



An Aerial Geoarchaeological Survey of the Laie Pier, Oahu, Hawaii, U.S.A., Using UAVs

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Abstract

Laie, Hawaii, is a small village on the windward side of the north shore of the Hawaiian island of Oahu. In 1868 the area of Laie was turned into a large sugar plantation. In order to get the stacks of raw sugar and molasses to Honolulu for shipment overseas, a warehouse and small pier, with a crane, was built on the beach, today called “Pounders Beach,” on the southeastern corner of the village in 1887 (although possibly as early as 1881). The pier was built extending from the berm of the beach out over the Pleistocene, fringing reef platform and marine terrace. At this location a deep channel extends through the reef and approaches close to shore, allowing for the approach of small steamships.

Although not definitively recorded, the pier was likely abandoned sometime between 1899 and 1907, when the Oahu Railroad was extended to Laie. Today all that remains of the pier, above sea-level, are the iron, vertical support columns that held up the pier platform. Below sea-level there are a few large pieces of coral-encrusted debris scattered in an area around the columns. Little to no documentation of the pier since its abandonment has taken place, although it is a valuable historical artifact for the area, as well as a possible reference structure for changes to the local beach and sea level. Although clearly visible from the ground, the structure itself does not appear on USGS topographic maps and is nearly invisible from normal air photos and Google Earth. In order to better understand the changes that have occurred to the beach in, and around, the pier since its abandonment, as well as to document the history of the pier itself, small UAVs (DJI Phantom II and III with GoPro cameras attached) were used to obtain high-resolution images of the beach and pier layout. The images were corrected for the fisheye-distortion caused by the GoPro lenses. The aerial views are much clearer than previously available aerial photographs and clearly show the outline of the pier and its alignment and layout. The images are now being used as base photomaps for documenting debris fields, dominant current and sand flow direction, as well as a better understanding of the overall relationship between the pier and the reef channel. The UAVs were invaluable as inexpensive aerial platforms for collecting aerial photographs for such a small-scale structure.

