

THE NATURAL ENERGY LABORATORY OF HAWAII



THE RESEARCH CORPORATION OF THE UNIVERSITY OF HAWAII
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NATURAL ENERGY LABORATORY OF HAWAII

I hope you will find that Hawaii, in its location and in its planning, is a model for the development of the new energy and mineral resources of the Pacific.

Almost all of the energy in Hawaii derives from oil, and all, of necessity, is imported by sea. It is a paradox of the Pacific that oil is now the Pacific's primary source of energy, although oil will not be found in the center of the Pacific Ocean, and these tropical islands are bathed in natural energy as is no other place on earth. It is in the development of natural energy, therefore, that we expect Hawaii to be a leader, both as a locale for energy development and as a place attractive to intellectual leadership.

I hope you will have a chance to visit the Big Island of Hawaii and see for yourselves nature's natural energy laboratory. On the Kona Coast of the Big Island you will be able to observe the many forms of energy produced by the sun. One need only stand on the tip of Keahole Point to be conscious of this energy . . .

Governor George R. Ariyoshi

(Excerpt from an address delivered at the Circum-Pacific Energy and Mineral Resources Conference, Hilton Hawaiian Village, August 26, 1974)

Introduction

The state of Hawaii is generously endowed with a variety and abundance of natural energy resources: geothermal, solar radiation, steady winds, ocean waves, and ocean temperature differential. The state has recognized these advantages and has moved aggressively to develop its natural energy resources. The 1972 State Legislature, well in advance of major concern regarding an energy crisis, allocated funds to initiate investigations into the development of geothermal power. These investigations are continuing with increased support from the National Science Foundation, the State of Hawaii and the County of Hawaii.

The 1974 State Legislature enacted many energy-related bills, one of which established a State Natural Energy Laboratory. This bill provided for planning funds which were matched on a dollar basis by the County of Hawaii.

The site for the Natural Energy Laboratory of Hawaii was chosen after a careful review of all the criteria necessary for its successful operation. Some of the most important criteria were: nearby availability of cold, deep ocean water; a warm ocean surface layer not subject to strong seasonal cooling; high annual solar radiation; accessibility to logistical support including major airports, harbors, and highways; and adequate quantities of undeveloped land. The Ke-ahole Point site is unique in fulfilling all of these major criteria, an additional advantage is this land is owned by the State of Hawaii.

The Scientific Community

The diverse and broad base of the scientific community in the State of Hawaii is a definite asset to any new program development. The main campus of the University of Hawaii, located a few minutes from Waikiki and from downtown Honolulu, houses the Hawaii Institute of Geophysics which has 44 active researchers. The Department of Oceanography has 14 faculty members and researchers on its staff. In addition, the Department of Ocean Engineering has 6 active staff, and the Department of Meteorology has 9 on the Manoa campus. The Hawaii Institute of Marine Biology, another research institute of the University of Hawaii, is located in Kaneohe Bay on the north coast of Oahu and employs 29 on its research staff. The University of Hawaii maintains two active



R/V Moana Wave



R/V Kana Keoki

research ships, the Kana Keoki, a 156 ft. vessel, and the Moana Wave, a 174 ft. ship. The shipyards and support facilities in Honolulu and Pearl Harbors are among the best in the United States. A major cement manufacturer and a steel reinforcing rod plant are located in the Barbers Point area of Honolulu.

The federal government supports a number of marine scientific establishments in the state of Hawaii. These include the University of Hawaii Sea Grant College which supports 22 Principal Investigators and staff; the U.S. Naval Undersea Center employing 35 scientists, which specializes in research and development in the areas of marine biology and undersea technology; the NOAA Joint Tsunami Research Effort with 8 scientists; and the Honolulu Laboratory of the U.S. National Marine Fisheries Service employing 17 scientists. There are a number of private organizations with ocean science and engineering capabilities located in the state. Detailed information on these may be obtained from the 52-page report, "Directory of Marine-Related Activities in the State of Hawaii, 1973", UNIH-SEAGRANT-MS-73-01 available from the Sea Grant Office, University of Hawaii, Honolulu, Hawaii 96822.

