

Drilling, Construction, Geologic, and Caliper Logs for Well 8-4010-01, Kaumana Exploratory Well, Island of Hawaii

By Charles J. Ewart

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Conversion Factors

	Multiply	By	To obtain
	foot (ft)	0.3048	meter
	gallon (gal)	3.785	liter
	million gallons per day (Mgal/d)	0.04381	cubic meter per second
	mile (mi)	1.609	kilometer
	inch (in.)	25.4	millimeter

Elevations in this report are referenced to mean sea level.

Drilling, Construction, Geologic, and Caliper Logs for Well 8-4010-01, Kaumana Exploratory Well, Island of Hawaii

By Charles J. Ewart

Abstract

The Kaumana exploratory well (State well number 8-4010-01) was drilled about 2 miles west of the community of Kaumana and at the western end of the Kaumana Estates subdivision. The well is located on Hawaii County land at a Department of Water Supply tank at an elevation of 1,799 feet. The well was drilled into the rocks of the Mauna Loa Volcano to a depth of 1,397 feet and encountered a water table standing at an elevation of 997 feet. Well-construction data, geologic log, driller's log, and caliper log are presented for the well. This well is one of three exploratory wells drilled on the island of Hawaii between September 1994 and April 1995 in cooperation with the County of Hawaii Department of Water Supply.

INTRODUCTION

The Kaumana exploratory well was the second of three deep exploratory wells drilled on the island of Hawaii between September 1994 and April 1995. These wells were drilled by the U.S. Geological Survey (USGS) as part of a program of exploratory/monitor well drilling carried out in cooperation with the County of Kauai Department of Water, the County of Hawaii Department of Water Supply, and the City and County of Honolulu Board of Water Supply. The program, begun in 1993, is designed to provide hydrologic and geologic information for aquifers on each of the island counties. This information is vital to the understanding of the ground-water systems on each island and for estimating the amount of available ground water.

In addition to providing needed hydrogeologic information, the exploratory wells completed under this

program will be used as long-term monitoring sites to provide data and information for the management, protection, and conservation of the ground-water resources. The rotation of the drilling rig between the islands and the duration of drilling on each island are determined by the three county water managers. Drilling sites are selected and prioritized jointly by the county water departments and the USGS.

The purpose of the Kaumana exploratory well was to provide information on the little known ground-water resources of the Kaumana area. The well was drilled on County of Hawaii property at the site of the Department of Water Supply's Kaumana tank at an elevation of 1,796 ft, and about 2 mi west of the community of Kaumana and at the western boundary of the Kaumana Estates subdivision. Water was encountered at a depth of 799 ft below land surface (997 ft above sea level). This previously unknown source of high-level water may prove to be a dependable source of water for the Kaumana area which currently relies on water from several springs. The extent and nature of the impounding structures are not known. This report presents a summary of the existing knowledge of the occurrence of ground water within the South Hilo District and geohydrologic data and construction details of the well.

Acknowledgments

The USGS gratefully acknowledges the assistance of the Hawaii County Department of Water Supply in site preparation and logistical support throughout the period of well construction.

Setting

The South Hilo District of the island of Hawaii lies partly on the northeastern slopes of Mauna Loa and

partly on the eastern slopes of Mauna Kea and has a land area of 250,900 acres (fig. 1). Elevations within the District range from sea level to 6,000 ft. Mean annual rainfall ranges from about 140 in. in coastal areas to about 300 in. in a lateral band from the Wailuku River north to Honomu, then diminishes to about 80 in. at the 6,000-ft elevation. The Kaumana exploratory well (State well number 8-4010-01) is located at a Department of Water Supply tank site at the western boundary of the Kaumana Estates subdivision about 2 mi west of the community of Kaumana and at an elevation of 1,796 ft (fig. 2). The rocks of the South Hilo District are from the Mauna Loa Volcano south of the Wailuku River and from the Mauna Kea Volcano north of the river. The historic lava flows of 1855 and 1881 from Mauna Loa Volcano extend into the southern part of the District with the 1881 flow almost reaching the sea. The Kaumana exploratory well was drilled through the 1881 lava flow into older rocks of the Mauna Loa Volcano. Mauna Loa rocks are generally highly permeable while those of Mauna Kea are of moderate to high permeability (Stearns and Macdonald, 1946).

GROUND-WATER OCCURRENCE

Ground-water occurrence in the South Hilo District has been described in detail by Stearns and Macdonald (1946), Davis and Yamanaga (1968), and summarized by Davis and Yamanaga (1973). The following generalized description of ground-water occurrence draws extensively from these works.

Within the South Hilo District, ground water is found as basal water, which is that roughly lens-shaped body of freshwater near sea level floating on seawater, and as high-level water manifested as numerous springs, most of which issue between 1,000 and 2,000 ft on the flanks of both Mauna Loa and Mauna Kea. Water from the springs is held up by ash beds, by soil formed on weathered lavas, and by dense lava flows. The perching bodies are thin and discontinuous and discharge from the springs fluctuates greatly with rainfall. There is thought to be high-level ground water held up by volcanic dikes in the interiors of Mauna Loa and Mauna Kea but there is no visible evidence of this type of occurrence within the South Hilo District. Recharge to the basal water body is from direct infiltration of rainfall on the permeable rocks and from subsurface discharge of high-level ground-water bodies. Recharge to the

high-level ground-water bodies is from direct infiltration of rainfall. Discharge from the basal water bodies is from springs and seeps visible near the coast or discharging below sea level offshore and by discharge to streams where the stream channel has cut deep enough into the rocks to intersect the basal water table. Discharge from high-level ground-water bodies is from springs and seeps and from sub-surface leakage to basal water bodies.

