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Views of a Century of Activity at Kīlauea Caldera—A Visual Essay

Chapter B of
The 2008–2018 Summit Lava Lake at Kīlauea Volcano, Hawai'i

Professional Paper 1867

U.S. Department of the Interior
U.S. Geological Survey

Cover. Watercolor by James Gay Sawkins made in 1851, titled “Panoramic view of the crater of Kilauea” (detail of two of seven panels). Image courtesy of the National Library of Australia. Image was digitally modified to remove crease mark.

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By Ben Gaddis and Jim Kauahikaua

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Views of a Century of Activity at Kīlauea Caldera—A Visual Essay

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Abstract

The 2018 eruption of Kīlauea Volcano marked the end of the first sustained period of volcanic activity at Halemaʻumaʻu Crater in 94 years. The views of the lava lake (informally named "Overlook," nestled within Halemaʻumaʻu) lasted for a decade and seemed timeless. But as we were recently reminded, the summit of Kīlauea is part of a dynamic system that has provided countless new views to observers over the centuries.

This visual essay features a few of the many scenes recorded by early observers at the volcano, from the first visits by westerners in 1823 through the explosive eruption of 1924. The early images left by casual visitors, artists, and photographers raise many questions: What is shown? Where is this? Who captured the scene and when? How accurate is the portrayal? Where possible, we attempt to answer these questions and provide interpretations of the images featured. Additional image details and support for our conclusions can be found in appendix 1.

In 1912, the nature of observations at Kīlauea changed when Thomas A. Jaggar, Jr., and others occupied the Hawaiian Volcano Observatory (HVO) on a full-time basis. They began a visual and written record of what they saw, heard, and experienced that has continued to this day. We describe some of the early work of these scientists and photographers, and showcase the results.

We conclude the essay with scenes of the explosive eruption of Halemaʻumaʻu Crater in 1924, which marked the end of more than a century of lava-lake activity at Kīlauea.

Early Views of Kīlauea Crater

A prolonged period of episodic explosive activity at Kīlauea Volcano has been preserved in the Keanakākoʻi Tephra, a thick unit deposited during centuries of explosive activity at the summit. Hawaiian observers who experienced these events may have recorded their impressions in oral chants and traditions, some versions of which were later committed to print (Jaggar, 1921a; Swanson, 2008; Kanahele, 2011). Some insights on the volcanic events of this period can be found in the stories of the people who left their footprints in the ash of Kīlauea (Swanson and others, 2015).

The first western depiction of the summit of Kīlauea Volcano (fig. 1) was provided by William Ellis, a member of a missionary deputation that explored the Island of Hawaiʻi in 1823. He described the caldera floor as "an immense gulf, in the form of a crescent, about two miles [3 kilometers (km)] in length, from north-east to south-west, nearly a mile [1.5 km] in width, and apparently 800 feet [240 meters] deep." Later measurements suggest that it was much deeper. See Mastin (1997) for a discussion. Ellis vividly describes the activity in Kīlauea (Ellis, 1826, p. 207):

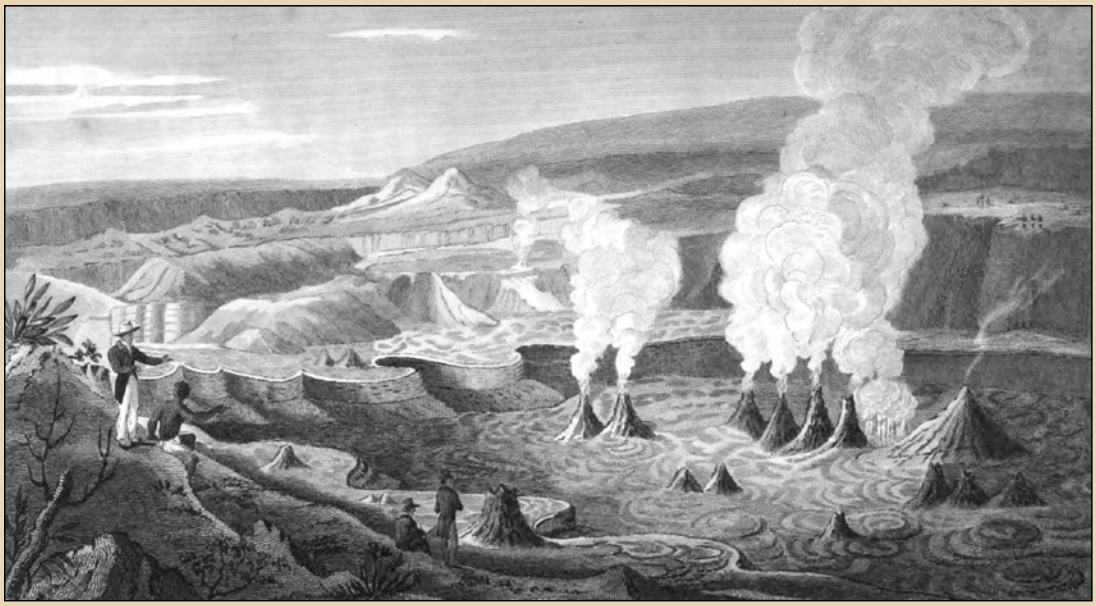

Figure 1. Print from an engraving made from a sketch by William Ellis in 1823 titled "The South-West End of the Volcano of Ki-rau-e-a" [Kīlauea].

> The bottom was covered with lava, and the south-west and northern parts of it were one vast flood of burning matter, in a state of terrific ebullition. . . . Fifty-one conical islands, of varied form and size, containing so many craters, rose either round the edge or from the surface of the burning lake. Twenty-two constantly emitted columns of grey smoke, or pyramids of brilliant flame; and several of these at the same time vomited from their ignited mouths streams of lava, which rolled in blazing torrents down their black indented sides into the boiling mass below.

A horizontal ledge of solidified lava extended completely around the crater above the "burning lake" (Ellis, 1826, p. 207). All sources appear to agree that this feature, called the "black ledge," was located approximately halfway between the crater's rim and the lava lakes within it.

In 1825, Lord Byron visited the volcano, and Robert Dampier, an artist in his group, provided what appears to be a more realistic view of Kīlauea Caldera (fig. 2). Again, a "black ledge" is shown around a very large and active lava lake. Black ledges are remnants of a solidified lava lake or stacked lava flows that remain around the margin of a collapsed area, leaving a flat "bathtub" ring of lava below the rim of the crater. The Byron party also noted that the focus of activity in the caldera appeared to be located at the southwest end (Byron, 1826), in the area where the crater of Halemaʻumaʻu was later identified.

Both Ellis and Dampier depict the caldera floor as punctuated by features variously called "conical islands," "blowing cones," or "spiracles" (Ellis, 1826; Dana, 1890; Hitchcock, 1909). Were these structures associated with a deep-seated magma source or were they landforms of a smaller scale, such as the rootless shields, shatter rings, and hornitos recently observed during the Puʻu ʻŌʻō-Kupaianaha eruption (Tilling and others, 2014)? The small-scale landform explanation seems more likely, but we cannot be sure.

In the first half of the 19th century, the caldera partly drained and filled on several occasions, overtopping the preexisting black ledge. Each time lava drained, a new black ledge was left around its rim (Wright and Klein, 2014).

One of the largest of these events occurred in May of 1840, when an eruption on the East Rift Zone of Kīlauea produced an extensive lava flow that reached the sea at Nānāwale Bay in the Puna District. As magma drained leaving a deep depression or inner pit in the floor of the caldera, numerous earthquakes shook the summit of the volcano, but were not felt elsewhere (Dana, 1890).

Months later, the U.S. Exploring Expedition visited the summit of the volcano and Joseph Drayton, an artist within the group, used a camera lucida (an optical device that assisted the artist in capturing a relatively accurate perspective) to make a sketch of Kīlauea Caldera. The print from the engraving made from Drayton's drawing shows the caldera from the north rim, surrounded by a new, wide, black ledge with a depressed inner pit (fig. 3). Visible in the distance (to the left) is Kīlauea Iki Crater. The artist depicts what appears to be Halemaʻumaʻu Crater, filled with fume, at the far end of the inner pit (Appleman, 1987, p. 1,608).

In 1851, James Gay Sawkins, a geologist and artist, painted what is probably the most realistic representation of Kīlauea in the 19th century (Forbes, 1991). In his watercolor, Sawkins meticulously depicted a wide panorama from the north. The watercolor features a complete view of the caldera, the surrounding denuded countryside, and a thatched hut for visitors near the crater rim. We focus on details of the caldera in two of the painting's seven panels (fig. 4).

By the time Sawkins made his sketch, the inner pit of the caldera had risen at least 45 meters (m) (about 150 feet [ft]) above the rest of the floor, forming a plateau bounded by a ring of angular blocks. The watercolor shows this plateau, surrounded by the brown ring of fragmented material. Observers at the time recognized that the elevated feature might have been partially formed through endogenous uplift (Lyman, 1851, p. 77).

Halemaʻumaʻu (shown fuming in the distance) had become a raised dome about 60 to 90 m (200 to 300 ft) high (Coan, 1851, p. 81). In his account of the visit, the artist described a lava lake, 30 m (100 ft) in diameter, which topped the dome (Sawkins, 1851). A light patch on the left side of the

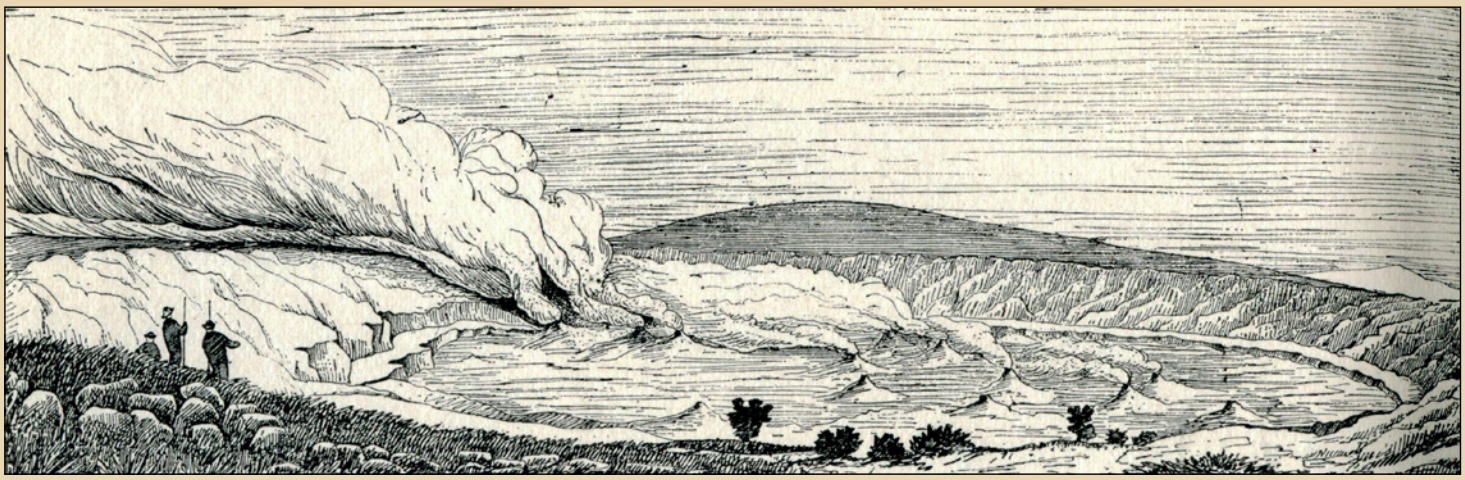

Figure 2. Print from an engraving made from a sketch by Robert Dampier in 1825 titled "Great Volcano of Peli, at Hawaii."

