

Selected Images of the Effects of the October 15, 2006, Kīholo Bay-Māhukona, Hawai‘i, Earthquakes and Recovery Efforts

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Photograph Captions

Note: Photo captions describing the setting within which earthquake-related damage occurred begin with the italicized words “Overview image.” Other Overview images are placed at the end of a sequence to show the completion of repair work or to show the site as is. In some cases, a decision was made to leave the damage as a manifestation of nature and a historical record unto itself; in other cases, structures were demolished if safety was an issue or if the cost of restoration exceeded the cost of other viable alternatives.

Acronyms: DLNR, State of Hawaii, Department of Land and Natural Resources; CSAV, Center for Study of Active Volcanoes.

1. Laupāhoehoe Gulch, Laupāhoehoe

1.1. View of the cliff and stumps of freshly cut trees at the northern end of Laupāhoehoe Gulch, Highway 19 (view to the northwest). USGS photo by T.J. Takahashi, 3/3/2007 (tjt2931).

1.2. Close-up view of exposed roots of a tree, pruned to prevent rock falls at the northern end of Laupāhoehoe Gulch on Highway 19 (view to the north-northwest). USGS photo by T.J. Takahashi, 3/3/2007 (tjt2924).

1.3. View of a rock-retaining fence, assembled on site to move into place at the southwest end of Laupāhoehoe Gulch, where rock and soil slides are common (view to the south-southwest). USGS photo by T.J. Takahashi, 2/9/2007 (tjt2422).

1.4. View of the rock-retaining fence, installed to capture rocks and debris at the northeast end of Laupāhoehoe Gulch, Highway 19 (view to the northeast). USGS photo by T.J. Takahashi, 3/3/2007 (tjt2791).

1.5. Profile view of the rock-retaining fence, showing rock debris caught behind the fence at the northeast end of Laupāhoehoe Gulch (view to the south-southwest). USGS photo by T.J. Takahashi, 3/3/2007 (tjt2937).

2. Kawāili Bridge, Pa‘auilo

2.1. View of the collapsed section of Highway 19, southeast of Kawāili Bridge, between Kūka‘iau and Pa‘auilo (view to the northwest). USGS photo by C. Francos, 10/17/2006 (cf016).

- 2.2. View of the collapsed section of Highway 19, approaching Kawāili Bridge from the southeast. Barricades and intermittent lights warn motorists away from the damaged area (view to the southeast). USGS photo by C. Francos, 10/17/2006 (cf018).
- 2.3. View of temporary traffic lights that regulate the single lane of traffic past the damaged road (view to the northwest on Highway 19). USGS photo by T.J. Takahashi, 10/20/2006 (tjt1141).
- 2.4. View of Driscoll lines (black plastic hoses)—anchored by green sandbags within the cordoned-off area—provide temporary delivery of potable water to nearby residents and animals after the water main ruptured ((M. Asato, oral commun., 11/17/09); view to the northwest on Highway 19). USGS photo by T.J. Takahashi, 10/20/2006 (tjt1143).
- 2.5. Close-up view of the collapsed guardrail on the north side of the highway. White plastic sheets, held in place by green sandbags, cover the collapsed roadway and slope to prevent further erosion from rainfall (view to the southeast on Highway 19). USGS photo by T.J. Takahashi, 10/20/2006 (tjt1146).
- 2.6. View of wooden struts supporting the concrete slabs of the bridge, exposed after the slabs broke off and fell into the gulch below. At the southeastern end of the bridge, white plastic sheets cover the collapsed slope to prevent erosion (view to the southeast). USGS photo by T.J. Takahashi, 10/20/2006 (tjt1148).
- 2.7. View of the cracked asphalt at the approach to the bridge from the southeast. The plastic sheeting, temporarily used to cover the failed slope, was replaced by a more durable nylon-polymer cloth (in center of photo). Construction of the bypass-road bridge is in progress (left rear of photo; view to the northwest on Highway 19). USGS photo by T.J. Takahashi, 2/9/2007 (tjt2480).
- 2.8. View of the failed slope, covered with the nylon-polymer cloth to prevent erosion. The collapsed abutment to the bridge is visible below the concrete railing (view to the northwest on Highway 19). USGS photo by T.J. Takahashi, 2/9/2007 (tjt2476).
- 2.9. Close-up view of the weather-resistant nylon-polymer fabric and 0.3-m-long (1-ft) stainless-steel pin used to fasten the cloth securely into the ground. USGS photo by T.J. Takahashi, 2/9/2007 (tjt2472).
- 2.10. View of the bridge for the bypass road (under construction), which provides a detour from the damaged section of the highway (view to the northwest on Highway 19). USGS photo by T.J. Takahashi, 1/20/2007 (tjt2322).
- 2.11. View of the bridge for the bypass road, completed and opened to traffic (view to the northwest on Highway 19). USGS photo by T.J. Takahashi, 2/4/2007 (tjt2387).
- 2.12. View of the relative location of the bypass from the damaged Kawāili Bridge road (view to the northwest on Highway 19). USGS photo by N.A. Ikeda, 7/26/2008 (nai960).
- 2.13. View of the damaged section of Highway 19 (approaching Kawāili Bridge from the southeast), riddled with cracks (view to the northwest). USGS photo by T.J. Takahashi, 7/19/2009 (tjt1385).

3. St. Joseph Catholic Church, Pa‘auilo

- 3.1. Overview image: St. Joseph Catholic Church, yellow-tagged (allowing restricted occupancy and use) and closed due to structural damage (view to the northeast). USGS photo by T.J. Takahashi, 10/20/2006 (tjt1150).

- 3.2. View of cracks in the concrete-block pillar and separation of the wooden overhang beam from the pillar in the covered entrance (view to the northeast). USGS photo by T.J. Takahashi, 10/20/2006 (tjt1154).
- 3.3. Close-up view of the separation of the horizontal concrete blocks from the brown, wooden beam above. The red arrow points to cracking along grout lines between concrete blocks in the covered entrance (view to the northeast). USGS photo by T.J. Takahashi, 10/20/2006 (tjt1155).
- 3.4. Close-up view of the separation of the concrete beam of the covered walkway from the reinforced hollow tile wall at the front entrance (view to the northwest). USGS photo by T.J. Takahashi, 10/20/2006 (tjt1210).
- 3.5. View, under the covered driveway, of an offset hollow tile block at the top of the concrete-block pillar and of cracks in the mortar between rows of reinforced hollow tile blocks (view to the southeast). USGS photo by T.J. Takahashi, 10/20/2006 (tjt1218).
- 3.6. Close-up view of damage in the covered driveway: cracked and dislodged hollow tile block (held up by the downspout, seen in photo 3.5 (tjt1218)) and beneath it, cracked hollow tile blocks with exposed rebar (view to the southwest). USGS photo by T.J. Takahashi, 10/20/2006 (tjt1221).
- 3.7. View of tape showing approximately 5 cm (1.9 in.) of offset in the displaced hollow tile block at the top of the driveway pillar (seen in photos 3.5 (tjt1218) and 3.6 (tjt1221); view to the west-northwest). USGS photo by T.J. Takahashi, 10/20/2006 (tjt1231).
- 3.8. View of cracks in the mortar (between reinforced hollow tile concrete blocks), caused by shaking and ground slumping. The slumping caused the separation of the building from the ground (view to the northwest). USGS photo by T.J. Takahashi, 10/20/2006 (tjt1179).
- 3.9. Close-up view of ground slumping and of cracks in the mortar (see photo 3.8 (tjt1179)) between reinforced hollow tile blocks (view to the west-northwest). USGS photo by T.J. Takahashi, 10/20/2006 (tjt1183).
- 3.10. View of the interior, the least damaged part of the church, with the exception of fallen drywall in the choir section, just under the American flag (view to the northeast). USGS photo by T.J. Takahashi, 10/20/2006 (tjt1215).
- 3.11. View of the separation between the concrete walkway and the entrance to the lānai (veranda) around the parish hall (view to the north). USGS photo by T.J. Takahashi, 10/20/2006 (tjt1196).
- 3.12. The earthquake caused offsets of the parish hall's posts from its piers. View of HVO volunteer measuring the extent and direction of pier displacement, 7.62 cm (3 in.) to the northwest. The posts were repositioned and bolted down to the piers. USGS photo by T.J. Takahashi, 10/20/2006 (tjt1208).
- 3.13. Overview image: The parish hall as it appeared nearly two years after the earthquake, repaired and still in use for classes and social gatherings (view to the north). USGS photo by N.A. Ikeda 6/25/2008 (nai293).

4. Pa‘auilo Hongwanji Mission and Cemetery, Pa‘auilo

4.1. View of the cemetery’s partially restored stacked-rock retaining wall, which collapsed during the earthquake. Displaced rocks were used to hold back the soil (view to the west-northwest). USGS photo by T.J. Takahashi, 10/20/2006 (tjt1237).

4.2. View of a headstone—which partially slipped off its base and rotated counter-clockwise—sitting precariously atop a slab, which is tilting from ground-settling. Other headstones in the cemetery (as in the background of the photo) suffered a similar fate (view to the east-southeast). USGS photo by T.J. Takahashi, 10/20/2006 (tjt1268).

4.3. View of rubble from toppled and broken tombstones in the cemetery. In numerous places, ground-settling caused bases of tombstones to tilt and headstones to topple over in every direction (view to the northeast). USGS photo by T.J. Takahashi, 10/20/2006 (tjt1274).

4.4. View of subsidence (to the southwest) in the slab base of a gravesite and the counter-clockwise rotation of its tilted headstone, balanced between the granite block and the offset concrete vase (view to the south). USGS photo by T.J. Takahashi, 10/20/2006 (tjt1272).

4.5. View of the headstone of a large gravesite—which rotated in a clockwise direction—and its concrete vase, which toppled over (view to the west-northwest). USGS photo by T.J. Takahashi, 10/20/2006 (tjt1287).

4.6. View of HVO volunteer measuring horizontal displacement—approximately 0.2 m (8 in.) to the northeast—of the marble headstone from its base (view to the northeast). USGS photo by T.J. Takahashi, 10/20/2006 (tjt1288).

4.7. View of subsidence of the temple grounds, caused by the collapsed cap of a cesspool built over a lava tube (view to the northwest) (R. Matsumoto, oral commun., 1/17/09). USGS photo by T.J. Takahashi, 10/20/2006 (tjt1293).

4.8. View of a collapsed pit, showing about 0.7 m (2.3 ft) of ground subsidence. Bowed-out wall in the background (beneath windows temporarily fitted with plywood), which nearly moved off its base, was torn down subsequently and rebuilt (R. Matsumoto, oral commun., 1/17/09) (view to the northwest). USGS photo by T.J. Takahashi, 10/20/2006 (tjt1292).

4.9. Overview image: The rock wall adjoining the parking lot could not be restored to its former state, but the soil is held in place by the stacked-rock retaining wall and by a ground cover of flowering plants (view to the west-northwest). USGS photo by N.A. Ikeda, 6/25/2008 (nai294).

5. Shingon-shu Pa‘auilo Kongoji, Pa‘auilo

5.1. Overview image: Sign leading to the tucked-away site of Shingon-shu Pa‘auilo Kongoji in Pa‘auilo (view to the east). USGS photo by T.J. Takahashi, 10/20/2006 (tjt1303).

