Seismic Volcanic Risk Assessment
Puna Geothermal Prospect Area
Hawaii

by

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George W. Bergantz
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for the

Seismic Risk Assessment

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Thermal Power Company
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(in pocket)

1.0 EXECUTIVE SUMMARY

1.1 Introduction

This report summarizes the geologic, volcanologic, and seismologic data that relate to evaluation of the Seismic-Volcanic Risk Assessment (SVRA) for the Puna Geothermal Prospect (PGP) of the Lower East Rift Zone (LERZ) on the volcano, Kilauea, Hawaii. The basis for the assessment sections is developed in detail in the Geology Section (3.0), with the volcanic and seismic assessments discussed in Sections 4.0 and 5.0, respectively.

The Volcanic Risk Assessment leads to conclusions that the hazards and risk from volcanic activity and associated fissuring and faulting are high and diverse, but the risk to engineered structures and installations can be mitigated by proper procedures in siting and design. Recommendations are made as to the methods and factors that should be considered for mitigation. The Seismic Risk Assessment demonstrates that the hazard and risk from ground motion is of three general sources: frequent low magnitude volcanic earthquakes with epicenters near the site, infrequent earthquakes of deep focus, low to moderate magnitudes and generally from Kilauea, and tectonic earthquakes of about 6.5 to 7.2 magnitude from the Hilina fault zone with epicenters at distances of from 20 to 50 km (12 to 30 mi).

1.2 Volcanic Risk Assessment

The Puna Geothermal Project is sited in one of the most active eruptive centers of one of the most rapidly growing volcanoes in the world. Important eruptions of lava have affected the area in 1750, 1790, 1840, 1955, and 1960.

Evidence from the log of the HGP-A well indicates that, on a long term basis, an individual site is over-run by lava about once every 900 years, but on a shorter time scale, the frequency is strongly influenced by topography; low areas are covered by flows much more frequently than high areas.

Although eruptions are frequent, they are also quite regular in their behavior and can be predicted with a much higher degree of certainty than is possible in other volcanic regions of the world. Large explosions of ash or pumice are highly unlikely; almost certainly, future eruptions will be like earlier ones, i.e. voluminous discharges of very fluid lava preceded or accompanied by earthquakes and surface deformation.

Future eruptions will be preceded by volcanic and seismic activity in the summit region and by extension and faulting of the ground surface near the site of the eruptive outbreak. They will be accompanied by numerous earthquakes and will form new fissures, avoiding previously active vents in favor of new ground. Fissures will almost certainly be located within the well-defined boundaries of the rift zone. Vents outside that zone are highly unlikely. Fountaining to heights of three or four hundered meters will cover the surrounding region with scoriaceous material, but ejection of explosive debris rarely has a serious effect beyond a few hundred meters from the vent.

The principal volcanic hazards to facilities sited in the East Puna zone are surface rupture, ground motion, and inundation by lava. By comparison, all other hazards are relatively minor. These hazards can be greatly reduced by a modest amount of planning and consideration of a few simple precautions.

If at all possible, permanent installations should not be constructed in low areas where lava is likely to be channeled. Old cinder cones and other areas of relatively high ground are unlikely to be over-run within the next four or five decades. Diversion barriers, if well situated and properly constructed, can deflect lava into an alternative course, but they are ineffective as dams opposing the flow of lava directly.

By orienting buildings and other permanent structures with their shortest dimensions parallel to the axis of the rift, the longest effects of ground deformation and surface rupture can be materially reduced.

Close coordination with the Hawaiian Volcano Observatory and the Hawaiian Institute of Geophysics will help ensure timely warnings of impending eruptions.

1.3 Seismic Risk Assessment

The maximum earthquake that is probable for the next 40 year period is an assumed tectonic earthquake from the Hilina fault zone, with an estimated magnitude of 6.75 and an epicentral distance of 25 km (15 miles). An earthquake of this magnitude would have a mean peak horizontal acceleration of about 0.25 g, a mean peak horizontal velocity of 25 cm/sec, and mean peak horizontal displacement of 10 cm, with a duration of more than 0.05 g motion for about 15 to 25 seconds. This strength and duration of motion, is the strongest motion to be expected from a 100 year earthquake of about Ms = 7.2, and is within the range that can be readily mitigated by appropriate design.

The two earthquake hazards that may consitute a risk to future engineering structures and installations are primarily the strong ground motion from tectonic earthquakes, and to a minor amount, landsliding, slumping or other secondary ground failures of steep slopes near the epicenter of earthquakes of above 5 magnitude. Surface faulting may occur in the site area in response to volcanic related activity, as is discussed in the volcanic risk assessment section of the report. Other seismic hazards and risks, including liquefaction, tsunamis and seiches are considered to be unimportant for this siting area.

2.0 INTRODUCTION

2.1 Purpose of Study

The goal of this report is to provide a seismic-volcanic risk assessment (SVRA) for the Puna Geothermal Prospect (PGP) located within the Lower East Rift Zone (ERZ) of Kilauea volcano, on the island of Hawaii (Fig. 2.1). The assessment is for the general siting area and is not intended to apply to any site-specific domain within the general prospect area.

2.2 Scope of Work and Quality of Data Base

The scope of our work includes a preliminary study of available geologic literature, aerial photographs, maps, historical records, and limited bore hole data. The aerial photographs were used to assist in the field review of the siting areas and to search for faults and fissures near the site. Reports on the geology, seismology, tectonic, and volcanic settings are used to prepare this evaluation of the general volcanic and seismic hazards and risk to engineering structures. The site visits included a review of the faults, eruptive vents and other linear structures defined on the aerial photographs or shown on geologic maps of the area. These visits also permitted discussions with seismologists and geologists at the Hawaiian Volcano Observatory (HVO) and the Hawaiian Institute of Geophysics (HIG). This report integrates the catalogs of eruptions and earthquakes and the newer instrumental seismologic data of the latest listings of the National Oceanic and Atmospheric Administration (NOAA) hypocenter data file for worldwide earthquakes, and the HVO summaries of seismic data (Appendices A, B, and C). The above

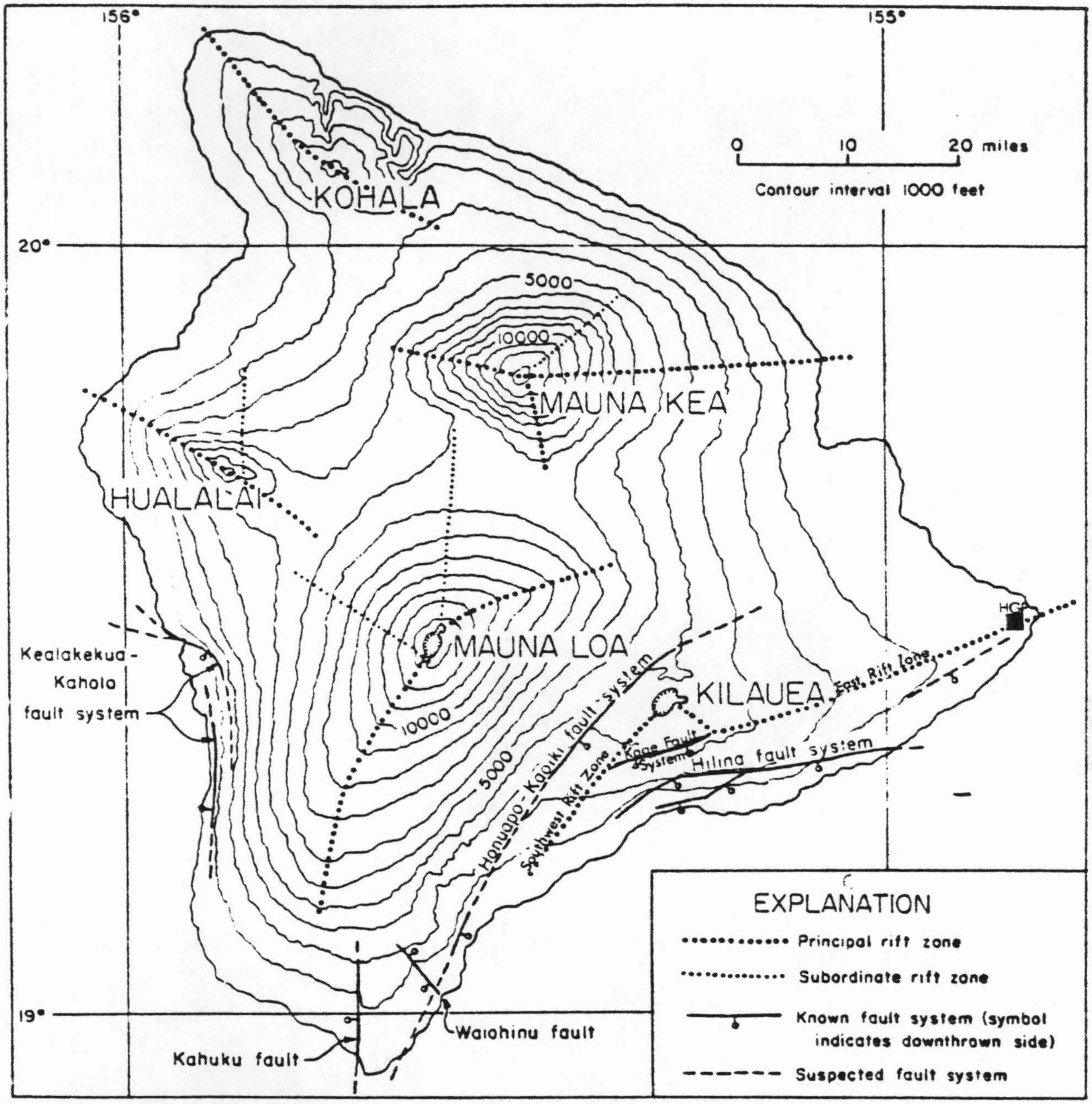


Figure 2.1. Map of major volcanoes, volcanic rift zones and faults on the island of Hawaii (from Macdonald and Abbott, 1970).

elements of the program are synthesized to provide a general evaluation of the maximum possible and maximum probable volcanic eruptions and earthquakes for structures of an assumed 40 year life-span. The general assessment for volcanic and seismic hazards is adequate for evaluation of the broad siting area, but risk assessment for specific structures or sites within the area are not included in the scope of this report.

This project was proposed and completed in the following stages:

A. Literature search, fault and lineament analysis of the aerial photographs supplied by Thermal Power Company.

B. Preliminary data collection and discussions with personnel of the HIG and HVO by George Bergantz and his preparation of a preliminary draft of this report.

C. Field Study by Mr. George Bergantz in June 1981, and by Dr. D. Burton Slemmons, Alexander R. McBirney, and Brian H. Baker in August 1981.

D. Preparation of the draft report.

E. Review and revision of draft report and final submission of the report.

The data base for the seismic risk assessment varies greatly in quality and scope, with poor documentation for early historic earthquake activity, and variable quality and accuracy of cataloging in the National Oceanic and Atmospheric Administration (NOAA) earthquake hypocenter data file of Appendix A. The HVO summaries since about 1962 are good and the data for the period 1975 to 1979 are excellent for most of the region.

2.3 Abbreviations

Abbreviations that are used in this report include the following:

ERZ, East Rift Zone

HIG, Hawaiian Institute of Geophysics

HGP, Hawaiian Geothermal Prospect

HVO, Hawaiian Volcano Observatory

LERZ, Lower East Rift Zone, between about 800 ft elevation and sea level

NOAA, National Oceanic and Atmospheric Administration

PGP, Puna Geothermal Project

SRZ, Southwest Rift Zone

3.0 GEOLOGY

3.1 Regional Geologic Setting

Kilauea is the southern-most of a chain of immense basaltic shield volcanoes extending northwestward across the north central Pacific. This chain has grown southeastward with time, so that the volcanoes are progressively older toward the northwest. Kilauea, the youngest and most active volcano of the chain, has grown to its present height of 1247 meters above sea level (nearly 6 kilometers above the sea floor) in a remarkably short period of about 500,000 years.

The chain has been described as the results of mid-plate volcanism, with northwestward movement of the Pacific plate over a "hot spot" or magmatic source, to form a series of islands and seamounts that vary in age and location from oldest at the northern end of the Emperor Seamount Chain, to the youngest on the south end of Hawaii in the Hawaiian Ridge segment of the chain (fig. 3.1 and 3.2). The potassium-argon dating of lava from these islands and seamounts (fig. 3.2) show a southeast migration of volcanism with time, with a mean migration rate of 11.0 cm/yr (Dalrymple and others, 1973). The volcanoes on the island of Hawaii conform to this general pattern with the northern volcanoes (Kohala and Mauna Kea) showing older ages and deeper dissection by erosion than the two southern, actively growing volcanoes, Mauna Loa and Kilauea which have prolific historic and neohistoric volcanic activity.

The five major volcanoes of Hawaii (pls. 1 and 2, and fig. 2.1) are built from flows and pyroclastic debris from central

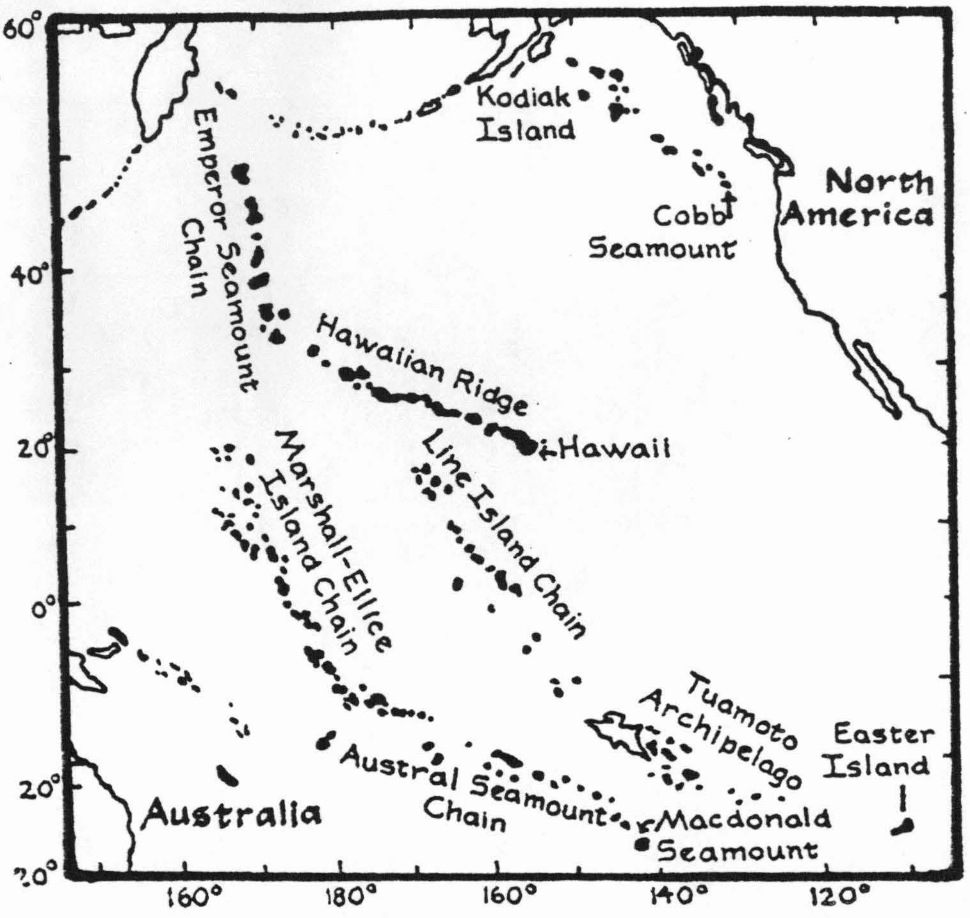


Figure 3.1. Chains of seamounts and volcanic islands in the Pacific Ocean (from Williams and McBirney, 1979).

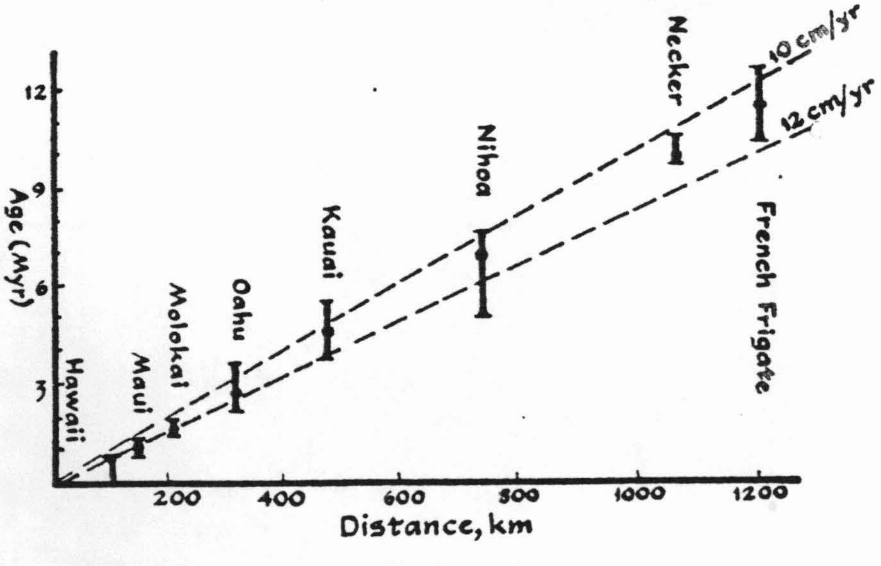


Figure 3.2. Relations of potassium-argon ages of lavas from the Hawaiian-Emperor chain north from Kilauea at the southeast end of the chain (from Williams and McBirney, 1979; and after Dalrymple and others, 1973).

conduits and rift zones. Cleaving these volcanic centers are radial rift zones which intersect at the central dome volcano, and which are the sites of, and passageways for, the bulk of the eruptive materials (Stearns, 1946). Mauna Loa and Kilauea are the southern-most major volcanoes of the island and of the chain. Both have many historic flows from their summits and northeast-trending rift zones.

Rocks in the vicinity of the Puna District and adjacent districts are typically aa and, less commonly, pahoehoe flows of olivine-bearing tholeiitic basalt and associated pyroclastic and hyaloclastic deposits (Stearns and Macdonald, 1946; Macdonald and Abbot, 1970). Three time-stratigraphic units are recognized, the Hilina Volcanic Series, the Pahala ash and the Puna Volcanic Series (fig. 3.3). The bulk of the older Hilina Volcanic Series is related to eruptive events from the Kilauea caldera with magmatic communication at moderate crustal depths inferred to connect with adjoining rifts (fig. 3.4). The Puna Volcanic Series include lavas that appear to have been differentiated from source magmas of the central conduit at Kilauea (Stearns and Macdonald, 1946).

3.2 Structural Features of Kilauea

Kilauea Volcano (fig. 3.5) can be divided into six structural zones (modified from the scheme of Swanson and others, 1976):

1. The summit area includes the caldera and two large pit-craters and has been the site of numerous eruptions and repeated surface deformation over the main reservoir of magma.

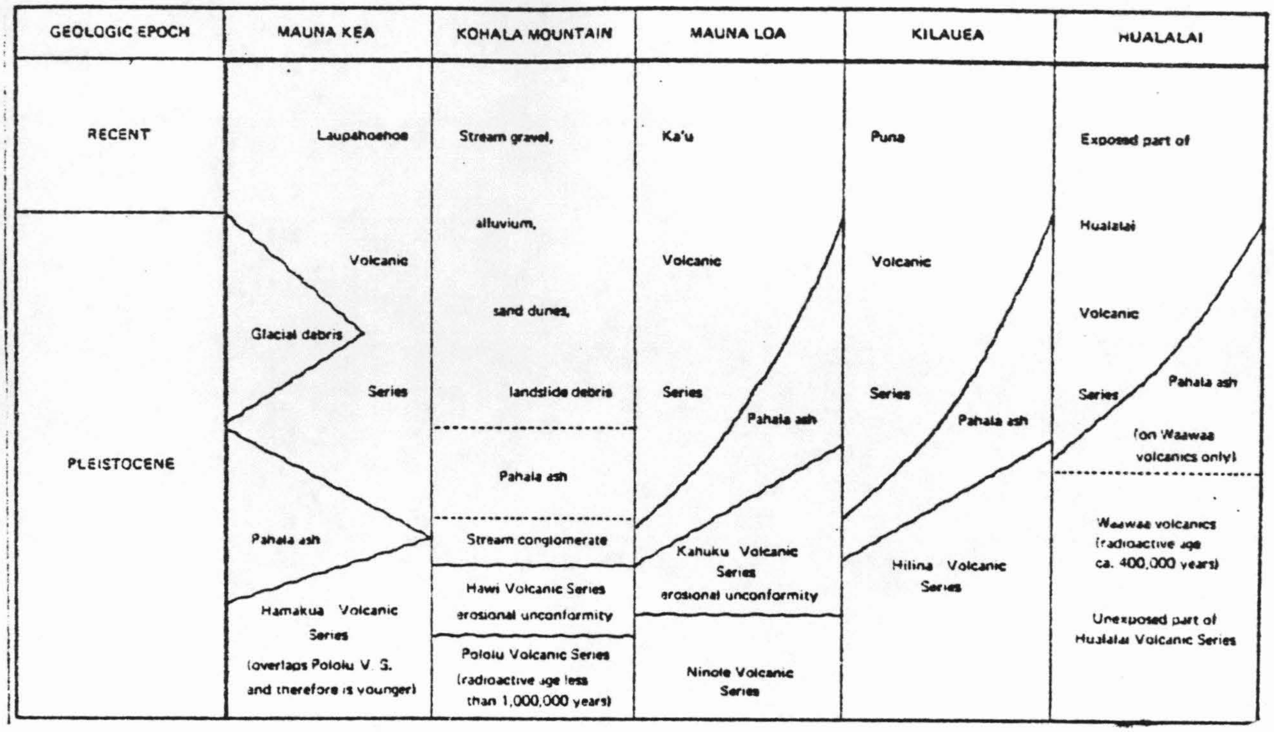


Figure 3.3. Geologic column for the main rock units on the island of Hawaii. All units have ages of less than 1,000,000 years; Recent extends to approximately 10,000 years ago (from Macdonald and Abbott, 1970).

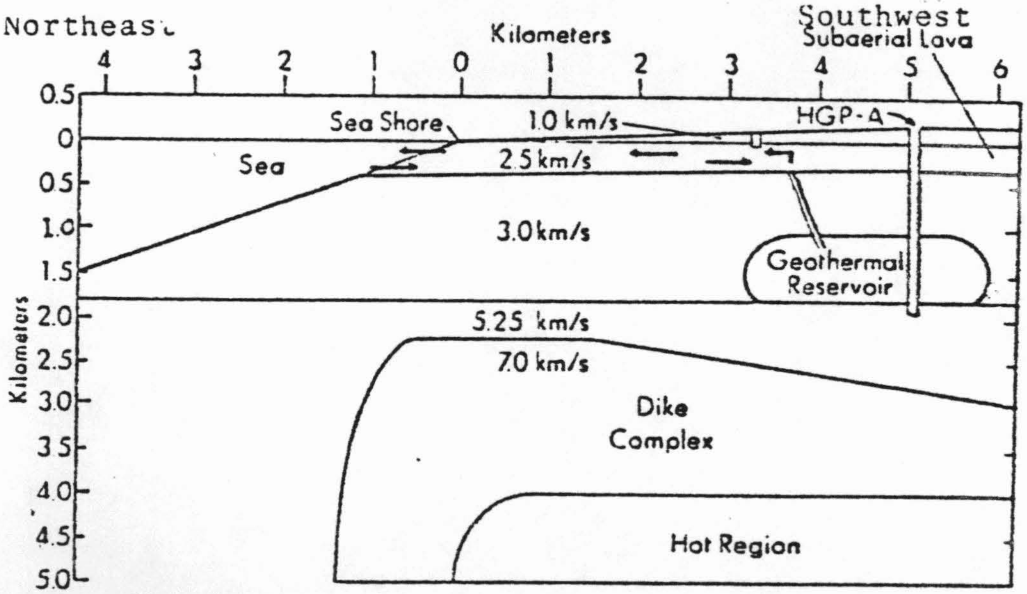


Figure 3.4. Inferred subsurface geologic structure of the East Rift Zone of Kilauea based on seismic refraction and gravity data (form Furumoto, 1978).

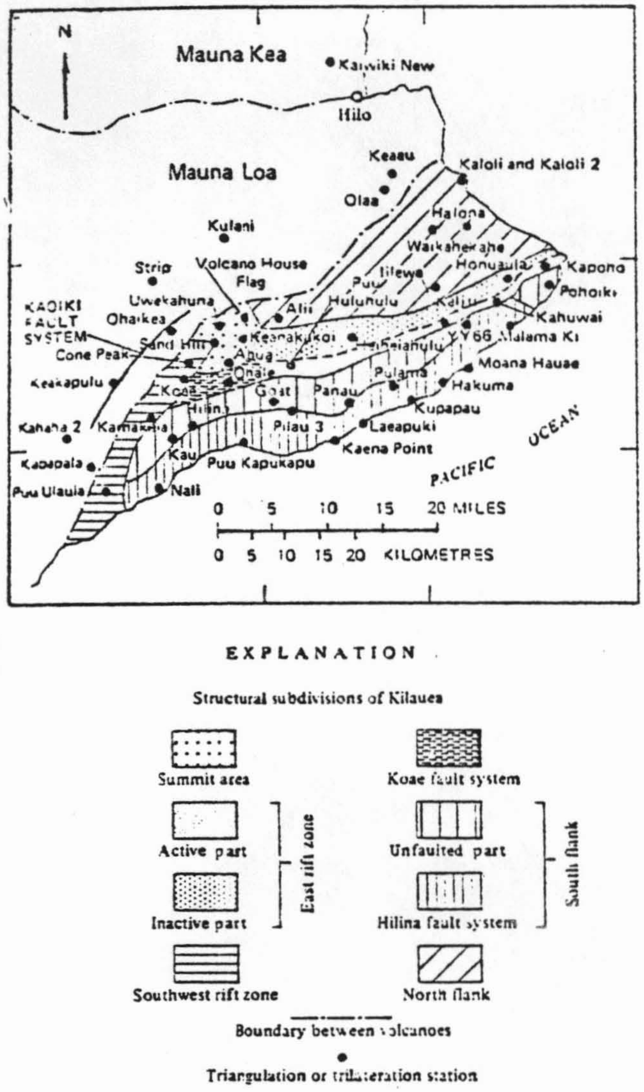


Figure 3.5. Structural subdivisions of Kilauea Volcano and locations of triangulation stations shown in Figure 4.5. Boundaries of subdivisions are gradational in most places (Swanson and others, 1976).

