DEPARTMENT OF THE INTERIOR

U.S. GEOLOGICAL SURVEY

Drytilt Stations on Kilauea, Hawaii

by

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TABLE OF CONTENTS

INTRODUCTION

The United States Geological Survey's Hawaiian Volcano Observatory (HVO) has, during the past 18 years, established a dense network of drytilt stations on Kilauea, Hawaii. This drytilt network has been essential in monitoring and modeling the volcanic activity of Kilauea. The drytilt technique was developed at HVO in 1968 by D.B. Jackson and T.L. Wright to complement the water-tube tilt technique that was already in existence. The purpose was to broaden the tilt coverage on Kilauea with the recognition that:

1. The expected changes generally far exceed the precision of the wet tilt system.
2. A method was needed that enabled ground tilt to be measured in the daytime (vs. at night using wet tilt) and in all but the most inclement weather conditions.

The early drytilt technique consisted of using a Zeiss Ni2 spirit level and Invar leveling rods to determine the elevation differences of three nails or benchmarks set approximately 100 meters apart in a triangle. In early 1969, HVO obtained a Wild N-3 precision level and precise Invar level rods. This improved instrumentation allowed the triangular array of benchmarks to be shortened to the current standard length of 30 to 40 meters apart. Thus, the establishment of the current drytilt network on Kilauea volcano began and continues to this day. Yamashita (1981) gives a more detailed summary of the development of the drytilt network at Kilauea.

PURPOSE

The purpose of this report is to identify, describe, and document the drytilt stations on Kilauea that are currently measured by HVO as of March, 1987. Many stations have been lost, destroyed, or abandoned over the years and are not included in this report. The drytilt stations have been divided into 5 geographic groups:

1. Summit
2. Upper east rift zone
3. Middle east rift zone
4. Lower east rift zone
5. Southwest rift zone

Each geographic group has a general station location map. Following that map, the stations in that group are described individually and in alphabetical order. The description consists of:

1. The station name with the dates of operation
2. Previous name (if any)
3. Latitude, longitude, and the quadrangle map of the station
4. The station data necessary to compute the station equation
5. The station equation to determine the tilt vector and magnitude
6. Brief instructions on how to get to the station.

Also, a map is included showing the station in relation to topographic features around it with an insert showing the orientation of the X, Y, and Z benchmarks.

STATION TILT EQUATIONS

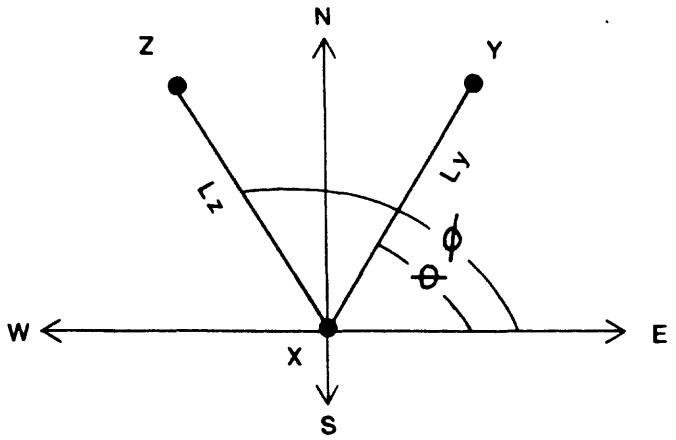
Each drytilt station consists of 3 benchmarks (X, Y, and Z) located 30 to 40 meters apart (ideally at the apices of an equilateral triangle). An equation unique to each station is used to determine the change in tilt over a period of time. This equation is derived from the general formula (modified from Eaton, 1959):

northward component of tilt

$$T(N) = \frac{(-\cos\phi)(10)}{(Ly)\sin(\phi-\theta)}\, d(y-x) - \frac{(\cos\theta)(10)}{(Lz)\sin(\phi-\theta)}\, d(x-z)$$

eastward component of tilt

$$T(E) = \frac{(\sin\phi)(10)}{(Ly)\sin(\phi-\theta)}\, d(y-x) + \frac{(\sin\theta)(10)}{(Lz)\sin(\phi-\theta)}\, d(x-z)$$



where:

Ly = length of line from X to Y

Lz = length of line from X to Z

θ = angle measured counterclockwise from east to line XY

ϕ = angle measured counterclockwise from east to line XZ

d(y-x) = changes in elevation differences between Y and X

d(x-z) = changes in elevation differences between X and Z

The three-rod method, described by Yamashita (1981), is used at HVO to measure the elevation differences of the three benchmarks.

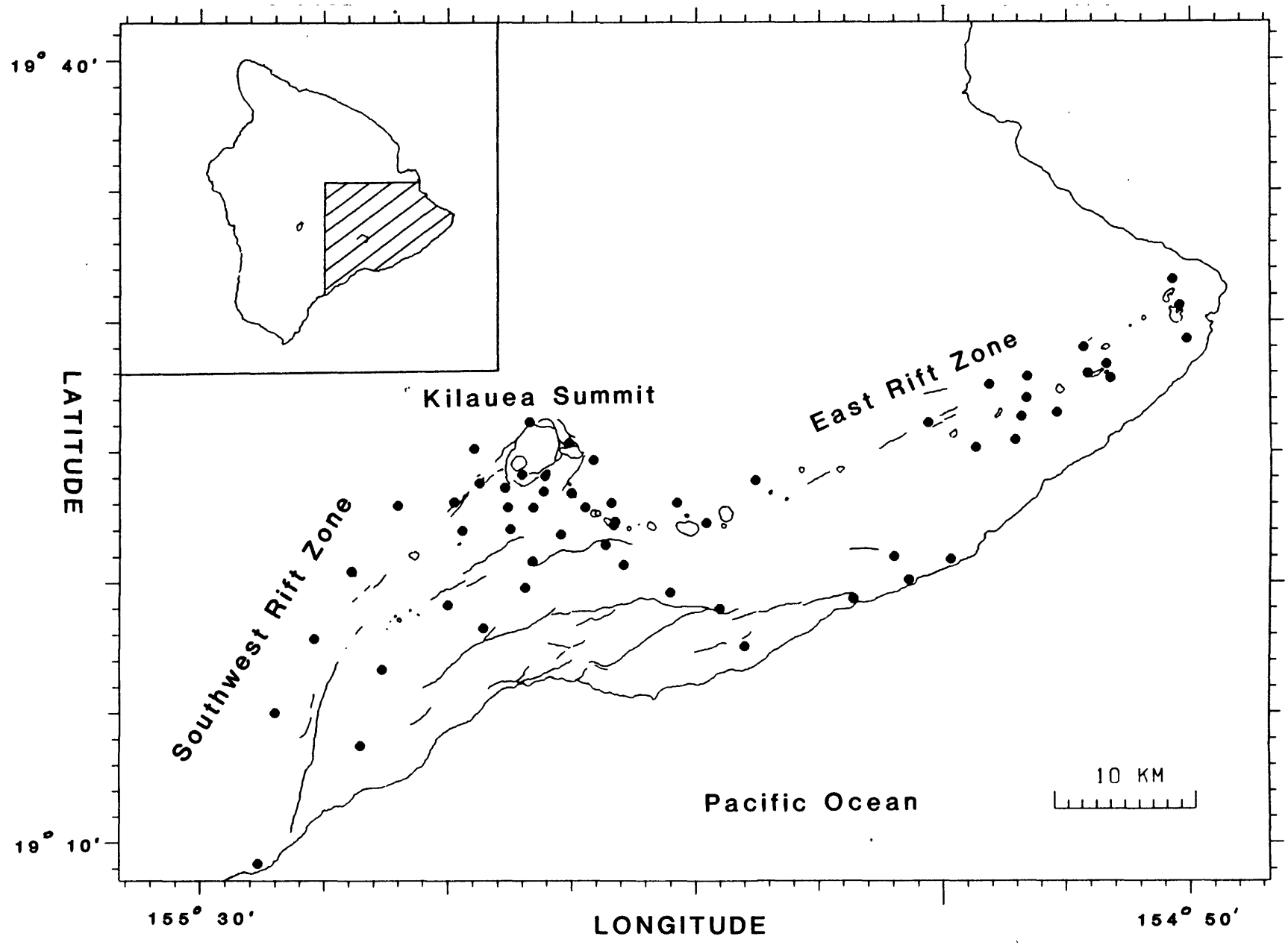
ACKNOWLEDGEMENT

HVO deformation workers, past and present, are gratefully acknowledged for the work done in establishing and measuring the drytilt network on Kilauea including D.B. Jackson, A.T. Okamura, G.S. Puniwai, M.K. Sako, T.L. Wright, and K.M. Yamashita. Special thanks to D.B. Jackson, R.Y. Koyanagi, and T.L. Wright for their constructive critical reviews.

REFERENCE

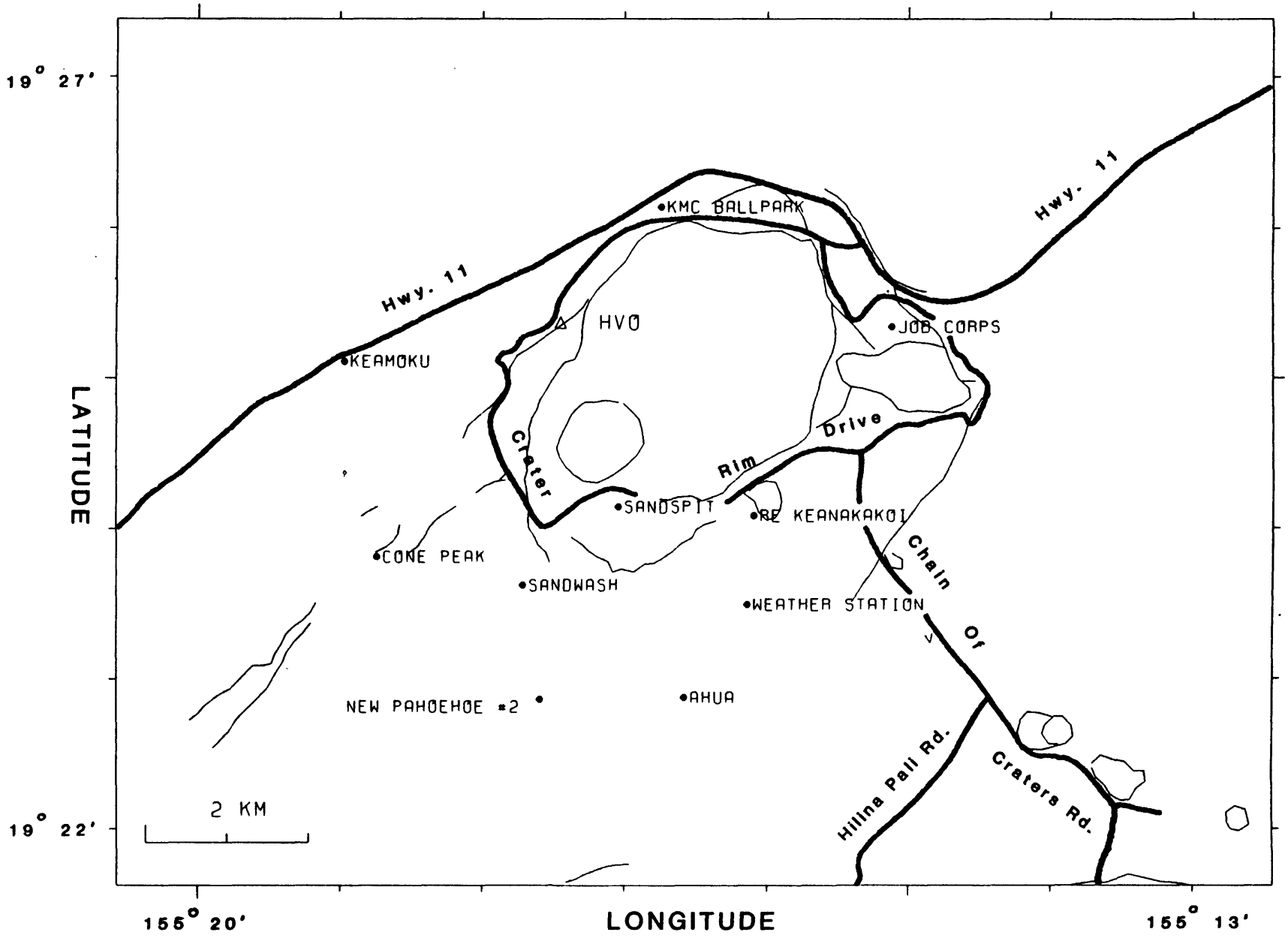
Eaton, J.P., 1959, A portable water-tube tiltmeter, Bull. Seismol. Soc. Am. 49, pp. 301-316.

Yamashita, K.M., 1981, Dry tilt: a ground deformation monitor as applied to the active volcanoes of Hawaii: U.S. Geological Survey Open-File Report 81-523, 14 p.


DRYTILT STATIONS ON KILAUEA, HAWAII
19° 40'
19° 10'
LATITUDE
Kilauea Summit
East Rift Zone
Southwest Rift Zone
Pacific Ocean
10 KM
155° 30'
LONGITUDE
154° 50'

KILAUEA SUMMIT DRYTILT STATIONS

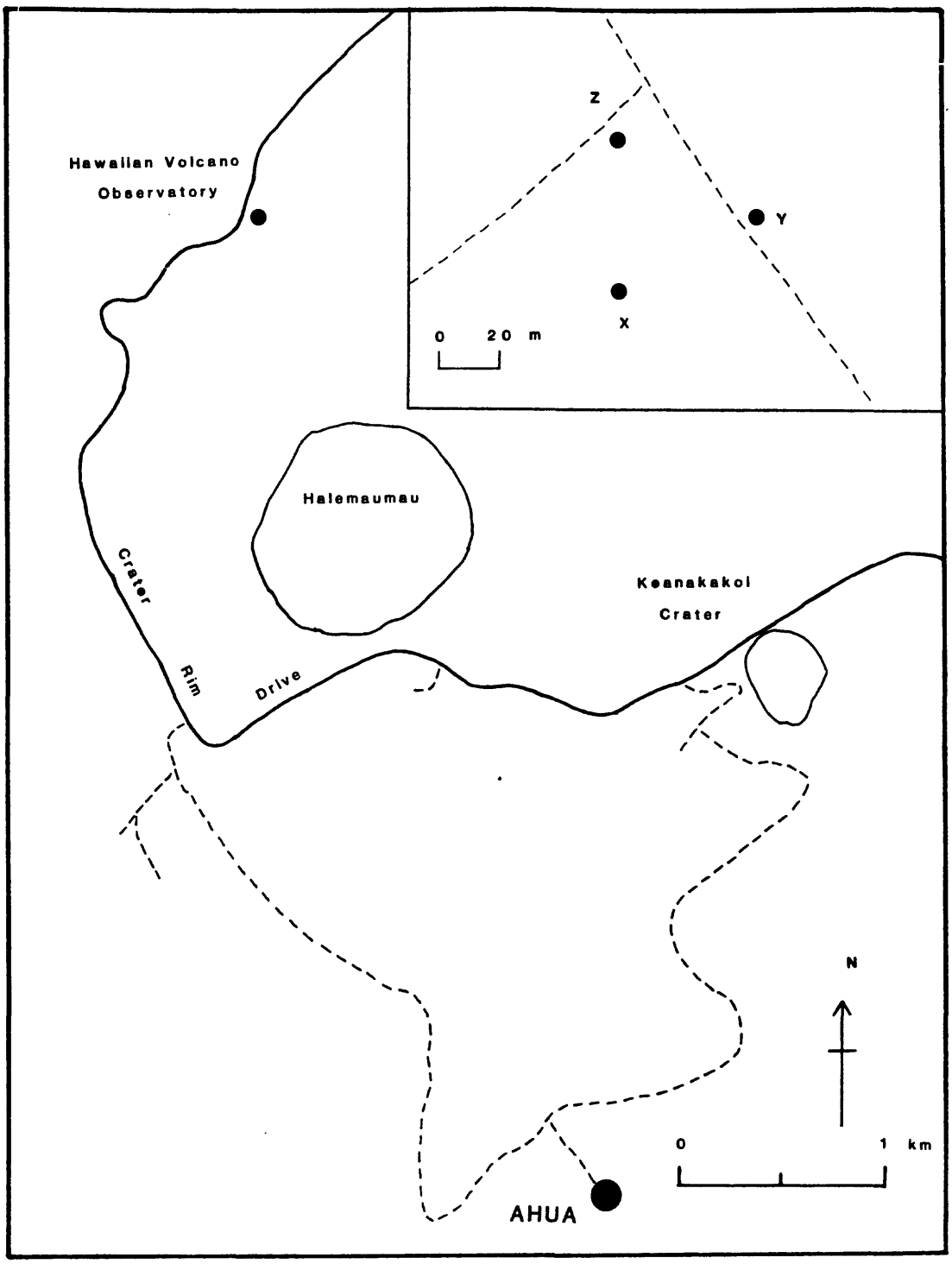
KILAUEA SUMMIT DRYTILT STATIONS



AHUA (10/31/69 to present)

PREVIOUS NAME : OLD AHUA (6/26/69 to 10/29/69)
MAP COORDINATES : N 19 22.87' W155 16.58' Kilauea Crater
STATION DATA : Ly = 50.00 m, Lz = 50.00 m, Theta = 30.0, Phi = 89.5
STATION EQUATION : T(n) = -0.200 d(X-Z)
T(e) = 0.232 d(Y-X) + 0.116 d(X-Z)

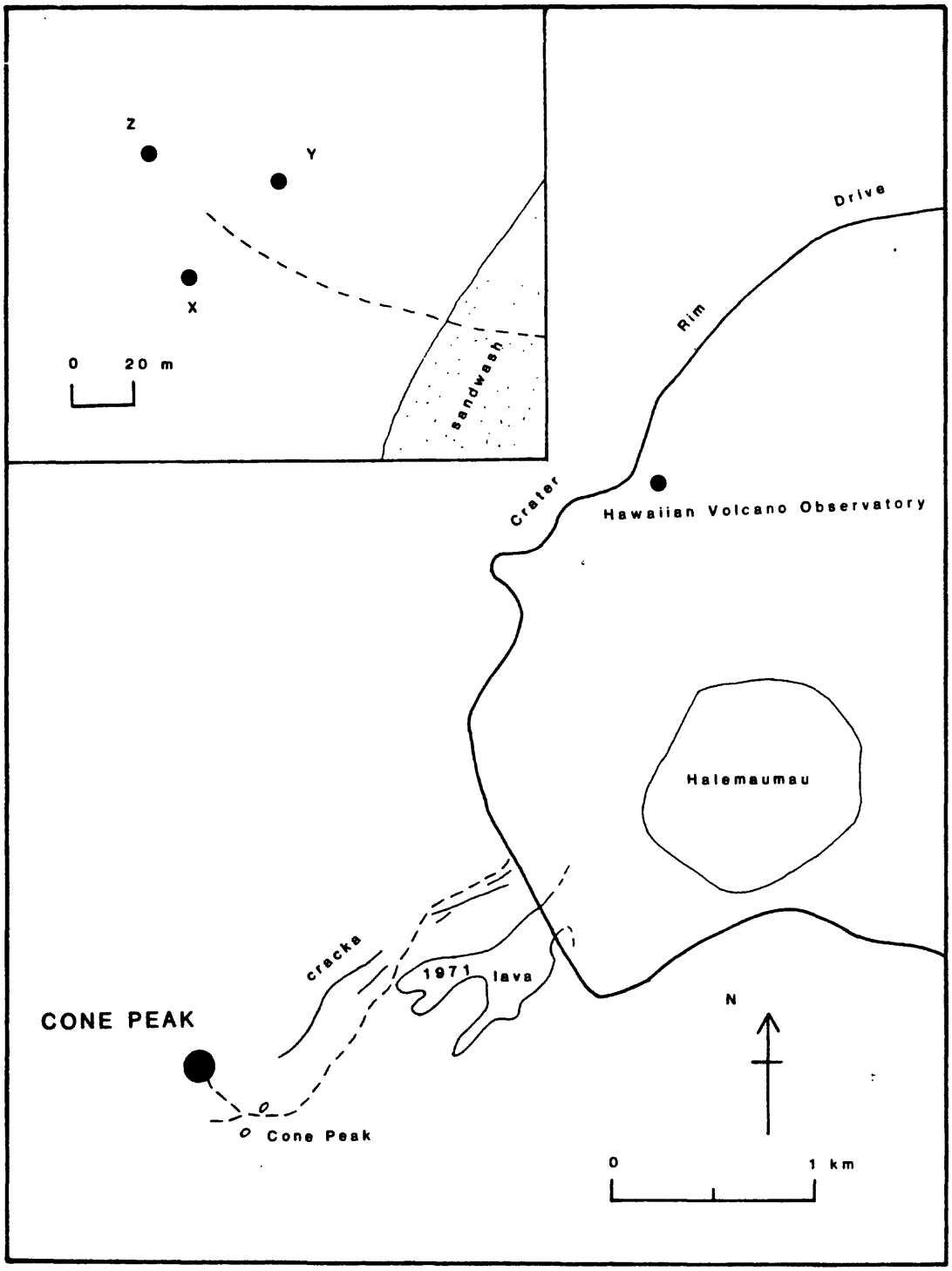
AHUA is located approximately 5.0 km south-southeast of the Hawaiian Volcano Observatory on top of the concrete piers of the AHUA "wet tilt" station in Hawaii Volcanoes National Park. From HVO, drive counter-clockwise on Crater Rim Drive for 3.5 miles to reach a dirt road on the right side (near Keanakakoi Crater). Turn right and go 0.4 miles to reach a dirt road on the left. Turn left and go 1.9 miles to reach a junction (just after leaving a large sand-wash). Take left road and go 0.3 miles to reach the AHUA station.



CONE PEAK (2/12/70 to present)

PREVIOUS NAME :	CONE PEAK NAILS (10/27/69 to 2/12/70)
MAP COORDINATES :	N 19 23.81' W155 18.74' Kilauea Crater
STATION DATA :	Ly = 39.80 m, Lz = 39.80 m, Theta = 45.2, Phi = 107.2
STATION EQUATION :	T(n) = 0.084 d(Y-X) — 0.200 d(X-Z)
	T(e) = 0.272 d(Y-X) + 0.202 d(X-Z)

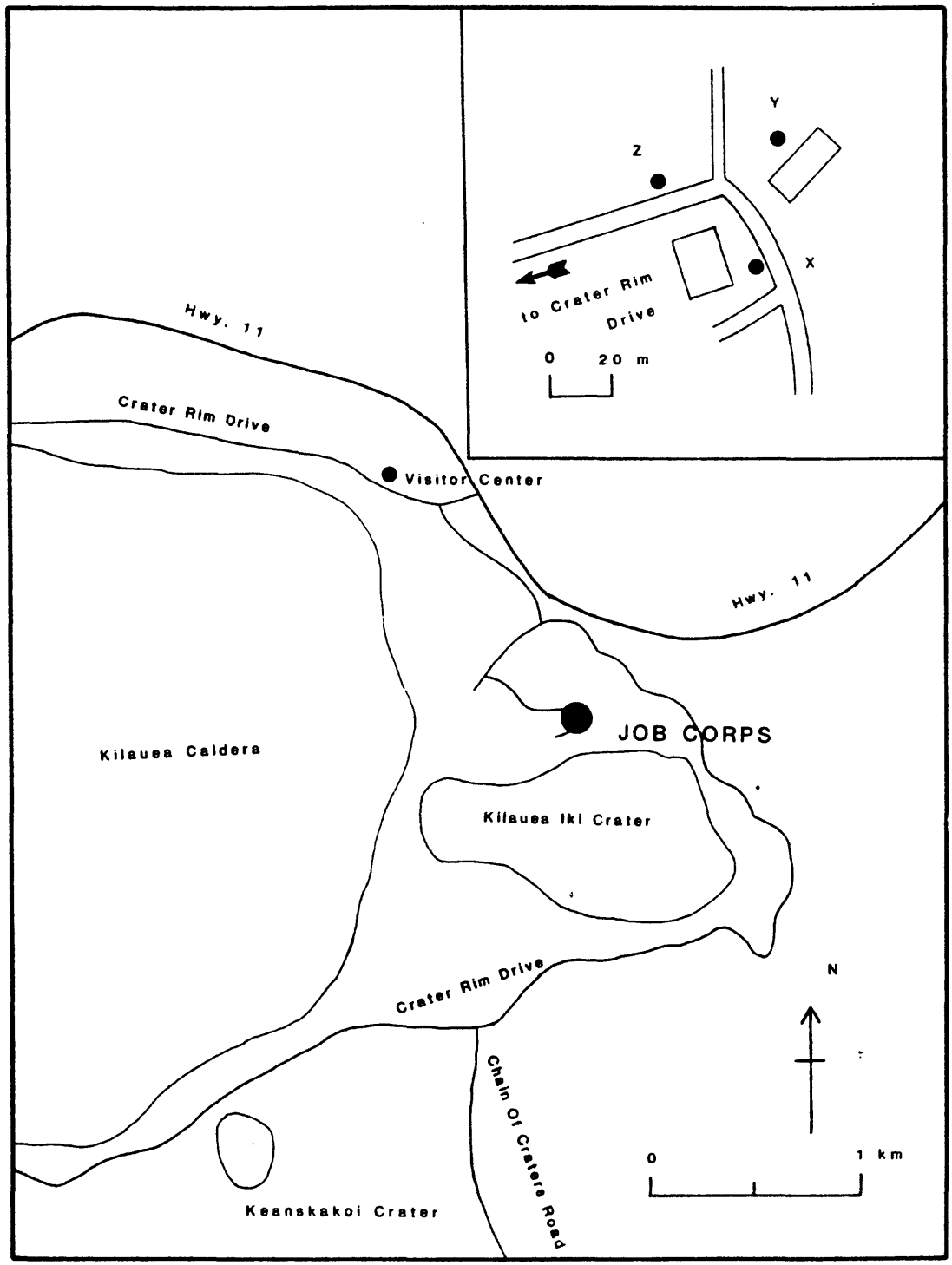
CONE PEAK station is located 3.65 km southwest of the Hawaiian Volcano Observatory in Hawaii Volcanoes National Park. From HVO, go 1.6 miles counterclockwise on Crater Rim Drive to reach a dirt road on the right side (just past the Kau Acid Rain Desert sign). Turn right and go 1.2 miles to reach an intersection on the west side of Cone Peak (approximately 60 meters past the top). Turn right and go 0.20 mile through a sandwash to reach the CONE PEAK station.



JOB CORPS (1/26/72 to present)

PREVIOUS NAME : None
MAP COORDINATES : N 19 25.34' W155 15.12' Kilauea Crater
STATION DATA : Ly = 40.00 m, Lz = 40.00m, Theta = 79.0, Phi = 139.0
STATION EQUATION : T(n) = 0.218 d(Y-X) - 0.055 d(X-Z)
T(e) = 0.189 d(Y-X) + 0.283 d(X-Z)

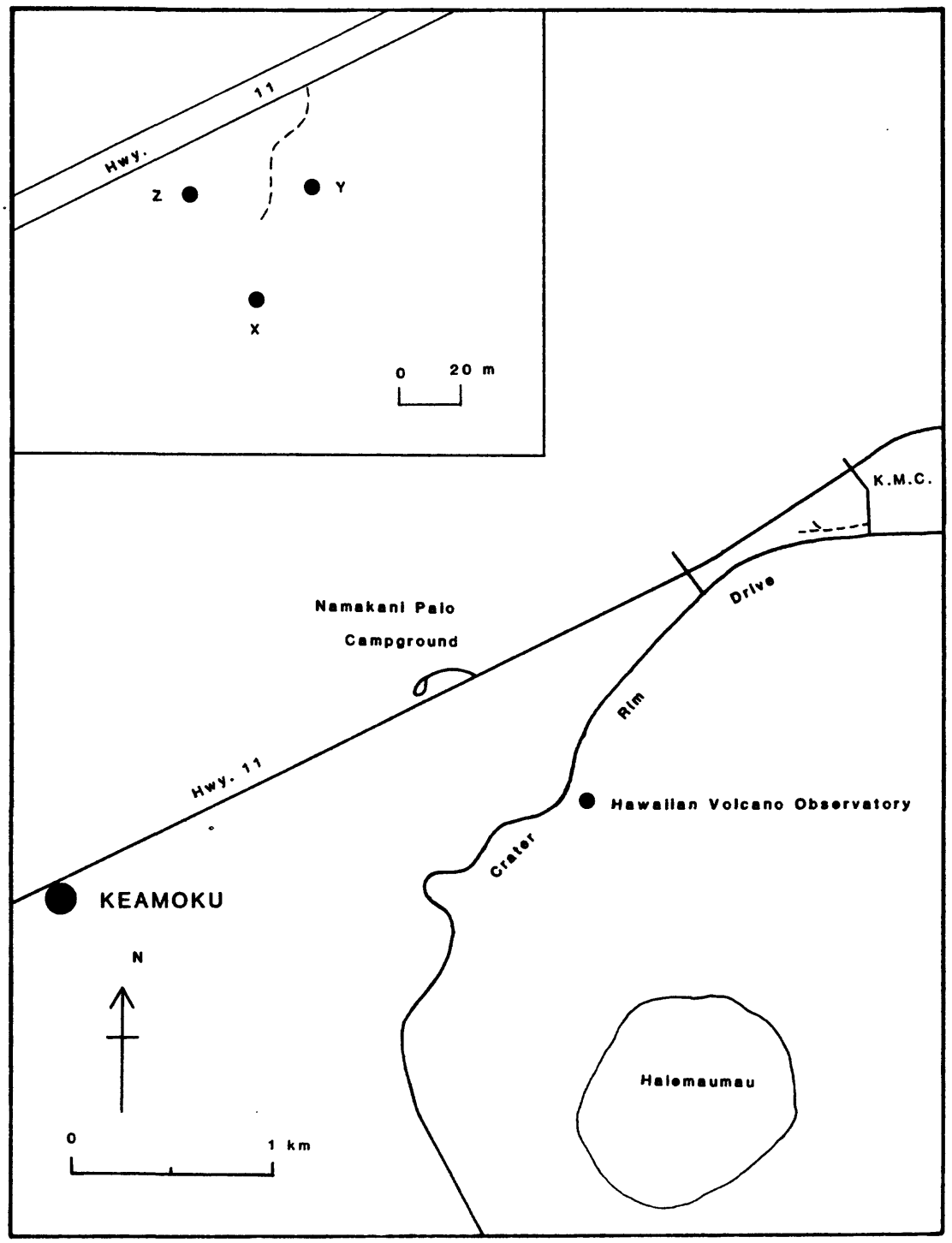
JOB CORPS is located approximately 4.1 km east of the Hawaiian Volcano Observatory near the National Park Service's Magma House in the Hawaii Volcanoes National Park. From the Hawaiian Volcano Observatory, drive 3.1 miles clock-wise on Crater Rim Drive until a "T" intersection is reached. Turn right and go 0.3 miles to reach a road on the left. Turn left and go 0.3 miles to reach the JOB CORPS station.



KEAMOKU (11/19/71 to present)

PREVIOUS NAME :	None
MAP COORDINATES :	N 19 25.11' W155 18.97' Kilauea Crater
STATION DATA :	Ly = 40.00 m, Lz = 40.00 m, Theta = 63.0, Phi = 123.0
STATION EQUATION :	T(n) = 0.157 d(Y-X) − 0.131 d(X-Z)
	T(e) = 0.242 d(Y-X) + 0.257 d(X-Z)

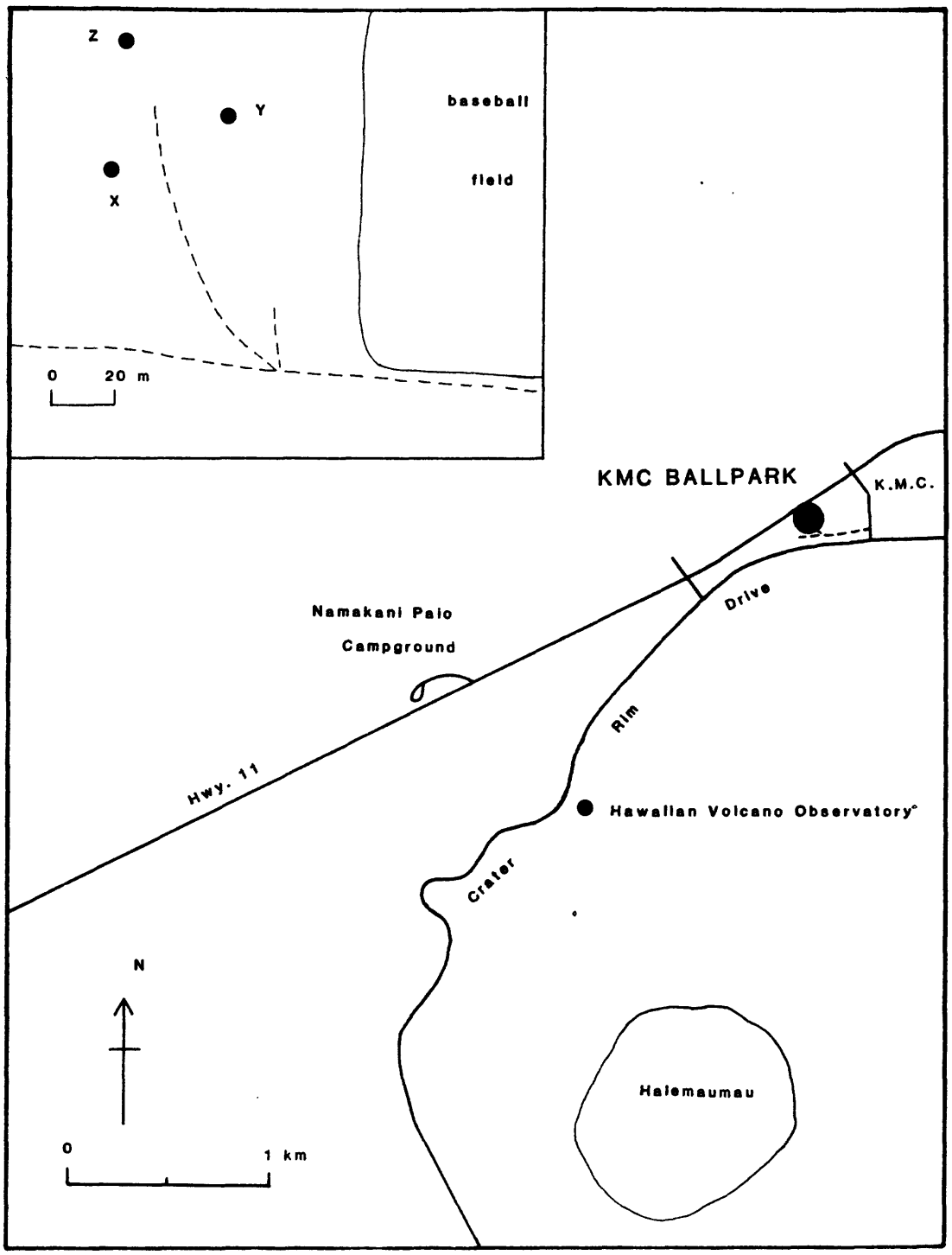
KEAMOKU is located approximately 2.7 km west-southwest of the Hawaiian Volcano Observatory in Hawaii Volcanoes National Park. From HVO, drive 0.8 miles clockwise on Crater Rim Drive to reach the intersection with Mauna Loa Strip Road. Turn left and go 0.1 miles to reach Highway 11. Turn left and go 2.2 miles to reach a dirt road on the left side. Turn left and go 50 meters to reach the KEAMOKU station.