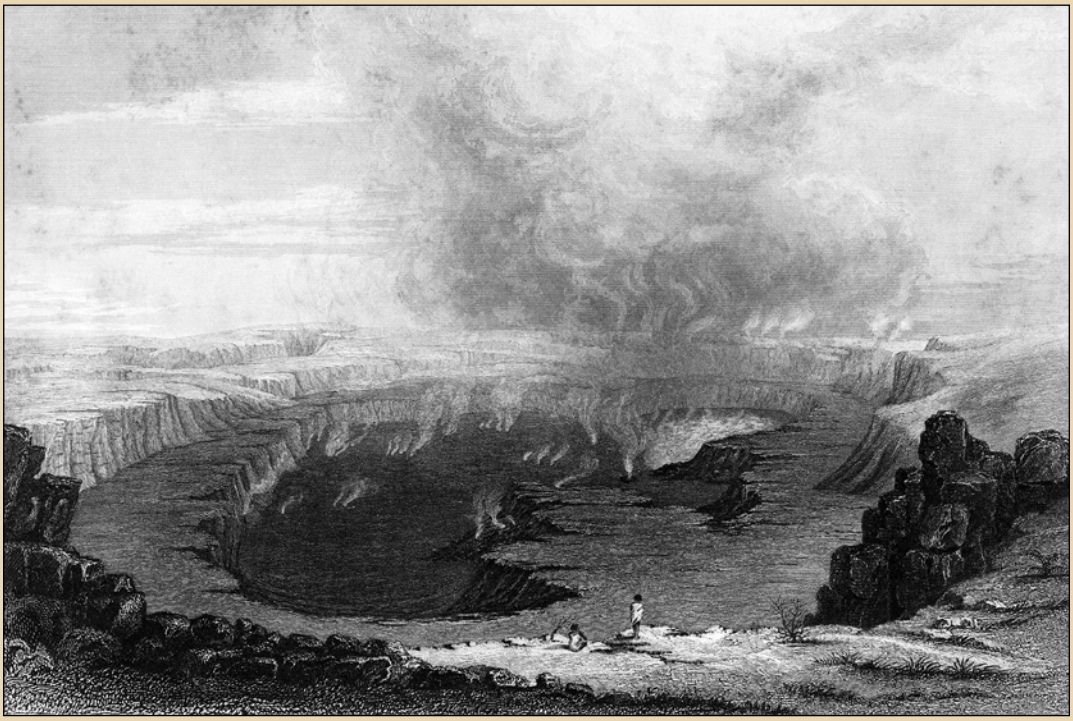

Figure 3. Print from an engraving made from a sketch by Joseph Drayton in 1841 titled "View of Crater Kilauea."

caldera wall appears to show the southern Sulphur Bank. This feature was covered by the filling of the crater in the later half of the 19th century but was exhumed and restored to its former glory by the collapse of the caldera floor in 2018.

According to Titus Coan, conditions at Kīlauea Crater remained in a state of "steaming stupefaction" through 1852 (Coan, 1852), but three years later, he reported the situation had changed (Coan, 1856, p. 100–101):

> The great dome is thundering and throwing up columns of dashing fusion from its horrid throat to a height of 200 feet [about 60 m], while its walls tremble at the fury of those waves which rage and dash within. . . . The whole of the surrounding belt, from its periphery at the base of the great walls of Kilauea, to the elevated central platform—and over eight miles [nearly 13 km] in circumference by half a mile [about 0.75 km] in diameter, is in a state of intense activity. Over this surface I could count sixty lakes of fusion whose flaming fires were sparkling, and surging, and dashing, and leaping in the most fantastic and brilliant manner, exceeding all that pen or pencil can paint.

An important new medium did provide a view. A daguerreotype made in the later part of 1855 (fig. 5) provides the first known photograph of Kīlauea Crater (Davis, 1980). The view of the image appears to be from Waldron Ledge looking toward the southwest. If so, the area of intense activity shown in the image may be the dome described by Coan with the "lakes of fusion" spreading to the east.

Figure 4. Watercolor by James Gay Sawkins made in 1851, titled "Panoramic view of the crater of Kilauea" (detail of two of seven panels). Image courtesy of the National Library of Australia. Image was digitally modified to remove crease mark.

Figure 5. Daguerreotype of Kīlauea Caldera by Hugo Stangenwald made in 1855. Image courtesy of the Hawaiian Mission Houses Historic Site and Archives.

Between 1864 and 1865, William T. Brigham visited Kīlauea (Brigham, 1909). He described the caldera and furnished a detailed map showing repeated overflows that had overtopped the plateau depicted by Sawkins, leaving only remnants of the ring of angular blocks to mark its former location (Brigham, 1868, plate XV).

In 1868, a great earthquake occurred in Kaʻū District, the southernmost district of the Island of Hawaiʻi. During this episode, the floor in the central part of Kīlauea's caldera collapsed again, forming another inner pit. This pit gradually filled as overflows from Halemaʻumaʻu spilled out onto the caldera floor (Wright and Klein, 2014).

In 1875, a photographer from the H.M.S. Challenger captured a panoramic view of the caldera, with a view to the southwest (fig. 6). The photograph appears to show fresh lava filling the central depression before the last evidence of the caldera's collapse was covered.

After the 1868 collapse, volcanic activity was largely confined to the Halemaʻumaʻu area in the southwest part of the caldera. The remainder of this essay will focus on views of this region.

The Halemaʻumaʻu Cluster

A print discovered in Hawaiian Volcano Observatory's (HVO) photograph collection (fig. 7) appears to be the earliest known photograph of Halemaʻumaʻu Crater and the southwest caldera area of Kīlauea. The image shows the crater with an active lava lake, backed by a cliff 10–15 m high. This cliff does not appear in any other illustration of the area and could be a caldera fault or a remnant of a wall from another crater. The white patches to the left of the fuming crater may be sulfur deposits that formed part of the southern Sulphur Bank.

The scene depicted in the photograph seems consistent with the state of the summit caldera before Kīlauea Crater drained in 1868. William T. Brigham took photographs at the summit in August 1865 and complained about the effect of fume on the wet-plate photographic process (Brigham, 1909, p. 89). But was the image his?

All we know for sure is that Princess Bernice Pauahi Bishop presented a photograph album that included a copy of this print as a gift on November 23, 1878. We are left to speculate about the date the photograph was taken and the identity of the photographer. See appendix 1 for additional information about this image.

Throughout its recorded history, the Halemaʻumaʻu area has undergone periods of uplift of the crater floor well above its lava lakes. For example, figure 8 shows a feature known as Cathedral Rock rising about 91 m (300 ft) above the surface of the lava lake in Halemaʻumaʻu Crater.

Figure 6. Photograph titled "Crater of Kilauea, Mona Loa," taken in 1875 by Jesse Lay, a photographer for the H.M.S. Challenger expedition. View is of Kīlauea Caldera to the west toward Halemaʻumaʻu. Image courtesy of Bernice Pauahi Bishop Museum, Library & Archives. Image was digitally modified to remove crease mark.

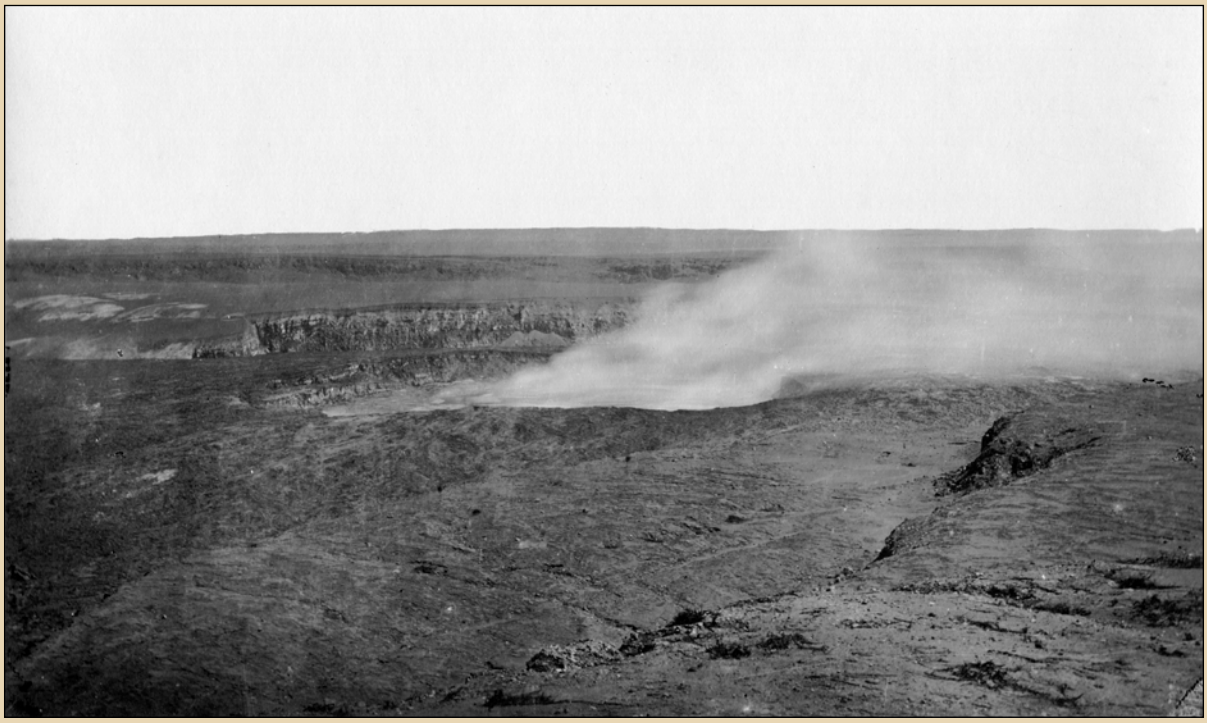

Figure 7. Photograph of the Halemaʻumaʻu area from Uēkahuna Bluff. Photographer unknown, date circa 1860–78. Print from the Hawaiian Volcano Observatory.

Figure 8. Photograph of Cathedral Rock in Halemaʻumaʻu Crater, taken by Eduard Arning on September 18, 1885. Print from the Hawaiian Volcano Observatory.

At other times, all lava lakes disappeared as summit lava drained, commonly accompanied by East Rift Zone intrusions and earthquake swarms (Wright and Klein, 2014). Figure 9 shows the gaping pit of Halemaʻumaʻu Crater after magma drained from the summit during an apparent intrusion in 1886.

At times, instead of the single crater, the area around Halemaʻumaʻu hosted multiple lava lakes (figs. 10 and 11). H.M. Whitney was probably correct in noting, "All the lakes which occasionally appear, such as South, New, Dana lakes, and others have all been located in what has been termed the 'Halemaumau cluster,' and are simply different vents of the same subterranean volcanic chimney of Halemaumau. . . ." (Whitney, 1891, p. 5).