The largest and most accessible freshwater supply can be found in the basal water body underlying the South Hilo District. Discharge from the basal water body near Hilo averages more than 100 Mgal/d, and comes from springs that discharge into Waiakea pond. Because of the occurrence of springs at elevations between 1,000 to 2,000 ft, the flow can be delivered by gravity to places of need at lower elevations. This favorable occurrence is offset by the fluctuating flow volume in response to rainfall and the scattered nature of the springs, and the generally small volume.

The Kaumana exploratory well (State well number 8-4010-01) was drilled through rocks of the Mauna Loa Volcano to a depth of 1,397 ft. High-level ground water was encountered at an elevation of 997 ft above sea level. The extent of this high-level ground-water body and the nature of the impounding structures are not known.

Information on selected drilled wells is given in table 1. Drilled wells and other sources of water in the South Hilo District are shown in figure 3.

DRILLING, CONSTRUCTION, GEOLOGIC, AND CALIPER LOGS FOR THE KAUMANA EXPLORATORY WELL (STATE WELL NUMBER 8-4010-01)

The Kaumana exploratory well was drilled by an air-rotary drill rig using a mixture of water, drilling foam, and polymer as the drilling fluid to stabilize the borehole and to aid in the removal of cuttings and water. Samples of the materials penetrated by the bit were obtained at 5 ft intervals down to a depth of 95 ft. Circulation was lost at this depth and never regained for the remainder of the drilling to total depth. Drilling began on December 6, 1994 and was completed on February 14, 1995. Drilling was hindered by the lost circulation and by several zones of cascading water. These zones of

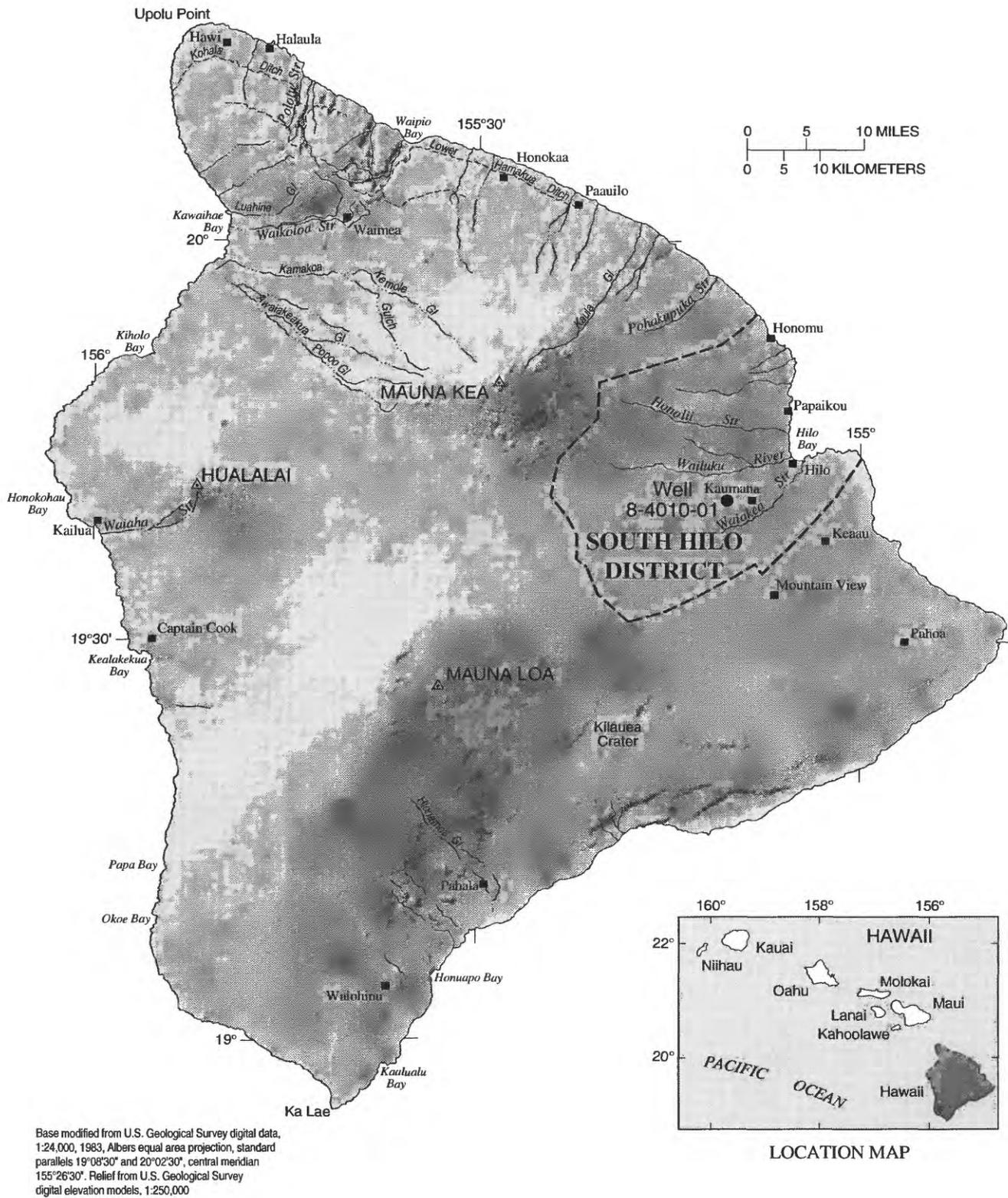


Figure 1. Location of Hawaiian islands, island of Hawaii, and South Hilo District.