2. The Chain-of-Craters zone (fig. 3.6) comprises a SE-trending belt of small satellite sheilds and pit craters. This is cut by ENE-trending fissures and merges into the East Rift Zone.

3. The ENE-trending East Rift Zone (ERZ) consists of small shields, pit craters, fissures, and faults. It is 3 to 5 km wide, extends 45 km from Mauna Ulu to Cape Kumakahi, and continues as a submarine ridge another 70 km to the northeast.

4. The Koae fault system of 20 km length is a 3 km wide zone of normal faults cutting the upper south flank of Kilauea. It is the direct structural continuation of the ERZ and links the East and Southwest Rift Zones.

5. The Southwest Rift Zone (SRZ) of about 20 km length is a less active counterpart of the East Rift Zone.

6. The Hilina fault zone of about 50 km length cuts the lower, southern flank of the Kilauea shield.

The SRZ and ERZ, together with the summit area and the Chain of Craters zone comprise the eruptive zone of Kilauea, whereas the Koae and Hilina fault systems are fracture zones from which little or no lava has been issued.

3.3 Crustal Structure of Kilauea and the East Rift Zone

In order to understand the nature of volcanic and seismic activity of Kilauea, it is helpful to review briefly the structure and evolution of the volcano and the mechanisms governing its behavior.

Seismic data indicate that the crust under Kilauea consists of 9 kilometers of volcanic rocks resting on 5 to 6 kilometers of older oceanic crust and a mantle composed of rocks with the

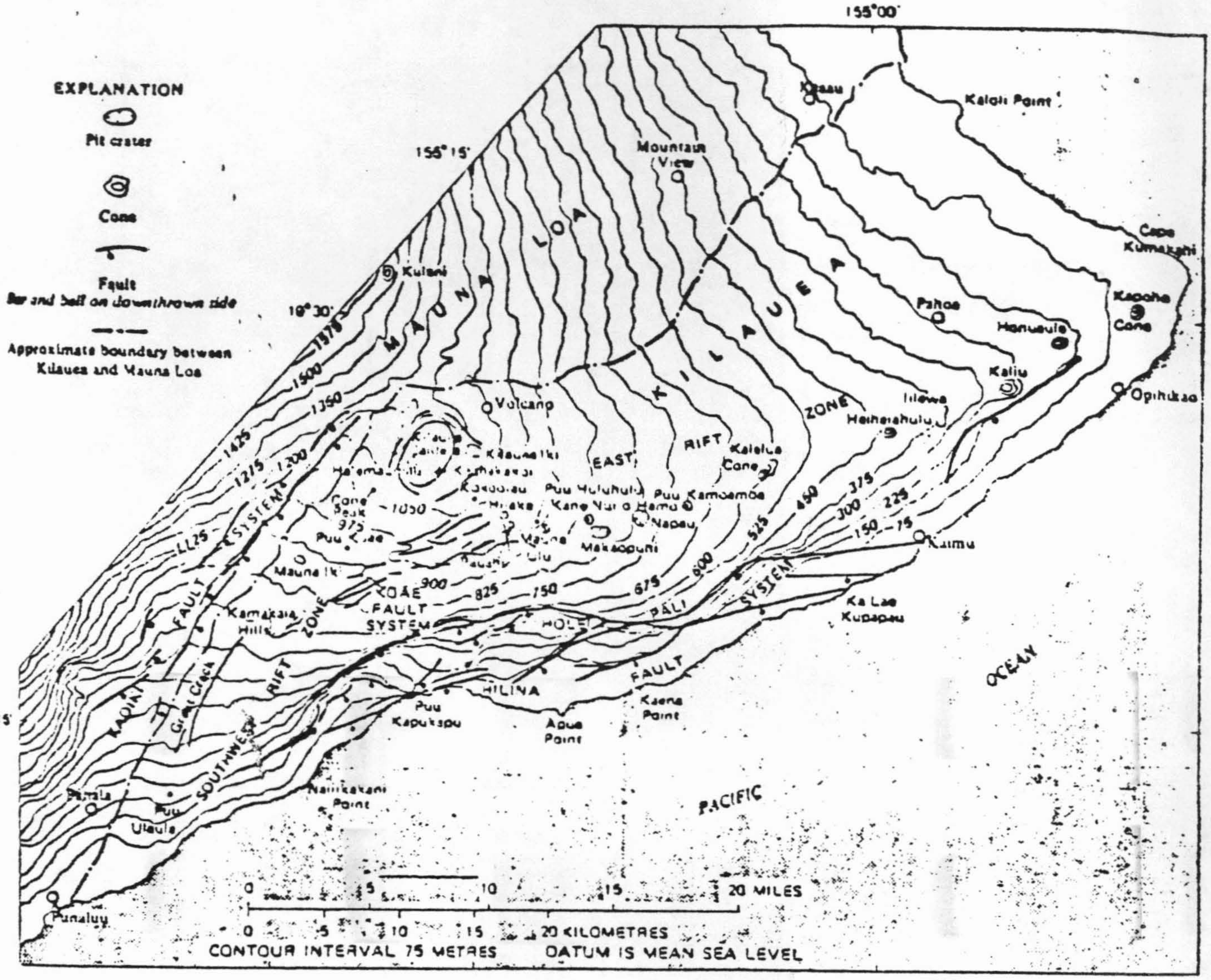


Figure 3.6. Map of Kilauea and the adjacent part of Maona Loa Volcanoes showing the summit caldera and the southwest and south-east rift zones, and the Koae and Hilina fault systems on the south flank. The Chain of Craters sector of the East Rift Zone extends from Halemaumau to Mauna Ulu (Swanson and others, 1976).

seismic properties of serpentinized peridotite (Crosson and Koyanagi, 1979). The top of the mantle under the island is depressed by the great weight of the volcanoes from its normal depth of 10 km to about 14 km below sea-level.

Seismic refraction, gravity and seismic velocity surveys of the lower ERZ have shown (fig. 3.5, 3.7 and 3.8) a shallow surface layer of low and varied seismic velocities corresponding to young porous volcanic rocks (Vp = 2.5 to 3.0 km/sec), overlying a water-saturated zone extending to a depth of 1.8 km below sealevel. From 1.8 to 5 km, velocities average 5.25 km/sec, with a zone of higher velocity (about 7.0 km/sec) corresponding to a presumed dike complex along the ERZ (Broyles and others, 1979). Their gravity data indicate that the high-density zone of dikes is 12 km to 17 km wide, in contrast to the 4 km width of the ERZ. Part of the zone of high density lies to the north of the ERZ, supporting the suggestion (Swanson and others, 1976) that the ERZ has migrated to the south as the volcano has grown.

Seismicity in the ERZ is concentrated at depths of less than 10 km and has been related to lateral movement of magma from the summit region into a reservoir complex under the ERZ (Koyanagi and others, 1981). Swarms of shallow earthquakes commonly precede eruptions in the upper part of the ERZ, but near Puu Honaula (in the lower ERZ) shallow earthquake swarms have occurred without surface deformation or eruption, and these are thought to result from local movement in a magmatic storage zone isolated from the remainder of the rift (Koyanagi and others, 1974 and 1981).

3.4 Characteristics of Volcanism of Kilauea

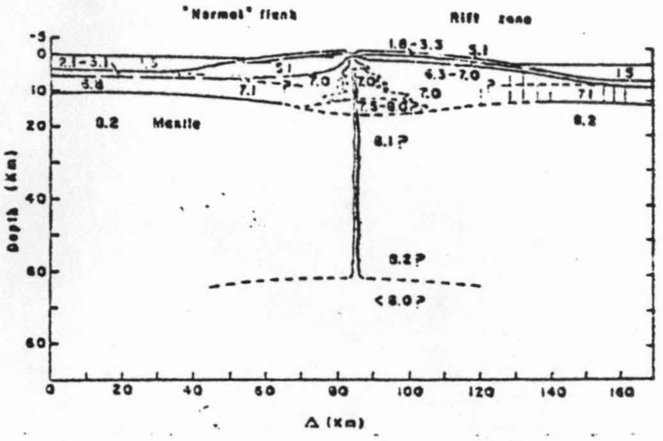


Figure 3.7 Schematic cross section showing idealized crustal structure of Hawaiian Volcano (based largely on Kilauea). Numbers indicate P-wave velocity in km/sec (hill, 1969).

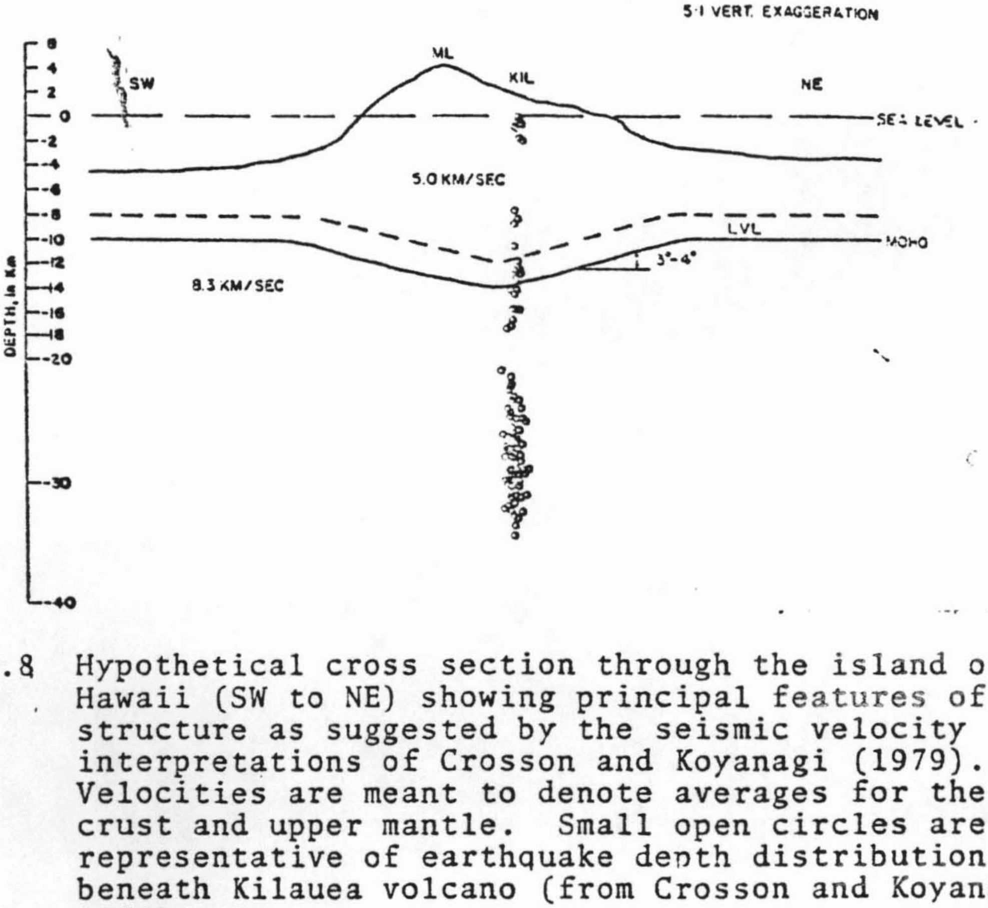


Figure 3.8 Hypothetical cross section through the island of Hawaii (SW to NE) showing principal features of structure as suggested by the seismic velocity interpretations of Crosson and Koyanagi (1979). Velocities are meant to denote averages for the crust and upper mantle. Small open circles are representative of earthquake depth distribution beneath Kilauea volcano (from Crosson and Koyanagi, 1979).

Because of the frequency of eruptions and many detailed studies carried out by the Hawaiian Volcano Observatory, the activity of Kilauea is more clearly understood than that of any other volcano. Techniques for monitoring and forecasting eruptions have reached a highly sophisticated and successful level of development.

While it is generally true that volcanism has a variety of forms and no two eruptions are exactly identical, Hawaiian activity is more regular than that of other types of volcanoes. The characteristics of the eruptive activity of Kilauea during its present mature stage of evolution have been well defined.

Eruptions are centered in two general regions, the summit caldera and the rift zones. In general, summit eruptions have a more localized effect, because they tend to be confined to depressions that restrict the flow of lava to a relatively small area. In recent years, however, activity in the summit region has shifted to the vicinity of the new eruptive center around Mauna Ulu, a short distance south of the caldera. Flows from this area have moved down the south flank of the volcano, but have no effect on the lower ERZ. Their significance for our present purposes is in the close connection between activity at the summit and eruptions farther down the rift zones.

Eruptions on the flanks of Kilauea are frequently linked with earlier activity in the summit region. The magma feeding flows discharged from the lower ERZ has been shown to come from a reservoir much higher in the volcanic structure. Swelling of the summit region is commonly observed before an outbreak on the flanks, and monitoring of this swelling provides a means of anticipating when the volcano is charged with magma at a high level and is capable of erupting. In all the eruptions for which good data are available, earthquakes and tumescence have been recorded around the caldera, and regardless of whether or not these subsurface events were followed by an eruption at the summit, outbreaks on the rift rarely occur except after notable swelling of the upper parts of the volcano.

Many, but by no means all eruptions have been preceded by broadly distributed deep earthquakes followed by more localized seismic activity at a shallow level beneath the immediate region of the impending eruption. In some instances there may be little deep-focussed seismicity and only shallow localized earthquakes. While many of the earthquakes are small, they are recorded in large numbers by the seismic network operated by the U.S. Geological Survey for many days or weeks prior to the outbreak of magma at the surface. For this reason, it is highly unlikely that a major eruption will come as a surprise. It will be preceded by swelling, tilting, and extensive seismic activity well before any lava is discharged.

The chemical and physical character of the magma at Kileaua is also very consistent. It is a very fluid tholeiitic basalt that commonly contains conspicuous crystals of olivine and, more rarely, plagioclase. Apart from minor variations in some of its components, mainly trace elements and concentrations of olivine crystals, it can be expected to vary little for many decades to come. It is normally erupted at temperatures between 1150 and 1200 degrees centigrade and has a low viscosity (in the range of

300 to 1000 poises). Its density ranges widely according to the proportion of gas bubbles but the interiors of flows can reach density of 2.7 grams per cubic centimeter.

Lava is generally of the pahoehoe type near the vent but commonly changes to the clinkery aa type as it flows downslope and cools. Some eruptions, such as that of 1790, produced lavas that were almost exclusively pahoehoe, whereas others, such as that of 1955, have been dominantly aa. There is no simple way of anticipating which type of lava will be erupted in a particular location.

Eruptions usually break out relatively quietly at one or two points on the rift and quickly spread along a well defined fissure for distances of a few hundred meters to as much as several kilometers. The initial eruptive phase is characterized by spectacular fire-fountaining, which quickly increases in height and intensity. It normally lasts for a period of hours, days, or, more rarely, weeks. Along most of the eruptive fissure, the products of these early stages are incandescent bombs, spatter, and fine glassy filaments known as "Pele's hair". Ash is usually subordinate to coarser material, and scoriaceous cinders may accumulate to thicknesses of many meters around a centralized vent that persists in activity for several days or weeks.

Close to the coast, particularly in the area of Kapoho where the ground water table is shallow and rocks are very permeable, water may enter the upper levels of the fissure and greatly augment the explosivity of the eruption. When this occurs, the ejecta are more voluminous and tend to be gray ash, quenched glass, and blocky lithic debris. Regardless of the mode of eruption, however, the deposits are confined to an area close to the vent and seldom accumulate to depths of more than a few meters at distances of more than half a kilometer. Violent explosions hurled large blocks several hundred meters during the steam-blast eruption at the summit of Kilauea in 1790 and 1924, but large events of this kind have been uncommon in historic times and have been confined to the summit area.

Subsidence may occur either as linear troughs or as cylindrical collapse pits up to one or two hundred meters in diameter. These latter features are more typical of the upper parts of the rift where magma has been drained by intrusions or eruptions at a lower elevation. But the connection between subsidence and eruptions may not be an obvious one. In 1924, for example, the area of Kapoho subsided several feet even though no surface eruption was observed. It is thought that magma drained into a submarine section of the rift zone and may have erupted below sea level.

Lava flows begin to emerge concurrent with or very soon after the initial episode of fire fountaining. They seldom pour from the entire width of the fissure, except in the earliest stages. More typically, the eruptive vent quickly becomes localized in a short section of the rift. Lava is often discharged at rates of two to five million cubic meters per hour and commonly flows reach lengths of the order of ten kilometers, widths of two or three hundred meters, and thicknesses of about four meters, but these dimensions vary within wide limits. The widths and thicknesses of flows depend mainly on the steepness of the slope and on how much of the fissure is active at a particular time. As the lava moves away from the source, its width may either increase or decrease depending on the local topography. Flows on the south side of the rift tend to become narrower where the slope steepens, and in many cases well-defined channels only a few meters wide develop after the first broad front of the flow has passed. The velocity of flow varies directly with the slope angle and rate of discharge and inversely with the viscosity and width. Velocities as high as 40 miles per hour have been measured in narrow steep channels of pahoehoe lava.

Upon reaching the sea, lava may interact with the water to produce a spray of quenched granular basaltic glass, and if fed by a well-defined and rapidly flowing channel, a flow may develop a littoral cone that can grow to the size of a moderately large cinder cone. Again, the area affected by this explosive activity is confined to the immediate area of the point at which the flow enters the sea.

Taking the volcano as a whole, at least 50 eruptions have been recorded since Europeans first visited the islands, but it is only since 1912, when the Hawaiian Volcano Observatory was established, that reliable records have been available. Table 3.1 lists 46 eruptions and a number of suspected intrusive events that have occurred in this period of 69 years or an average of one every 1.5 years. Of these, 19 occurred in the ERZ and only two, those of 1955 and 1960, affected the East Puna District.

Klein (in press) recently examined this record and found that the timing of eruptions had no detectable periodicity. He observed that subsequent eruptions were independent of the date of the previous eruption. He has, however, found a number of fairly regular (or at least non-random) relationships. These can

TABLE 3.1

Kilauea Eruptions (1918-1979) and intrusions (1959-1980).

EVENT	STARTING DATE	DURATION (d)	LOCATION[1] & TYPE OF EVENT			DAYS SINCE LAST ERUPTION	DAYS SINCE LAST INTRUSION	ERUPTED VOLUME ($10^6 m^3$)	DEFLATION (TILT AT HVO, IN MICRORADS)
			SUMMIT	ER	SWR				
1	2/23/18	14	E	—	—	—	—	.2	—
2	2/7/19	294	E	—	--	349	—	27	—
3	12/21/19	221	—	—	E	317	—	49	—
4	3/18/21	7	E	—	—	453	—	7	—
5	5/28/22	2	—	E	—	436	—	?	—
6	8/25/23	1	—	E	—	454	—	.1	—
7	5/10/24	17	E	—	—	259	—	ASH	—
8	7/19/24	11	E	—	—	70	—	.3	—
9	7/7/27	13	E	--	--	1083	—	2.5	—
10	2/20/29	2	E	--	--	594	—	1.5	—
11	7/25/29	4	E	—	--	155	—	2.8	—
12	11/19/30	19	E	--	--	482	—	7	—
13	12/23/31	14	E	--	--	399	—	8	—
14	9/6/34	33	E	--	--	988	—	8	—
15	6/27/52	136	E	—	--	6504	—	51	—
16	5/31/54	3	E	--	--	703	—	7	—
*17	2/28/55	88	--	E	--	273	—	95	—
18	11/14/59	36	E	—	--	1720	—	40	-45
*19	1/13/60	36	—	E	—	60	60	119	-300
20	2/24/61	1	E	--	--	408	408	.2	<2
21	3/3/61	22	E	—	--	7	7	.3	-6
22	7/10/61	7	E	—	--	129	129	13	-8
*23	9/22/61	4	--	E	--	74	74	2.5	-166
24	12/7/62	3	--	E	--	441	441	.3	-18
	5/9/63	1	—	—	I	—	153	—	-32
	7/1/63	2	--	I	—	—	53	--	-20
25	8/21/63	3	--	E	—	257	51	.8	-11
*26	10/5/63	2	—	E	—	45	45	8	-79
*27	3/5/65	11	—	E	—	517	517	18	-84
	8/25/65	1	I	I	—	—	173	—	+8
28	12/24/65	2	—	E	—	294	121	.8	-45
*29	11/5/67	251	E	—	—	681	681	84	-11
30	8/22/68	5	--	E	—	291	291	.01	-54
31	10/7/68	16	--	E	—	46	46	7	-60
32	2/22/69	7	--	E	--	138	138	17	-46
*33	5/24/69	875	--	EP	--	91	91	185	-24
	11/3/69	1	--	I	--	—	163	--	-6
	1/22/70	1	I	--	--	—	80	--	-6
	2/3/70	8	--	I	I	—	12	--	-4
	4/5/70	5	--	I	I	—	61	--	-9
	5/15/70	2	--	I	--	--	40	--	-8
	6/11/71	3	--	--	I	—	392	--	-4
34	8/14/71	1	E	—	--	812	64	10	-16
35	9/24/71	5	E	—	(E)	41	41	8	+12
	12/24/71	6	--	--	I	—	91	--	-3
*36	2/4/72	455	--	EP	--	133	42	125	-2
37	5/5/73	1	--	E	--	456	456	1	-23
38	5/7/73	187	--	EP	--	2	2	2.5	<2
	6/9/73	1	--	I	--	—	33	--	-8
39	11/10/73	30	--	E	--	187	154	3	-14
40	12/12/73	222	--	EP	--	32	32	30	-2
	3/24/74	1	--	I	--	—	102	--	-5

TABLE 3.1. Continued.

EVENT	STARTING DATE	DURATION (d)	LOCATION[1] & TYPE OF EVENT			DAYS SINCE LAST ERUPTION	DAYS SINCE LAST INTRUSION	ERUPTED VOLUME ($10^6 m^3$)	DEFLATION (TILT AT HVO, IN MICRORADS)
			SUMMIT	ER	SWR				
41	7/19/74	3	E	--	--	219	117	10	-17
42	9/19/74	1	E	--	—	62	62	11	+25
*43	12/31/74	1	--	—	E	103	103	15	-155
*44	11/29/75	1	E	(I)	--	333	333	.2	-221
	6/21/76	1	--	I	—	—	205	—	-7
	7/14/76	1	--	I	--	—	23	--	-7
	2/8/77	1	--	I	--	—	209	—	-6
45	9/12/77	20	--	E	--	653	216	40	-109
	5/29/79	1	--	I	--	—	624	--	-3
	8/12/79	1	--	I	--	—	75	--	-2
46	11/16/79	1	--	E	--	795	96	.4	-8
	3/2/80	1	--	I	--	—	107	--	-3
	3/10/80	1	--	I	--	—	8	—	-16
	8/27/80	1	--	I	--	—	170	--	-7
	10/22/80	1	--	I	--	—	56	--	-2
	11/2/80	1	--	I	--	—	11	—	-6

[1] Location codes: Summit, Kilauea summit caldera or its margin; ER, east rift zone; SWR, southwest rift zone; Event codes: E, eruption; I, intrusion with no surface lava; EP, major phase of Mauna Ulu eruption of 1969-74. Data are complete through November 1980.

*Largest eruptions: volume exceeds 70 x $10^6 m^3$, or deflation exceeds 70 microradians.

be briefly summarized as follows.

1. Large-volume eruptions tend to be followed by longer reposes, which are interpreted as the time required for the shallow magma reservoirs refill to the extent that another eruption is possible.

2. The mean repose time between eruptions has been 282 days. Long periods of repose lasting several years are correlated with periods when Mauna Loa is active. The short repose times of a few days are probably due to brief physical obstructions that interupt an eruption that would otherwise be continuous. Intermediate repose time appear to be of random duration and cannot be correlated with any known phenomenon.

3. Summit and flank eruptions are often paired with flank eruptions following a summit eruption rather than vice versa, but the pattern is far from regular, and the time of the last summit eruption cannot be used to forecast the next flank eruption. Moreover, long sequences of summit eruptions have continued without a flank eruption. Conversely, long runs of flank eruption rarely occur without an intervening summit eruption.

3.5 Rift Zones

Rift zones radiate from calderas of historically active Hawaiian volcanoes and are sites of most of the eruptive and seismic activity. The rifts are defined by broad zones of linear grabens, fissures, aligned cinder cones, spatter cones, pit craters and associated earthquake foci and geophysical anomalies. Subsurface data and exposure by erosion of the older underlying volcanic foundations on other Hawaiian islands to the north show the rifts to be composed of multiple, narrow dikes of basalt, generally with steep dips. They generally show continuity to the summit calderas or their deeper, central magmatic sources.

The PGP (fig. 3.3 and 3.6) is on the ERZ of the eastern flank of Kilauea. The volcanic geology of the ERZ has been studied in detail by Holcomb, (1981). Most of this east flank is covered with lavas of no more than a few tens of thousands of years age, with most of its surface less than one thousand years old. The ERZ originates near the summit of Kilauea as a southeasterly trending alignment of vents, craters, and small calderas (figs. 3.3, 3.6, and 3.9). About 5 km south of Kilauea it joins the eastern end of the Kaoe fault zone where it changes in trend to a nearly straight ENE zone that passes through the PGP and continues offshore (Furumoto and Kovach, 1979).