Confusion has lingered for more than a century about the name "Dana Lake." When James D. Dana visited Kīlauea Volcano for the second time in August 1887, he found that a large debris-cone had risen high above the basin of Halemaʻumaʻu (Dana, 1890, p. 113):

> The cone was found to be literally a debris-cone, not a lava-cone or cinder-cone in any part; and the debris was like that of fallen walls of lava, not of loose scoria such as might have come from the central vent of a cone. No eruptions of lava or scoria from the central depression had been at any time observed, and there was no evidence visible over the surface that any such ejections had taken place.

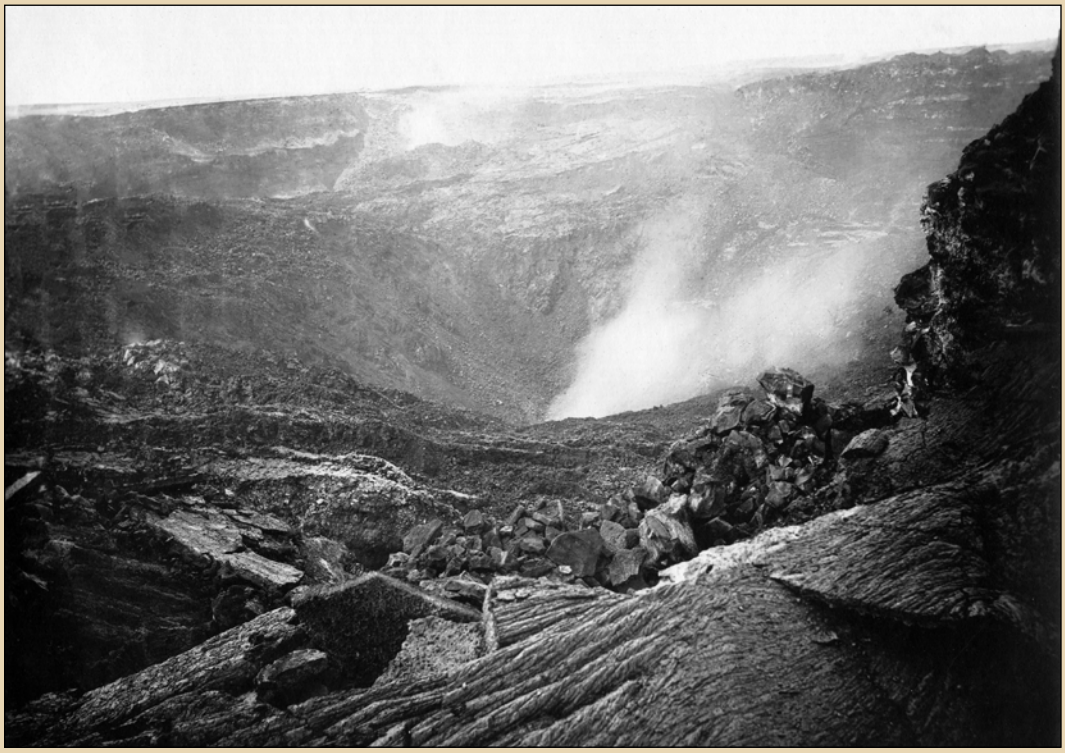

Figure 9. Photograph of subsidence at Halemaʻumaʻu after the earthquake of 1886. From the photographic studio of J.J. Williams. Print from the Hawaiian Volcano Observatory.

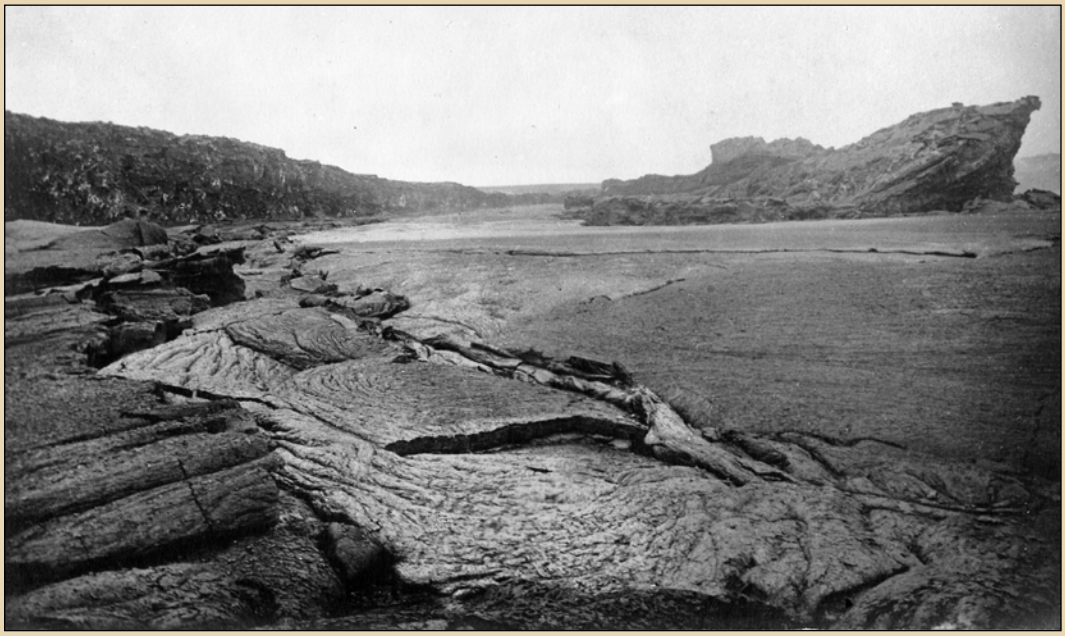

Figure 10. Photograph of "New Lake," taken by Eduard Arning on September 18, 1885. Print from the Hawaiian Volcano Observatory.

Figure 11. Photograph titled "Dana Lake from the north, 1890," from the photographic studio of J.J. Williams. Photograph courtesy of the National Park Service, Hawai'i Volcanoes National Park.

To the west, Dana's party found a small, active lava lake (later named in honor of the famous geologist). By July 1889, the debris cone described by Dana had risen about 60 m (200 ft) above the floor of a triangular depression in the Halemaʻumaʻu area. Dana Lake remained active to the west of the depression (Dana, 1890, p. 113–123).

The debris cone at Halemaʻumaʻu collapsed in March 1891, leaving a pit 210 m (700 ft) deep. By the time Sereno Bishop visited Kīlauea in April 1892, the Halemaʻumaʻu area was a huge, nearly circular pit about 730 m (2,400 ft) in diameter, and Dana Lake was gone (Bishop, 1892).These changes are well illustrated in a series of plans and sections of Halemaʻumaʻu by Frank S. Dodge (fig. 12).

Between 1892 and 1894, a new lake rose within the crater, and the name Halemaʻumaʻu was applied to the feature once again. A perched lava pond formed at the crest of a dome-like structure that rose more than 120 m (400 ft) in two years (Castle, 1893).

In 1893, Henry C. Lyons wrote a letter to the Hawaiian Gazette describing a visit to Halemaʻumaʻu Crater by a tour group called the Raymond and Whitcomb party (fig. 13). He noted that the entire crater of Halemaʻumaʻu covered more than 100 acres (40 hectares [ha]) and had risen at the rate of more than 3 m (10 ft) a month, or about 40 m (125 ft), during the previous year. He estimated that the lake of molten lava covered nearly 15 acres (6 ha). Lyons also described the accommodations for volcano viewers at the time (Lyons, 1893, p. 7):

> Thanks to the enterprise of Peter Lee, the able manager for the Volcano House Company, we were able to mount our horses at the door of the hotel and ride with perfect ease and safety over a trail directly to the edge of Halemaumau, three miles, where we found not only a most excellent house for our comfort, but also a well-built stable for our horses. A telephone is the latest addition to this house, and you can now talk to your friends in any part of Hawaii and report every new "flop" which Madame Pele gives to the seething cauldron just below you.

Photographer Joaquin A. Gonsalves also took a photograph of a perched lava pond, which he identified as Dana Lake (fig. 14). The photograph became one of the iconic images of Kīlauea from the 19th century. However, it appears likely that Gonsalves mislabeled his print, leaving a legacy of misinformation about the feature. Rather than Dana Lake, the crater and lava pond shown in the Gonsalves image are, instead, the perched lava pond at Halemaʻumaʻu that appeared after Dana Lake was destroyed (see fig. 13).

In 1894, the perched lava pond and dome in Halemaʻumaʻu Crater collapsed again. Between 1894 and 1905, the crater continued to deepen, and lava was visible only infrequently (Wright and Klein, 2014). In 1906, the lava lake level in the crater began to rise as a gradual influx of magma brought the lake surface to less than 30 m (100 ft) below the rim. In 1909, during his first visit to Kīlauea, Thomas A. Jaggar, Jr., reported that the surf-like roar of the fountains in Halemaʻumaʻu Crater were loud enough to be heard at the Volcano House hotel two miles away (Jaggar, 1947, p. 91). Figure 15 shows the appearance of the lava lake at about that time.

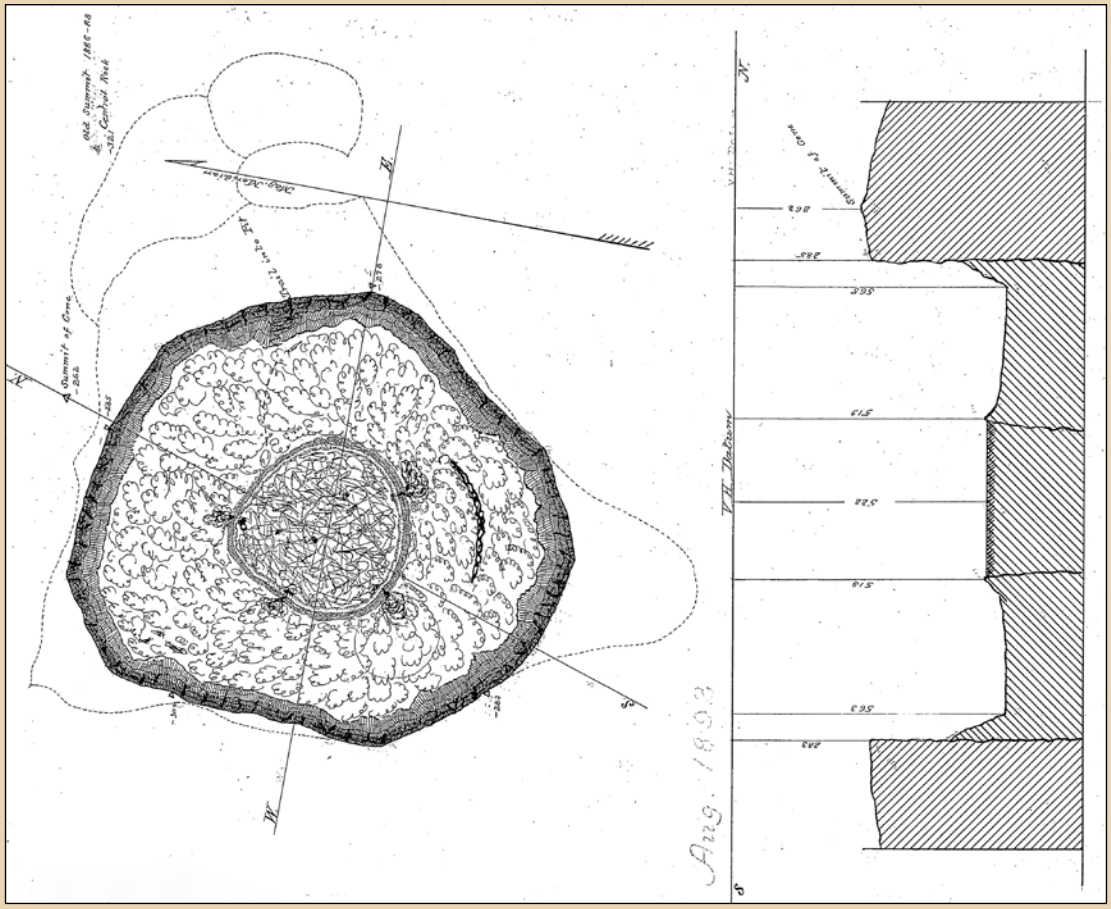

Figure 12. Maps and cross sections of Halema'uma'u Crater by F.S. Dodge. *A*, Map and cross section of Halema'uma'u, drafted by F.S. Dodge in July 1888. *B*, Map and cross section of Halema'uma'u, drafted by F.S. Dodge in August 1892. Images courtesy of the Hawaii State Survey Division.

