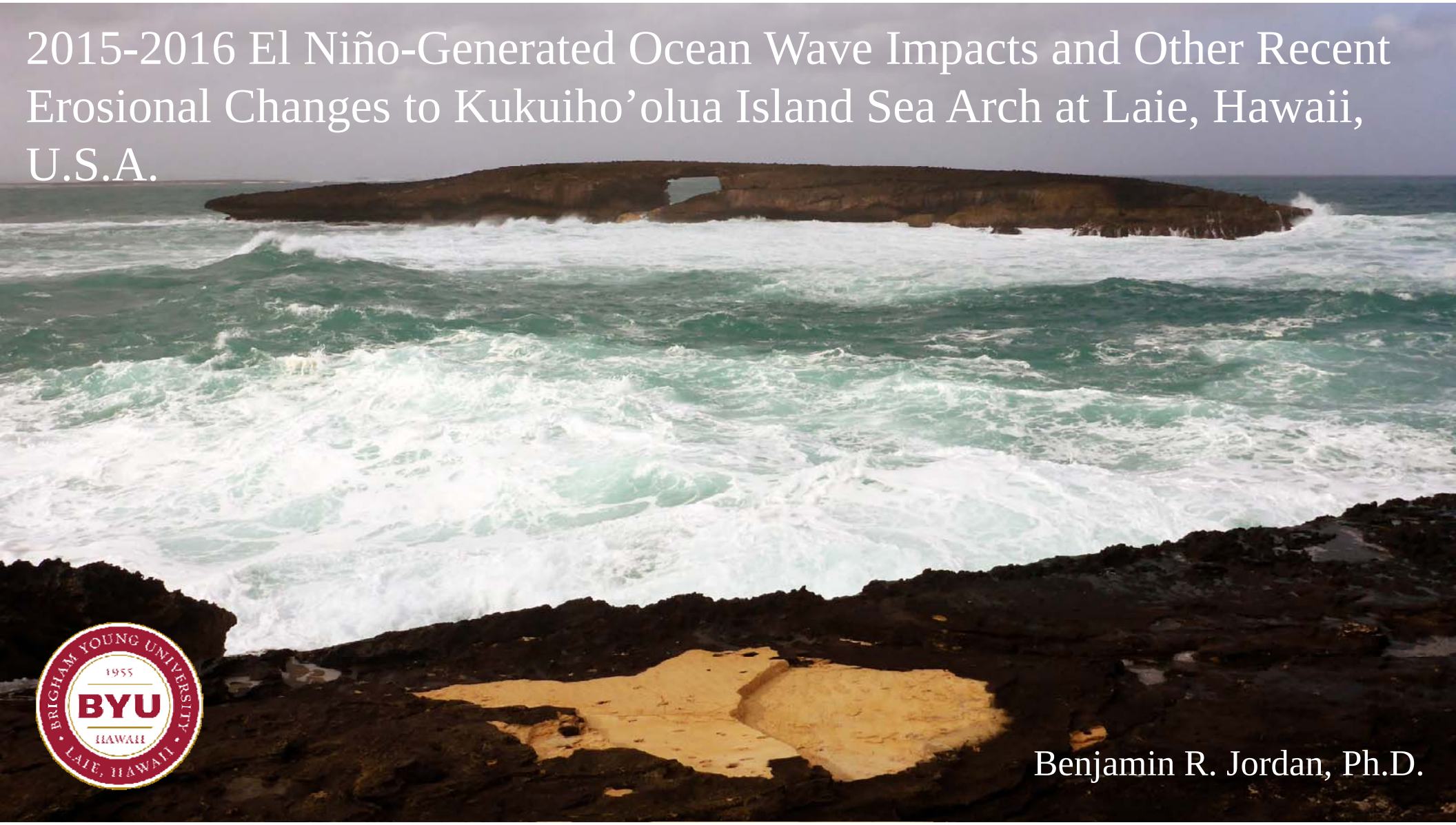
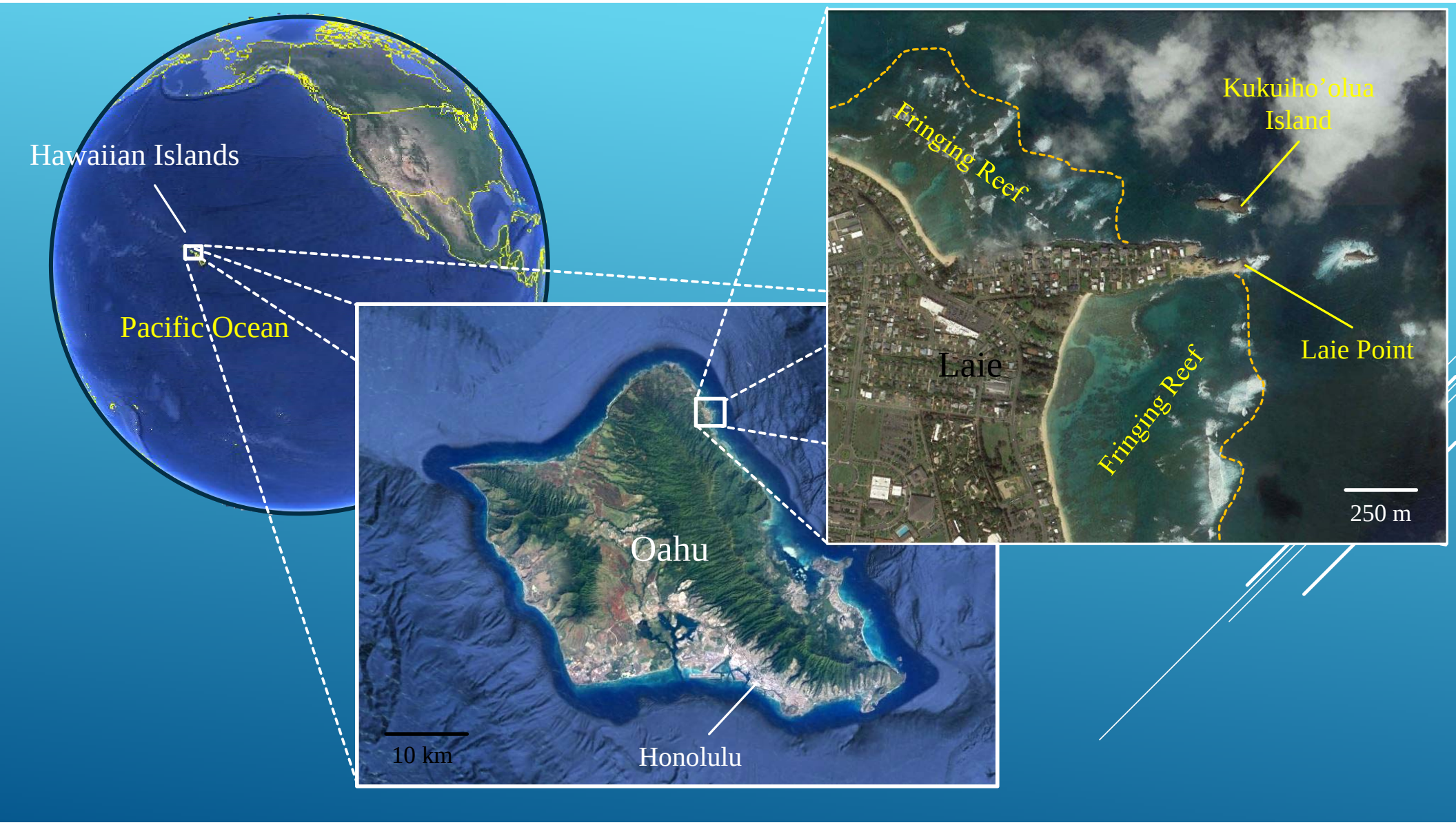
2015-2016 El Niño-Generated Ocean Wave Impacts and Other Recent Erosional Changes to Kukuiho'olua Island Sea Arch at Laie, Hawaii, U.S.A.