KMC BALLPARK (11/2/71 to present)

PREVIOUS NAME :	None
MAP COORDINATES :	N19 26.14' W155 16.74' Kilauea Crater
STATION DATA :	Ly = 40.00 m, Lz = 40.00 m, Theta = 24.0, Phi = 84.0
STATION EQUATION :	T(n) = −0.030 d(Y-X) − 0.264 d(X-Z)
	T(e) = 0.287 d(Y-X) + 0.117 d(X-Z)

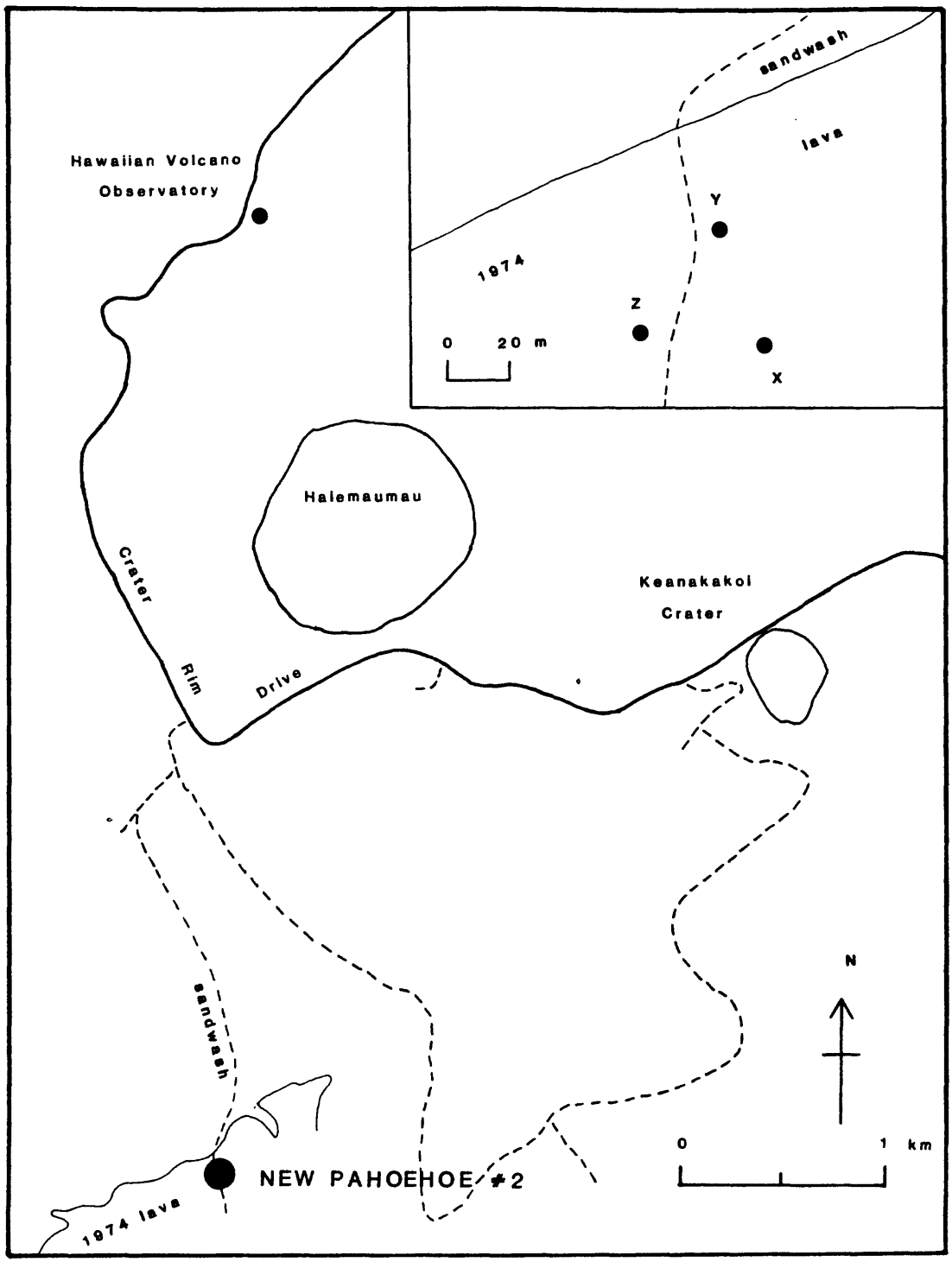
KMC BALLPARK is located approximately 1.8 km north-northeast of the Hawaiian Volcano Observatory in Hawaii Volcanoes National Park. From HVO, drive 1.2 miles clock-wise on Crater Rim Drive to reach the first paved road to the Kilauea Military Camp. Turn left and go 0.1 miles to reach a dirt road on the left. Turn left and go 0.1 mile along the southern end of a baseball field to reach two roads that fork to the right. Turn right on the second road and go 100 meters to reach the KMC BALLPARK station.



NEW PAHOEHOE #2 (8/22/80 to present)

PREVIOUS NAMES : PAHOEHOE (11/22/71 to 10/7/74)
NEW PAHOEHOE (6/19/75 to 9/27/79)
MAP COORDINATES : N19 22.86' W155 17.60' Kilauea Crater
STATION DATA : Ly = 40.00 m, Lz = 40.00 m, Theta = 112.0, Phi = 172.0
STATION EQUATION : T(n) = 0.286 d(Y-X) + 0.108 d(X-Z)
T(e) = 0.040 d(Y-X) + 0.268 d(X-Z)

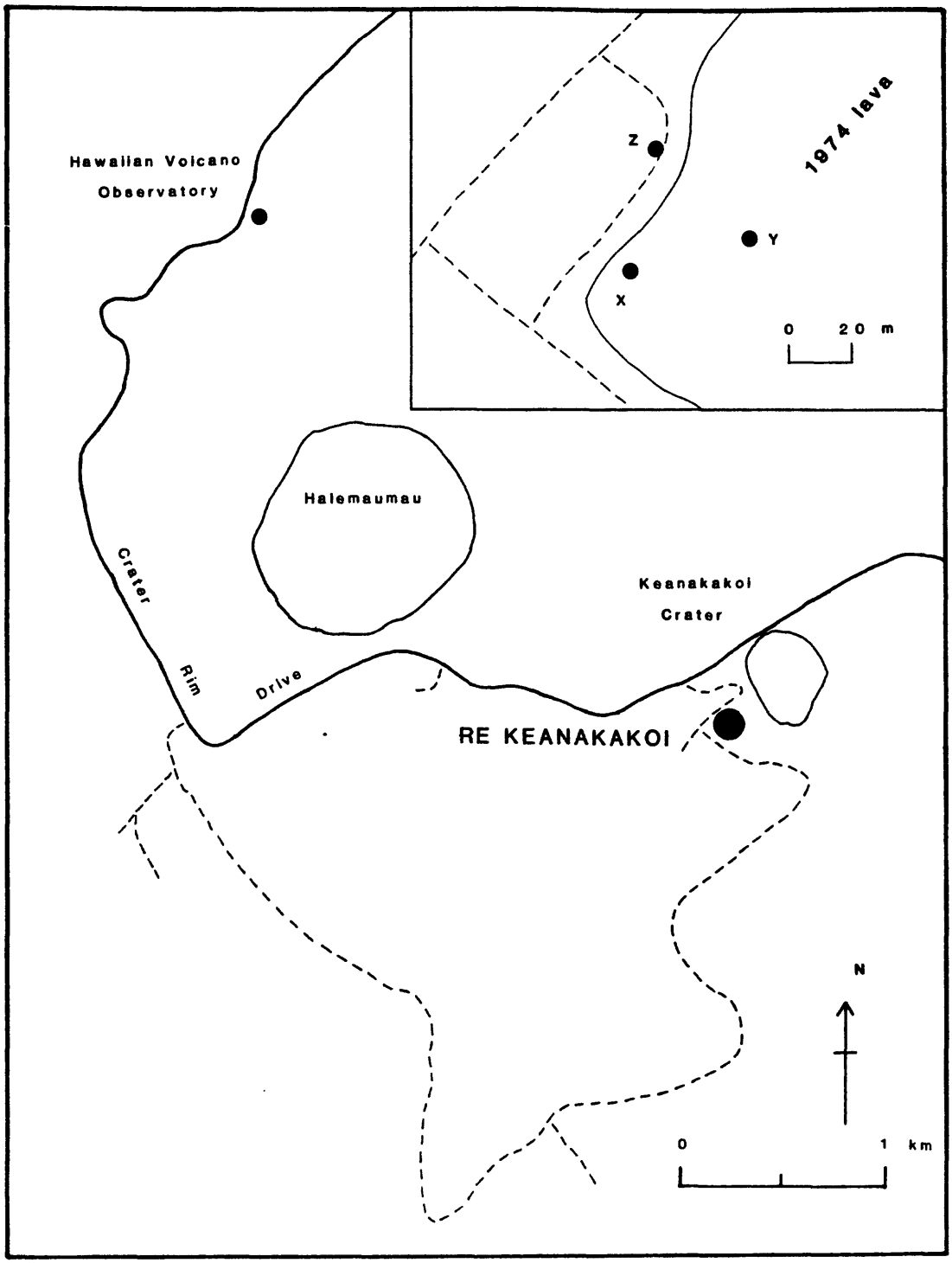
NEW PAHOEHOE #2 is located approximately 4.6 km south of the Hawaiian Volcano Observatory in Hawaii Volcanoes National Park. From HVO, drive counter-clockwise on Crater Rim Drive for 1.9 miles to reach a dirt road on the right side. Turn right and go 0.1 mile to reach a fork in the road. Turn right and go 0.25 mile to reach a dirt road on the left. Turn left and go 1.2 miles (past the SANDWASH drytilt station and following a large sandwash) to reach the NEW PAHOEHOE #2 station.



RE KEANAKAKOI (6/27/84 to present)

PREVIOUS NAMES :	KEANAKAKOI (7/3/69 to 5/23/74)
	NEW KEANAKAKOI (6/19/75 to 11/30/83)
MAP COORDINATES :	N19 24.08' W155 16.09' Kilauea Crater
STATION DATA :	Ly = 40.00 m, Lz = 40.00 m, Theta = 16.0, Phi = 76.0
STATION EQUATION :	T(n) = −0.070 d(Y-X) − 0.278 d(X-Z)
	T(e) = 0.280 d(Y-X) + 0.080 d(X-Z)

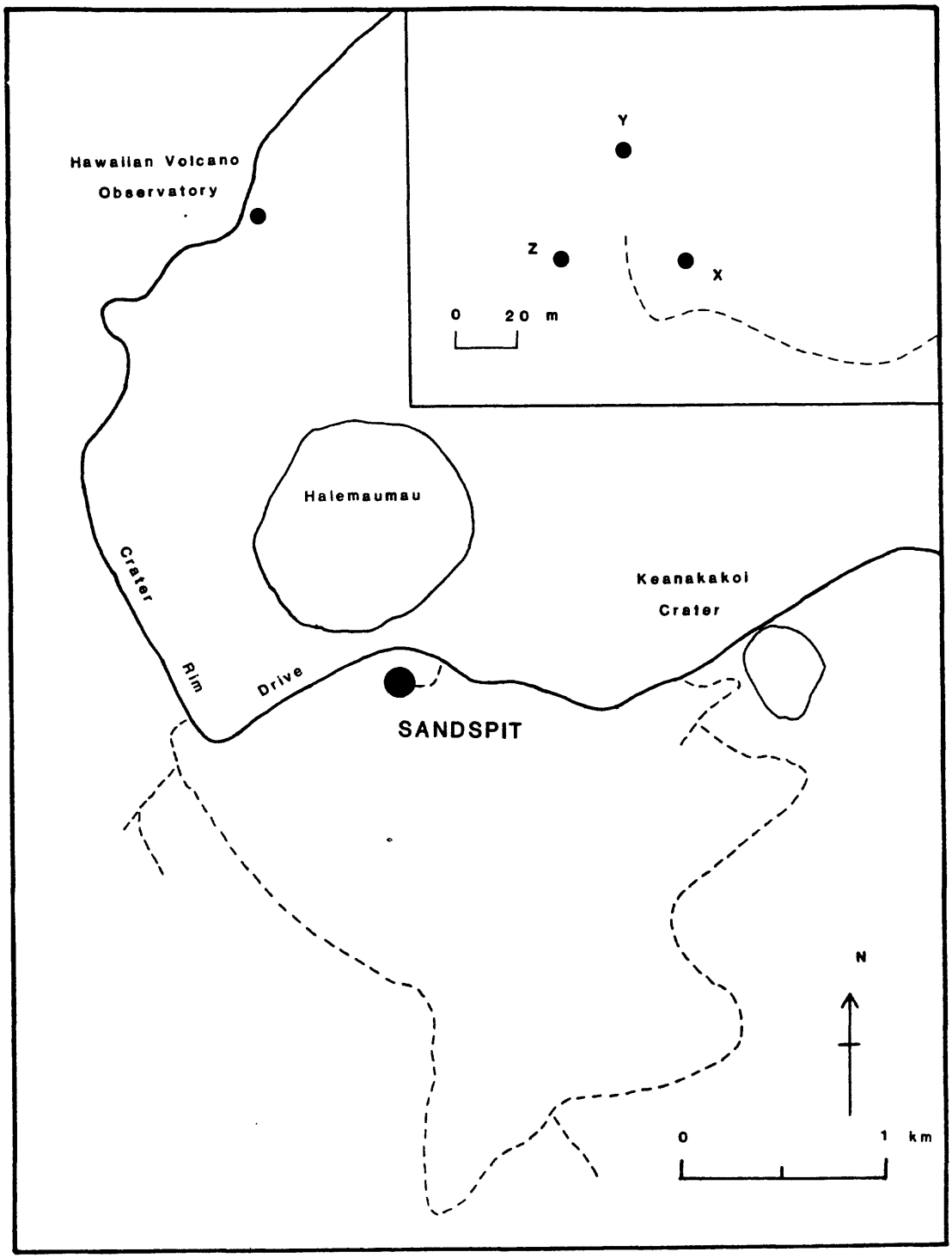
RE KEANAKAKOI station is located approximately 3.3 km southeast of the Hawaiian Volcano Observatory in Hawaiian Volcanoes National Park. From HVO, drive counter-clockwise on Crater Rim Drive for 3.5 miles to reach a dirt road on the right side (near Keanakakoi Crater). Turn right and go 0.3 miles to reach a road on left. Turn left and go 100 meters to reach the RE KEANAKAKOI station. The X and Y benchmarks are located on the 1974 lava flow and the Z benchmark is on a concrete pier in a tephra deposit.



SANDSPIT (6/5/69 to present)

PREVIOUS NAMES :	None
MAP COORDINATES :	N19 24.14' W155 17.04' Kilauea Crater
STATION DATA :	Ly = 40.00 m, Lz = 40.00 m, Theta = 0.0, Phi = 60.0
STATION EQUATION :	T(n) = −0.145 d(Y-X) − 0.289d(X-Z)
	T(e) = 0.250 d(Y-X)

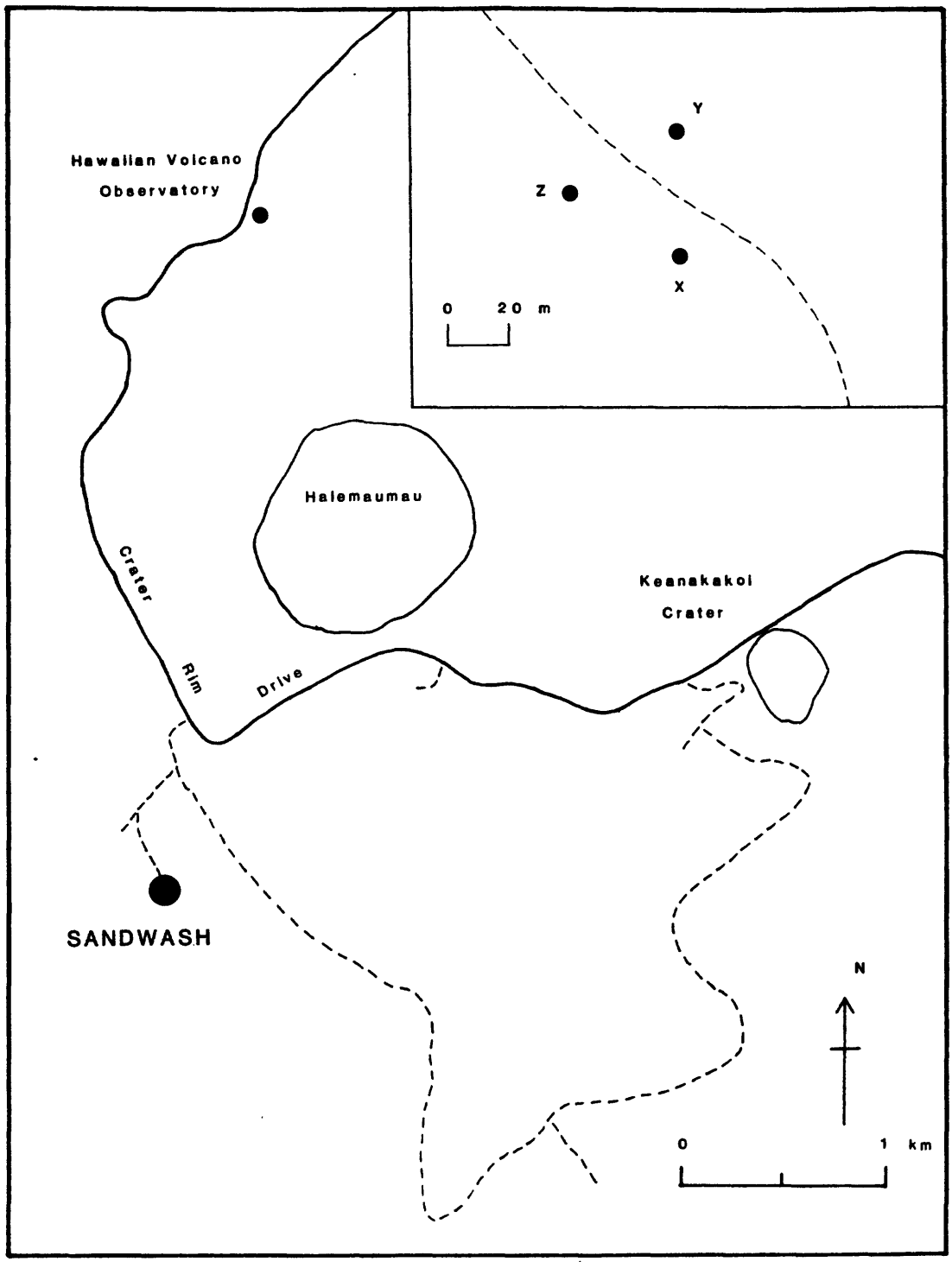
SANDSPIT station is located approximately 2.3 km south-southeast of the Hawaiian Volcano Observatory on 1921 lava flow in Hawaii Volcanoes National Park. From HVO, drive counter-clockwise on Crater Rim Drive for 2.85 miles to reach a dirt road on the right side, 80 meters beyond the east side of the parking lot for the Halemaumau overlook. Turn right and go 0.2 miles to reach the SANDSPIT station.



SANDWASH (6/26/69 to present)

PREVIOUS NAMES :	None
MAP COORDINATES :	N19 23.62' W155 17.72 Kilauea Crater
STATION DATA :	Ly = 40.00 m, Lz = 40.00 m, Theta = 90.2, Phi = 149.7
STATION EQUATION :	T(n) = 0.250 d(Y-X)
	T(e) = 0.144 d(Y-X) + 0.289 d(X-Z)

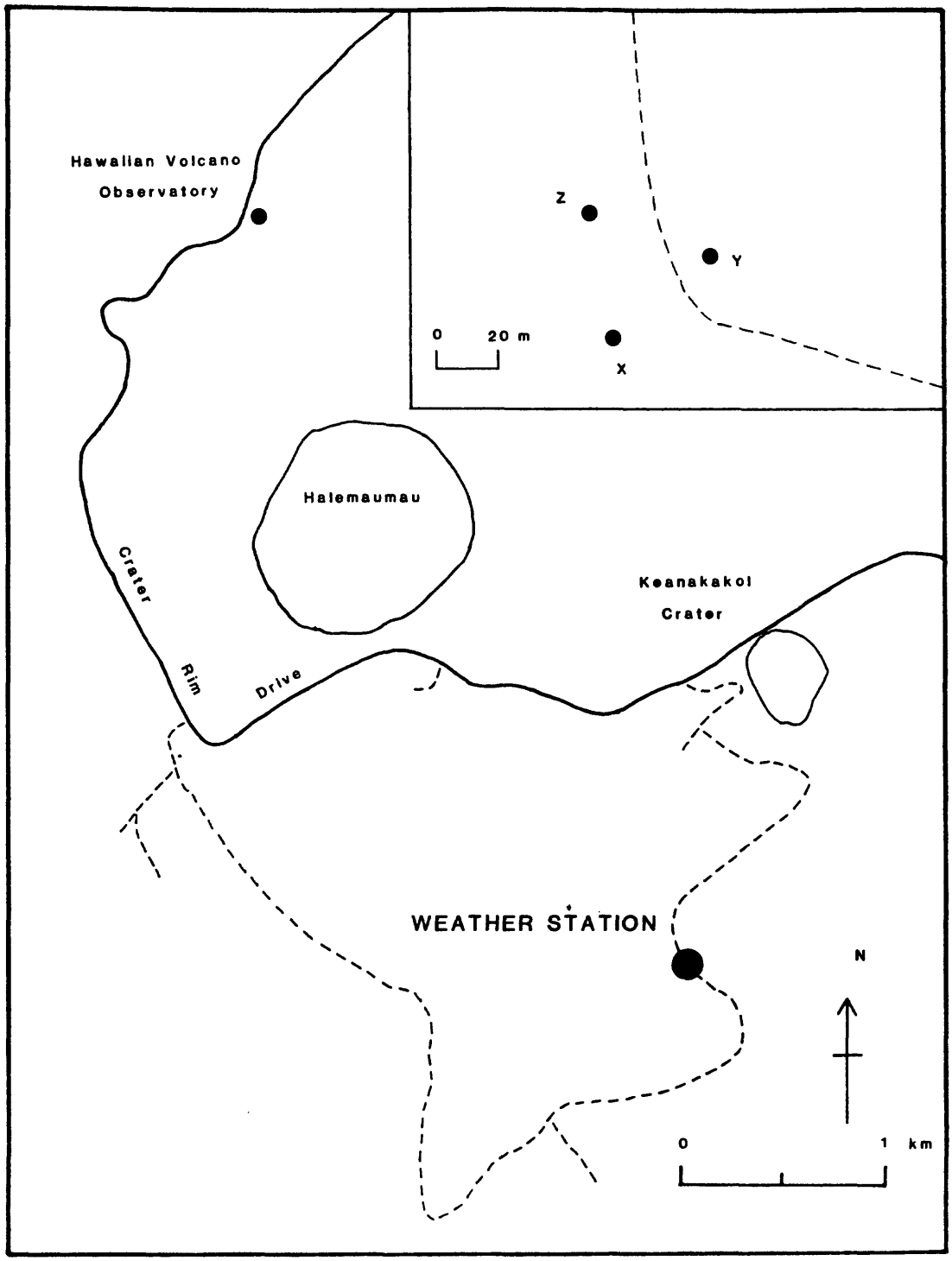
SANDWASH station is located approximately 3.25 km south of the Hawaiian Volcano Observatory in Hawaii Volcanoes National Park. From HVO, drive counter-clockwise on Crater Rim Drive for 1.9 miles to reach a dirt road on the right side. Turn right and go 0.1 mile to reach a fork in the road. Turn right and go 0.25 mile to reach a dirt road on the left. Turn left and go 0.35 miles to reach the SANDWASH station. The X benchmark is approximately 0.5 m below the ground surface and protected by a large pipe collar.



WEATHER STATION (11/22/71 to present)

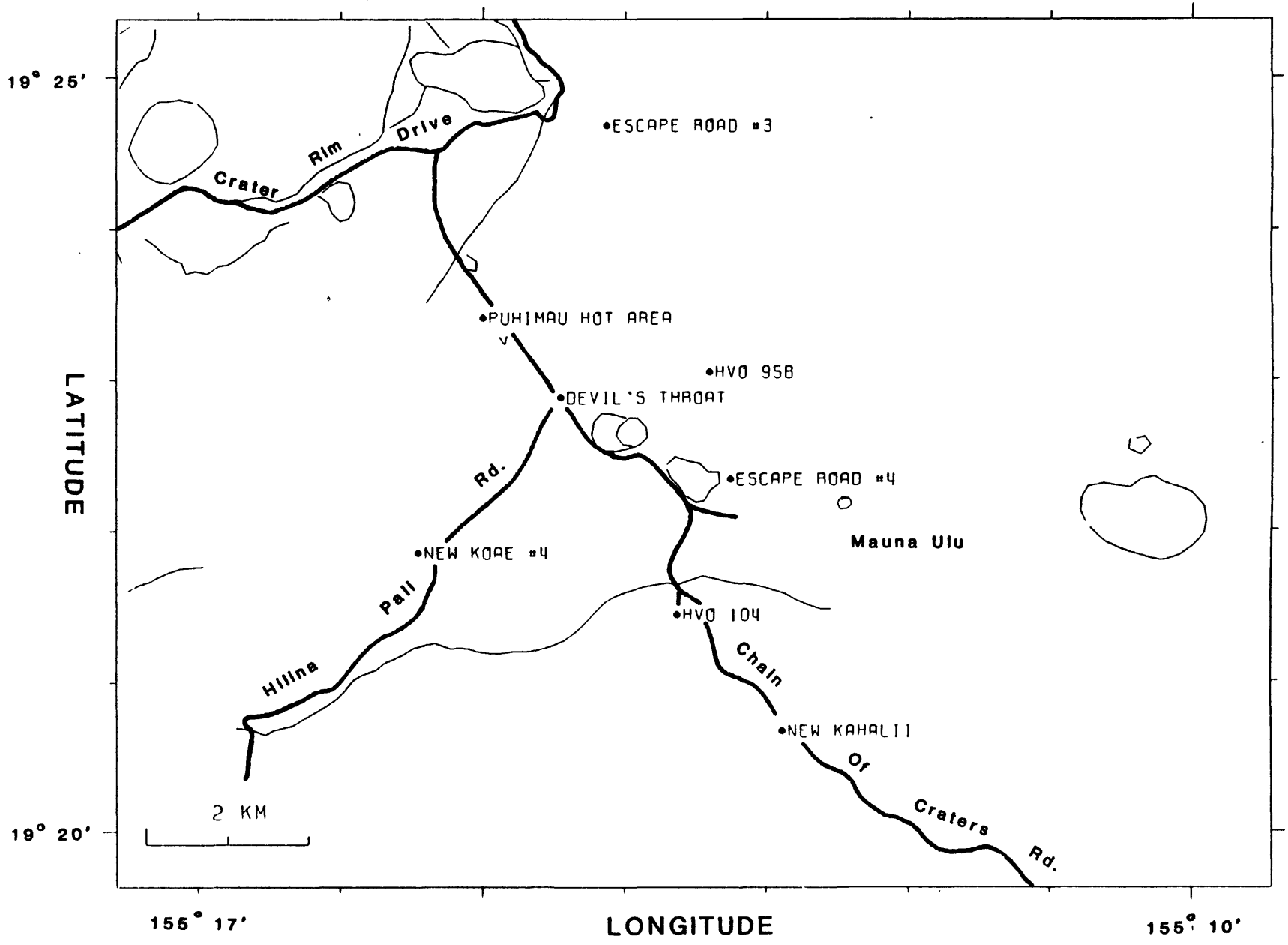
PREVIOUS NAMES :	None
MAP COORDINATES :	N19 23.49' W155 16.14' Kilauea Crater
STATION DATA :	Ly = 40.00 m, Lz = 40.00 m, Theta = 40.0, Phi = 100.0
STATION EQUATION :	T(n) = 0.050 d(Y-X) — 0.221 d(X-Z)
	T(e) = 0.284 d(Y-X) + 0.186 d(X-Z)

WEATHER STATION is located approximately 4.1 km southeast of the Hawaiian Volcano Observatory in Hawaii Volcanoes National Park. From HVO, drive counter-clockwise on Crater Rim Drive for 3.5 miles to reaach a dirt road on the right side (near Keanakakoi Crater). Turn right and go 0.35 miles to reach a dirt road on the left. Turn left and go 1.0 mile to reach the WEATHER STATION. The X benchmark is approximately 0.5 m below the ground surface and protected by a large pipe collar.



KILAUEA UPPER EAST RIFT ZONE DRYTILT STATIONS

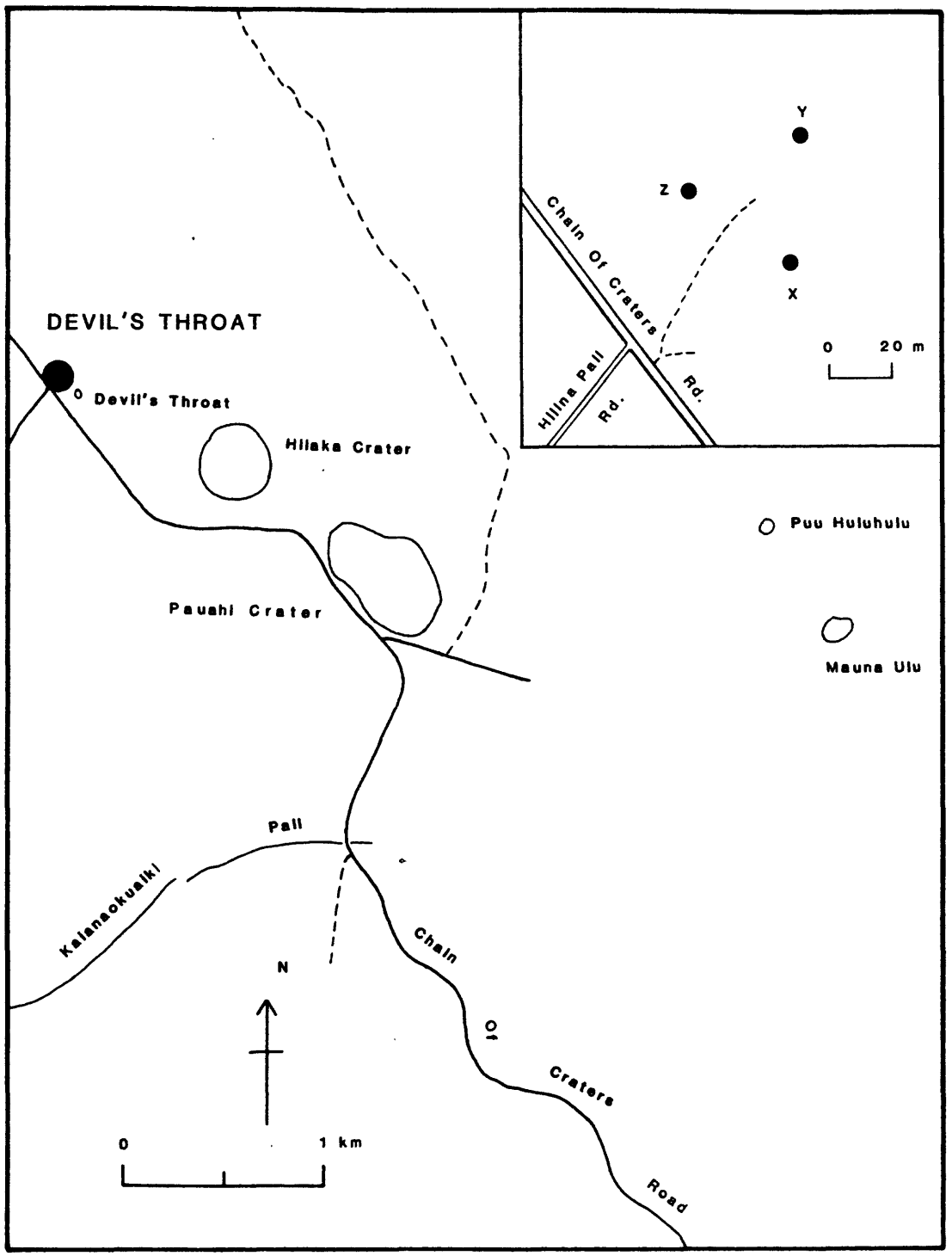
KILAUEA UPPER EAST RIFT ZONE DRYTILT STATIONS



DEVIL'S THROAT (11/24/71 to present)

PREVIOUS NAME : None
MAP COORDINATES : N 19 22.88' W155 14.45' Volcano
STATION DATA : Ly = 40.00 m, Lz = 40.00 m, Theta = 85.0, Phi = 145.0
STATION EQUATION : T(n) = 0.236 d(Y-X) — 0.025 d(X-Z)
T(e) = 0.166 d(Y-X) + 0.288 d(X-Z)

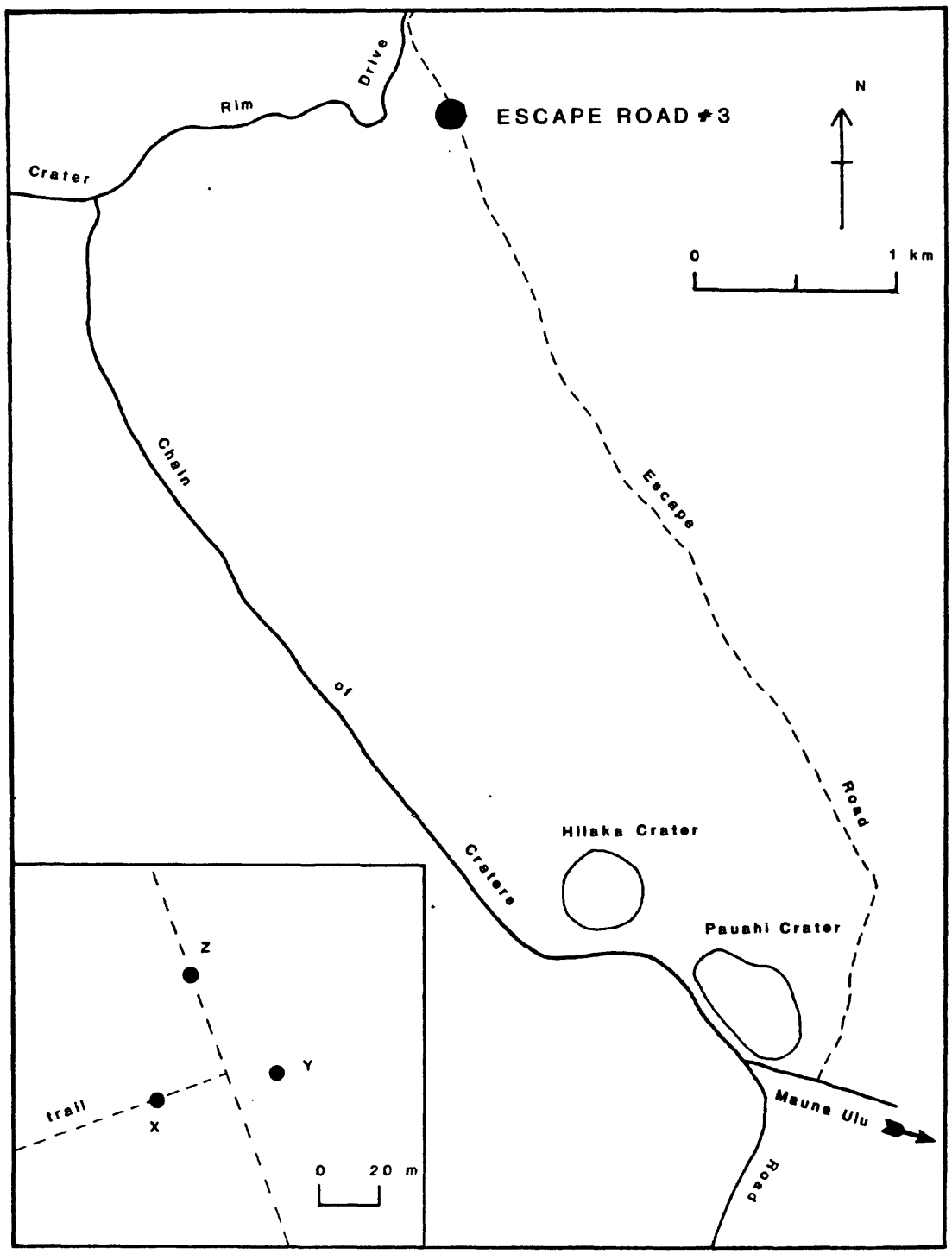
DEVIL'S THROAT station is located approximately 6.9 km southeast of the Hawaiian Volcano Observatory in the Hawaii Volcanoes National Park. From HVO, drive counter-clockwise on Crater Rim Drive for 4.6 miles to reach the intersection with Chain of Craters Road. Turn right and go 2.0 miles to reach the intersection with Hilina Pali Road. DEVIL'S THROAT station is approximately 55 meters northeast of the intersection.