5.2. View of the collapsed stacked-rock retaining wall of the garden, which fronts the rows of shrines located on the slope above it (view to the southwest). USGS photo by T.J. Takahashi, 10/20/2006 (tjt1294).

5.3. View of concrete-block shrines (some rotated clockwise), offset from their bases (view to the northeast). USGS photo by T.J. Takahashi, 10/20/2006 (tjt1296).

5.4. View from the northwest side of the garden shows some toppled shrines and the clockwise angle of rotation (view to the southeast). USGS photo by T.J. Takahashi, 10/20/2006 (tjt1299).

5.5. View of HVO volunteer measuring about 0.2 m (8 in.) of clockwise displacement of a shrine (view to the southeast). USGS photo by T.J. Takahashi, 10/20/2006 (tjt1302).

5.6. Overview image: Restored shrines stand upright, facing forward again (view to the southwest). USGS photo by N.A. Ikeda, 6/25/2008 (nai296).

6. Kalōpā Cemetery, Kalōpā

6.1. View of the collapsed rock retaining wall of Kalōpā Cemetery, yellow-tagged for restricted use (view to the southwest). USGS photo by T.J. Takahashi, 2/4/2007 (tjt2378).

6.2. View of ground slumping that caused offset and cracking of the concrete enclosure of a gravesite (view to the south). USGS photo by T.J. Takahashi, 2/4/2007 (tjt2441).

6.3. View of a concrete cross, fallen onto the collapsed concrete border around a gravesite (view to the northeast). USGS photo by T.J. Takahashi, 2/4/2007 (tjt2453).

7. Kalōpā Mauka (“Sand Gulch”) Road, Kalōpā

7.1. View of large soil and rock-fall scar—the aftermath of uprooted trees and loosened material—on a cliffside along Sand Gulch Road (view to the northwest). USGS photo by T.J. Takahashi, 12/22/2006 (tjt2210).

7.2. View of trees pruned from the cliffside to reduce hazard to motorists (view to the south). USGS photo by T.J. Takahashi, 12/22/2006 (tjt2177).

7.3. View of damage to the slope, and of the rocks, soil, and debris shaken loose by the earthquake or deposited into the ravine below (view to the south). USGS photo by T.J. Takahashi, 12/22/2006 (tjt2185).

7.4. View of a thick layer of fine gravel covering a geohazard fabric to soften the fall of trees cut down to prevent further damage to the cracked road (view to the north). USGS photo by T.J. Takahashi, 12/22/2006 (tjt2230).

7.5. View of rocks, soil, and pruned or fallen trees on the narrow Sand Gulch Road (view to the north). USGS photo by T.J. Takahashi, 12/22/2006 (tjt2189).

7.6. View of workers sawing and removing sections of the massive tree’s multiple trunks, which are subject to fracturing in high winds. Due to the narrow, cracked road, moving the large tree sections and removing all debris to clear the road for safe passage were also hazardous (view to the north). USGS photo by T.J. Takahashi, 12/22/2006 (tjt2237).

7.7. View of cracks alongside the road and barrier marking the failed slope (view to the south). USGS photo by T.J. Takahashi, 2/4/2007 (tjt2351).

7.8. View of highway overseer, standing beside a concrete barrier blocking access to the damaged road. In the early phase of the road-clearing work, frustrated drivers removed wooden roadblocks to regain passage on the damaged road. Equally exasperated workers placed the large concrete roadblocks across the roadway to reduce the hazard for motorists and enabled them to get their work done (view to the southwest). USGS photo by T.J. Takahashi, 12/22/2006 (tjt2219).

7.9. View of the one-lane road, finally cleared of trees, rocks, and debris, passable once more (view to the northeast). USGS photo by N.A. Ikeda, 7/11/2008 (nai596).

8. Honoka‘a High School, Honoka‘a

8.1. View of the concrete base of the stairway that buckled, cracked, and moved approximately 15.24 cm (~6 in.) to the northwest (view to the southwest). USGS photo by C. Francos, 10/17/2006 (cf022).

8.2. View of concrete stairs that cracked and separated from the main walkway (view to the northwest). USGS photo by C. Francos, 10/17/2006 (cf023).

8.3. View of papers and books that spilled out when cabinet doors burst open during the earthquake. Cabinet shelves were dislodged, and papers and notebooks were disarrayed as desks skidded from their original positions in the room. Ceiling tiles crashed to the floor (photo angle not available). USGS photo by C. Francos, 10/17/2006 (cf025).

8.4. View of ceiling tiles, hanging precariously from the ceiling of an empty classroom (photo angle not available). USGS photo by C. Francos, 10/17/2006 (cf029).

8.5. View of fragments of fallen ceiling tiles scattered across the floor of the classroom (photo angle not available). USGS photo by C. Francos, 10/17/2006 (cf031).

9. Hale Ho‘ōla Hāmākua, Honoka‘a

9.1. View of scaffolding and red tape (designation for structures unsafe to enter or occupy) that indicate the level of damage to Hale Ho‘ōla Hāmākua (view to the southwest). USGS photo by T.J. Takahashi, 10/20/2006 (tjt1332).

9.2. View of damage to the support beam’s exterior corner joint under the eaves of the facility’s covered entrance (view to the southeast). USGS photo by T.J. Takahashi, 10/20/2006 (tjt1348).

9.3. View of the most extensive damage, which occurred from fallen stucco panels and their steel supports under the eaves (view to the southwest). USGS photo by T.J. Takahashi, 10/20/2006 (tjt1336).

9.4. Side view (from the southwest) of the damaged exterior stucco ceiling tiles under the eaves, showing roof frame still intact (view to the northeast). USGS photo by T.J. Takahashi, 10/20/2006 (tjt1334).

9.5. View of the partially repaired covered entrance and driveway awning (view to the west). USGS photo by N.A. Ikeda, 6/25/2008 (nai299).

9.6. View of exterior repair work under the roof’s eaves. Fallen panels were replaced with wooden boards (view to the east-northeast). USGS photo by N.A. Ikeda, 6/25/2008 (nai298).

10. Waipi‘o Valley

10.1. Overview image: Waipi‘o Valley’s floor and west valley wall, with grass-covered “bald” spots, presumably from historical rock and soil slides. The fertile plain was once extensively cultivated in taro and, later, rice (view to the west from Waipi‘o Overlook). USGS photo by R.W. Jibson, 11/7/2006 (rwj050).

10.2. Overview image: Aerial view of the steep, one-car road that cuts diagonally across the eastern walls to the floor of Waipi‘o Valley. The road is a 1.2-km (.75-mi) steep descent and a 274.32-m (900-ft) vertical drop from the top of the cliff to the valley floor (Pelletier, 1999). Wailoa Stream (seen at lower right of photo) flows calmly into the Pacific Ocean (view to the east). USGS photo by R.W. Jibson, 11/8/2006 (rwj105).

10.3. Overview image: Aerial view of Waipi‘o Valley’s floor and west valley wall. The Waimanu Trail, also known as the Muliwai Trail, or Z Trail (visible on the right side of the photo), heads up the north side of the cliff from the valley floor. The arduous hiking trail cuts across the top of Muliwai ahupua‘a and crosses numerous streams and gulches before dropping down to the floor of Waimanu Valley to the northwest (view to the northwest). USGS photo by E.L. Harp, 11/8/2006 (elh1163).

10.4. Overview image: Aerial view of the now sparsely inhabited, but still cultivated, alluvial plain of Waipi‘o Valley (view to the north-northwest). USGS photo by E.L. Harp, 11/8/2006 (elh1162).

10.5. Aerial view of the terraced waterfall of Alakahi Stream, flowing parallel to the trace of a long, narrow water mark from a dried-up waterfall. (view to the north-northwest). USGS photo by R.W. Jibson, 11/8/2006 (rwj090).

11. Coastline, ‘Āinahou Debris Fan

11.1. Aerial view of the steep sea cliff and the ‘Āinahou debris fan, north of Waipi‘o Valley (view to the northwest from the mouth of Waipi‘o Valley). In the distance, the toe of the Laupāhoehoe Nui debris fan points into the sea. USGS photo by E.L. Harp, 11/8/2006 (elh1164).

12. Waimanu Valley

12.1. Overview image: Aerial view of the broad floor and mouth of Waimanu Valley. Waimanu Stream meanders its way to the sea (view to the northeast). USGS photo by J.P. Kauahikaua, 11/8/2006 (jpk5952).

12.2. Overview image: Aerial view of the floor and mouth of Waimanu Valley, looking toward the Pacific Ocean. Rock slides occurred on both sides of the valley (view to the north-northeast). USGS photo by J.P. Kauahikaua, 11/8/2006 (jpk5940).

12.3. Overview image: Close-up aerial view of the scar left from rock and soil slides (left foreground in photo) at the head of the Waihīlau Branch on the windward side of Waimanu Valley, looking toward the ocean (view to the northeast). USGS photo by J.P. Kauahikaua, 11/8/2006 (jpk5950).

12.4. Aerial view of Wai‘ilikahi Falls and Stream, surrounded by walls of vegetation scrubbed by shallow rock and soil slides (view to the west). USGS photo by E.L. Harp, 11/8/2006 (elh1187).

12.5. Close-up aerial view of the bottom of Wai‘ilikahi Falls, showing blockage of the stream by rock-slide debris (view to the west). USGS photo by E.L. Harp, 11/8/2006 (elh1188).

12.6. Aerial view of the shallow rock falls and slides that sheared the high cliffs at the head of Waihīlau Branch in Waimanu Valley. Numerous waterfalls feed Waihīlau Stream. Note deep scar from a rock slide in the left foreground of the photo (view to the southwest). DLNR photo by S. Bergfeld, 10/16/2006 (sb855).

12.7. Close-up aerial view of the walls and rock-slide debris in Waihīlau Branch, Waimanu Valley. The debris that blocked the stream initially was breached subsequently by a large rock slide (view to the southwest). USGS photo by E.L. Harp, 11/8/2006 (elh1177).

12.8. Close-up aerial view of the scoured cliffs and rock-fall debris in Waihilau Stream at the head of the Waihilau Branch (view to the southwest). USGS photo by E.L. Harp, 11/8/2006 (elh1180).

12.9. Close-up aerial view of the large rock slide that breached the dam. Waihilau Stream flows on, over the deposit (view to the southwest). USGS photo by E.L. Harp, 11/8/2006 (elh1176F).

13. Coastline, Laupāhoehoe Iki Debris Fan to Laupāhoehoe Nui Debris Fan

Hāmākua District

13.1. Aerial view of rock and soil slides from the north end of Laupāhoehoe Iki (in the foreground) to Laupāhoehoe Nui, the larger debris fan, in the background (view to the northwest). USGS photo by E.L. Harp, 11/8/2006 (elh1189).

13.2. Aerial view of rock falls and their deposits at Laupāhoehoe Nui (foreground) and Laupāhoehoe Iki (middle ground). The profile of the ‘Āinahou debris fan can be seen in the distance (view to the southeast from the north end of Laupāhoehoe Nui). USGS photo by J.P. Kauahikaua, 11/8/2006 (jpk5954).

13.3. Aerial view of sea cliffs, abraded by rock falls, and the Laupāhoehoe Nui debris fan, covered with a dense forest of indigenous trees, fed by the rich soil and ash of older rock falls. Groundwater discharge seeps through the saturated land mass and drips down from the lower third of the sea cliff (view to the west). USGS photo by E.L. Harp, 11/8/2006 (elh1191).