The zone is a very straight topographic high, with a plateau-like character, that appears to be defined by the width of the zone of fissures. The ERZ extends at least 60-80 km ENE (Suyenaga and other, 1978) to the coastline, and the submarine topography indicate ENE extension of several tens of kilometers beyond. The extensional features in the zone, such as normal faults, linear cracks and fissures, and tilted fault blocks, delineate a zone of about 5 km width at the HGP-A well site. The volcanic eruptions on the zone are tabulated (tbl. 3.1) and are described in Section 4.0 of this report. They have been accompanied by seismic activity as is discussed in Section 4.0 and 5.0 and listed in Appendices A, B and C. All, or at least most, of the earthquake activity of the ERZ is directly associated with the volcanic activity. The nearest tectonic activity is along the

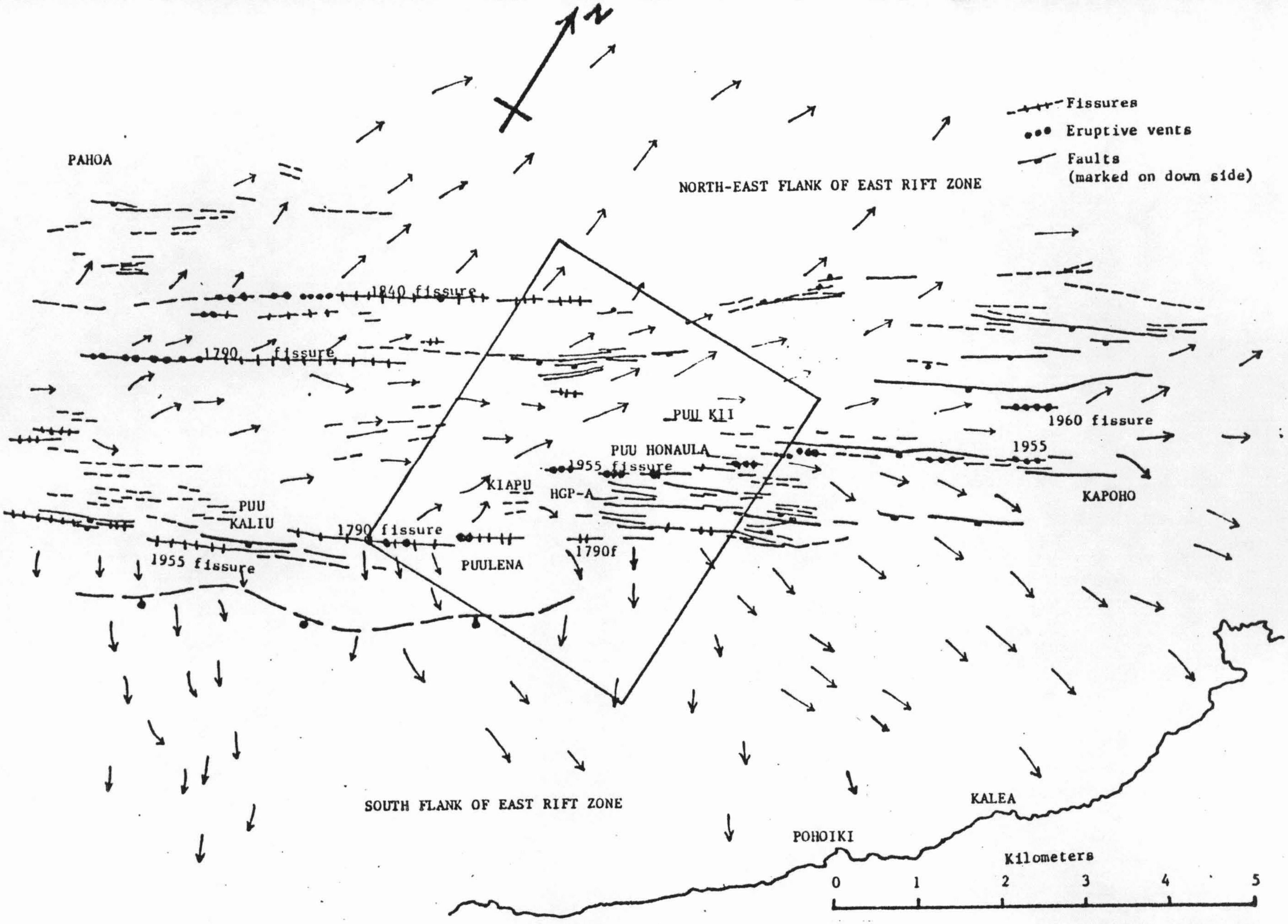


Figure 3.9. Structural map of the Lower East Rift (after Holcomb, 1981). Arrows denote the direction of flowage.

Hilina fault zone, a few kilometers south of and sub-parallel to the rift.

The instrumentation for earthquake studies of the ERZ was poor before about 1960. Since 1960 improvements in the seismologic network have provided good data. Koyanagi and others (1981) document a major improvement in ability to assess the seismicity of this zone in about 1976, although the eastern part of the Puna district has not been fully instrumented. The most recent major eruptions on the ERZ near the PGP were in 1955 and 1960. Furumoto (1978) has modeled the subsurface geologic structure of the ERZ at the PGP, using on seismic refraction and gravity data (fig. 3.5).

The relationship between the ERZ and the central summit caldera has been reviewed by Koyanagi and others (1981). They state:

> From seismic and tilt data, Eaton (1962) developed a structural model of Kilauea where magma traced to nearly 60 km depth rises to fill a small storage system a few kilometers beneath the summit. His data further indicated that magma is transported laterally through shallow rift zones to feed eruptions along these linear fissure systems.
>
> The mechanics of magmatic movement in the rift zones were later studied in detail by Fiske and Jackson (1972). The laboratory experiments they conducted using gelatin models demonstrated how stresses from magmatic pressures could create extensive swarms of thin magma-transporting dikes within the rift zones. Also studied in their investigation was how the orientation of shallow rift zones could be influenced by gravitational loading of existing volcanic masses.
>
> Koyanagi and others (1972) described the asymmetric distribution of crustal earthquakes along the East Rift Zone to support the concept that stresses generated by magmatic intrusions are relieved on the seaward, free slopes of the volcano: the north flank is buttressed against the massive Mauna Loa volcano and

remains stable and relatively immobile. Epicenter maps prepared in summary bulletins from HVO since 1962, such as in Koyanagi and others, 1978a, 1978b, 1978c, show the high concentration of crustal earthquakes on the seaward slopes of Kilauea, particularly in 1975-77 during the intensive aftershock activity following a 7.2-magnitude earthquake on November 29, 1975 (see fig. 3.10 of this report). The aftershocks clustered in the south flank along an elongate zone that extended from the southwest rift eastward to about Puu Honuaula on the east rift. The areas north of the east rift, as well as east of Puu Honuaula are contrastingly aseismic. Swanson and others (1976) verified the crustal instability and showed the trend of southward movement of Kilauea's south flank with detailed deformation surveys. They contend that magma forcefully intrudes the rift zones by forming many thin and near vertical dikes. The intrusion forces the wallrocks apart normal to the direction of intrusion ultimately causing the seaward displacement of the south flank.

Zablocki (in Keller and others, 1977) summarized these concepts by putting into perspective his findings from geoelectric surveys of the East Rift Zone, with particular emphasis in the lower part of the subaerial rift southeast of the Pahoa in an area of known microearthquake localization. He described a positive thermal anomaly elongated transverse to the major axis of the rift zone at a place that corresponds to an apparent left-lateral offset of the principal volcanic features that define the surface of the rift zone. He suggested that the buttressing effect of Mauna Loa north of the rift lessens with increasing distance away to the east, and eastward from Puulena the more symmetrical topography and deformation pattern accordingly indicate symmetry in the distribution of stress normal to the rift zone. Such changes in the stress field may cause structural offsets to develop in the rift and may cause magma fed laterally from the summit to accumulate, forming secondary storage zones.

Furumoto (1978), using seismic and gravity data and information gathered from the geothermal well, proposed a crustal model for the geothermal area (see fig. 3.5 of this report). He described the core of the rift as a broad zone that extends downward from a depth of 4 km. This hot zone is overlain by a 2 km thick dike swarm.

The Southwest Rift Zone (SRZ) is similar to the ERZ, and currently is the focus of frequent earthquakes activity, major tilting and probable magmatic movement. This zone appears to be

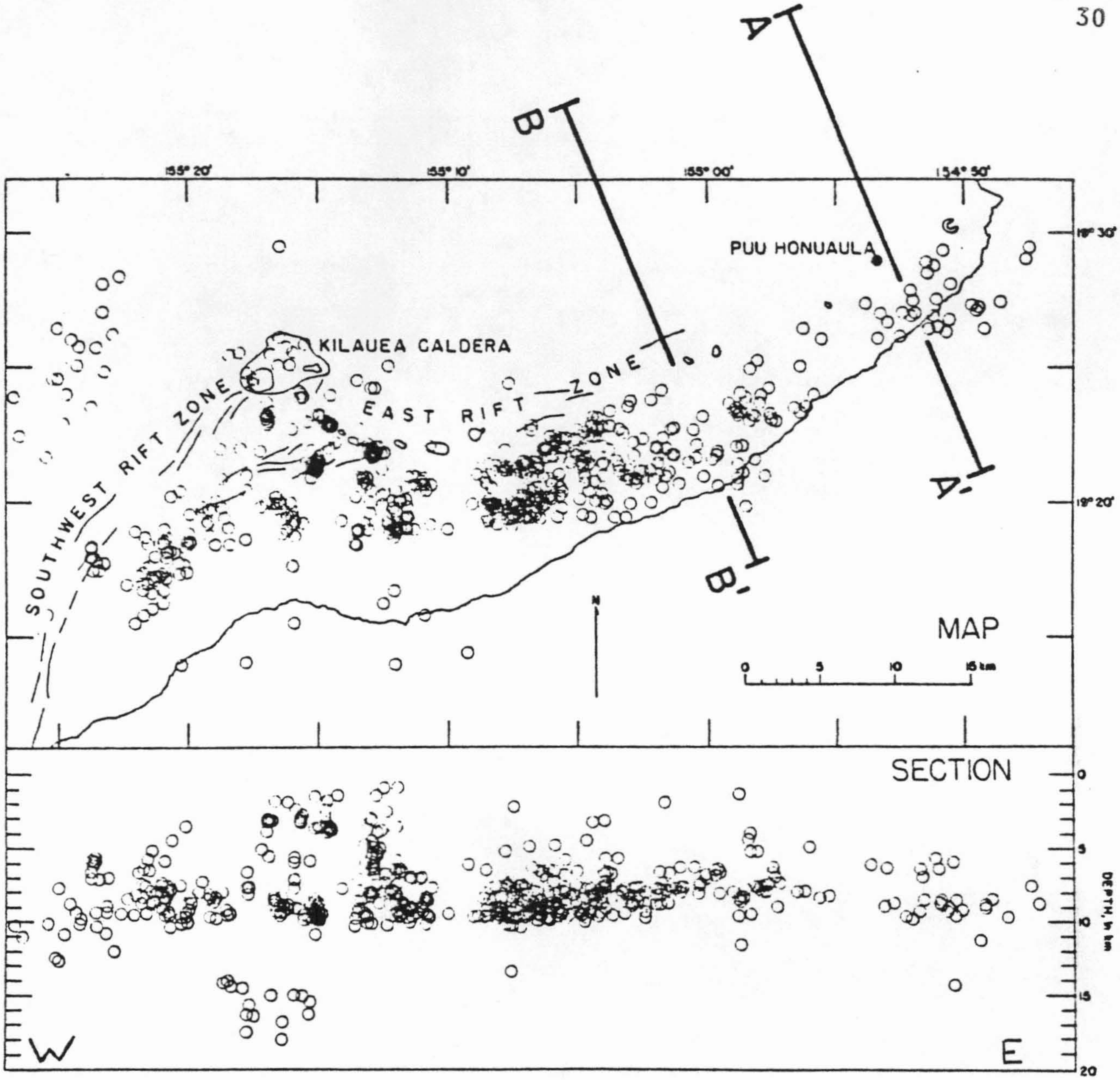


Figure 3.10. Locations of $M_A \geq 3.0$ earthquakes with focal depth of 0-20 km at Kilauea from December 1975 to December 1977. The Quality of location for most of the events plotted are less than 2 km in standard errors of epicenter (upper plot) and depth (lower plot). A-A' and B-B' are center lines for cross-sectional hypocenter plots prepared in the following figure 4b (Koyanagi and others, 1981).

narrower than the ERZ and does not extend as far offshore. (fig. 3.3 and 3.6). Forceful injection of dikes does not appear to initiate earthquakes of larger size (Swanson and others, 1976), but, like the ERZ, may be associated with frequent and, at times, rhythmic earthquakes. Eruptions from this zone are less frequent than in the ERZ and the total volume of historically erupted material is much smaller.

Historic eruptions, with associated earthquake activity at Kilauea and on its rift systems is summarized in Table 3.1. Sixteen of forty-nine eruptions (about 33 percent) are associated with the ERZ. Many eruptions were preceded within five years by deeper focus upper mantle to shallow-focus crustal earthquakes associated with magmatic movement in the summit region of Kilauea.

3.6 Fault Zones

3.6.1. General Comments

Four prominent fault zones are identified on the island of Hawaii, and in order of increasing distance from the site (fig. 3.3 and pls. 1 and 2) are:

A. Hilina fault zone,
B. Koae fault zone,
C. Hanuapo-Kaoiki fault zone, and
D. Kealakekua-Kholo fault zone.

The Hilina fault zone is the most significant zone to the PGP, because of both its proximity, and its high magnitude earthquakes. The Koae fault zone has a short length and historically has only low-magnitude earthquakes. This zone is located just south of Kilauea. The Hanuapo-Kaoiki fault zone at the base of the southeast flank of Mauna Loa and the northwest flank of Kilauea may be an inactive, or less active, antecedent structure to the Hilina fault zone (fig. 3.3 and pls. 1 and 2) and shows little or no historic earthquake activity. The Kealakekua-Kholo fault zone is a subarcuate zone along the western edge of the island.

3.6.2 Hilina Fault Zone

The Hilina fault zone is a branching, complex normal fault zone with an arcuate surface expression trending east-west across the southern flank of Kilauea (fig. 3.3). The zone extends offshore from both its eastern and western ends, and this offshore extent is not well defined. From aftershock distribution following the 1975 earthquake and the tsunami source parameters, the zone appears to have a large offshore extent (Swanson and others, 1976). This fault zone has south-facing, sub-parallel and *en echelon* fault scarps of up to 500 m height in late Quaternary basalts. The fault morphology of the Hilina fault zone is characterized by block failures that are suggestive of slumping or landsliding. Lavas at the base of the scarp have dips that are rotated landward. This rotation is similar to that observed on blocks affected by landsliding.

This fault has two large historic earthquakes, the 1868 earthquake of poorly known magnitude, about 7.5 to 8.0 as inferred from intensity (Tilling and others, 1976), and the Ms = 7.2 earthquake of 1975. The tsunami effects of the 1868 earthquake were greater than that of the 1975 earthquake. The 1868 earthquake is assigned an estimated magnitude of Ms = 7.75 ± 0.25.

The Hilina fault zone appears to be a gravity controlled fault that is affected by dilation from intrusive activity and associated pressure effects by magmas of the south flank of Kilauea and the ERZ. Various workers (Fiske and Kinoshita, 1969; Koyanagi and others, 1972; Swanson and others, 1976) propose that the stress regime and the geodetic deformation is affected by progressive instrusion of dikes and dilation of the ERZ. Failure during the 1975 earthquake by southeastward sliding or thrusting led to an observed geodetic decrease in elevation and southeastward movement of the land area and the companion uplift at the toe of the transported block to cause the tsunami (fig. 3.11). The direction of displacement (fig. 3.12) is in agreement with the maximum stress axis determined from the focal mechanism of the earthquakes (Swanson and others, 1976). During the 1975 deformation, there were associated swarms of earthquakes and ground cracking on the ERZ.

Geodetic data from stations on the north and south sides of the Hilina fault system shows displacements in the same direction but of different magnitudes, with both elongation and shortening of lines across the fault. Surveys of lines across the fault zone in 1970 prove that shortening does occur (Swanson and others, 1976), moreover, the net strain across the zone since 1914 shows overall shortening.

Leveling surveys across the south flank of Kilauea between 1958 and 1971 shows that the north side of the Hilina fault system has been uplifted relative to the south coast by 1.8 to 2.1 m.

The Hilina fault system has long been interpreted as a

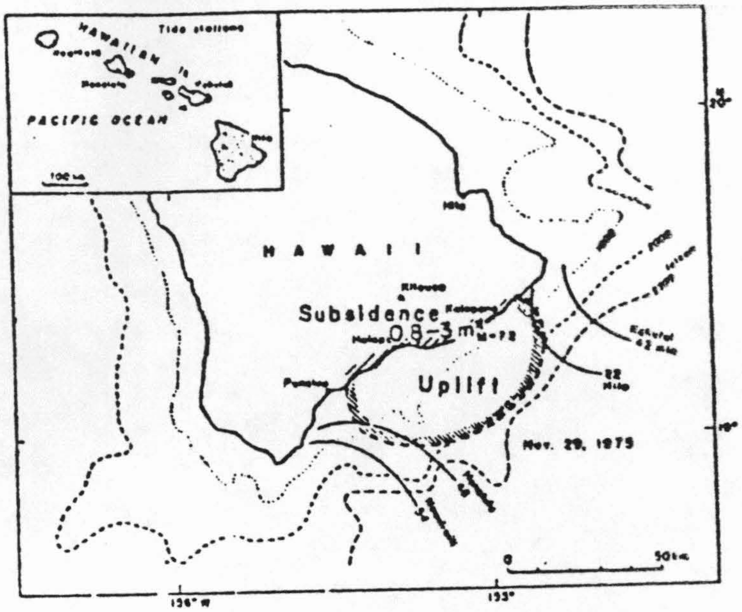


Figure 3.11. Inverse refraction diagram to obtain tsunami generation area showing area of landward subsidence and offshore uplift (from Furumoto and Kovach, 1979).

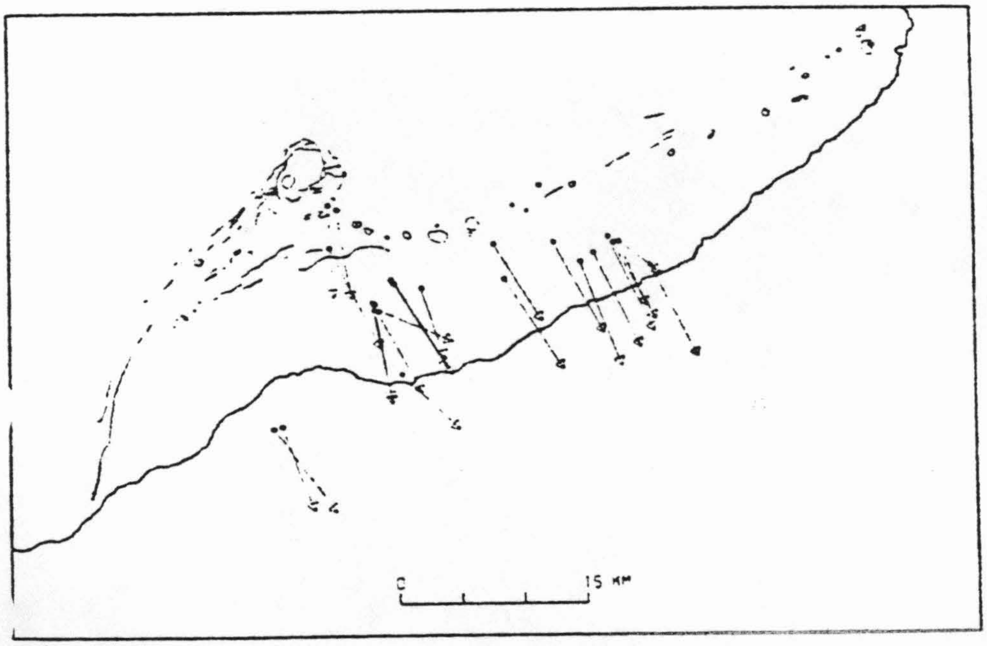


Figure 3.12. Map of south flank of Kilauea on the island of Hawaii showing slip directions. Arrow lengths linearly indicate dip of slip vector with 9 km being horizontal and 0 km vertical (from Crosson and Endo, 1981).

gravity fault zone, the analogy being made with large landslides (Stearns and Macdonald, 1946; Moore and Krivoy, 1964), but this interpretation conflicts with the data suggesting historical horizontal shortening across the system, uplift of its northern side, and southward tilt of the fault blocks. Macdonald (1956) later abandoned the 'landslide' hypothesis, and suggested that tumescence in the summit and rift zones causes near vertical faults with the inland side upthrown.

Study of the focal mechanism of the November, 1975, Kalapana earthquake at the east end of the Hilina fault system led Ando (1979) to propose a near-horizontal slip-plane at a depth of 10 km, with southward movement of the southern flank of Kilauea owing to magma injection of the ERZ. Study of the aftershocks by Crosson and Endo (1981) confirmed a sub-horizontal slip-plane and SSE directed slip vectors, and emphasized the role of a weak horizontal (low velocity) layer at a depth of 10 km on which the south flank of the Kilauea shield is supposed to slide southwards in response to magmatic injection in the rift zone. This model is preferable to the 'landslide' models (Swanson and others, 1976), in that it provides for the accumulation of compressive stresses and vertical uplift of the zone between the Hilina fault system and the ERZ during phases of magmatic injection, and subsequent stress release by southward sliding on a weak layer at or below the base of the volcanic pile.

The available data suggest that the faulting at depth does not break cleanly to the surface, but is distributed or compensated by broad subsidence on the land area, with gently dipping listric faults that extend along the hyaloclastic deposits at depth and dip SE at between 4° and 10°. Furumoto and Kovach (1979) suggest that the interface is on the ancient sea floor, with the toe of the block moving as a thrust at a depth of 5 to 7 km. These models are in general agreement with the geomorphic, seismologic, geodetic and tsunami data.

3.6.3. Koae Fault Zone

The Koae fault zone defines the northern edge of the mobile south flank of Kilauea (Swanson and others, 1976), as shown in Figure 3.3 and Plates 1 and 2. This fault zone spans the gap between the southwest and ERZ and trends EW a few kilometers south of Kilauea caldera. This fault zone consists of a pattern of en echelon cracks and normal faults with north-facing scarps that are usually less than 5 m high. During initial stages of eruptions or ground-cracking events on the East or Southward rift zones, the Koae fault zone has many more earthquakes from seismic swarms than does the Hilina fault zone (Swanson and others, 1976). Swanson and others (1976) indicate that the Koae fault zone is not generally the site for eruptions, but is more of a "tear away zone" as the result of dilation due to magma intrusion into the neighboring SRZ and ERZ.

3.6.4. Hanuapo-Kaoiki Fault Zone

The Hauapo-Kaoiki fault zone follows the SE boundary of Mauna Loa (fig. 3.3), and is of uncertain activity. No historic flows or eruptions have occurred along this zone and it is not characterized by well defined seismic activity, although some earthquake epicenters are on, or near, this zone. This zone is farther from the siting area than the Hilina fault zone and is of shorter exposed length and presumably of lower seismic potential. No maximum magnitudes are assigned to this fault zone.

3.6.5. Kealakekua-Kholo Fault Zone

This zone has an acurate pattern that is similar to the Hilina fault zone on the south flank of Kilauea, and may have a similar gravitational relation to the actively growing western flank of Mauna Loa. The length is poorly defined, because much of the fault zone is offshore. The Ms = 6.25 earthquake of 1950 is the maximum historic earthquake for this fault zone.

4.0 VOLCANIC-RISK ASSESSMENT OF THE PUNA DISTRICT

4.1 Volcanic and Structural Features of Lower East Rift Zone

4.1.1 Structure

For the purpose of this report, the Lower East Rift Zone (LERZ) is the sector ENE of Puu Kaliu (elevation 800 ft or 200 m above sea level) to sea level. Topographically, the zone runs along the crest of a broad ridge 3 km wide, from which gentle slopes descend to the NE and steeper slopes to the SE. Structural and volcanic features consist of faults and open fissures, some without lava and others with aligned spatter cones and ramparts of agglutinate. Faults and fissures are remarkably linear and parallel along a trend of N 55-60 E for distances of up to 10 km (fig. 3.9). Cinder cones and small lava shields (with and without craters), steep-sided tuff rings with deep craters resulting from phreatic eruptions, and broad expanses of lava are scattered along the central part of the rift zone.

The distribution of faults in the lower ERZ (fig. 3.9) suggests a concentration in the Kapoho area, and a scarcity in the PuuKaliu - Kiapu area. Numerous faults have been mapped in the middle part of the ERZ (west of the area shown in fig. 3.9), especially on its northern side (Holcomb, 1981). The scarcity of faults in the western side of the map is because they have been buried under the extensive lavas of the 1790 and 1840 eruptions.

<u>4.1.1.1 Fissures</u> The 3 km-wide zone of fissures and faults coincides with a zone of eruptive vents. No vents have been identified outside the zone on the flanks of the ridge. There is

abundant evidence of vent alignment along fissures, but there is no example of vents that were fed from faults, and this indicates that the mechanisms of fissuring and faulting are different. Since the surface rocks of the LERZ are mostly less than 500 years old, the structural features are well preserved and commonest in the oldest lavas that have escaped innundation during more recent eruptions. The oldest identifiable fissure in the LERZ fed a chain of small shields, spatter cones, and cinder cones along the 3 km long Puu Kii-Halemahina alignment, which is thought to be 300 to 500 years old by Holcomb (1981), but is thought to be more than 750 years old by R. J. Moore (personal communication, 1981). This fissure is centrally located in the LERZ and flows from it descended the LERZ to sea level east of Kapoho.

The next youngest activity was from the Puu Honaula fissure located immediately south of the Puu Kii zone. Three cinder cones, were built on low lava shields along this fissure. Another fissure close to the south edge of the LERZ was also active and both are dated at 500 to 750 years B.P. (R. J. Moore, pers. comm.).

Very extensive lavas of the eruptive phase of 1750 issued from fissures along much of the length of the ERZ. Just west of the LERZ long fissures from this eruption follow the northern and southern edges of the rift zone (fig. 3.9), and the flows flooded much of the crest and SE flank.

A 9 km fissure at the northern extremity of the ERZ opened during 1840 (fig. 3.9) and discharged lava about one mile down the NE flank. The volume of this flow totalled about 281,000 cubic yards and covered an area of 6.6 square miles. An additional discharge of lava is believed to have come from vents below sea level.

The fissures formed during the 1955 eruption are short and are off-set en echelon to the left toward to NE. In the middle part of the ERZ the main fissure is at the southern margin of the zone; to the ENE it steps toward the center of the rift. A gap of about 2 miles separates the two offset sections, and the HGP-A well is sited near the NNE end of this gap.

The 1960 eruptions took place from a short fissure near the NE end of LERZ, near the center of the Kapoho graben (right side of fig. 3.9). The 1977 flank eruptions occurred in the middle part of the ERZ, to the WSW of LERZ, on a single fissure near the center of the zone.

Historic fissures have formed immediately prior to eruptions, and developed by rapid growth of cracks to widths of up to 30 cm in a few hours, during swarms of microearthquakes. Fissures rarely exceed 1 meter in width and extend laterally at rates of up to 100 meters per hour. For each eruptive episode they have developed in different places within the width of the ERZ, and no case of regeneration of a pre-existing fissure is known. Each phase of fissuring and eruption typically occurs along a single linear fissure system. During one eruption, that of 1750, there may have been simultaneous eruption from parallel fissures, but this is very exceptional. The fissures represent the result of surface dilation and tensile fracture of rock due to dike injection at depth. The mechanism by which they are formed is summarized in a later section (Section 4.2.4.3).