ESCAPE ROAD #3 (2/8/72 to present)

PREVIOUS NAME :	None
MAP COORDINATES :	N 19 24.68' W155 14.33' Volcano
STATION DATA :	Ly = 40.00 m, Lz = 40.00 m, Theta = 13.0, Phi = 73.0
STATION EQUATION :	T(n) = −0.084 d(Y-X) − 0.281 d(X-Z)
	T(e) = 0.276 d(Y-X) + 0.065 d(X-Z)

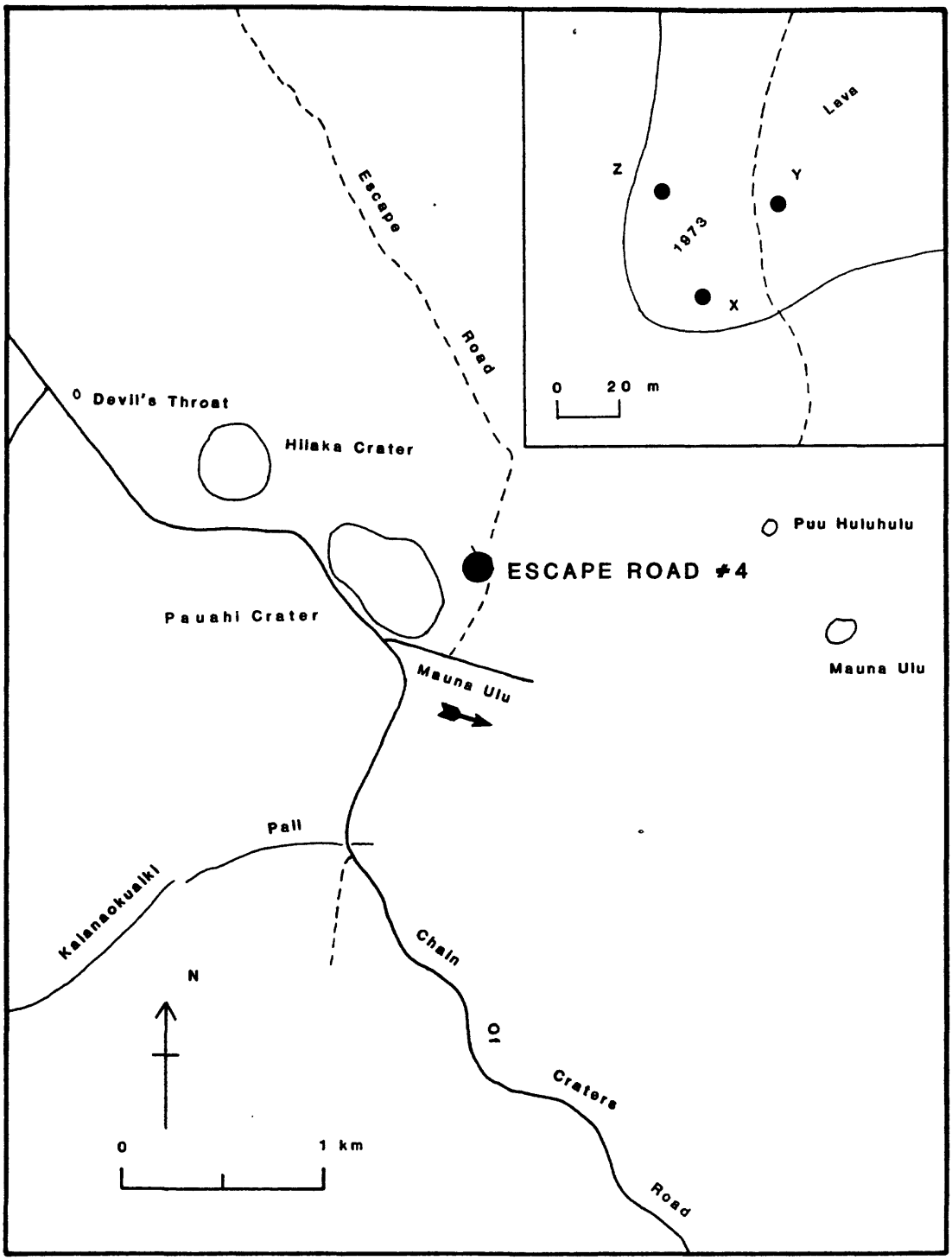
ESCAPE ROAD #3 station is located approximately 5.55 km east of the Hawaiian Volcano Observatory in Hawaii Volcanoes National Park. From HVO, drive counter-clockwise on Crater Rim Drive for 4.6 miles to reach the intersection with Chain of Craters Road. Turn right and go 3.5 miles to reach the intersection with Mauna Ulu road. Turn left and go 0.1 mile to reach a dirt road on the left (the Escape Road). Turn left through a locked gate and go 3.5 miles to reach the ESCAPE ROAD #3 station at the intersection with the Crater Rim Trail.



ESCAPE RD #4 (6/27/84 to present)

PREVIOUS NAME :	None
MAP COORDINATES :	N 19 22.17' W155 13.17' Makaopuhi Crater
STATION DATA :	Ly = 37.19 m, Lz = 35.58 m, Theta = 50.0, Phi = 110.0
STATION EQUATION :	T(n) = 0.106 d(Y-X) — 0.209 d(X-Z)
	T(e) = 0.292 d(Y-X) + 0.249 d(X-Z)

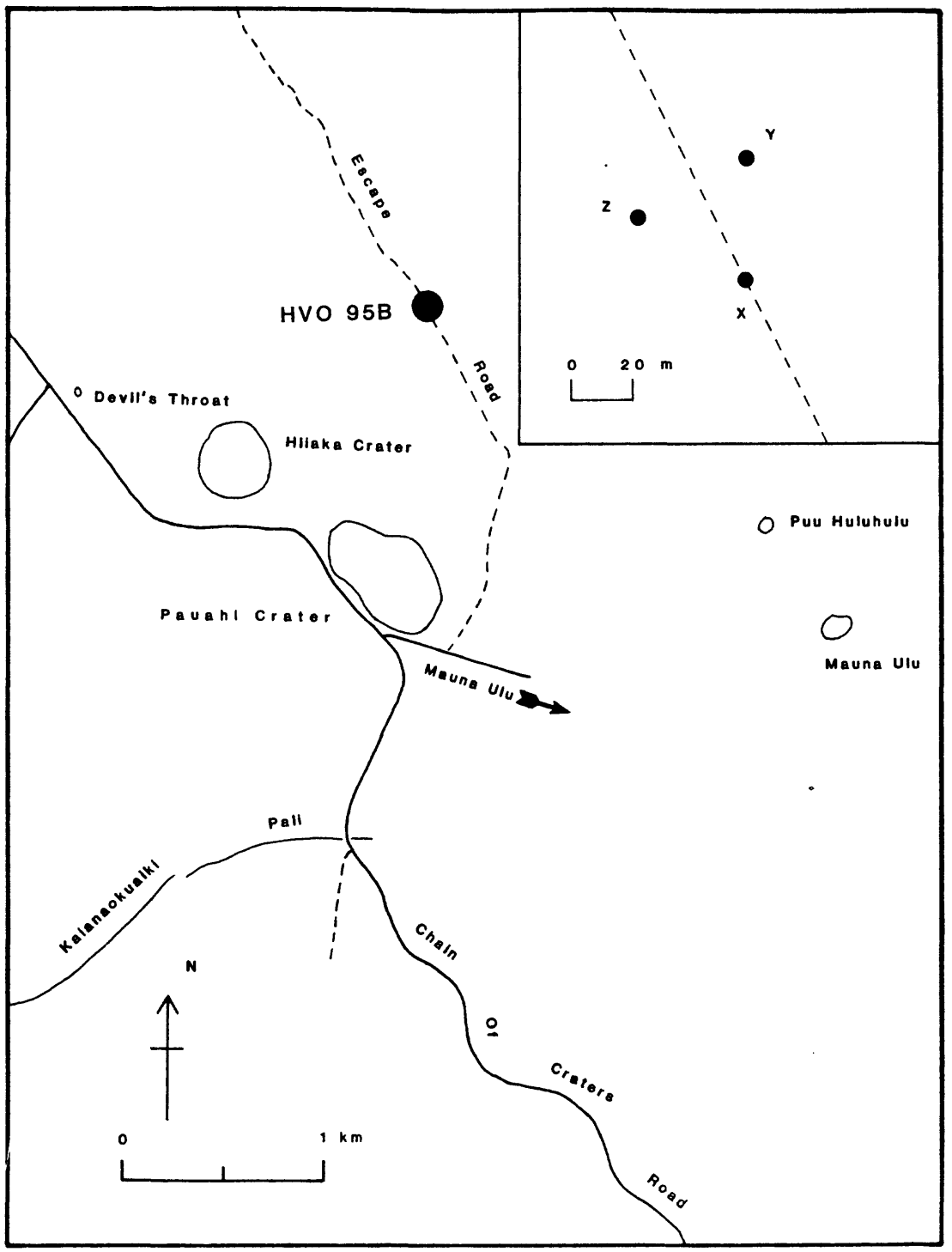
ESCAPE ROAD #4 station is located approximately 9.15 km southeast of the Hawaiian Volcano Observatory in Hawaii Volcanoes National Park. From HVO, drive counter-clockwise on Crater Rim Drive for 4.6 miles to reach the intersection with Chain of Craters Road. Turn right and go 3.5 miles to reach the intersection with Mauna Ulu road. Turn left and go 0.1 mile to reach a dirt road on the left (the Escape Road). Turn left through a locked gate and go 0.35 mile to reach the ESCAPE ROAD #4 station.



HVO 95B (7/2/84 to present)

PREVIOUS NAMES :	HVO 95 (9/24/73 to 1/9/75)
	NEW HVO 95 (6/18/75 to 10/23/80)
	NEW HVO 95A (10/23/80 to 8/3/83)
MAP COORDINATES :	N 19 23.05' W155 13.40' Volcano
STATION DATA :	Ly = 40.00 m, Lz = 40.00 m, Theta = 90.0, Phi = 150.0
STATION EQUATION :	T(n) = 0.250 d(Y-X)
	T(e) = 0.144 d(Y-X) + 0.289 d(X-Z)

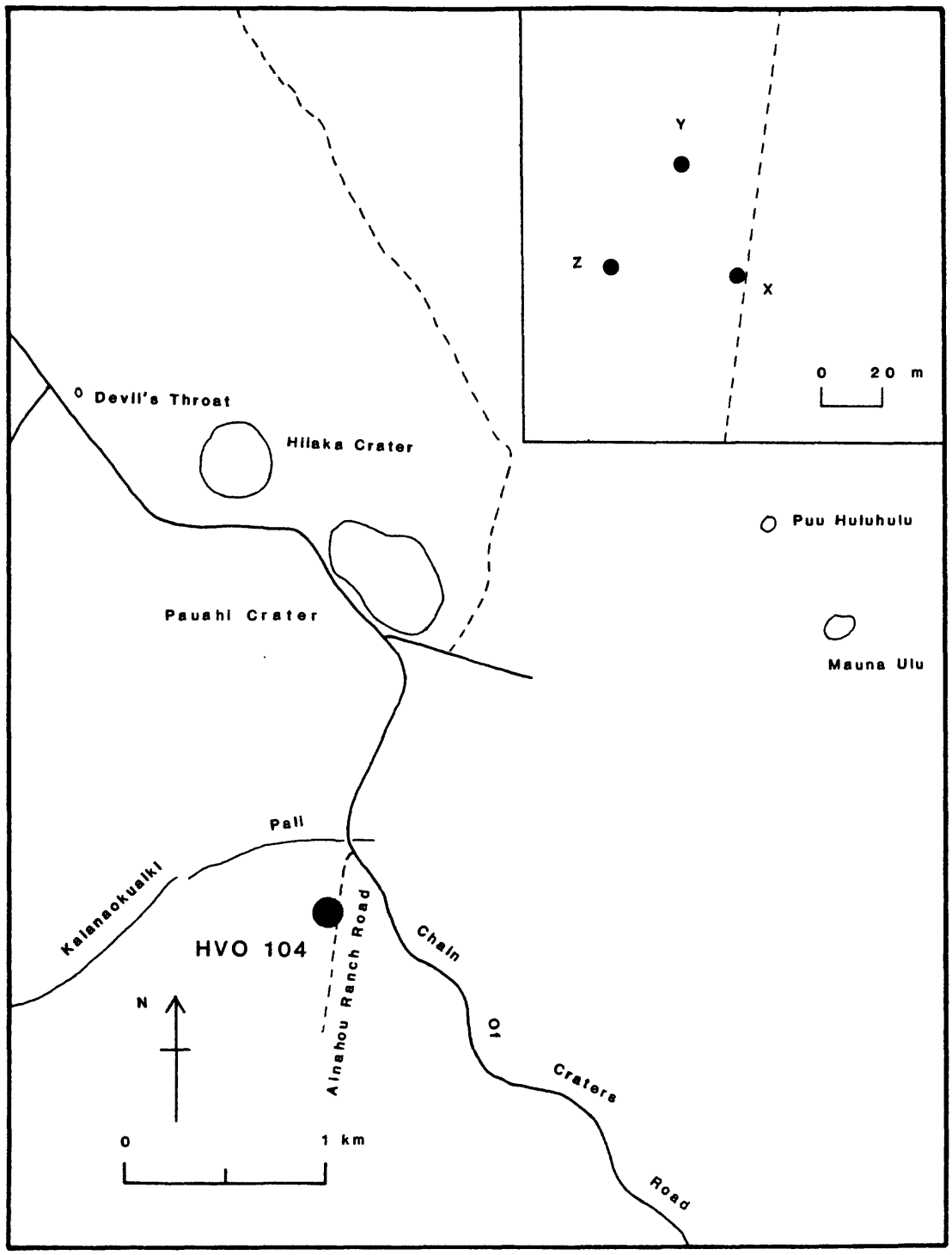
HVO 95B station is located approximately 8.25 km southeast of the Hawaiian Volcano Observatory in Hawaii Volcanoes National Park. From HVO, drive counter-clockwise on Crater Rim Drive for 4.6 miles to reach the intersection with Chain of Craters Road. Turn right and go 3.5 miles to reach the intersection with Mauna Ulu road. Turn left and go 0.1 mile to reach a dirt road on the left (the Escape Road). Turn left through a locked gate and go 1.3 miles to reach the HVO 95B station.



HVO 104 (9/24/73 to present)

PREVIOUS NAME :	None
MAP COORDINATES :	N 19 21.44' W155 13.68' Makaopuhi Crater
STATION DATA :	Ly = 40.00 m, Lz = 40.00 m, Theta = 115.0, Phi = 175.0
STATION EQUATION :	T(n) = 0.288 d(Y-X) + 0.122 d(X-Z)
	T(e) = 0.025 d(Y-X) + 0.263 d(X-Z)

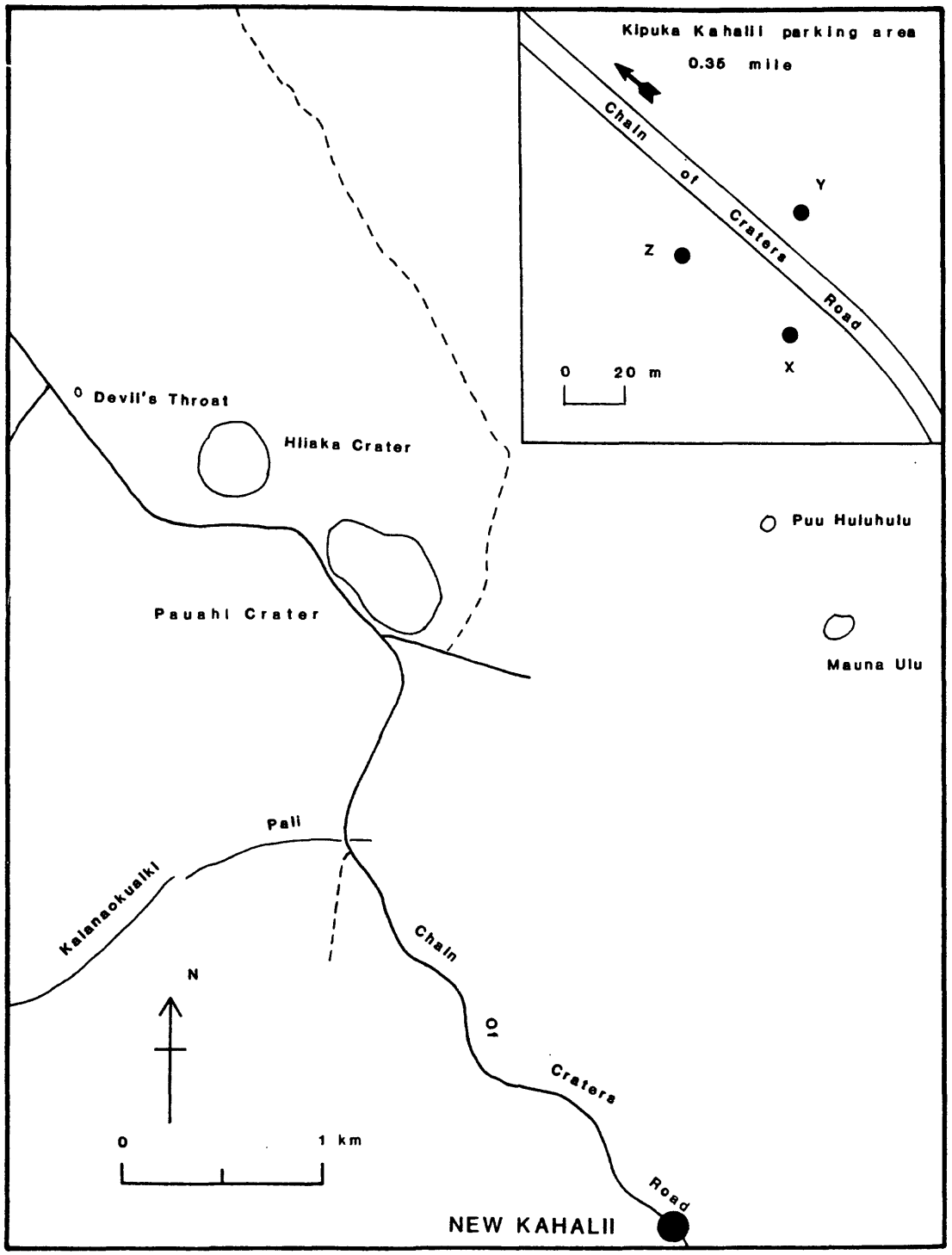
HVO 104 station is located approximately 9.7 km southeast of the Hawaiian Volcano Observatory in Hawaii Volcanoes National Park. From HVO, drive counter-clockwise on Crater Rim Drive for 4.6 miles to reach the intersection with Chain of Craters Road. Turn right and go 4.1 miles to reach the intersection with Ainahou Ranch road. Turn right through a locked gate and go 0.15 mile to reach the HVO 104 station.



NEW KAHALII (12/20/84 to present)

PREVIOUS NAME :	KAHALII (7/11/79 to 12/20/84)
MAP COORDINATES :	N 19 20.73' W155 12.84' Makaopuhi Crater
STATION DATA :	Ly = 39.65 m, Lz = 41.98 m, Theta = 85.0, Phi = 143.0
STATION EQUATION :	T(n) = 0.238 d(Y-X) — 0.025 d(X-Z)
	T(e) = 0.179 d(Y-X) + 0.280 d(X-Z)

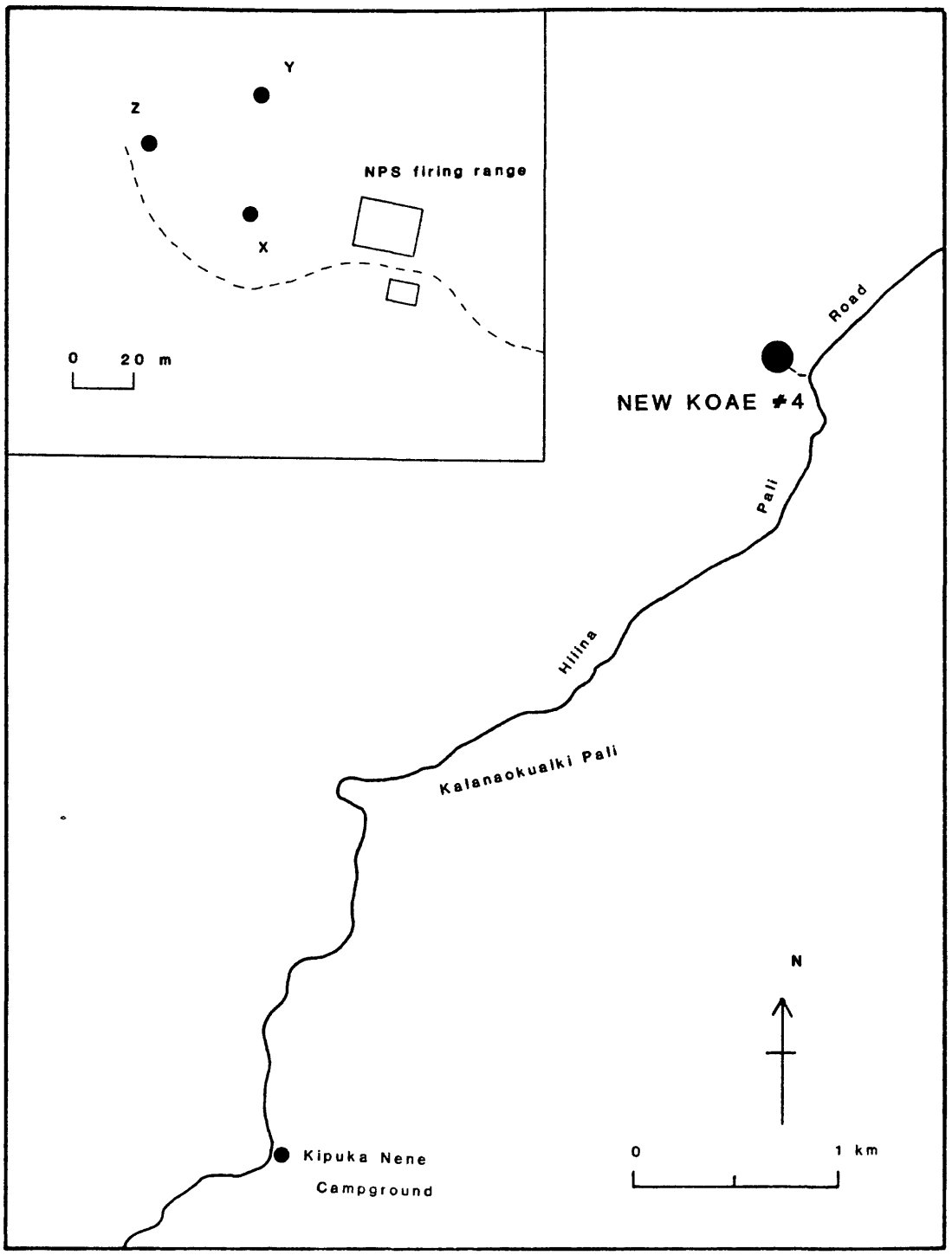
NEW KAHALII station is located approximately 3.0 km south-southwest of Mauna Ulu and 11.7 km southeast of the Hawaiian Volcano Observatory in Hawaii Volcanoes National Park. From HVO, drive counter-clockwise on Crater Rim Drive for 4.6 miles to reach the intersection with Chain of Craters Road. Turn right and go 5.6 miles to reach the NEW KAHALII station.



NEW KOAE #4 (7/18/84 to present)

PREVIOUS NAME :	KOAE #4 (2/17/70 to 11/30/83)
MAP COORDINATES :	N19 21.85' W155 15.45' Kau Desert
STATION DATA :	Ly = 37.93 m, Lz = 40.08 m, Theta = 84.0, Phi = 145.0
STATION EQUATION :	T(n) = 0.247 d(Y-X) — 0.030 d(X-Z)
	T(e) = 0.173 d(Y-X) + 0.284 d(X-Z)

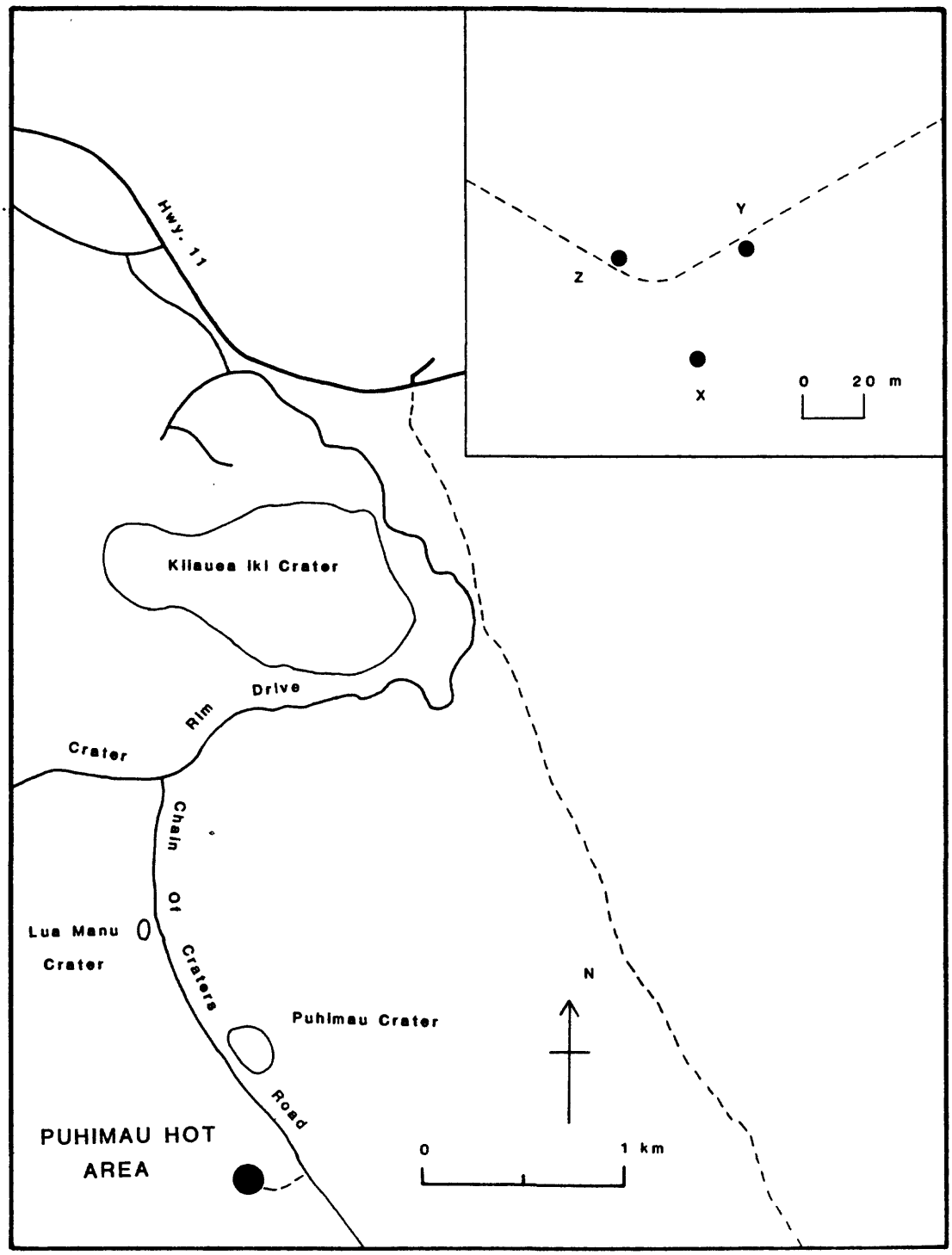
NEW KOAE #4 station is located approximately 4.6 miles southeast of the Hawaiian Volcano Observatory in Hawaii Volcanoes National Park. From HVO, drive counter-clockwise on Crater Rim Drive for 4.6 miles to reach the intersection with Chain of Craters Road. Turn right and go 2.0 miles to reach the intersection with Hilina Pali Road. Turn right and go 1.6 miles to reach a dirt road on the right side (just before the road goes over the first pali). Turn right and go 0.1 mile to reach the NEW KOAE #4 station.



PUHIMAU HOT AREA (8/16/71 to present)

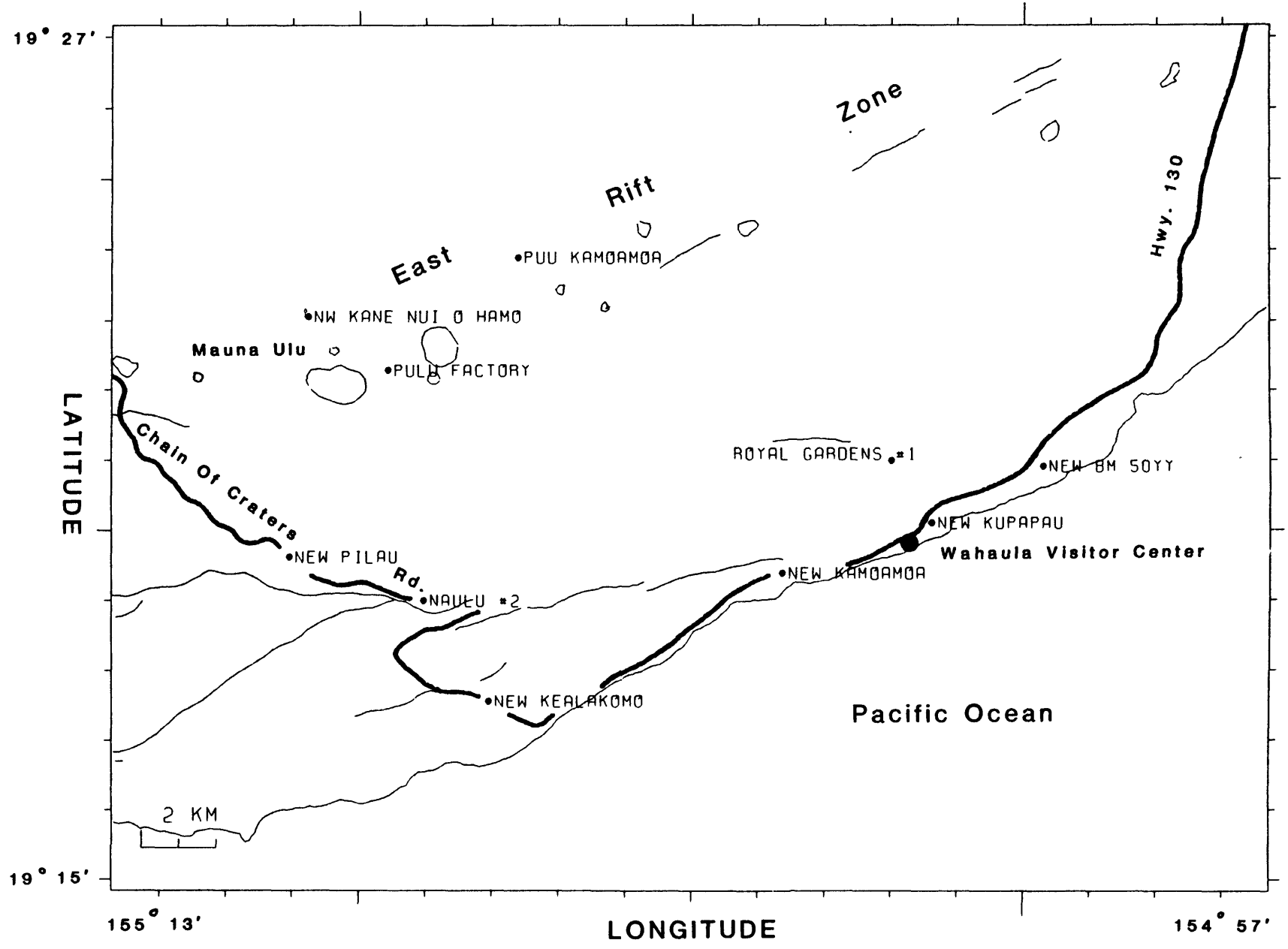
PREVIOUS NAME :	None
MAP COORDINATES :	N19 23.41' W155 15.00' Kilauea Crater
STATION DATA :	Ly = 40.00 m, Lz = 40.00 m, Theta = 70.0, Phi = 130.0
STATION EQUATION :	T(n) = 0.186 d(Y-X) — 0.099(X-Z)
	T(e) = 0.221 d(Y-X) + 0.271(X-Z)

PUHIMAU HOT AREA station is located approximately 5.6 km southeast of the Hawaiian Volcano Observtory in Hawaii Volcanoes National Park. From HVO, drive counter-clockwise on Crater Rim Drive for 4.6 miles to reach the intersection with Chain of Craters Road. Turn right and go 1.3 miles to reach a dirt road on the right side (near a cattle guard across the road). Turn right and go 0.1 mile to reach the PUHIMAU HOT AREA station.