Figure 13. Photographs of the Raymond and Whitcomb party making lava specimens at Halema‘uma‘u Crater, April 1, 1893. Prints from the Hawaiian Volcano Observatory.

Figure 14. Photograph titled “Lava Flow on Dana Lake” (actually, Halema‘uma‘u), taken by J.A. Gonsalves, circa 1893. Photograph courtesy of the Hawai‘i State Archives.

Observations by Members of the Hawaiian Volcano Observatory

The turn of the century brought a new era of monitoring to Kīlauea Volcano when Thomas A. Jaggar, Jr., began his efforts to secure funding for a permanent scientific observatory in Hawaii. As a result, in 1911, Frank A. Perret, a prominent American volcanologist who had studied eruptions in Italy and the Caribbean, came to Hawaii and observed Kīlauea Volcano for many months. By that time, another subsidence had lowered the level of the lava lake in Halemaʻumaʻu Crater to about 450 ft (135 m) below its rim (Jaggar, 1947).

Perret constructed a small structure called the "Technology Station," named for its funding agency, the Massachusetts Institute of Technology (fig. 16). He took photographs from this perch on the rim of Halemaʻumaʻu Crater and issued regular reports to the public about the volcanic activity he observed (Tilling and others, 2014).

In 1912, Jaggar moved to Hawaii and became the first full-time Director of the newly formed HVO. Upon his arrival, he established a routine of daily observations of the ongoing eruption in Halemaʻumaʻu Crater. He developed uniform note pads with detachable sheets for use by all employees and insisted that anyone from the observatory who visited the crater take notes of their observations (Jaggar, 1956). For decades, staff and volunteers at the observatory faithfully recorded what they saw and measured at Kīlauea.

These notes and sketches, along with any related photographs, were carefully copied into binders called Record Books (figure 17). The Record Books formed the basis for published newspaper reports and periodic scientific publications, such as the Weekly Bulletin, Monthly Bulletin, and The Volcano Letter. These reports were compiled into four volumes and republished on the 75th anniversary of the founding of HVO (Fiske and others, 1987; Bevens and others, 1988).

Subsequently, the Technology Station was relocated and improved, and a structure called the "Instrument Shelter" (extending over the rim of Halemaʻumaʻu) was built with a wall open to the crater for a wide-angle view (figs. 18–20).

Figure 16. Photograph of Halemaʻumaʻu Crater, with the Technology Station (red arrow) on the rim, taken by Frank Perret in August 1911. Print from the Hawaiian Volcano Observatory.

Figure 15 (pages 10 and 11). Photographs of Halemaʻumaʻu Crater, taken by Ernest Moses on November 26, 1909. Prints from the Hawaiian Volcano Observatory. Images were digitally modified to remove crease mark.

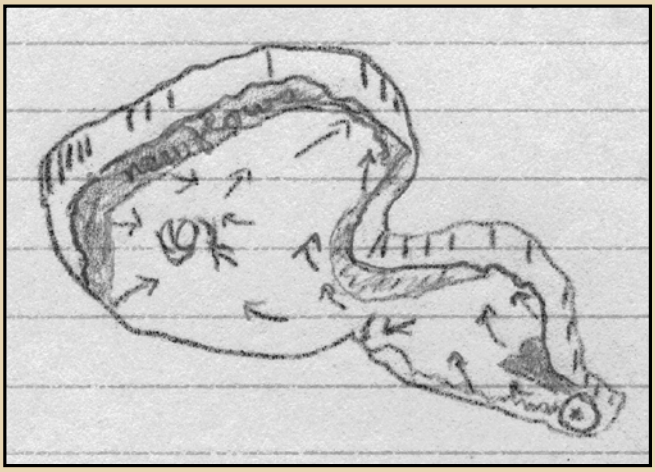

Figure 17. Photograph and sketch by T.A. Jaggar, Jr., made on January 17, 1913. *A*, A Record Book photograph of the east end of Halema‘uma‘u Crater. *B*, A Record Book sketch of the same scene showing lava lake features and flow directions. Images courtesy of Bernice Pauahi Bishop Museum, Library & Archives.

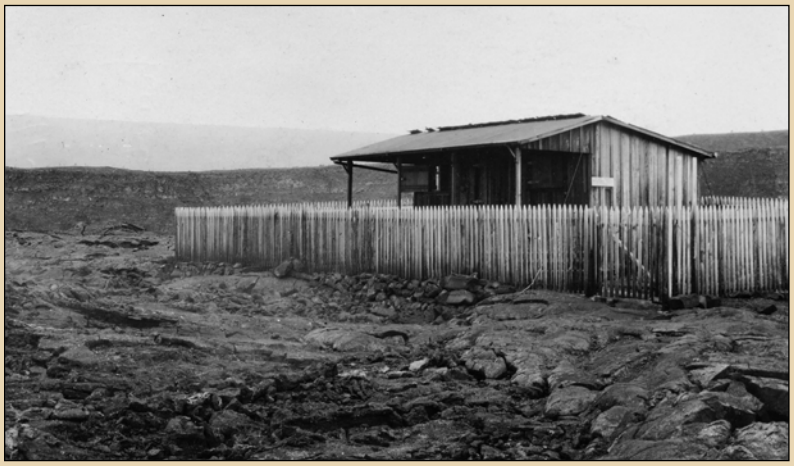

Figure 18. Photograph titled “The Technology Station,” taken by T.A. Jaggar, Jr., on January 14, 1913. Image from the Hawaiian Volcano Observatory Record Book for 1913. Photograph courtesy of Bernice Pauahi Bishop Museum, Library & Archives.

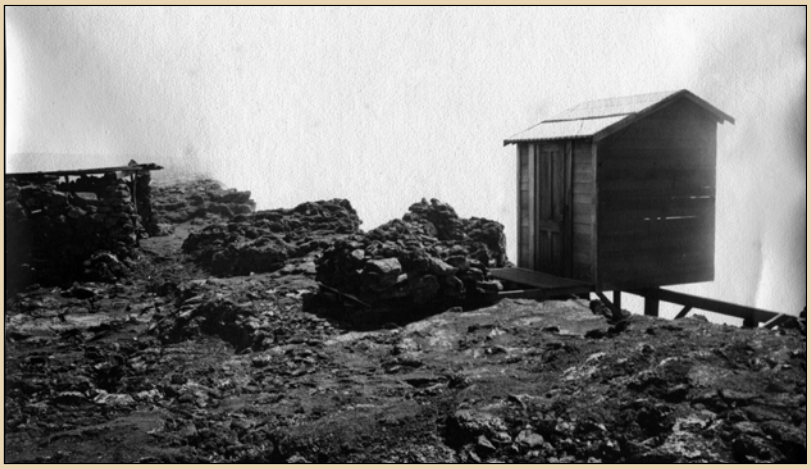

Figure 19. Photograph titled "The Instrument shelter," taken by T.A. Jaggar, Jr., on October 5, 1913. Image from the Hawaiian Volcano Observatory Record Book for 1913. Photograph courtesy of Bernice Pauahi Bishop Museum, Library & Archives.

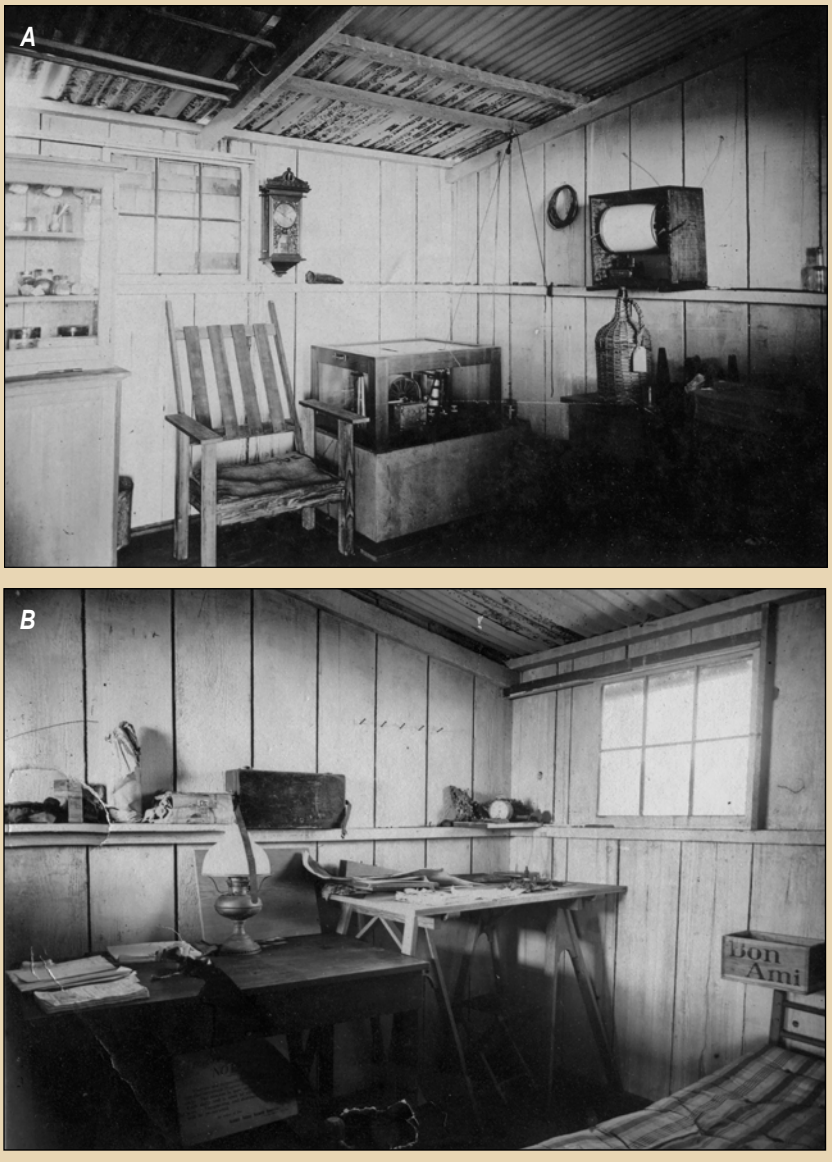

Figure 20. Photographs from the interior of the Technology Station taken by T.A. Jaggar, Jr., on October 5, 1913. *A*, Photograph showing the seismograph room. *B*, Photograph showing the bedroom. Images from the Hawaiian Volcano Observatory Record Book for 1913 (courtesy of Bernice Pauahi Bishop Museum, Library & Archives).