4.1.1.2 Faults Zones of parallel normal faults of small displacement occur throughout the ERZ and are best developed within the northern part of the middle rift zone and in the Kapoho area of the LERZ (fig. 3.9). The displacement pattern gives rise to step-faults downthrown to the NW and SE. Along the southern edge of the LERZ there is a predominence of minor faults downthrown to the SE.

The ERZ faults show displacements of only a few meters, even where they cut the oldest rocks, and they are remarkably linear, with no tendency to curve or branch. In these respects they differ markedly from faults of the Koae and Hilina fault systems, which are long systems of curving and branching faults with large displacements (up to 500 meters) that evolved over long periods of time. The ERZ faults and the systems cutting the south flank of Kilauea are not only spatially separate but show contrasts of form and history reflecting their distinctly different origins.

Faulting in the LERZ normally occurs during or immediately before an eruption in the same part of the rift. Examples are the eruptions of 1955 and 1960. In 1924, however, strong faulting was observed in the LERZ without an observed eruption of lava (Jaggar and Finch, 1924). Many earthquakes were felt at Kapoho on April 21, 1924, and the next day a fissure 15 feet wide opened across the coast road. Vertical displacement reached 8 to 12 feet. Near Kukii a graben block 20 feet wide sank 6 feet, and numerous cracks up to 3 feet wide developed nearby. This episode is thought to have been due to flow of magma into the lower ERZ, because it was accompanied by rapid drainage of the Halemaumau pit crater. The occurrence of earthquakes in the submarine part of the ERZ during the same period suggests that an eruption below sea level may have drained magma from the ERZ.

4.1.2 Examples of Recent Flank Eruptions

4.1.2.1 1955 East Puna Eruption (Macdonald and Eaton, 1964): After a repose of 273 days, Kilauea began to erupt on the morning of February 28 from a new fissure on the southwest slope of Puu Honaula, 24.5 miles ENE of Kilauea caldera (fig. 4.1). The outbreak was preceded for several months by earthquakes, which gradually increased in number to several hundred a day just before the eruption. Discharge of lava continued at the initial vents for only 28 hours and on March 1 was replaced by mild phreatic explosions and clouds of steam.

On March 2, a new series of earthquakes accompanied the formation of fault scarps and opening of fissures 2 miles farther northeast, and at 1415 hours lava broke out on the fissures. Through the next 2 days the eruptive fissures gradually extended another 2 miles NE, to the outskirts of Kapoho village. Lava fountains at the main vents reached a height of at least 800 feet, and flows from them covered approximately 1,100 acres. Activity in that area stopped on March 6.

On March 6 a new series of earthquakes commenced, originating in the area 2 to 12 miles southwest of the initial outbreak, and a new outbreak in that area was predicted. On March 12 lava broke out in that region, and between then and March 27 a series of new vents developed along the rift zone for 4 miles to the southwest. Three lava flows from these vents entered the ocean.

Activity ceased on April 7 but resumed weakly on April 24

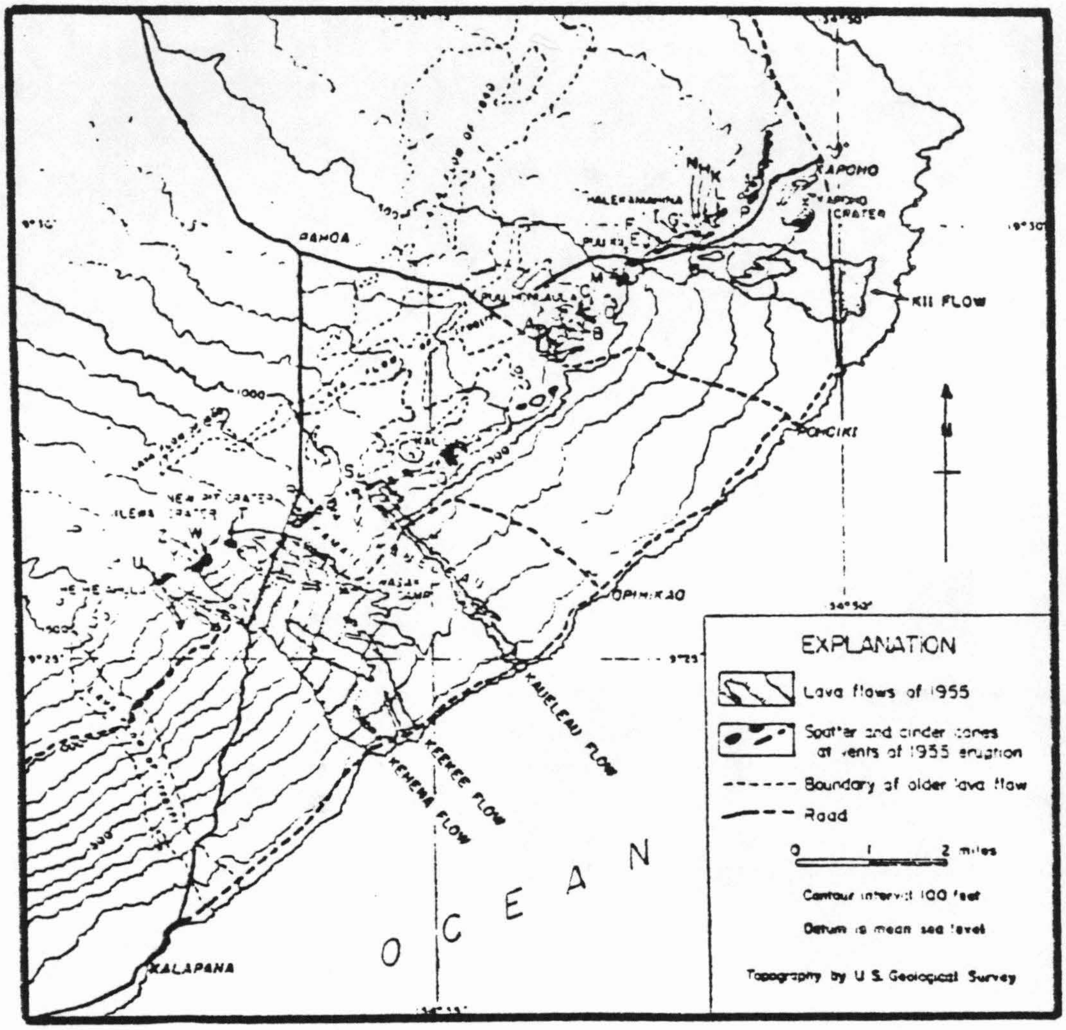


Figure 4.1. Map of the eastern part of the Puna District, Island of Hawaii, showing the vents and lava flows of the 1955 eruption of Kilauea Volcano (Macdonald, 1959).

and gradually increased until a strong resurgence occurred on May 16. New flows covered the upper parts of earlier flows, and some new area, including one village. The eruption ended abruptly on May 26.

The volume of erupted material was approximately 141 million cubic yards. The flows covered an area of about 3,900 acres, of which 1,100 acres was under cultivation. Approximately 6.3 miles (10 km) of public road and many miles of cane-field road were buried, and 21 houses were destroyed. There were no human casualties.

The erupted lavas were basalts, becoming slightly more mafic as the eruption progressed. The temperature of lava as it was erupted was approximately 1,100 degrees centigrade.

Tilt records at the Pahoa seismograph station (north of the ERZ), and remeasurement of a triangulation network, showed that northward tilt began two days before the start of the 1955 eruption, and occurred again before the second and major eruptive phase. This suggests that dilation of the ERZ took place before and during the ground fissuring and shallow microseismic activity that immediately preceded the eruption. Ground deformation consisted of a general uplift of the LERZ of at least 0.4 m, accompanied by a 0.3 - 0.4 m subsidence of the zone adjacent to active fissures. Horizontal displacements were normal to the LERZ and ranged from 0.2 to 1.6 m. During the easterly extension of the fissure a pre-existing fault NW of Kapoho was rejuvenated, with a new displacement of 1.6 m (SE side down).

<u>4.1.2.2 1960 Kapoho Eruption (Richter and others, 1970)</u>: On

the evening of November 14, 1959, after a quiet period of nearly five years, Kilauea Volcano renewed activity with an eruption in Kilauea Iki, a collapse crater adjacent to the main caldera. The eruption consisted of 17 separate eruptive phases, which ranged in duration from one week to less than two hours. At the cessation of activity on December 20, 1959, Kilauea Iki Crater held 50 million cubic yards of lava in a lake 335 feet deep.

After the summit eruption, shallow earthquake hypocenters migrated out along the ERZ and rose from 2 km to very shallow depths. On 13 January, an intense series of earthquakes near Kapoho was accompanied by subsidence of a graben bounded by two parallel faults trending N 60 E (fig. 4.2). The southern boundary fault running through the village of Kapoho had been active in 1924, when a maximum of 3.8 meters displacement was measured, and again in 1955 when minor displacement was observed at the west end of Kapoho. By the end of the day displacement reached a maximum of about 1.1 meters and the total length of the fault measured about 2.7 km. Similar movement on the northern fault (near the town of Koae; see fig. 4.2) reached a maximum displacement of 4 feet (1.3 meters) and a length of 3.04 km. At 1935 hours an eruption broke out along a 320 meter fissure somewhat north of the center of the graben and parallel to the boundary faults. No lava emerged from the faults. Fountaining up to heights of 100 meters was soon accompanied by a discharge of lava, mainly from the east end of the fissure. The fissure reached a maximum length of 370 meters around 2130 hours at which time activity began to concentrate in the central part of the fissure, and the rate of discharge of lava continued to increase.

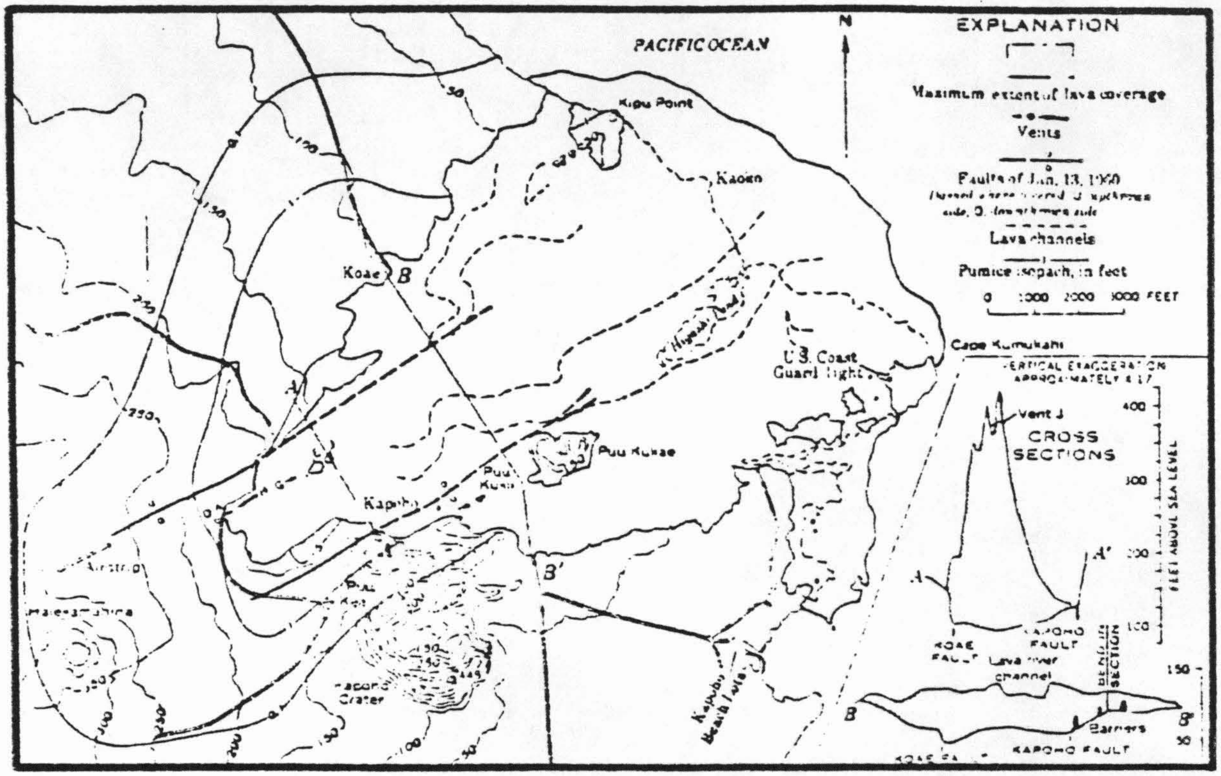


Figure 4.2 Map showing the eruptive fissure of the 1960 eruption (Richter and others, 1970) in the Kapoho area of the Lower East Rift Zone, and the active faults of the Kapoho graben. The maximum extent of the lava field, and isopachs of the pumice blanket are also shown. The 1960 lavas were unusually thick - see cross-section B-B' (inset).

4.1.2.3 The 1977 eruption (Moore and others, 1980; Dzurisin and others, 1980): Kilauea volcano began to erupt on September 13, 1977, after a 21.5-month period of quiescence. The eruption was preceded by four intrusive events during 1976 and early 1977. Motion of magma was reflected in deflation of the summit area, migration of shallow earthquakes into the upper and middle ERZ, extensional deformation across the Koae fault, and inflation of the ERZ. Harmonic tremor in the upper and central ERZ and rapid deflation of the summit area occurred for 22 hours before the outbreak of surface activity.

On the first night, spatter ramparts formed along a discontinuous, en echelon, 5.5 km-long fissure system (fig. 4.3) that trends N 70 degrees E between two prehistoric cones, Kalalua and Puu Kauka. Activity soon became concentrated at a central vent that erupted sporadically until September 23 and extruded flows that moved a maximum distance of 2.5 km to the east. On September 18, new spatter ramparts began forming west of Kalalua, extending to 7 km the length of the new vent system. A vent near the center of this latest fissure became the focus of sustained fountaining and continued to extrude spatter and short flows intermittently until September 20.

The most voluminous phase of the eruption began late on September 25. A discontinuous spatter rampart formed on a 700 m long segment near the center of the new, 7 km-long fissure system; within 24 hours activity became concentrated at the east end of this segment. One flow from the 35 m-high cone that formed at this site moved rapidly southeast and eventually reached an area 10 km from the vent and 700 m from the nearest house in the

Sea water appears to have entered the east end of the fissure about this time, because dark ash-laden steam began to be discharged from the east end of the fissure.

During the next 37 days of virtually uninterrupted activity, 160 million cubic yards of lava, covering about 2,500 acres, were erupted (fig. 4.2). The lava was at first confined to the graben and flowed down the northern side until it reached the sea around 800 hours on the 15th. After the 19th the lava began to over-top the margins of the graben and spread to both the north and south. An effort was made to restrict the southward flow by a series of three successive artificial barriers, but all of these were eventually overrun. Nearly all the lava was of the aa type; the main exceptions were channels within the central interior of the flow and small toes that from time to time broke out from the advancing front or through the base of barriers.

A cinder cone at the main eruptive vent grew to a height of about 64 meters and discharged fountains of incandescent scoria to heights of 300 meters above the vent. The small villages of Kapoho and Koae, a United States Coast Guard station, and a number of residences along the coast were destroyed.

Almost concurrent with the beginning of the flank eruption, the summit area of Kilauea rapidly deflated as magma moved from beneath the summit into the rift zone to the flank eruption. Culmination of the summit subsidence occurred on February 7, 1960, when the floor of Halemaumau - a deep crater in Kilauea caldera - collapsed because of the withdrawal of the still-fluid core of the 1942 lava lake. Two smaller collapses on March 9 and March 11 in Halemaumau marked the end of the eruption.

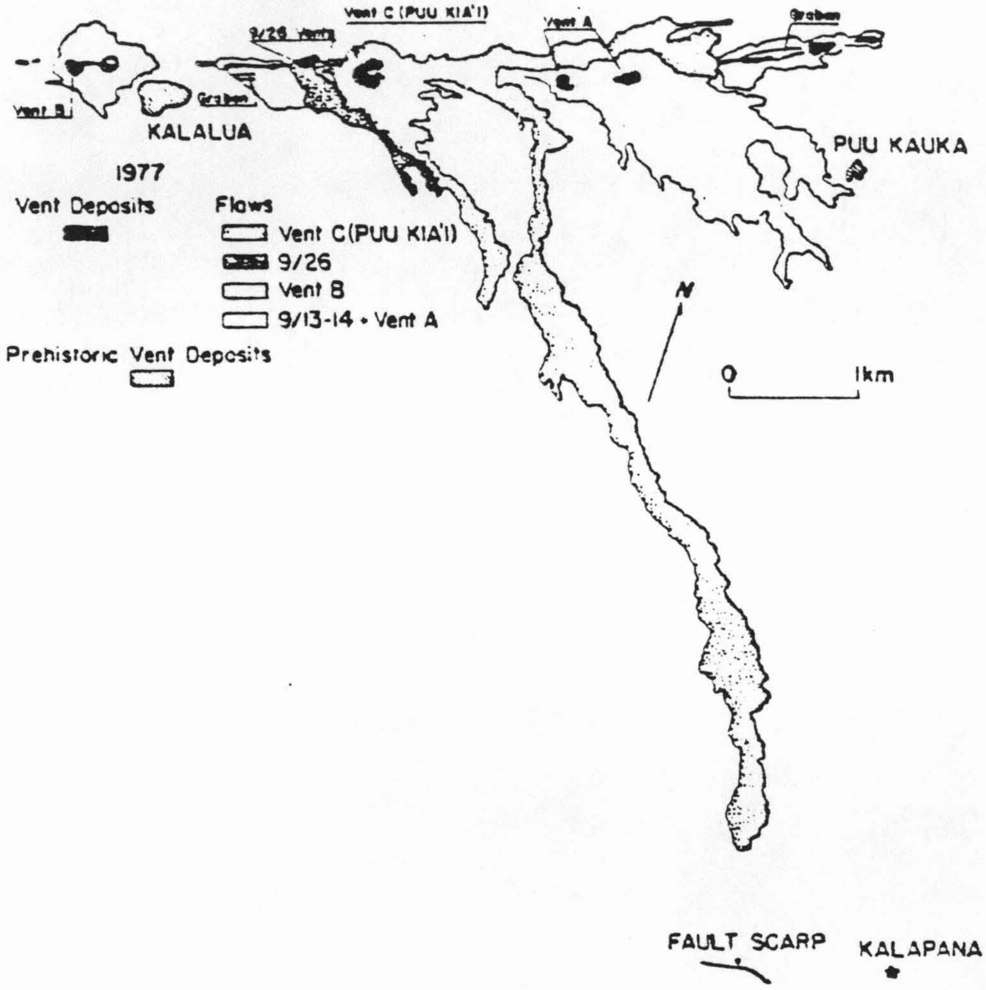


Figure 4.3. Map showing eruptive products and active structures of the 1977 eruption in the middle East Rift Zone (Moore and others, 1980).

evacuated village of Kalapana.

An estimated total volume of 35 million cubic meters was produced during the 18-day eruption. Samples from active vents and flows are differentiated quartz-normative tholeiitic basalt, similar in composition to lavas erupted from Kilauea in 1955 and 1962. Plagioclase is the only significant phenocryst; augite, minor olivine, and rare orthopyroxene and opaque oxides accompany it as microphenocrysts. Sulfide globules occur in fresh glass and as inclusions in phenocrysts in early 1977 lavas; their absence in chemically-similar basalt from the later phases of the eruption suggests that more extensive intratelluric degassing occurred as the eruption proceeded. Bulk composition of lava varies somewhat during the eruption, but the last basalt produced also is differentiated, suggesting that magma withdrawn from the summit reservoir during the rapid deflation had not yet been erupted.

4.1.3 Frequency of Eruptions in the East Puna District

Considering only the lower ERZ, the average frequency of lava flows for the 231 years of recorded activity has been one eruption per 46 years. Because the spacing of eruptions is so irregular and the historic record contains only a small number of such events, this average has little meaning in terms of the probability of an eruption in a given period of time. Moreover, the frequency of lava flows at an individual site within this zone is much lower than that of the zone as a whole.

4.1.4 Deformation Associated with ERZ Eruptive Phases

A wealth of data suggests that the Kilauea magmatic system consists of a vertical holding reservoir 2 to 5 km beneath the summit caldera. This reservoir is periodically fed by primary magma from depths of about 65 km, which usually causes inflation of the summit region and numerous shallow earthquakes owing to failure of the volcano superstructure. Inflation may be followed by summit eruptions, or by deflation accompanied by migration of seismic activity as a result of lateral movement of magma into a rift zone at depths of 3-5 km. Upward movement of magma under the rift zone (probably displacement of magma remaining from previous injections) causes tensile failure and dike injection accompanied by shallow earthquakes, dilation and uplift of the rift zone. As dikes ascend, fissures extend to the surface and widen rapidly, begin to emit fumes, and often emit lava fountains along their central parts. The fissures extend laterally at rates of up to 100 meters per hour.

The sequence of events during a typical ERZ eruption starts with shallow earthquake swarms of decreasing focal depth, followed by dilation of the active zone, formation of fissures, faulting and/or rejuvenation of nearby pre-existing faults, followed by eruption. The premonitory seismic and dilational phases may last as little as two days, and fissuring followed by eruption may occur in a few hours. This sequence may be repeated as a fissure extends laterally, or as successive phases of magmatic injection take place during a protracted eruption.

Seismicity of the rift zones is concentrated in a zone 8 km wide under the rift zones and immediately to the south. Hypocenters are concentrated at depths of 5 to 10 km (fig. 4.4), with a very sharp decrease in the number of earthquakes at focal

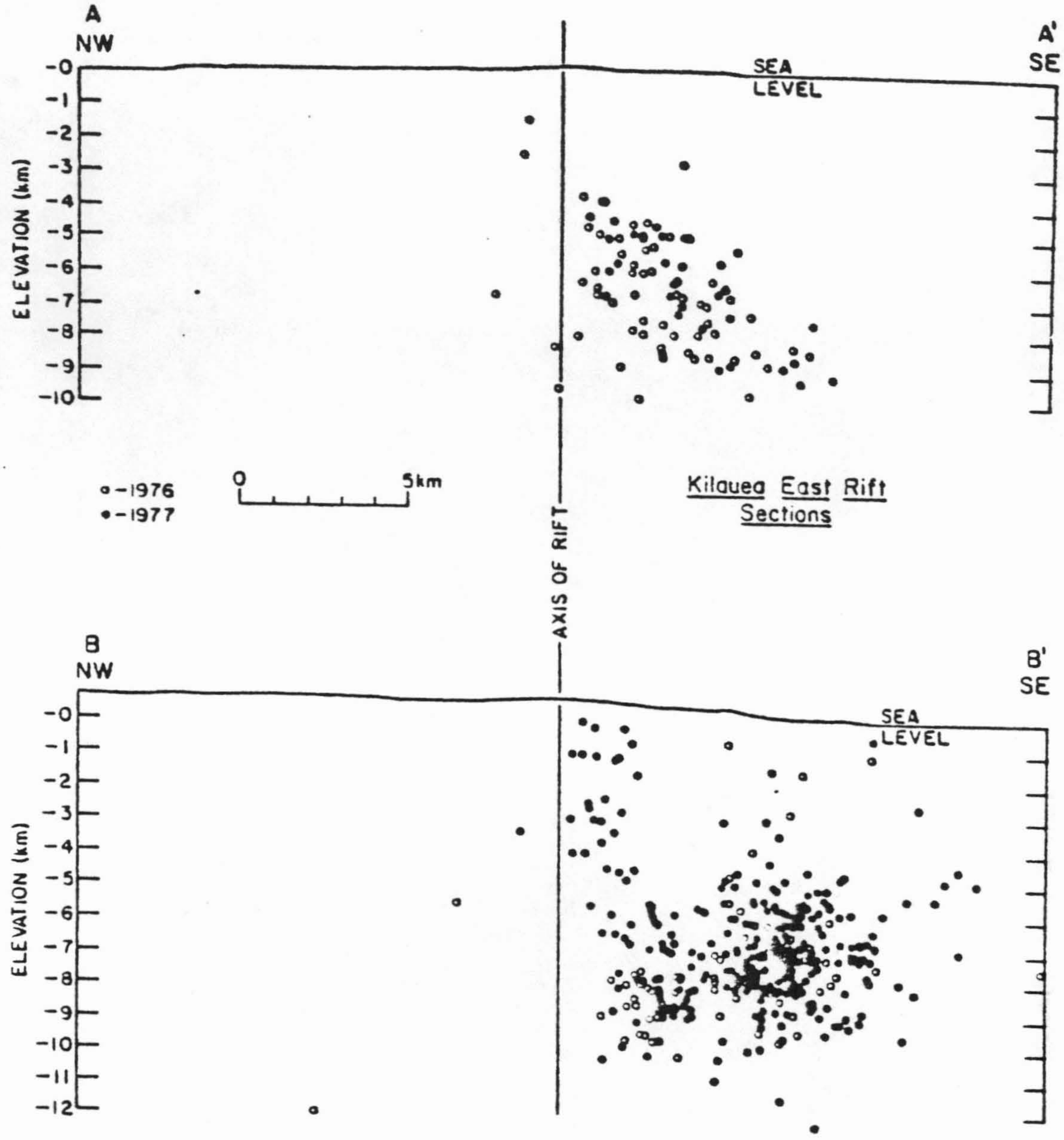


Figure 4.4. Earthquake hypocenters plotted within 10-km wide sections centered on lines A-A' and B-B' oriented normal to the rift zone as shown in Figure 3.10. Earthquakes of all magnitudes and with standard errors in epicenter and depth less than 2.5 km are included. Hypocenters for earthquakes in 1976 are marked with open circles and those in 1977 are indicated by black dots. The column of progressively shallow earthquakes immediately south of the axis of the rift in the middle East Rift Zone in section B-B' mainly occurred about the time of the September 1977 mid-east rift eruption (Koyanagi and others, 1981).

depths greater than 10 km (fig. 3.10). Earthquake epicenters cluster along the ERZ during the early period of an eruption, but are dispersed in the area of the Hilina fault system during the middle and later periods (Swanson and others, 1976). The north flank of the ERZ is strikingly aseismic, and the seismicity is strongly asymmetrical in a north-south direction, showing the tectonic instability is concentrated in the ERZ, within its south flank, and at depths of less than 10 km within the lower part of the volcanic superstructure and above the depressed top of the prevolcanic oceanic crust. Seismic sections across the ERZ (fig. 4.4) show that hypocenters define a diffuse zone dipping at about 45 deg. to the SSE (Koyanagi and others, 1981).