KILAUEA MIDDLE EAST RIFT ZONE DRYTILT STATIONS

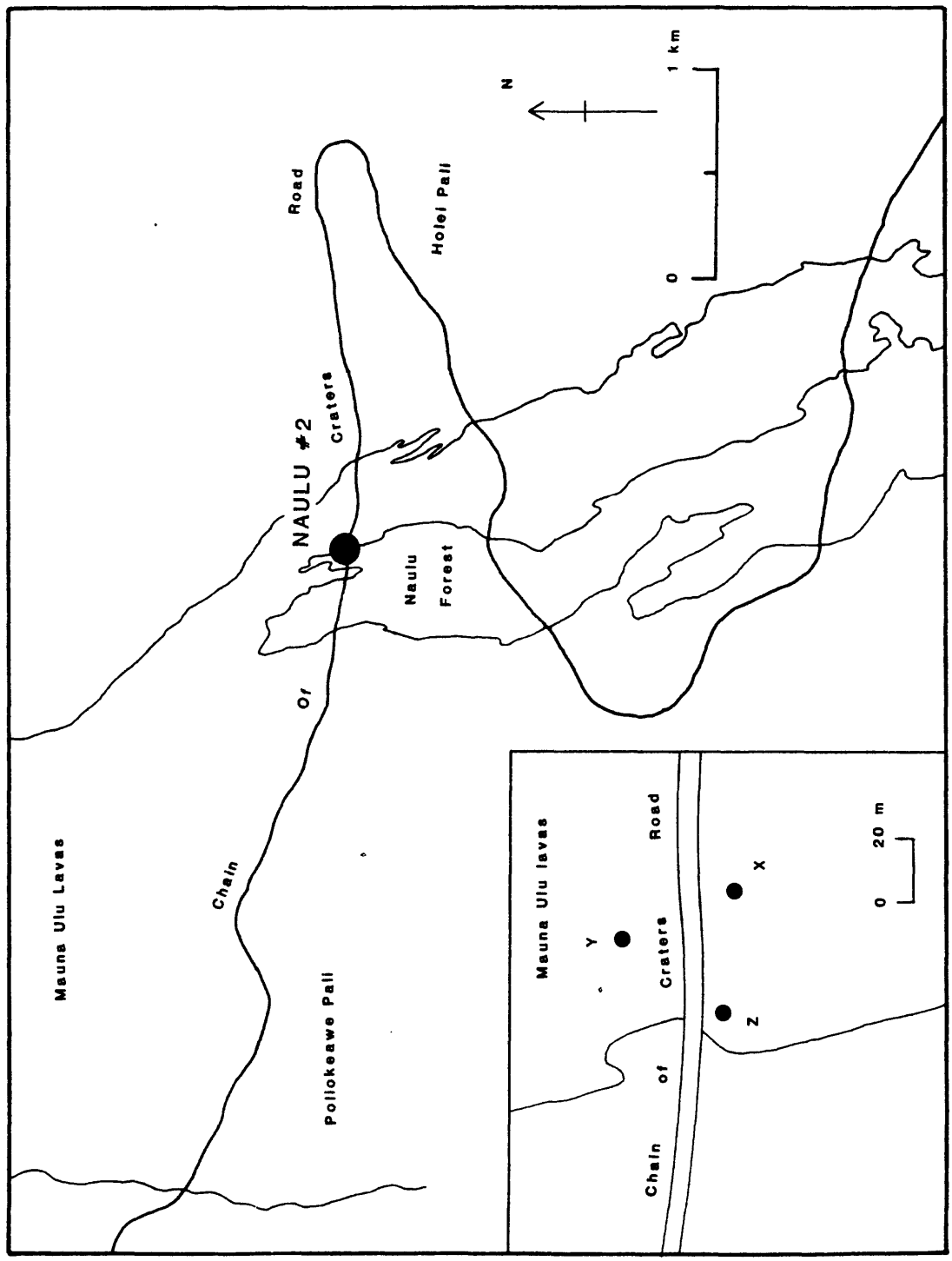
KILAUEA MIDDLE EAST RIFT ZONE DRYTILT STATIONS



NAULU #2 (11/14/80 to present)

PREVIOUS NAME :	NAULU (7/11/79 to 5/6/80)
MAP COORDINATES :	N 19 18.99' W155 09.03' Makaopuhi Crater
STATION DATA :	Ly = 40.17 m, Lz = 40.30 m, Theta = 112.0, Phi = 175.0
STATION EQUATION :	T(n) = 0.278 d(Y-X) + 0.104 d(X-Z)
	T(e) = 0.024 d(Y-X) + 0.258 d(X-Z)

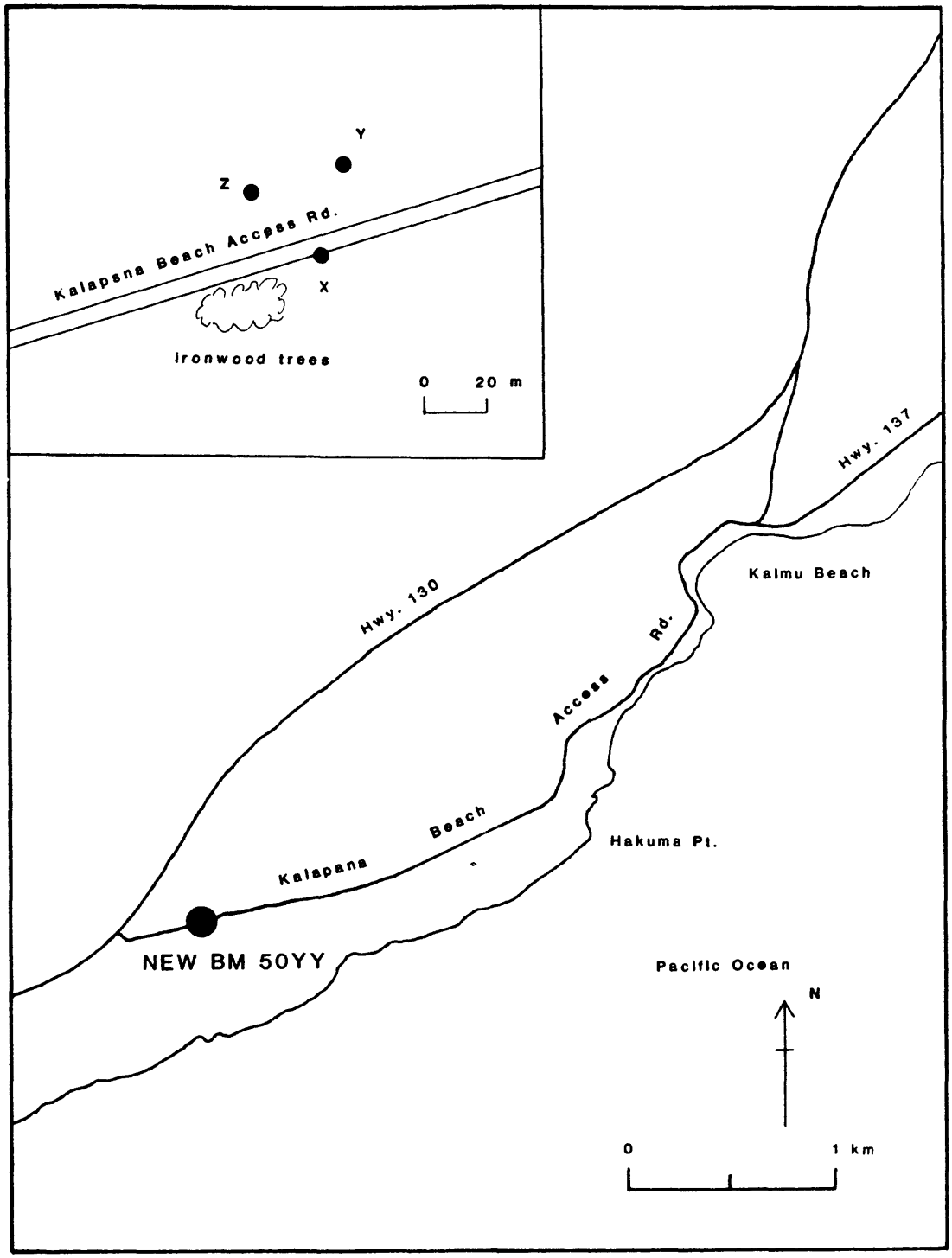
NAULU #2 station is located approximately 8.3 km southeast of Mauna Ulu in Hawaii Volcanoes National Park. From HVO, drive counter-clockwise on Crater Rim Drive for 4.6 miles to reach the intersection with Chain of Craters Road. Turn right and go 10.2 miles to reach the NAULU #2 station (approximately 0.95 mile past the Kealakomo overlook).



NEW BM 50YY (2/18/82 to present)

PREVIOUS NAME :	BM 50YY (2/5/76 to 2/18/82)
MAP COORDINATES :	N 19 20.91' W154 59.71' Kalapana
STATION DATA :	Ly = 30.51 m, Lz = 30.51 m, Theta = 76.0, Phi = 136.0
STATION EQUATION :	T(n) = 0.272 d(Y-X) — 0.092 d(X-Z)
	T(e) = 0.263 d(Y-X) + 0.367 d(X-Z)

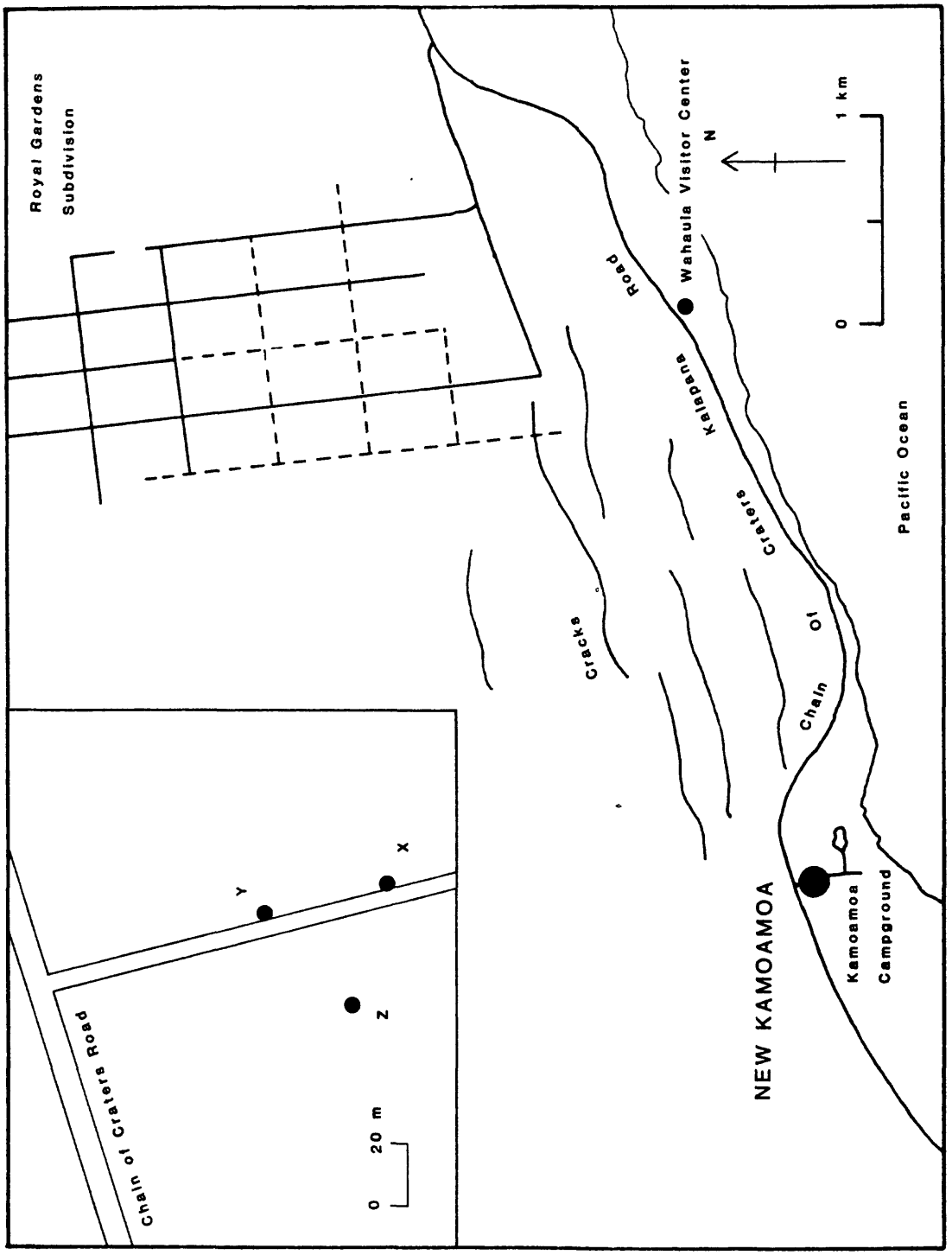
NEW BM 50YY station is located approximately 4.5 km east-northeast of the Wahaula Visitor Center near the east rift zone of Kilauea. From the Wahaula Visitor Center, go 2.5 miles northeast to reach the Kalapana beach access road. Turn right and go 0.3 mile to reach the NEW BM 50YY station.



NEW KAMOAMOA (12/20/84 to present)

PREVIOUS NAME :	KAMOAMOA (2/2/76 to 12/20/84)
MAP COORDINATES :	N 19 19.38' W155 03.62' Kalapana
STATION DATA :	Ly = 40.00 m, Lz = 40.00 m, Theta = 103.5, Phi = 163.5
STATION EQUATION :	T(n) = 0.277 d(Y-X) + 0.067 d(X-Z)
	T(e) = 0.082 d(Y-X) + 0.281 d(X-Z)

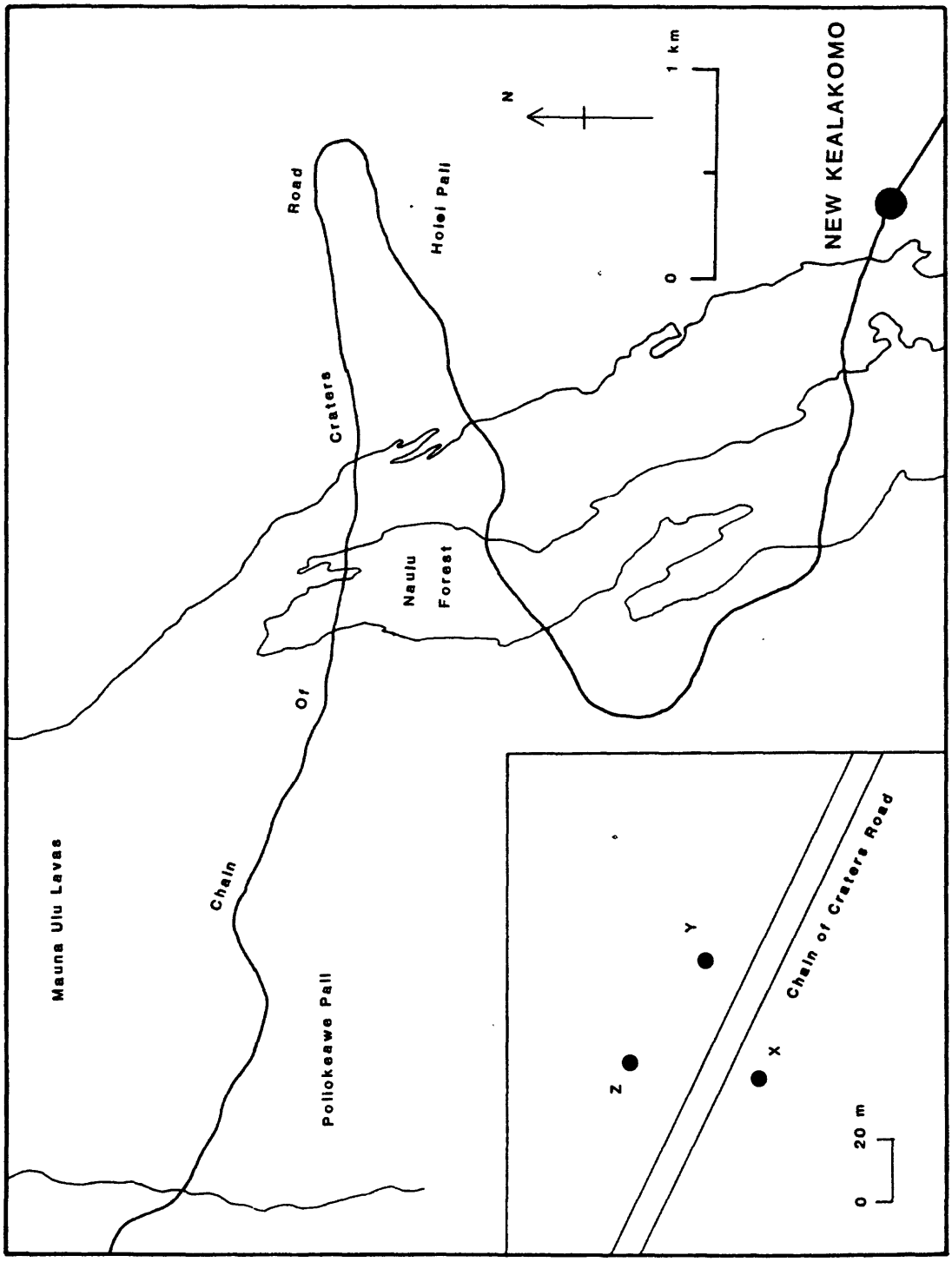
NEW KAMOAMOA station is located at the Kamoamoa campground near the east rift zone of Kilauea in Hawaii Volcanoes National Park. From HVO, drive counter-clockwise on Crater Rim Drive for 4.6 miles to reach the intersection with Chain of Craters Road. Turn right and go 20.8 miles to reach the access road to the Kamoamoa campground (approximately 2.0 miles southwest of the Wahaula Visitor Center). Turn right and go 100 meters to reach the NEW KAMOAMOA station.



NEW KEALAKOMO (12/20/84 to present)

PREVIOUS NAME :	KEALAKOMO (2/2/76 to 12/27/82)
MAP COORDINATES :	N 19 17.56' W155 08.04' Makaopuhi Crater
STATION DATA :	Ly = 40.00 m, Lz = 40.00 m, Theta = 23.0, Phi = 83.0
STATION EQUATION :	T(n) = −0.035 d(Y-X) − 0.266 d(X-Z)
	T(e) = 0.287 d(Y-X) + 0.113 d(X-Z)

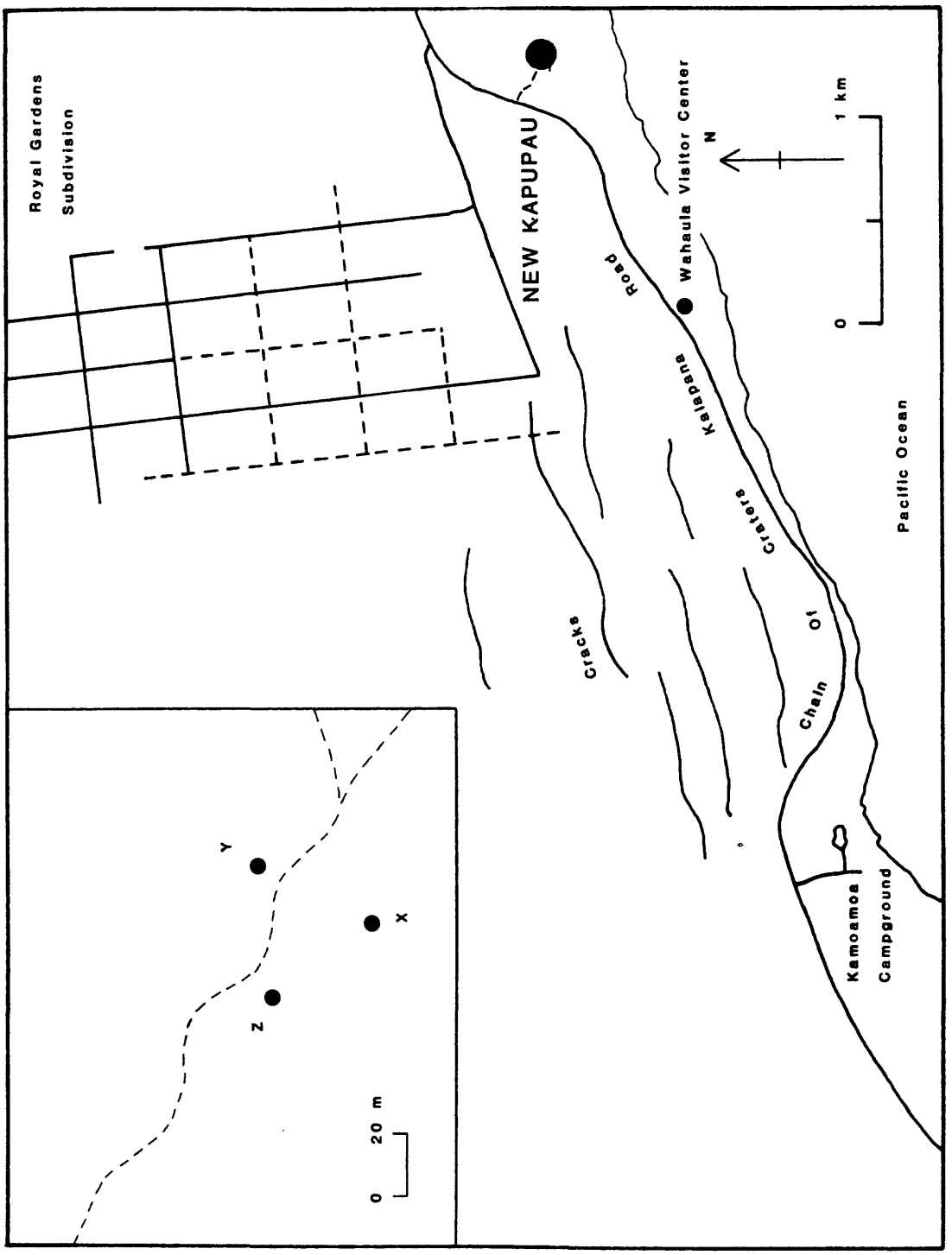
NEW KEALAKOMO station is located approximately 11.4 km southeast of Mauna Ulu near the east rift zone of Kilauea in Hawaii Volcanoes National Park. From HVO, drive counter-clockwise on Crater Rim Drive for 4.6 miles to reach the intersection with Chain of Craters Road. Turn right and go 15.2 miles to reach the NEW KEALAKOMO station (0.15 mile before the Puuloa Petroglyphs parking area).



NEW KUPAPAU (12/20/84 to present

PREVIOUS NAME :	KUPAPAU (2/2/76 to 12/20/84)
MAP COORDINATES :	N 19 20.10' W155 01.38' Kalapana
STATION DATA :	Ly = 40.00 m, Lz = 40.00 m, Theta = 64.0, Phi = 126.0
STATION EQUATION :	T(n) = 0.166 d(Y-X) — 0.124 d(X-Z)
	T(e) = 0.229 d(Y-X) + 0.255 d(X-Z)

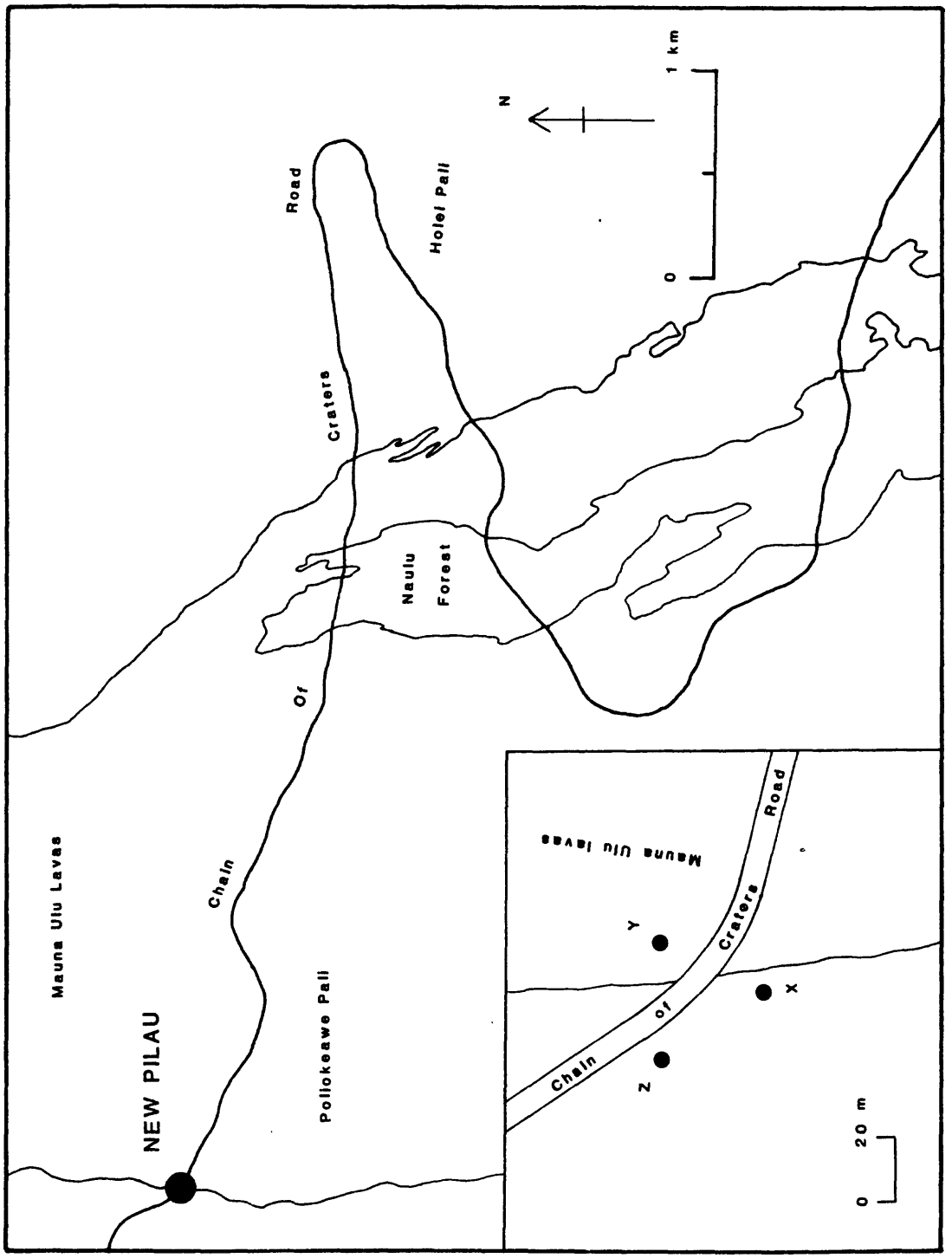
NEW KUPAPAU station is located approximately 1.35 km ENE of the Wahaula Visitor Center in Hawaii Volcanoes National Park. From the Wahaula Visitor Center go 0.9 miles to reach a dirt service road (with a locked gate) on the right side. Turn right and go 320 meters to reach the NEW KUPAPAU station.



NEW PILAU (12/20/84 to present)

PREVIOUS NAME :	PILAU (7/11/79 to 12/20/84)
MAP COORDINATES :	N 19 19.62' W155 11.04' Makaopuhi Crater
STATION DATA :	Ly = 37.98 m, Lz = 39.01 m, Theta = 70.5, Phi = 124.0
STATION EQUATION :	T(n) = 0.183 d(Y-X) — 0.107 d(X-Z)
	T(e) = 0.272 d(Y-X) + 0.301 d(X-Z)

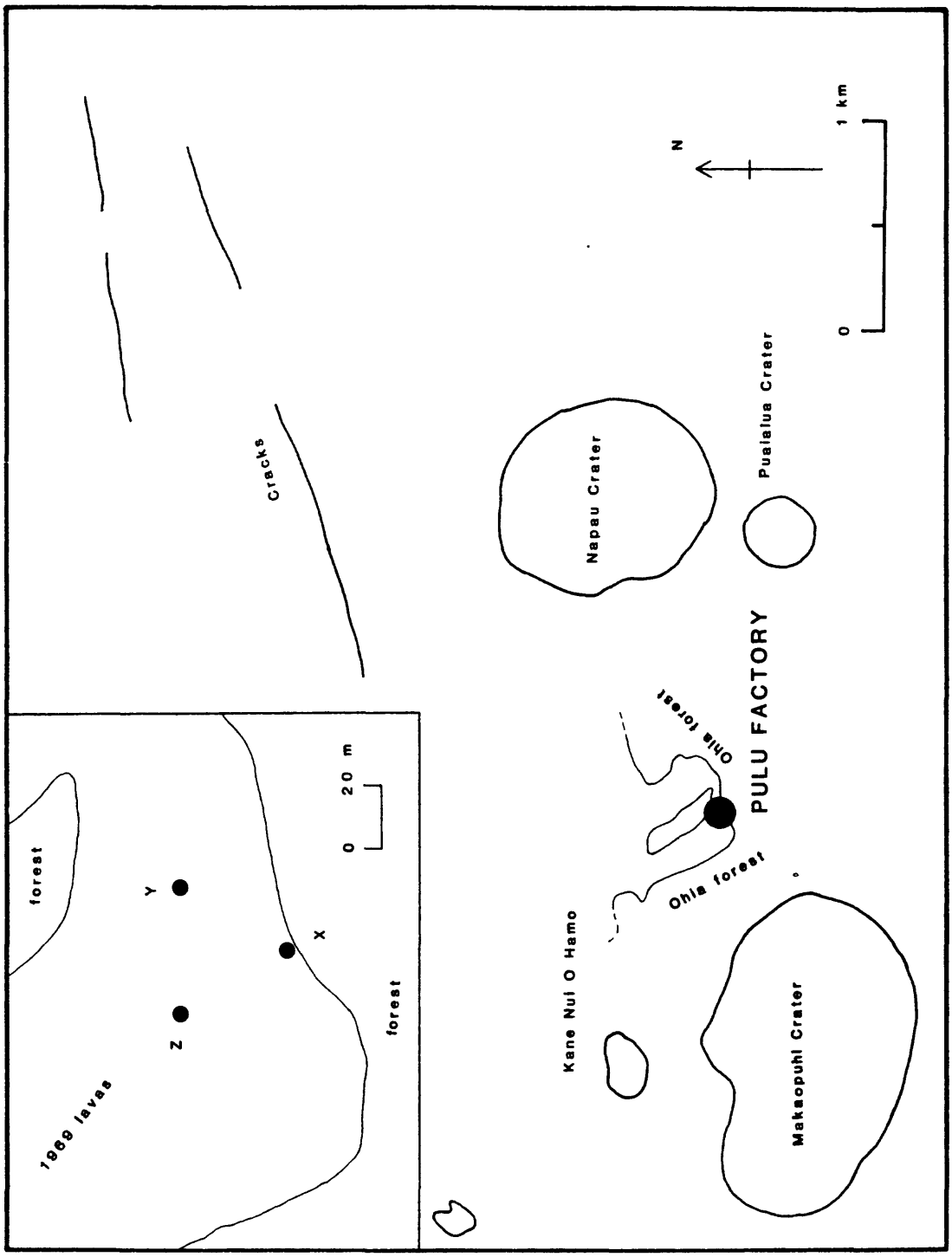
NEW PILAU station is located approximately 5.75 km southeast of Mauna Ulu in Hawaii Volcanoes National Park. From HVO, drive counter-clockwise on Crater Rim Drive for 4.6 miles to reach the intersection with Chain of Craters Road. Turn right on Chain of Craters Road and go 8.2 miles to reach the NEW PILAU station (1.2 miles after the Muliwai a Pele overlook).



PULU FACTORY (7/15/69 to present)

PREVIOUS NAME :	None
MAP COORDINATES :	N 19 22.28' W155 09.57' Makaopuhi Crater
STATION DATA :	Ly = 40.00 m, Lz = 40.00 m, Theta = 60.5, Phi = 120.5
STATION EQUATION :	T(n) = 0.147 d(Y-X) — 0.142 d(X-Z)
	T(e) = 0.249 d(Y-X) + 0.251 d(X-Z)

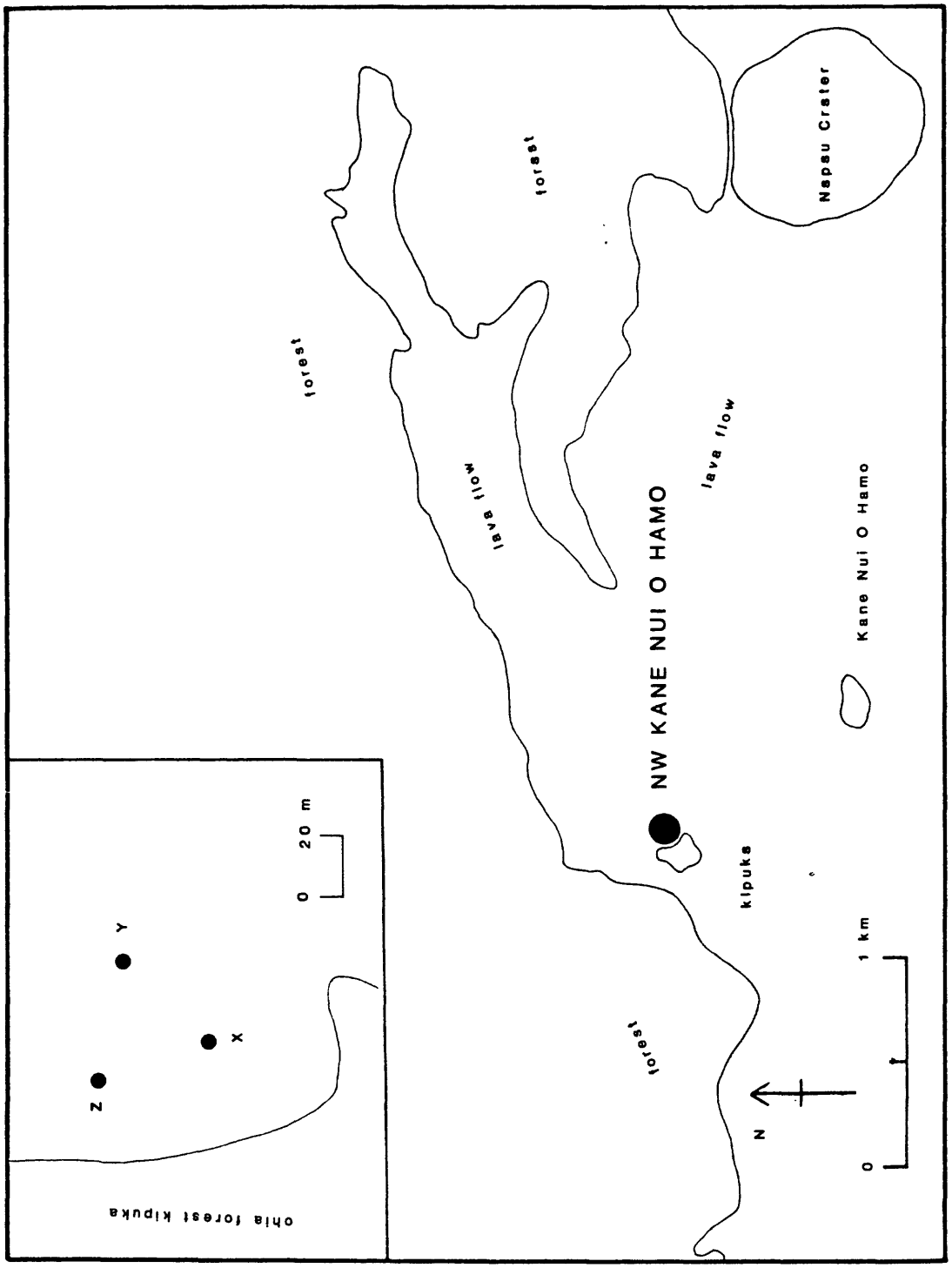
PULU FACTORY station is located 4.7 km east of Mauna Ulu on 1969 lava in Hawaii Volcanoes National Park. PULU FACTORY is at 2820' elevation on the southern edge of 1969 lava and a helicopter is normally used to reach the station.



NW KANE NUI O HAMO (8/23/84 to present)

PREVIOUS NAME :	None
MAP COORDINATES :	N 19 23.05' W155 10.76' Volcano
STATION DATA :	Ly = 37.76 m, Lz = 38.68 m, Theta = 47.0, Phi = 108.0
STATION EQUATION :	T(n) = -0.094 d(Y-X) – 0.202 d(X-Z)
	T(e) = 0.288 d(Y-X) + 0.216 d(X-Z)

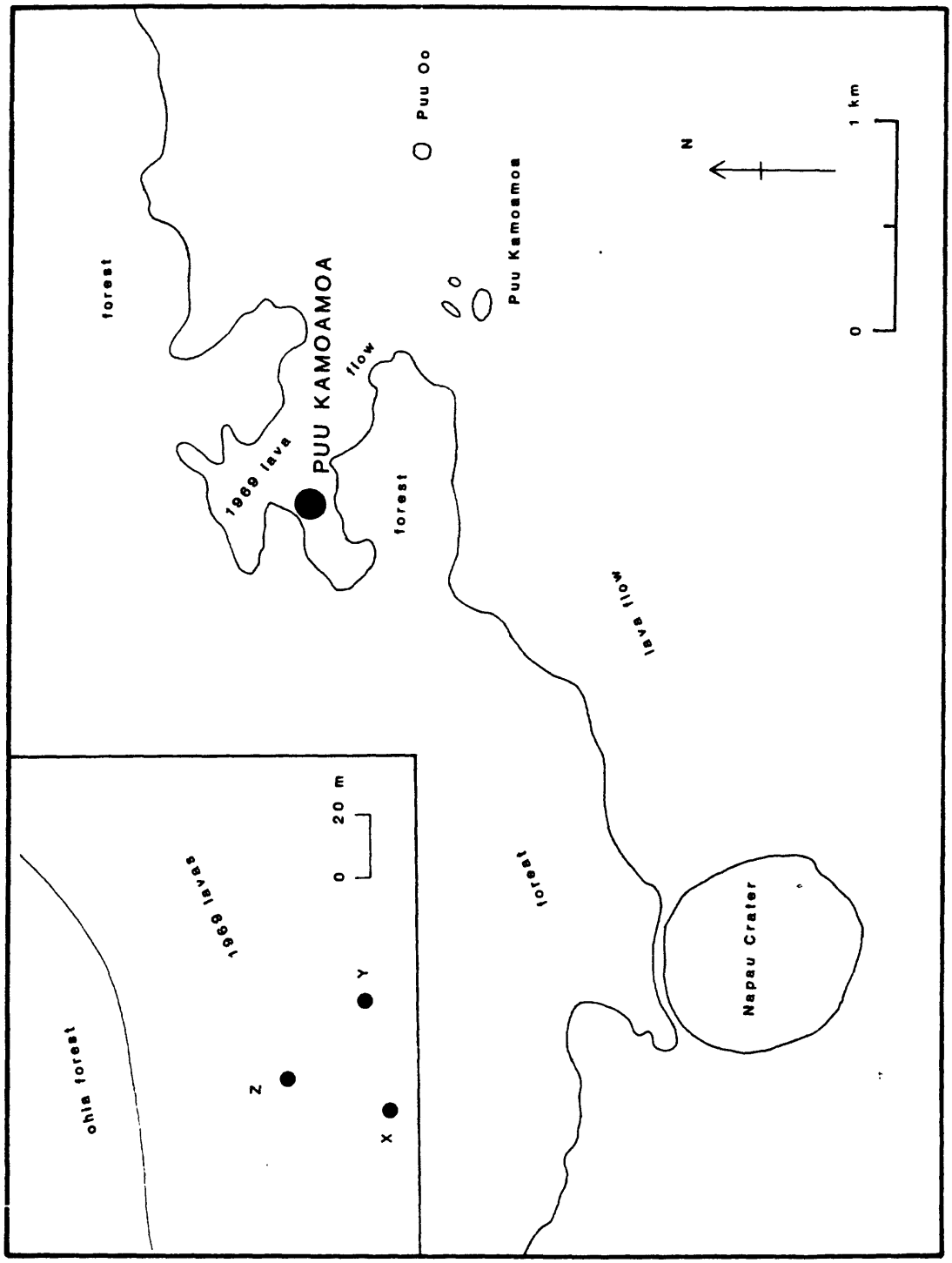
NW KANE NUI O HAMO station is located 1.0 km north-northwest of Kane Nui O Hamo cone in Hawaii Volcanoes National Park. The station is located northeast of a small Ohia tree kipuka on a pahoehoe lava flow near the edge of the forest . NW KANE NUI O HAMO is at 2980' elevation and is reached by helicopter.