The Island of Hawaii

The island of Hawaii is known as the Big Island. Its land area of 4,038 square miles is almost twice that of all the other islands combined. With its large land mass the Big Island has attracted many agricultural ventures in the past. Of the early ventures, cattle ranching and sugar production have survived as leaders of the island's modern agriculture industry.

Since about 1965, increased tourism provided the impetus to promote tourist-related industry. In 1967 direct flights were initiated between Hilo and the west coast, and in 1971 the State completed construction of the first phase of a new inter-island airport at the Ke-ahole Point area. The next phase of construction includes plans for expansion to overseas standards in order to better serve the growing needs of the west or Kona coast of the Big Island. At the present time there are approximately 16 daily flights connecting the mainland with Ke-ahole airport. With the present flight schedules it is possible to leave New York at midmorning and arrive at Kailua-Kona in time for dinner.

At the end of 1974 there were more than 3,000 hotel units in the Kailua-Kona area with a resident population in excess of 6,000. This population is



Ke-ahole Point



The town and south industrial area of Kailua-Kona



primarily engaged in tourist-related activities either directly in the hotel-restaurant business or indirectly in construction and service industries. Aside from tourism the preferred new industry on the Big Island, as in the state as a whole, is research and development. The summit area of Mauna Kea on the Big Island is rated one of the best accessible sites in the world for astronomical observation. At the present time there is a facility operated by the University of Hawaii featuring an 88-inch mirror built for NASA as well as several smaller instruments. Construction is presently underway for the installation of the world's fourth



Ke-ahole Point and adjacent land area for the Natural Energy Laboratory. Main airport in background.



Honokohau Small Boat Harbor



Kawaihae Deep Draft Harbor

largest telescope in a joint venture by France, Canada, and the University of Hawaii at an estimated cost of \$18 million.

The Cloud Physics Observatory is located on the Hilo Campus of the University of Hawaii. Administered by the Hawaii Institute of Geophysics, the Observatory is conducting research programs in cloud physics and atmospheric conditions.

The west coast of the Big Island offers excellent potential for ocean-related research. Research vessels can easily moor at the deepwater port at Kawaihae. There is also a small marine biological research

laboratory administered by the University of Hawaii, located at Kawaihae. Small-boat facilities are available at Honokohau just three miles south of Ke-ahole Point.

The Ke-ahole Point site fulfills the requirements for ocean-related natural energy research. A land parcel of approximately 140 acres along the shoreline has already been designated. A second parcel to the north and adjoining the original one may also be made available if conditions warrant. Thus the site size is more than adequate for an expanded pilot project, and the flat nature of the land and availability of oceanic water lend itself perfectly for such research.