13.4. Near-vertical aerial view of rock-fall debris and groundwater seeps near the base of the sea cliff at Laupāhoehoe Nui (view to the west). DLNR photo by S. Bergfeld, 10/16/2006 (sb867).

13.5. Aerial view of waterfall ending in a pool between sea cliffs scoured by rock falls at Laupāhoehoe Nui (view to the west). DLNR photo by S. Bergfeld, 10/16/2006 (sb866).

14. Coastline, Laupāhoehoe Nui Debris Fan to Honopue Valley

14.1. Aerial view of sea cliffs, crowned by dense vegetation and scoured by rock slides, north of Laupāhoehoe Nui. Note the two levels of groundwater seeps (darker-colored drip lines) across the cliff faces (view to the northwest). USGS photo by E.L. Harp, 11/8/2006 (elh1192).

14.2. Aerial view of large rock and soil slides along sea cliffs north of Laupāhoehoe Nui. The Āpau debris fan lies at the base of the cliff, below the groundwater seeps in the foreground of the photo (view to the northwest). USGS photo by E.L. Harp, 11/8/2006 (elh1193).

14.3. Aerial view of the sheared cliff, cleaved by a stream feeding a waterfall, flowing into the sea, near Honopue Valley. The Āpau debris fan lies between the two waterfalls (near the left edge of the photo; view to the southeast). DLNR photo by S. Bergfeld, 10/16/2006 (sb938).

14.4. Aerial view of rock slides between Honopue Valley and the “toe” of Laupāhoehoe Nui in the distance. The Āpau debris fan lies between the two waterfalls (view to the southeast). DLNR photo by S. Bergfeld, 10/16/2006 (sb937).

15. Honopue Valley

15.1. Aerial view of the abraded sea cliffs, with profiles of Laupāhoehoe Nui in the background and the Āpau debris fan between the two waterfalls. Traces of the sediment that rained down from the cliffs into the ocean are visible at the lower right of the photo (view to the southeast). DLNR photo by S. Bergfeld, 10/16/2006 (sb936).

15.2. Aerial view of the mouth of northwest Honopue Valley. Aside from the dominant rock-fall scar, numerous slides scraped the western wall (view to the southwest). USGS photo by E.L. Harp, 11/8/2006 (elh1195).

15.3. Aerial view of the long rock-fall scar in Honopue Valley. Other, smaller slides thinned out the dense vegetation covering the valley's western wall (view to the north). DLNR photo by S. Bergfeld, 10/16/2006 (sb873).

15.4. Close-up aerial view of the rock fall that peeled away the thick growth on the west wall of Honopue Valley (view to the west). DLNR photo by S. Bergfeld, 10/16/2006 (sb940).

15.5. Aerial overview, looking out to sea, of the heavily forested valley floor and rock and soil slides along the western walls of Honopue Valley. Untrammled by animals or human habitation, the valley floor and much of its walls are covered with a dense growth of kukui (candlenut) trees, distinguished by their light-green canopy (view to the north-northeast). DLNR photo by S. Bergfeld, 10/16/2006 (sb878).

16. Honoke‘ā Valley

16.1. Aerial view of the barren sea cliff, rock-fall deposit, and seawater muddy from runoff at the entrance to Honoke‘ā Valley (view to the southeast, toward Honopue Valley, the indentation at the left edge of the photo). DLNR photo by S. Bergfeld, 10/16/2006 (sb934).

16.2. Aerial view of the heavily forested floor and walls of Honoke‘ā Valley. Massive rock falls along the upper western valley walls are visible in the distance (view to the southwest). DLNR photo by S. Bergfeld, 10/16/2006 (sb935).

16.3. Close-up aerial view of extensive deforestation by rock falls along the western cliffs of Honoke‘ā Valley (view to the north). DLNR photo by S. Bergfeld, 10/16/2006 (sb880).

17. Coastline, Honopue Valley to ‘Āko‘ako‘a Point

17.1. Aerial view of the rock and soil debris that laid waste the cliffs along the Hāmākua and North Kohala coasts (the fresh deposits yet to be washed away from the base of the cliffs)—from the entrance of Honokāne Iki Valley, southeast along the coast, toward Honoke‘ā Valley, and beyond, to the entrance of Honopue Valley. Waipahi Stream flows into the sea at the deep cleft, mantled by vegetation (view to the southeast). DLNR photo by S. Bergfeld, 10/16/2006 (sb933).

17.2. Close-up aerial view of sea cliffs, scoured by rock falls, between Honoke‘ā and Honokāne Iki valleys. Waipahi Stream empties into the ocean between sea cliffs, where seawater is muddy from rock falls and runoff (view to the southwest). USGS photo by E.L. Harp, 11/8/2006 (elh1200).

17.3. Aerial view of eroded sea cliffs, with a fresh rock-fall deposit at its base, between Waipahi Stream and Honokāne Iki Valley, North Kohala coast. Honokāne Iki Valley is hidden behind the foreground sea cliff and Honokāne Nui Valley, tucked behind the ridge (outlined by the 'Āwini Trail), whose truncated promontory juts out into the sea. In the far distance (top right of photo), the scoured coastal cliff face, with bald spots in its crown, conceals Pololū Valley from view (view to the southwest). USGS photo by E.L. Harp, 11/8/2006 (elh1201).

17.4. Aerial view of the North Kohala coastline, from the mouth of Honokāne Valley in the foreground to 'Āko'ako'a Point (upper right of photo) in the background. Honokāne Nui Valley is hidden behind the ridge (with the 'Āwini Trail), terminating at the blunt end of the point in the foreground. Pololū Valley is concealed behind the raw sea cliff and damaged crown, and 'Āko'ako'a Point ends the long coastline facing the viewer. Sediment from runoffs muddied the ocean following several days of heavy rainstorms after the earthquake (FEMA, 2006) (view to the northwest). USGS photo by R.W. Jibson, 11/8/2006 (rwj143).

18. Honokāne Nui Valley

18.1. Aerial view of the massive rock slide whose debris diverted the course of Honokāne Nui Stream (view to the north-northwest). USGS photo by E.L. Harp, 11/8/2006 (elh1205).

18.2. Close-up aerial view of the talus deposit from the large rock slide that diverted the stream in Honokāne Nui Valley (view to the north-northwest). USGS photo by E.L. Harp, 11/8/2006 (elh1204).

18.3. Broad aerial view of the scarred cliffs of Honokāne Nui Valley, including the large rock slide and talus deposit (in center of image), seen in photos 18.1 (elh1205) and 18.2 (elh1204) (view to the north-northwest). DLNR photo by S. Bergfeld, 10/16/2006 (sb922).

18.4. Close-up aerial view of the long rock slide and numerous other slides that raked across the eastern wall of Honokāne Nui Valley. The large rock slide seen in photos 18.2 (elh1204) and 18.3 (sb922) is partially visible, right of center, in the image (view to the north) farther down the valley. DLNR photo by S. Bergfeld, 10/16/2006 (sb921).

18.5. Aerial view of the extensive series of rock slides across the eastern and western walls of Honokāne Nui Valley. The ridge in the center divides Honokāne Nui and Honokāne Iki valleys. Part of the long rock slide seen in photo 18.4 (sb921) is visible in the lower left foreground (to the right of the aircraft) in this image (view to the north-northwest). USGS photo by J.P. Kauahikaua, 11/8/2006 (jpk6020).

18.6. Close-up aerial view of the trail (light diagonal line), damaged by rock slides and debris, in the lower part of Honokāne Nui Valley approximately 1.6 km (1 mi), south of the massive rock slide seen in photo 18.1 (elh1205) (view to the west-northwest). USGS photo by R.W. Jibson, 11/8/2006 (rwj160).

18.7. Aerial view of the large debris pile at the base of a rock slide in the West Branch of Honokāne Nui Valley (view to the south). USGS photo by J.P. Kauahikaua, 11/8/2006 (jpk5975).

18.8. Vertical aerial view of the dust cloud, rising from a rock fall that has just occurred near a collapsed section of flume in the East Branch of Honokāne Nui Valley. DLNR photo by S. Bergfeld, 10/16/2006 (sb899).

18.9. Aerial view of the floor of the East Branch of Honokāne Nui Valley, littered by rock falls and debris. The old Boy Scout Camp (structures with red roof in the foreground), situated just above the mouth of the East Branch of the valley, survived the onslaught of the debris, which stopped just short of the stream (view to the south-southeast). USGS photo by E.L. Harp, 11/8/2006 (elh1210).

18.10. Aerial view of the Kohala Ditch Trail system (faint zigzag lines two-thirds of the way up the bare wall), inundated by rock-fall debris from the earthquake (view to the south-southeast from the Boy Scout Camp, just out of visual range at the bottom of the photo). USGS photo by E.L. Harp, 11/8/2006 (elh1209).

18.11. Close-up aerial view (see also photo 18.10 (elh1209)) of the extensive damage to the Kohala Ditch Trail that zigzags across the now bare walls of the East Branch of Honokāne Nui Valley (view to the southeast). USGS photo by E.L. Harp, 11/8/2006 (elh1211).

18.12. Close-up aerial view (see also photos 18.10 (elh1209) and 18.11 (elh1211)) of the Kohala Ditch Trail, damaged by rock slides, in the East Branch of Honokāne Nui Valley (view to the south-southwest). USGS photo by E.L. Harp, 11/8/2006 (elh1230).

18.13. Aerial view of the stream and rock-fall scars on the eastern wall, about .74 km (~.46 mi) south of the Boy Scout Camp, in the East Branch of Honokāne Nui Valley (view to the south-southeast). USGS photo by J.P. Kauahikaua, 11/8/2006 (jpk5990).

18.14. Close-up aerial view of rock slides that scraped the walls along the West Branch of Honokāne Nui Valley (view to the northeast). USGS photo by E.L. Harp, 11/8/2006 (elh1226).

18.15. Close-up aerial view of the rock-fall scar in photo 18.14 (elh1226) at the head of the West Branch of Honokāne Nui Valley (view to the northwest). USGS photo by E.L. Harp, 11/8/2006 (elh1221).

18.16. Aerial view of the base of the rock-fall scar and its talus deposit, which blocked the flow of a stream in the West Branch of Honokāne Nui Valley (see also photos 18.14 (elh1226) and 18.15 (elh1221); view to the northwest). USGS photo by E.L. Harp, 11/8/2006 (elh1220).

18.17. Aerial view of the waterfalls and rock slides near the head of the East Branch of Honokāne Nui Valley (view to the south-southeast). USGS photo by E.L. Harp, 11/8/2006 (elh1235).

18.18. Aerial view of the sheared walls, cut by streams of cascading water, near the head of the East Branch of Honokāne Nui Valley (view to the south). USGS photo by E.L. Harp, 11/8/2006 (elh1236).

19. Pololū Valley and Pololū Valley Lookout

19A. Pololū Valley

19.1. Close-up aerial view of extensive coalescing rock falls and slides near the entrance of Honokāne Nui Valley along Kohala's northeast coast. Note stripped trees along the shoreline (view to the southeast, just northeast of the Pololū Valley entrance). DLNR photo by K. Gooding, 10/19/2006 (kg1441).