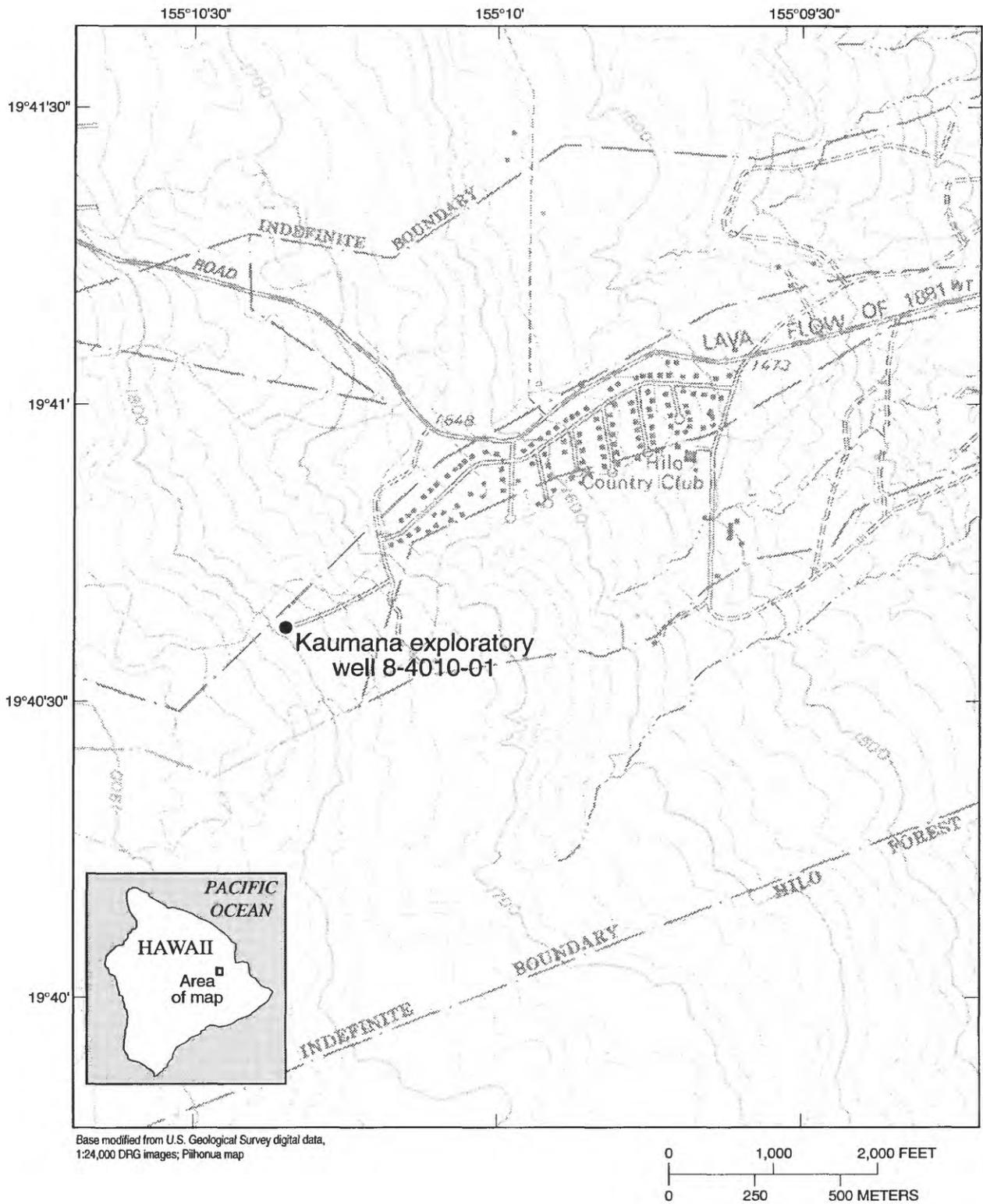


Figure 2. Location of the Kaumana exploratory well (State well number 8-4010-01), island of Hawaii.

Table 1. Elevation, water-level, and chloride-concentration data for selected drilled wells in the South Hilo District, island of Hawaii

[Datum is mean sea level; data from records in the district office of the U.S. Geological Survey, Hawaii; --, no data]

State well number	Year drilled	Elevation (feet)	Water level (feet)	Chloride concentration (milligrams per liter)
8-3844-01	1987	552	33	12
8-3810-01	1900	2,100	--	--
8-4003-01	1963	206	13	8
8-4010-01	1995	1,796	997	--
8-4100-01	1971	47	6	280
8-4202-01	1944	59	4	108
8-4203-04	1961	47	7	11
8-4203-10	1973	55	6	13
8-4203-13	1948	23	3	13
8-4203-15	1987	81	9	21
8-4304-01	1941	12	0.7	5,600
8-4306-01	1973	278	42	2
8-4706-01	1972	369	21	4
8-5005-01	1946	304	11	16
8-5005-05	1977	74	7	285
8-5006-01	1976	378	12	7
8-5307-02	1981	101	80	--

cascading water were observed by a video log of the well made on January 13, 1995. A 12-1/4 in. hole was drilled to a depth of 90 ft and an 8-in. inside-diameter steel casing grouted in place. The remainder of the hole was drilled using a 6-3/4 in. tricore tungsten carbide bit. Well-construction data are provided in table 2 and construction details are shown in figure 4.

