zones are track lines which accurately detail the paths followed by the sea floor and continents as they drift across the surface of the earth. The proof of these ideas has caused a revolution in the earth sciences and oceanography.

Part of that revolution can be credited to the good ship *Horizon*.