Benjamin R. Jordan, Ph.D.


Hawaiian Islands
Pacific Ocean
Oahu
10 km
Honolulu
Laie
Fringing Reef
Fringing Reef
Kukuiho'olua Island
Laie Point
250 m

From: Sherrod, D. A., Sinton, J. M., Watkins, S. E., and Brunt, K. M., 2007, Geologic Map of the State of Hawai'I, USGS Open File Report 2007-1089, Sheet 3.

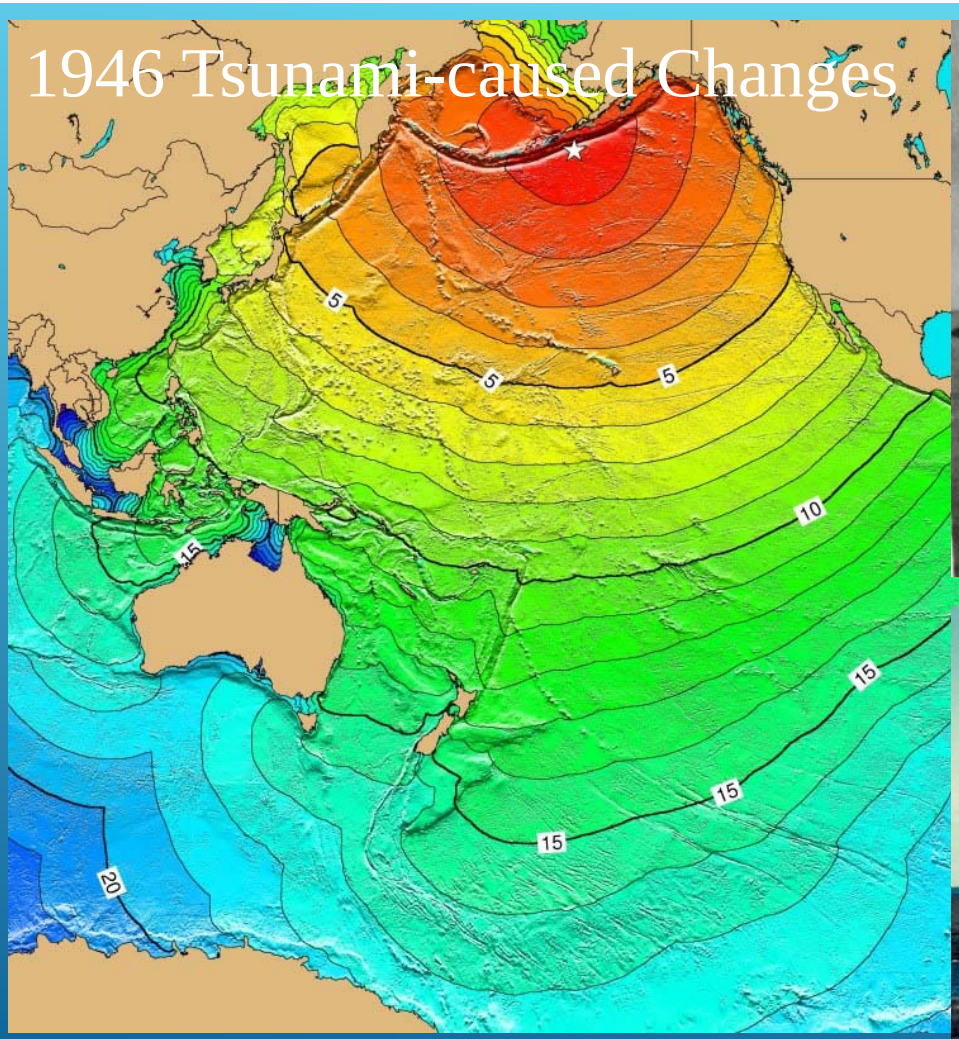
Kukuiho'olua Island

Pleistocene and Holocene (~0.01 – 0.1 Ma) Dune Deposits.