During the second decade of the 20th century, Jaggar and other observatory scientists captured spectacular views of Halemaʻumaʻu as lava lakes within the crater repeatedly rose and fell (fig. 21). The lake level of Halemaʻumaʻu overtopped the caldera floor at times. Huge slabs of congealed lava crust, which Jaggar called "crags," rose above the molten lake, providing spectacular sights for visitors (fig. 22).

When Jaggar described such scenes, he commonly employed language evocative of water bodies, such as in his description of the photograph in figure 23, "Halemaumau from the north rim, forenoon of September 20, 1921. North pool, connected with main lake, seen cracking and foundering in the foreground. Spire of Northwest Peak on the right. South Crag in the distance" (Jaggar, 1921b).

The end of 1923 brought a new era of photography to Hawaii's volcanoes, when the 11th Photo Section of the U.S. Army Air Corps conducted a successful airplane flight to the Island of Hawaiʻi. Part of an area of the caldera informally known as "Sand Spit" was converted into a landing field for the aircraft. Flyers used large, wide-format cameras to capture high-resolution aerial oblique photographs of the volcano (Honolulu Advertiser, 1923).

Figures 24*A* and 24*B* are from a group of the first aerial photographs of Kīlauea's caldera. The images show the landing field at Sand Spit with parked biplanes and a narrow automobile road leading to a circular turnaround at the edge of Halemaʻumaʻu Crater. Uēkahuna Bluff can be seen in the distance. Such high-resolution military photographs were carefully collected at HVO.

Figure 21. Photograph of the inner lava lake of Kīlauea Volcano after the subsidence of molten lava left a terrace, taken by T.A. Jaggar, Jr., on March 30, 1917. From the Hawaiian Volcano Observatory Record Book for 1917. Photograph courtesy of the U.S. Geological Survey Library, Reston, Virginia.

Figure 22. Photograph of visitors observing a fresh overflow of the rim from the central pond of Halema‘uma‘u Crater, taken by T.A. Jaggar, Jr., on February 22, 1918. From the Hawaiian Volcano Observatory Record Book for 1918. (Courtesy of the U.S. Geological Survey Library, Reston, Virginia.)

Figure 23. Photograph titled “Central Lake from the North Station,” taken by T.A. Jaggar, Jr., on September 20, 1921. Image from Hawaiian Volcano Observatory Record Book for 1921. Photograph courtesy of the U.S. Geological Survey Library, Reston, Virginia.

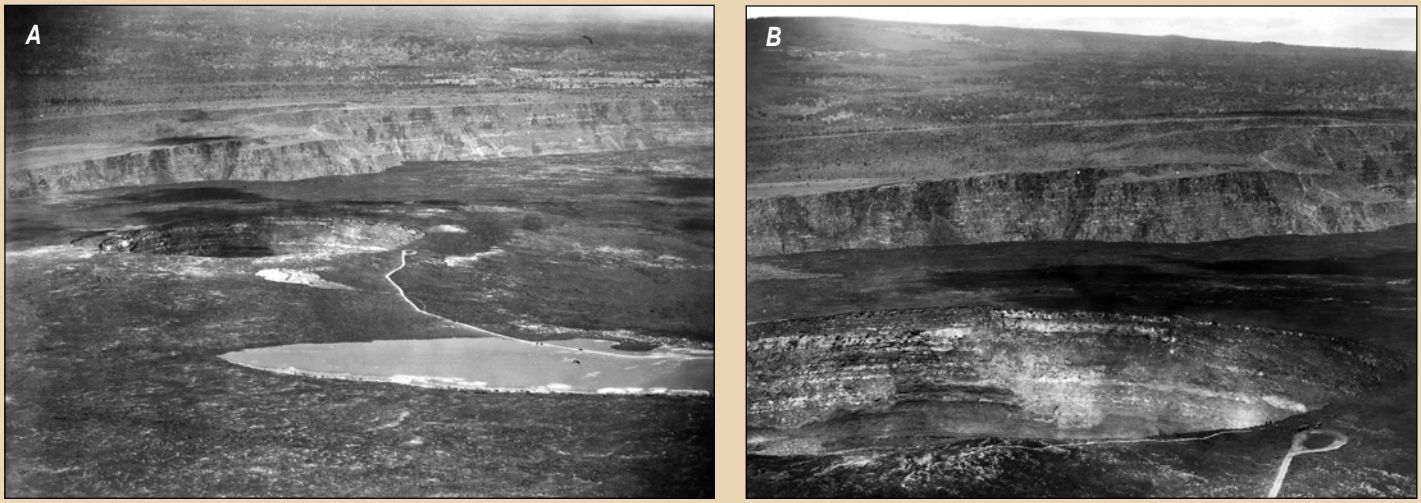

Figure 24. Photographs of Kīlauea Caldera taken by the 11th Photo Section of the U.S. Army Air Corps, November 9, 1923. *A*, Photograph titled "Landing Field and Fire Pit." *B*, Photograph titled "Kilauea from the southwest." Photographs Courtesy of the National Archives, Airscapes Collection, Hawaii.

The Explosive End of an Era

The lava lake in Halemaʻumaʻu drained in February 1924, and, in April, magma from the summit intruded into the East Rift Zone of Kīlauea Volcano, causing gaping cracks and severe subsidence at Kapoho. However, by the end of the month, perceptible activity in that area had tapered off. At the summit, Halemaʻumaʻu Crater began to collapse. By May 10, the size and frequency of dust clouds and avalanches had increased tremendously (fig. 25). Later, scientists at the observatory marked May 10 as the first day of the explosive eruption.

On May 13, Thomas R. Boles, Superintendent of Hawaii National Park, and others were near the rim of Halemaʻumaʻu Crater when an explosion showered the party with hot rocks (fig. 26). Boles and others were injured. As a result, new restrictions were placed on public access to the park (Belknap, 1924).

Sometimes records and photographs intended for scientific use capture human drama. On May 18, 1924, Ruy Finch (acting Director of HVO) watched the eruption from the southern edge of the airplane landing field at Sand Spit on the south side of the caldera. Suddenly, one of the most powerful explosions of the eruption occurred. Despite warnings to stay away, more than a dozen sightseers were near Halemaʻumaʻu Crater at the time.

Finch provided an account of what happened in the HVO Record Book:

> A wave of increased air pressure that distinctly hurt my head was felt at 11:09 a.m. I jumped and exclaimed, "Here comes a terrible one". Started to take picture but saw rocks of great dimension high in the air headed toward our locality. Ran to cliff and slid down a wash. A rock, judging from its air appearance to have weighed about 300 lb., cleared the cliff and landed on 1921 lava

Figure 25. Photograph titled "Dust cloud at pit from Crater Trail." One of the first photographs of the eruption cloud from Halemaʻumaʻu Crater, taken on May 10, 1924, by Ruy Finch. Image from Hawaiian Volcano Observatory Record Book for 1924 (courtesy of Bernice Pauahi Bishop Museum, Library & Archives).

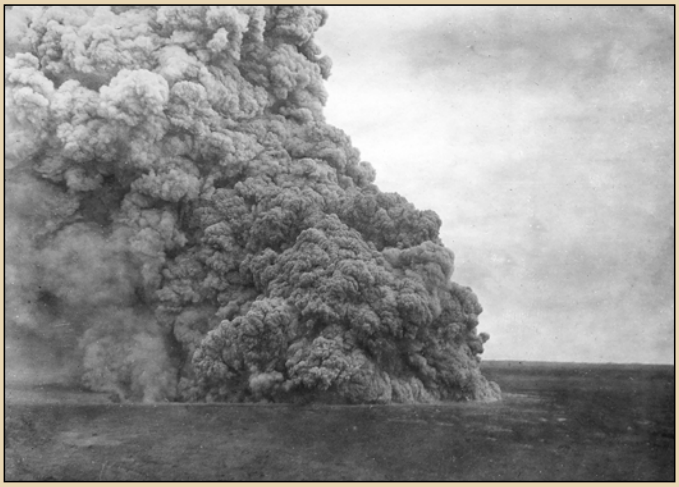

Figure 26. Photograph of the explosion from Halemaʻumaʻu Crater, taken by Ruy Finch from Uēkahuna Bluff at 4:00 p.m., May 13, 1924. Image from Hawaiian Volcano Observatory Record Book for 1924 (courtesy of Bernice Pauahi Bishop Museum, Library & Archives).

[behind Finch]. . . . Climbed cliff and took picture of 11:14 a.m. explosion (Finch, 1924).

Photographs by Finch capture two sightseers, first sitting at 11:00 a.m., before the largest blast occurred, and then running for their lives at 11:14 a.m. (figs. 27 and 28).

Finch's account of this incident in the HVO Record Book captures the moment well, but he does not mention the spectators shown in his photographs. The published account in the Monthly Bulletin for May 1924 also omits many dramatic details (Jaggar, 1924a, p. 45).

The explosions of May 18 tossed an eight-ton ballistic block onto the landing field more than 1,000 m (3,200 ft) from Halemaʻumaʻu Crater, forming a deep impact cavity. Showers of ballistic blocks, lapilli, and coarse ash fell on the caldera floor, fatally injuring one observer (fig. 29).

Between May 10 and 27, 1924, scientists and volunteers at HVO recorded 580 felt earthquakes, 22 electrical storms, and 53 explosions from Halemaʻumaʻu Crater, 35 of which ejected ballistic material (fig. 30; Jaggar, 1924a, p. 52).

By May 31, the eruption was over, and scientists were finally able to measure the changes at Kīlauea caused by the May eruption. Jaggar observed that the rim of Halemaʻumaʻu Crater "remained an irregular oval with edges that had gone back about equally in all directions." The crater had almost doubled in diameter, and the lowest part of its flat bottom was found to be more than 400 m (1,335 ft) below a station on the eastern rim (fig. 31; Jaggar, 1924b, p. 71).

Even more surprising was a less obvious change—the summit of the volcano had dropped substantially. Measurements taken after the eruption showed that during an interval between 1922 and 1926, the Volcano House benchmark had dropped more than 1 m (3 ft), whereas the east rim of Halemaʻumaʻu had dropped almost 4 m (13 ft). Most of this subsidence probably occurred during the 1924 eruption (Waesche, 1937).

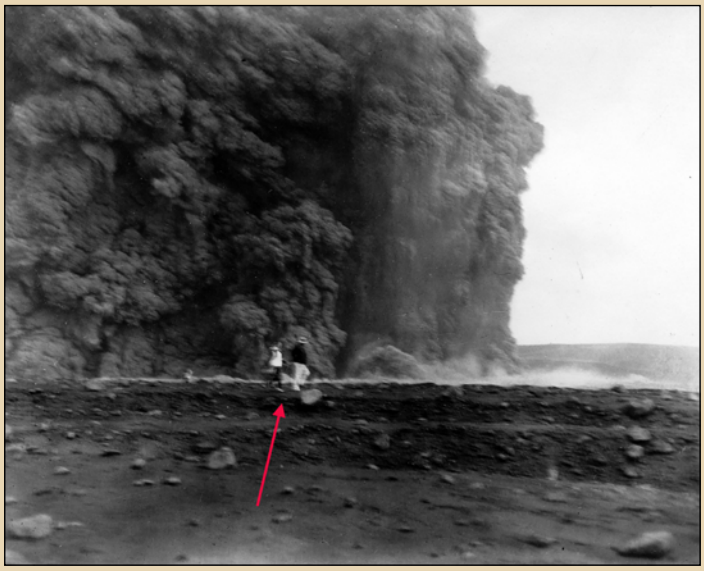

Figure 28. Photograph titled "Explosion cloud from same place at 11:14," taken by Ruy Finch on May 18, 1924. Image from Hawaiian Volcano Observatory Record Book for 1924. Arrow pointing to the spectators added. Photograph courtesy of Bernice Pauahi Bishop Museum, Library & Archives.