Historical Background

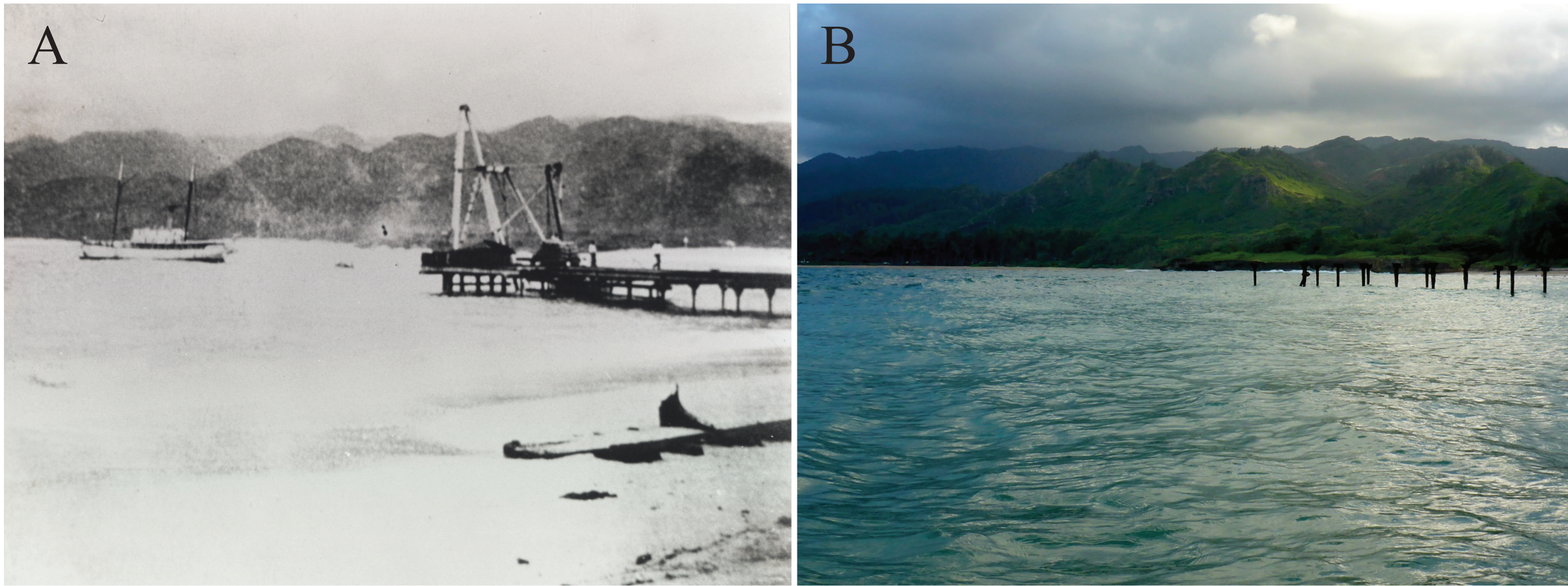
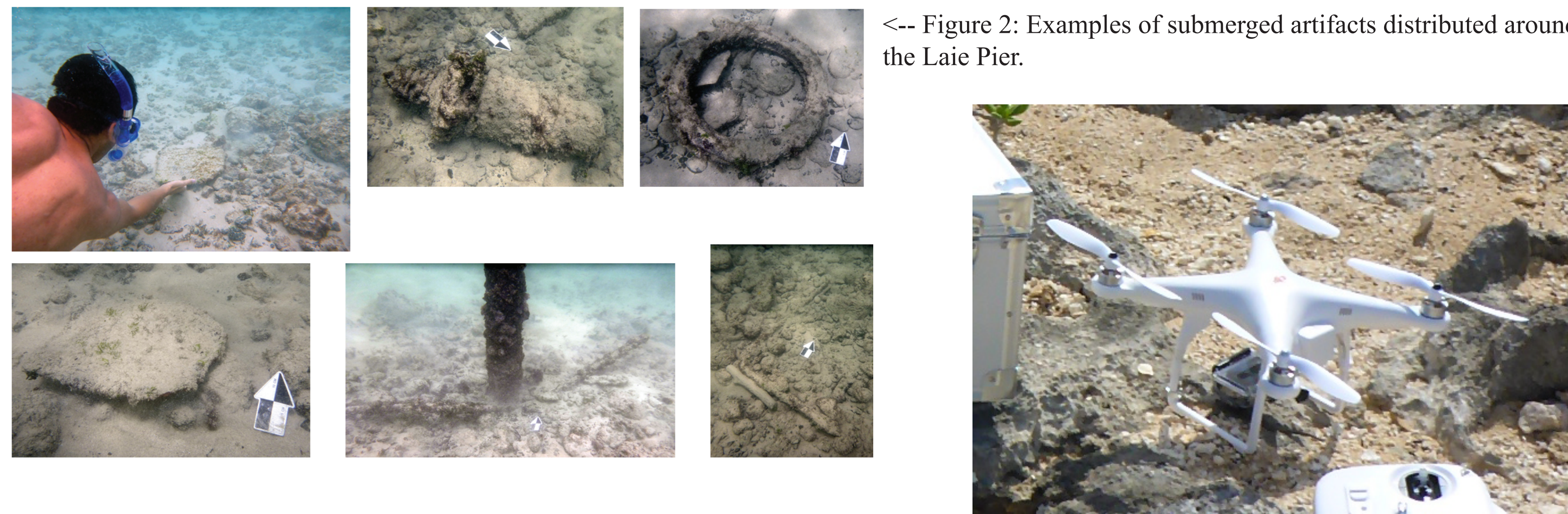


Figure 1: A. The only known image of the Laie Pier in use – undated image (inferred 1887). B. 2015 view of the Laie Pier from the same vantage point as A. Both images are taken at low tide, but not necessarily at the same time of year. However, a significant change in beach elevation and sedimentation is still evident. Figure 1A courtesy of the Brigham Young University-Hawaii Archives.