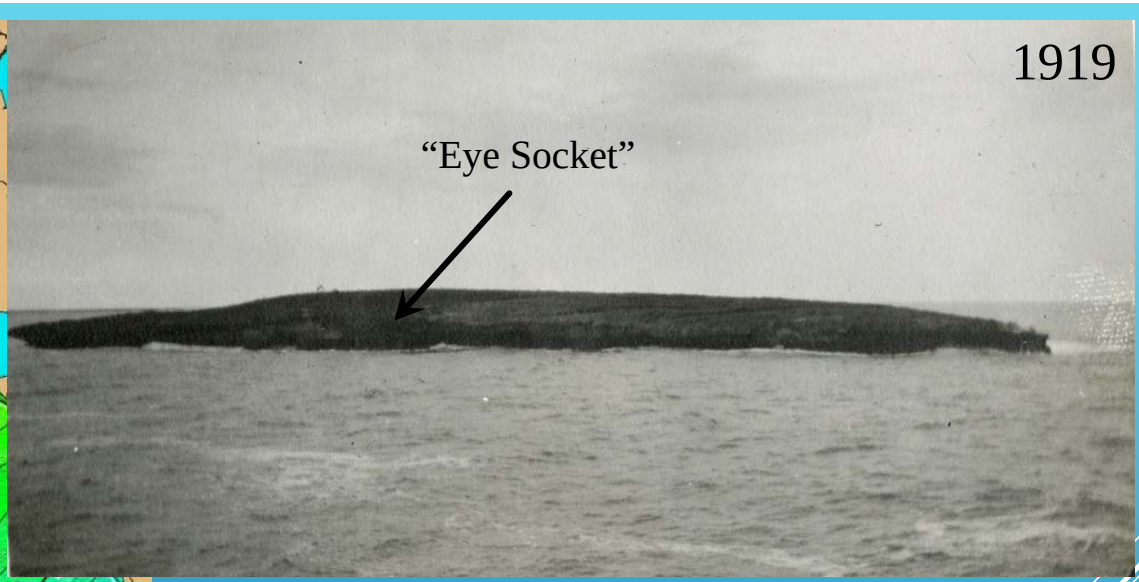
Laie Point

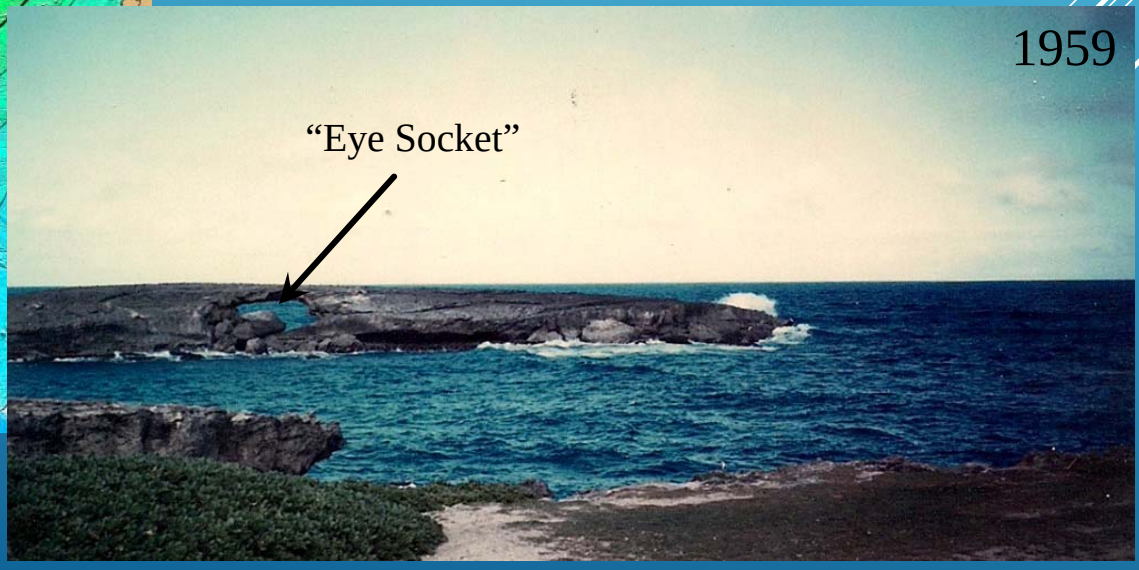
QTkdc

1946 Tsunami-caused Changes