Finally, the hole was cased with 4-in. inside-diameter, flush joint, steel casing. Blank casing was installed to a depth of 732 ft and slotted casing was installed from 732 to 1,375 ft. Prior to the installation of the 4.5-in. outside-diameter casing, 22 ft of the hole was lost because of caving. A 4 ft by 4 ft by 4 in. concrete pad was constructed around the well, and the well was secured with a locking cover.

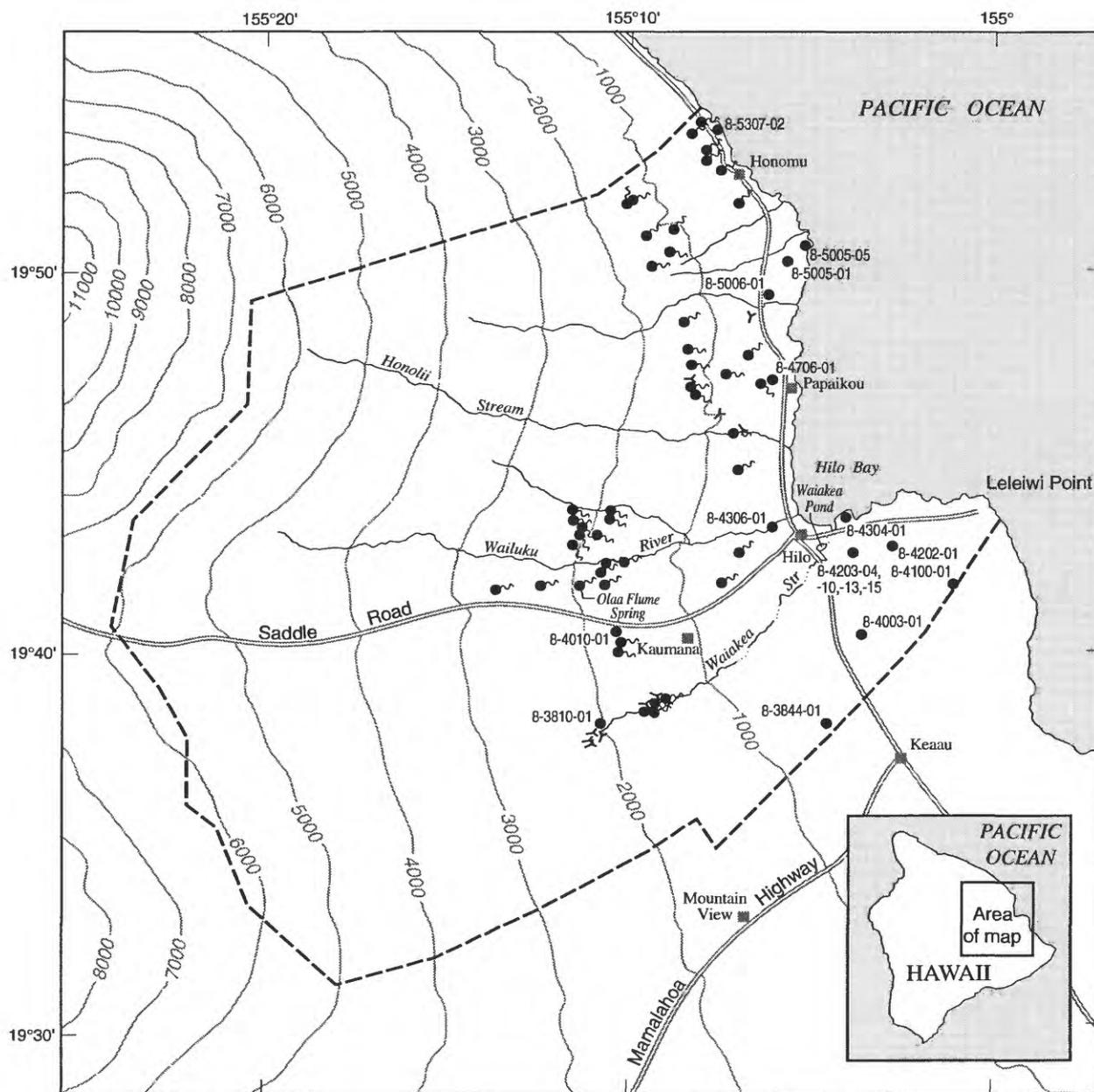
A geologic log of the first 95 ft of the well is found in table 3 and a driller's log is given in table 4. The caliper log (fig. 5) was made after reaching the final depth of 1,397 ft. The caliper tool is a means to indirectly measure hole diameter and smoothness. The tool has three 16-inch spring-loaded arms that are extended when the tool reaches the bottom of the hole. As the tool

is slowly raised, a logging unit records the extension of the arms as they drag against the walls of the borehole. The maximum extension of the caliper arms is 32 in.

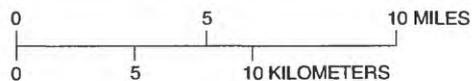
A video log of the borehole from ground surface to a depth of 405 ft is available at the USGS Hawaii District Office. The log showed that water was cascading into the hole at depths below ground of 158, 200, 240, 249, 317, 384, and 405 ft.