PUU KAMOAMOA (2/22/78 to present)

PREVIOUS NAME :	None
MAP COORDINATES :	N 19 23.89′ W155 07.61 Volcano
STATION DATA :	Ly = 35.10 m, Lz = 34.32 m, Theta = 14.0, Phi = 74.0
STATION EQUATION :	T(n) = −0.091 d(Y-X) − 0.326 d(X-Z)
	T(e) = 0.316 d(Y-X) + 0.081 d(X-Z)

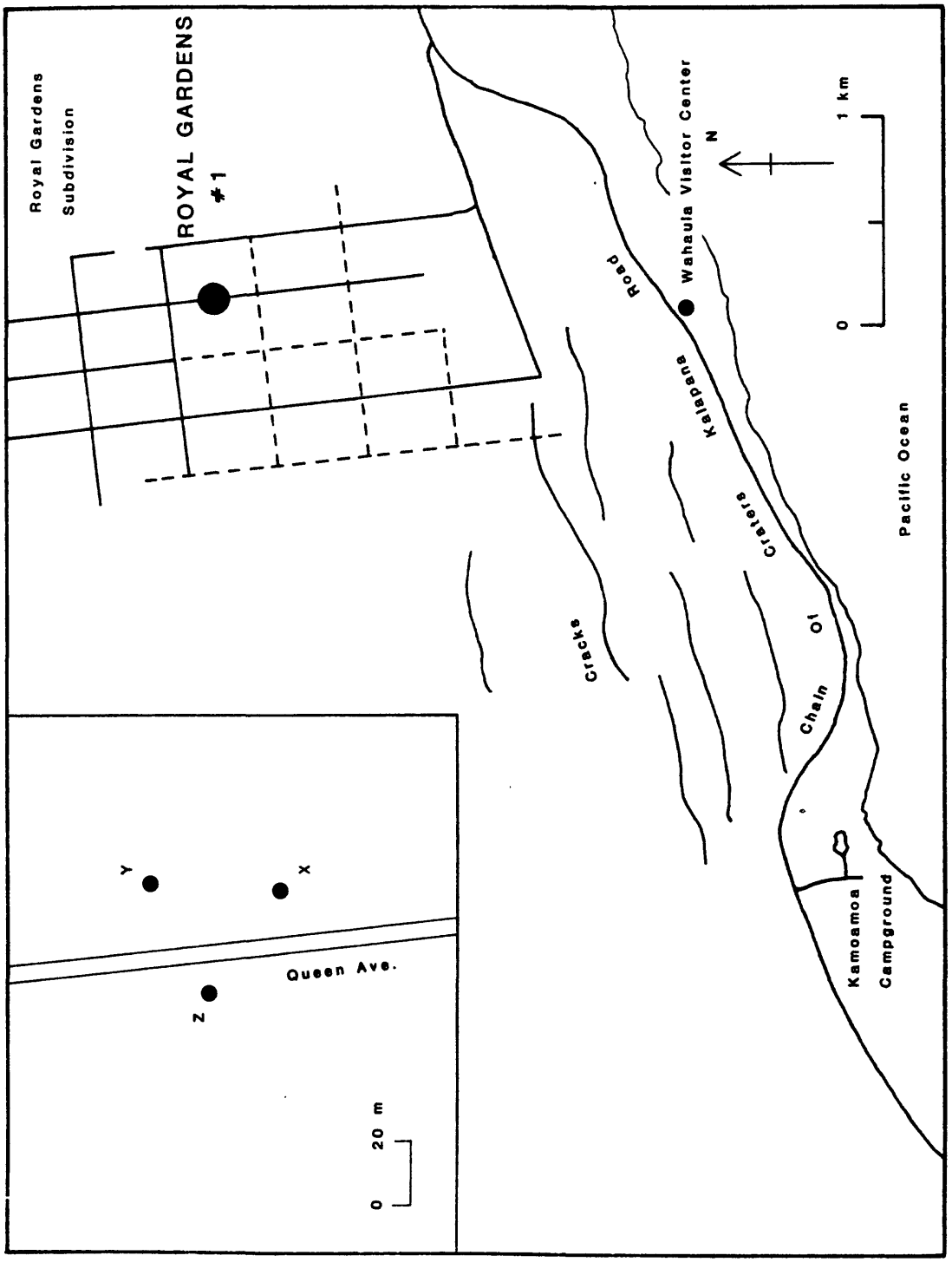
PUU KAMOAMOA station is located approximately 1.8 km west-northwest of Puu Oo on 1969 lavas on the east rift zone of Kilauea. This station is at the 2490′ elevation surrounded by forest on three sides and is reached by helicopter.



ROYAL GARDENS #1 (2/2/76 to present)

PREVIOUS NAME :	None
MAP COORDINATES :	N 19 20.99' W155 01.99' Kalapana
STATION DATA :	Ly = 40.00 m, Lz = 40.00 m, Theta = 87.0, Phi = 147.0
STATION EQUATION :	T(n) = 0.242 d(Y-X) — 0.015 d(X-Z)
	T(e) = 0.157 d(Y-X) + 0.288 d(X-Z)

ROYAL GARDENS #1 station is located approximately 2.3 km north of the Wahaula Visitor Center in the Royal Gardens subdivision near the east rift zone of Kilauea. From the Wahaula Visitor Center, go 1.1 miles to reach the entrance road to the Royal Gardens subdivision. Turn left and go 1.0 mile to reach the intersection with Royal Ave. Turn right and go 1.1 miles to reach the intersection with Lehua St. Turn right and go 0.5 mile to reach the intersection with Princess Ave. Turn right and go 240 m to reach ROYAL GARDENS #1 station.



KILAUEA LOWER EAST RIFT ZONE DRYTILT STATIONS

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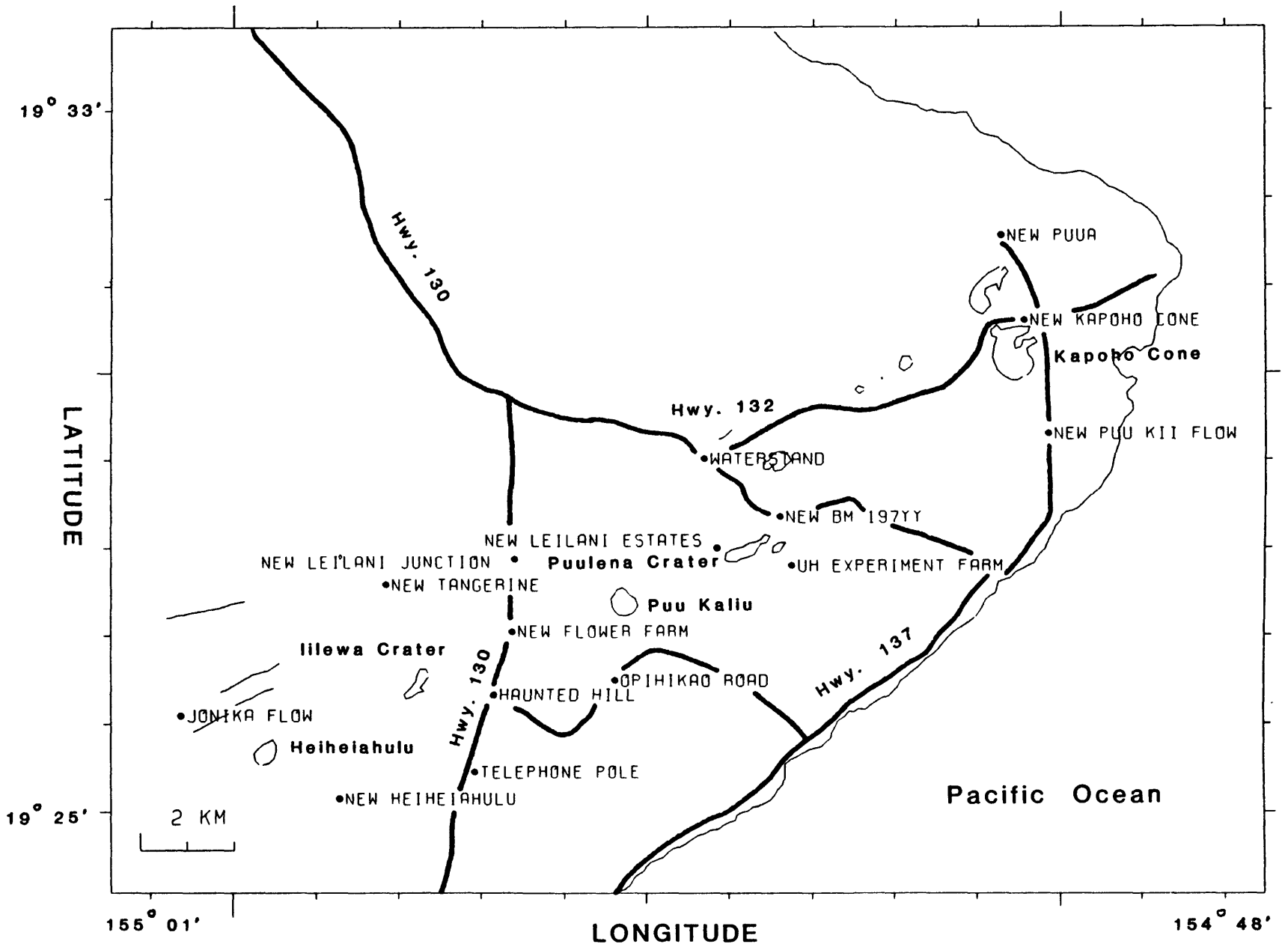
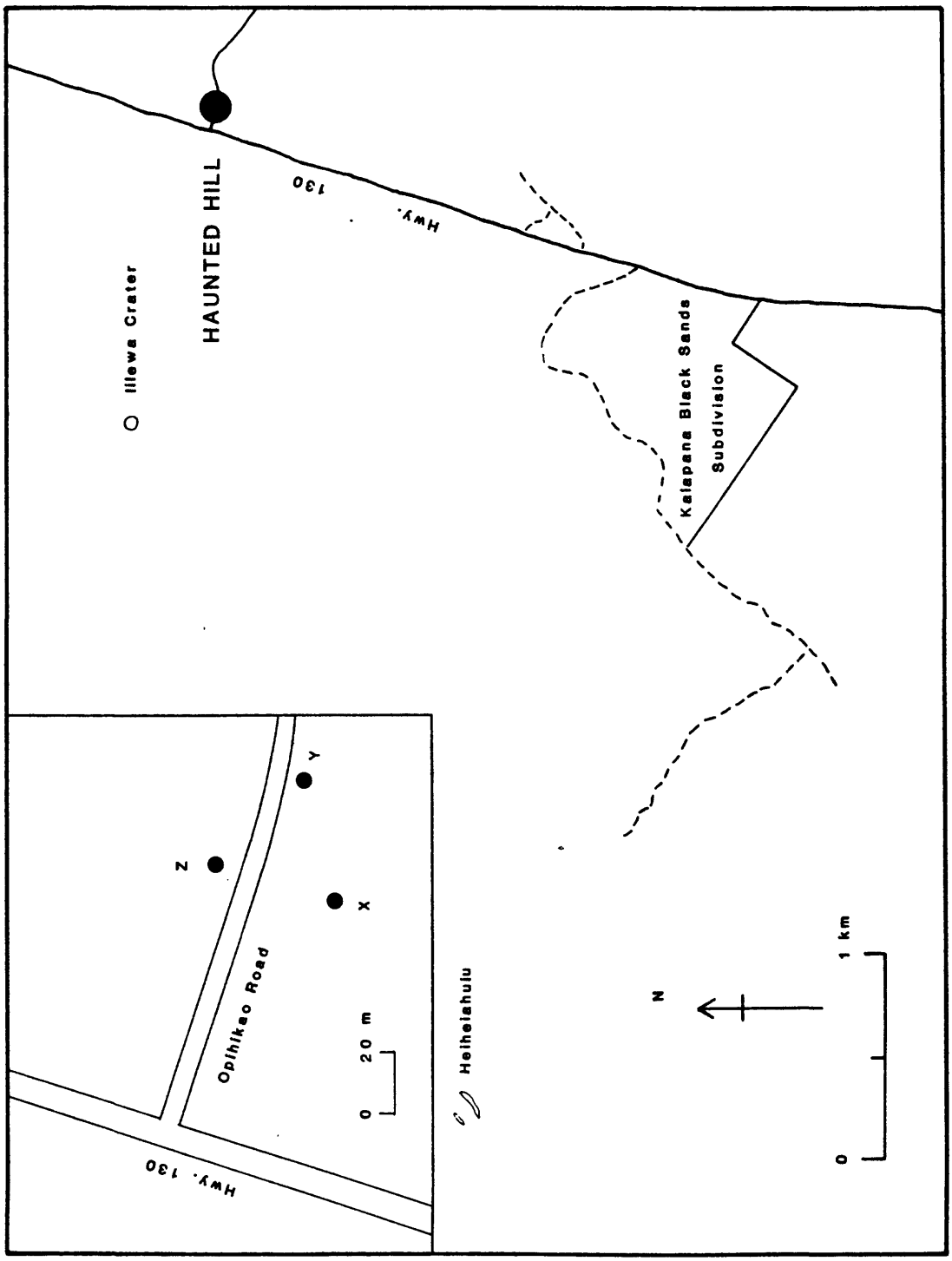


HAUNTED HILL (2/1/71 to present)

PREVIOUS NAME :	None
MAP COORDINATES :	N 19 26.32' W154 56.85' Pahoa South
STATION DATA :	Ly = 40.00 m, Lz = 40.00 m, Theta = 15.0, Phi = 74.0
STATION EQUATION :	T(n) = -0.075 d(Y-X) - 0.279 d(X-Z)
	T(e) = 0.279 d(Y-X) + 0.075 d(X-Z)

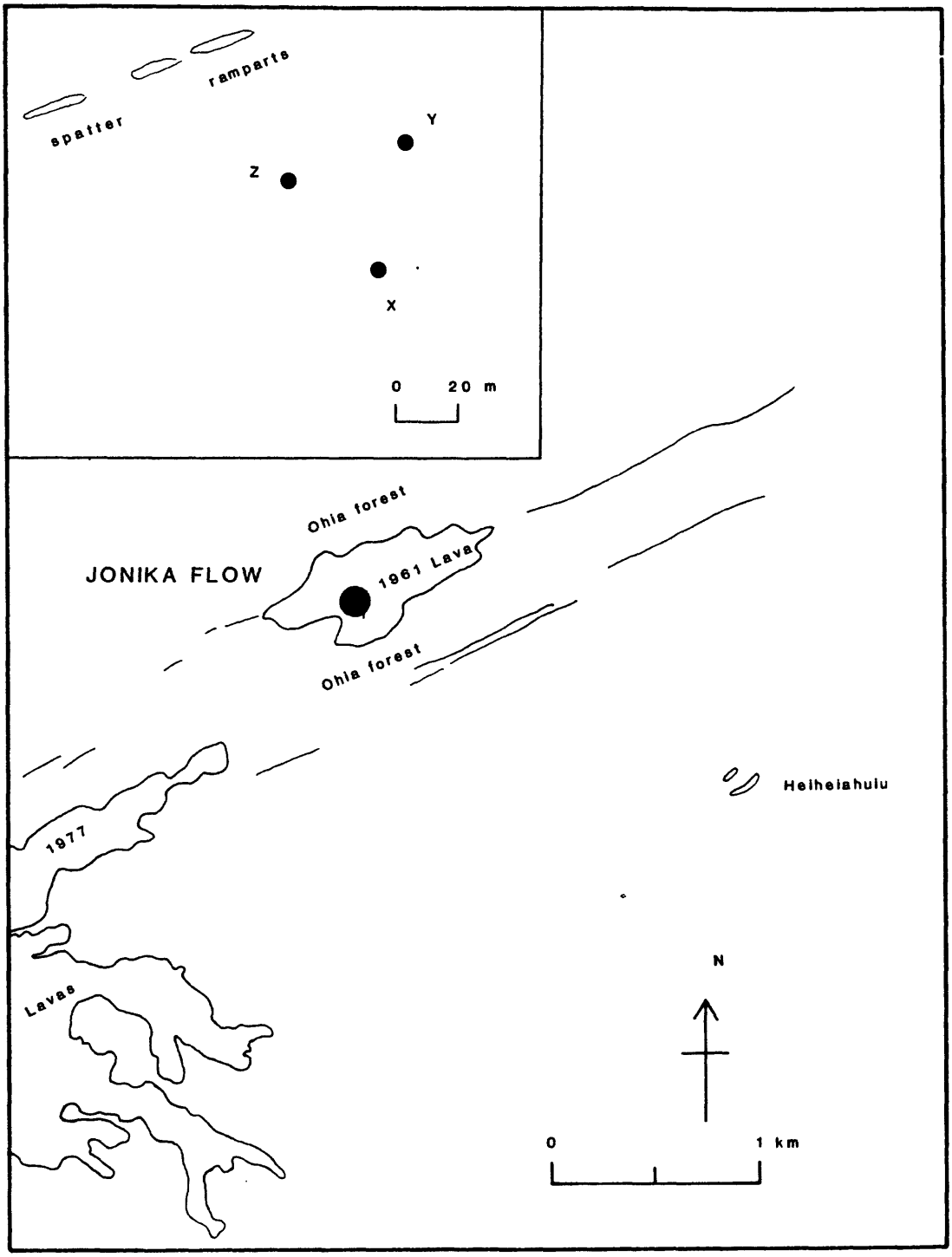
HAUNTED HILL station is located approximately 1.5 km east-southeast of Iilewa crater on the east rift zone of Kilauea. From the intersection of Hwy. 130 and Hwy. 132 (at Pahoa High School), go 3.8 miles on Hwy. 130 to reach Opihikao Road on the left side. Turn left and go 100 meters to reach the HAUNTED HILL station.



JONIKA FLOW (6/5/79 to present)

PREVIOUS NAME :	None
MAP COORDINATES :	N 19 26.09' W155 00.63' Kalalua
STATION DATA :	Ly = 40.00 m, Lz = 40.00 m, Theta = 77.0, Phi = 137.0
STATION EQUATION :	T(n) = 0.211 d(Y-X) − 0.065 d(X-Z)
	T(e) = 0.197 d(Y-X) + 0.281 d(X-Z)

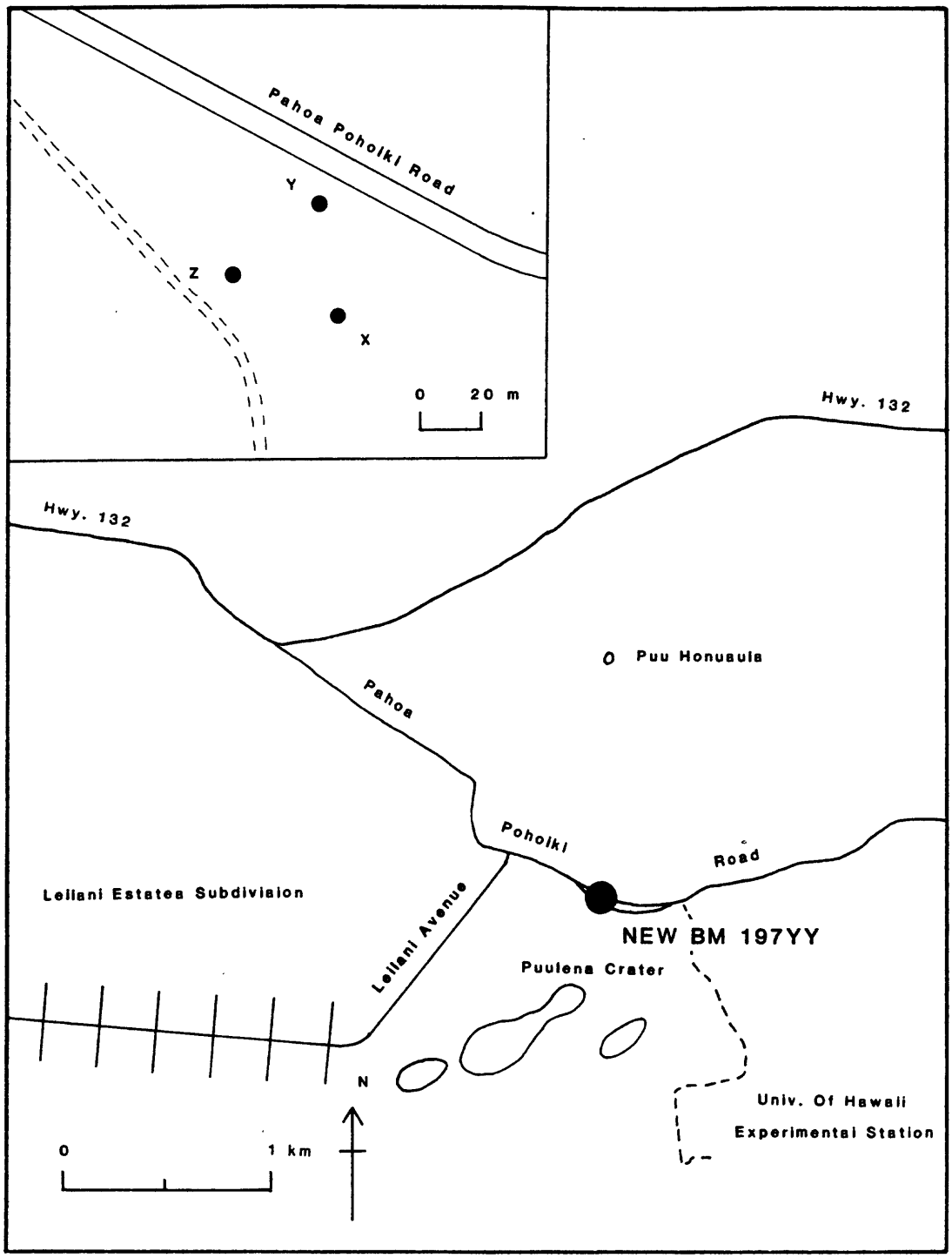
JONIKA FLOW station is located approximately 2.0 km northwest of Heiheiahulu on the east rift zone of Kilauea on 1961 lava surrounded by dense Ohia forest. JONIKA FLOW is at 1540' elevation and is only accessible by helicopter.



NEW BM 197YY (1/23/85 to present)

PREVIOUS NAME :	BM 197YY TRIANGLE (2/1/71 to 5/17/72)
MAP COORDINATES :	N 19 28.35' W154 53.39' Pahoa South
STATION DATA :	Ly = 35.05 m, Lz = 35.05 m, Theta = 106.0, Phi = 166.0
STATION EQUATION :	T(n) = 0.320 d(Y-X) + 0.091 d(X-Z)
	T(e) = 0.080 d(Y-X) + 0.317 d(X-Z)

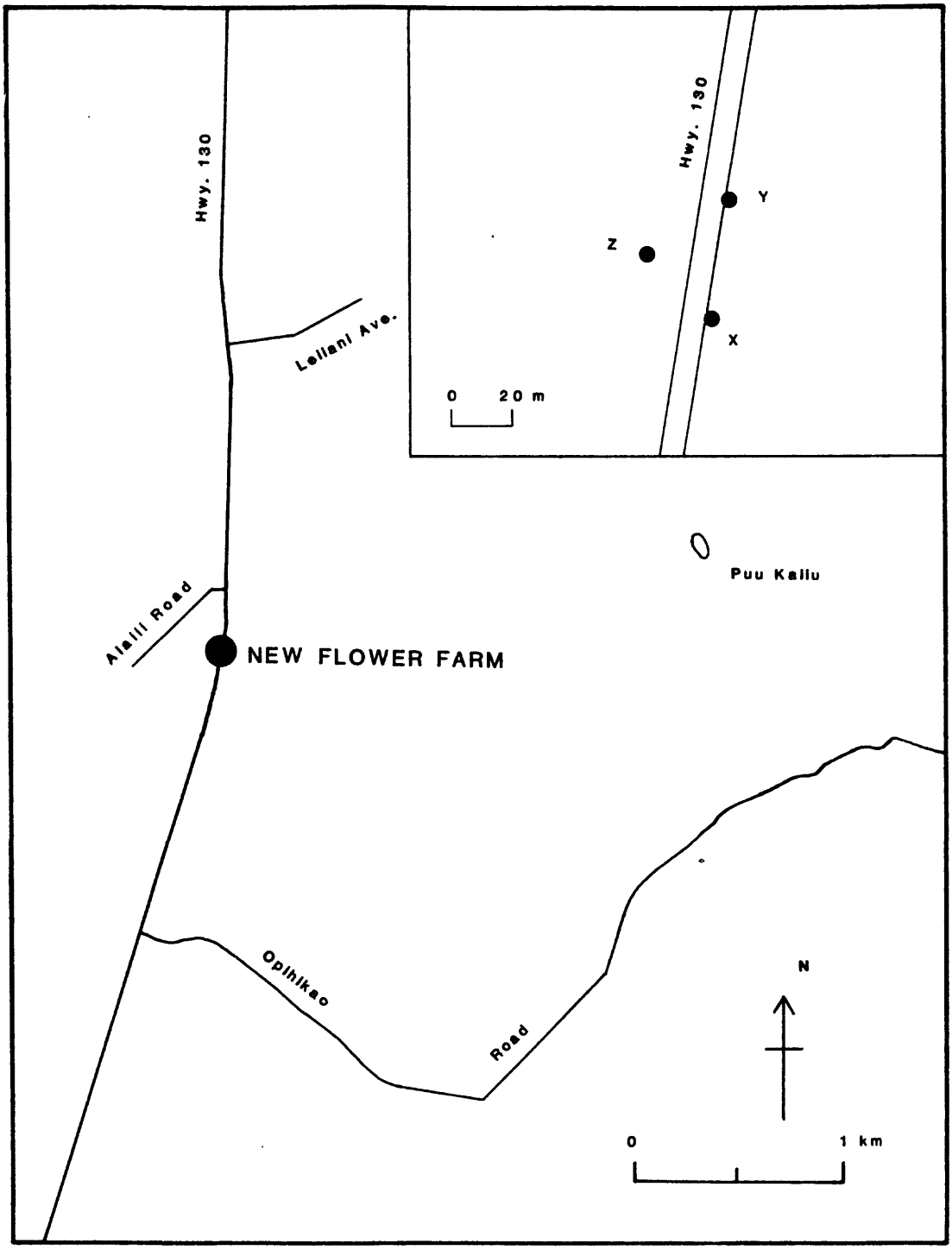
NEW BM 197YY station is located approximately 1.1 km south of Puu Honuaula in the Kapoho district on the lower east rift zone of Kilauea. From the intersection of Hwy. 130 and Hwy. 132 (at Pahoa High School), go 2.6 miles on Hwy. 132 to reach the intersection with Pahoa-Pohoiki Road on the right. Turn right and go 1.3 miles to reach the NEW BM 197YY station (0.4 miles from the geothermal power plant).



NEW FLOWER FARM (1/21/85 to present)

PREVIOUS NAMES :	PUNA FLOWER FARM (2/1/71 to 2/10/72)
	FLOWER FARM #2 (2/5/76 to 2/19/82)
MAP COORDINATES :	N 19 27.04' W154 56.63' Pahoa South
STATION DATA :	Ly = 39.31 m, Lz = 29.93 m, Theta = 83.5, Phi = 133.0
STATION EQUATION :	T(n) = 0.228 d(Y-X) − 0.050 d(X-Z)
	T(e) = 0.244 d(Y-X) + 0.437 d(X-Z)

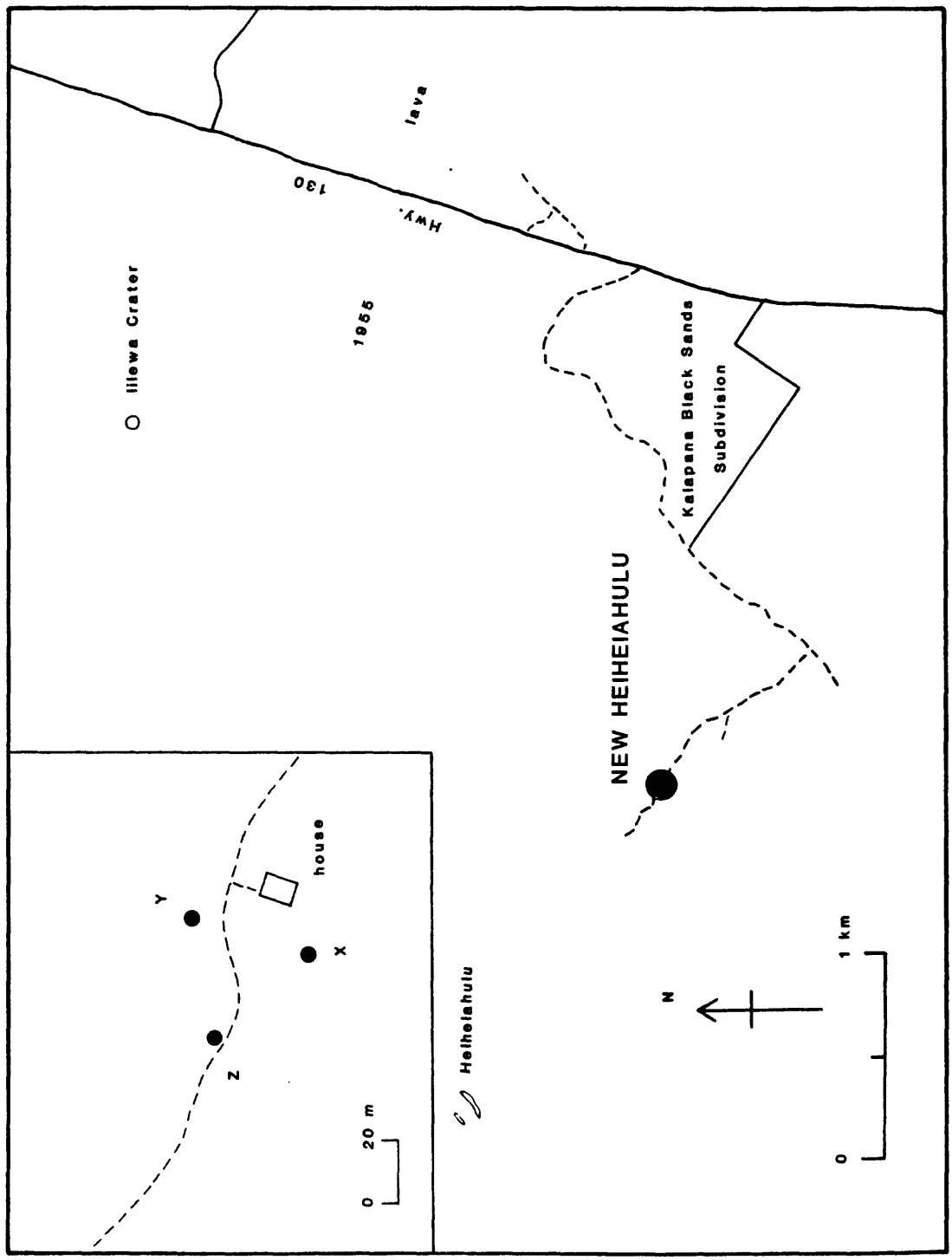
NEW FLOWER FARM station is located approximately 2.4 km west-southwest of Puu Kaliu on the lower east rift zone of Kilauea. From the intersection of Hwy. 130 and Hwy. 132 (at Pahoa High School), go 2.9 miles on Hwy. 130 to reach the NEW FLOWER FARM station.



NEW HEIHEIAHULU (1/21/85 to present)

PREVIOUS NAME :	HEIHEIAHULU (10/26/76 to 2/19/82)
MAP COORDINATES :	N 19 25.15' W154 58.72' Pahoa South
STATION DATA :	Ly = 40.50 m, Lz = 40.01 m, Theta = 72.0, Phi = 132.0
STATION EQUATION :	T(n) = 0.191 d(Y-X) − 0.089 d(X-Z)
	T(e) = 0.021 d(Y-X) + 0.275 d(X-Z)

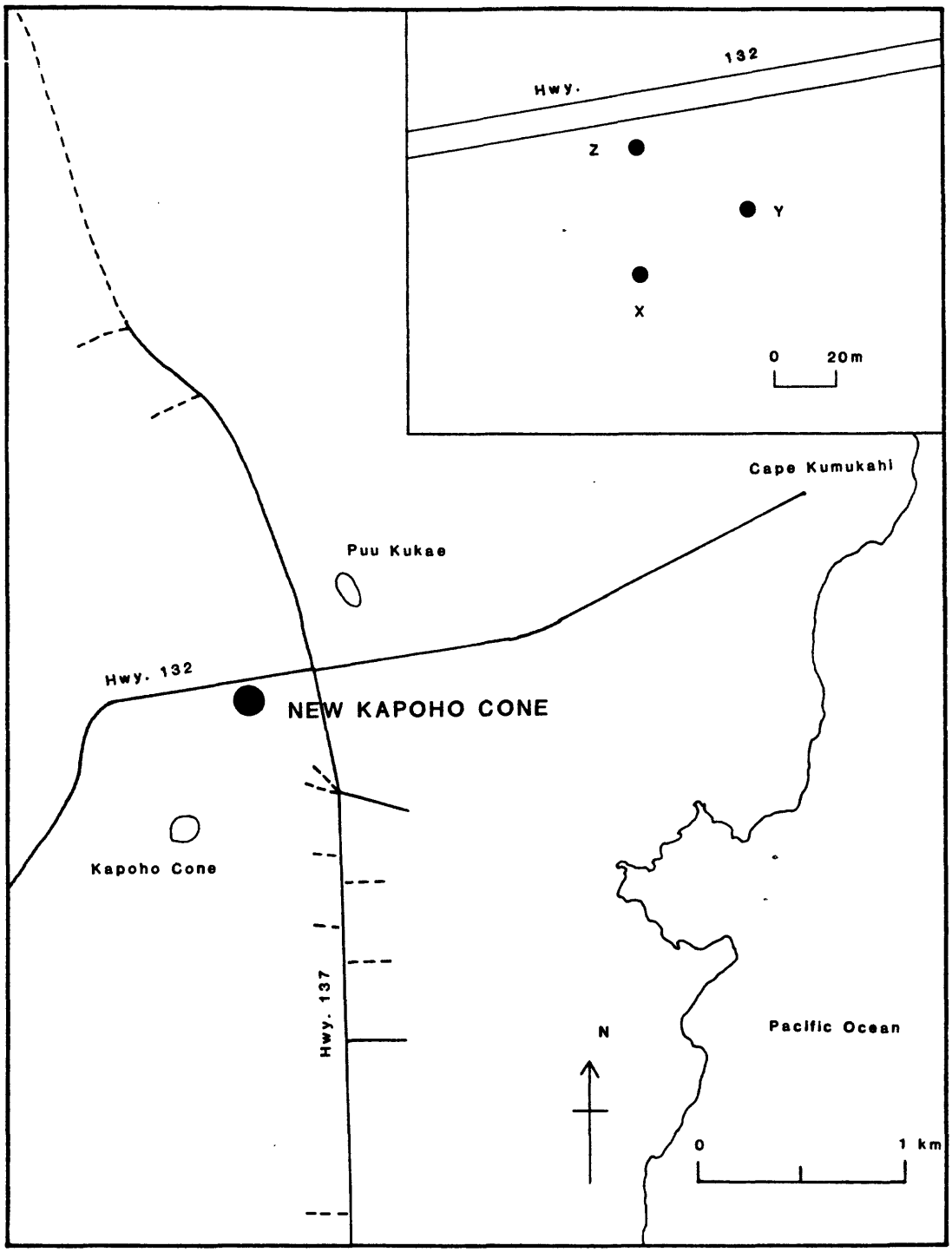
NEW HEIHEIAHULU station is located approximately 1.8 km southeast of Heiheiahulu cone on the lower east rift zone of Kilauea. From the intersection of Hwy. 130 and Hwy. 132 (at Pahoa High School), go 5.1 miles on Hwy. 130 to reach a dirt road on the right side (southern edge of the 1955 lava flow). Turn right and go 1.7 miles to reach a dirt road on the right side. Turn right and go 0.32 mile through a locked gate to reach a fork in the road. Take the right hand fork and go 0.38 mile to reach the NEW HEIHEIAHULU station.