- 19.2. Overview image: Aerial view of the mouth of Pololū Valley. The road to the overlook can be seen in the upper left corner of the photo (view to the north). DLNR photo by K. Gooding, 10/19/2006 (kg1432).
- 19.3. Overview image: Aerial view of the verdant floor of Pololū Valley and, beyond it, ‘Āko‘ako‘a Point. The light-green canopy of kukui nut trees predominates in the upper, uncultivated part of the valley (view to the north). DLNR photo by S. Bergfeld, 10/13/2006 (sb847).
- 19.4. Aerial overview of the floor and rock falls along the cliffs on the west (windward) side of Pololū Valley (view to the northeast). USGS photo by E.L. Harp, 11/8/2006 (elh1255).
- 19.5. Aerial view of the extensive rock falls in Pololū Valley. The broad plain and front of the valley can be seen in the distance. Part of the southern slope of a knife-like ridge (see photos 19.6 (elh1247), 19.7 (rwj216), and 19.8 (elh1245)) is visible in the right foreground of this photo (view to the northeast). USGS photo by J.P. Kauahikaua, 11/8/2006 (jpk6031).
- 19.6. Close-up aerial view of a knife-like ridge, its vegetation diminished by rock falls, in Pololū Valley (view to the north-northeast). USGS photo by E.L. Harp, 11/8/2006 (elh1247).
- 19.7. Close-up aerial view (looking up the axis, to the east) of rock-slide damage on both sides of the knife-like ridge in Pololū Valley (see photo 19.6 (elh1247)). USGS photo by R.W. Jibson, 11/8/2006 (rwj216).
- 19.8. Close-up aerial view of rock-slide damage on the north side of the knife-like ridge in Pololū Valley (see photos 19.6 (elh1247) and 19.7 (rwj216)); view to the south-southwest). USGS photo by E.L. Harp, 11/8/2006 (elh1245).
- 19.9. Close-up aerial view of damage along cliff walls by numerous rock slides at the head of Pololū Valley (see photo 19.8 (elh1245)). The knife-like ridge described in the previous three images is in the left foreground of this photo; in the background is a broad swath of cliffs extensively scrubbed of vegetation by rock falls (view to the south-southwest). USGS photo by E.L. Harp, 11/8/2006 (elh1246).
- 19.10. Aerial view of debris and rock falls along a valley wall near an irrigation flume section in Pololū Valley (view to the west-northwest). USGS photo by J.P. Kauahikaua, 11/8/2006 (jpk6025).
- 19.11. Aerial view of the irrigation flume, left unharmed by earthquake and rock falls, near a debris pile at the base of the cliff (see photo 19.10 (jpk6025)) in Pololū Valley (view to the west). USGS photo by E.L. Harp, 11/8/2006 (elh1253).
- 19.12. Close-up aerial view of the debris pile at the base of the abraded wall (see photo 19.10 (jpk6025) and 19.11 (elh1253)) near an irrigation flume in Pololū Valley (view to the west). USGS photo by E.L. Harp, 11/8/2006 (elh1254).
- 19.13. Aerial view of cliffs sheared of vegetation by rock falls in amphitheater-headed Waiakala‘e Gulch on the west wall of Pololū Valley (view to the west-southwest). DLNR photo by S. Bergfeld, 10/16/2006 (sb927).
- 19.14. Aerial view of waterfalls, rock and soil slides, and knife-like ridge in Pololū Valley (view to the west). DLNR photo by K. Gooding, 10/19/2006 (kg1459).

19.15. Aerial view of terraced Waiakala‘e Falls, blocked in places by rock-fall debris (view to the south-southwest). DLNR photo by S. Bergfeld, 10/16/2006 (sb929).

19B. Pololū Valley Lookout, Niuli‘i

19.16. Aerial view of Niuli‘i-Hāwī Road, the Lookout, and the head of the trail into Pololū Valley (view to the north). Both the Lookout and the trail were closed after the earthquake. DLNR photo by S. Bergfeld, 10/16/2006 (sb930).

19.17. Aerial view of road cracks and collapsed rock retaining wall at Pololū Valley Lookout (view to the north). DLNR photo by S. Bergfeld, 10/16/2006 (sb931).

19.18. Overview of cracks in Niuli‘i-Hāwī Road (Hwy 270), from the Lookout at the end of the road (view to the northwest). USGS photo by M.P. Poland, 10/19/2006 (mpp004).

19.19. View, from the overlook, of the mouth of Pololū Valley, with Paokalani and Mokupuku islets in the distance. The coastal waters are muddy from the rock-fall and rock-slide debris off the sea cliffs, washed down by heavy rainstorms for several days after the quake (view to the southeast). USGS photo by M.P. Poland, 10/19/2006 (mpp006).

19.20. View of cracks in the asphalt pavement of Niuli‘i-Hāwī Road (Highway 270) to Pololū Valley Lookout. Rock-fall debris from the sea cliffs color the water (view to the southeast). USGS photo by T.J. Takahashi, 10/21/2006 (tjt1485).

19.21. View of failure of the shoulder that resulted in cracks 2–3 cm wide (~1 in.) in the asphalt pavement of Niuli‘i-Hāwī Road (view to the southeast). USGS photo by M.P. Poland, 10/19/2006 (mpp014).

19.22. View of large cracks, 2–3 cm wide (~1 in.), in Niuli‘i-Hāwī Road near the Pololū Valley Lookout (view to the south). USGS photo by M.P. Poland, 10/19/2006 (mpp003).

19.23. Pololū Valley Lookout, a popular tourist destination, draws visitors after the road is repaved and the retaining wall rebuilt (view to the south). USGS photo by N.A. Ikeda, 6/25/2008 (nai304).

19.24. View of newly repaved Niuli‘i-Hāwī Road, which enables visitors to enjoy the view from the Pololū Valley Lookout once more (view to the northwest). USGS photo by N.A. Ikeda, 6/25/2008 (nai308).

20. Kēōkea Park Road Intersection to Waikani Gulch One-Lane Bridge, Makapala

20.1. View of the rock-fall debris just past the intersection of Kēōkea Park Road (driving from Pololū Valley Lookout) and the Waikani Gulch one-lane bridge (view to the west-southwest). USGS photo by T.J. Takahashi, 10/21/2006 (tjt1513).

20.2. View from the opposite direction (from photo 20.1 (tjt1513)) of the road-cut failure, resulting in the rocky debris on Akoni Pule Highway (view to the east-northeast). CSAV photo by D.A. Whilldin, 10/19/2006 (daw005).

20.3. View of the Waikani Gulch one-lane bridge (foreground) and the Niuli‘i Stream bridge (background) near the intersection of Kēōkea Park Road. The bridge, repainted and repaired with fresh concrete reinforcing the fence posts and the base of the bridge, was yellow-tagged for restricted use after new cracks developed following initial repairs (view to the east). USGS photo by T.J. Takahashi, 10/21/2006 (tjt1521).

20.4. Close-up view of the cracks between the new concrete repair work and the road at the Waikani Gulch bridge (looking at the southwest corner of the bridge). USGS photo by T.J. Takahashi, 10/21/2006 (tjt1523).

21. Kēōkea Beach Park, Makapala

21A. Kēōkea Beach

21.1. View of boulders and coastal waters along the northwest end of Kēōkea Beach after the rock slides and the rain-washed sediment into the ocean (view to the north). USGS photo by T.J. Takahashi, 10/21/2006 (tjt1437).

21.2. View of cliffs, barren from rock slides at Kēōkea Beach, nearly three years after the earthquake uprooted the ironwood trees that grew there (view to the southwest). USGS photo by T.J. Takahashi, 7/19/2009 (tjt1400).

21.3 and 21.4. View of vegetation that recovered more quickly along the side of the bay less battered by wind and surf (view to the west-southwest). USGS photos by T.J. Takahashi, 7/19/2009 (tjt1401 and tjt1403).

21B. Kēōkea Beach Park Gazebo

21.5. Overview image: The concrete staircase, supported by the stone wall, leads up to the gazebo, whose roof is visible above the shrubbery (view to the north-northwest). USGS photo by N.A. Ikeda, 6/25/2008 (nai312).

21.6. View of cracks in the concrete barbecue pit and pavement in the gazebo at Kēōkea Beach Park (view to the north). USGS photo by T.J. Takahashi, 10/21/2006 (tjt1444).

21.7. View of cracks in the concrete pavement and post of the gazebo (view to the north-northwest). USGS photo by T.J. Takahashi, 10/21/2006 (tjt1439).

21.8. View of cracks in the concrete post supporting the roof beam of the gazebo (view to the north-northwest). USGS photo by T.J. Takahashi, 10/21/2006 (tjt1454).

21.9. View of cracks in the mortar around the rocks in the wall next to the gazebo (view to the southwest). USGS photo by T.J. Takahashi, 10/21/2006 (tjt1450).

21.10. View of a fractured boulder, shaken loose from the asphalt, next to the gazebo (view to the north). USGS photo by T.J. Takahashi, 10/21/2006 (tjt1445).

21C. Kēōkea Beach Park Pavilion

21.11. View of the red-tagged pavilion, marked unsafe to enter or occupy, at Kēōkea Beach Park (view to the south-southwest). USGS photo by T.J. Takahashi, 10/21/2006 (tjt1465).

21.12. View of cracks in the pavement and rain-gutter pipe at the pavilion (view to the south-southwest). USGS photo by T.J. Takahashi, 10/21/2006 (tjt1458).

21.13. View of a large crack in the concrete foundation and cracks in the wall of the pavilion (view to the north-northwest). CSAV photo by D.A. Whilldin, 10/19/2006 (daw034).

21.14. View of the crack in a concrete beam supporting the roof of the pavilion (view to the north-northwest). CSAV photo by D.A. Whilldin, 10/19/2006 (daw036).

21.15. View of cracking and slumping of asphalt around the pavilion (view to the south-southeast). USGS photo by T.J. Takahashi, 10/21/2006 (tjt1464).

- 21.16. View of cracks in the cinder-block wall of the pavilion (view to the south-southeast). USGS photo by T.J. Takahashi, 10/21/2006 (tjt1459).
- 21.17. View of ground-slumping around the pavilion (view to the south-southeast). USGS photo by T.J. Takahashi, 10/21/2006 (tjt1462).
- 21.18. View of ground-slumping that undermined the concrete foundation of the corner of the pavilion (view to the south). USGS photo by T.J. Takahashi, 10/21/2006 (tjt1461).

22. Makapala Chapel, Makapala

- 22.1. View of the collapsed vertical wooden poles and battens, cemented corner rock pillar, and rock railing of the front steps and entryway (viewed to the southwest). USGS photo by M.P. Poland, 10/19/2006 (mpp001).
- 22.2. Close-up view of the collapsed stone-wall railing and front steps (view to the south). USGS photo by M.P. Poland, 10/19/2006 (mpp002).
- 22.3. Detail of the collapsed stone-wall railing and cracks in the front steps and in the landing, which buckled from the shaking (view to the south). USGS photo by M.P. Poland, 10/19/2006 (mpp003).
- 22.4. Cracked rock support for the front steps and entryway at Makapala Chapel await repairs (view to the south). USGS photo by N.A. Ikeda, 7/26/2008 (nai018).