4.1.4.1 Horizontal Displacements in the ERZ: Horizontal displacements across the ERZ and the south flank of Kilauea have been obtained from triangulation surveys in 1896, 1914, 1949, 1958, and 1961, and from geodimeter trilateration surveys in 1970 and 1971 (Swanson and others, 1976). The observed displacements are large and systematic: displacement vectors are normal to the trend of the ERZ, and displacements are associated in time and space with fissuring and eruptive events (figs. 4.5A and B). During the 1955 eruption the Puu Kaliu and Puu Honaula stations north of the fissure were displaced north relative to stations far to the north (fig. 4.6). Stations to the south of eruptive fissures and on the south coast show larger SSE displacements (fig. 4.5; B, D, E and F). In a few cases horizontal displacements can be related to specific events in the ERZ: During the 1955 eruption there was 210 cm of extension near Puu Honaula, and in 1969 a 2 km wide zone west of Alae Crater in the upper ERZ

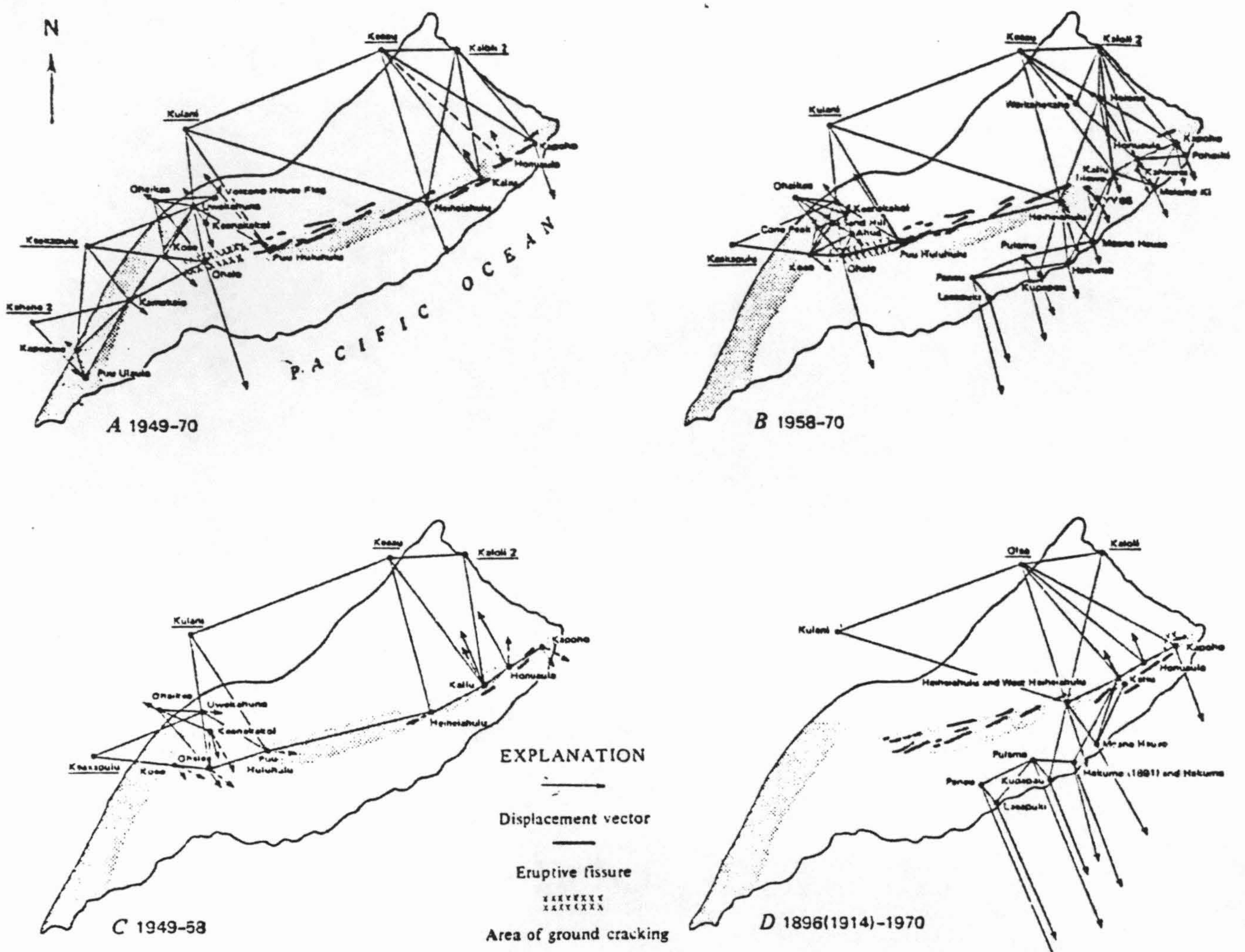


Figure 4.5. Horizontal displacements of trilateration stations for various periods during the years 1896 - 1970. Base stations for the determination of displacement vectors (arrows) are underlined (Swanson and others, 1976).

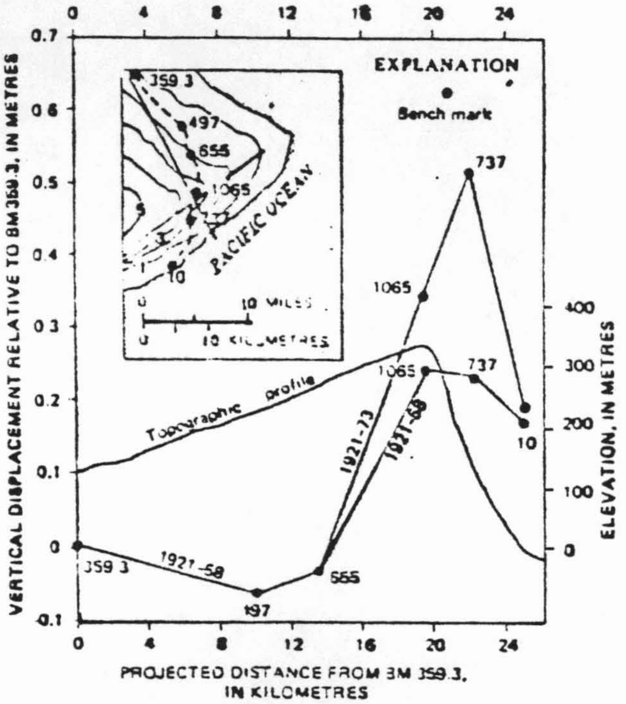


Figure 4.6. Vertical displacement and topographic profiles across Lower East Rift Zone and eastern part of south flank between 1921, 1958, and 1973. Datum is 1958 elevation of BM 359.3. Inset shows location of bench marks, leveling route (dashed line), line of topographic profile (light solid line), and generalized eruptive fissures for 1955 eruption (heavier solid lines). Displacement data are projected onto line of topographic profile. Contour interval on inset map is 100 m (Swanson and others, 1976).

extended 105 cm. These extensions are of the same magnitude as the aggregate width of observed fissures, showing that the fissures, and to a much lesser degree the faults, are responsible for most of the strain. The evidence suggests that the dilations of the ERZ immediately preceding eruptive events, are accompanied by surface fissuring, which result in relative horizontal displacements of the order of 1-2 meters.

4.1.4.2 Vertical Displacements in the ERZ: Surveys of benchmarks along the Pahoa-Kalapana highway were made in 1921, 1958, 1969, and 1973. These indicate 0.2 m of uplift of the ERZ during 1921-1958 (fig. 4.6), and a progressive uplift of 0.3 m during 1958-1973 (fig. 4.7A). These uplifts are broadly sinusoidal in shape and are centered 0.5 to 1.5 km south of the axis of the ERZ. The 1958-1973 displacement profiles show development of a narrow graben at an elevation of 270 m (840 feet) on the south flank of the middle ERZ, but this cannot be identified with any mapped structure.

Another levelling line extends along the Pahoa-Pohoiki highway, which passes the HGP-A well site (fig. 4.7B). This shows progressive development of a 0.12 m subsidence with its axis close to the line of 1955 fissures, which has been interpreted as due to thermal contraction following the 1955 eruption (Swanson and others, 1976). We prefer to interpret this subsidence as due to residual elastic extensional strain, or to withdrawal of magma from the deeper parts of the 1955 dike system.

Data on vertical displacement therefore suggest that the south flank of Kilauea has been increasingly uplifted toward the ERZ and Koae fault system, with a maximum displacement within or

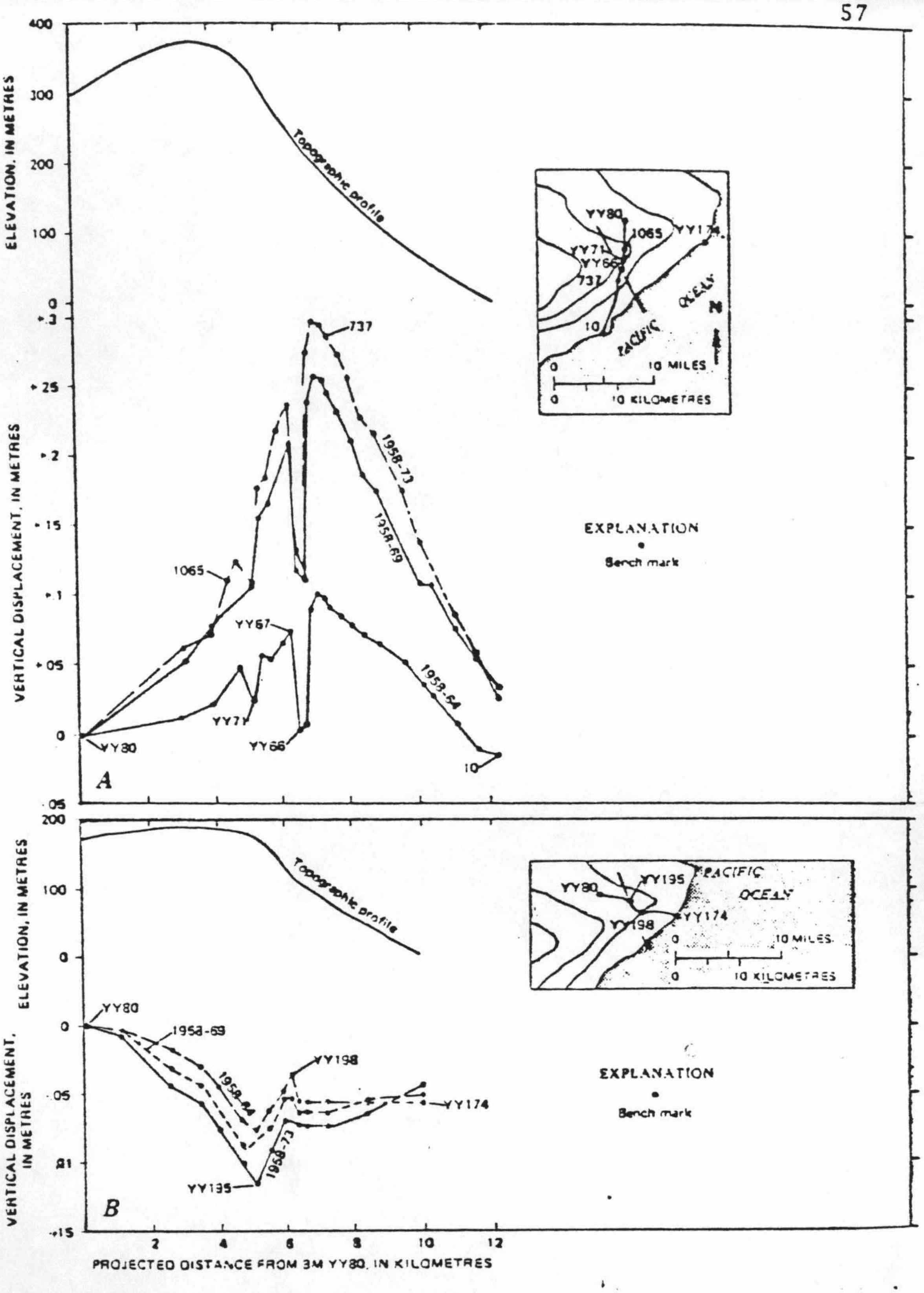


Figure 4.7. Vertical displacement and topographic profiles across Lower East Rift Zone of Kilauea between 1958 and 1973. (A) Profiles between BM YY80 (Pahoa) and BM10 (Kalapana); (B) Profiles between BM YY80 and BM YY174 (Pa hoiki). Datum is 1958 elevation of BM YY80. Inset maps show locations of leveling route, key bench marks, and line of topographic profile. Displacement data are projected onto line of topographic profile. Contour interval of inset maps is 150 m (Swanson and others, 1976).

just south of the rift zone. Records of tilt near the ERZ show that phases of uplift correlate with periods of shallow seismicity that precede or accompany intrusive and/or eruptive events.

4.1.4.3 Mechanical Models of ERZ Deformation: The curvature of the Kilauea rift zones, their parallelism to the strike of the southeast flank of Mauna Loa, and the asymmetry of structure across the volcano have been attributed to the gravitational loading of the Kilauea volcanic pile on the flank of Mauna Loa. The north flank of the volcano is buttressed, whereas the south flank is free to move SSE in response to dilations caused by magma injections in the rift zones (fig. 4.8) The injections into the rift zone occur during the filling of the high level magma reservoir beneath the summit, and are a result of the ascent of magma to the surface and the tumescence of the summit region. This creates a hydraulic head in the magma column adequate to cause lateral injection of magma into the still molten roots of the rift zone. Increased magmatic pressure then results in lateral and upward injection of dikes.

The deformation that accompanies upward injection of a dike has been analyzed theoretically (Koide and Bhattacharji, 1975a and b; Dieterich and Decker, 1975; Pollard and Holzhausen, 1979), and excellent observations of such deformation have been made in Iceland (Bjornsson and others, 1979). When the fluid pressure at the top of a dike exceeds the least horizontal stress in the adjacent rock, tensile failure can occur at the apex of the dike, and a fissure can propagate upward in a plane normal to the least principal stress in the rock. Under a ridge such as the ERZ the plane of tensile failure would be steep and located below the

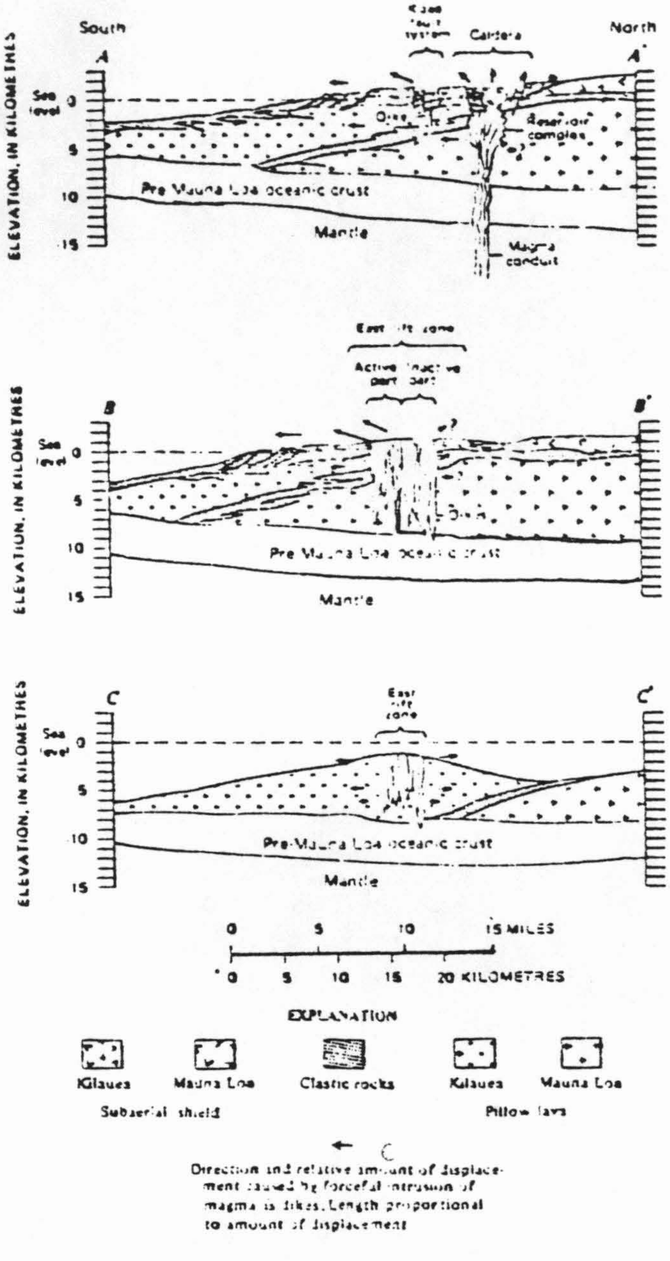


Figure 4.8. Crustal structure models across the summit region (A-A'), East Rift Zone (B-B'), and the submarine part of the Lower East Rift Zone (C-C'), showing the relation between injection into the rift zone and faulting in the Hilina fault system according to the "landslide" model (Swanson and others, 1976).

axis of the ridge (Fiske and Jackson, 1972). The rate of upward propagation of the crack depends on the magmatic pressure and on the speed with which magma can rise. At any instant during ascent the region between the apex of the dike and the free surface consists of two parts: A far field in which horizontal compressive stress is increased, and slight upward deformation of the surface occurs, and a near field of conical cross-section above the dike in which horizontal stresses are decreased and the surface subsides. Between these two regions there are two surfaces of maximum shearing stress that are potential fault surfaces. Thus the surface deformation above an ascending dike, when it has reached 100 - 200 m below the surface, consists of a broad, slight uplift, with a narrow central depression cut by a fissure. On each side of the fissure normal faults of small-displacement may develop to form a graben, or pre-existing faults may be re-activated.

The width of the zone that is affected by faulting during a dike injection episode is determined by several unpredictable factors, such as the number of dikes and their widths (the total horizontal strain), the depth of the top of the dikes, their attitude, the presence of pre-existing planes of weakness, and the cohesive shear strength of the rocks (Koide and Bhattacharji, 1975a and b; Dietrich and Decker, 1975). The graben that formed during the 1977 eruption was only 100 m wide, whereas the Kapoho graben that subsided during the 1960 eruption was 900 m wide. Leveling along the Pahoa-Kalapana road between 1958 and 1964 indicated subsidence of a sharply defined zone 600 m wide, presumably during the 1960 eruption further to the northeast.

This was probably the effect of a dike that failed to reach the surface, and the subsidence was located to the south of the projection of the 1960 fissure, which led Dietrich and Decker (1975) to propose that the dike dipped to the south.

At present the ground deformation data for a LERZ eruptive event are not adequate for predicting the distribution of faulting, but the zone of faulting is not likely to be more than 1 km wide, and commonly will be much narrower than this. During intrusion events faulting may occur without fissuring, and the fault zone is likely to be on the south side of the ERZ. During fissuring and eruption events faulting may occur a few hundred meters on either side of the fissure. In either case vertical displacements of 1 to 2 meters are to be expected, with a maximum of 4 meters, and fault movement will occur during a period of a few hours to a few days immediately before an eruption.

When magma finally reaches the surface the axial zone of subsidence with its marginal faults becomes stabilized and uplifted. When dikes are not vertical the surface deformation is asymmetrical, with greater uplift over the hanging wall of the dike (Dieterich and Decker, 1975). The asymmetry of the vertical displacement profiles across the ERZ led Dietrich and Decker (1975) to suggest that the dikes dip SSE at 45 degrees, and this dip is similar to that of the zone of earthquake hypocenters under the ERZ (see fig. 4.4). Swanson and others, (1976) prefer a vertical dip for the dikes, but the attitude of the dikes remains unknown.

The factors that determine whether a summit inflation will be followed by magma flow into the rift zones, and whether such a

flow would result in a flank intrusion or eruption, are impossible to evaluate with our present knowledge. Similarly it is not possible to predict where in the rift zone an eruption is likely to occur.

4.2 The Puu Honaula Area

4.2.1 Outline of the Geology and Structure

The following summary, and the accompanying geological map (fig. 4.9) are based on detailed maps by Holcomb (1981), and on the unpublished map of the Kapoho quadrangle by R.J. Moore. We have made slight modifications as a result of our own photogeological interpretation and a brief visit to the area.

The area lies across the upper part of the Lower East Rift Zone (LERZ), which is a broad shallow ridge between sea level and 800 feet elevation. In the western part of the area the top of the ridge is a shallow trough-like depression bordered by higher ground formed by the Puu Kaliu vent-fissure zone to the south, and by fissure zones of the 1790 and 1840 eruptions to the north. Further east the rift zone has a central low ridge composed of small shields and cones of the Puu Kii and Puu Honaula fissure zones. The southeast slope of the rift zone south of Puulena is unusually steep, and a lava mantled fault scarp is inferred to underlie this slope.

The oldest rocks are the cinder and spatter cones of Kiapu, which underlie a lithic tuff dated at 1,000 years before present (R.J. Moore, pers. comm., 1981). Small cones southwest of Puulena and at Puu Pilau may be of similar age.

The Puulena crater walls expose thin lava flows that are

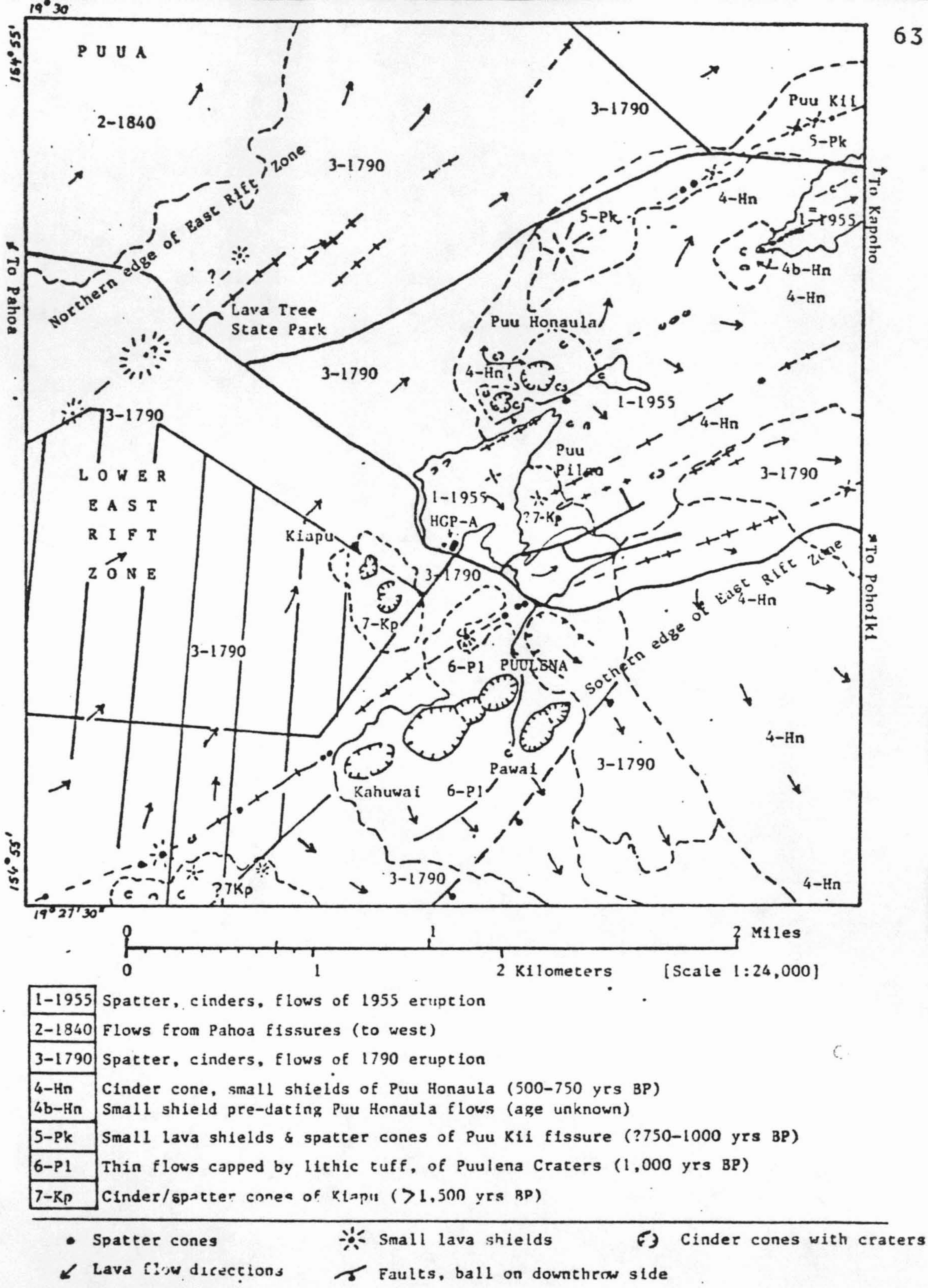


Figure 4.9. Geological map of the Puu Honaula area, East Puna Hawaii (modification of map of Holcomb, 1981, by B. Baker using field studies, photogeology, and pers. comm. with R. Moore).

capped by a lithic tuff dated at 1,000 years before present (YBP) and represent a small shield built on fissures along which deep pit craters developed, probably during a phase of magma withdrawal.

In the northeast, an alignment of small low shields, spatter cones, and cinder cones marks the line of the Puu Kii eruptive fissure. Holcomb (1981) estimated the age of these rocks at 350-500 YBP, whereas R.J. Moore (pers. comm., 1981) reports they are older than the Puu Honaula vents to the south, which he dates at 500-750 YBP.

The most extensive lavas are those of the 1790 eruption, which flooded a large portion of the crest of the ERZ. In the northwest of the area these flows were derived from a fissure system higher up the rift zone, but in the south they were erupted from a fissure zone extending from the southwest corner of the area past the northern flank of Puulena. These flows ponded around Kiapu and almost covered the Puulena shield.

The northwest portion of the area consists of flows from the 1840 fissure, which lies at the northern edge of the middle ERZ, to the west of the area. These flows descended the northeast flank of the rift zone.

The most recent lavas were erupted in 1955 from a discontinuous en echelon fissure south and east of Puu Honaula. They are of limited extent and thickness in the mapped area (fig. 4.9).

The steep southern flank of the Puulena craters is believed to represent a buried normal fault downthrown to the southeast (Holcomb, 1981). A localized normal fault cuts the south side of the Puu Honaula cinder cones. The western end of the southern fault of the Kapoho graben ends at the eastern boundary of the area, at the junction of the Puu Kii and 1955 flows. The last two faults are downthrown to the southeast less than 2 meters.