NEW KAPOHO CONE (12/28/82 to present)

PREVIOUS NAME :	KAPOHO CONE (8/28/73 to 12/28/82)
MAP COORDINATES :	N 19 30.60' W154 50.45' Kapoho
STATION DATA :	Ly = 40.00 m, Lz = 40.00 m, Theta = 31.0, Phi = 91.0
STATION EQUATION :	T(n) = 0.005 d(Y-X) − 0.247 d(X-Z)
	T(e) = 0.289 d(Y-X) + 0.149 d(X-Z)

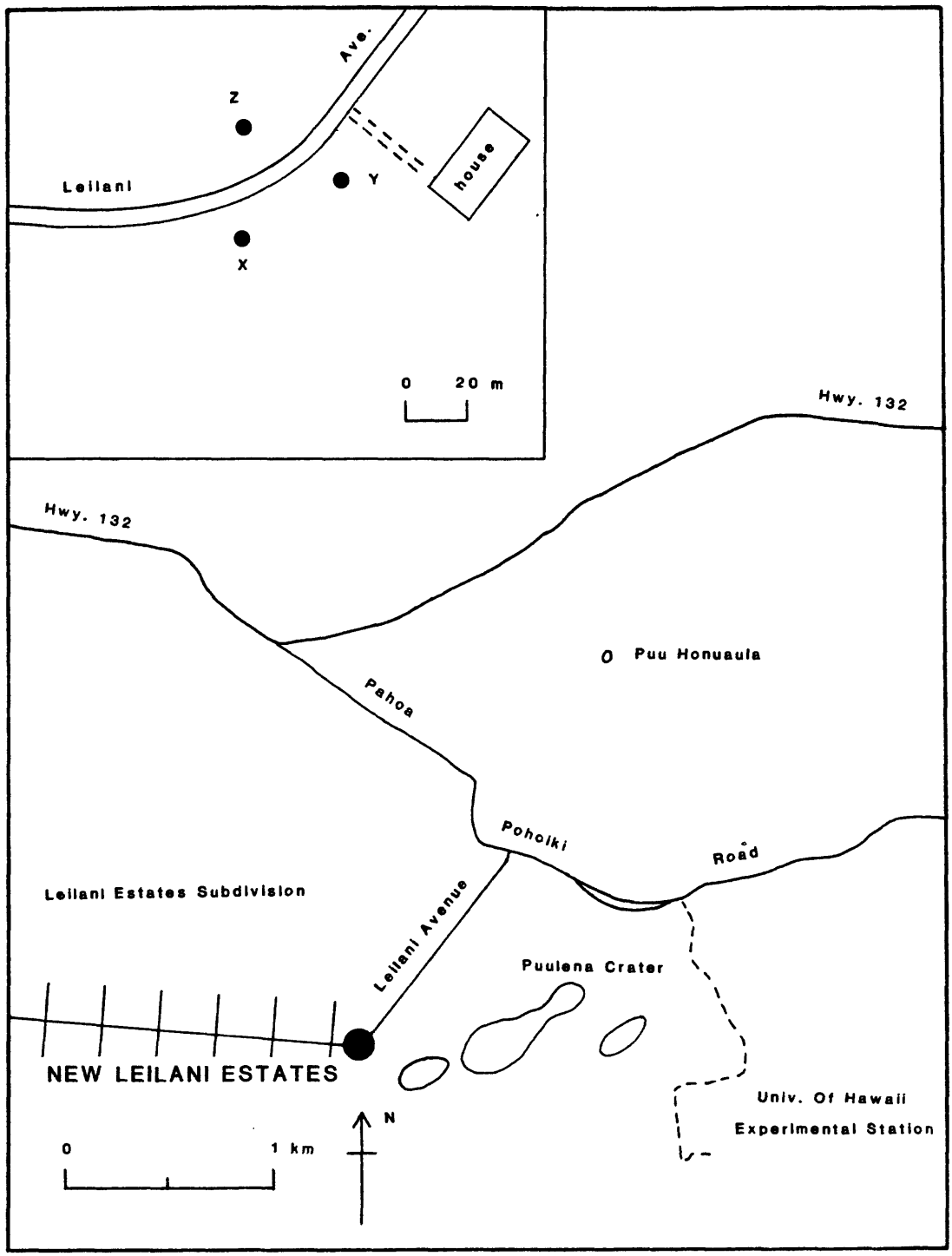
NEW KAPOHO CONE station is located on the 1960 lava flow at the base of the north side of Kapoho Cone on the lower east rift zone of Kilauea. From the intersection of Hwy. 130 and Hwy. 132 (at Pahoa High School), go 7.3 miles on Hwy. 132 to reach the NEW KAPOHO CONE station.



NEW LEILANI ESTATES (12/28/82 to present)

PREVIOUS NAME :	LEILANI ESTATES (8/28/73 to 12/28/82)
MAP COORDINATES :	N 19 27.99' W154 54.15' Pahoa South
STATION DATA :	Ly = 35.00 m, Lz = 35.00 m, Theta = 31.0, Phi = 91.0
STATION EQUATION :	T(n) = 0.006 d(Y-X) − 0.283 d(X-Z)
	T(e) = 0.330 d(Y-X) + 0.170 d(X-Z)

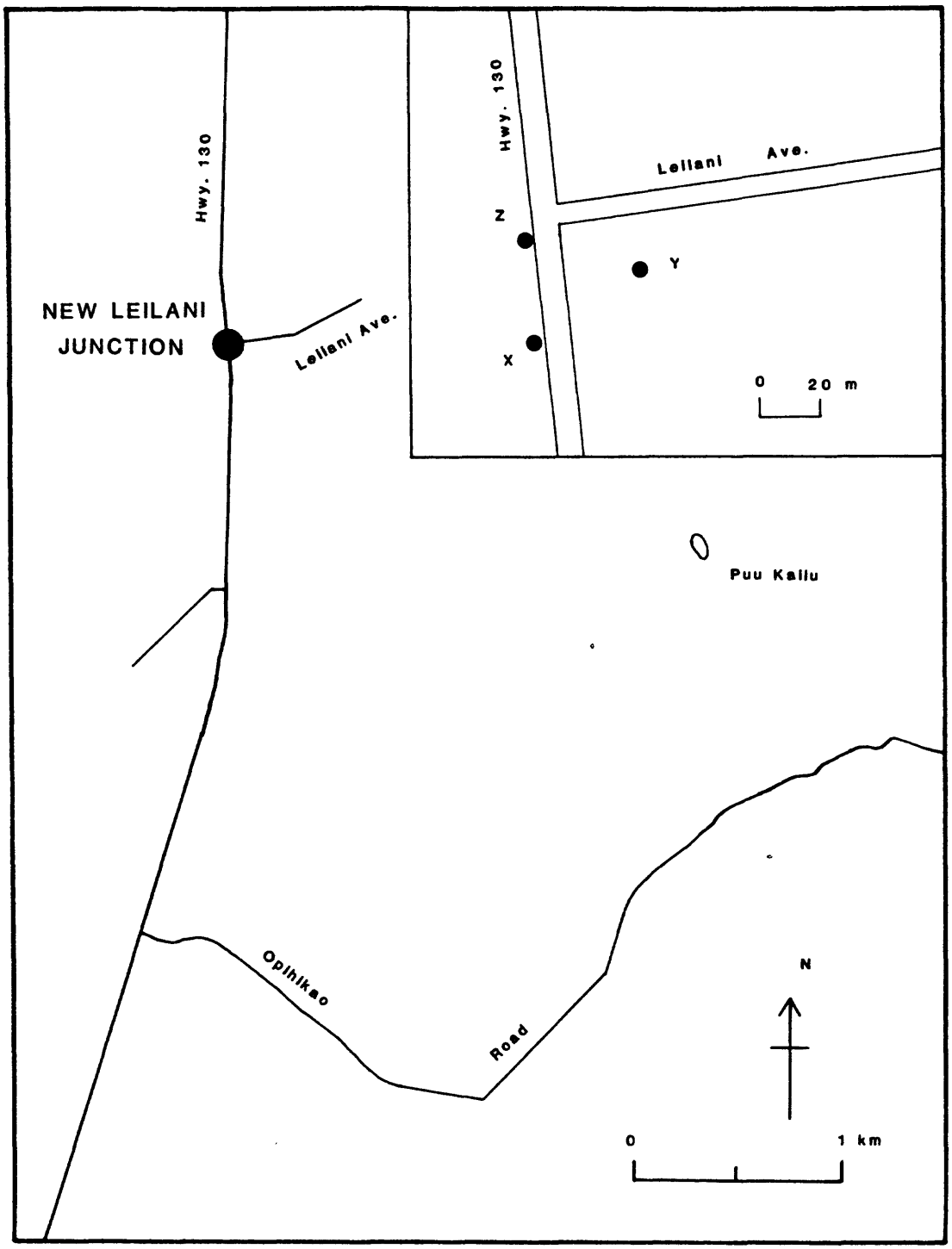
NEW LEILANI ESTATES station is located approximately 650 m west of Puulena Crater on the lower east rift zone of Kilauea. From the intersection of Hwy. 130 and Hwy. 132 (at Pahoa High School), go 2.6 miles on Hwy. 132 to reach the intersection with Pahoa-Pohoiki Road on the right. Turn right and go 1.0 mile to reach Leilani Ave. on the right. Turn right and go 0.7 mile to reach the NEW LEILANI ESTATES station.



NEW LEILANI JUNCTION (1/23/85 to present)

PREVIOUS NAME :	LEILANI JUNCTION (2/12/80 to 5/19/81)
MAP COORDINATES :	N 19 27.87' W154 56.60' Pahoa South
STATION DATA :	Ly = 44.87 m, Lz = 36.88 m, Theta = 65.0, Phi = 117.0
STATION EQUATION :	T(n) = 0.128 d(Y-X) — 0.145 d(X-Z)
	T(e) = 0.252 d(Y-X) + 0.312 d(X-Z)

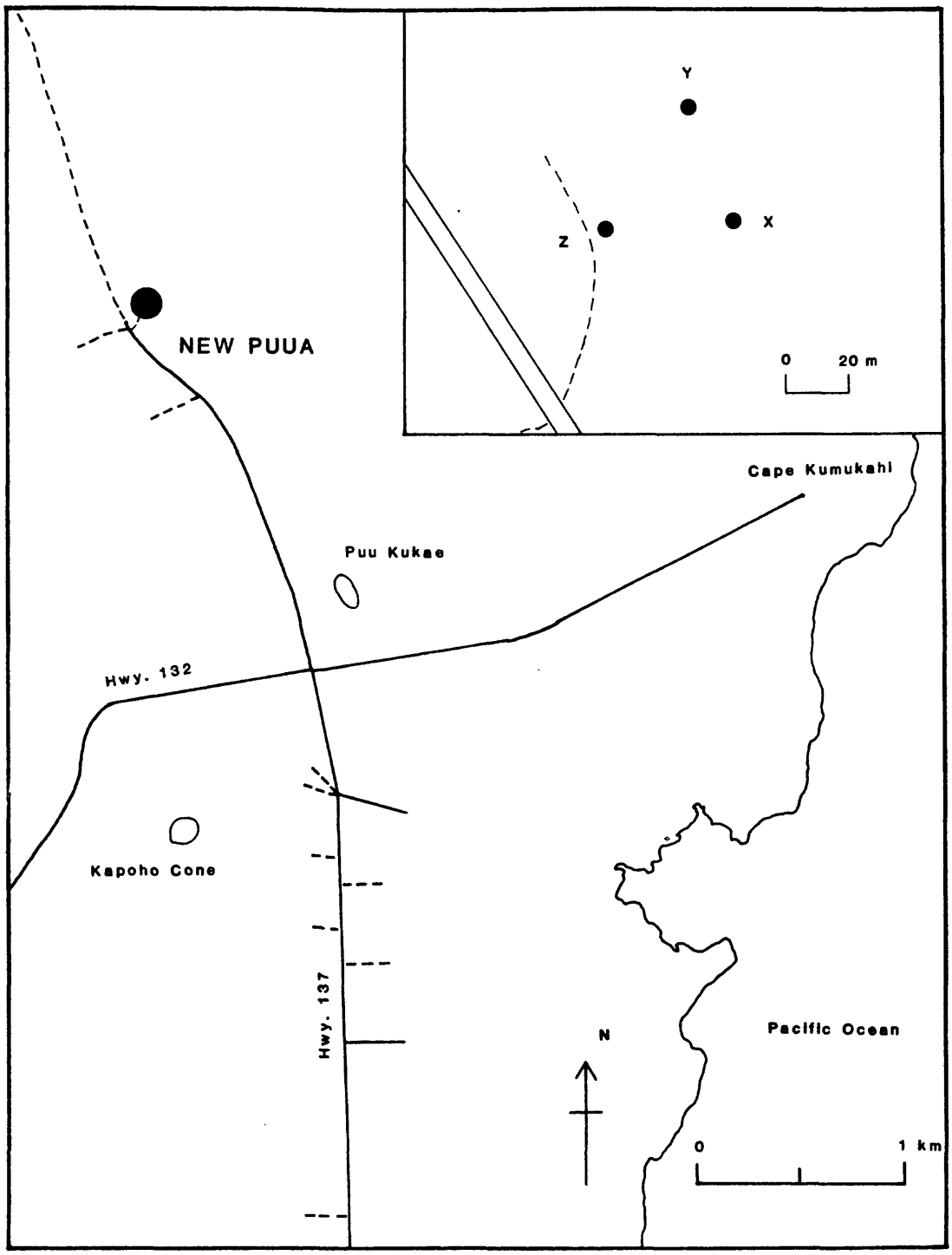
NEW LEILANI JUNCTION station is located approximately 2.5 km west-northwest of Puu Kaliu on the lower east rift zone of Kilauea. From the intersection of Hwy. 130 and Hwy. 132 (at Pahoa High School), go 2.0 miles to reach the NEW LEILANI JUNCTION station (at the intersection of Hwy. 130 and Leilani Ave.).



NEW PUUA (1/22/85 to present)

PREVIOUS NAME :	PUUA (5/13/76 to 2/15/78)
MAP COORDINATES :	N 19 31.57' W154 50.73' Kapoho
STATION DATA :	Ly = 40.77 m, Lz = 41.54 m, Theta = 122.0, Phi = 183.0
STATION EQUATION	T(n) = 0.280 d(Y-X) + 0.150 d(X-Z)
	T(e) = −0.010 d(Y-X) + 0.240 d(X-Z)

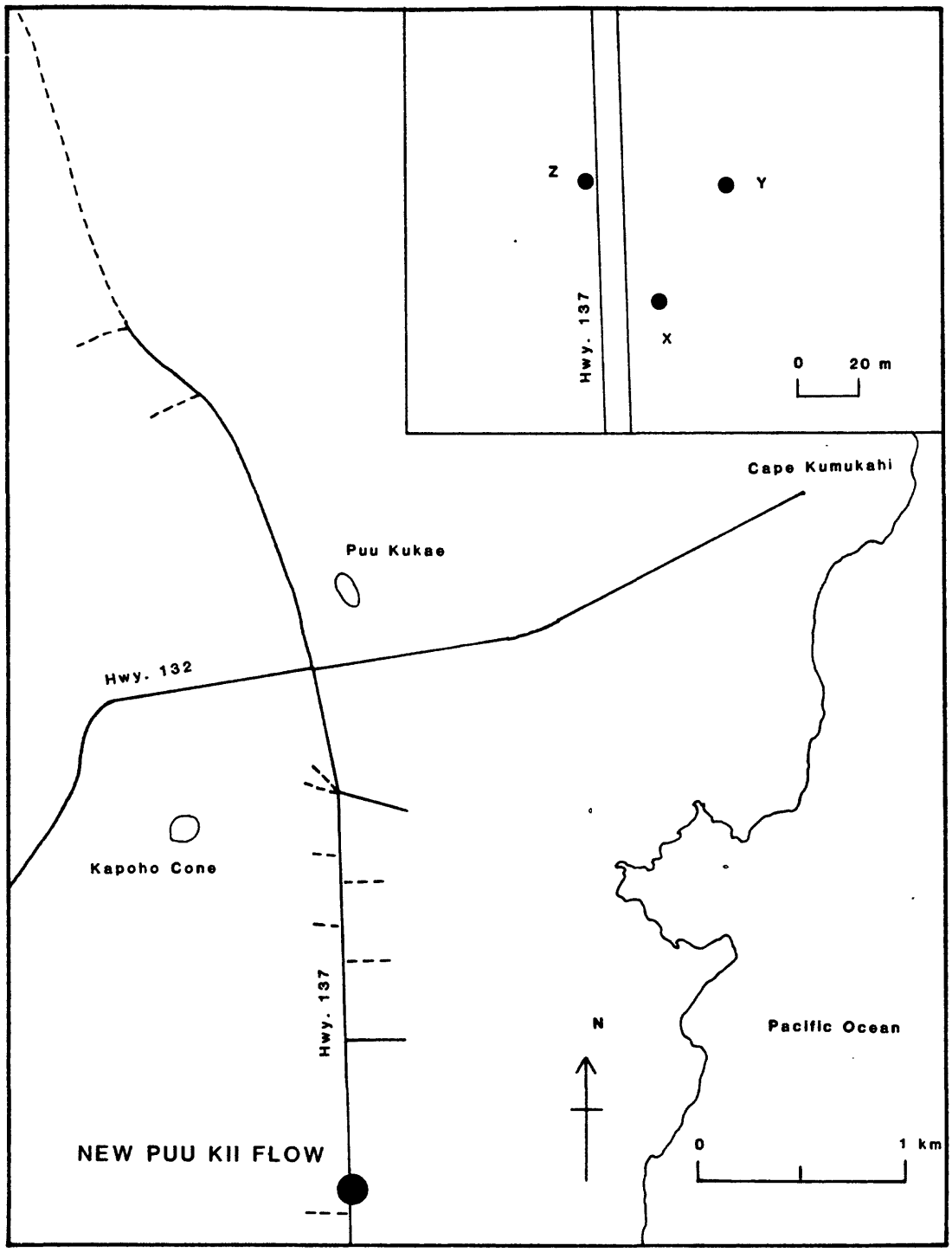
NEW PUUA station is located approximately 2.5 km north of Kapoho Cone on the lower east rift zone of Kilauea. From the intersection of Hwy. 130 and Hwy. 132 (at Pahoa High School), go 7.5 miles on Hwy. 132 to reach the intersection with Hwy. 137. Turn left and go 1.1 miles to reach a dirt road on the right side (just before Hwy. 137 becomes a dirt road). Turn right and go 50 meters to reach the NEW PUUA station.



NEW PUU KII FLOW (1/23/85 to present)

PREVIOUS NAME :	1955 PUU KII FLOW (10/17/80 to 11/14/80)
MAP COORDINATES :	N 19 29.30' W154 50.15' Kapoho
STATION DATA :	Ly = 43.02 m, Lz = 43.11 m, Theta = 60.5, Phi = 120.5
STATION EQUATION :	T(n) = 0.136 d(Y-X) — 0.132 d(X-Z)
	T(e) = 0.231 d(Y-X) + 0.233 d(X-Z)

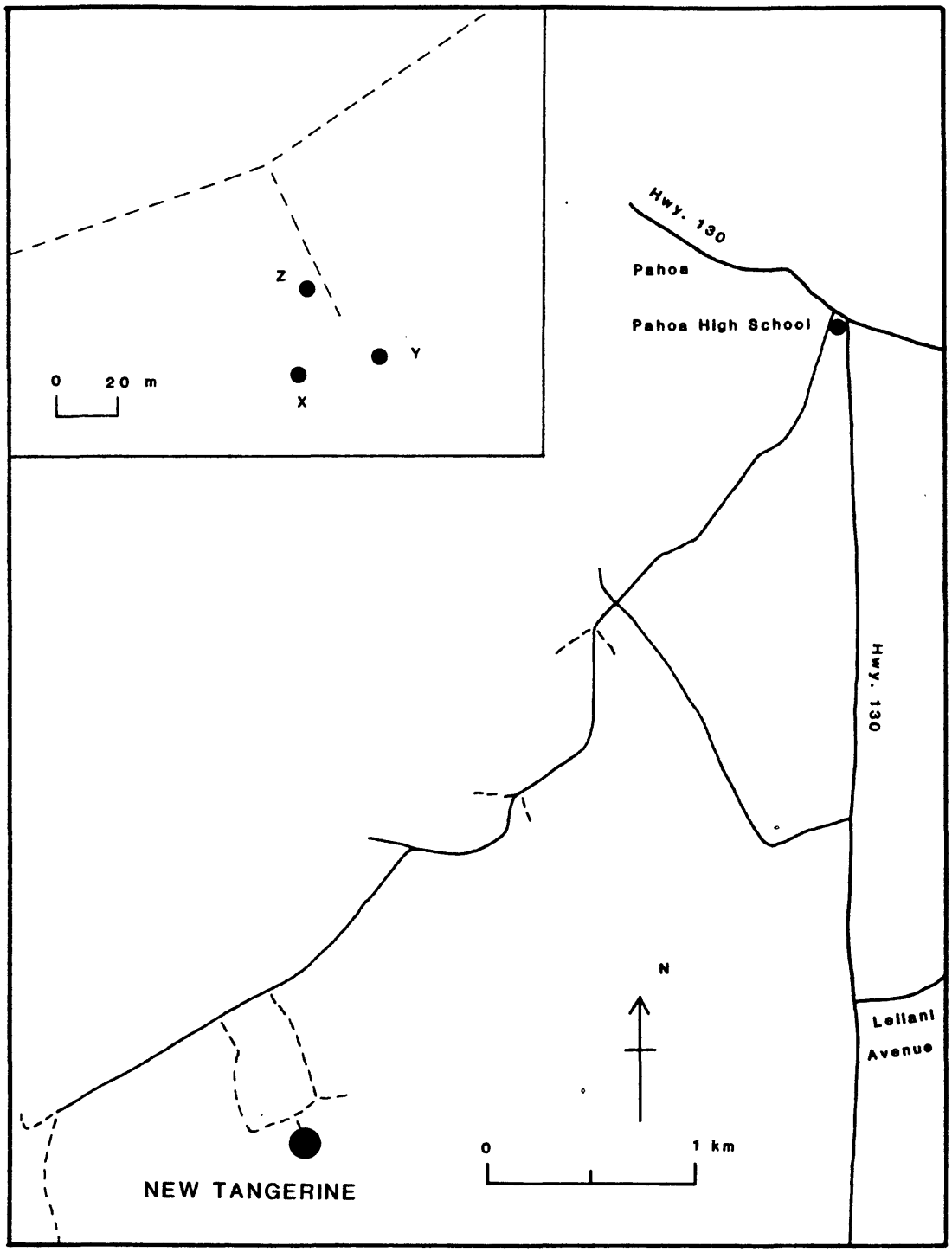
NEW PUU KII FLOW station is located approximately 2.0 km south-southeast of Kapoho Cone on the lower east rift zone of Kilauea. From the intersection of Hwy. 130 and Hwy. 132 (at Pahoa High School), go 7.5 miles on Hwy. 132 to reach the intersection with Hwy. 137. Turn right on Hwy. 137 and go 1.4 miles to reach the NEW PUU KII FLOW station.



NEW TANGERINE (1/23/85 to present)

PREVIOUS NAME :	TANGERINE (7/28/77 to 1/23/85)
MAP COORDINATES :	N 19 27.57′ W154 58.16′ Pahoa South
STATION DATA :	Ly = 26.40 m, Lz = 27.92 m, Theta = 12.0, Phi = 83.0
STATION EQUATION :	T(n) = −0.049 d(Y-X) − 0.371 d(X-Z)
	T(e) = 0.398 d(Y-X) + 0.079 d(X-Z)

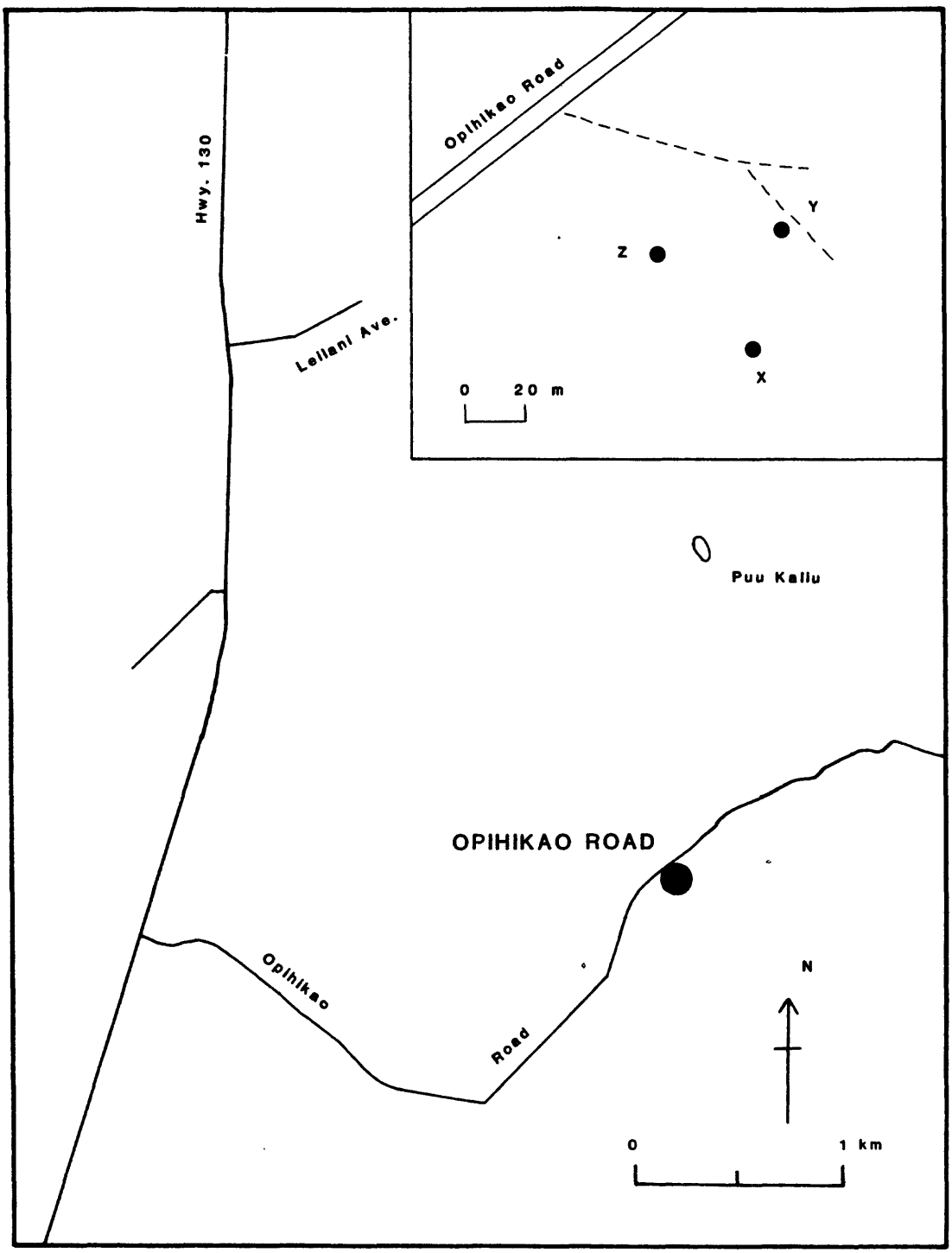
NEW TANGERINE station is located approximately 2.1 km north-northwest of Iilewa Crater near the lower east rift zone of Kilauea. From the intersection of Hwy. 130 and Hwy. 132 (at Pahoa High School), go 80 meters on Hwy. 130 towards Pahoa town to reach a paved road on the left side. Turn left and go 2.9 miles to reach a dirt road on the left side. Turn left and go 0.35 mile to reach a dirt road on the right side (with a locked gate). Turn right and go 0.1 mile to reach the NEW TANGERINE station.



OPIHIKAO ROAD (10/17/80 to present)

PREVIOUS NAME :	None
MAP COORDINATES :	N 19 26.48' W154 55.39' Pahoa South
STATION DATA :	Ly = 39.47 m, Lz = 43.49 m, Theta = 76.0, Phi = 133.0
STATION EQUATION :	T(n) = 0.206 d(Y-X) − 0.066 d(X-Z)
	T(e) = 0.221 d(Y-X) + 0.266 d(X-Z)

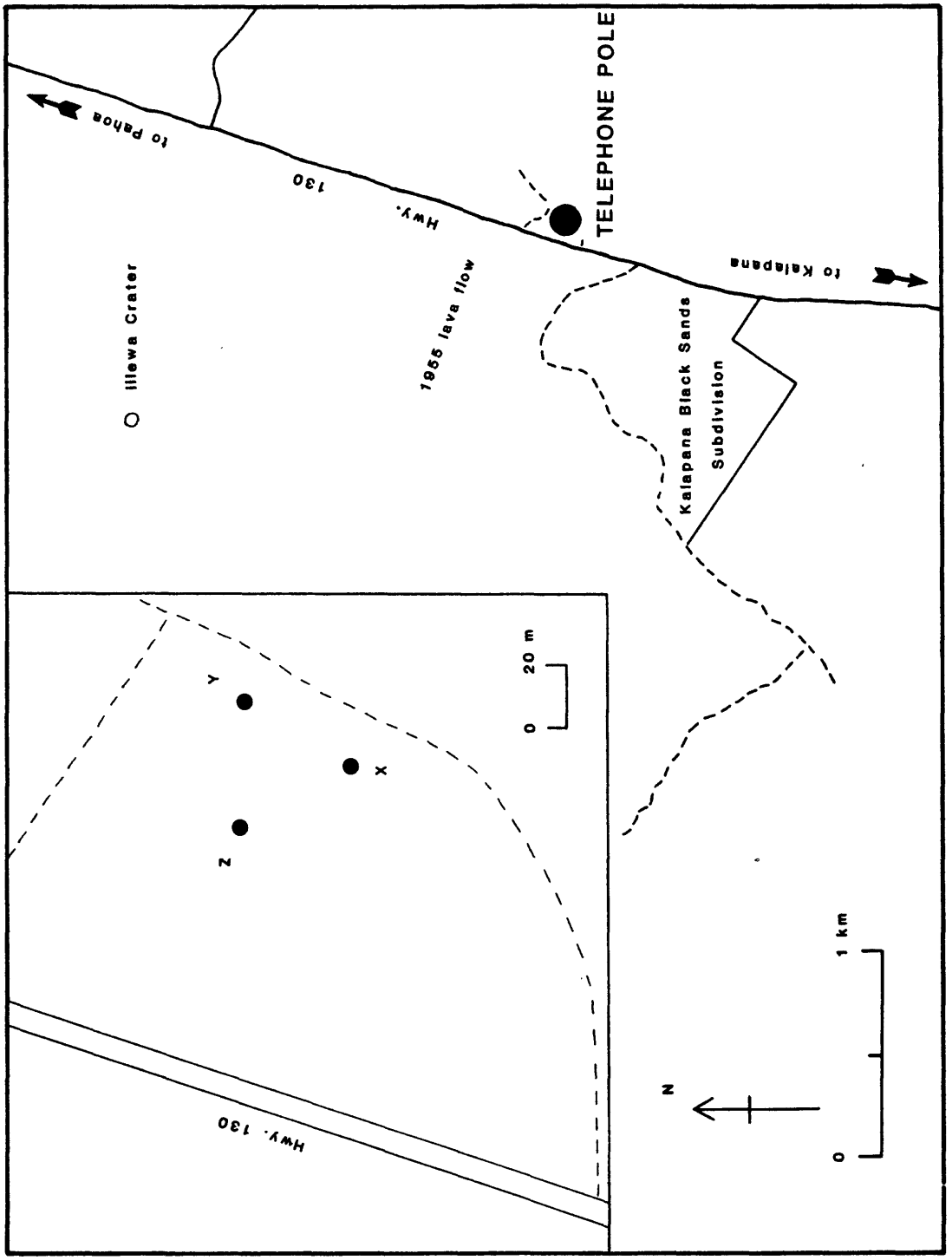
OPIHIKAO ROAD station is located approximately 1.6 km south of Puu Kaliu on the lower east rift zone of Kilauea. From the intersection of Hwy. 130 and Hwy. 132 (at Pahoa High School), go 3.8 miles on Hwy. 130 to reach Opihikao Road on the left side. Turn left and go 2.1 miles to reach a dirt driveway on the right side. Turn right and go 60 meters to reach the OPIHIKAO ROAD station.



TELEPHONE POLE (2/1/71 to present)

PREVIOUS NAME :	None
MAP COORDINATES :	N 19 25.45' W154 57.08' Pahoa South
STATION DATA :	Ly = 40.00 m, Lz = 40.00 m, Theta = 60.0, Phi = 120.0
STATION EQUATION :	T(n) = 0.144 d(Y-X) — 0.144 d(X-Z)
	T(e) = 0.250 d(Y-X) + 0.250 d(X-Z)

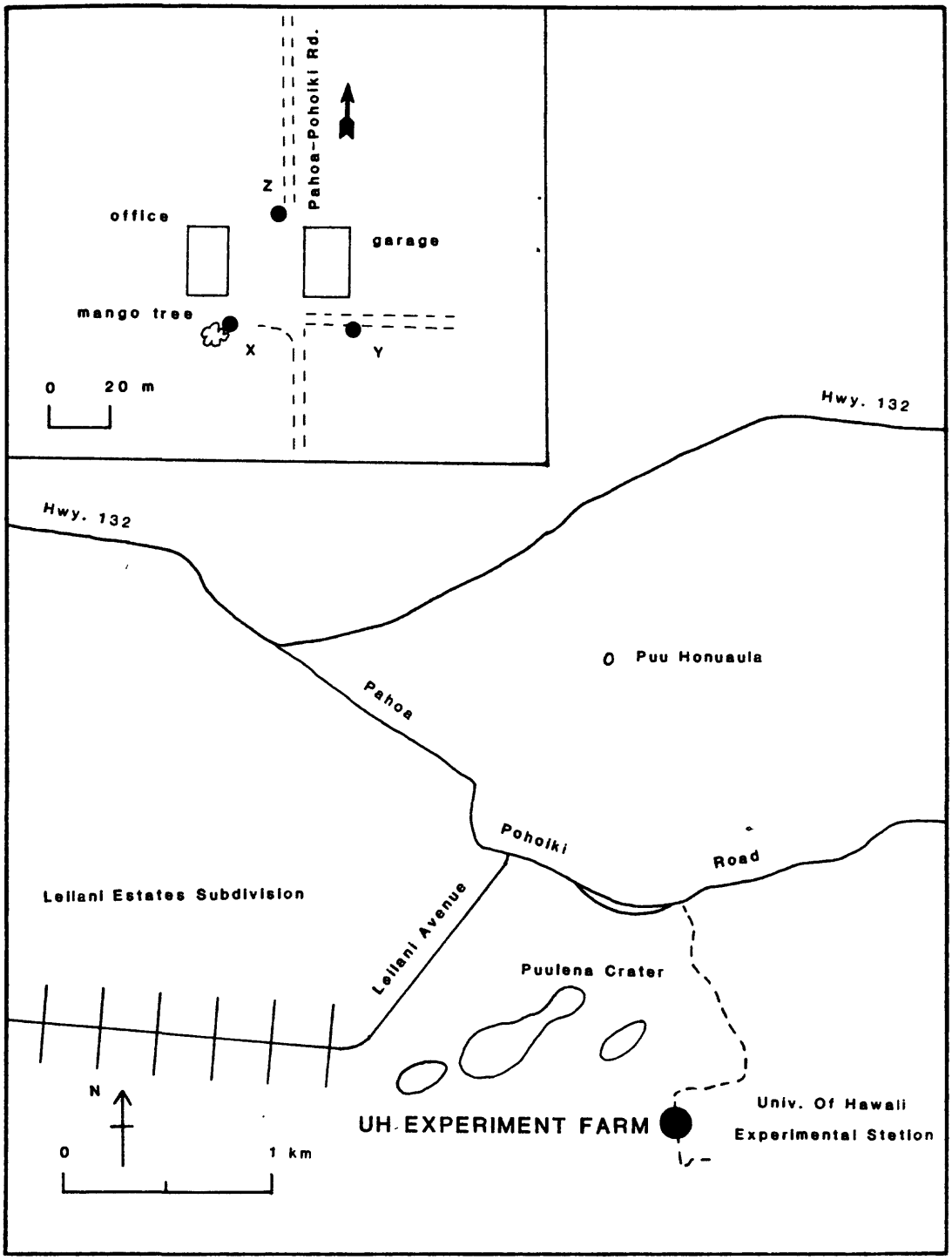
TELEPHONE POLE station is located approximately 2.3 km south-southeast of Iilewa Crater near the lower rift zone of Kilauea on the 1955 lava flow. From the intersection of Hwy. 130 and Hwy. 132 (at Pahoa High School), go 4.9 miles on Hwy. 130 to reach a dirt road on the left side (on the southern edge of the 1955 lava flow). Turn left and go 0.1 mile to reach the TELEPHONE POLE station.