23. Pūwā‘i‘ole Gulch, Makapala

- 23.1. View of the earthquake’s effects: the rock-fall debris, swept to the side of the road cut, the crack zigzagging into the roadway, and cracks in the concrete guard wall at Pūwā‘i‘ole Gulch (view to the southwest). USGS photo by T.J. Takahashi, 10/21/2006 (tjt1535).
- 23.2. View of the cleared roadside debris (see photo 23.1, tjt1535) and cracks in the road, sealed and labeled “Danger” and “Hazardous” (view to the southwest). USGS photo by N.A. Ikeda, 7/26/2008 (nai1022).
- 23.3. View of the sealed road cracks and words of warning on the road (view to the northeast). USGS photo by N.A. Ikeda, 7/26/2008 (nai1024).
- 23.4. Close-up view of crack in the concrete guard wall at Pūwā‘i‘ole Gulch (view to the northwest). USGS photo by N.A. Ikeda, 7/26/2008 (nai1023).

24. Kalāhikiola Congregational Church, Kapa‘au

- 24.1. View, from the east, along the north wall of Kalāhikiola Congregational Church. The church, red-tagged as unsafe to enter or occupy, sustained extensive damage to the interior and exterior walls, ceiling, windows, and floor (view to the west-southwest). USGS photo by C. Francos, 10/17/2006 (cf056).
- 24.2. View of damage to the rock and stucco exterior of the north wall (view to the southwest). USGS photo by T.J. Takahashi, 10/20/2006 (tjt1357).
- 24.3. View (from the north side of the church) of fragments from the archway’s former east base (view to the south-southeast). USGS photo by T.J. Takahashi, 10/20/2006 (tjt1364).
- 24.4. View of the cracked archway’s rock-wall interior and its stucco façade (view to the south). USGS photo by T.J. Takahashi, 10/20/2006 (tjt1362).

24.5. View of completely collapsed section of the northeast corner wall and exterior stucco of the church. Part of the collapsed ceiling is also visible through the opening (view to the south). USGS photo by T.J. Takahashi, 10/20/2006 (tjt1360).

24.6. View of the damaged interior rock wall and ceiling, as seen through a gaping hole in the exterior, where a stained-glass window was situated (view to the east-northeast). CSAV photo by D.A. Whilldin, 10/19/2006 (daw075).

24.7. View (view to the southeast) of the sign “God is our refuge and strength,/ an ever-present help in trouble” at the church’s side entrance. The lines—literally describing the effects of the earthquake—are from a song whose words were adapted from Psalm 46 of The Bible:

1. God is our refuge and strength, a very present help in trouble.
2. Therefore will not we fear, though the earth be removed, and though the mountains be carried into the midst of the sea;
3. Though the waters thereof roar and be troubled, though the mountains shake with the swelling thereof. Selah.

CSAV photo by D.A. Whilldin, 10/19/2006 (daw006).

24.8. Profile view of the damage at the church’s front entrance (view to the south-southwest). USGS photo by T.J. Takahashi, 10/20/2006 (tjt1366).

24.9. View of the extensive damage to the church’s front entrance (west side) and to the rock wall and stucco exterior of the north wall (view to the southeast). USGS photo by T.J. Takahashi, 10/20/2006 (tjt1370).

24.10. View of the church’s front entrance, showing the collapsed wall under the eave, framing, and wall above the doors (view to the east-southeast). USGS photo by T.J. Takahashi, 10/20/2006 (tjt1371).

24.11. View of the southwest corner and south side of the church, showing collapsed walls and peeling stucco on remaining walls (view to the northeast). USGS photo by T.J. Takahashi, 10/20/2006 (tjt1373).

24.12. Close-up view of the collapsed southwest corner wall and the church’s interior. The framing for the windows literally held up the church (view to the north-northeast). USGS photo by T.J. Takahashi, 10/20/2006 (tjt1375).

24.13. View of HVO volunteer looking at the damage to the interior, beyond the red-posted notice (structure unsafe to enter or occupy) on the south wall of the church (view to the northeast). USGS photo by T.J. Takahashi, 10/20/2006 (tjt1378).

24.14. Detail of cracks in the stucco, showing the crumbling mortared stone wall at the southeast corner of the church (view to the north-northeast). The sunburst pattern at the top of the window frame, repeated in the design of the bell tower, reflects the meaning of “Kalāhikiola” (“the life-bringing sun”). USGS photo by T.J. Takahashi, 10/20/2006 (tjt1380).

24.15. View of the end of the wall at the southeast corner, showing the pattern of cracking in the exterior stucco. Note lines incised into the stucco to resemble building blocks (view to the northeast). USGS photo by T.J. Takahashi, 10/20/2006 (tjt1379).

24.16. View of backhoes and cranes resting on a Saturday morning during the reconstruction phase of the 26 m (85 ft) by 14 m (45 ft) Kalāhikiola Church (view to the southeast). USGS photo by T.J. Takahashi, 1/17/2009 (tjt960).

- 24.17. View of stones from the collapsed walls of the church, carefully piled beside the driveway for later use in a stone wall around the church (view to the south-southwest). USGS photo by T.J. Takahashi, 1/17/2009 (tjt964).
- 24.18. View of the dried-out mortar, which contributed to the walls' collapse (view to the west). USGS photo by T.J. Takahashi, 1/17/2009 (tjt970).
- 24.19. View of the support pillars that insured structural stability while the church underwent extensive repairs. The ceiling and roof nearly collapsed from the effects of the earthquake. Water pooled on the floor as a result of ground subsidence from a succession of earthquakes over time, culminating in the effects of the October 15, 2006, earthquake. The floor was raised to prevent damage from moisture and provide elastic movement during earthquakes (B. Bond, oral commun., 1/17/09) (view to the northwest). USGS photo by T.J. Takahashi, 1/17/2009 (tjt973).
- 24.20. View of the upper part of the bell tower and its sunburst motif, inspired by the rays of the sun, which illuminated the tower in the morning. Although it appears unscathed, the tower sustained water-related damage, as well as damage from the shaking during the October 15, 2006, earthquake (view to the north-northeast) (B. Bond, oral commun., 1/17/09). USGS photo by T.J. Takahashi, 1/17/2009 (tjt983).
- 24.21. View of the steel-reinforced concrete archway, rebuilt after the original one collapsed during the earthquake. Repairs are also in progress on the lower-to-middle section of the bell tower (view to the south). USGS photo by T.J. Takahashi, 9/5/2009 (tjt1463).
- 24.22. View of the north (side) and west (front) entrances of the church, rebuilt with wood for flexibility of interior walls and with steel-reinforced concrete blocks for strength of exterior walls (view to the southeast). USGS photo by T.J. Takahashi, 9/5/2009 (tjt1469).
- 24.23. View of the newly rebuilt west and south sides of the church. Due to building-code requirements, steel-reinforced concrete was used in place of stone for the walls. The concrete walls were plastered over, with grout lines incised, to replicate the original design of the church (view to the northeast). USGS photo by T.J. Takahashi, 9/5/2009 (tjt1470).
- 24.24. View, from the interior of the church, of the wood-lath framing for a window. A steel-mesh screen covers the right side for subsequent plastering. The rebuilt archway, seen through the window, echoes the peaked-arch design motif of windows and doors (view to the north). USGS photo by T.J. Takahashi, 9/5/2009 (tjt1477).
- 24.25. View of the completed archway, facing the north side of the church. Stones from the walls of the church were used to merge both sides of the archway with the wall surrounding the church (see photos 24.21 (tjt1463) and 24.4 (tjt1362); view to the south). USGS photo by T.J. Takahashi, 3/13/2010 (tjt1937).
- 24.26. View of the north (side) entrance and west (front) entrance of the completed church (see photos 24.22 (tjt1469) and 24.9 (tjt1370); view to the southeast). USGS photo by T.J. Takahashi, 3/13/2010 (tjt1940).

24.27. View of the newly restored bell tower and the west and south sides of the church. The sunburst pattern in the windows reflect the sun's rays once more, and the small window panes reduce the glare. Following the design of the original church, grout lines were incised into the plaster overlay for the concrete walls (see photos 24.23 (tjt1410) and 24.11 (tjt173); view to the northeast). USGS photo by T.J. Takahashi, 3/13/2010 (tjt1941).

24.28. View of the new setting for the recently dedicated "Great Stone Church," now surrounded by a long, low enclosure built from the stones that constituted the original walls of the church (see photos 24.2 (tjt1357); view to the southwest). USGS photo by T.J. Takahashi, 3/13/2010 (tjt1969).

25. Lapakahi State Historical Park, Māhukona

25.1. Overview image: Undamaged circular driveway and welcome sign of Lapakahi State National Historical Park (view to the southwest). USGS photo by T.J. Takahashi, 3/3/2007 (tjt2806).

25.2. Overview image: Undamaged information office (view to the east-northeast). USGS photo by N.A. Ikeda, 7/11/2008 (nai612).

25.3. Overview image: Coastal section of the park (view to the west-southwest). USGS photo by N.A. Ikeda, 7/11/2008 (nai614).

25.4. View of the collapsed stacked-rock walls of a house site (view to the northwest). USGS photo by N.A. Ikeda, 7/11/2008 (nai616).

25.5. View of the collapsed rock wall of a house site (view to the northwest). USGS photo by T.J. Takahashi, 3/3/2007 (tjt2825).

25.6. View of a collapsed rock wall along the coastal trail (view to the southeast). USGS photo by T.J. Takahashi, 3/3/2007 (tjt2819).

25.7. View of a partially collapsed rock wall along the coastal trail (view to the north-northwest). USGS photo by T.J. Takahashi, 3/3/2007 (tjt2860).

25.8. View of the collapsed rock wall in front of a Hawaiian thatched house (view to the north). USGS photo by N.A. Ikeda, 7/11/2008 (nai619).

26. Honokoa Bridge, Māhukona

26.1. View of the spalled (chipped) concrete guardrail and separated walkway and pavement at Honokoa Bridge (view to the southwest). CSAV photo by D.A. Whilldin, 10/20/2006 (daw073).

26.2. View of another section of the spalled concrete guardrail and separated walkway and pavement at Honokoa Bridge (view to the southwest). CSAV photo by D.A. Whilldin, 10/20/2006 (daw076).

26.3. View of separation in the concrete guardrail (view to the northeast). CSAV photo by D.A. Whilldin, 10/20/2006 (daw080).

26.4. View of separation in the bridge above the supporting pillar (view to the east). CSAV photo by D.A. Whilldin, 10/20/2006 (daw016).

26.5. Close-up view of separation in the bridge above the supporting pillar (view to the east). CSAV photo by D.A. Whilldin, 10/20/2006 (daw084).

26.6. Close-up view of the repaired concrete guardrail and walkway. USGS photo by N.A. Ikeda, 7/11/2008 (nai623).

26.7. View of the newly repaired bridge, freshly paved and striped (view to the northwest). USGS photo by N.A. Ikeda, 7/11/2008 (nai621).

27. Honokoa Gulch Culvert, Māhukona

27.1. View of the slump in the road fill at Honokoa Gulch. Note two culverts at center left of the image (view to the north-northeast). USGS photo by T.J. Takahashi, 10/21/2006 (tjt1540fl).

27.2. View of the failed shoulder and damage to the culverts at Honokoa Gulch (view to the northwest). USGS photo by T.J. Takahashi, 10/21/2006 (tjt1563).

27.3. View of the damage to the railing from fill failure and flooding, which washed the debris of uprooted trees and boulders across the highway the day after the earthquakes (view to the northwest). USGS photo by T.J. Takahashi, 10/21/2006 (tjt1558).