Laie, Hawaii, is a small village on the windward side of the north shore of the Hawaiian island of Oahu. In 1865, the area of Laie was purchased by the Church of Jesus Christ of Latter-day Saints as a place for new Mormon converts to gather and form a community. In 1868 the area of Laie, in order to become self-sufficient, was turned into a large sugar plantation and a mule-powered sugar mill was built (Britsch, 1989). Originally, the sugar and molasses that was processed at the mill was stored at the mill until a ship came in to shore. At that time the mill was shut down while everyone worked to carry the sugar down to beach and load it onto the ship's boats to be taken onboard. The stacks of raw sugar and molasses would then be taken to Honolulu for shipment overseas.

The work to move all of the sugar from the mill to the beach, all at the same time, took an extensive amount of time and labor. In 1887, in order to save time and labor, a warehouse for storage was built at the beach where the sugar could be stored each day. In addition to the warehouse, a small wharf or pier, with a crane, was built on the beach (Figure 1a) (Jensen, 1935; Berge, undated). Today, the beach is called “Pounders Beach,” and lies on the southeastern corner of the village (Moffat, 2008). The pier was built extending from the berm of the beach out over a Pleistocene, fringing reef platform and marine terrace. At this location a deep channel extends through the reef and approaches close to shore, allowing for the approach of small steamships.

Although not definitively recorded, the pier was likely abandoned sometime between 1898 and 1900, when the Oahu Railroad was extended to Laie, first by portable track and eventually by permanent tracks (Woolley, 1901). Today all that remains of the pier, above sea-level, are the iron, vertical support columns that held up the pier platform (Figure 1b). Below sea-level there are a few large pieces of coral-encrusted debris scattered in an area around the columns and extending in an area out to approximately 100 m (Figure 2). Little to no documentation of the pier since its abandonment has taken place, although it is a valuable historical artifact for the area, as well as a possible reference structure for changes to the local beach and sea level.



<-- Figure 2: Examples of submerged artifacts distributed around the Laie Pier.



Figure 4: A DJI Phantom II UAV with a GoPro camera attached.

UAV Views

The remains of the pier are clearly visible from the ground (Figure 1B). However, the structure itself does not appear on USGS topographic maps and is nearly invisible from normal air photos and Google Earth (Figure 3). In order to better define the extent of the pier remains and to understand the changes that have occurred to the beach in and around the pier since its abandonment, small UAVs (DJI Phantom II and III with cameras attached - Figure 4) were used to obtain high-resolution images of the beach and pier layout over a year's time (2014-2015). These images were corrected (using Adobe PhotoShop) for the fisheye-distortion caused by the GoPro lenses.

The aerial views are much clearer than previously available aerial photographs and clearly show the outline of the pier and its alignment and layout (Figure 5). Significantly, in the time interval between the first images in 2014 and the images in 2015, one of the columns was removed, either by waves or by people (or some combination of both) - see Figure 5. The two images also show a clear change in the amount of sand around the pier remains. In 2014, the foundations of three additional columns are clearly visible, but are no longer visible in 2015, likely buried due to seasonal changes in the beach - see Figure 5.