REFERENCES CITED

- Davis, D.A., and Yamanaga, George, 1968, Preliminary report on the water resources of the Hilo-Puna area, Hawaii: Hawaii Division of Water and Land Development, Department of Land and Natural Resources, Circular C45, 38 p.
- Davis, D.A., and Yamanaga, George, 1973, Water resources summary, island of Hawaii: Hawaii Division of Water and Land Development, Department of Land and Natural Resources, Report R47, 42 p.
- Stearns, H.T., and Macdonald, G.A., 1946, Geology and ground-water resources of the island of Hawaii: Hawaii Division of Hydrography Bulletin 9, 363 p.



Base modified from U.S. Geological Survey digital data, 1:24,000, 1983, Albers equal area projection, standard parallels 19°08'30" and 20°02'30", central meridian 155°26'30"



EXPLANATION

- | | | | |
|-------------|--------------------------|------------|--|
| 8-4010-01 ● | DRILLED WELL AND NUMBER | ---2000--- | TOPOGRAPHIC CONTOUR--Interval 1,000 feet |
| ● | SPRING | - - - - - | SOUTH HILO DISTRICT BOUNDARY |
| Y | WATER-DEVELOPMENT TUNNEL | | |

Figure 3. Selected wells, springs, and tunnels, South Hilo District, island of Hawaii.

Table 2. Construction data for the Kaumana exploratory well, island of Hawaii

[Elevation datum is mean sea level; in., inches; ft, feet; id, inside diameter; USGS, U.S. Geological Survey]

Well Name	Kaumana exploratory well
State well number	8-4010-01
Latitude and longitude	19°40'35" 155°10'23"
Hawaii tax map key number	2-5-002:024
Landowner	Hawaii County
Well completed	February 14, 1995
Driller	G. Wayne Heick, USGS
Surface hole diameter	12-1/4 in.
Bottom of surface casing	1,706 ft
Surface casing type and diameter	Steel, 0.188-in. wall, 8-in. id
Final hole diameter	6-3/4 in.
Bottom of well elevation.	399 ft
Inner casing type and diameter	Steel, 4-in. id
Slotted interval elevations.	1,064 to 421 ft
Reference mark elevation (plate in concrete pad).	1,796.10 ft
Measuring point (top of 4-in. casing)	1,796.29 ft
Water level and date of measurement	997.0 ft; February 13, 1995