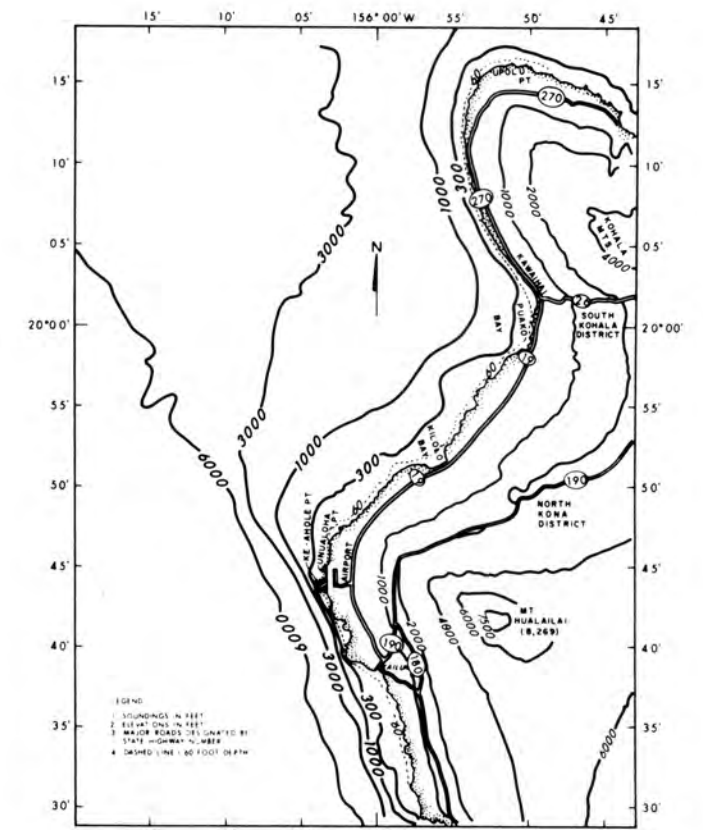
The Ocean

Deep oceanic water is as close to shore as anywhere else in the world. In addition, nearshore bathymetric contours have revealed the existence of small submarine canyons extending from very close to shore to at least the 2,500-foot depth. These small canyons would furnish excellent natural protection for any pipelines extending to deep water.

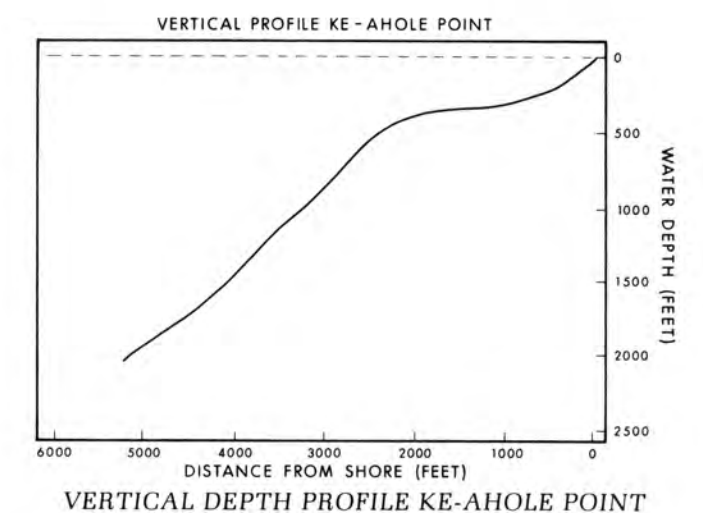
The vertical profiles of temperature and nutrients show that cold, nutrient-rich deep water is available within 2,000 feet of the shoreline. The illustration shows two profiles as they occurred off Ke-ahole Point in the spring of 1972. Water with a temperature less than 10°C (50°F) is found at 1,200-foot depth decreasing to nearly 5°C at about 2,500 feet. Although the surface mixed layer of water undergoes seasonal changes in thickness and temperature, the water properties below about 500 feet tend to remain the same throughout the year with temperature decreasing with depth and nutrient concentrations increasing. At Ke-ahole Point water less than 10°C may be obtained within one-half mile of the shoreline.

The surface layer (mixed layer) responds to the seasonal changes in circulation, mixing, and incident radiation (insolation). The general pattern is that the mixed layer is deeper (350 ft) and colder (25°C) in the spring and shallower (200 ft) and warmer (28°C) in the summer. There are small diurnal changes and some variation within a month ($\pm 1/2^\circ\text{C}$). Annual averaged differences among succeeding years do not exceed $\pm 1/2^\circ\text{C}$. These variations depend upon actual conditions, but they do represent expected maximum values and variations.