4.2.2 Frequency of Eruptions

It is difficult to estimate the average frequency of flows accumulating in a vertical sequence at a given site in the Puu Honaula area because there is no dated horizon in the prehistoric lavas. A crude estimate can be obtained from the measured depth of the interface between submarine and subaerial lavas in the HGP-A well. This horizon was logged at a depth of 1750 feet (533 m) or 1175 feet (358 m) below present sea level. The rate of subsidence measured by tide gauges is about 4.1 mm per year. If this rate is assumed for the area of the HGP-A bore hole, the age of the first subaerial lava would be approximately 87,313 YBP. Assuming an average thickness of 18.3 feet for individual lava flows above this level, an average frequency of one flow per 898 years is obtained for the site of HGP-A well. This estimate may be too low, as some data suggest the rate of subsidence in the LERZ is greater than that of the coast line at Hilo, but this factor cannot be determined from the presently available data. Conversly, if some of the section of HGP-A well is made up of sills injected between lava flows, the frequency of surface flows would be correspondingly less.

Within the Puu Honaula area (fig. 3.9), an area of about 20 square kilometers, there have been at least 6 periods of eruptive activity in the last 1,000 years, with an average recurrence interval of 166 years. Three events have occurred in the last 191 years for a recurrence interval of 64 years. In the entire LERZ, 4 major eruptions have occurred in 191 years, with an average recurrence of 48 years. This is a low level of activity compared to the ERZ as a whole, for which Klein (in press) lists 20 extrusive and 19 intrusive events since 1918, with an average recurrence interval of 3 years for each type of event. We estimate that a conservative recurrence interval of 40 years applies to the Puu Honaula area.

4.3 Volcanic Hazards

4.3.1 Introduction

A survey of the volcanic hazards of the island of Hawaii by the U.S. Geological Survey (Mullineau and Peterson, 1974) concludes that lava flows and volcanic related ground rupture to be the main hazards to property in the East Rift Zone (ERZ). We consider the probabilities for occurrence of these hazards to be the highest for any region on the island (and possibly in the world). Other hazards such as falling rock fragments, volcanic fumes, earthquakes, and tsunamis are much less serious.

4.3.2 Surface Deformation

Surface deformation in the LERZ consists of periodic uplift and horizontal extension, accompanied by fissuring and possibly normal faulting. All the evidence suggests that such deformation takes place before eruptions, or before renewed eruptions during lengthy periods of activity. Relatively slight deformation also occurs during periods of intrusive activity.

The broad arching, uplift, and tilting that accompanies extrusive events is not of sufficient magnitude or rate to constitute a hazard to property. The significant deformation hazards are fissuring and faulting.

Within the area mapped (fig. 4.9) there are 16 individual fissure systems, and others may lie buried under lava flows. These have formed during a minimum of 6 eruptive episodes during the last 1,000 years in a zone 3 km wide extending from Pawaii Crater to the Lava Tree State Park.

The majority of fissuring events have formed lines of en echelon fissures, and development of paralled fissures is rare. Therefore we adopt a conservative model of formation of a single fissure 1 m wide every 40 years. The area affected by such a fissure would be 5,000 square meters, which is about 0.002 per cent of the area of the LERZ in Figure 4.9. There appears to be no control for the location of new fissures, which randomly form anywhere in the active zone. The risk to property is therefore a function of the frequency of fissuring (1 in 40 years), the average width of a fissure (1m), the width of the zone liable to fissuring (3,000 m), and the dimensions of the engineered structure at risk in a directional normal to the rift zone. The probability of a fissure intersecting a structure during a period of 40 years (the effective life of a plant) is shown in Table 4.2.

The risk of damage is proportional to the dimensions, shape, and orientation of the structure under consideration. For extensive structures, such as steam pipelines, that must cross some part of the rift zone the risk of damage is considerable, unless the structure is specially designed to accomodate large displacements. For smaller structures, such as generating plants, the risk is less, but the cost of damage may be greater.

TABLE 4.2

Dimensions of engineered structures versus probability of damage for a 40 year period in the LERZ.

Horizontal dimension of structure in direction normal to rift zone (ft)	Probability (per cent) of damage in a 40 year period
3,000	100
500	17
100	3
50	2

4.3.3 Hazards from Eruptions of Lava

The risk of an installation being destroyed by lava is the highest of all potential risks in the Puu Honaula area, because for a single eruptive event, the surface area affected is greater than the surface area affected by a fissuring and/or faulting event. Two types of risks from lava flows can be distinguished; (1) those associated with lava from an eruptive vent directly under or adjacent to the site and, (2) those due to lava flows coming from a more distant source.

Eruptive vents that have been active in the recent past are of three types. In the opening stages of an eruption, they are linear fissures that discharge fountains of incandescent spatter and scoria. With time these become more localized and discharge flows of lava. Cinder cones may form where there is prolonged ejection of pyroclastic material. Finally, in those areas where ground water is abundant or where sea water has access to the fissure system, steam blast eruptions may eject lithic debris, including blocks a foot or more in diameter. The effective radius of the effects of explosive discharge from these three types is essentially the same. They are unlikely to have a serious effect beyond a distance of a kilometer.

The fact that no eruptive vents have been found outside the boundaries of the LERZ makes it unlikely that one will occur there in the future, but this possibility cannot be completely discounted. Within the rift zone, most eruptions have been on the south side. It has been suggested the rift zone is moving southeastward (Swanson and others, 1976), but the evidence for this interpretation is not conclusive. There is convincing evidence, however, that new vents rarely coincide with old ones, and by this reasoning, one of the safest siting areas in the rift zone may be on an old cinder cone.

From these relations we conclude that the danger from a new eruptive vent is lowest outside the northern or southern boundaries of the rift zone. Within the rift zone, there is a marginally lower risk at a site situated on an older vent, especially within the northern half of the rift zone. These risks must be weighed against the practical disadvantages of increasing the distances steam must be transmitted.

The risk of a site being overrun by lava from a vent outside its immediate vicinity is largely a function of topography. Low areas into which lava is likely to be channeled have the highest risk, and elevated ground or areas in the lee of hills standing between the site and possible sources would have a much lower risk. Ground with a high slope angle will be covered by thinner flows than flat ground or depressions into which lava could be ponded, but flow velocities on these slopes here would be higher.

Figure 4.10 assesses the level of risk in the study area from lava flows as highest, intermediate, and lowest, using the principles of risk assessment outlined in this section. These are intended as general guidelines, and should be examined on a site-specific basis following the final selection of a site for installation of permanent structures.

Average thickness and rate of advance of lava flows may also be crudely calculated. Neglecting the eruption below sea level in 1884 and another event of a similar nature in 1924, five eruptions have occurred at elevations below 1,000 feet. Lava flows

MAP OF VOLCANIC RISK LEVELS - PUU HONAULA AREA, E. PUNA, HAWAII

(Scale 1:24,000)

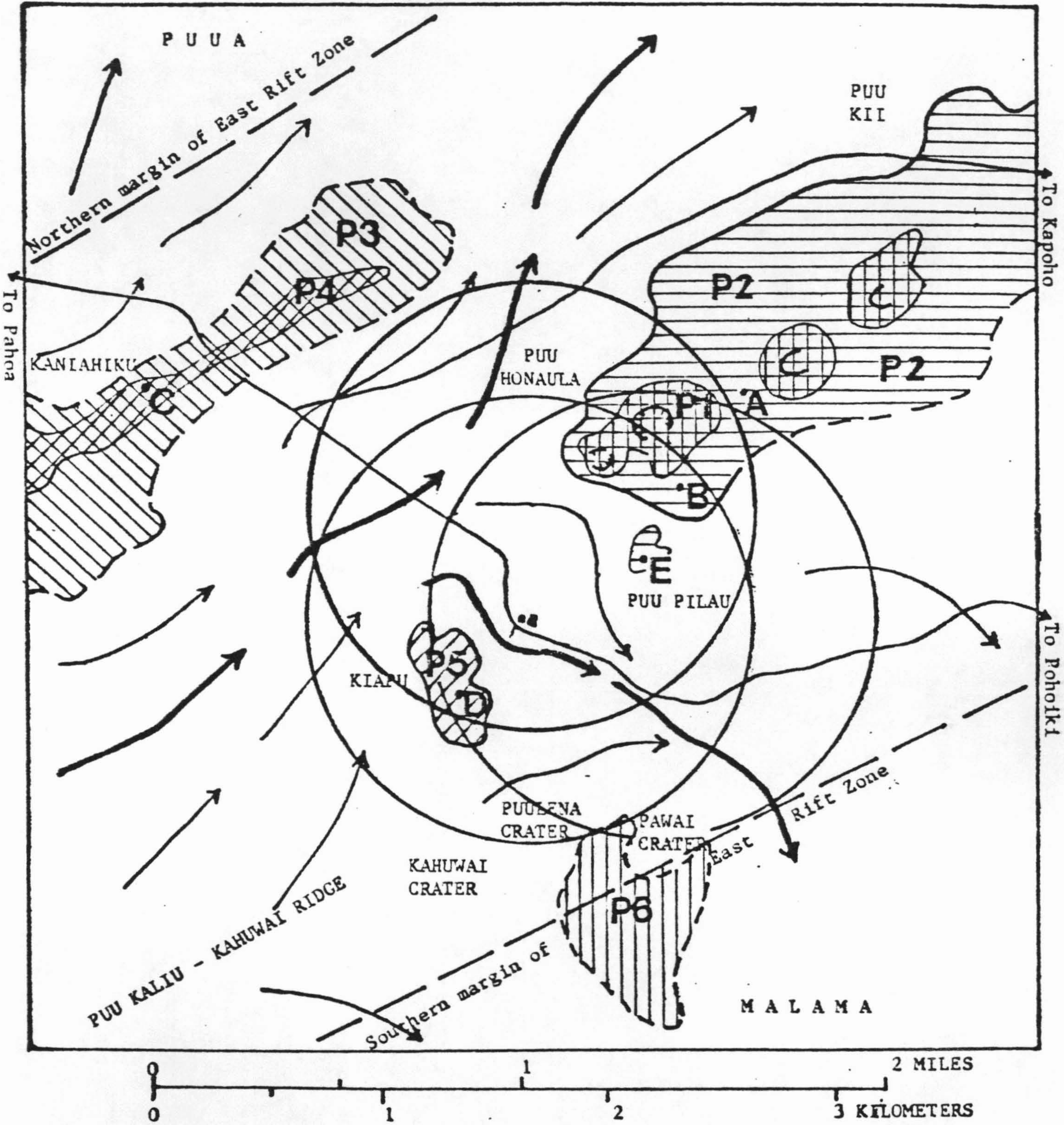


Figure 4.10. Map showing relative risk of lava flow incursions. Arrows show likely directions of flow of lavas in future eruptions. The most likely paths of flow are shown with thick arrows. P1 marks areas with least risk of lava incursion and P6 marks areas of intermediate risk. Unshaded areas are those of greatest risk.

from eruptions, such as that of 1977, which occurred at higher elevations would not affect a site in the Pahoa district.

An average thickness of 18.3 feet (5.6 m) can be calculated from the total volumes and areas of the five historic flows. This average is strongly affected by the exceptional thickness of the lava of 1960, which averaged 36.7 feet (11.2 m) because it accumulated in a depression on a very gentle slope. Flows on steeper slopes average about 12 feet (3.6 m) in thickness. Thickness also varies from place to place according to the local topography and rate of discharge. It is greatest where ponding occurs or narrow constrictions limit the flow and cause the lava to form thicker flows in an upstream direction.

It must also be stressed that the thicknesses of lavas are greater during active flow than they are after forward motion is arrested. This is especially apparent in fluid pahoehoe flows on moderate to steep slopes. At a given point in the lava stream, the thickness normally diminishes as the flow spreads downslope and drains lava from higher elevations. This effect is dramatically illustrated at Lava Forest Park, where tree molds stand two or three meters above the final surface. Therefore, it should be anticipated that, for pahoehoe flows, transient thicknesses may be as much as twice the observed final thicknesses of about 12 feet (3.6 m). The exact magnitude of this difference will depend on the viscosity, rate of discharge, gradient and course of the flow, and the local topographic variations. Because of these factors, thickness of a flow cannot be predicted, but thicknesses of 30 feet or more can be attained at certain points during the course of an eruption.

Rates of advance of flow fronts are governed by the slope angle, viscosity of the lava, and rate of discharge at the vent. During historic eruptions, measured rates have ranged from as much as a few hundred feet per hour to as little as a few feet per day. In the East Puna District, rates of advance are much slower than on higher segments of the rift where slope angles are greater. During a prolonged eruption, it is common for the flow front to advance in one area for a day or two, and then shift to another front before returning to the earlier front, so that with time, advance may be highly sporadic for any particular portion of the front.

4.3.4 Alleviating Volcanic Hazards

4.3.4.1 Monitoring: Volcanic eruptions in the LERZ have an abundance of premonitory phenomena that make it possible to foresee a coming eruption for several days or weeks. This allows adequate warning time to evacuate personnel and portable equipment. For this reason, hazards to persons working in the area, and hazards to portable equipment, are not as serious as hazards to fixed facilities.

The methods currently in use to monitor the LERZ and to forecast eruptions and their accompanying deformation employ seismographic records, tiltmeter readings, resurvey of trilateration networks, and geodimeter measurements. These methods are applied by the staff of the Hawaiian Volcano Observatory (HVO) operated by the U.S. Geological Survey. Members of the staff of the Hawaiian Institute of Geophysics have established a geodimeter network around the existing geothermal well (HGP-A) to monitor ground deformation resulting from extraction of geothermal fluids. The seismographs provide continuous records, whereas the tiltmeters and geodetic techniques provide data at infrequent intervals. Currently the HVO staff re-levels the trilateration stations twice a year and measure tilt two or three times a year. Geodimeter measurements have not been made since 1978.

Seismological techniques are the most effective methods of forecasting impending events in the ERZ, and the HVO network appears adequate for monitoring seismic activity. In the event that large-scale geothermal development takes place in East Puna, consultation with the staff of HVO should be accomplished to determine whether additional seismographs would be needed to improve the capacity to monitor shallow, very low magnitude activity. There is probably no advantage to be gained from installation of additional tiltmeters, but it is desirable to maintain the present HIG geodimeter network, to allow ground deformation in the area of any future geothermal plant to be monitored, especially during nearby extrusive or intrusive events. This would serve to locate zones of potential fissuring and faulting during any activity that may occur in the future. Such data are important for design considerations before construction of permanent installations in the area of the geothermal development.

Apart from these preliminary data bearing on the design and siting criteria of new facilities, the basic objectives of monitoring seismic activity and ground deformation should be to provide warnings of possible eruptions or ground rupture to allow time for precautionary measures. Frequent remeasurement of a geodometer network, particularly before and after swarms of earthquakes in the LERZ, would provide more detailed information on the location of tectonically active zones that are likely to be affected by an eruptive event.

4.3.4.2 Site Selection: By judicious site selection and design, it is also possible to greatly reduce the probability of inordinate losses to permanent facilities by taking advantage of topographic relief. For future development in the Puu Honaula area the question of selection of one or more sites for generating plants will become increasingly important. Figure 4.10 shows areas within a radius of one kilometer of the HPG-A well and proposed drilling sites to the north and east which are prime targets for future plant site locations.

Current knowledge of eruptive processes provides no basis for long term predictions of the locations where future eruptions are likely within the ERZ, but as historic eruptions have been more common on the south side, an outbreak in that part of the zone is more probable.

Topography is the controlling factor determining the risk of lava incursion on a selected site. The area at greatest risk within 1 km at HGP-A well or proposed wells is the shallow depression bounded by the Kaniahiku ridge to the north, and the Puu Kaliu - Kahuwai Kiapu - Puu Honaula - Puu Kii line to the south (fig. 4.11). Lavas originating within this area and in the ERZ up to 4 km west of the area are likely to be channeled down into this depression as indicated by the heavy arrows in fig. 4.11. Ponding of lavas on the nearly level ground immediately northwest and southwest of Kiapu could result in overflow between Kiapu and the HGP-A site. This would result in the flow of lava down the southeast flank of the rift (heavy arrows in fig. 4.11). Lavas originating in the northern part of the area would flow to the northeast, and those erupted south of the Puu Honaula ridge would flow to the southeast.

Areas of reduced risk from lava flows are primarily hills and, secondarily ridges, that rise at least 40 feet above the pathways of flows and are not within areas subject to ponding. Such areas are shown on fig. 4.11 and are graded from P1 (having the lowest risk) to P6 (intermediate risk). Unshaded areas have the highest risk.

The southeast flank of Puulena Crater (P6) is protected by the north rim of Kuhawai Crater, and by the Puulena Crater itself, which, if it were filled by lava, would overflow its eastern end. This site is located close to a buried fault (fig. 4.9) and is too distant from the geothermal area. This site has the advantage of being close to the edge of the southern (but most active) side of the LERZ.

Kiapu Hill (P5) rises 60 feet above the surrounding plain but lies in the path of any lava erupted in the southern third of the rift zone. The NE-trending Kaniahiku ridge (P4) rises 20 to 60 feet above the surrounding area, and, according to Holcomb (1981), is formed by 17th century lavas cut by normal faults. No evidence of faulting was found in a photogeological interpretation of this area. The ridge provides well protected sites close to a paved highway, but may not be feasible because of distance from the HGP.

We have selected five sites strictly on the basis of risk from lava flows, with little regard for distance from the geothermal area. The safest of these (A in fig. 4.10) is in the saddle between Puu Honaula and the next cone to the northeast, at an elevation of 660 feet. The site is 90 feet above the low ground to the north.

The second site (B) is 350 m south-southeast of the summit of Puu Honaula at an elevation of 650 feet, 45 feet above the low ground 800 m to the west. The site is on a shallow ridge 850 m from HGP-A.

The third site (C) is on the Kaniahiku ridge 310 m southwest of the Pahoa highway at an elevation of 700 feet. This site is 60 feet above the low ground on each side of the ridge. The ridge is shown as a zone of short normal faults by Holcomb (1981), but photogeologic methods do not confirm the existence of these faults. Should this site be seriously considered, the question of the existence of these faults should be investigated by trenching. The site is 2000 m from HGP-A.

A fourth site (D) is on Kiapu, an old spatter and cinder cone, at an elevation of 700 feet, 50 feet above the western base of the hill. A disadvantage of this site is that it lies in the path of flows that could descend from a considerable area higher in the ERZ, but it is unlikely that these flows would be thicker than 50 feet. Site D is 530 m southwest of HGP-A.

The last site (E) is on a low, horseshoe shaped ridge of old spatter immediately northwest of Puu Pilau, at an elevation of 630 feet. It is somewhat restricted in size (200 by 50 m) and is only about 30 feet above the level of ground to the west. The northwest side of the low cone on which the site is situated is partly protected by a ridge of boulders dozed from cultivated fields. The ridge served as a diversion barrier during the 1955 eruption and could be enlarged in height and width to provide added protection. Site E is 550 m from HGP-A.

While site A is undoubtedly the safest of the ones we have listed, based on the listed criteria, there is little to choose between sites B and C, which are slightly less secure, and between sites D and E, which we consider more exposed.

4.3.4.3 Diversion Barriers: Efforts to influence the directions and rates of advance of lava flows have, for the most part, been unsuccessful in Hawaii, but elsewhere, particularly at Mt. Etna in Sicily, they have been more effective. During the 1960 eruption near Kapoho, large-scale efforts were made to construct barriers along the south side of the graben, and although in some instances they delayed the advance for a few hours or at most a day or two, all were eventually overrun.

Barriers fail either by being bodily pushed ahead of the flow or by penetration of their base by fluid injections. The high density and mass of thick basaltic flows, even when moving slowly, exerts such a large force against any obstacle in its path that it can simply force it ahead or aside. The bulk density of basaltic lava (about 2.7 grams per cubic centimeter) is considerably greater than that of the fragmented, scoriaceous rock and cinders used in hastily constructed barriers. To be effective, barriers of loose material would have to be wide and much higher than the anticipated level of encroaching lava flows.

If a flow can be diverted into an open channel, especially one having a smooth floor and steep gradient, the barrier does not receive the full force of the flow and may survive. This principle accounts for the success of barriers at Mt. Etna. Owing to the steeper and more irregular topography on that volcano, it is easier to divert flows from one channel to another. In addition, the lavas of Etna, being more viscous, are less likely to penetrate the base of the barrier.

A well anchored barrier constructed of dense material, such as concrete, may be capable of protecting a narrow front at a given locality if the force of the flow can be diverted into a channel of lower resistance. In general, pahoehoe flows have a lower viscosity and can flow around obstacles, such as trees or small cones, more readily than aa lavas, but when ponded they also have a greater capacity for flowing beneath a light structure resting on the surface. The important principle governing the success of barriers is to deflect the flow into a more favorable course rather than attempting to oppose it directly.

4.3.4.4. Design Considerations: Of the various structures associated with a geothermal project - steam wells, pipelines, power plant, and associated facilities - wells and pipelines must be sited in accordance with relatively inflexible geological requirements, whereas more freedom is possible in placing the remaining facilities. It has been shown that the risk of lava flows is mainly a function of topography, and the risk of surface displacement is mainly a function of the dimensions and orientation of a structure across the trend of the ERZ.

The safety of pipelines, power lines, and large buildings can be enhanced by observing certain general guidelines.

1. Long linear structures within the ERZ may be subjected to horizontal ground displacements of at least 2 meters in a

direction N 30 W (normal to the rift axis) and up to 4 meters in a vertical direction. Pipelines, powerlines, and their supports can be constructed with sufficient vertical and horizontal compliance to withstand this magnitude of ground deformation.

2. Under favorable conditions diversion barriers may be capable of diverting lavas but are of little use as dams to oppose a flow directly. Short barriers on the north side of site B, the southwest side of site C, the west side of site D, and the northwest and northeast sides of site E would enhance the security of these sites.

3. To minimize the probability of failure by surface deformation, fixed facilities entailing relatively high costs, such as generating and auxiliary plants, should have a minimum dimension transverse to the trend of the LERZ (N 60 E). These facilities should, where possible, be built to withstand ground deformation of the magnitude indicated above (see 1).

4. It would be desirable to design roofs of buildings capable of shedding scoriaceous pyroclastic debris or supporting the load of a 1-meter layer of ash or cinders having a bulk density of 2 grams per cubic centimeter.

5.0 SEISMIC RISK ASSESSMENT OF THE PUNA DISTRICT, HAWAII

5.1 Introduction

5.1.1 Purpose of Study

This part of our study evaluates the earthquake hazard and general risk to future facilities for the Puna Geothermal Prospect (PGP) in the Puna District of Hawaii. Section 5.0 only considers ruptures of tectonic origin. Volcanic related fissures and faults are considered in Section 4.0.

5.1.2 Approach

Current state-of-the-art methods call for the detection, delineation, and definition of the character of seismogenic faults of a region to prepare an assessment of the location and faulting potential of active tectonic faults, and to evaluate the potential strong ground motion that could affect engineering structures at the site (Slemmons, 1977; and Glass and Slemmons, 1978). The usual methods of assessment include consideration of:

A. Seismicity and source mechanisms of regional earthquakes.

B. Geomorphic expression for fault rate of activity and fault slip type.

C. Geologic assessment of stratigraphic and soil-stratigraphic evidence for fault activity.

D. Assignment of maximum or maximum credible, and maximum probable earthquakes for the province and each seismogenic fault effecting the study area, with an estimation of future earthquake frequency and expected attenuated ground motion at the engineering site.

Review of aerial photographs, consideration of the youthful and active historic and geologic record and the nature of the historic earthquake activity, support the classification of faults and fissures into two, very different, categories:

1. Volcanic faults, fissures, and rifts, including the fractures of the East Rift Zone and the Southwest Rift Zone, along nearly straight volcanic alignments.
2. Tectonic faults of the Hilina and Kealaekua-Kaholo fault type, with dipping fault planes and common arcuate traces.

These two types provide the source of most shallow-focus earthquakes, the former associated with magmatic movements, as discussed in Sections 3 and 4 of this report, and the latter with higher magnitude tectonic earthquakes.

5.1.3. Terminology

The following terms are defined for use in this report:

The maximum or maximum credible earthquake is defined as the severest earthquake that is believed to be possible at the site, or to be generated by a fault, as determined by geological and/or seismological evidence. The maximum earthquake for a site has a ground motion that is based on one or more assumed future earthquake sources or source areas, with the motion attenuated to the site as a function of the distance from the source to the site.

The maximum probable earthquake is the strongest earthquake that is likely to provide motion at a given site or area, for a specified period of time, generally assumed to be the life expectancy of an engineered structure. This is approximately 40 years for the purpose of this study.

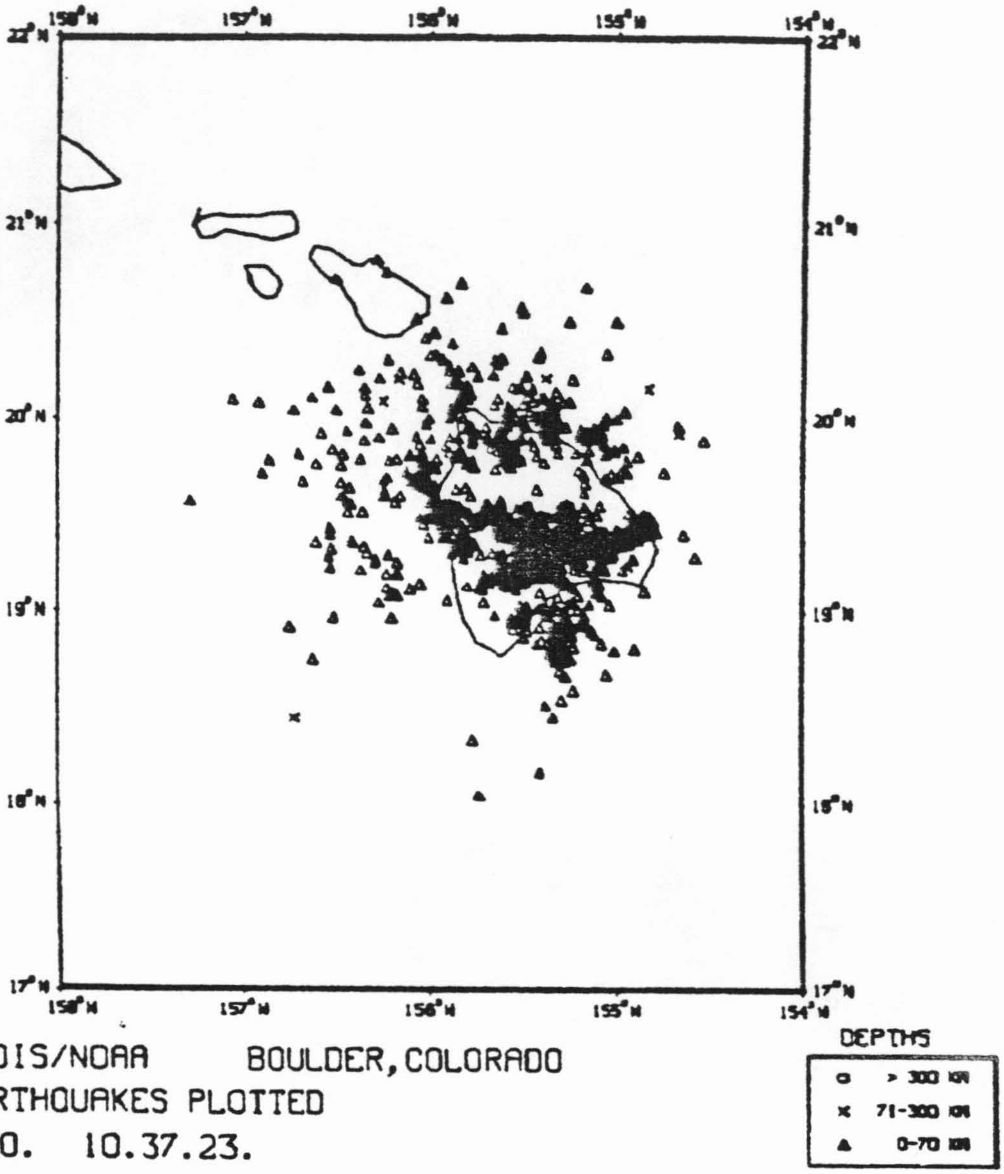
5.2 Regional Seismicity

The regional seismicity of the island of Hawaii is high compared with many tectonically active regions of the world, and appears to be related mainly, or solely, to volcanic activity and processes. The seismic activity is generally very low along the old Emperor segment north of the island chain and along the northern, old part of the Hawaiian chain (fig. 3.1). Most of the activity is concentrated at the southern, currently active, end of this zone of "hot spot" volcanoes. No known major fault zones affect the chain in terms of major active tectonic plate boundaries.