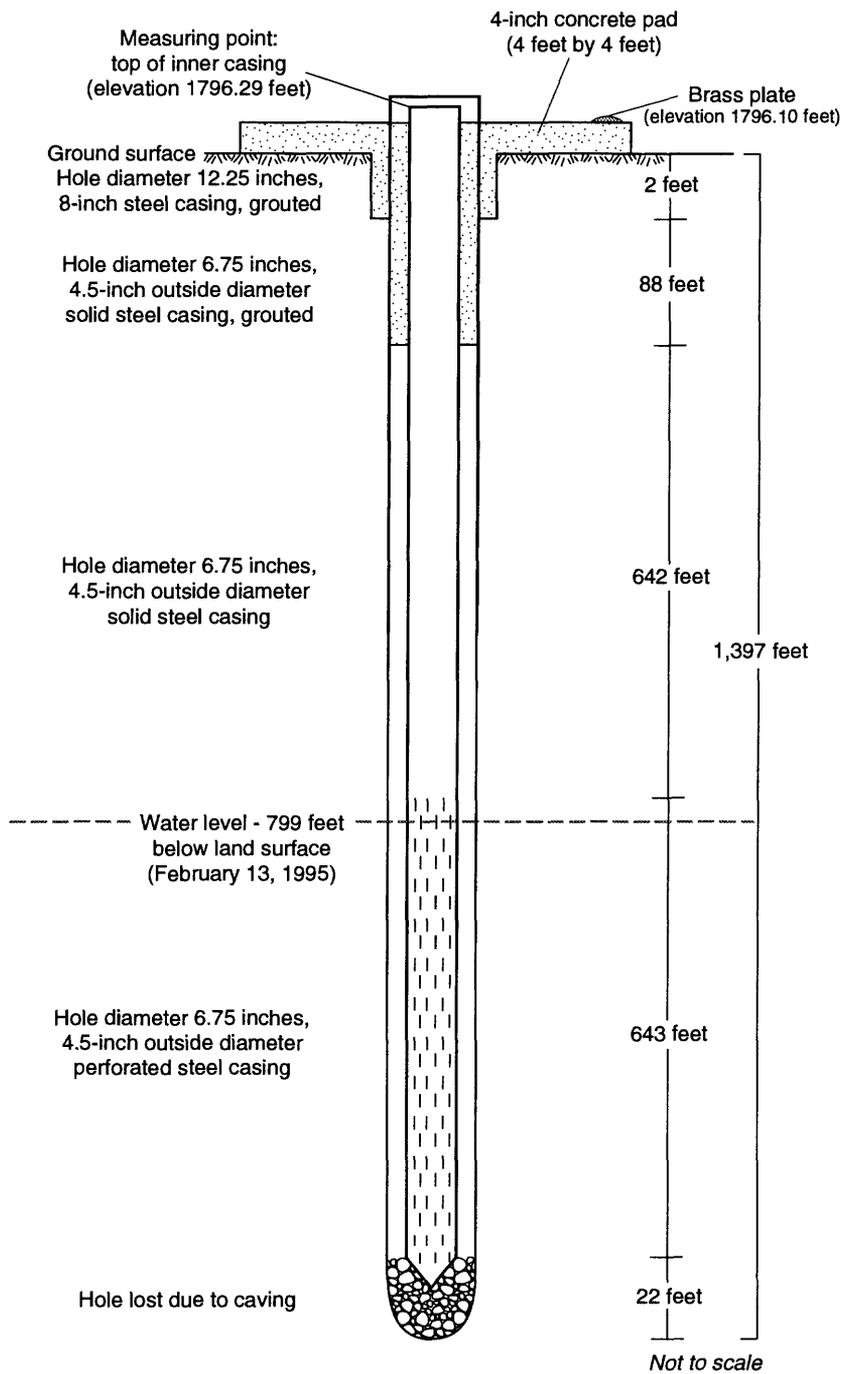


Figure 4. Construction details of the Kaumana exploratory well (State well number 8-4010-01), island of Hawaii.

Table 3. Geologic log for the Kaumana exploratory well (State well number 8-4010-01), island of Hawaii

Depth (in feet)	Sample description	Geologic description
0-9	gray, moderately vesicular, aphanitic basalt	lava flow of 1881
9-17	weathered, yellowish-brown ash	ash
17-20	slightly weathered, light gray, sparsely vesicular aphanitic basalt	pahoehoe lava flow
20-25	no sample	
25-30	weathered, light-gray, highly vesicular aphanitic basalt	pahoehoe lava flow
30-35	moderately weathered, light-gray, vesicular aphanitic basalt	pahoehoe lava flow
35-45	moderately weathered, light-gray, vesicular aphanitic basalt	pahoehoe lava flow
45-55	unweathered, medium-gray, highly vesicular, aphanitic basalt	aa lava flow
55-60	moderately weathered, light purplish-gray, vesicular aphanitic basalt	pahoehoe lava flow
60-65	moderately weathered, light-gray, vesicular aphanitic basalt	pahoehoe lava flow
65-70	moderately weathered, light-gray, vesicular aphanitic basalt	pahoehoe lava flow
70-75	slightly weathered, medium-gray, sparsely vesicular aphanitic basalt	pahoehoe lava flow
75-85	unweathered, medium-gray, highly vesicular, aphanitic basalt	pahoehoe lava flow
85-95	unweathered, medium-gray, highly vesicular, aphanitic basalt	pahoehoe lava flow
95-1,397	no sample	

Notes: Circulation ended at 95 feet and never regained

Samples collected by: G. Wayne Heick, Kimo Akina, and Frederick Thibedeau

Sample type: Cuttings from rotary drilling with foam and polymer

Sample repository: USGS Hawaii District office, 677 Ala Moana Blvd., Suite 415, Honolulu, HI 96813

Geologic descriptions by: S.K. Izuka, U.S. Geological Survey

Date of logging: January 1996

Table 4. Driller's log for the Kaumana exploratory well (State well number 8-4010-01), island of Hawaii
 [gal/min, gallons per minute; Drill crew--G. Wayne Heick, Kimo K. Akina, Frederick Thibedeau; circulation lost at 95 ft and never regained]

Date	Depth (feet)	Log/remarks
12/6/94	0-9	Broken aa rock
	9-17	Red clay, soft, moist
	17-24	Hard blue rock, good returns
	24-25	Fractured rock, wet spot
	25-82	Blue rock, solid, uniform, good returns
	82-85	Brownish-red, solid, good returns
	85-87	Puka rock, good returns
	87-92	Blue rock, solid, good return
	92-95	Blue rock, void, lost circulation
12/7/94	95-98	Lava tube, (void) no returns
	98-102	Aa rock, medium hard
	102-112	Red oxidized rock, medium soft
	112-137	Blue rock, medium hard
	137-142	Blue rock, pahoehoe?, solid
	142-149	Red oxidized, very broken, loose clinkers
	149-154	Blue rock, hard
	154-162	Red oxidized, medium-soft, water at 158?
	162-171	Red oxidized, some blue rock seams
	171-174	Lava tube, (void), tools fell, some water
	174-183	Blue rock, hard
	183-189	Red, oxidized, very broken, soft
	189-190	Puka rock, clinkers, broken
	190-193	Blue rock, solid, medium-hard
	193-198	Red clay, soft, possible water
	198-200	Red oxidized, soft
	200-202	Clinker material, soft, water at 200?
	202-203	Red oxidized, soft cinder or clay seams
	203-229	Blue rock, solid, medium hard
	229-234	Red oxidized rock, soft
234-249	Blue rock, medium-hard	
249-253	Lava tube, full of clinkers	
253-255	Red oxidized, very broken, loose	
12/14/94	255-270	Blue rock, hard
	270-273	Broken rock, medium hard
	273-275	Blue rock, hard
12/15/94	275-300	Blue rock, very hard slow drilling
	300-328	Red oxidized rock, medium-soft
	328-330	Void, tools dropped, no clinkers
	330-334	Blue rock, medium hard
	334-338	Broken, soft rock
	338-351	Red, oxidized, broken, soft
	351-373	Blue rock, medium-hard
	373-388	Red oxidized, soft, possible water
	388-410	Blue rock, hard
	410-430	Broken, soft rock
	430-440	Blue rock, hard
	440-456	Broken, soft, clay 451-456 feet, water?
456-475	Blue rock, medium-hard	
12/16/94		Strip tools, attempt to get water level, water cascading in hole, no luck
12/28/94		Caliper log hole twice, no water in hole, added new bit ran tools into hole, clean hole of about 3 feet of cuttings
12/29/95	475-484	Blue rock, hard
	484-486	Void, tools dropped
	486-490	Blue rock, medium-hard
	490-500	Red oxidized rock, soft