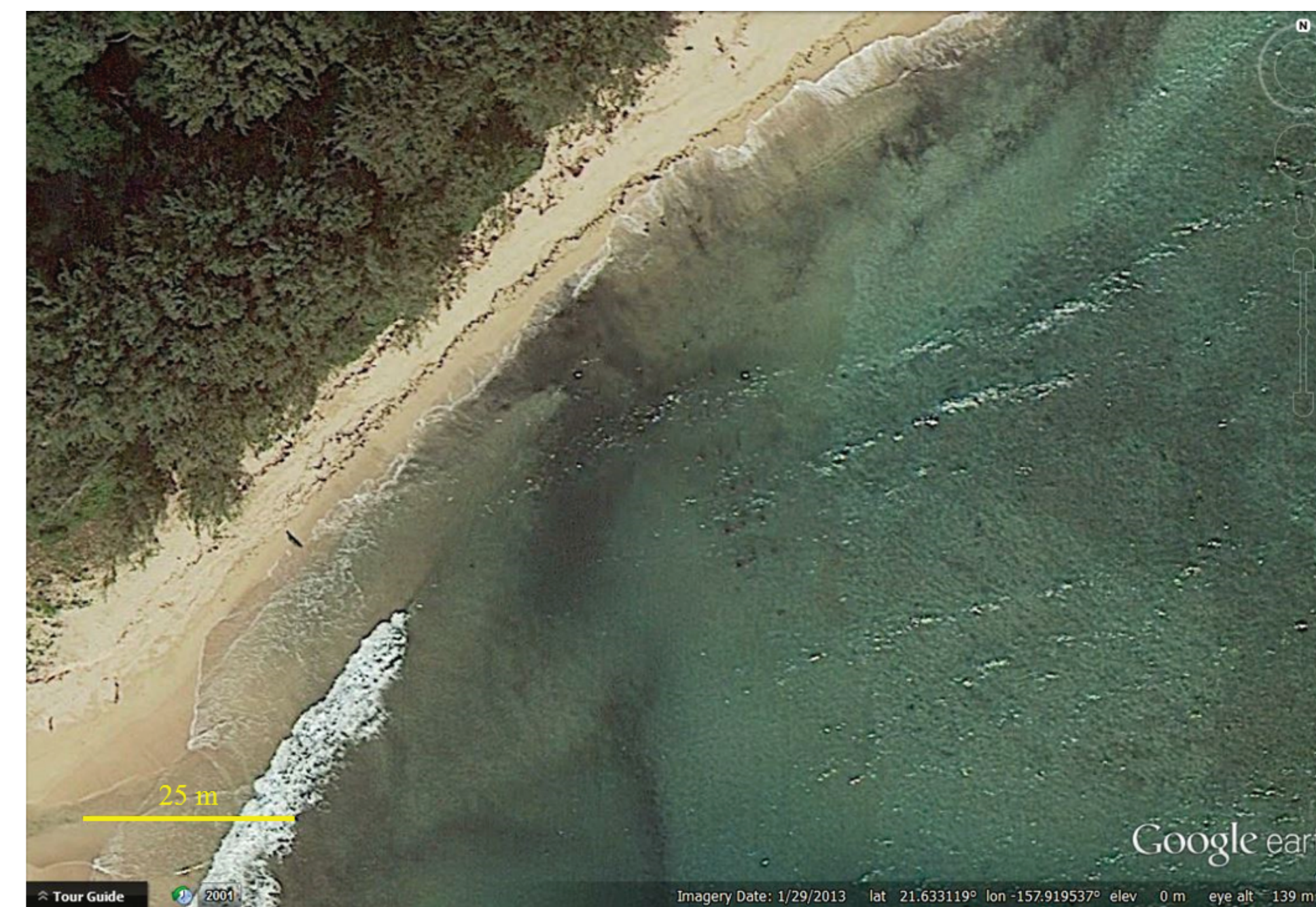


Figure 3: The highest possible resolution of the Laie Pier using Google Earth.