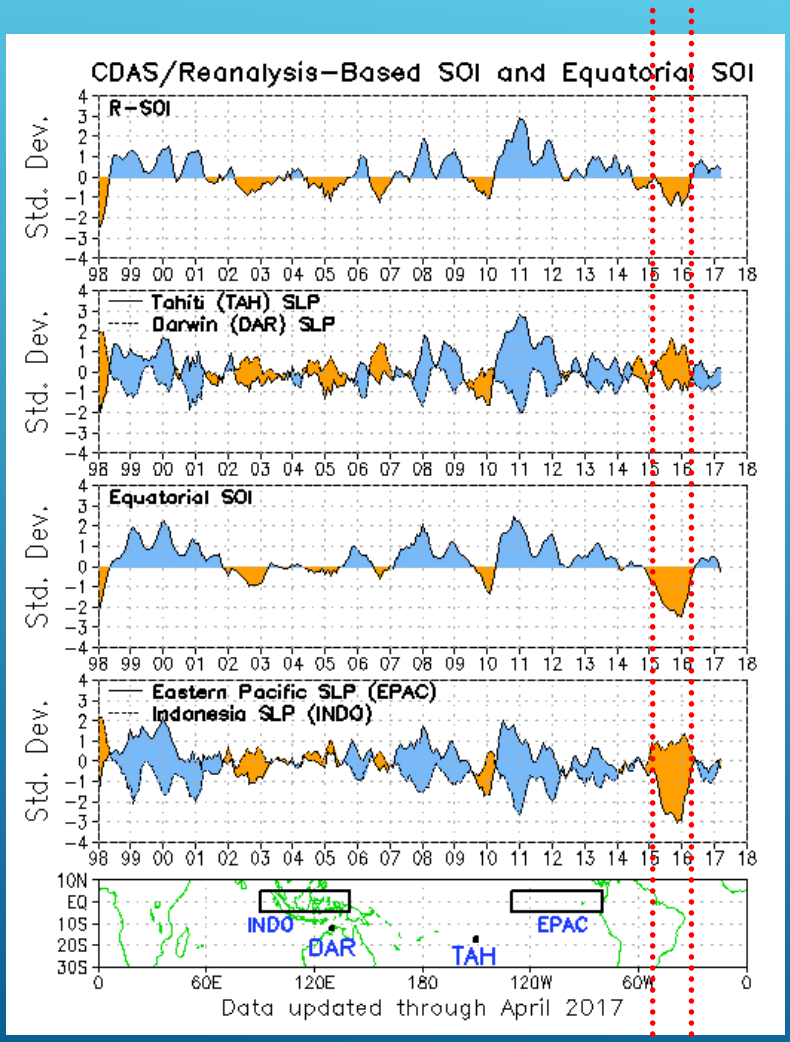
1 April 1946 Alaskan earthquake (M_s=7.4) epicenter and tsunami travel times (hours).
Source: NOAA