Table 4. Driller's log for the Kaumana exploratory well (State well number 8-4010-01), island of Hawaii--Continued
 [gal/min, gallons per minute; Drill crew--G. Wayne Heick, Kimo K. Akina, Frederick Thibedeau; circulation lost at 95 ft and never regained]

Date	Depth (feet)	Log/remarks
	500-517	Red clay, possible cinder, very soft water?
	517-530	Broken clinkery, medium-soft
	530-547	Blue rock, medium-hard
	547-550	Void, no clinkers
	550-571	Blue rock, medium-hard
	571-594	Broken rock, medium-soft
	594-605	Blue rock, hard
	605-615	Blue rock into broken rock, medium-hard
12/30/94	615-617	About 100 feet water in hole, blue rock, hard
	617-620	Blue rock, hard, uniform
	620-627	Loose, fractured rock
	627-635	Blue rock, hard
	635-642	Broken rock, medium-soft
	642-645	Blue rock, very hard
	645-655	Blue rock, very hard slow drilling
12/31/94	655-662	Blue rock, very hard, bit plugged from fine material due to cascading water
	662-674	Blue rock, broken, medium-hard
	674-689	Blue rock with broken rock layers
	689-716	Broken rock, aa, medium-hard
	716-720	Red oxidized with hard streaks
	720-746	Red oxidized, soft smooth drilling water?
	746-755	Pahoehoe, solid few breaks
	755-765	Red-blue rock, medium-soft
	765-770	Blue rock, very hard
	770-786	Blue rock to broken, clinkery
	786-802	Blue rock, hard, smooth drilling
	802-817	Red oxidized, medium-soft
1/3/95	817-833	No water in hole, soft-medium hard rock
	833-839	Blue rock, hard
	839-875	Broken, clinkery, medium-soft
	875-891	Very soft, silty, possible water
	891-892	Broken, medium-soft
	892-895	Void, full of silt or cinders
	895-897	Blue rock, broken, medium-hard
	897-955	Blue rock, very hard, bit is worn
1/4/95		Strip tools out, bit is worn, caliper log hole. New bit, run tools back into hole
1/13/95		Start video log at 11am, complete 3pm Cascading water observed at depths of 158, 200, 240, 249, 317, 384, 405 feet. Major flow at 405 feet 100-120 gal/min estimated, blocked out light on camera, buffeting camera could not go much further
1/14/95		Heavy rains with some lightning, unsafe, secured site
1/15/95		Ran steel back in hole, checked on static water level through drill pipe, found at depth of 650 feet. More lightning and heavy rain. Unsafe to work secured site at 2pm
1/16/95		Bridge in hole from cascading water. Added one joint of steel, rotated clear, static water level at 662.4 feet below table. More rain
1/17/95		Strip out tools to check water level, level at 662.5 below table. Checked air test shows 665 feet. All tools out for 4-day break
1/25/95		Attach new bit, run tools into hole, mixed new batch of fluid, tools to bottom, circulate to condition hole
1/26/95	955-965	About 130 feet of water in hole. Blue rock, hard
	965-973	Aa broken, clinkery, medium-soft
	973-985	Blue rock, very hard

Table 4. Driller's log for the Kaumana exploratory well (State well number 8-4010-01), island of Hawaii--Continued
 [gal/min, gallons per minute; Drill crew--G. Wayne Heick, Kimo K. Akina, Frederick Thibedeau; circulation lost at 95 ft and never regained]

Date	Depth (feet)	Log/remarks
	985-989	Aa, medium-hard
	989-993	Cinders? soft silt-like
	993-1,097	Aa, clinkery, broken, medium-soft, possible more water
1/27/95		Pulled all tools out of hole by noon. Removed check valves and put tools back into hole to try to measure water level. Best measurement through drill pipes is 610.5 feet below table. Cascading water creating a venturi effect and agitating foam remnants
1/28/95		Had to replace compressor oil lines. Unable to get good water-level reading. Got some defoamer and ran fresh water down drill string. Water level varying from 725.6 to 726.6 feet
1/29/95		Water level at 0800 hours is 725.2 feet but fluctuating. Resume drilling
	1,097-1,111	Blue rock, hard
	1,111-1,132	Broken, clinkery, aa, medium-soft
	1,132-1,138	Blue rock, uniform, medium-hard
	1,138-1,221	Aa, broken, unconsolidated, medium-soft
	1,221-1,237	Blue rock, hard
1/30/95		Measured water level after flushing drill pipes with water and adding de-foamer. Level is steady at 783.3 feet. Mix new fluid batch and resume drilling
	1,237-1,240	Blue rock, hard
	1,240-1,280	Broken, clinkery, aa?, medium-soft
	1,280-1,284	Cinders, silt?, very soft
	1,284-1,297	Blue rock, some broken, medium-hard
1/31/95		About 500 feet of water in hole
	1,297-1,315	Blue rock, hard
	1,315-1,340	Broken, aa?, medium-soft
	1,340-1,345	Clinkers, loose, air up to 270 pounds per square inch (psi)
	1,345-1,361	Blue rock, hard
	1,361-1,374	Broken, clinkery, aa?, medium-soft
	1,374-1,397	Blue rock, hard caving at 1,374 feet, some problems
2/1/95		Flush drill pipe with clean water, add de-foamer, water level is at 784.6 feet from table. Pull tools out of hole back to 777 feet
2/6/95		Flush drill pipe with clean water, add de-foamer added steel. Water level is between 725 and 730 feet below table
2/7/95		Water level measured, good measurement, level is bouncing between 745 and 749 feet below table. Pulled all tools, set up to run caliper log. Caliper hit bridge at 472 feet. Ran tools back in hole broke bridge tools now at 655 feet
2/9/95		Ran tools to 938 feet. Water level is at 741.8 below table. Pulled all tools for another caliper run. Caliper tool hit bridge at 950 feet. Ran drill tools back in hole, drilled out bridge at 950 feet
2/10/95		Run tools back in hole, tag bottom at 1,374 feet. About 23 feet of hole loss. Not willing to blow air and disturb hole more. Pulled all drill tools for log attempt. Run caliper tool, hit bridge at 524 feet. Pull caliper tool, run drill rods back in to 595 feet, no obstructions. Remove all tools again. Caliper tool went to 1,156.4 and we logged hole
2/11/95		Ran all tools back in hole to 1,156.4 Drilled down to 1,375.0. Pulled drill tools, ran caliper to bottom at 1,375 feet and logged hole. Good log
2/12/95		Loaded casing at yard, delivered to site began casing the hole. Secured with casing at 732 feet
2/13/95		Completed casing well. Casing reached bottom (1,375 feet) at 2pm, water level 799 feet
2/14/95		Grouted 90 feet--well finished. Made pad