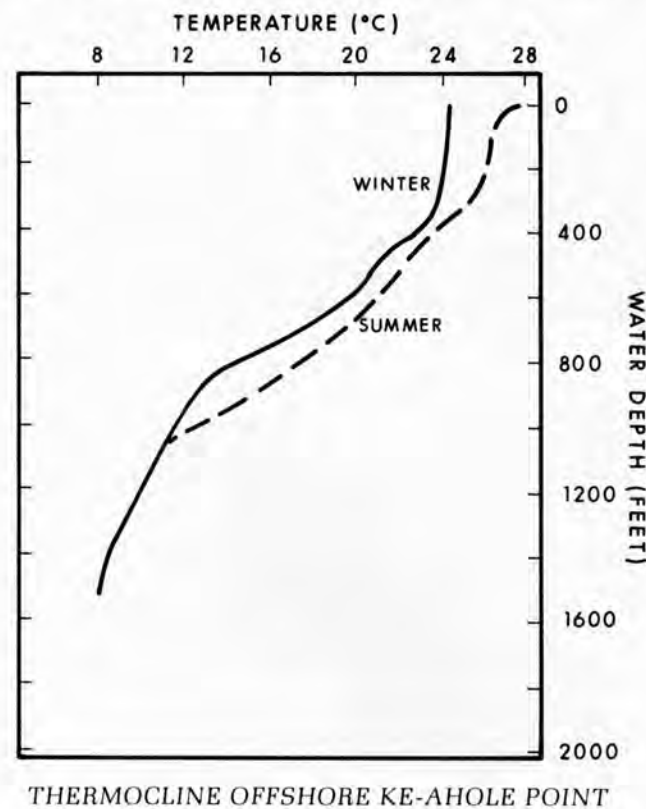
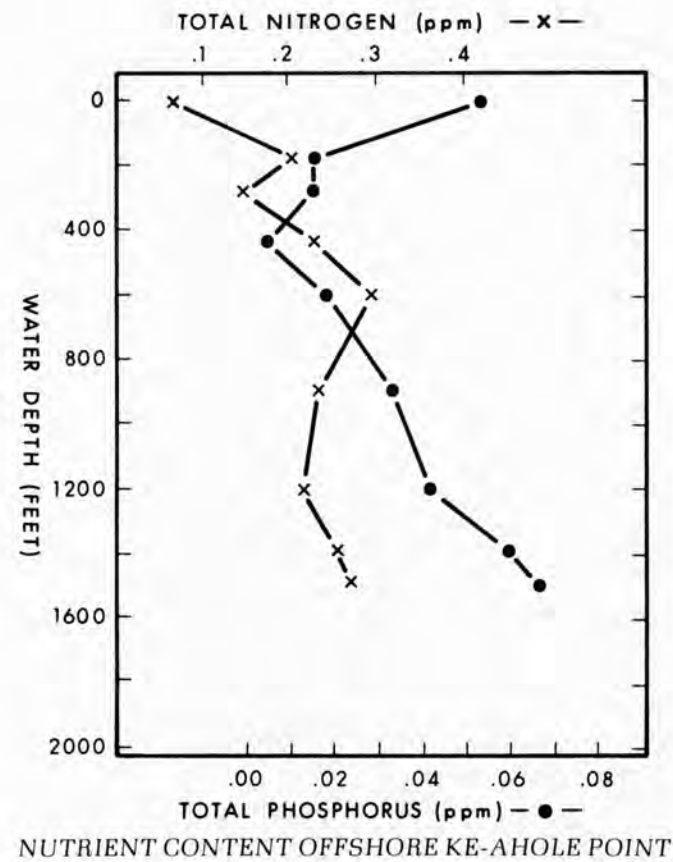
Recent observations in the offshore Ke-ahole area have indicated that the currents are a combination of tidal and geostrophic with a modal value of one-half to three quarters of a knot. The north easterly tending drift is dominant in the area, indicating an overall net transport in that direction.