UH EXPERIMENT FARM (10/17/80 to present)

PREVIOUS NAME : None
MAP COORDINATES : N 19 27.79' W154 53.25' Pahoa South
STATION DATA : Ly = 39.74 m, Lz = 39.33 m, Theta = 0.0, Phi = 66.5
STATION EQUATION : T(n) = -0.109 d(Y-X) - 0.277 d(X-Z)
T(e) = 0.252 d(Y-X)

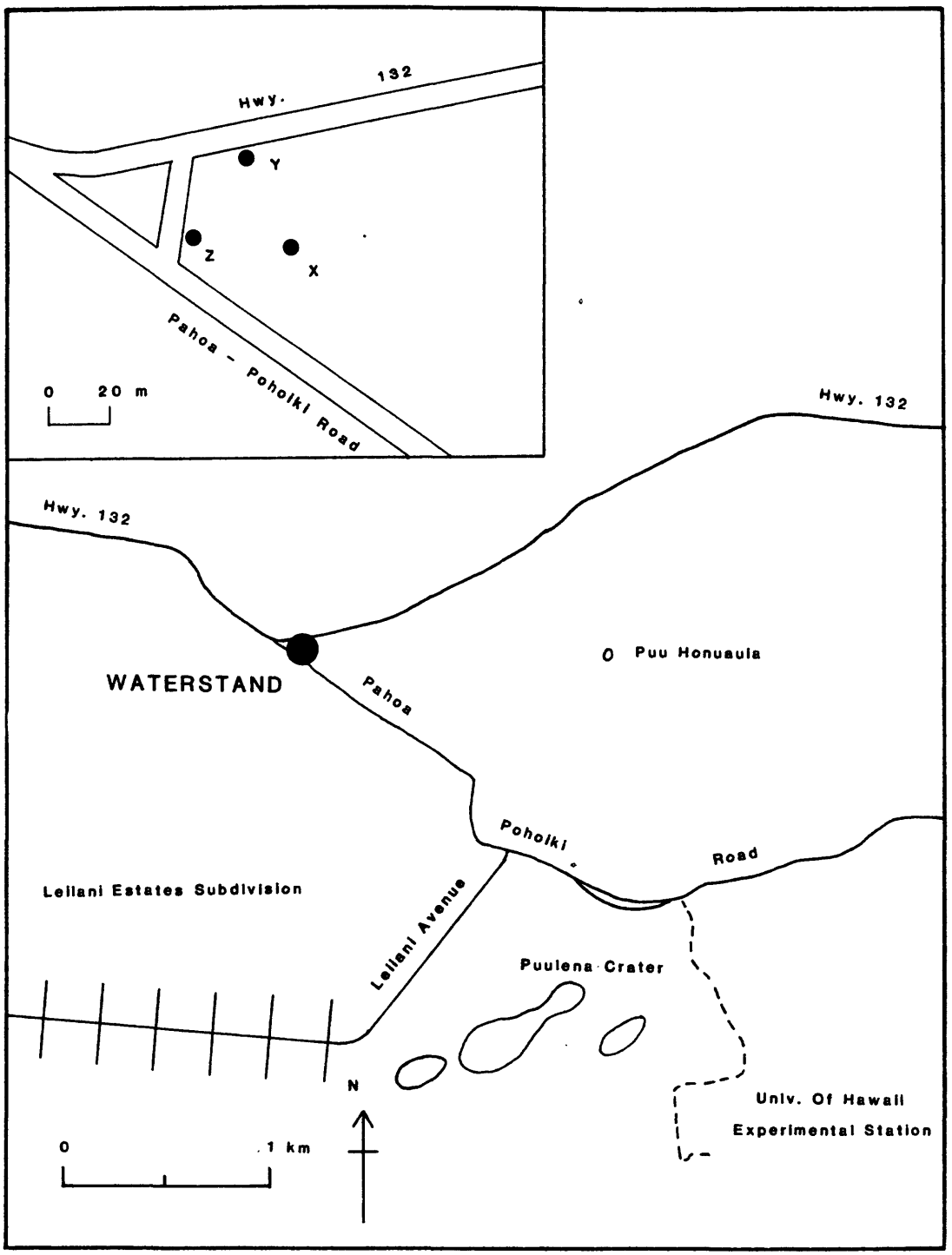
UH EXPERIMENT FARM station is located approximately 2.3 km south-southeast of Puu Honuaula on the lower east rift zone of Kilauea. From the intersection of Hwy. 130 and Hwy. 132 (at Pahoa High School), go 2.6 miles on Hwy. 132 to reach the intersection with Pahoa-Pohoiki Road on the right. Turn right and go 1.5 miles to reach a dirt road on the right side leading to the University of Hawaii Experimental Farm (approximately 0.6 miles from the geothermal plant). Turn right and go 0.88 mile to reach the farm buildings and the UH EXPERIMENT FARM station.



WATERSTAND (1/23/85 to present)

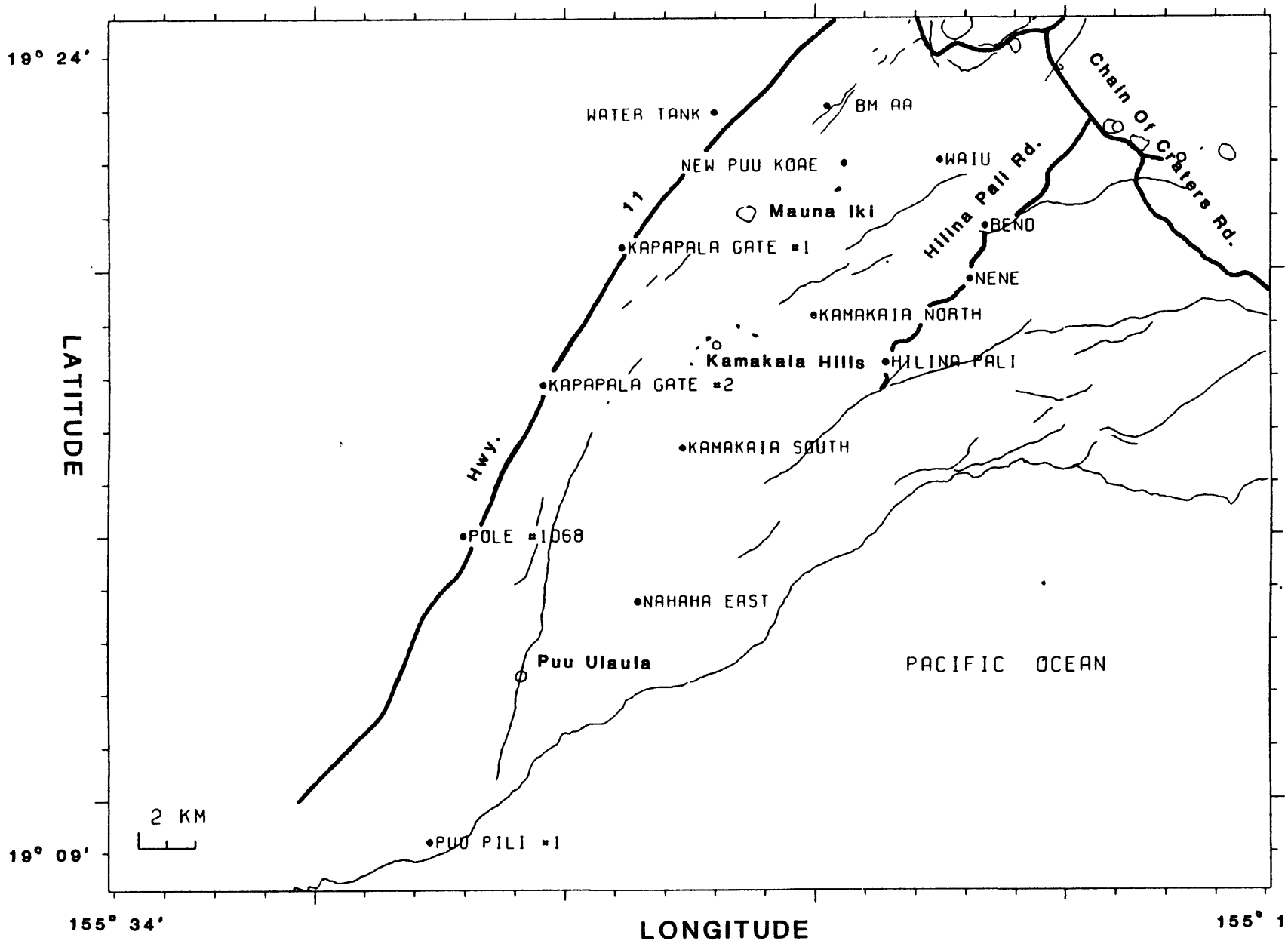
PREVIOUS NAME :	POHOIKI-KAPOHO ROAD (2/1/71 to 2/10/72)
MAP COORDINATES :	N 19 29.01' W154 54.30' Pahoa South
STATION DATA :	Ly = 33.22 m, Lz = 31.09 m, Theta = 114.0, Phi = 173.0
STATION EQUATION :	T(n) = 0.349 d(Y-X) + 0.153 d(X-Z)
	T(e) = 0.043 d(Y-X) + 0.343 d(X-Z)

WATERSTAND station is located approximately 1.5 km west of Puu Honuaula on the lower east rift zone of Kilauea. From the intersection of Hwy. 130 and Hwy. 132 (at Pahoa High School), go 2.6 miles on Hwy. 132 to reach the intersection with the Pahoa-Pohoiki Road on the right. The WATERSTAND station is at this intersection.



KILAUEA SOUTHWEST RIFT ZONE DRYTILT STATIONS

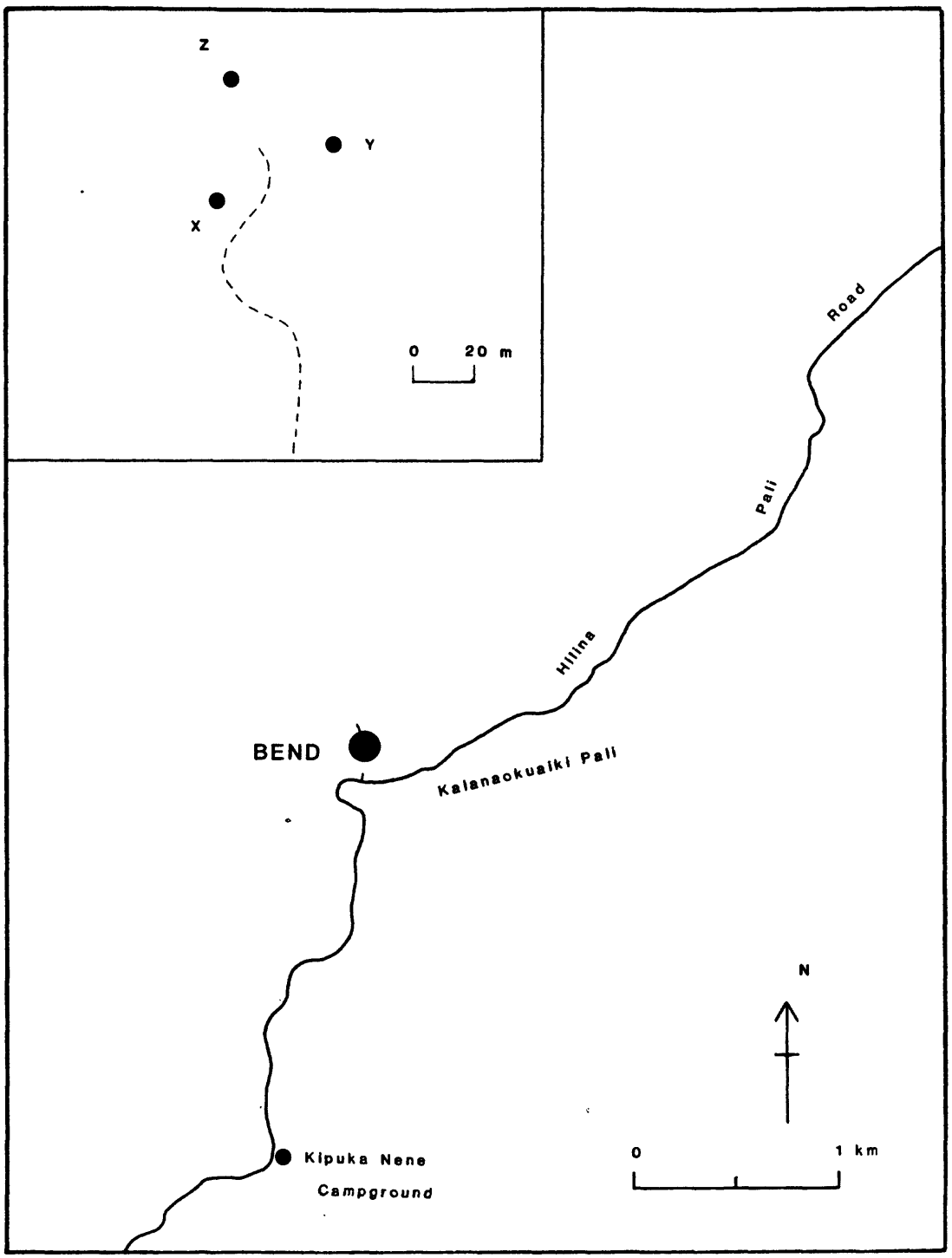
KILAUEA SOUTHWEST RIFT ZONE DRYTILT STATIONS



BEND (2/5/81 to present)

PREVIOUS NAME :	None
MAP COORDINATES :	N 19 20.82' W155 16.61' Kau Desert
STATION DATA :	Ly = 40.04 m, Lz = 39.98 m, Theta = 26.5, Phi = 86.5
STATION EQUATION :	T(n) = −0.018 d(Y-X) − 0.258 d(X-Z)
	T(e) = 0.288 d(Y-X) + 0.129 d(X-Z)

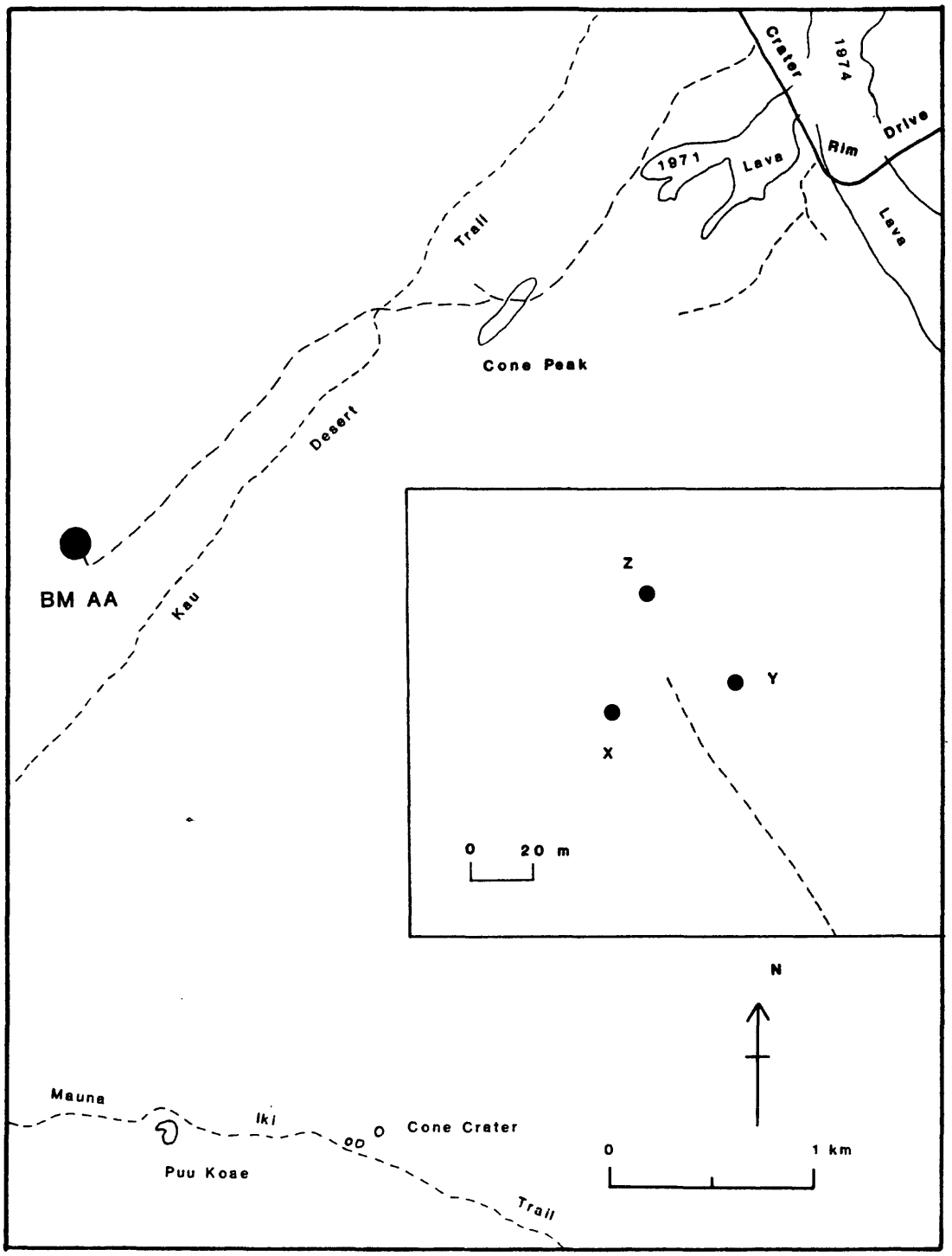
BEND station is located approximately 8.4 km south-southeast of the Hawaiian Volcano Observatory in Hawaii Volcanoes National Park. From HVO, drive counter-clockwise on Crater Rim Drive for 4.6 miles to reach the intersection with Chain of Craters Road. Turn right and go 2.0 miles to reach the intersection with Hilina Pali Road. Turn right and go 3.6 miles to reach a dirt road on the right side (just before the road goes over the Kalanokuaiki Pali). Turn right and go 150 meters to reach the BEND station.



BM AA (10/22/79 to present)

PREVIOUS NAME :	None
MAP COORDINATES :	N 19 23.07' W155 19.76' Kilauea Crater
STATION DATA :	Ly = 40.20 m, Lz = 40.08 m, Theta = 14.5, Phi = 74.5
STATION EQUATION :	T(n) = -0.077 d(Y-X) - 0.279 d(X-Z)
	T(e) = 0.277 d(Y-X) + 0.072 d(X-Z)

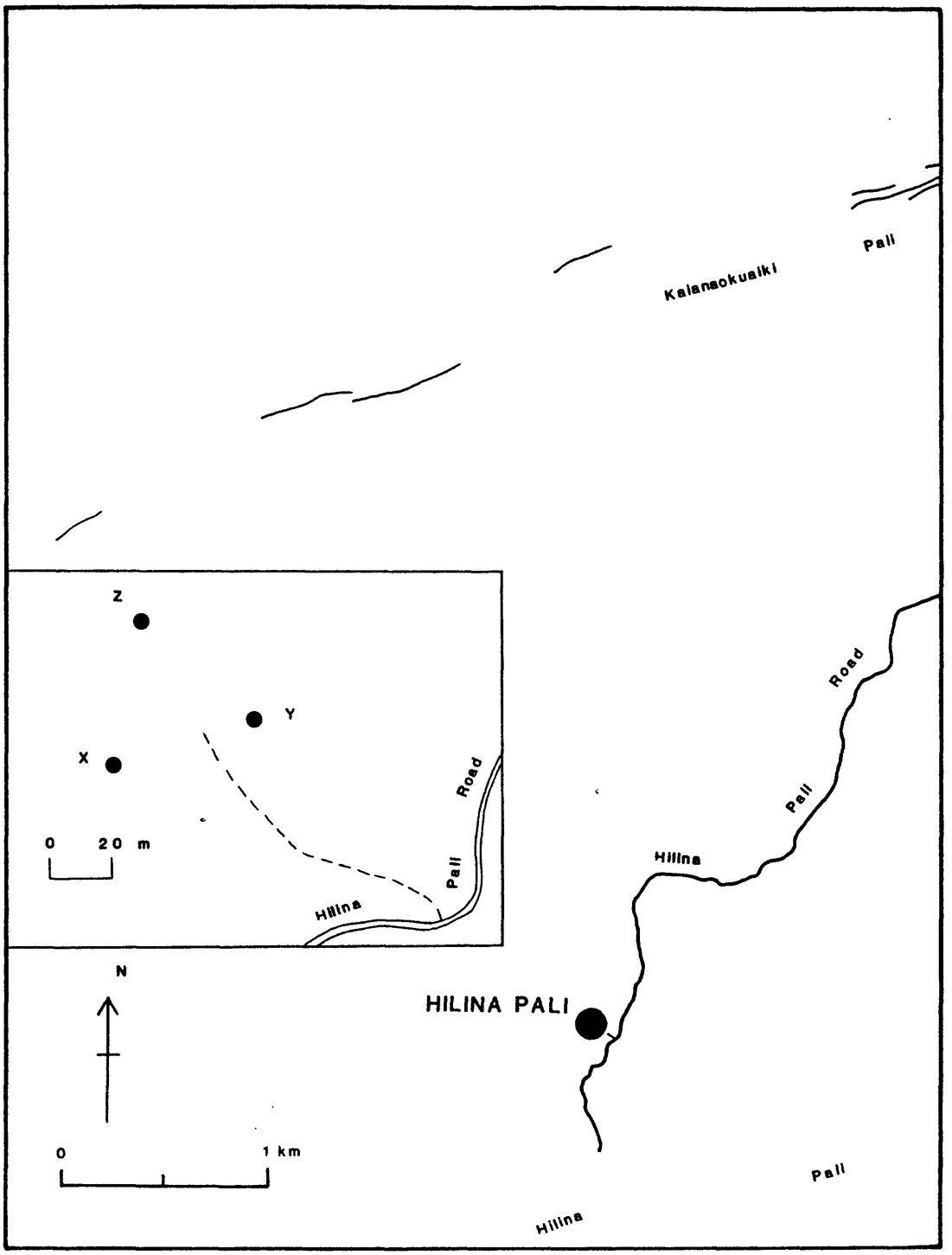
BM AA station is located approximately 5.9 km southwest of the Hawaiian Volcano Observatory on the southwest rift zone of Kilauea in Hawaii Volcanoes National Park. From HVO, drive counter-clockwise on Crater Rim Drive for 1.6 miles to reach the intersection with a dirt road on the right (just past the Kau Acid Rain Desert sign). Turn right and go 1.2 miles to reach an intersection on the west side of Cone Peak (approximately 60 meters past the top). Turn left and go 1.8 miles to reach the BM AA station.



HILINA PALI (2/10/81 to present)

PREVIOUS NAME :	None
MAP COORDINATES :	N 19 18.26' W155 18.58' Kau Desert
STATION DATA :	Ly = 47.76 m, Lz = 47.68 m, Theta = 19.9, Phi = 79.5
STATION EQUATION :	T(n) = −0:044 d(Y-X) − 0.229 d(X-Z)
	T(e) = 0.239 d(Y-X) + 0.083 d(X-Z)

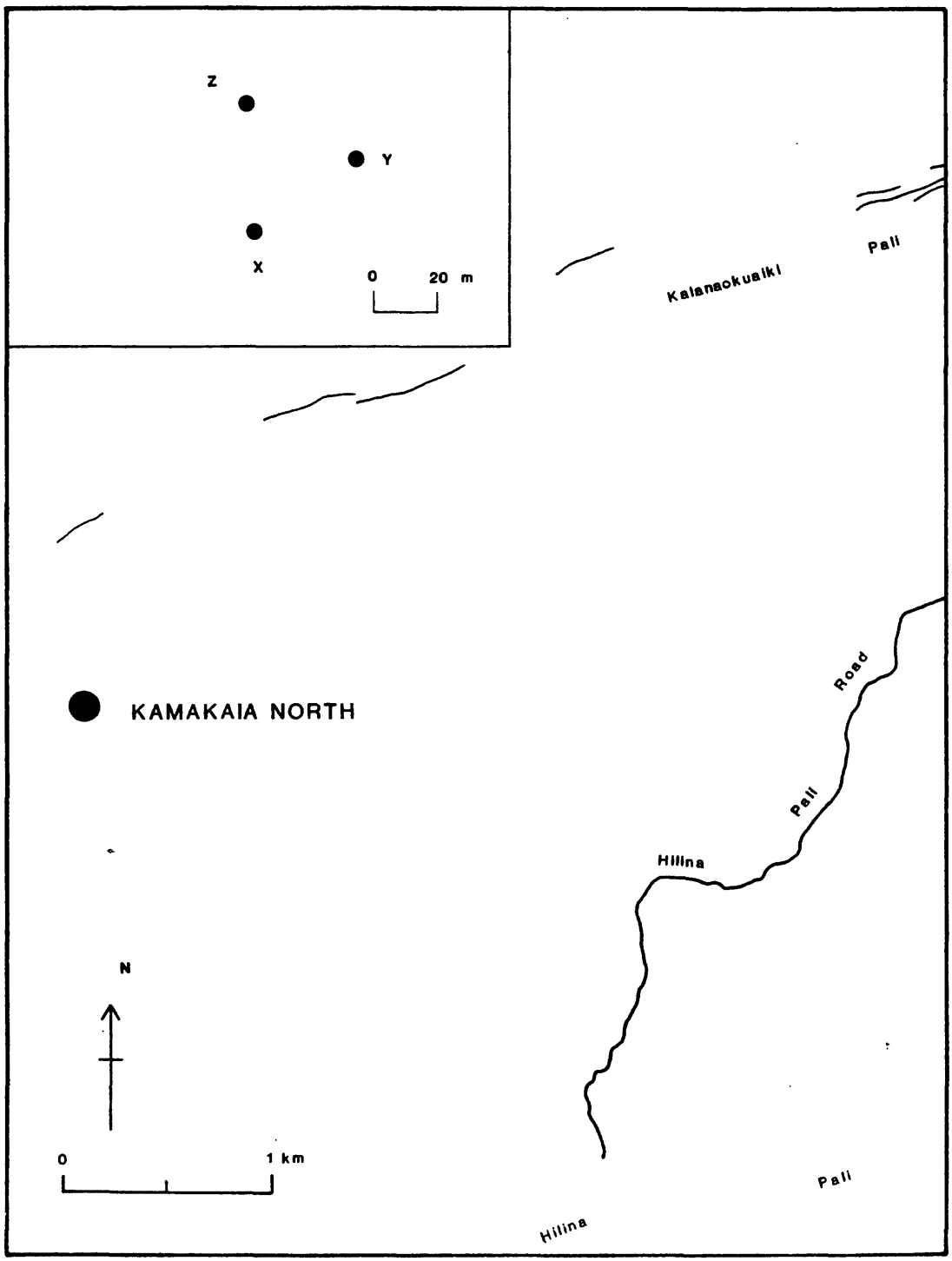
HILINA PALI station is located approximately 13.2 km south-southwest of the Hawaiian Volcano Observatory in Hawaii Volcanoes National Park. From HVO, drive counter-clockwise on Crater Rim Drive for 4.6 miles to reach the intersection with Chain of Craters Road. Turn right and go 2.0 miles to reach the intersection with Hilina Pali Road. Turn right and go 7.9 miles to reach a dirt road on the right side. Turn right and go approximately 100 m to reach the HILINA PALI station. The station is located on concrete wet tilt piers.



KAMAKAIA NORTH (2/17/81 to present)

PREVIOUS NAME :	None
MAP COORDINATES :	N 19 19.15' W155 20.01' Kau Desert
STATION DATA :	Ly = 39.97 m, Lz = 39.97 m, Theta = 33.9, Phi = 93.9
STATION EQUATION	T(n) = 0.020 d(Y-X) - 0.240 d(X-Z)
	T(e) = 0.288 d(Y-X) + 0.161 d(X-Z)

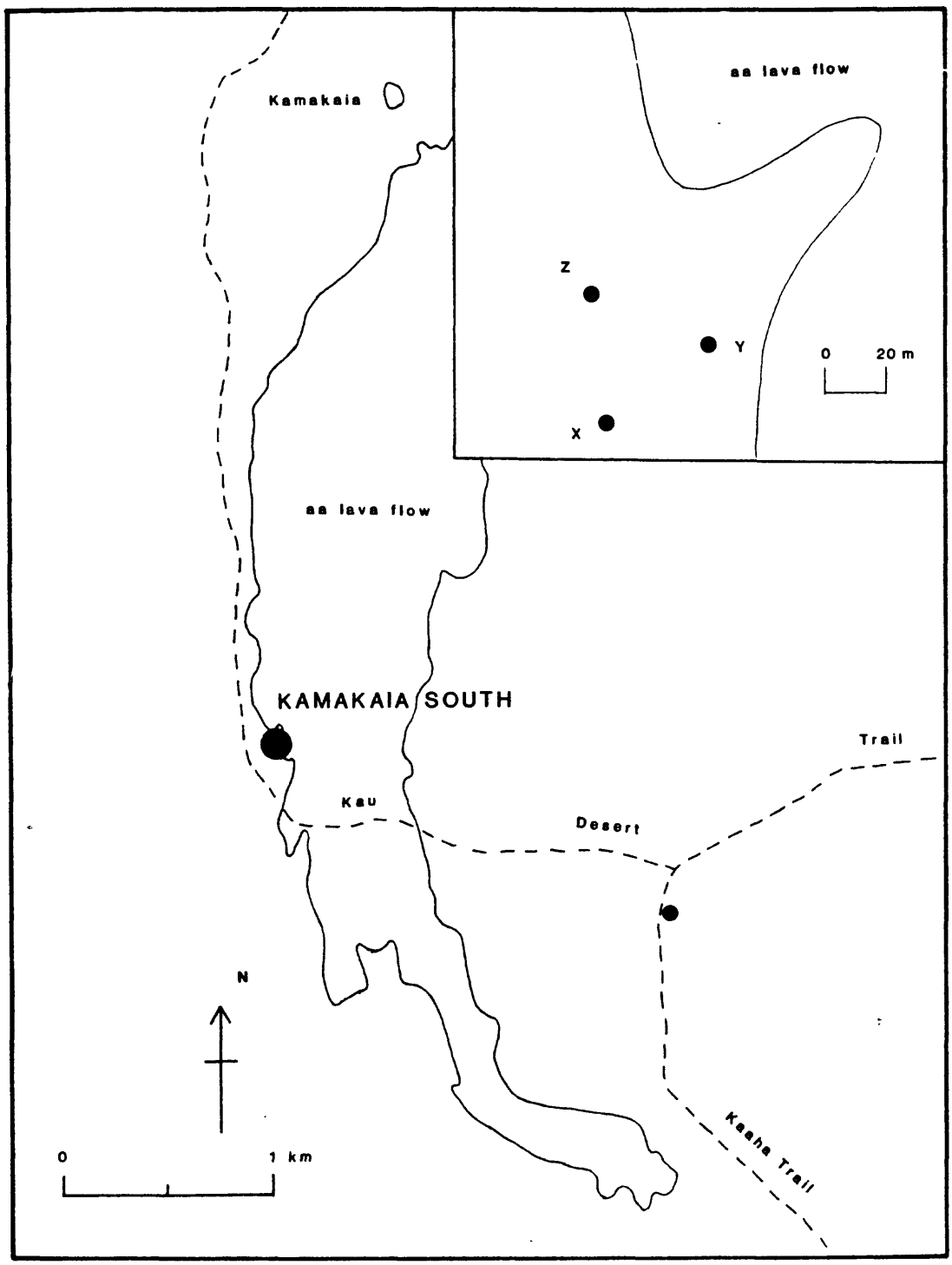
KAMAKAIA NORTH station is located approximately 4.6 km east-northeast of the Kamakaia Hills in Hawaii Volcanoes National Park. The KAMAKAIA NORTH station is reached by helicopter and is at the 2700' elevation. The station is on barren pahoehoe lava with no obvious landmarks nearby except for a large yellow circle painted on the ground nearby.



KAMAKAIA SOUTH (2/17/81 to present)

PREVIOUS NAME :	None
MAP COORDINATES :	N 19 16.66' W155 22.64' Wood Valley
STATION DATA :	Ly = 40.00 m, Lz = 40.00 m, Theta = 34.5, Phi = 96.0
STATION EQUATION :	T(n) = 0.030 d(Y-X) − 0.235 d(X-Z)
	T(e) = 0.283 d(Y-X) + 0.161 d(X-Z)

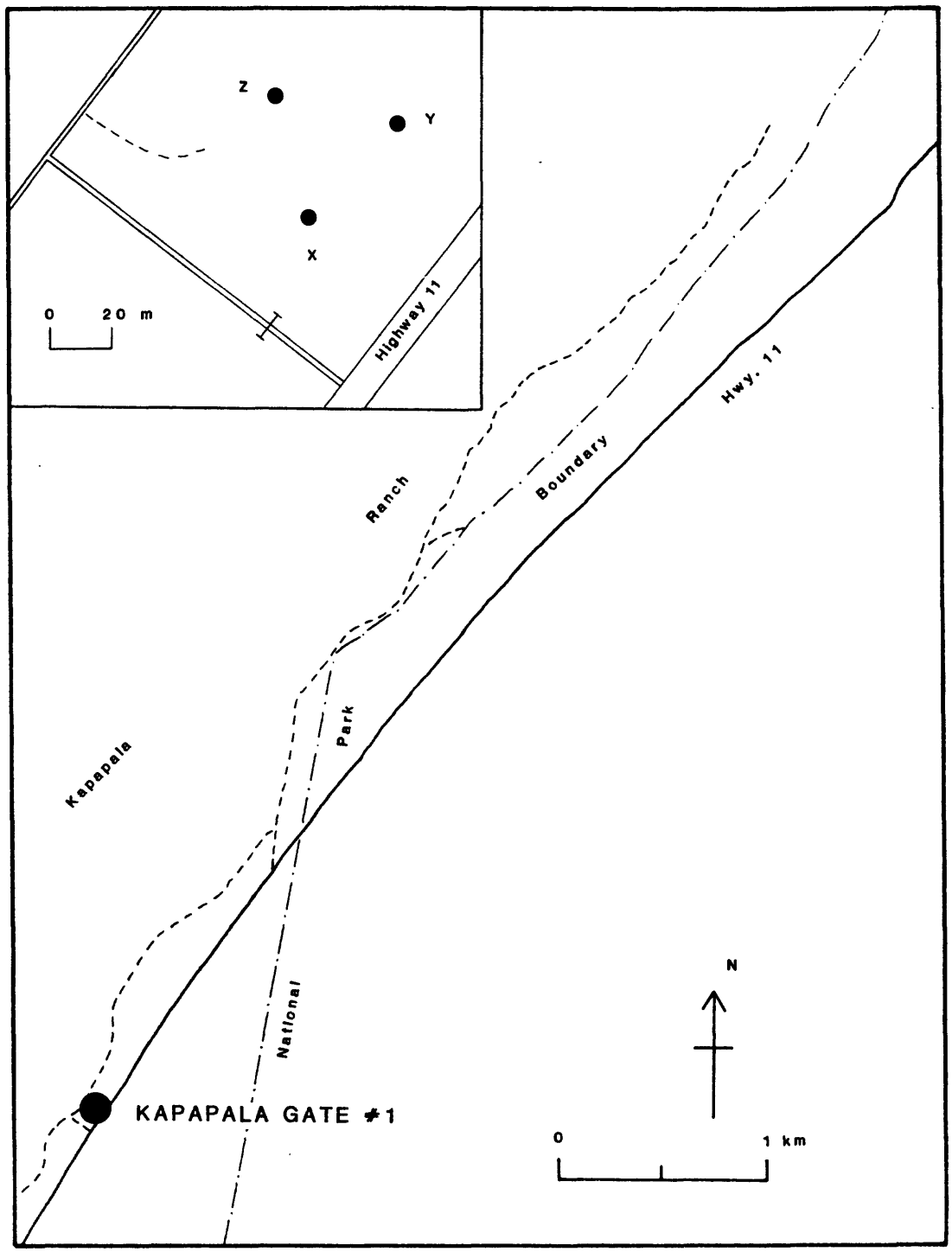
KAMAKAIA SOUTH station is located approximately 2.9 km south of the Kamakaia Hills in Hawaii Volcanoes National Park. The KAMAKAIA SOUTH station is approximately 300 m east of the Kau Desert Trail and is at the 1900' elevation. The station is on the west side of a large, obvious aa flow on older pahoehoe lava. It is surrounded by several Ohia trees and has a large yellow circle painted on the ground nearby. The KAMAKAIA SOUTH station is reached by helicopter.