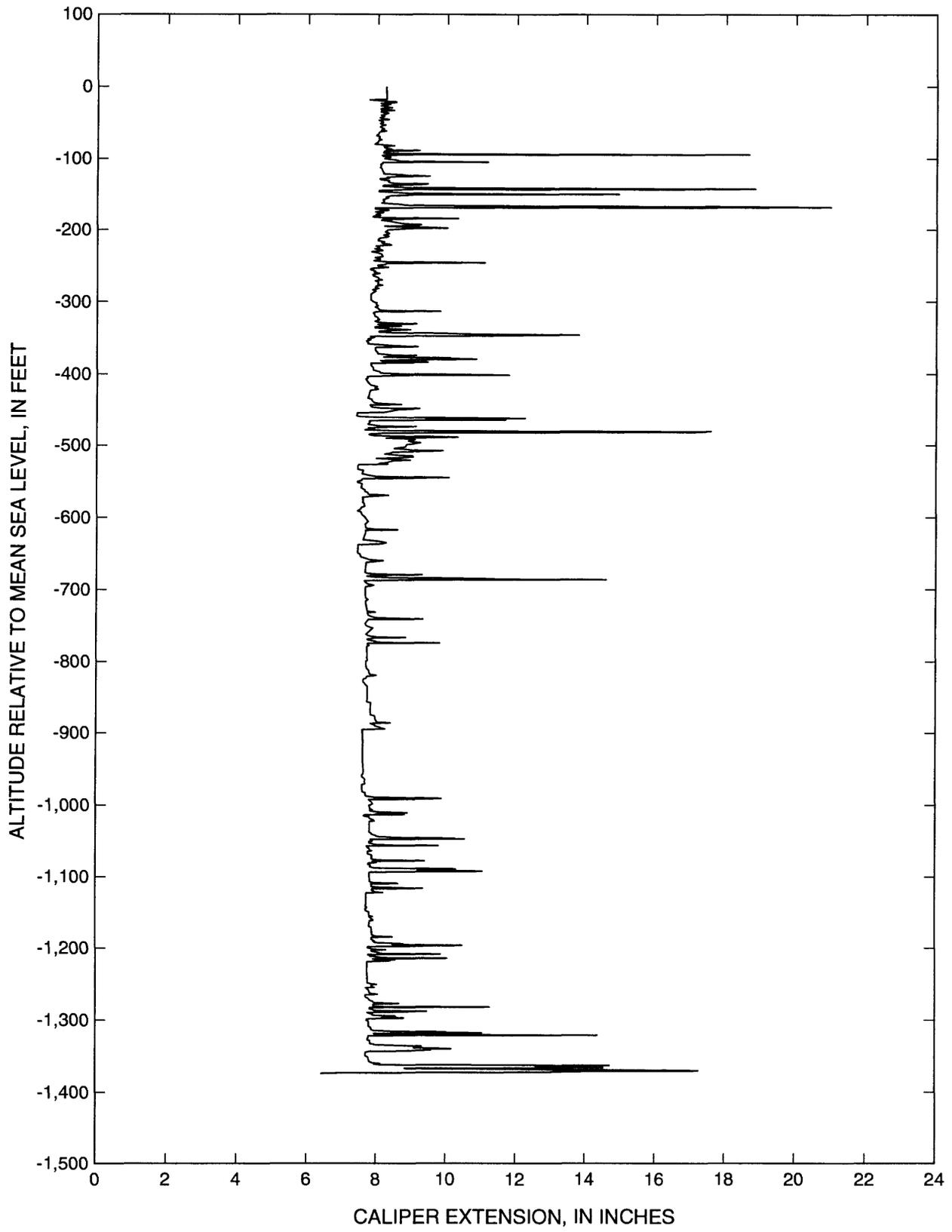


Figure 5. Caliper log for the Kaumana exploratory well (State well number 8-4010-01), island of Hawaii.