The record of seismicity, particularly for low magnitude earthquakes is not well documented for the entire historic record and there is no unified catalog of earthquakes available. The main sources of information for earthquake hypocenters are:

1. The NOAA earthquake hypocenter data file (app. A),
2. The Gutenberg and Richter (1954) catalog of pre-1951 data for moderate to high magnitude earthquakes, and
3. The HVO summary reports of regional seismicity.

These data bases all have significant deficiencies in quality and sensitivity of earthquake detection and location that change with time. The post-1960 NOAA file has many duplicate listings for the 100 mile (160 km) radius of HGP (see app. A). The epicentral map prepared from the data of Appendix A (fig. 5.1 and pls. 1 and 2) show a broad pattern of earthquake epicenters for earthquakes of more than about 25 km hypocentral depth, with a denser cluster near the deep central conduits of Kilauea and Mauna Loa; the



NGSDC/EDIS/NOAA BOULDER, COLORADO
2087 EARTHQUAKES PLOTTED
81/07/20. 10.37.23.

Figure 5.1 Earthquakes of greater than magnitude 3 within a 100 mile (160 km) radius of the Puna Geothermal Project. Many of these events are plotted twice because of duplication in the NOAA file - see Explanation for Appendicies A, B, and C.

epicentral pattern for earthquakes of less than 25 km focal depth show concentrated activity along and near the ERZ, SRZ, the rift zones of Mauna Loa, and along the Hilina fault zone and its offshore southeastern extension.

Two patterns are apparent on the epicentral map of deeper focus earthquakes (pl. 1):

1. A clustering along the deep conduits of Mauna Loa and Kilauea, where pulses of new magma from the upper mantle are accompanied by earthquake activity, and
2. A broad pattern around the edges of the island of Hawaii, where crustal loading from the recent loading by rapid volcanic growth is believed to cause upper mantle tectonic adjustments, although mechanisms of these deep earthquakes is not well understood (Unger and Ward, 1979).

The maximum magnitude for earthquakes of more than about 25 km depth is about 7 for the west flank of the volcano (August 21, 1951) and 6.2 for the east flank of the volcano (April 26, 1973). These deeper focus earthquakes have caused less damage than shallower focus earthquakes of similar magnitude (Nielsen and others, 1977). The likelihood of future activity of this type near the site is considered by us to be low, with only two earthquakes of above 6 magnitude within the 31,400 sq mi area centered on the site for a 30 year period. Adjustments of this type should be more common to the north of the site, since the volcanic heights of Mauna Loa and Mauna Kea are greater and the volume of eruptive material is greater than in the Kilauea-East Rift Zone sector of the island.

Earthquakes of less than about 25 km focal depth are localized along the central conduits, but also have narrow and concentrated clustering along the active volcanic rifts. In addition a broad zone of distributed, very shallow focus earthquakes are described for zones of magmatic movement as has been summarized by Koyanagi and other (1981). The relationship of the ERZ to the Hilina fault zone is described in Section 2.0 and Section 5.3.

5.3 Seismicity of Faults near the Puna Geothermal Prospect

5.3.1 Hilina Fault Zone

The historic record shows a high rate of activity along the Hilina fault zone, with a large earthquake, perhaps of 7.5 to 8 magnitude in 1868 and a Ms = 7.2 earthquake in 1975. This zone shows a long history of small earthquakes as suggested by the earthquake catalog (app. A, B and C and pls. 1 and 2), and the activity shown in pre-1975 epicentral plots. The activity from 1963 to 1969 is shown in Figure 5.2 with volcanic related epicenters along the ERZ and epicenters on and near the Hilina fault zone. The epicenter map of all earthquakes for 1976 and 1977 (fig. 5.3) shows the earthquake activity in Hawaii, including the epicentral and aftershock area for the 1975 Kalapana earthquake, with a dense distribution of earthquakes to the south of the ERZ and the offshore zone of submarine uplift and tsunami generation (fig. 3.11). The focal mechanisms of earthquakes of this zone are compatible with a southeastward movement (figs. 3.11 and 3.12) of a block bounded on the northwest by the surface trace of the Hilina fault and extending into the offshore region (Fitch and Kinoshita, 1969; Furumoto and Kovach, 1979; Crosson and Endo,

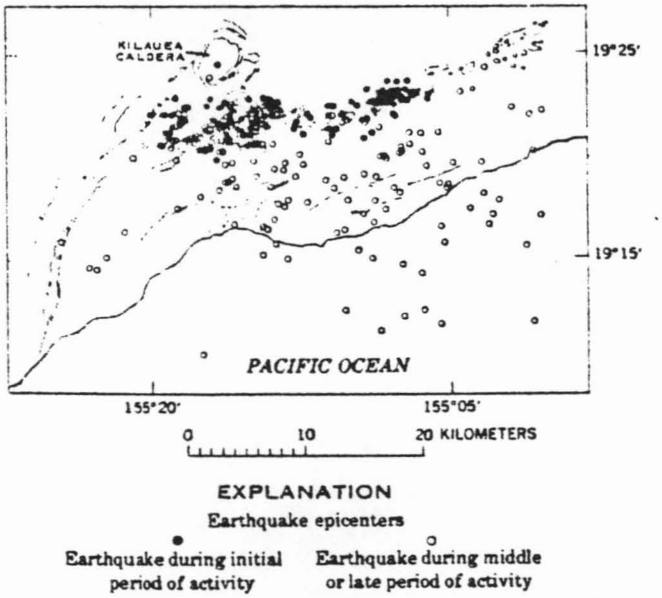


Figure 5.2. Compilation of earthquake epicenters from short seismic swarms that are associated with magmatic processes from 1963 to 1969. Earthquakes selected are of magnitude 2.0 and greater, and depths less than 15 km. The epicenters were plotted according to two time categories in which they occurred. Earthquakes during the initial stages of activity were concentrated near the outbreak area along the Koae faults and the ERZ. Earthquakes during the middle and late stages scattered far to the south toward the Hilina fault zone (Koyanagi and others, 1972). Note the close spatial association of the earthquakes associated with the eruption (solid dots) with the ERZ.

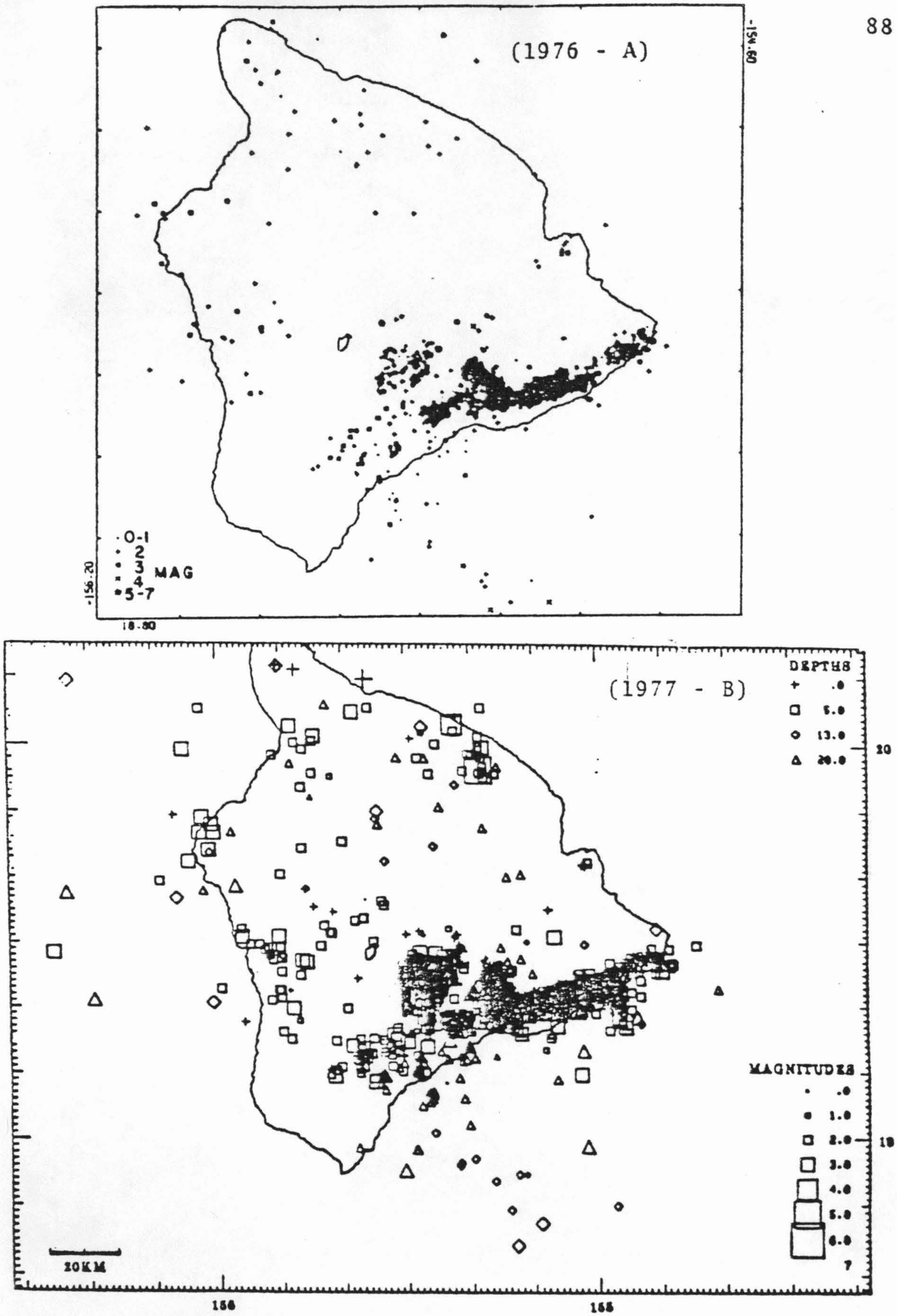


Figure 5.3. Epicenter plots presented in Hawaiian Volcano Observatory Summaries 76 and 77 for 1976 (A) and 1977 (B) showing the concentration of earthquakes in the south flank of Kilauea (from Koyanagi and others, 1981).

1981); Crosson and Endo (1981) show (fig. 3.12) vectors for displacements in this block. Wyss and others (1981) show that precursors to the Kalapana earthquake may have included aseismic stress drop by fault creep in the area indicated in fig. 5.4. Wyss (in press) also indicates that this event may represent three earthquakes of mb = 6.5 in close temporary association, to give the higher Ms value of 7.2.

The average seismic moment for the Kalapana earthquake (Ms = 7.2) was 1.2 x 10^{27} dyn cm, with an inferred stress drop of 12 bars (Furumoto and Kovach, 1979). These calculations, the geologic and tsunami relations for this earthquake, and the aftershock data suggest rupture of a large percentage of the total fault surface. The size of the faulted surface for the 1868 earthquake is unknown, but it does not appear likely that it could have been much greater than for the 1975 earthquake. The possibly larger magnitude (Ms greater than about 7.5) may be from a larger average displacement on a similar fault surface area, or more multiple events in a very short time period.

5.3.2 Koae Fault Zone

The Koae fault zone has frequent earthquake activity and appears to be related to combined tectonic and volcanic activity. The maximum volcanic earthquake is about 5.5 magnitude, which is approximately the maximum noted for volcanic related activity on any of the rift zones. Earthquake epicenters from this fault zone are more than 45 km from the site. When ground motion is attenuated, they are not likely to result in damaging motion at the HGP site.

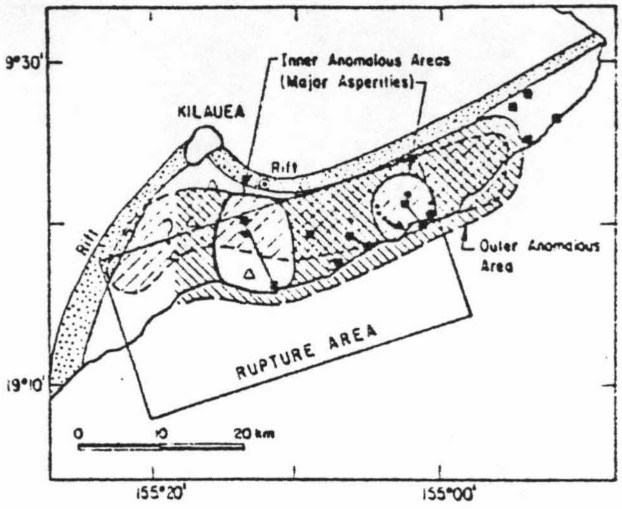


Figure 5.4. Map of the rupture area of the Kalapana earthquake of 1975 in relation to the distribution of crustal anomalies. The one month aftershock zone is shown. The rupture area was estimated by Ando (1979) and is indicated by the rectangle. Squares indicate triangulation benchmarks, small dots show foreshock locations, the medium size dot marks the location of the M = 5.0 foreshock and the large dot indicates the epicenter of the magnitude 7.2 main shock (Wyss and others, 1981).

5.3.3 Honuapo-Kaoiki Fault Zone.

This zone has no known evidence for youthful or current activity. It may represent an older, ancestral Hilina fault zone type of feature. The zone is near some epicenters (pl. 1), but its current activity is uncertain. The 35 km distance of this fault zone from the PGP eliminates the need to consider it as an important source of damaging ground motion at PGP.

5.3.4 Kealakekua-Kaholo Fault Zone

This zone is near the source of the 1950 earthquake of Ms = 6.25. The zone is a system of arcuate to linear patterns of fractures similar to the Hilina fault zone. Earthquakes of more than Ms = 6.25 are possible, perhaps with a maximum of about 7.0. If the poorly known character of this structure is assumed to be similar to the Hilina fault zone, the 110 km distance from PGP eliminates the need to consider this fault zone as an important source of damaging ground motion at PGP.

5.4 East Rift Zone

The general geological and geophysical setting of the ERZ is discussed in Sections 3 and 4. The recent high quality data on seismicity and focal depths show frequent, low magnitude earthquakes of volcanic origin for this zone (figs. 3.10 and 5.3). Koyanagi (pers. comm., 1981) believes that the lack of deeper foci events on the ERZ is due to doming effects from intrusions on the ERZ which cause the high number of events and shallow area of activity. These data show a high level of volcanic activity related to uplift from magmatic injection, with modification from aftershocks of the 1975 earthquake. The depth profile of these aftershocks is suggestive of a possible southwest dip of a fault plane or rift zone (fig. 4.4).

The maximum magnitude for volcanic-related activity on the ERZ is about 5, based on the maximum historic earthquake. The historic record suggests that earthquakes of about Ms = 5 to 5.5 could occur at PGP. Planning for seismic design at this site should, for conservatism, assume that earthquakes of up to this magnitude range could occur during a 40 year time interval. This upper bound magnitude value may be limited by the high frequency of volcanic activity along the ERZ limiting the amount of stress and strain accumulation on this zone, and the frequent relief of such accumulations.

5.5 Earthquake Magnitude and Ground Motion

5.5.1 East Rift Zone

The strongest historic earthquakes on the ERZ are of volcanic origin, and for the NOAA hypocenter data file (app. A) of the last 20 years, indicate a maximum earthquake of about Ms = 5. The high frequency of volcanic activity suggests that relief of stress and strain on faults and dikes may occur every few years. Since the magnitude 5 earthquakes that have been recently observed may not represent the long-term maximum, we recommend that a higher maximum earthquake magnitude of 5.5 be assumed for the PGP, with an epicentral distance of from 0 to 10 km. High acceleration, displacement and velocity may occur at the site, but with only a few high frequency cycles of short duration. Motion of this type is not likely to cause structural damage to engineered structures. The following are the estimated ground motion parameters, defined by data on figs. 5.4 to 5.7.

A. Mean Peak Horizontal Acceleration: The mean peak horizontal acceleration is 0.2 to 1 g (fig. 5.5).

B. Mean Peak Horizontal Velocity: The mean peak horizontal velocity is 10 to 100 cm/sec (fig. 5.6).

C. Mean Peak Horizontal Displacement: The mean peak horizontal displacement is 5 to 15 cm (fig. 5.7).

D. Duration: The duration of ground motion greater than 0.05 g is 5 to 12 seconds (fig. 5.8).

5.5.2 Hilina Fault Zone

The relief of stress and strain by the 1972 earthquake, which ruptured most of the known length of the Hilina fault zone, is likely to mark the start of a new seismic cycle of accumulating stress and strain. Residual strain on possible unruptured parts of this fault zone, or aftershocks appear to have a potential for generating earthquakes of about Ms = 6.5. The gradual increase in strain could lead to another 7.2 magnitude earthquake in approximately 100 years. We estimate the earthquake potential to gradually increase during the next 100 years from Ms = 6.5 to Ms = 7.2 and assume for planning purposes that the maximum credible earthquake for the next 40 year period is about Ms = 6.75 for the PGP area.

The distance from PGP to the epicenter of a potential earthquake on the Hilina fault zone is difficult to determine from the present geologic and seismologic data base. Future specific design of vital engineered structures may need a special assessment of this problem. Alternative methods of measuring the length include the following:

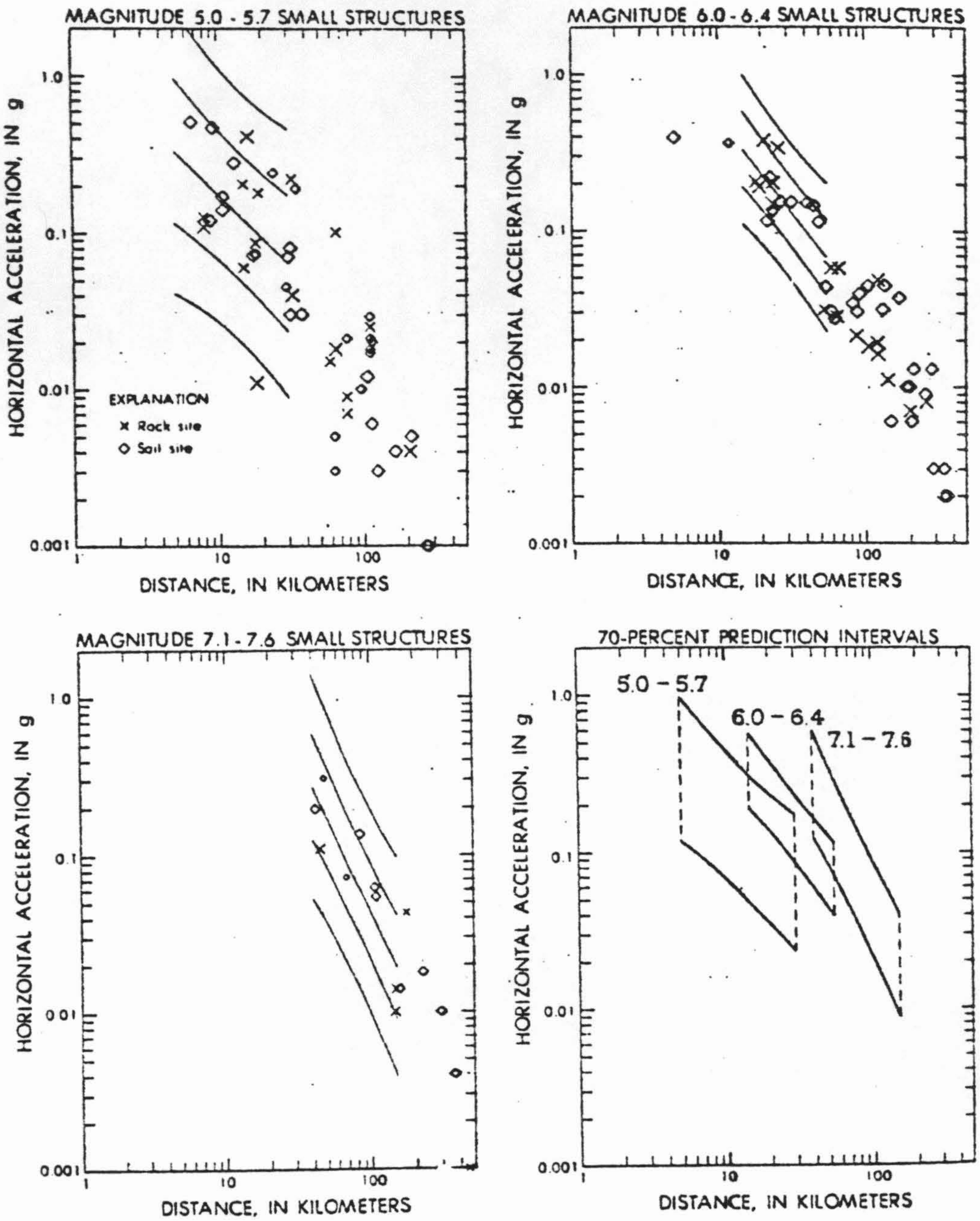


Figure 5.5. Peak horizontal acceleration recorded at base of small structures versus distance to the slipped fault for three magnitude ranges. Center line, mean regression line. Outer pair of lines represent 95 percent prediction interval; inner pair, 70 percent prediction interval. Length of lines represent distance interval considered in regression analysis. Uncertainty in distance is inversely related to symbol size. The lower right figure shows a comparison of the 70 percent prediction intervals for the three magnitude ranges (from Boore and others, 1981).

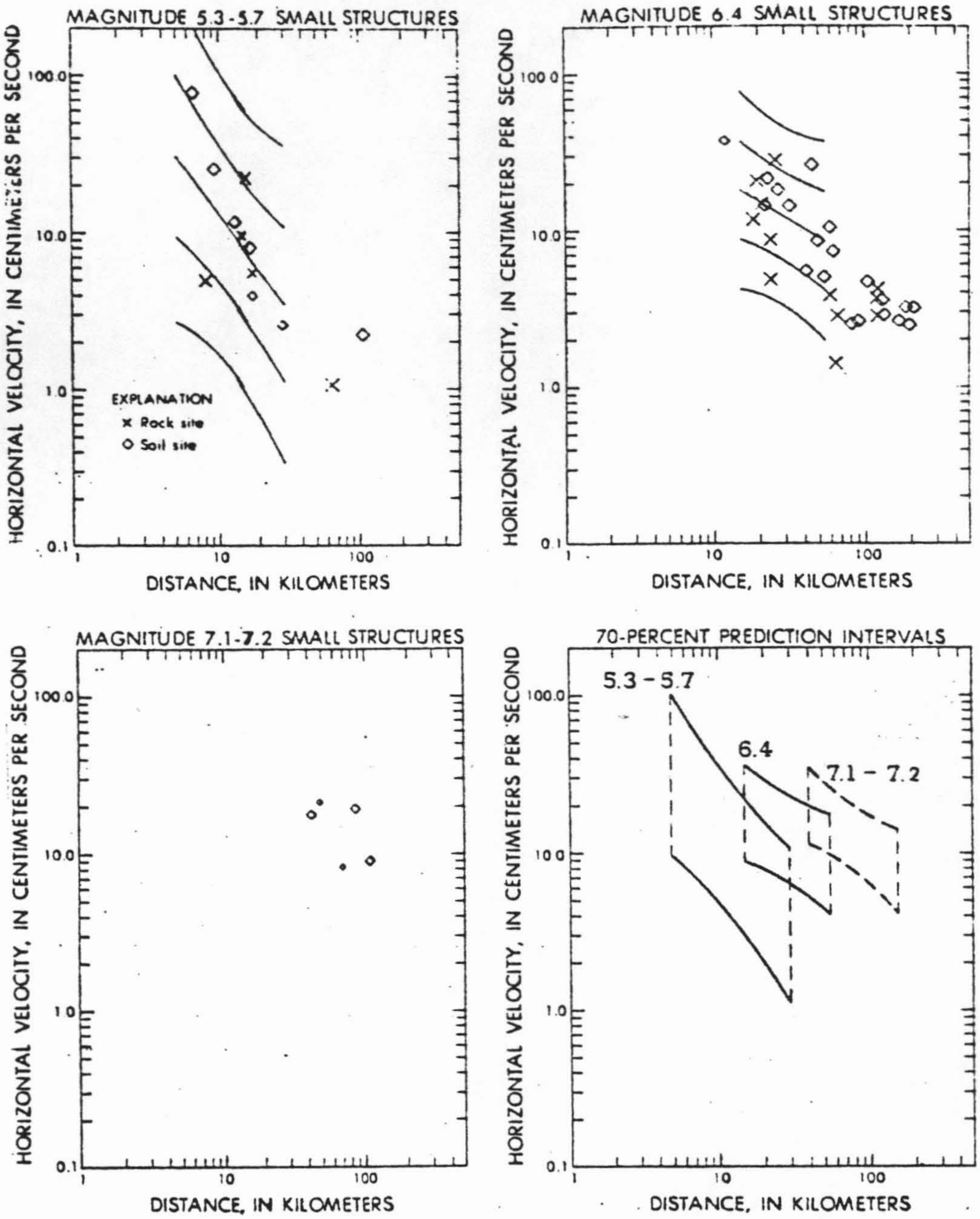


Figure 5.6. Peak horizontal velocity. See Figure 5. for explanation of symbols and curves. Dashed curves the lower right figure for Magnitude 7.1 to 7.2 emphasize uncertainty in slope (from Boore and others, 1981).