KAPAPALA GATE #1 (1/13/76 to present)

PREVIOUS NAME :	None
MAP COORDINATES :	N 19 20.43' W155 23.86' Wood Valley
STATION DATA :	Ly = 40.60 m, Lz = 40.60 m, Theta = 45.5, Phi = 105.5
STATION EQUATION :	T(n) = 0.077 d(Y-X) − 0.201 d(X-Z)
	T(e) = 0.276 d(Y-X) + 0.204 d(X-Z)

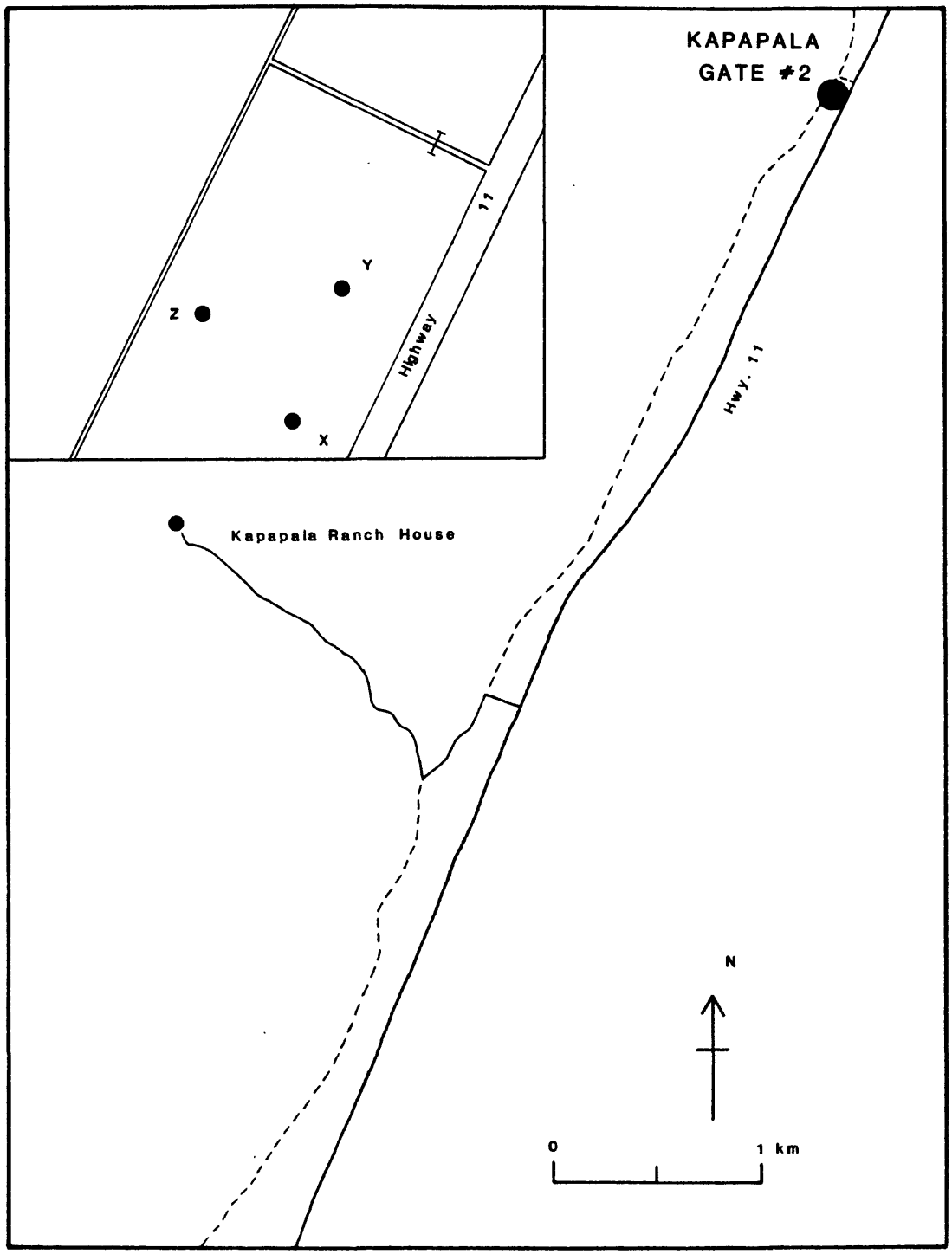
KAPAPALA GATE #1 is located approximately 4.6 km west-southwest of Mauna Iki on private ranchland. From HVO, drive 0.8 miles clockwise on Crater Rim Drive to reach the intersection with Mauna Loa Strip Road. Turn left and go 0.1 miles to reach the intersection with Highway 11. Turn left and go 10.1 miles to reach the KAPAPALA GATE #1 station.



KAPAPALA GATE #2 (1/13/76 to present)

PREVIOUS NAME :	None
MAP COORDINATES :	N 19 17.86' W155 25.42' Wood Valley
STATION DATA :	Ly = 46.42 m, Lz = 46.36 m, Theta = 53.0, Phi = 112.0
STATION EQUATION :	T(n) = 0.094 d(Y-X) − 0.151 d(X-Z)
	T(e) = 0.233 d(Y-X) + 0.201 d(X-Z)

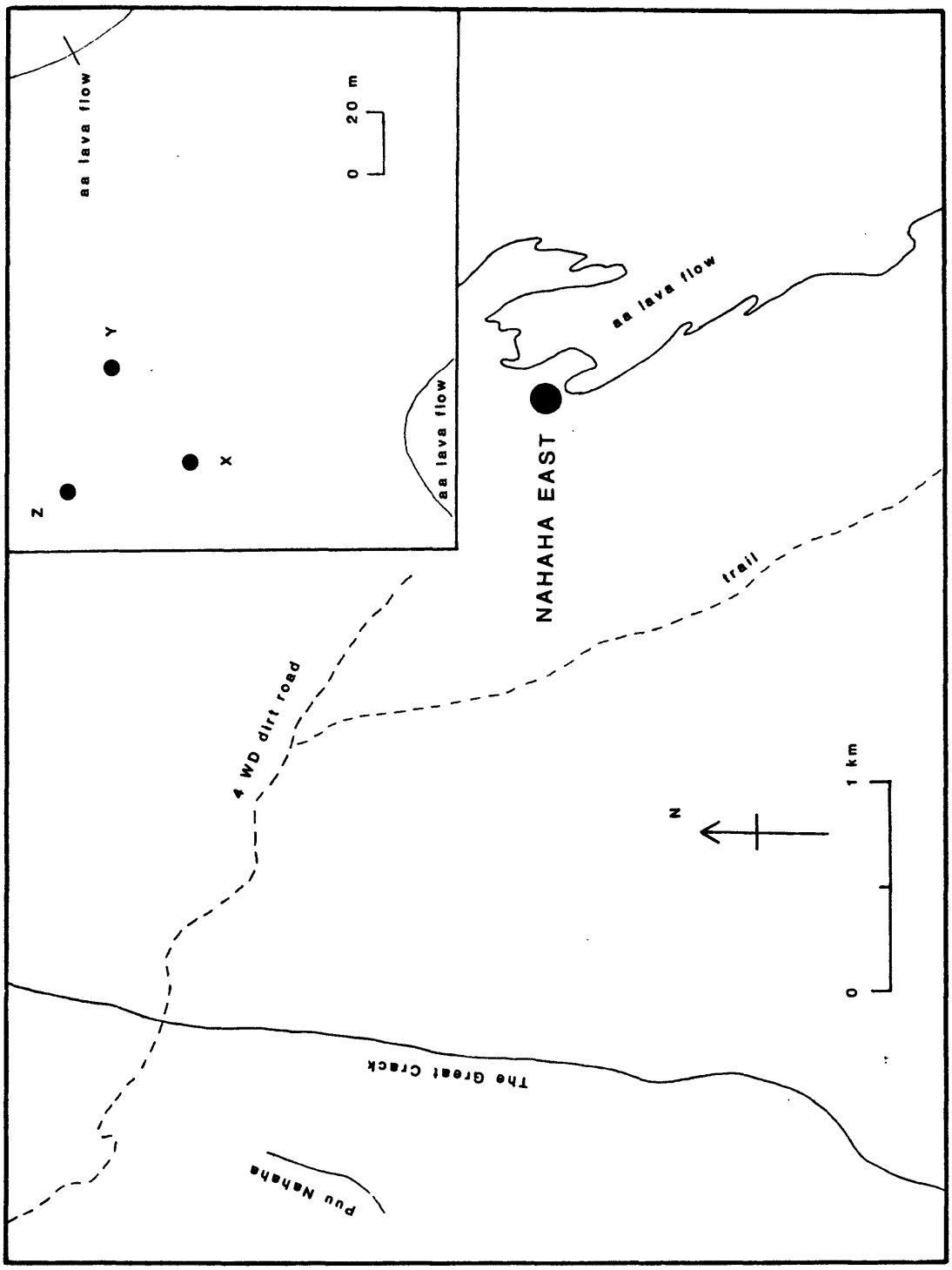
KAPAPALA GATE #2 is located approximately 5.3 km west-southwest of the Kamakaia Hills on private ranchland. From HVO, drive 0.8 miles clockwise on Crater Rim Drive to reach the intersection with Mauna Loa Strip Road. Turn left and go 0.1 miles to reach the intersection with Highway 11. Turn left and go 13.5 miles to reach the KAPAPALA GATE #2 station.



NAHAHA EAST (2/17/81 to present)

PREVIOUS NAME :	None
MAP COORDINATES :	N 19 13.75′ W155 23.54′ Pahala
STATION DATA :	Ly = 40.04 m, Lz = 40.03 m, Theta = 39.5, Phi = 101.0
STATION EQUATION :	T(n) = 0.054 d(Y-X) − 0.219 d(X-Z)
	T(e) = 0.279 d(Y-X) + 0.181 d(X-Z)

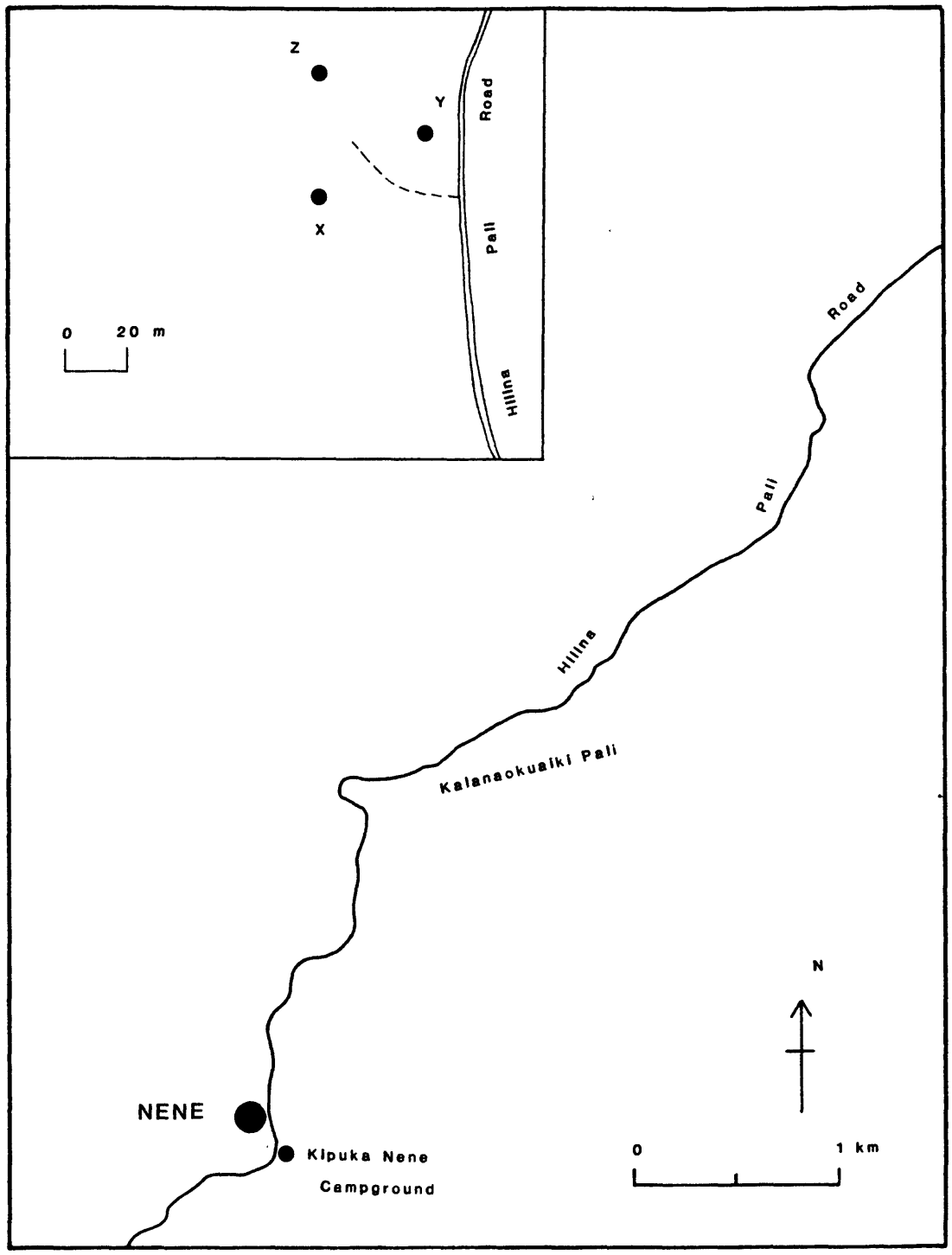
NAHAHA EAST station is located approximately 4.95 northeast of Puu Ulaula in Hawaii Volcanoes National Park. The station is reached by helicopter and is marked by a large yellow painted circle. NAHAHA EAST station is on pahoehoe lava at the 860′ elevation and has several Ohia trees around it.



NENE (2/5/81 to present)

PREVIOUS NAME :	None
MAP COORDINATES :	N 19 19.82' W155 16.91' Kau Desert
STATION DATA :	Ly = 40.03 m, Lz = 40.03 m, Theta = 29.8, Phi = 89.9
STATION EQUATION :	T(n) = -0.250 d(X-Z)
	T(e) = 0.288 d(Y-X) + 0.143 d(X-Z)

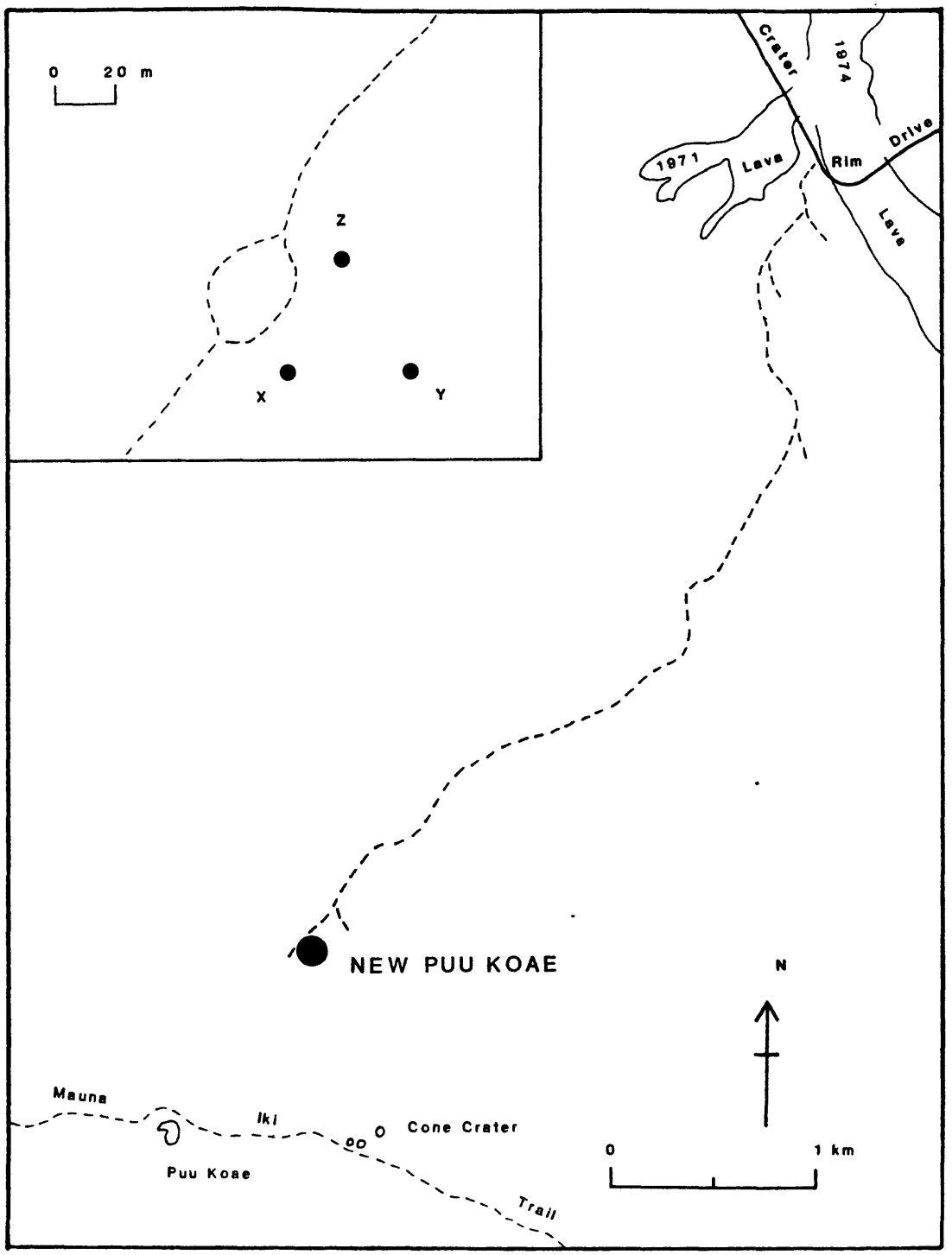
NENE station is located approximately 10.2 km south-southeast of the Hawaiian Volcano Observatory in Hawaii Volcanoes National Park. From HVO, drive counter-clockwise on Crater Rim Drive for 4.6 miles to reach the intersection with Chain of Craters Road. Turn right and go 2.0 miles to reach the intersection with Hilina Pali Road. Turn right and go 4.8 miles to reach the NENE station.



NEW PUU KOAE (12/23/75 to present)

PREVIOUS NAME :	None
MAP COORDINATES :	N 19 22.00' W155 19.42' Kau Desert
STATION DATA :	Ly = 40.00 m, Lz = 40.00 m, Theta = 2.0, Phi = 62.0
STATION EQUATION :	T(n) = -0.136 d(Y-X) - 0.288 d(X-Z)
	T(e) = 0.255 d(Y-X) + 0.010 d(X-Z)

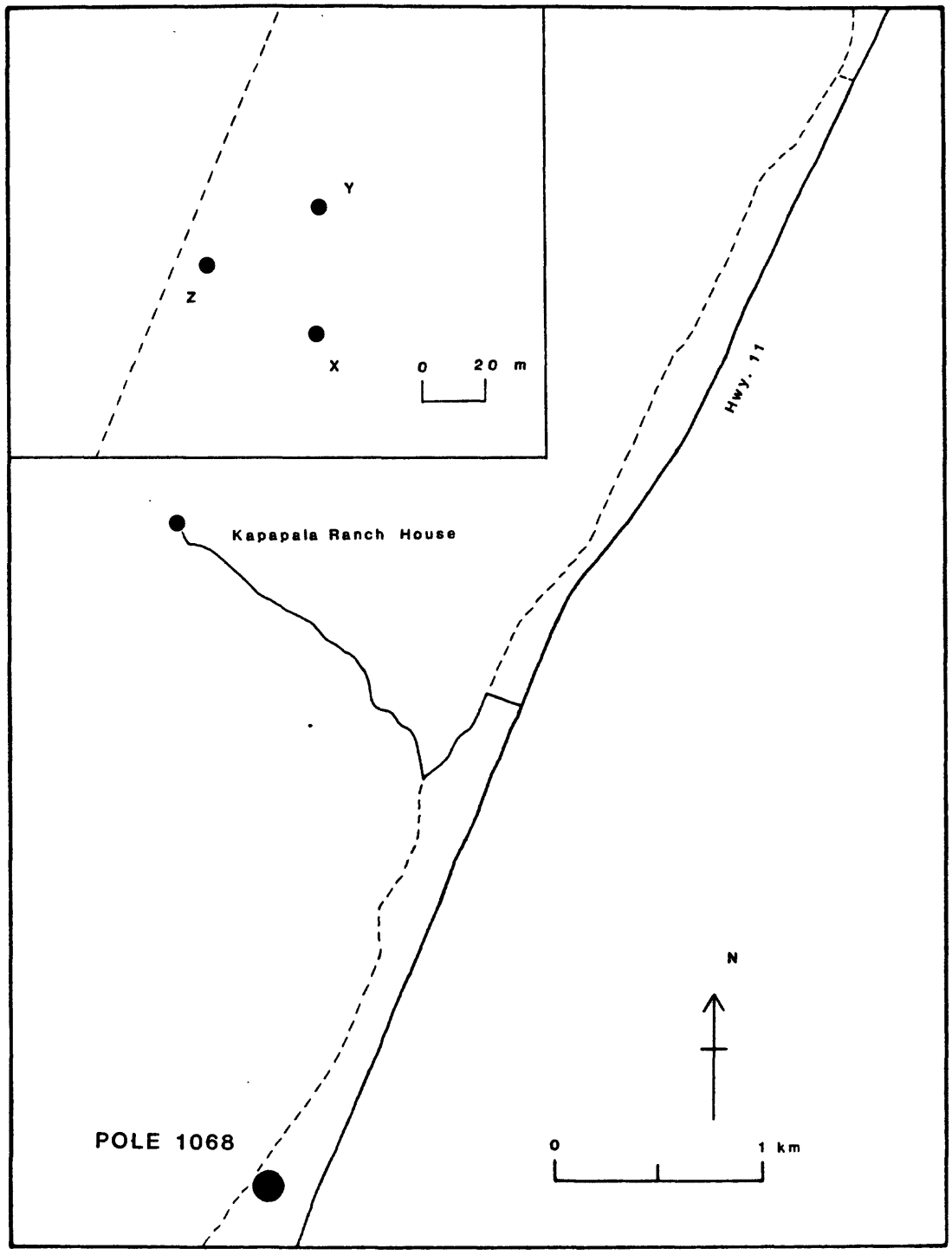
NEW PUU KOAE is located approximately 7.1 km west-southwest of the Hawaiian Volcano Observatory on the southwest rift zone of Kilauea in Hawaiian Volcanoes National Park. From HVO, drive counter-clockwise on Crater Rim Drive for 1.9 miles to reach the intersection with a dirt service road on the right side. Turn right and go 0.1 mile to reach a fork in the road. Turn right and go 3.8 miles to reach the NEW PUU KOAE station.



POLE 1068 (1/12/76 to present)

PREVIOUS NAME : None
MAP COORDINATES : N 19 15.01' W155 27.02' Wood Valley
STATION DATA : Ly = 41.00 m, Lz = 41.00 m, Theta = 90.0, Phi = 150.0
STATION EQUATION : T(n) = 0.244 d(Y-X)
T(e) = 0.141 d(Y-X) + 0.282 d(X-Z)

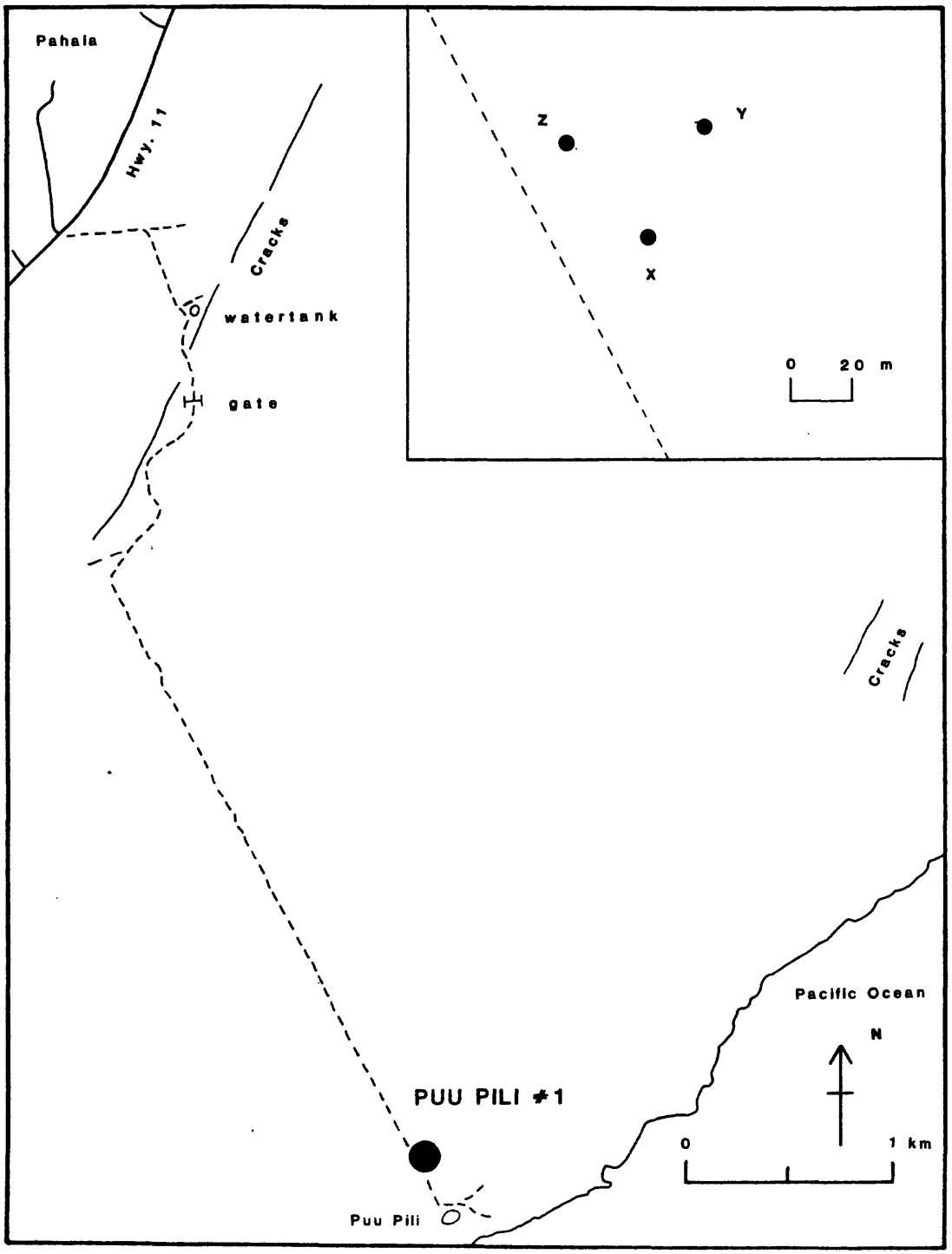
POLE 1068 is located approximately 5.1 km north-northwest of Puu Ulaula on private ranchland. From HVO, drive 0.8 miles clockwise on Crater Rim Drive to reach the intersection with Mauna Loa Strip Road. Turn left and go 0.1 mile to reach the intersection with Highway 11. Turn left and go 15.7 miles to reach the intersection with a dirt road to the Kapapala Ranch on the right side. Turn right on the dirt road (through an unlocked gate) and go 100 m to reach the intersection with a paved road. Turn left and go 0.4 mile to reach a dirt road on the left. Turn left and go 1.4 miles to reach the POLE 1068 station.



PUU PILI #1 (1/12/76 to present)

PREVIOUS NAME : None
MAP COORDINATES : N 19 09.20' W155 27.70' Pahala
STATION DATA : Ly = 40.00 m, Lz = 40.00 m, Theta = 65.0, Phi = 125.0
STATION EQUATION : T(n) = 0.166 d(Y-X) − 0.122 d(X-Z)
T(e) = 0.236 d(Y-X) + 0.262 d(X-Z)

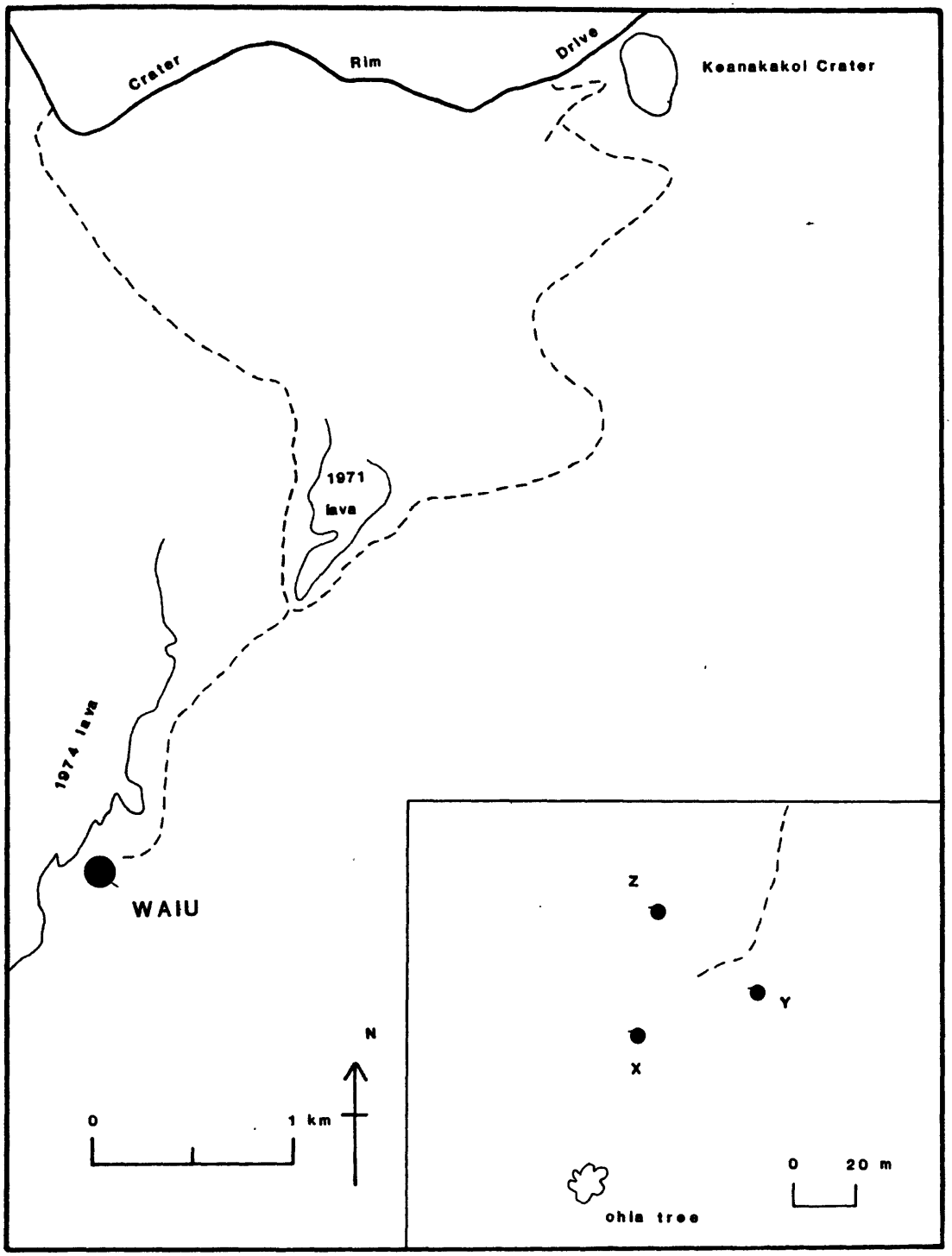
PUU PILI #1 station is located approximately 6.7 km southwest of Puu Ulaula on private land. From HVO, drive 0.8 miles clockwise on Crater Rim Drive to reach the intersection with the Mauna Loa Strip Road. Turn left and go 0.1 mile to reach the intersection with Highway 11. Turn left and go 21.3 miles to reach the intersection with a dirt road on the left side (opposite the middle entrance road to Pahala town). Turn left and go 3.7 miles (through a locked gate) to reach the PUU PILI #1 station.



WAIU (2/5/81 to present)

PREVIOUS NAME : None
MAP COORDINATES : N 19 22.05' W155 17.51' Kau Desert
STATION DATA : Ly = 39.89 m, Lz = 40.01 m, Theta = 20.2, Phi = 79.8
STATION EQUATION : T(n) = -0.051 d(Y-X) - 0.272 d(X-Z)
T(e) = 0.286 d(Y-X) + 0.100 d(X-Z)

WAIU station is located approximately 6.1 km south of the Hawaiian Volcano Observatory near the southwest rift zone of Kilauea in Hawaii Volcanoes National Park. From HVO, drive counter-clockwise on Crater Rim Drive for 1.9 miles to reach the intersection with a dirt service road on the right side. Turn right and go 1.9 miles to reach a fork in the road (southern terminus of the 1971 lava flow). Turn right and go 1.3 miles to reach the WAIU station. The station is 50 meters north of a prominent ohia tree.



WATER TANK (1/3/76 to present)

PREVIOUS NAME :	None
MAP COORDINATES :	N 19 22.95' W155 22.02' Kilauea Crater
STATION DATA :	Ly = 40.00 m, Lz = 40.00 m, Theta = 62.5, Phi = 122.5
STATION EQUATION :	T(n) = 0.155 d(Y-X) − 0.133 d(X-Z)
	T(e) = 0.243 d(Y-X) + 0.256 d(X-Z)

WATER TANK station is located approximately 9.2 km southwest of the Hawaiian Volcano Observatory on private ranchland. From HVO, drive 0.8 mile clockwise on Crater Rim Drive to reach the intersection with Mauna Loa Strip Road. Turn left and go 0.1 mile to reach the intersection with Highway 11. Turn left and go 9.1 miles to reach a road with a locked gate on the right side (just outside of the Hawaii Volcanoes National Park boundary). Turn right and go 1.1 miles to reach a dirt road on the left. Turn left and go 1.5 miles to reach the WATER TANK station.