27.4. View of regrading after earth, boulders, and tree branches piled up at the guardrail. Much of the debris was held back by the guardrail, but some tree branches and rocks overtopped the railing and were washed to the seaward side of the highway (view to the north). USGS photo by T.J. Takahashi, 10/21/2006 (tjt1584).

27.5. View of the collapsed shoulder, damaged railing, and debris of uprooted trees and rocks, which resulted in the blockage of Highway 270 (view to the southeast). USGS photo by T.J. Takahashi, 10/21/2006 (tjt1572).

27.6. View of new concrete and stone revetment for the twin culverts (view to the north-northeast). USGS photo by N.A. Ikeda, 7/11/2008 (nai628).

28. North Kawaihae Small Boat Harbor, Kawaihae

28.1. Overview image: Kawaihae Small Boat Harbor sustained much damage as a result of the earthquake. Children play on their boogie boards, and a couple of boats tie up to Loading Dock Number 1 in the foreground, lined with old tires. The dock is attached to the boat-launching ramp (to the left in the photo), hidden by a rock wall in the foreground. Behind Loading Dock Number 1 in the photo is Loading Dock Number 2, the smaller of the two. The marginal wharf is in the background; the southeast side of the breakwater extends beyond it (near the right edge of the photo). Beyond the dark brown comfort station are the twin towers of Kawaihae Pier (view to the east-southeast). USGS photo by T.J. Takahashi, 11/28/2008 (tjt698).

28.2. Overview image: Loading Docks 1 (with 7 tire bumpers) and 2 (with one tire bumper) at North Kawaihae Small Boat Harbor. The rock revetment wall fronting the parking area (to the left in the photo) slumped and moved seaward when the earthquake occurred (view to the east-southeast). USGS photo by T.J. Takahashi, 11/28/2008 (tjt718).

28.3. View of the conventional entry into the water at Loading Dock Number 2, blocked at the end of the handrail (to the left in the photo); but the dock is linked to the seawall by a new makeshift wooden plank, replacing the previous one that failed (view to the east-southeast). USGS photo by T.J. Takahashi, 11/28/2008 (tjt730).

- 28.4. View of the plank to Loading Dock Number 2 that bypasses the hole created in the concrete slab as a result of the earthquake (view to the south-southwest). USGS photo by T.J. Takahashi, 11/28/2008 (tjt736).
- 28.5. View of the numerous cracks that opened up in the pavement at the boat-launching ramp (view to the south). USGS photo by T.J. Takahashi, 11/28/2008 (tjt721).
- 28.6. View of lateral spreading and slumping of the ground parallel to the seawall at North Kawaihae Small Boat Harbor. The crack, which grew between the seawall and the parking lot, extends along the entire length of the seawall (view to the southeast). The area was yellow-tagged, allowing restricted use. CSAV photo by D.A. Whilldin, 10/25/2006 (daw064).
- 28.7. View of slumping of the shoreline behind the rock revetment wall, exposing coconut tree roots and rocks under the sand-filled ground cracks (view to the east). USGS photo by T.J. Takahashi, 11/28/2008 (tjt740).
- 28.8. Overview image: View of the marginal wharf, with the rock revetment wall behind it. The railing (at the left edge of the photo) is built upon a concrete slab attached to the wooden walkway. The entire platform of the wharf is in disrepair from previous damage and is periodically repaired (view to the south). USGS photo by T.J. Takahashi, 11/28/2008 (tjt744).
- 28.9. View of the cracked concrete slab and mortar beside the walkway ramp leading to the wharf's platform (view to the southeast). USGS photo by T.J. Takahashi, 11/28/2008 (tjt760).
- 28.10. View of slumping of the ground along the rock revetment seawall (view to the west-northwest). USGS photo by T.J. Takahashi, 11/28/2008 (tjt780).
- 28.11. View of slumping along the rock revetment seawall (view to the east-southeast). USGS photo by T.J. Takahashi, 11/28/2008 (tjt789).
- 28.12. View of the cracked concrete platform between the seawall at the marginal wharf and the parking lot (view to the north-northeast). USGS photo by T.J. Takahashi, 11/28/2008 (tjt806).
- 28.13. View of lateral displacement of boulders along the marginal wharf's platform (view to the north-northeast). USGS photo by T.J. Takahashi, 11/28/2008 (tjt771).
- 28.14. View of cracks in concrete, poured over rocks to stabilize the approach to the walkway at the marginal wharf (view to the south). USGS photo by T.J. Takahashi, 11/28/2008 (tjt819).
- 28.15. View of hairline fractures along the curb and through the asphalt pavement of the parking lot near the comfort station (view to the east-southeast). USGS photo by T.J. Takahashi, 11/28/2008 (tjt821).
- 28.16. View of hairline fractures in the curb near the comfort station. USGS photo by T.J. Takahashi, 11/28/2008 (tjt824).
- 28.17. View of ground slumping and of rocks loosened by lateral displacement along the rock revetment seawall (view to the west-northwest). USGS photo by T.J. Takahashi, 11/28/2008 (tjt834).

28.18. Close-up view of slumping and lateral displacement of the ground along the rock revetment seawall (view to the west-northwest). USGS photo by T.J. Takahashi, 11/28/2008 (tjt839).

28.19. View of cracks in the concrete pavement over mortared rocks in the west-side breakwater of the harbor (view to the northwest). USGS photo by T.J. Takahashi, 11/28/2008 (tjt715).

28.20. View of cracks in the concrete pavement upon mortared rocks in the west-side breakwater of the harbor (view to the north-northwest). USGS photo by T.J. Takahashi, 11/28/2008 (tjt703).

29. Kawaihae Pier, Kawaihae

29.1. View of laterally spreading crack, approximately 0.3-m wide (1 ft), of the asphalt pavement at Kawaihae Pier 1 shipping yard, built upon dredged fill. The crack, 3.3 m (10.8 ft) deep, runs the length of the 145-m- (477-ft) long pier (view to the northwest). USGS photo by T.J. Takahashi, 10/20/2006 (tjt1419).

29.2. View of lateral spreading, approximately 3-cm wide (1.18 in.), of the edge beam at Kawaihae Pier 1, which was built upon unconsolidated gravelly sand (view to the south). USGS photo by T.J. Takahashi, 10/20/2006 (tjt1422).

29.3. View of a torsional crack in the pavement surrounding the boat tie at Kawaihae Pier 1 (view to the northwest). USGS photo by T.J. Takahashi, 10/20/2006 (tjt1420).

29.4. View of HVO volunteer measuring the subsidence of the pavement—approximately 15 cm (5.9 in.)—at Kawaihae Pier 1 (view to the southwest). USGS photo by T.J. Takahashi, 10/20/2006 (tjt1405).

29.5. View of cracks in the northwest corner of the warehouse foundation at Kawaihae Pier 1 (view to the southeast). USGS photo by T.J. Takahashi, 10/20/2006 (tjt1416).

29.6. View of a laterally spreading crack, approximately 0.4-m wide (1.3 ft), in the warehouse threshold (view to the south). USGS photo by T.J. Takahashi, 10/20/2006 (tjt1423).

29.7. View of HVO volunteer measuring vertical subsidence, approximately 10 cm (3.9 in.), in the warehouse floor at Kawaihae Pier 1 (view to the west). USGS photo by T.J. Takahashi, 10/20/2006 (tjt1400).

29.8. View of the slumping warehouse floor at Kawaihae Pier 1. The warehouse was demolished in September 2009 (view to the west). USGS photo by T.J. Takahashi, 10/20/2006 (tjt1407).

30. Pu‘ukoholā Heiau National Historic Site, Kawaihae

30A. Overviews: Pu‘ukoholā and Mailekini Heiau

30.1. Overview image: Aerial view of Pu‘ukoholā Heiau (in the foreground of the photo; view to the west), Maleikini Heiau next to it (northwest of the larger heiau), and Kawaihae harbor landfill (upper right of photo). DLNR photo by S. Bergfeld, 10/16/2006 (sb941).

30.2. Overview image: Low, oblique aerial view of Mailekini and Pu‘ukoholā (the larger of the two) heiaus (view to the northwest). DLNR photo by S. Bergfeld, 10/16/2006 (sb942).

30.3. Overview image: View of Pu‘ukoholā Heiau at the top of the hill and, to the west of it, Mailekini Heiau, viewed from the sandbar offshore (view to the east). USGS photo by T.J. Takahashi, 3/12/2007 (tjt3249).

30.4. Overview image: Pelekane, a wayside exhibit installed at the royal courtyard of the heiau, shows an artist’s rendering of early life at Pu‘ukoholā and a Hawaiian canoe greeting the arrival of a British sailing ship (view to the northwest). USGS photo by T.J. Takahashi, 3/12/2007 (tjt3239).

30B. Exterior walls of Pu‘ukoholā Heiau:

30.5. View of slumping along parts of the west (seaward-facing) wall of Pu‘ukoholā Heiau (view to the east). USGS photo by M.K. Sako, 11/9/2006 (mks008).

30.6. Close-up view of slumping in the west wall of Pu‘ukoholā Heiau (view to the southeast). USGS photo by T.J. Takahashi, 3/12/2007 (tjt3187).

30.7. View of the southwest end of the rock wall at Pu‘ukoholā Heiau. The trail was closed due to potential hazards from fallen rocks (view to the east-northeast). USGS photo by T.J. Takahashi, 3/12/2007 (tjt3203).

30.8. View of rounded, sea-worn rocks that rolled down the trail from the southwest wall of Pu‘ukoholā Heiau. These rocks are part of a collapsed wall that extended out from the heiau (view to the northeast). USGS photo by T.J. Takahashi, 3/12/2007 (tjt3206).

30.9. Overview image: The southwest corner of Pu‘ukoholā Heiau, as viewed from ground level. Part of the collapsed wall extension (see photo 30.8 (tjt3206)) is visible in the lower left corner of the image. Just beyond it, at the left of the photo, is the lele (sacrificial altar) (view to the west). USGS photo by T.J. Takahashi, 3/12/2007 (tjt3216).

30.10. View of the south (foreground) and adjacent east walls of Pu‘ukoholā Heiau. (The sloped walls are broader at the base to ensure stability.) Earthquakes caused rippling along the entire length of the eastern wall. ‘Ilima (*Sida fallax* Walp.), a shrub of the mallow family indigenous to drier regions of the tropical Pacific, grows at the southeast corner (Pratt, 1996) (view to the north). USGS photo by T.J. Takahashi, 3/12/2007 (tjt3210).

30.11. View of the ripple caused by the earthquake, preserved in the east wall of Pu‘ukoholā Heiau. Note the use of smaller, rounded, water-worn stones to fill gaps in the mortarless rock wall (view to the south). USGS photo by T.J. Takahashi, 3/12/2007 (tjt3156).

30.12. View of the northeast corner and part of the collapsed north wall of Pu‘ukoholā Heiau. Stones from the partially collapsed north wall rolled onto the trail around the base of the structure (view to the west). USGS photo by T.J. Takahashi, 3/12/2007 (tjt3159).

30.13. View of the collapsed entrance into Pu‘ukoholā Heiau along the north wall (view to the south). USGS photo by T.J. Takahashi, 3/12/2007 (tjt3169).

30.14. View of rocks that rolled onto the trail on the north side of Pu‘ukoholā Heiau (view to the west). USGS photo by T.J. Takahashi, 3/12/2007 (tjt3176).