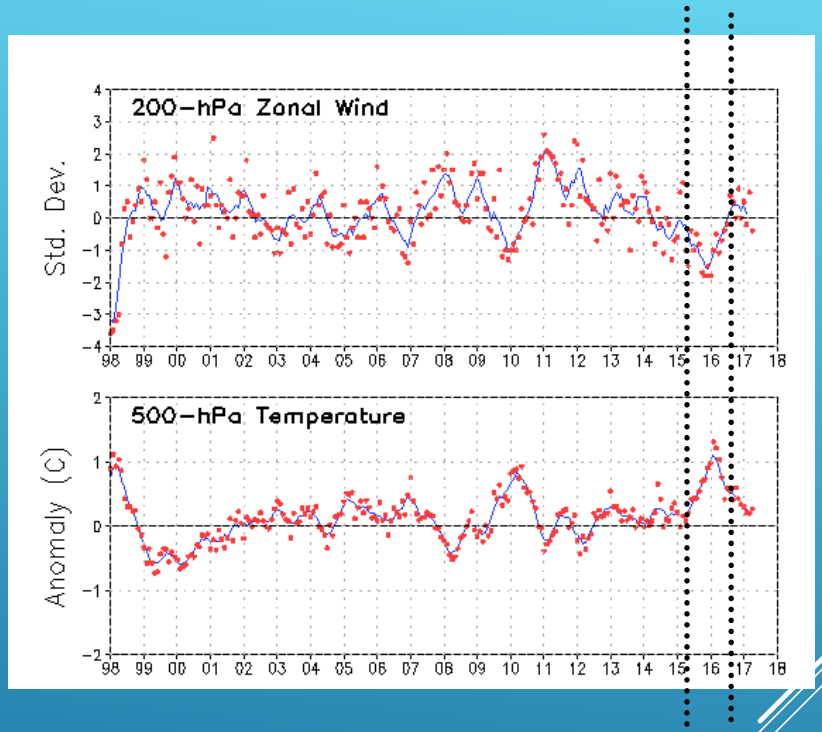




SOI, Temperature, and Wind Conditions during the 2015-2016 El Niño

SOI: Southern Oscillation Index



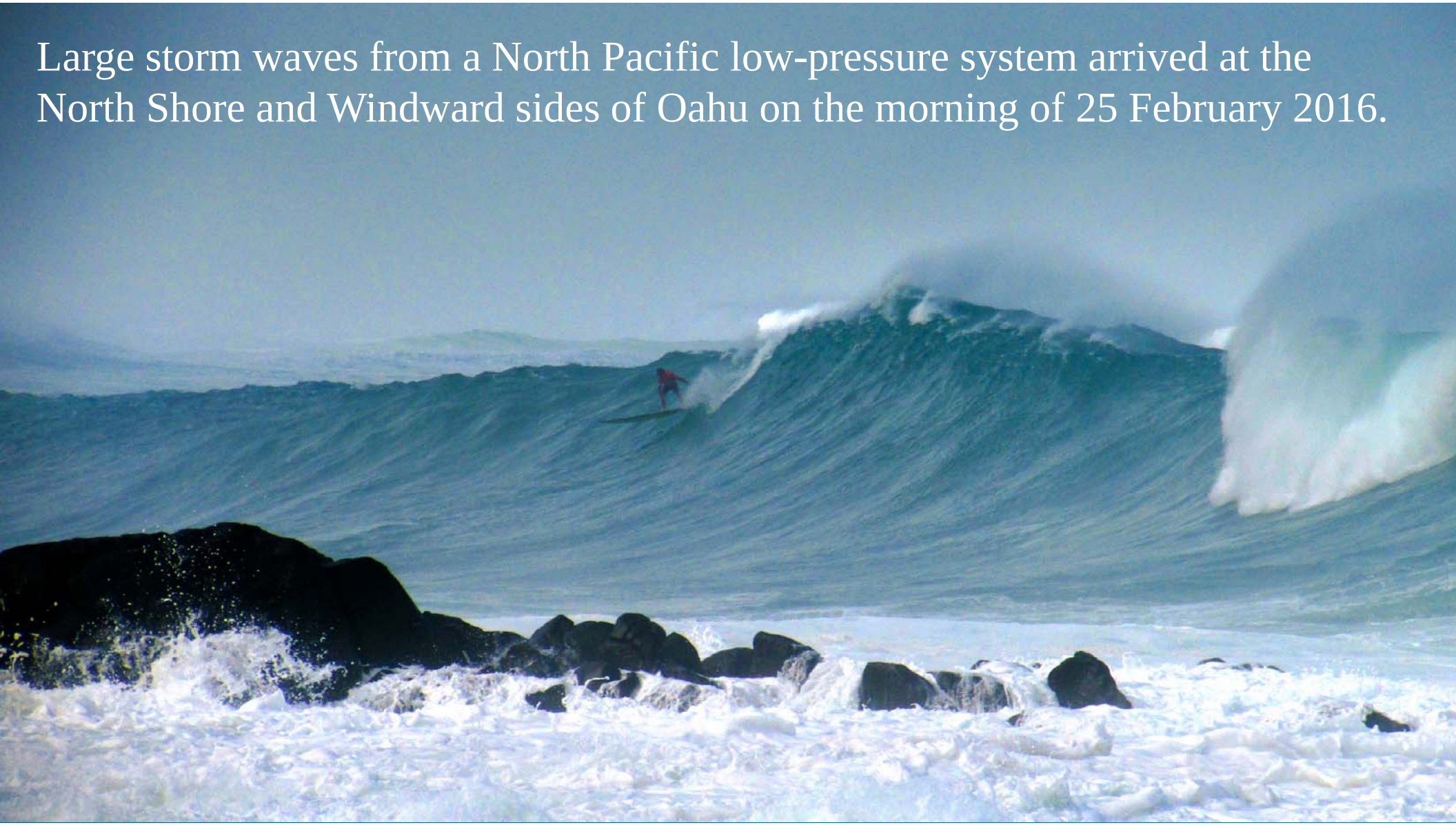


200-hPa: Surface Winds

500-hPa: Troposphere Temperature

Courtesy of the U.S. National Weather Service Climate Prediction Center

Large storm waves from a North Pacific low-pressure system arrived at the North Shore and Windward sides of Oahu on the morning of 25 February 2016.