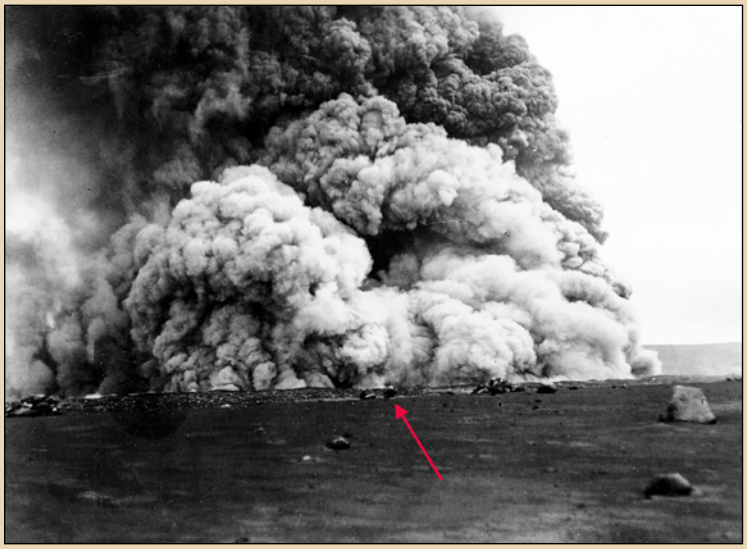

Figure 27. Photograph titled "Just before big 11:09 a.m. explosion," taken by Ruy Finch at 11:00 a.m. on May 18, 1924. Image from Hawaiian Volcano Observatory Record Book for 1924. Arrow pointing to the spectators added. Photograph courtesy of Bernice Pauahi Bishop Museum, Library & Archives.

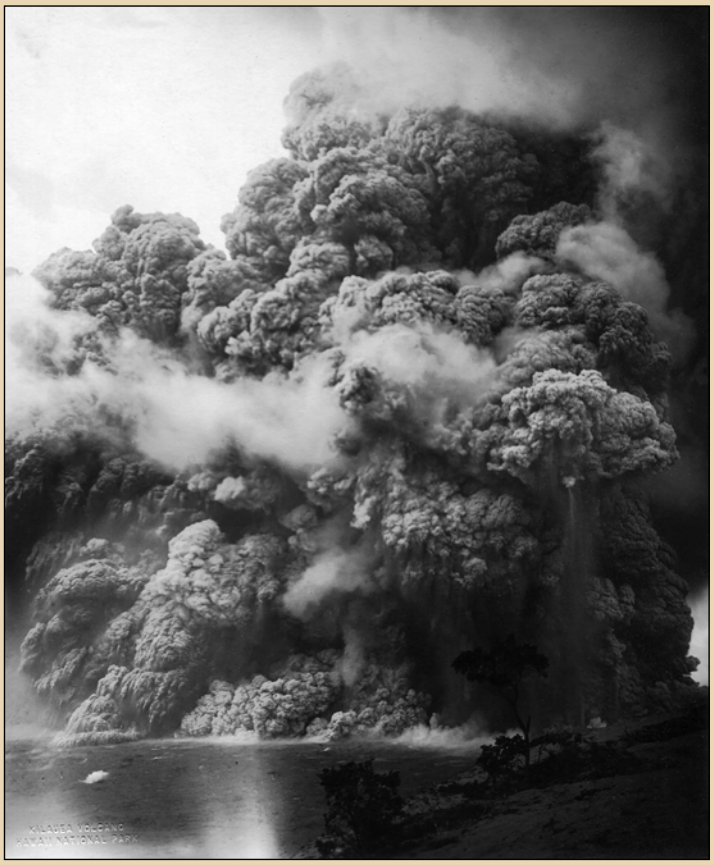

Figure 29. Photograph of the explosion from Uēkahuna Bluff at 11:15 taken by Kenichi Maehara on May 18, 1924. Photograph courtesy of the James Tsuchiya family.

Figure 30. Photograph titled "Eight-ton block on the airplane field," taken by Oliver Emerson on May 22, 1924. Geologists Harold Stearns and W.O. Clark stand by the ballistic block, thrown about 1,000 meters (3,300 feet) from Halemaʻumaʻu Crater on May 18, 1924 (Emerson, 1924). Image from Hawaiian Volcano Observatory Record Book for 1924. Photograph courtesy of Bernice Pauahi Bishop Museum, Library & Archives.

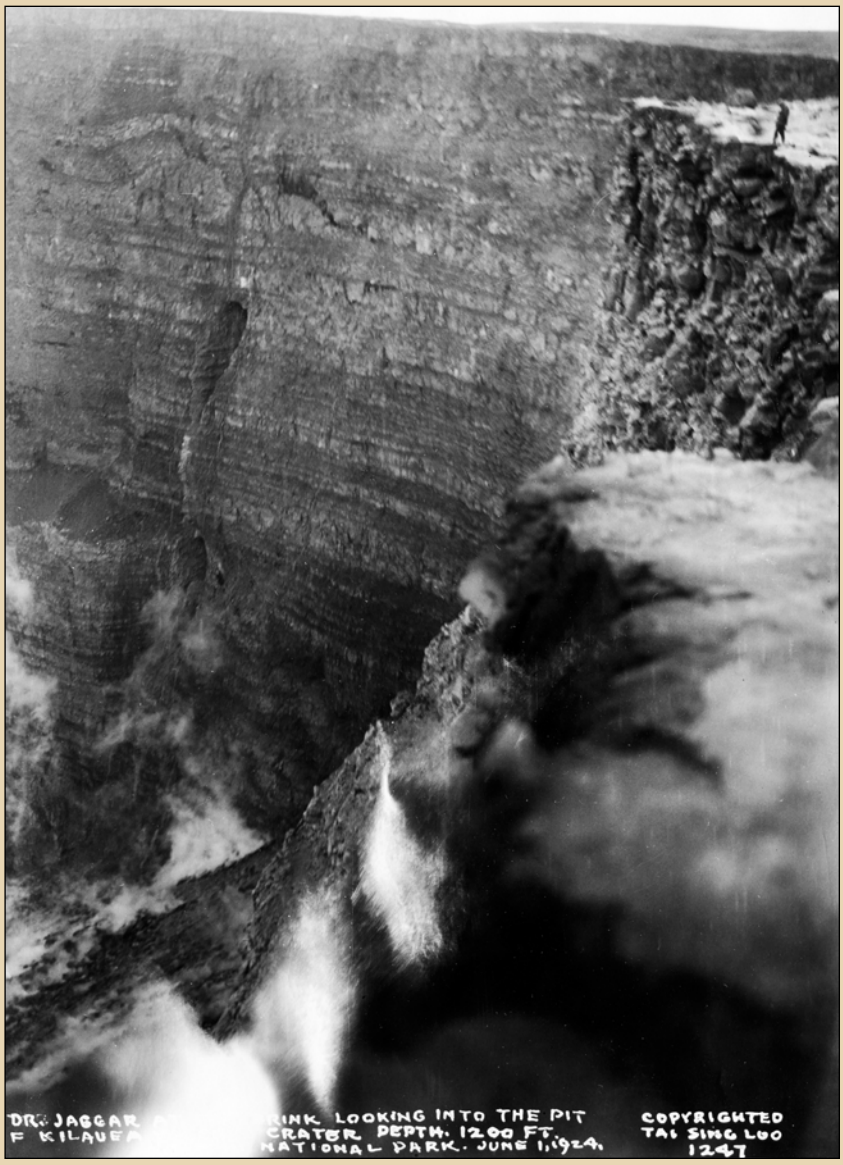

Figure 31. Photograph titled "Dr. Jaggar on the brink looking into the pit of Kilauea Crater, depth 1200 feet," taken by Tai Sing Loo on June 1, 1924. Photograph courtesy of the James Tsuchiya family.

Conclusion

Though lava made occasional appearances in Halemaʻumaʻu Crater thereafter, including a 251-day-long active lava lake in 1967–68, eighty-four years would pass before the molten lava lake commemorated in this volume reestablished long-term occupancy at the summit of Kīlauea Volcano.

During the 2008–2018 lava lake activity at Kīlauea, many terabytes of still images and videos were digitally captured by the staff of HVO and their associates. Will this material stand the test of time, as did the images reproduced in this essay? One hundred years from now will our descendants puzzle over views (such as figure 32) that have survived from our time with the same questions? What is shown? Where is this? Who captured the scene and when? Only time will tell.

Acknowledgments

The images featured and discussed in this essay provide only brief glimpses of a century of volcanic activity at Kīlauea, one of the best-studied volcanoes on Earth. During this era, countless artists, scientists, and volcano enthusiasts captured splendid views of the volcano. Though much of this material has been lost, art, illustrations, and photographs of Kīlauea are preserved in museums, archives, and other collections all over the world. New views from the past emerge every year, and much material remains to be discovered. We wish to thank all the sources, too numerous to mention, from England to Australia, which have provided volcano images for our study and use.

Our special thanks go to all the museums and archival repositories from Hawaii that have given generous permission for us to examine their collections and use their materials. We also acknowledge the many families that have donated copies of their private collections of volcano images to HVO.

A great many of the images featured in this essay are from the photographic archives of HVO, probably the best collection of photographs and film of Hawaiian volcanism in existence.

Material such as this does not preserve itself. We owe a debt of gratitude to Thomas A. Jaggar, Jr., Gordon Macdonald, Reggie Okamura, Takeo (Jane) Takahashi, Jim Griggs, and many HVO volunteers, such as Mack Wills and Frances Wong, whose efforts have enhanced and preserved this record over time.

Sadly, the eruption of 2018 badly damaged the HVO's Reginald T. Okamura building located on the rim of Kīlauea Caldera. As a result, the contents of the observatory basement, a wonderful mélange of records, equipment, samples, and archival material, were removed and the photograph collection has been stored in a climate-controlled facility where most of the items remain boxed and unavailable as of this writing. Our thanks to staff members of the U.S. Geological Survey and the Hawaiʻi Volcanoes National Park who assisted in this salvage operation under difficult conditions. Fortunately, much of the photographic collection has been digitized, but we look forward to the day when the original material will be fully reassembled and restored.