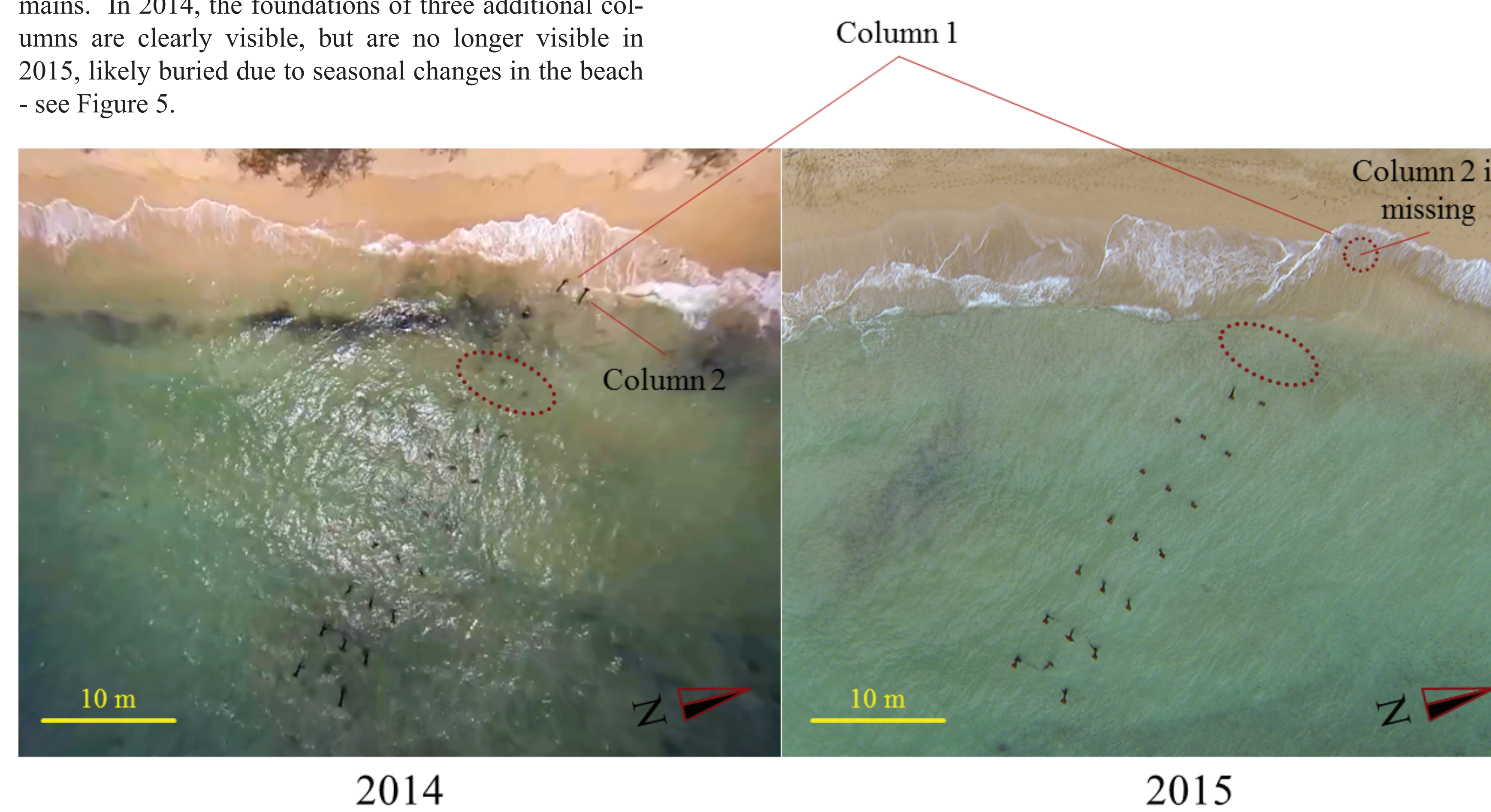


Figure 5: UAV views of the remains of the Laie Pier illustrating the greater clarity that is possible using a UAV as well as documenting changes in the structure of the pier and the sediments around it. Compare to Figure 3.