Significant Erosion and Geomorphologic Change to Kukuiho'olua Island's Sea Arch

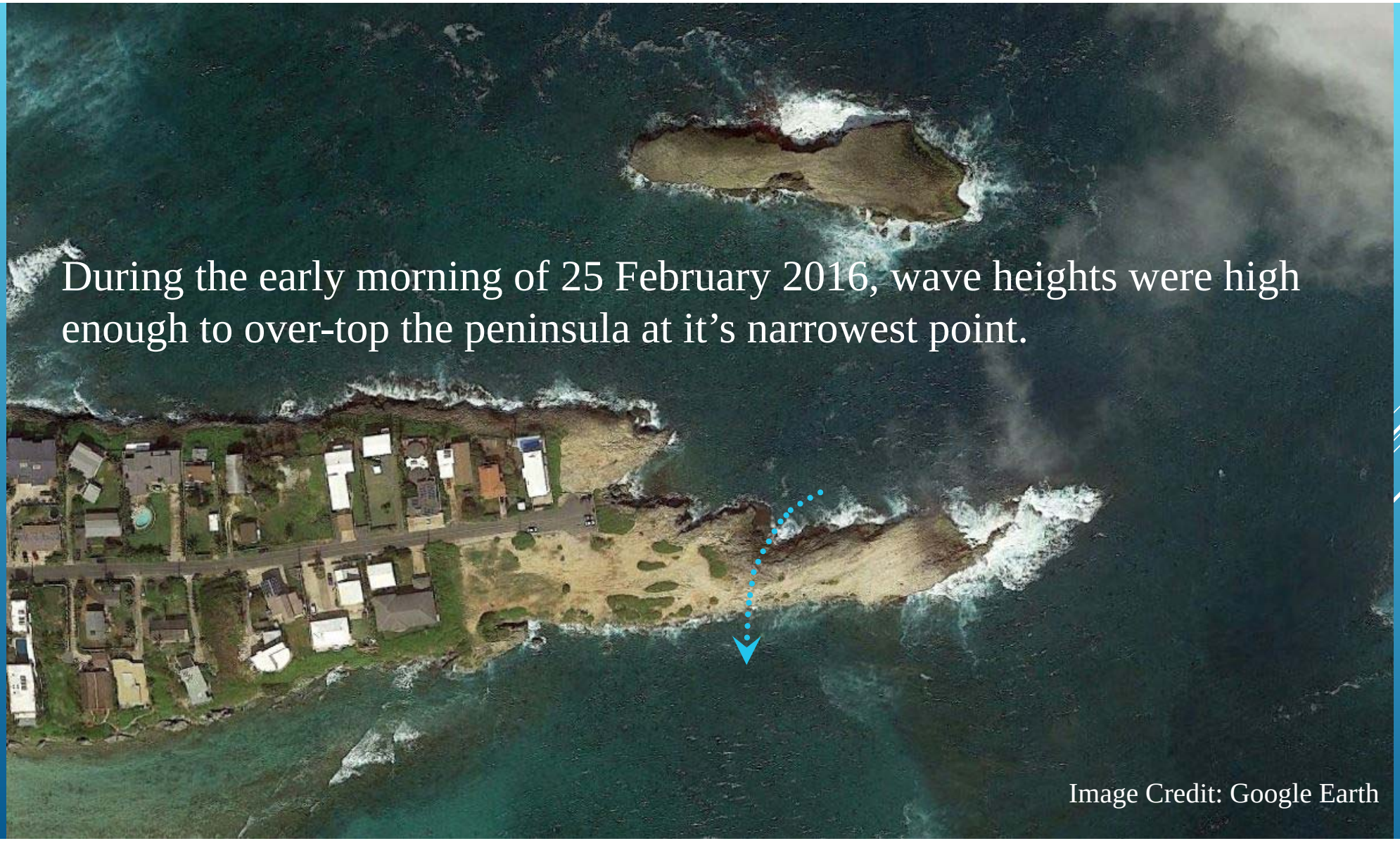
Prior to 25 February 2016

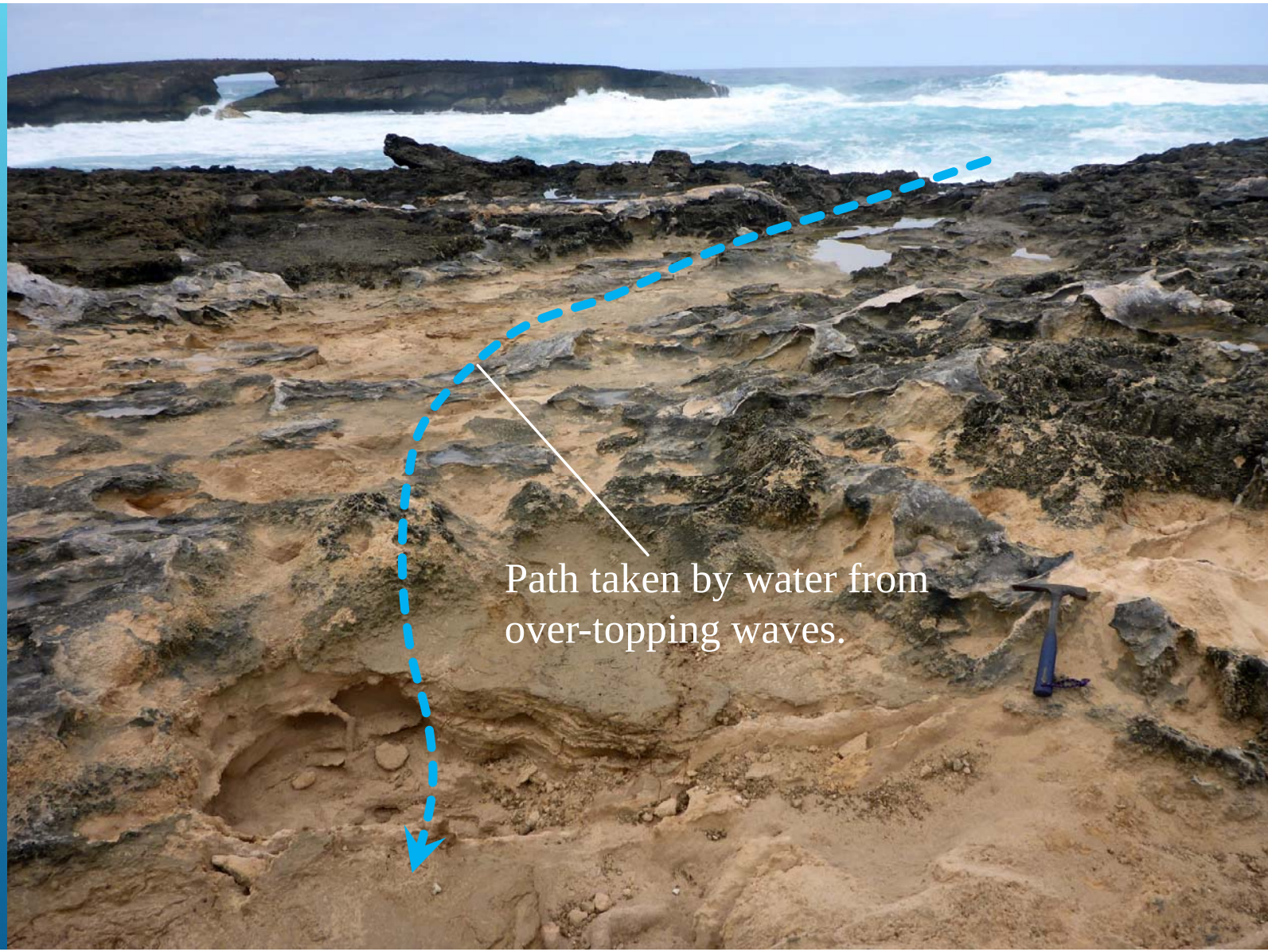
After to 25 February 2016

Date (2016)	Time (LST)	Wave Height (m)	Estimated Tide (MSL)
24 February	21:00	3.66	-0.23
24 February	22:00	3.49	-0.24
24 February	23:00	3.86	-0.18
25 February	00:00	4.06	-0.08
25 February	01:00	4.36	0.04
25 February	02:00	4.66	0.16
25 February	03:00	5.49	0.25
25 February*	04:00	5.57	0.28
25 February	05:00	5.12	0.25
25 February	06:00	6.12	0.17
25 February	07:00	5.77	0.05
25 February	08:00	5.52	-0.07
25 February	09:00	6.37	-0.16

*High tide occurred at 04:01, but sunrise was at 06:56.

The most likely time for the boulder to have been washed out from beneath the arch was when the storm waves coincided with the local high tide.


During the early morning of 25 February 2016, wave heights were high enough to over-top the peninsula at it’s narrowest point.
Image Credit: Google Earth


Path taken by water from
over-topping waves.


Kukuiho’olua Island
Kukuiho’olua Island
Path taken by water from over-topping waves.

1946 April Fools Tsunami

2015-2016 El Niño

Conclusion

While being one small location in the Pacific Ocean, the changes that occurred at Laie Point and Kukuiho'olua Island during the 2015-2016 El Niño serve as a dramatic example of the rapidity at which coastal changes can occur after long periods of seeming stasis. Overall, the impacts of the waves at Laie Point were significant and dramatic.

These changes suggest that additional events of similar magnitude produced during El Niño conditions, and coinciding with high tide, can lead to rapid, unexpected, and possibly hazardous changes to areas that are often taken for granted to be relatively unchanging. Coastal monitoring, especially during extreme El Niño years, should be of a high priority for local communities as much as it is for larger regions.

Acknowledgments

- Wei Shi, Ph.D, - Meteorologist, Climate Prediction Center/NCEP/NWS/NOAA
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- NOAA
- JPL/NASA
- USGS
- Google