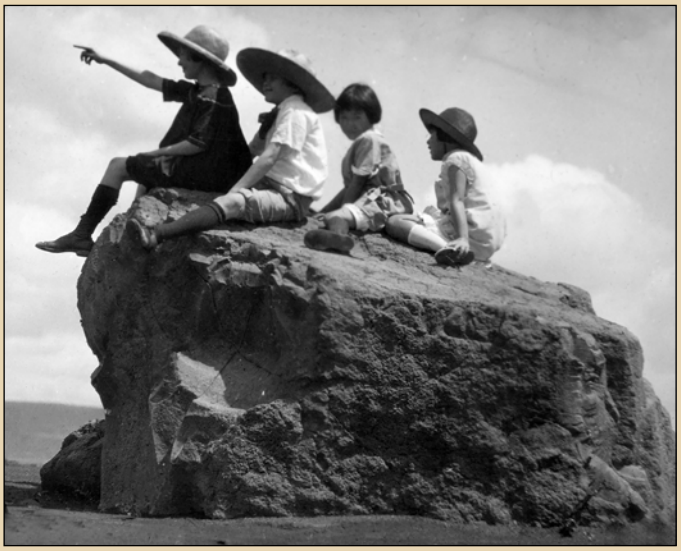

Figure 32. Photograph of children playing on a ballistic block at "Hawaii National Park," circa 1926. Photographer unknown. Photograph courtesy of the National Park Service, Hawai'i Volcanoes National Park.

Matt Patrick, lead editor of this volume, strongly encouraged us to prepare this essay. Don Swanson, Bruce Houghton, Tim Orr, and Ashton Flinders provided careful and thoughtful reviews, as did Christina Neal. Lynn Davis, an expert on the photographers of old Hawaii, has provided enormous assistance on this project, as well as others. Takeo (Jane) Takahashi carefully reviewed and edited the manuscript and spent many hours crafting appropriate citations for some unusual source material. John Mark Brigham, Kimber Peterson, and Cory Hurd provided editorial assistance and help with the layout and presentation of the images.

And our special thanks to our wives, Mary and Jeri, who have tolerated our absorption with this essay with patience and understanding.

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Appendix 1. Figure Commentary

Figure 1. "The South-West End of the Volcano of Ki-rau-e-a." Print from an engraving made from a sketch by William Ellis in 1823. There are several very different engravings of this scene in various editions of the Ellis books. All were based on a sketch by Ellis, which has been lost. The first edition, published in Boston in 1825 by the American Board of the Missionary Society, features another engraving, which appears even more exaggerated than the one shown (Ellis, 1825). The image featured is from the second edition, Narrative of a Tour Through Hawaii, or, Owhyhee (Ellis, 1826, plate facing p. 207), published in London and generally considered an expanded and improved version of the work (Forbes, 1999, p. 442–443). Ellis' estimate of the caldera's depth at 240 meters (m) (800 feet [ft]), made at the time of his visits, has been questioned by many. Joseph Goodrich, another member of the party (in a letter dated April 20, 1825), estimated the depth at "above 1,000 feet" (more than 300 m) (Goodrich, 1826). Larry Mastin notes that Goodrich later revised his estimate and suggests that the total depth of the caldera could have been more than 545 m (1,790 ft) in 1823 (Mastin, 1997, p. 20,105–20,106).

Figure 2."Great Volcano of Peli, at Hawaii." Print from an engraving made from a sketch by Robert Dampier in 1825. The original sketch was made on the spot by Dampier (Forbes, 1999, p. 437–440). The image was used as the frontispiece for the account of the voyage by Lord George Anson Byron, the ship's captain (Byron, 1826). The reproduction shown was featured by Dana (1890, p. 52).

Figure 3. "View of Crater Kilauea." Print from an engraving made from a sketch by Joseph Drayton in 1841. The image was featured in the United States Exploring Expedition narrative by Wilkes (1845; unnumbered page after p. 134). James Dana accompanied the U.S. Exploring Expedition, commanded by Charles Wilkes, as the expedition geologist. He visited the summit of Kīlauea Volcano in November 1840 but was allowed to remain there for only one day (Appleman, 1987). Dana preferred Drayton's representation of the caldera to that of the Wilkes map published with the expedition report, suggesting that the connection shown by the map between Halemaʻumaʻu Crater and the main body of the lower pit was much too narrow (Dana, 1890, p. 66).

Figure 4. "Panoramic view of the crater of Kilauea" (detail of two of seven panels). Watercolor by James Gay Sawkins, 1851. This painting is from the National Library of Australia PIC drawer 63 #T1486 NK6298/4. Some of the details in the painting, such as the ring of angular blocks around the elevated plateau, are also shown on the map of Kīlauea Crater prepared by C.S. Lyman in August 1846 (Lyman, 1846). Sawkins, who resided in Hawaii between 1850 and 1852, painted many watercolors of Kīlauea and Mauna Loa, as well as other island scenes, providing "the most important pictorial record of the 19th century Hawaiian landscape" that has survived (Forbes, 1991). None of the early chroniclers of volcanic activity in Kīlauea Crater featured art by Sawkins, probably because he quickly moved on to Australia, where most of his paintings remain.

Figure 5. Daguerreotype of Kīlauea Caldera, 1855, taken by Hugo Stangenwald. The image from Hawaiian Mission Houses Historic Site and Archives, catalogue no. N-1177. The identity of the photographer and the date of the photograph are suggested by a letter dated August 18, 1855, from missionary Levi Chamberlain to Mattie Chamberlain of Lahaina, "There is a kind of misty smoky atmosphere here nowadays and the natives say that Pele has broke forth. I hope it will be in good action when Mr. Stangenwald gets up there, for I should like to see a good daguerreotype of it in action." Hugo Stangenwald quit taking photographs in 1858, so both the date and identity of the photographer seem well established (Davis, 1980).

Figure 6. Photographic view to the west across Kīlauea Caldera, toward the Halemaʻumaʻu area, taken in 1875 by Jesse Lay. Photograph from Bishop Museum, scans SP_206885A and 206885B). Titled "Crater of Kilauea, Mona Loa, 1875," this photograph was featured as the frontispiece of the Report of the Scientific Results of the Voyage of H.M.S. Challenger during the Years 1873–76 (Thomson and Murray, 1885). The Challenger's visitors to Kīlauea signed the Volcano House Register (the guest book of the hotel), which lists Jesse Lay as the photographer (Bevens, 1988). The photograph's caption, "Crater of Kilauea Mona Loa," suggests that the author considered Kīlauea as a vent of Mauna Loa (a common view in the 19th century); or perhaps the profile of Mauna Loa, surely visible in the background on a clear day, has been lost by image deterioration through the passage of time.

Members of the Challenger party visited the two lava lakes named Halemaʻumaʻu and Kīlauea, which were active in the southwest caldera. In the text describing the Challenger's activities (Thomson and Murray, 1885), a description of the photograph was included, "In the morning the crater was seen to be bounded by a range of cliffs all round, and at the bottom was a wide flat expanse of hardened lava which looked as fresh as if it had only just set." Crossing the caldera floor, the party noted that the smooth surface of solidified lava was cracked by contraction and cooling in all directions and that all of the cracks were glowing hot at a depth of about a foot (Thomson and Murray, 1885, p. 767). Their description suggests that the active craters had recently overflowed, continuing to fill the central caldera depression.

Several years before the Challenger's visit, J.M. Lydgate prepared a map of the caldera that shows the same ledge remnant with the caldera filling from the two active craters, Kilauea and Halemauamu (Lydgate, 1875).

Figure 7. Photograph of the Halemaʻumaʻu area from Uēkahuna Bluff; photographer unknown, date circa 1860–1878. On the back of this print discovered at Hawaiian Volcano Observatory (HVO), scrawled in pencil, are the tantalizing words, "First view of volcano in the 60s." A copy of this print can be

found in the Mission Houses Historic Site and Archives (catalogue no. N-3187). This copy of the photograph includes the notation "Kilauea Crater, contact print in PA 23. ca. 1887." Another copy of the print, discovered in an album of photographs titled "Hawaiian Views 1870s" at Bishop Museum (catalogue no. 1930.137), bears the inscription "For Mr. G.D. Gilman with the regards and aloha [indistinct] of his friend, Bernice P. Bishop. Halealoha, Honolulu Nov 23rd 1878." The inscription date from Princess Bernice Pauahi Bishop in the Gilman album establishes that the image was captured before 1879. Yet another version of this view was discovered at the Hawaii State Archives (catalogue no. PP-114-4- 001). This photograph is virtually identical in composition and orientation to the one featured, but the view shows dense black smoke or fume emanating from the lava lake. The Hawaii State Archives print is of poor quality, and the image may have been doctored by adding fume to the original photograph to create a more dramatic scene.

No other volcano scene by William T. Brigham from this period has been discovered, yet many copies of this image have been found. This suggests that the photograph was made by a professional photographer who marketed his images rather than Brigham.

Despite copies of the image from several sources, we remain uncertain about the identity of the photographer and the date when the photograph was taken.

Figure 8. "Halemaumau looking west towards 'Cathedral rock' 300 feet [90 m] above the surface of the lake." Photograph by Eduard Arning, September 18, 1885**.** Arning annotated his photographs on the back of each print. For this view, he wrote, "Halemaumau looking west towards 'Cathedral rock' 300 feet [90 m] above the surface of the lake. Wave of molten lava but no blowing cones." This feature, located on the southern rim of Halemaʻumaʻu Crater, was the highest point of the crater rim and was visible from the Volcano House hotel (Thrum, 1886, p. 2). It served as a key reference point for surveys from this period.

Figure 9. Halemaʻumaʻu subsidence after the 1886 earthquake. Photograph attributed to Theo Severin. The photograph caption, "Halemaumau after the earthquake, 1887," may be misleading. Based on various reports and versions of the image, the photograph appears to have been taken in the spring of 1886, shortly after the earthquake occurred. The photograph date of 1887 seems doubtful because, by that year, although the Halemaʻumaʻu basin remained, another debris cone was rising rapidly in the crater (Dana, 1890, p. 101–120). Theo Severin, assistant to J.J. Williams, was the likely photographer. Between March 24 and April 14, 1886, he assisted J.S. Emerson in a survey conducted after the resulting subsidence (Emerson, 1887).

Figure 10. "New Lake." Photograph by Eduard Arning, September 18, 1885. On the back of this print, Arning wrote, "New Lake looking south. Camera within a yard from fluid lava. 3 waves in different directions. I could clearly see the wrinkles forming on the pahoehoe slabs of cooling down lava, both by pressure of new molten lava and by contraction due to cooling." New Lake first appeared in May 1881 and emptied in March 1886 (Dana, 1890, p. 97–98).

Figure 11. "Dana Lake from the north, 1890." From the photographic studio of J.J. Williams. Image from the National Park Service Hawaiʻi Volcanoes National Park, catalogue no. HAVO 1213. This print is from an album of old photographs of Kīlauea Volcano. All of the prints in the album are identified and dated.

Figures 12*A* and *B*. Maps and cross sections of Halemaʻumaʻu Crater by F.S. Dodge. *A*, This map is one of three that Dodge drafted and used for comparison in a consolidated map titled "Plans and Sections of Halemaumau, Kilauea, showing changes in crater since March, 1886," published October 1, 1892 (Dodge, 1892; Hawaii State Survey Division registered map no. 1829). This map was adapted from a more detailed map captioned "The Crater of Kilauea Hawaii, by F.S. Dodge, Aug 86. Triangulation and details of the sunken part from Survey of April, 1886 by J.S. Emerson. Outline of Kilauea and the Small Craters from Wm T. Brigham's Survey of 1865" (Hawaii State Survey Division registered map. no. 1273). *B*, This map is another of the three that Dodge drafted and used for comparison in a consolidated map titled "Plans and Sections of Halemaumau, Kilauea, showing changes in crater since March, 1886," published October 1, 1892 (Dodge, 1892; Hawaii State Survey Division registered map no. 1829). The map was sketched on August 25, 1892, in the Volcano House Register, volume 1891– 1898 (catalogue no. HAVO 397, S-F3, p. 40) (Bevens, 1988). Figure 12*B* is another copy of this map with less detail, but with cross sectional and profile diagrams added. It is on file at the Hawaii State Survey Division as registered map no. 1827.

