West Hawai`i Offshore Electromagnetic Imaging Survey

June 2025

- **Survey Purpose**: Researchers aim to locate and map possible deep, offshore freshwater reservoirs beneath the seafloor of West Hawai‘i.
- **Research Team**: Under contract with the Natural Energy Laboratory of Hawaii Authority with funding provided by the State legislature, the project is a collaboration between the Hawai‘i Institute of Geophysics and Planetology and the Scripps Institution of Oceanography.
- **Background**: A 2018 survey suggested the existence of deep freshwater or brackish aquifers beneath the ocean floor—challenging traditional hydrological models.
- **Scientific Importance**: Confirming these reservoirs could explain discrepancies between groundwater recharge and coastal discharge, revealing significant "missing water."
- **Methodology**: Non-invasive geophysical imaging methods will be used—specifically, controlled source electromagnetic (CSEM) and magnetotelluric (MT) techniques.
- **Survey Zones**: The study spans three offshore areas: from Kiholo Bay to Honōkohau Harbor, from Kailua Bay to Kealakekua, and a deep offshore transect from Wāwahiwa‘a Point extending 6.5 miles seaward.
- **Environmental Impact**: Instruments will be temporarily placed on the seafloor, with minimal impact to marine habitats. Most will be retrieved after data collection.
- **Marine Safety**: A chase boat and onboard observers will monitor for marine life and vessels; operations will pause if animals or boats enter the area.
- **Ecological Assessment**: Over 400 studies show that the electromagnetic signals used in CSEM surveys pose no significant risk to fish, seabirds, turtles, or marine mammals.
- **Potential Benefits**: If viable freshwater reserves are confirmed, they could become a valuable resource and aid long-term water management in West Hawai‘i. These studies will also improve our understanding of freshwater resources on volcanic islands across the world.

Project Summary

For two weeks starting in late June, a team of researchers from the Hawaii Institute of Geophysics Planetology and from Scripps Institution of Oceanography will be plying the waters offshore of West Hawaii in search of freshwater. Under contract with the Natural Energy Laboratory of Hawaii Authority with funding provided by the State legislature, the team seeks to confirm and expand on the findings of a smaller survey carried out six years ago, which identified what is theorized to be one or more large reservoirs of fresh or brackish water beneath the seafloor off West-Hawai'i.

Background

In 2018, researchers identified what is theorized to be a deep confined layer of fresh or brackish water where, under standard hydrological models of ocean islands, there should be none. They proposed this "deep water" is an extension of the island's onshore aquifer, with rainfall being captured on the exposed slopes of the island's volcanoes and channeled beneath the conventional basal freshwater lens through a multilayer formation of water-saturated basalt interbedded with low-permeability layers of ash and soil.

This discovery, along with other evidence of submarine vents discharging freshwater to the ocean on a regional scale, may help explain significant discrepancies between groundwater recharge of the aquifer and discharge from that body of water at the coastline. The conventional hydrologic models come up short – there is a large amount of "missing water".

The 2018 survey was limited in scale but provided strong evidence of what may be a large reservoir of freshwater in West-Hawai'i, extending from far inland to miles offshore. The present study aims to confirm, extend and add detail to that earlier effort.

Significance

If one or more pockets of "deep water" are identified and confirmed, scientific information gathered on the capacities and dynamics of those reservoirs will inform water resource modelling and management decisions for the region and may highlight them as a potential source of freshwater.

Methods and Technology

Like in 2018, the present survey will use using non-invasive, non-destructive and transient geophysical imaging techniques: low-power controlled source electromagnetic (CSEM) methods in water depths of 60 to 75 meters as well as passive magnetotelluric methods further offshore.

The CSEM imaging technique relies on two types of scientific instruments. The first type of instruments are nodal electromagnetic receivers that are temporarily deployed from the survey vessel to sit on the seafloor. The second are passive instruments that are towed behind the vessel in a 1000 m (3500 ft) long array that record the electric field of the earth. These instruments listen passively to electromagnetic echoes from the rock layers beneath the seafloor as these are bathed by weak electromagnetic signals generated both from the natural magnetic field of the earth as well as an electric field produced by a 150-foot-long cable towed

behind the vessel. This long array of instruments is towed over the seafloor nodal instruments across the survey area at a speed of 2 to 3 knots.

Study Area

The survey will take place in three separate survey phases. The first "north" phase is between Hou Point (the northern edge of Kiholo Bay) and Honōkohau Harbor, followed by the area South of Kaiwi Point, between Oneo (Kailua) Bay and Keawekāheka Point at Kealakekua, and finally a "Deep MT line" running offshore from Wāwahiwa'a Point (at Kohanaiki), starting ¾ of a mile offshore at a water depth of 560 meters and extending offshore 6-½ miles to a water depth of 2,900 meters.

Risks, Impacts and Mitigation

Based on a USGS study offshore of Kaloko-Honokohau National Historical Park, as well as hundreds of hours of accumulated observations using manned submersibles and remotely operated vehicles offshore of Keahole Point, the areas where study nodes are to be deployed are expected to be uncolonized sand sheet with some coral rubble, scattered rocks, and occasional boulders. The macroorganisms most likely to be encountered in the study area are transient bottom-dwelling fish, rays and shrimp. In these areas, the footprint on the seafloor created by the deployed instrument packages will be minimal, and in the case of the CSEM portions, temporary: after two or three days of data collection, the instrument packages will be recovered, including their 1-meter-square concrete pedestal ballasts. In the case of the much deeper deployment along the "Deep MT Line", recovery of the 8 concrete pedestals is not feasible, and these will be abandoned on the seafloor to degrade by natural processes.

Non-Human and human interaction with the CSEM umbilical

While the survey timeframe is outside the time-window when migratory humpback whales are typically present in West-Hawai'i, other species of whales and other protected animals (dolphins, seals, turtles, whale sharks, rays, birds) may be present in the study area. Because the CSEM umbilical floats at the water surface, it poses a potential risk to these animals as well as to motorized boats. To avoid such interactions, a chase-boat will patrol the area, and along with observers on the survey vessel, watch for presence of animals and approaching vessels in or near the survey area. Should any appear and persist in the area, the survey transect will be temporarily halted and the umbilical spooled onto the deck of the survey vessel until such time as the animal or boat has moved out of the zone of possible interaction.

Potential effects of CSEM surveys on animals

An authoritative review of the potential effects of CSEM surveys on animals has reviewed over 400 reports and publications, providing data and information on hundreds of species of marine animals. The analysis concludes that the electromagnetic signals used in surveys such as this have no potential for significant transient or cumulative effects on fish, seabirds, sea turtles, or marine mammals.

For more information send inquires to alexander.leonard@hawaii.gov.