30C. Interior of Pu‘ukoholā Heiau:

30.15. View of the platform terrace, made up of smooth, flat beach rocks and pebbles (light and dark-gray colors) inside Pu‘ukoholā Heiau. Note the rock slide from the interior of the east wall and the northeast corner (top right edge of the heiau in the photo) (view to the northwest). USGS photo by M.K. Sako, 11/9/2006 (mks002).

30.16. View of the collapsed interior section of the east wall (to the right of the large platform in the photo) and at the northeast corner of Pu‘ukoholā Heiau (view to the north). CSAV photo by D.A. Whilldin, 10/20/2006 (daw031).

30.17. Interior view of the collapse (foreground in photo) along the east wall (left wall in photo) and the collapsed section of the south wall (rear wall in photo) of Pu‘ukoholā Heiau (view to the south). CSAV photo by D.A. Whilldin, 10/20/2006 (daw041).

30.18. Interior view of the collapsed wall in the left foreground, vertical rippling along the east wall (left wall in the photo), and the collapsed section of the south wall (rear wall in the photo), of Pu‘ukoholā Heiau (view to the south). USGS photo by M.K. Sako, 11/9/2006 (mks091).

30.19. Interior view of the ripple in the east wall—and the collapsed rock wall in the foreground—of Pu‘ukoholā Heiau (view to the south). USGS photo by M.K. Sako, 11/9/2006 (mks090).

30.20. Close-up view of the collapse and ripple in the east wall of Pu‘ukoholā Heiau (view to the southeast). USGS photo by M.K. Sako, 11/9/2006 (mks093).

30.21. Close-up interior view of failure in the collapsed section of the south wall (center of photo) of Pu‘ukoholā Heiau (view to the south-southwest). The structures and the parking area at Spencer Beach Park are visible in the (right) background. USGS photo by M.K. Sako, 11/9/2006 (mks101).

30D. Mailekini Heiau:

30.22. Overview image: Southern half of the east-facing wall of Mailekini Heiau (view to the west-southwest). USGS photo by M.K. Sako, 11/9/2006 (mks036).

30.23. Overview image: Northern half of the east-facing wall of Mailekini Heiau (view to the northwest). USGS photo by M.K. Sako, 11/9/2006 (mks037).

30.24. View of the northern end of the failed east-facing wall of Mailekini Heiau, showing slumping at the end of the rock wall (view to the northwest). USGS photo by M.K. Sako, 11/9/2006 (mks035).

30.25. Interior view of the collapsed east wall—and minor damage to the west wall—of Mailekini Heiau (view to the north). USGS photo by T.J. Takahashi, 3/12/2007 (tjt3232).

30.26. View of the interior southeast corner of Mailekini Heiau that remained intact (view to the east-southeast). USGS photo by T.J. Takahashi, 3/12/2007 (tjt3231).

30.27. Close-up view of the undamaged beach-pebble floor in the southeast corner of Mailekini Heiau (view to the east). USGS photo by T.J. Takahashi, 3/12/2007 (tjt3230).

30.28. View of four-way fractures in a shaped rock vessel on a stone platform at the front of the south wall near the interior southeast corner of Mailekini Heiau after a rain (view to the south). CSAV photo by D.A. Whilldin, 10/20/2006 (daw021).

30.29. View, when dry, of fractures in the same shaped-rock vessel (see image 30.28 (daw021); (view to the southeast). USGS photo by T.J. Takahashi, 3/12/2007 (tjt3228).

30E. Restoration work at Pu‘ukoholā:

30.30. View of closure notice at Pu‘ukoholā Heiau while it undergoes repairs (view to the north). USGS photo by N.A. Ikeda, 7/11/2008 (nai629).

30.31. View of a movable display panel explaining the earthquake and repair work at Pu‘ukoholā Heiau. USGS photo by N.A. Ikeda, 7/11/2008 (nai631).

30.32. View of a movable display panel showing traditional methods of repairing stone walls. USGS photo by N.A. Ikeda, 7/11/2008 (nai632).

30.33. View of a closure sign, symbolic crossed standards, and gate barring entry to the area under restoration (view to the northeast). USGS photo by N.A. Ikeda, 7/11/2008 (nai638).

30.34. View of work crew members carrying freshly cut ironwood logs to the west terrace of Pu‘ukoholā Heiau, where they will be laid out for drying near the restoration work. After drying, the logs are light enough to be carried by a single person (view to the northwest). NPS photo by A.M. Johnson, 6/10/2008 (amj003).

30.35. View of work crew members erecting ‘oloke‘a (scaffolding) to repair the south wall of Pu‘ukoholā Heiau. Dried logs and branches for constructing ladders are sorted and carefully laid out (foreground) (view to the south). NPS photo by A.M. Johnson, 6/30/2008 (amj006).

30.36. View of crew members working on cross-members of ‘oloke‘a, using traditional methods of ladder construction, to repair the east wall of Pu‘ukoholā Heiau (view to the west). NPS photo by A.M. Johnson, 6/30/2008 (amj039).

30.37. View of crew members working on light, sun-dried ladders to realign the west wall of Pu‘ukoholā Heiau (view is to the southeast). NPS photo by A.M. Johnson, 6/11/2008 (amj055).

30.38. View of a completed ladder resting against the east wall of Pu‘ukoholā Heiau (view to the northwest). NPS photo by A.M. Johnson, 6/11/2008 (amj035).

30.39. Close-up view of the traditional method of ladder construction. A ladder rests on the west terrace of Pu‘ukoholā Heiau (view to the east-northeast). NPS photo by A.M. Johnson, 6/11/2008 (amj036).

30.40. View of completed and partially completed ladders leaning against the west wall of Pu‘ukoholā Heiau (view to the east). USGS photo by N.A. Ikeda, 7/11/2008 (nai635).

30.41. Overview image: Ladders lean against the west wall of Pu‘ukoholā Heiau (view to the east-northeast). USGS photo by N.A. Ikeda, 7/11/2008 (nai644).

30.42. View of crew members repairing Mailekini Heiau (view to the east-southeast). NPS photo by A.M. Johnson, 6/11/2008 (amj045).

31. Queen Ka‘ahumanu Highway Road Cut, Puakō

31.1. Overview image: Road cut, approximately 2.4 km (~1.5 mi) past the Puakō turnoff, shows the dense core of an ‘a‘ā flow, topped with a soil layer (view to the north). USGS photo by T.J. Takahashi, 1/24/2009 (tjt1122).

31.2–31.5. Overview image: A panorama of road cuts showing a soil-‘a‘ā layer over the dense core of an ‘a‘ā flow (view to the west). USGS photo by T.J. Takahashi, 1/24/2009 (tjt1112, tjt1111, tjt1115, and tjt1117).

31.6–31.7. Close-up view of fracturing in the dense core of an ‘a‘ā flow (view to the west). USGS photo by T.J. Takahashi, 1/24/2009 (tjt1050, tjt1055).

31.8–31.9. Close-up view of the dense core of an ‘a‘ā flow. Note the pattern and depth of vertical and horizontal fractures (view to the west). USGS photo by T.J. Takahashi, 1/24/2009 (tjt1100, tjt1099).

31.10–31.11. Detail of irregular fracturing in the dense core of an ‘a‘ā flow (view to the west). USGS photo by T.J. Takahashi, 1/24/2009 (tjt1098, tjt1096).

32. Moku‘aikaua Church, Kailua-Kona

32.1. Overview image: Front entrance of Moku‘aikaua Church (view to the east). USGS photo by T.J. Takahashi, 3/23/2007 (tjt3314).

32.2. Overview image: Pāhoehoe lava slab archway, gate, and front entrance of Moku‘aikaua Church (view to the east). USGS photo by T.J. Takahashi, 10/24/2006 (tjt1662).

32.3. View of the repaired front exterior wall of Moku‘aikaua Church, where grout was cracked from earthquake-related damage (view to the east-southeast). USGS photo by T.J. Takahashi, 10/24/2006 (tjt1667).

32.4. View of the undamaged interior of Moku‘aikaua Church (view to the east). USGS photo by T.J. Takahashi, 10/24/2006 (tjt1671).

32.5. View of a lithograph, displayed in the vestibule, of Moku‘aikaua Church, showing little change in its present-day appearance over time (view to the west-southwest). USGS photo by T.J. Takahashi, 10/24/2006 (tjt1684).

32.6. View of undamaged model of the brigantine *Thaddeus*—on which members of the Sandwich Islands Mission arrived from Boston in 1820 to work in Hawai‘i—displayed in the vestibule of Moku‘aikaua Church (view to the north-northeast). USGS photo by T.J. Takahashi, 10/24/2006 (tjt1674).

33. Hulihe‘e Palace, Kailua-Kona

33.1. Overview image: Hulihe‘e Palace (green-roofed structure) stands next to Moku‘aikaua Church (building with the steeple), in fog-shrouded Kailua town, with Kailua Bay in the foreground (view from Kailua pier, looking east-northeast). USGS photo by T.J. Takahashi, 3/23/2007 (tjt3362).

33.2. Overview image: Street-side and front-gate entrance to Hulihe‘e Palace and grounds (view to the southwest, across from Ali‘i Drive). Exterior views of the following photos (all but 33.11–33.18) take the viewer in a clockwise direction from this photo. USGS photo by T.J. Takahashi, 10/28/2006 (tjt1714).

33.3. View of the damage to the exterior façade of the south gable at Hulihe‘e Palace. The covered walkway is yellow-tagged for restricted use (view to the west). USGS photo by T.J. Takahashi, 10/28/2006 (tjt1716).

33.4. View of the damage to the exterior façade of the south gable at Hulihe‘e Palace (view to the north). USGS photo by T.J. Takahashi, 10/28/2006 (tjt1738).

- 33.5. Close-up view of the damage to the façade above a south gable window (view to the north). USGS photo by T.J. Takahashi, 10/28/2006 (tjt1741).
- 33.6. Overview image: The rear lānai (veranda), on the side opposite from the front gate, at Hulihe‘e Palace (view to the north). USGS photo by T.J. Takahashi, 3/23/2007 (tjt3320).
- 33.7. Close-up view of linear cracks in plaster along the entire length of the upper veranda at Hulihe‘e Palace (view to the northeast from ground level). USGS photo by T.J. Takahashi, 10/28/2006 (tjt1733).
- 33.8. View of linear cracks in plaster along the entire length of the upper veranda, where the wall buckled outward (view to the east). USGS photo by T.J. Takahashi, 10/28/2006 (tjt1780).
- 33.9. View of cracks in the stucco façade of the north gable at Hulihe‘e Palace—under the peak of the roof between the upper two windows, above the damaged door frame, and between the lower window and the white-painted building (view to the south). USGS photo by T.J. Takahashi, 10/28/2006 (tjt1731).
- 33.10. Close-up view of the crack in the stucco façade under the pitch of the roof. Smaller cracks can be seen all over the wall (view to the southeast). USGS photo by T.J. Takahashi, 10/28/2006 (tjt1726).
- 33.11. View from the front entrance of Hulihe‘e Palace, looking out. Note restricted-use notice attached to the wreath-hung koa door. There are also cracks in the entrance of the concrete walkway (view to the north). USGS photo by T.J. Takahashi, 10/28/2006 (tjt1883).
- 33.12. View of the chandelier and the koa bed for visiting royalty that were unscathed by the earthquake, but the ceiling and walls surrounding them were extensively damaged (view to the south). USGS photo by T.J. Takahashi, 10/28/2006 (tjt1833).
- 33.13. Close-up view of damage along the upper wall, near the ceiling, and alongside the window framing in the bedroom for visiting royalty (view to the southeast). USGS photo by T.J. Takahashi, 10/28/2006 (tjt1836).
- 33.14. Close-up view of cracked wall plaster, showing interior stone work in the bedroom for visiting royalty (view to the south). USGS photo by T.J. Takahashi, 10/28/2006 (tjt1817).
- 33.15. View of a chest of drawers in the bedroom for visiting royalty that appears to be tilting, but it is the room that is leaning. Note displacement of the wall behind the lower middle of the chest (view to the south). USGS photo by T.J. Takahashi, 10/28/2006 (tjt1821).
- 33.16. Close-up view of damage to the ceiling, where plaster separated from the wood lath. The lath remained intact, for the most part (view to the northeast). USGS photo by T.J. Takahashi, 10/28/2006 (tjt1847).
- 33.17. View of vertical cracks along the wall and lateral damage to the cornice (view to the east). USGS photo by T.J. Takahashi, 10/24/2006 (tjt1802).
- 33.18. Close-up view of vertical and horizontal cracks along the wall and cornice (view to the east). USGS photo by T.J. Takahashi, 10/28/2006 (tjt1875).