Figures 13*A* and 13*B*. Photographs of Raymond and Whitcomb party collecting lava specimens at Halemaʻumaʻu Crater on April 1, 1893. Photographer J.J. Williams was a member of the group, and this series of photographs is attributed to him. The identity of the visitors are known because another copy of Figure 13*A* was found in the Williams collection at the Hawaiian Historical Society (catalogue no. 06106), bearing the caption "Raymond and Whitcomb Party 1893 making specimens by dipping up molten lava." Though no information has been found about figure 13*B*, this photograph appears to have been made at the same time as the image in figure 13*A*. Note the matching clothing of the lava samplers and the identical caption.

Figure 14. "Lava Flow on Dana Lake" (actually, Halemaʻumaʻu), image from Hawaii State Archives, catalogue no. PP-113-3-050). This image was very popular, and variations of the print were reproduced many times, commonly tinted, for such items as postal cards. Unfortunately, Gonsalves appears to have misidentified the lava lake in this photograph as "Dana Lake." Consequently, this ubiquitous, incorrectly labeled tourist image used by many authors and artists has caused much confusion. Charles Hitchcock used the Gonsalves photograph with the caption "Dana Lake" in his book, thus perpetuating the error about the age and appearance of the pond (Hitchcock, 1909, p. 231–235). Artist D. Howard Hitchcock (no relation to Charles) made a painting of the same feature, which he also titled "Dana Lake" (Gaddis and Kauahikaua, 2018, p. 13).

Rather than the small lava lake shown in figure 11, the print by Gonsalves shows a perched lava pond surrounded by a large crater. The map by Dodge (shown as fig. 12) demonstrates the size

difference between the two lava lakes, suggesting that the view was of Halemaʻumaʻu Crater. The Gonsalves print also shows a distant man-made structure on the opposite side of the crater's rim. The only known structure located in the caldera during this period was the visitor hut at Halemaʻumaʻu, described by Henry C. Lyons after the visit of the Raymond and Whitcomb party.

Sections of the crater wall in the Gonsalves photograph can be matched with the features from the same walls, identified as Halemaʻumaʻu Crater in figure 13.

Gonsalves visited Kīlauea Volcano and signed the Volcano House Register on May 3, 1893. A comparison of other prints showing the evolution of the perched pond at Halemaʻumaʻu suggests that the photograph was probably taken at that time (Bevens and others, 1988).

Figure 15. Photographs of Halemaʻumaʻu Crater, taken by Ernest Moses on November 26, 1909. Four photographs were merged to create this panoramic view.

Figure 16. Halemaʻumaʻu Crater, with the Technology Station on the rim. A newspaper described the structure as a little frame shack anchored and tied down to prevent the frequent blasts (of wind) from toppling the quarters into the lavas below (The Hawaiian Gazette, 1911). The station was later moved to another location.

Figure 17. Photograph and sketch by T.A. Jaggar, Jr., made on January 17, 1913. Images from Hawaiian Volcano Observatory Record Book for 1913, p. 30–31. The Record Books were kept between 1912 and 1939, followed by a gap from 1940 through 1951. The books resumed in 1952 and continued with gaps until late 1965, but later books are little more than albums of photographs of episodic eruptions. Some Record Books remain in the HVO archives, and others are held by the Bernice P. Bishop Museum in Honolulu, Hawaii (accession no. 1972.265) or by the U.S. Geological Survey Library in Reston, Virginia (accession no. 220[950]H3d). The volumes from these archives have been compiled and duplicated by B. Gaddis, F. Wong, and J. Takahashi to complete HVO's collection, but the material has not been published.

Figure 18. Photograph titled "The Technology Station," taken by T.A. Jaggar, Jr., on January 14, 1913. The image is from the Hawaiian Volcano Observatory Record Book for 1913, p. 26; Bernice P. Bishop Museum accession no. 1972.265. In February 1912, the original Technology Station built by Frank Perret was moved to a location a short distance from the north rim of Halemaʻumaʻu Crater, where it was rebuilt and enlarged. A porch and a picket fence were also added (Jaggar, 1912, p. 61).

Figure 19. Photograph titled "The Instrument shelter," taken by T.A. Jaggar, Jr., in October 1913. From the Hawaiian Volcano Observatory Record Book for 1913, p. 203; Bernice P. Bishop Museum accession no. 1972.265. This hut was constructed a few meters from the rebuilt Technology Station at the edge of the north side of Halemaʻumaʻu Crater. The structure could be easily seen from other parts of the crater rim and provides a useful way to orient other crater rim photographs of Halemaʻumaʻu to north. The Instrument Shelter was burned by a March 1921 overflow of the lava lake onto the caldera floor (Jaggar, 1947, plate 31b).

Figure 20. Photographs of the interior of the seismograph room and the bedroom at the Technology Station, taken by T.A. Jaggar, Jr., in October 1913. From the Hawaiian Volcano Observatory Record Book for 1913, p. 202; Bernice P. Bishop Museum accession no. 1972.265.

Figure 21. Photograph of the inner lava lake of Kīlauea Volcano after the subsidence of molten lava left a terrace, taken by T.A. Jaggar, Jr., on March 30, 1917. From the Hawaiian Volcano Observatory Record Book for 1917, p. 161; U.S. Geological Survey Library, Reston, Virginia, accession no. 220[950]H3d. Jaggar used this image in his book "Origin and Development of Craters" (plate 24a) with a more detailed caption, "Interior of Halemaumau looking west showing preservation of high border bench after subsidence, the integrity of the subsided crags, inner bench around the crags from revival of inflow, and temporary negative movement of liquid lake relative to this bench" (Jaggar, 1947, p. 449).

Figure 22. Photograph of visitors observing a fresh overflow of the rim from the central pond of Halemaʻumaʻu Crater, taken by T.A. Jaggar, Jr., on February 22, 1918. From the Hawaiian Volcano Observatory Record Book for 1918, p. 93; U.S. Geological Survey Library, Reston, Virginia, accession no. 1972.265.

Figure 23. Photograph titled "Central Lake from the North Station," taken by T.A. Jaggar, Jr., on September 20, 1921. Image from Hawaiian Volcano Observatory Record Book for 1921, p. 351; U.S. Geological Survey Library, Reston, Virginia, accession no. 1972.265 (unnumbered page, labeled "Figure 32," preceding p. 145. This photograph is also featured on p. 181 of vol. 3 of Bevens and others, 1988, reprinted edition)

Figure 24. Photographs titled "Landing Field and Fire Pit, Kilauea from the southwest," taken by the 11th Photo Section of the U.S. Army Air Corps (from the National Archives, Airscapes Collection, Hawaii, no. 18-AA-40-040. The National Archives has digitized and posted online an enormous number of military oblique aerial photographs from all States, including Hawaii (National Archives at College Park "Airscapes" of American and Foreign Areas, 1917–1964, https://catalog.archives.gov/id/512841).

Another attempt to secure aerial views of the caldera preceded the efforts of the 11th Photo Section by a decade. In 1913, F.W. Haworth spent several months at Kīlauea and made a series of aerial photographs of the crater using huge kites. These images were used by Robert W. Sayles to construct a detailed model of Kīlauea Caldera that was displayed in the Harvard University Museum for many years (Sayles, 1918). Unfortunately, the Hayworth kite photographs have disappeared, and the Sayles model has been destroyed (Sayles, 1918).

Figure 25. Photograph titled "Dust cloud at pit from Crater Trail" taken on May 10, 1924, by Ruy Finch (Hawaiian Volcano Observatory Record Book for 1924, p. 81; Bernice P. Bishop Museum accession no. 1972.265).

Figure 26. Photograph of the explosion from Halemaʻumaʻu Crater, taken by Ruy Finch from Uēkahuna Bluff on May 13, 1924 (Hawaiian Volcano Observatory Record Book for 1924, p. 111; Bernice P. Bishop Museum accession no. 1972.265).

Figure 27. Photograph titled "Just before big 11:09 a.m. explosion, from sand spit landing field, 11 a.m." taken by Ruy Finch on May 18, 1924 (Hawaiian Volcano Observatory Record Book for 1924, p. 143; Bernice P. Bishop Museum accession no. 1972.265).

Figure 28. Photograph titled "Explosion cloud from same place (a cliff above Algae locality) at 11:14," taken by Ruy Finch on May 18, 1924 (Hawaiian Volcano Observatory Record Book for 1924, p. 144; Bernice P. Bishop Museum accession no. 1972.265). The exact location of the "algae locality" is not known, but the site was probably on the cliff bounding the south side of Sand Spit. The feature may have been covered by a lava flow in 1982.

Figure 29. Photograph of the explosion from Uēkahuna Bluff at 11:15 taken by Kenichi Maehara on May 18, 1924. This Maehara photograph can also be found in the May 1924 Hawaiian Volcano Observatory Monthly Bulletin with the caption "May 18, 11:15 a.m. Detail of the maximum explosion taken from Uwekahuna" (Jaggar, 1924a, fig. 12, [third unnumbered page after p. 44]).

Figure 30. Photograph titled "Eight-ton block on the airplane field," taken by Oliver Emerson on May 22, 1924 (Hawaiian Volcano Observatory Record Book for 1924, p. 157; Bernice P. Bishop Museum accession no. 1972.265).

Figure 31. Photograph titled "Dr. Jaggar on the brink looking into the pit of Kilauea Crater," taken by Tai Sing Loo on June 1, 1924. The standing figure of Dr. T.A. Jaggar can be seen on the rim of Halemaʻumaʻu Crater in the upper right. Exposed in the crater's wall are the conduits thought to have fed the Mauna Iki eruption of 1919–20. The depth of the crater was more precisely estimated at approximately 407 meters (1,335 feet) at the time (Jaggar, 1924b, p. 71).

Figure 32. Photograph of children playing on a ballistic block at Hawaii National Park, circa 1926. Photographer unknown. This delightful photograph was not annotated. As a result, we are left to speculate about what is shown, but some detective work suggests answers. The image is copied from a lantern slide in the collection of the Hawaiʻi Volcanoes National Park, formerly known as Hawaii National Park, catalogue no. HAVO BX12-08-12.

Hawaii National Park superintendent Thomas Boles was an avid photographer and the image may have been left in the park collection by him. The daughter of Boles was a playmate of the three daughters of James Tsuchiya, a cashier and bookkeeper at the Volcano House Hotel. Mr. Tsuchiya was also an excellent photographer and his family donated copies of his photographs of the volcano to HVO.

Among the Tsuchiya images at HVO are other photographs of the girls. In one photograph, the four playmates wearing the same large hats pose together and are identified by name. In another image, some of the girls, wearing the same hats, pose at the eight-ton ballistic block featured in figure 30.

We believe that figure 32 shows children from the Tsuchiya and Boles families playing together atop the eight-ton block at Sand Spit or a similar block several years after the explosive eruption of 1924.

Whether photographs are for scientific purposes or family albums, annotations bring images to life and provide important context for visual material presented. We encourage all science photographers to annotate their images to enhance their value over time.

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