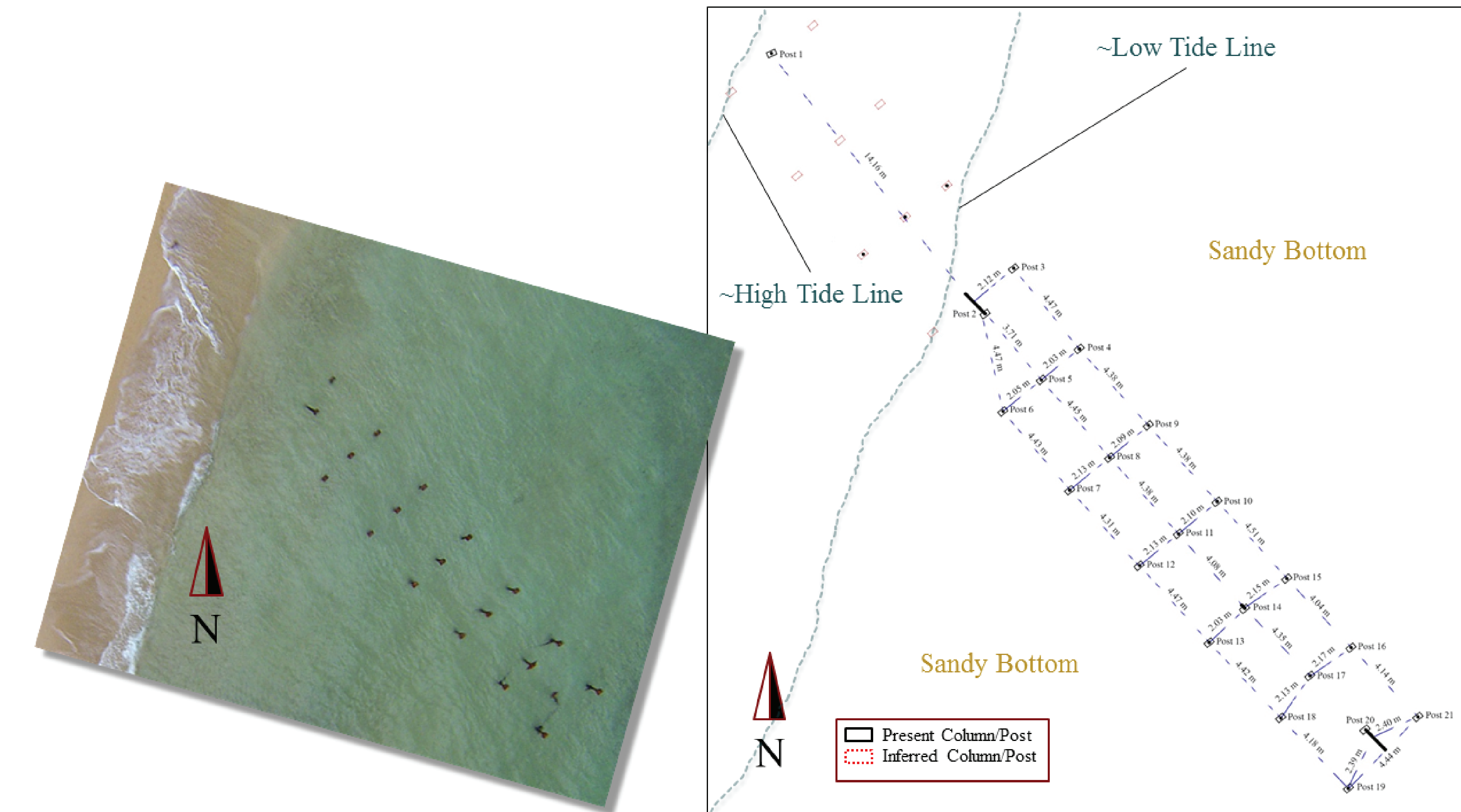


Figure 6: The preliminary map of the remains of the Laie Pier based on a combination of UAV imagery and ground-based measurements.

The images are now being used to develop a base map for documenting the debris field around the pier remains, seasonal changes in the beach sediments, as well as a better understanding of the overall state of the pier and further changes to its structure over time (Figure 6). The UAVs are serving as invaluable and inexpensive tool platforms for collecting high resolution aerial photographs for such a small-scale structure.

In addition, a part of the work on this project was done with the assistance of undergraduate oceanography students. UAVs are a valuable educational tool in helping students to gain a birds-eye view and a deeper understanding of the geologic and oceanographic processes affecting the pier remains (as well as other natural and man-made structures) over time (Jordan, 2015).

Acknowledgements

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