33.19. View from the front gate of scaffolding erected to undertake repairs to the walls of Hulihe‘e Palace (view to the southwest). USGS photo by N.A. Ikeda, 7/27/2008 (nai1048).

33.20. View of repair work in progress at the south-gable end of Hulihe‘e Palace (view to the west). USGS photo by N.A. Ikeda, 7/27/2008 (nai1055).

33.21. View of the north-gable end of Hulihe‘e Palace, showing repaired façade beneath the scaffolding (view to the south). USGS photo by N.A. Ikeda, 7/27/2008 (nai1052).

33.22. View of restored entrance (northeast side) of Hulihe‘e Palace, fronted by the stone wall and the entrance gate (view to the southwest). USGS photo by T.J. Takahashi, 2/7/2009 (tjt1129).

33.23. View of restored south gable of Hulihe‘e Palace (view to the north-northwest). USGS photo by T.J. Takahashi, 2/7/2009 (tjt1146).

33.24. View of restored rear veranda of Hulihe‘e Palace (view to the north). USGS photo by T.J. Takahashi, 2/7/2009 (tjt1144).

33.25. View of restored north gable of Hulihe‘e Palace (view to the south). USGS photo by T.J. Takahashi, 2/7/2009 (tjt1140).

33.26. Close-up view of the Hulihe‘e Palace sign, embedded in the stone wall, to the right of the entrance gate (view to the southwest). USGS photo by T.J. Takahashi, 3/23/2007 (tjt3329).

34. Hōlualoa Catholic Cemetery, Hōlualoa

34.1. View of slumping roadway shoulder approaching yellow-tagged Hōlualoa Catholic Cemetery, restricting entry (view to the northwest). USGS photo by T.J. Takahashi, 10/24/2006 (tjt1692).

34.2. View of slumping roadway shoulder fronting the cemetery, and dislodged sections of the stone wall fronting the cemetery (view to the southeast). USGS photo by T.J. Takahashi, 10/24/2006 (tjt1693).

34.3. View of cracks in the base of the largest headstone (view to the east). USGS photo by T.J. Takahashi, 10/24/2006 (tjt1709).

34.4. View of collapsed ground between cemetery plots (view to the west-southwest). USGS photo by T.J. Takahashi, 10/24/2006 (tjt1699).

34.5. View of slumping cemetery plot and its collapsed headstone (view to the west-southwest). USGS photo by T.J. Takahashi, 10/24/2006 (tjt1695).

34.6. View of collapsed earth in a cemetery plot (view to the north-northwest). USGS photo by T.J. Takahashi, 10/24/2006 (tjt1708).

34.7. View of slumping ground that caused the slab to crack and the headstone to topple over (view to the south-southwest). USGS photo by T.J. Takahashi, 10/24/2006 (tjt1706).

34.8. Overview image: New sign and view of the partially restored Hōlualoa Catholic Cemetery. Many of the headstones and sunken bases were filled and reset, but fragments of some structures remain untouched (view to the west-southwest). USGS photo by N.A. Ikeda, 7/27/2008 (nai1045).

- 34.9. Overview image: The friable nature of the ground and the closely spaced plots present a quandary in the restoration of the cemetery (view to the northwest). USGS photo by N. Steiner and T. Steensen, 1/24/2009 (nas-tss192).
- 34.10. Overview image: The degree of slope contributed to ground slumping and the fracturing of headstones (view to the northeast). USGS photo by T.J. Takahashi, 2/7/2009 (tjt1163).
- 34.11. View of a large headstone replacing the one that cracked as a result of the earthquake (see 34.3 (tjt1709); view to the east). USGS photo by T.J. Takahashi, 2/7/2009 (tjt1159).
- 34.12. View of the newly restored cemetery plot (as seen in photo 34.6 (tjt1708); view to the northwest). USGS photo by N. Steiner and T. Steensen, 1/24/2009 (nas-tss199).

35. Kona Community Hospital, Kealahou

- 35.1. Overview image: Kona Community Hospital's Keakealani building (view to the east). USGS photo by T.J. Takahashi, 1/15/2007 (tjt2318).
- 35.2. Overview image: The Keakealani building (foreground), the administrative building (center of photo), and the hospital wing (in background; view to the southeast). USGS photo by T.J. Takahashi, 1/15/2007 (tjt2319).
- 35.3. Overview image: The three-story hospital wing, connected to the administrative building by a covered walkway (view to the north-northeast). USGS photo by D.C. Dow (dcd1274).
- 35.4. Overview image: Another view of the hospital wing. The ambulance port is the dark area at the end of the driveway (view to the north-northwest). USGS photo by D.C. Dow (dcd1273).
- 35.5. View of damage to the wall, intersected by a post beam, on the ground floor of the hospital wing in the ambulance port (view to the east). USGS photo by T.J. Takahashi, 10/28/2006 (tjt1616).
- 35.6. View of damage to suspended ceiling panels, light fixtures, and ventilation (view to the south). USGS photo by T.J. Takahashi, 10/28/2006 (tjt1647).
- 35.7. View of plastic sheeting used to protect obstetrics ward from dust contamination. Note damage to suspended ceiling (view to the south). USGS photo by T.J. Takahashi, 10/28/2006 (tjt1651).
- 35.8. View of backup tents, quickly set up on the grounds of Kona Community Hospital (view to the northwest). USGS photo by T.J. Takahashi, 10/28/2006 (tjt1627).
- 35.9. View of a tent's interior, fully stocked with medical supplies and equipment (view to the west). USGS photo by T.J. Takahashi, 10/28/2006 (tjt1626).
- 35.10. View of portable lua (toilets), set up at the hospital for the medical tent facility (view to the west). USGS photo by T.J. Takahashi, 10/28/2006 (tjt1629).
- 35.11. View of the gas tank, anchored to the concrete pavement to prevent movement during future earthquakes (view to the west). USGS photo by T.J. Takahashi, 10/28/2006 (tjt1631).

35.12. Close-up view of anchors for the gas tank, bolted to the pavement for security during earthquakes (view to the north). USGS photo by T.J. Takahashi, 10/28/2006 (tjt1632).

35.13. View of the backup generator, borrowed from the County of Hawaii, to supply electrical power during outages until the hospital became fully operational again (view to the north-northwest). USGS photo by T.J. Takahashi, 10/28/2006 (tjt1633).

35.14. View of HVO strong-motion seismometer from the National Strong Motion Seismometer Program, located in the hospital's basement (view to the west). USGS photo by T.J. Takahashi, 10/28/2006 (tjt1620).

35.15. View of GPS antenna (little white dome), used mostly for accurate timing of earthquakes, mounted by cable on the outside wall. The unit is attached to the seismometer in the hospital's basement (view to the east). USGS photo by T.J. Takahashi, 10/28/2006 (tjt1621).

36. Kealakekua Bay, Kealakekua

36.1. View of the dust cloud that blew across the ocean and obscured the Ka'awaloa lava delta of Kealakekua Bay from view (view to the north-northwest from Ke'ei shoreline). Photo by J.P. Lockwood, 10/15/2006 (jpl001).

36.2. View of scarring by rock slides at the southeastern end of the fault, across the mid-section of the sea cliff along Kealakekua Bay (view to the northwest from the Napo'opo'o shoreline). USGS photo by T.J. Takahashi, 11/8/2006 (tjt1966).

36.3. Close-up view of scarring on the sea cliff at Napo'opo'o, toward the west-northwest end of the bay from the rock falls. Note talus from rock falls at the base of the cliff (view to the northwest from the Napo'opo'o shoreline). USGS photo by T.J. Takahashi, 11/8/2006 (tjt1983).

36.4. Wide-angle view of Kealakekua Bay, from the boat at the Napo'opo'o end of the bay—showing fresh scarring on the sea cliff about halfway across the bay—to the Ka'awaloa lava delta (view to the west-northwest). DLNR photo by K. Gooding, 10/19/2006 (kg1374).

36.5. Extensive series of rock falls above the Ka'awaloa lava delta, viewed from the boat in Kealakekua Bay. Note Captain Cook Monument (lower left of photo) at the cliff's base (view to the northwest). DLNR photo by K. Gooding, 10/19/2006 (kg1378).

36.6. Detail of rock-fall damage across the sea cliff and talus deposits toward the end of the fault at the Ka'awaloa lava delta. The Captain Cook Monument stands at the base of the cliff (view to the north-northwest from the boat). DLNR photo by K. Gooding, 10/19/2006 (kg1303).

36.7. Detail of the light orange-brown scar on the sea cliff and rock-fall deposits on the shoreline of the Ka'awaloa lava delta, north-northeast of the Captain Cook Monument (view to the northeast). DLNR photo by K. Gooding, 10/19/2006 (kg1308).

36.8. Detail of the light-brown scar on the sea cliff and rock-fall deposits above the Ka'awaloa lava delta, north-northeast of the Captain Cook Monument (view to the north-northeast). DLNR photo by K. Gooding, 10/19/2006 (kg1334).

36.9. Detail of rock-fall deposits and scarring of the entire section (from top to bottom) of the sea cliff and the adjoining Ka'awaloa lava delta north-northeast of the Captain Cook Monument (view to the north). DLNR photo K. Gooding, 10/19/2006 (kg1510).

36.10. Close-up aerial view of the scarred sea cliff and rock-fall deposits adjoining the Ka'awaloa lava delta north-northeast of the Captain Cook Monument (view to the north). DLNR photo by K. Gooding, 10/19/2006 (kg1513).

36.11. Close-up aerial view of the sea cliff and talus deposit approximately two-thirds of the way across the Kealakekua fault (view to the northeast). DLNR photo by K. Gooding, 10/19/2006 (kg1518).

36.12. View of the sea cliff, showing recovery of vegetation near a heiau at Napo'opo'o (view to the north-northeast). USGS photo by N.A. Ikeda, 7/19/2008 (nai748).

36.13. View of the sea cliff north-northeast of Captain Cook Monument, on the Ka'awaloa lava delta, showing orange-brown discoloration of rock-fall path and slow recovery of vegetation on vertical cliffs, where soil deposit is lacking (view to the northeast). USGS photo by N.A. Ikeda, 7/19/2008 (nai764).