GENERAL TOPOGRAPHY AND BATHYMETRY OF WEST COAST OF ISLAND OF HAWAII

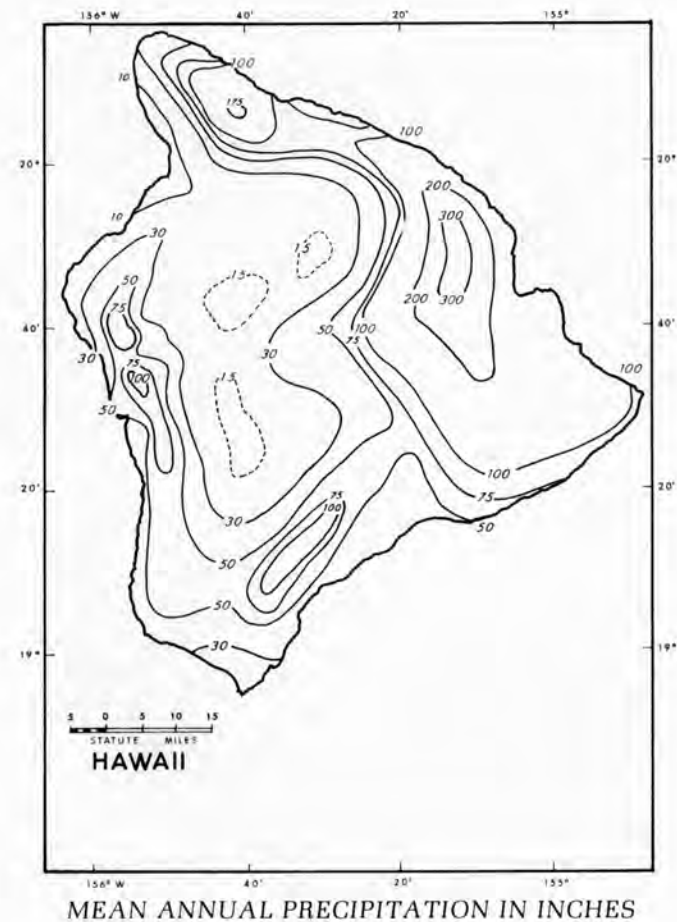


VERTICAL DEPTH PROFILE KE-AHOLE POINT



Winds and Sky

The Ke-ahole area is located on the southwestern or Kona (lit. leeward) side of the island of Hawaii. Because of the relatively large land mass of this island, diurnal onshore-offshore breezes are observed. They are not significant on any of the other Hawaiian Islands. The daytime onshore breeze causes clouds to build up against Mt. Hualalai at altitudes between 2,500-4,000 feet. Along the coastline, however, the sky is relatively cloud-free most of the year. During 1972, only 22 days with significant amounts of cloud cover were reported from the Ke-ahole Airport. Rainfall, which is correlated with cloud cover, is also low for this area. Predominant wind speeds are between 8 and 10 knots principally from the southwest sector. Occasional winter storms which approach the islands from the southwest can cause rough surf conditions and locally heavy rain for brief periods.



Transportation

Air transportation to Honolulu from the mainland United States is available from any major airport. Excluding charter flights and foreign airlines, there are approximately 28 daily scheduled landings at Honolulu International from the mainland. In addition, there are a few daily flights directly to Hilo on the island of Hawaii.

The Big Island has two major all-weather airports, one located on the east side at Hilo and the other near the town of Kailua-Kona at Ke-ahole Point. There is a third secondary airport located about 30 miles north of Ke-ahole near the town of Waimea. The three local airlines serving the Big Island presently have 20 daily arrivals at Hilo, 16 at Ke-ahole and 7 at Waimea. The flight time from Honolulu to Ke-ahole averages 30 minutes by the DC-9 jets currently in use.

Surface shipping is provided by barge from Honolulu. The schedule provides for three trips per week

into the port of Hilo and two per week into Kawaihae Harbor north of Kona. In addition there are direct shipping routes from the mainland to Hilo. Operational this year will be a high speed hydrofoil system from Honolulu to Kawaihae. Future plans include a roll-on/roll-off ferry system.

The port of Kawaihae, located 23 miles northeast of Ke-ahole Point, is a commercial deep water harbor. It is about 150 sea miles southeast of Honolulu and 2,051 sea miles from San Francisco. This harbor is protected to a great extent against northeasterly storms by the Kohala Mountains and against southerly storms by a promontory to the south. The harbor is partially exposed to waves approaching from the northwest direction, but these are not usually severe due to the sheltering offered by the other islands lying in that direction. This port, now dredged to an average depth of 40 feet, has adequate facilities for any vessels used in oceanographic research or deep water pipeline installation. Smaller vessels may be moored at the small boat harbor at Honokohau located just three miles south of Ke-ahole Point.