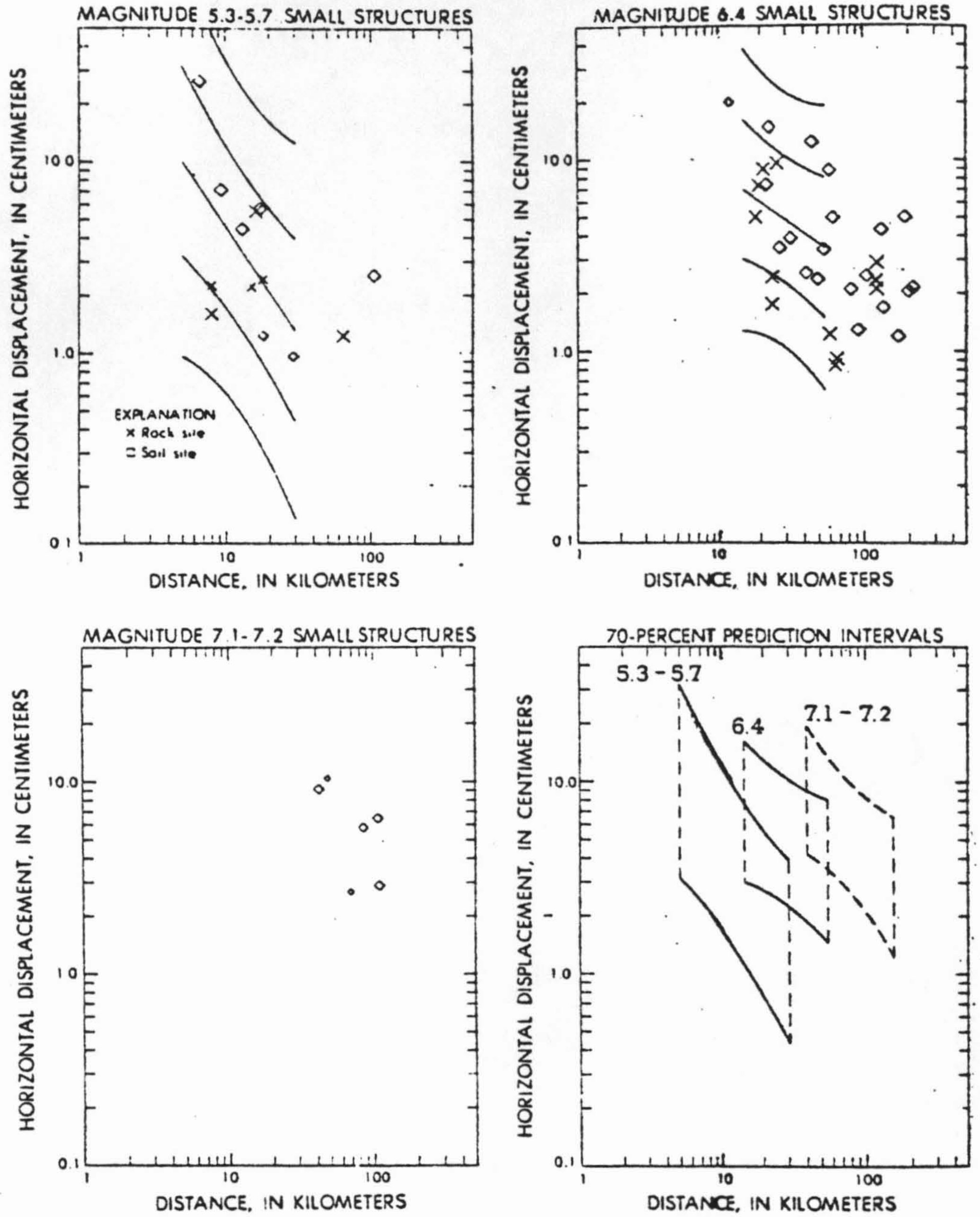


Figure 5.7. Peak horizontal displacement. See Figure 5. for explanation of symbols and curves (from Boore and others (1981).

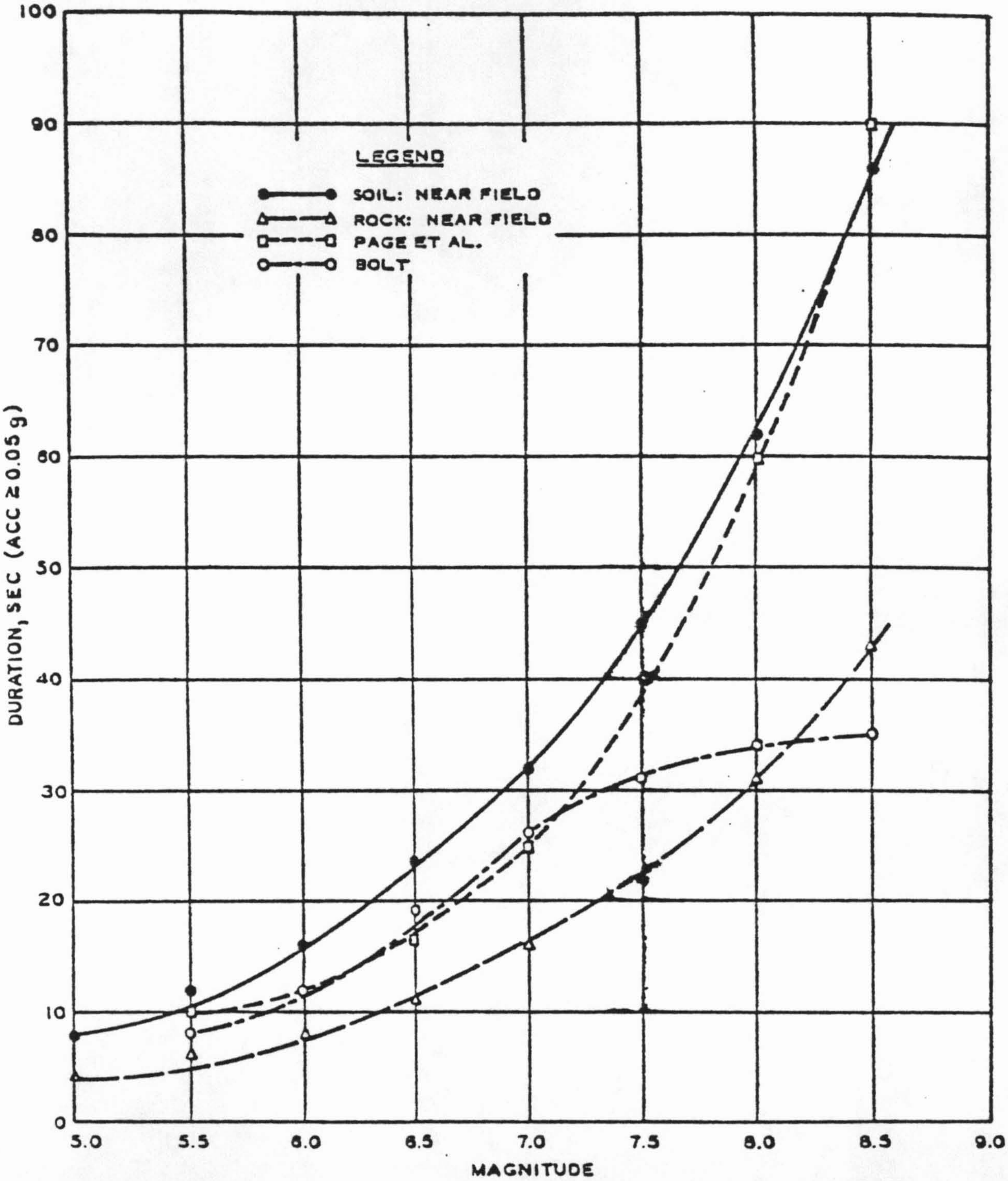


Figure 5.8. Near field duration of ground motion with acceleration greater than or equal to 0.05 g from historic earthquakes (Chang and Krinitzsky, 1977).

1. From PGP to the nearest point on the surface trace of the Hilina fault, about 20 km.
2. From PGP to the nearest potential hypocenter to the southwest on the bottom of the tectonically active block, about 25 to 30 km.
3. From PGP to the center of energy release, about 40 to 50 km.

For conservative planning purposes, the nearest hypocenter for a large magnitude tectonic earthquake on this fault zone can be assumed at 25 km from PGP.

The estimated ground motion at PGP, is assumed to be an earthquake of about 6.75 magnitude for the next 40 year time period, with a source earthquake distance of 25 km. This provides the following estimate of ground motion:

A. <u>Mean Peak Horizontal Acceleration:</u> The estimated mean peak horizontal acceleration from figure 5.4 is about 0.15 for M = 6.0-6.4 and 0.4 for M = 7.1-7.6. The peak acceleration from fig. 5.9 is about 0.16 for an earthquake of about 6.6 magnitude and 0.28 for 7.6 magnitude. These values are consistent with the recorded 0.22 g for the Ms = 7.2 earthquake in 1975, at Hilo with an epicentral distance of 43 km (Rojahn and Morrill, 1977). These data lead to an estimate of a mean peak horizontal acceleration of 0.25 g for the next 40 year period at the site.

B. <u>Mean Peak Horizontal Velocity:</u> The estimated mean peak horizontal velocity from fig. 5.5 is about 15 cm/sec for M = 6.4 and 35 cm/sec for an earthquake of M = 7.1-7.2. These data lead to an estimate of mean peak horizontal velocity of 25 cm/sec for the next 40 year period at the site.

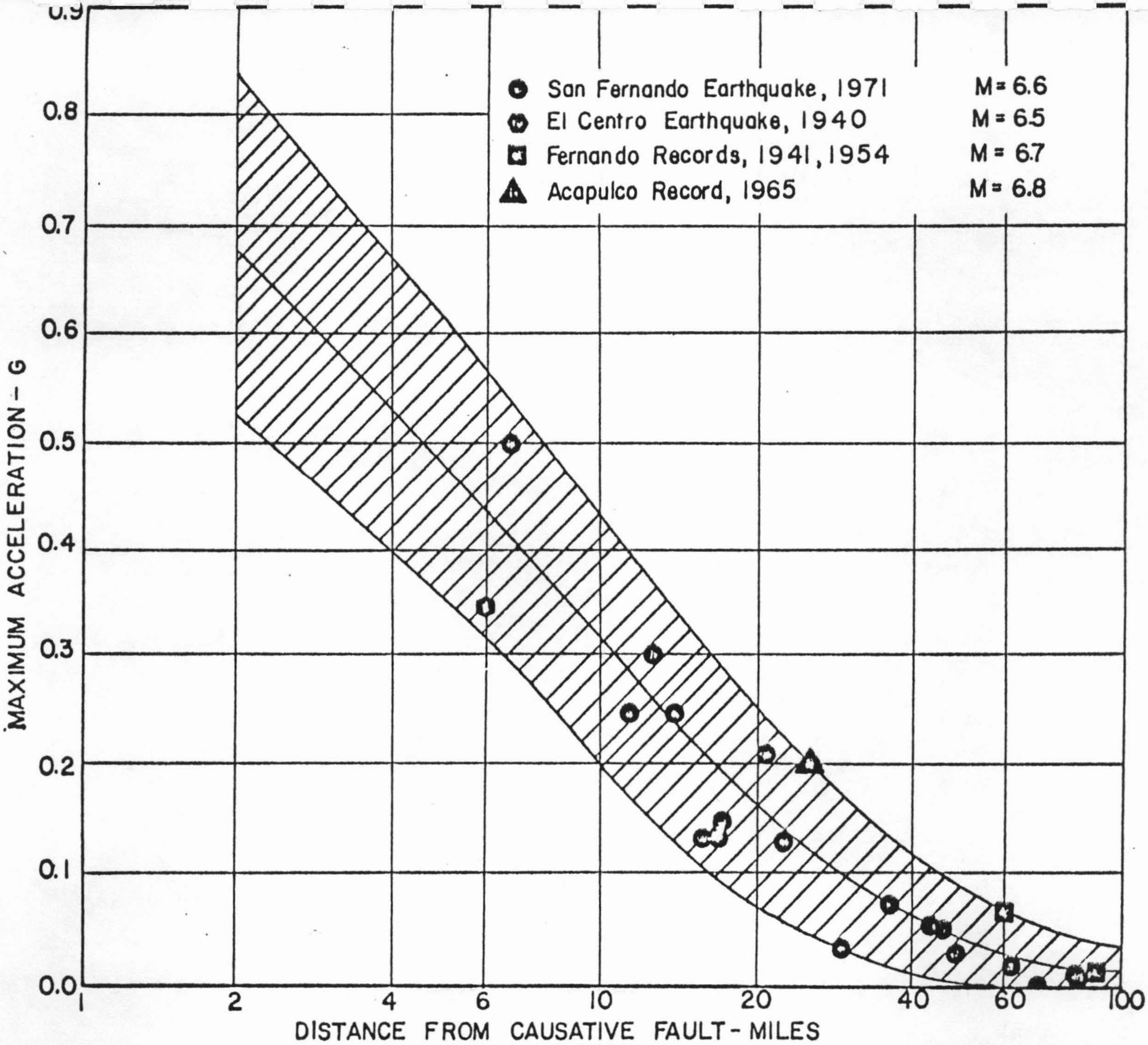


Figure 5.9. Maximum accelerations in rock for earthquakes with magnitude of about 6.6 (Schnable and Seed, 1972).

C. Mean Peak Horizontal Displacement: The estimated mean peak horizontal displacement from fig. 5.6 is about 5 cm for M = 6.4 and 15 cm for M = 7.1-7.2. The relative displacement was 3.4 cm at Hilo for the Ms = 7.2 earthquake in 1975, at an epicentral distance of 43 km (Rojahn and Morrill, 1977). These data lead to our estimate of mean peak horizontal displacement of 10 cm for the next 40 year period at the site.

5.6 Seismic Hazards at the Puna Geothermal Prospect

The main earthquake hazards are, in a general decreasing order of risk:

1. Ground motion
2. Landslides, slumps, and other secondary ground failures
3. Liquefaction
4. Surface faulting
5. Tsunamis and seiches

The principal hazard for the PGP is from strong ground motion from tectonic and volcanic related earthquakes. Tectonic earthquakes and their probable ground motions at the site are discussed in Section 5.4. Earthquakes caused by magmatic movements, although of high frequency and closer sources, have lower magnitudes and are expected to result in only minor damage and other effects (see Section 4.0).

Landslides, slumps and other gravity failures induced by strong earthquake motion are likely to affect the siting area. Liquefaction and tsunami effects are not important in the siting area, which is well above sea level and is generally devoid of materials that are susceptible to liquefaction. Surface faulting in the siting area is considered in Section 4.0.

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EXPLANATION OF ABBREVIATIONS AND SYMBOLS IN APPENDICIES A, B, AND C

SOURCE CODES

CGS - Coast and Geodetic Survey
ERL - Environmental Research Laboratories
G-R - Gutenberg and Richter, 1954
GS - U.S. Geological Survey, Denver, CO, U.S.A.
HVO - Hawaiian Volcano Observatory, Hawaii National Park, HI, U.S.A.
ISS - International Seismological Summary, Kew, England, U.K.
NOS - National Ocean Survey
USE - United States Earthquakes

TIME

Date and Origin time in Universal (Greenwich) Time. (Note: Many earthquakes from HVO given in Hawaiian Standard Time in Appendix A, and duplicated with data from other sources in Greenwich Time. Those events in Appendix A preceeded by a (●) are duplicated because of this use of two time zones in the NOAA listing. Those events in Appendix A preceeded by a (■) are duplicated in Appendix B. These two types of duplications are omitted from the data in use in this report).

AUTHORITY (follows origin time)

H - Parameters of hypocenter supplied by the USGS Hawaiian Volcano Observatory

MAGNITUDES

For source, see source codes above. Under surface wave, SH = Horizontal components used.

INTENSITY

Maximum in Modified Mercalli (MM) scale or converted to MM scale.

PHENOMENA

D	Diastrophism	-F, surface faulting; -U, uplift/subsidence; -D, faulting and uplift/subsidence
T	Tsunami	-t, tsunami generated; -Q, possible tsunami
S	Seiche	-S, seiche; -Q, possible seiche
V	Volcanism	-V, earthquake associated with volcanism
N	Non-tectonic	-C, coal bump or rockburst in coal mine; -E, explosion, accidental, controlled, or suspected explosion; -I, collapse; -L, lights or other such visual phenomena seen; -M, meteoritic source; -R, rockburst
O	Waves Generated	-A, acoustic wave; -G, gravity wave, -B, both A and G; -T, T-wave

REGION NUMBER (RN)

Geographic region number as described in Flinn, Engdahl, and Hill, 1974

CULTURAL EFFECTS (CE)

C - casualties
D - damage
F - felt

QUALITY/NUMBER OF STATIONS (Q/S)

Quality indicators are usually on an A, B, C, or D basis (A-very accurate; B-good; C-fair; D-poor). When used in combination for deep shocks, these represent the accuracy of (in order) epicenter, origin time, and depth.

MARSDEN/DEGREE SQUARE (MAR DG)

Numbering system dividing the world into 10° squares (MAR) and 1° subsquares (DG).

DISTANCE (DIST)

The distance in kilometers between the earthquake location and the designated point for radius searches.

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                                          EARTHQUAKE DATA FILE

DR. D.B. SLEMMONS   UNIVERSITY OF NEVADA          160-KM RADIUS OF 19.467N., 155.883W.                      81/07/17. 14.55.45.

PRINTED OUTPUT WILL BE DISPOSED TO THE EDIS SITE LINE PRINTER
                                                                                              INT FHENOM  PN CE Q/S  MAP DG   DIST
  SOURCE YEAR  MO DA HR MN SEC       LAT      LONG  DEPTH ---------MAGNITUDES---------        MAX DISVNO                       (KM)
                                                    (KM)    BODY   SURF   OTHER   LOCAL

**N INDICATES A POSSIBLE DUPLICATE
     G-R  1929  09 26 04 50 56.0  19.750N 156.000W                .5.60FAS               VII          613 D        052 96    34.
     G-R  1929  10 36 07 32 31.0  19.750N 156.000W                .6.50FAS               VII          613 D        052 96    34.
     G-R  1935  05 28 19 35 05.0H 19.500N 155.250W                .5.60FAS               V            613 D        052 95    66.
     G-R  1940  06 17 10 26 47.1  20.500N 155.250W                .6.00PAS               VI           613 D        068 05   133.
     G-R  1940  07 16 05 17 33.0H 20.500N 155.000W                .5.60FAS                            613 F        028 05   147.
     G-R  1941  09 25 17 48 38.0  19.500N 155.500W                .6.00FAS               VII          613 D        052 95    40.
     G-R  1944  12 27 14 11 41.3  19.500N 155.500W                .5.60FAS               VI           613 D        052 95    40.
     G-R  1950  05 3   1 15 15.1  19.500N 156.000W                .6.25FAS               VI           613 D        052 96    13.
     USE  1951  04 24    [illegible]  21.0  19.   0N 155.500W                .6.50PAS               VII          613 D        052 95    66.
     G-R  1951  08 21 1  57    .0  19.700N 156.  0W  60.         .6.90PAS               IX    T      613 C        052 96    34.
     USE  1952  05 27    1  26.07 19.413N 155.413W                        .6.00ML HVO    VI           613 D        052 95    42.
**1  1?3  1954  03 3  16 4    0.0  19.5 0N 155.1  W                .6.00FAS                            613 F        052 95    42.
**2  USE  1954  03 3     4    3.0H 2 .   N 155.  0W                        .6.50                      613 D        068 05    82.
     G-S  1954  03 3  2  41 54.0   .   N 155.  0W                .6.50FAS               VII          613 D        068 05   110.
     USE  19    02 1     1 51.0H 19.1  N 155.283W 005                     3.50ML HVO                  613 F        052 95    64.
     USE  19    02 2     5 01.0H 19.350N 155.150W 005                    .4.00ML HVO                  613 F        052 95    78.
     USE  1960  03  5 15 32 10.0H 19.333N 155.283W 005                     3.50ML HVO                  613 F        052 95    65.
     USE  19    03  7    43 15.0H 19.733N 155.2  W 015                    .4.00ML HVO                  613 F        052 95    77.
     USE  19    03 24 14 2  42.0  19. 73N 155.633W 015          3.50                                   613 F        052 95    44.
     USE  19    0  1  17 44 55.0  20.015N 155.416W 015                    .4.00ML HVO                  613 F        068 05    78.
     USE  19    0  1   7 4   7.0H 19.4 0N 155.533W 015                     3.50ML HVO                  613 F        052 95    37.
     HV   1961  01  7 13 57   .   19.5 7N 156.175W 0                       3.70ML HVO                  613 F        052 96    33.
     HVO  1961  01 15 1  44 41.3H 19.6 7N 155.628W 0 8                    .4.20ML HVO                  613 F        052 95    55.
     HVO  1961  01 1  15 54 34.0H 19.382N 155.422W 003                     3.20ML HVO                  613 F        052 95    10.
     USE  1961  01 21 1     36.1H 19.2 8N 155.633W 008                    .4.70ML HVO                  613 F        052 95    39.
     USE  1961  01 24        42.0H 19.7  N 155.483W 006                     3.40ML HVO                  613 F        052 95    68.
     USE  1961  02 14  3     01.0H 19.4 0N 155.083W 03                      3.40ML HVO                  613 F        052 95    63.
     USE  1961  03 3   4 41 14.0H 19.557N 155.260W 025                     3.10ML HVO                  613 F        052 95    66.
     USE  1961  04 02 1   4 1 .  20.010N 155.405W 0                        3.30ML HVO                  613 F        068 05    76.
     USE  1961  04 13     3  47.5H 19. .3N 155.453W 018                     3.00ML HVO                  613 F        052 95    49.
     USE  1961  04 1   4 1  23.0H 19.4 0N 155.2 3. 03                      3.30ML HVO                  613 F        052 95    63.
     USE  1961   4 2     1   4.0H 19.3  N 155.192W 005                     3.20ML HVO                  613 F        052 95    53.
     USE  1961   4 2      1 .  H 19.447N 155.453W .05                     3.10ML HVO                  613 F        052 95    45.
     USE  1961   4 27 16 3      .  H 19. 32N 155.392W 018                     3.  ML HVO                  613 F        052 95    52.
     USE  1961   5 1   2 27 32.0H 19.4  N 155. 83W 039                     3.00ML HVO                  613 F        052 95    63.
     USE  1961  05 1     41  . H 19. 52N 155.233W 013                    .4.30ML HVO                  613 F        052 95    62.
     USE  1961   5 27 0  1  45.0H 19.442N 155.437W 008                     3.60ML HVO                  613 F        052 95    47.
     USE  1961  06 1  2       . H 19.455N 155.368W 008                     3.30ML HVO                  613 F        052 95    64.
     USE  1961  06 24  5     59.5H 19.33 N 155.328W 0 5                     3.30ML HVO                  613 F        052 95    60.
     USE  1961  06 2  14 13 17.0H 19.4  N 155.293. 03                      3.70ML HVO                  613 F        052 95    63.
     USE  1961  06 3  13 24 25.0H 19.4  N 155. 63W 03                      3.10ML HVO                  613 F        052 95    63.
     USE  1961  06 3  16 41 55.0H 19.515N 155.172W 034                     3.50ML HVO                  613 F        052 95    75.
     USE  1961  07  2    3    . H 19.40 N 155. 83W 03                      3.40ML HVO                  613 F        052 95    63.
     USE  1961  07 14     3    .  H 19.297N 155.470W 015                     3.60ML HVO                  613 F        052 95    48.
     USE  1961  07 23 13 24 17.1H 19.400N 155.283W 030.                   .5.10ML HVO    V            613 D        052 95    63.
     USE  1961  07 23 16 2  2 . H 19.4  N 155.283W 032.                   .4.70ML HVO    V            613 F        052 95    63.
     USE  1961  07 23 13 3  5 . H 19.4  N 155.2 0W 03                      3.50ML HVO                  613 F        052 95    63.
     USE  1961  07 24 13 22 42.0H 19.4  N 155.283W 03                      3.10ML HVO                  613 F        052 95    63.
     USE  1961  07 23  2 5  4 .4H 19.4 0N 155.263W 03                      3.20ML HVO                  613 F        052 95    63.
     USE  1961  07 2     19 2 .0H 2 . 03N 155. 17W 00                      3.30ML HVO                  613 F        068 05    93.
-1   /17.                                                  PAGE    1
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SOURCE YEAR  MO DA HR MN SEC      LAT       LONG  DEPTH ---------MAGNITUDES--------- .        INT FHENOM  RN CE G/S  MAR DG   DIST
                                                  (KM)   BODY   SURF   OTHER   LOCAL       MAX DTSVNO                         (KM)
**N INDICATES A POSSIBLE DUPLICATE
  USE  1961  08 21 16 55 11.0H 19.420N 155.220W 003                          3.00ML HVO                 613 F        052 95    70.
  USE  1961  08 25 18 45 35.1H 19.665N 155.070W 035*                        *4.50ML HVO                 613 F        052 95    96.
  USE  1961  09 13 14 24 29.3H 19.655N 155.435W 013                          3.60ML HVO                 613 F        052 95    64.
  USE  1961  09 22 08 19 37.9H 19.333N 155.083W 003                          3.00ML HVO                 613 F        052 95    65.
  USE  1961  09 22 00 33 00.5H 19.333N 155.083W 003                          3.50ML HVO                 613 F        052 95    85.
  USE  1961  09 22 00 54 21.7H 19.335N 155.083W 003                          3.00ML HVO                 613 F        052 95    85.
  USE  1961  09 23 03 31 32.4Z 19.400N 155.100W 003                         *4.10ML HVO      V      V   613 D        052 95    82.
  USE  1961  09 25 05 39 39.6H 19.400N 155.283W 030                          3.00ML HVO                 613 F        052 95    63.
  USE  1961  09 25 05 25 08.7H 19.368N 155.100W 003                         *4.10ML HVO             V   613 F        052 95    83.
  USE  1961  09 25 05 21 53.5H 19.400N 155.100W 003                5.88FAS *4.20ML HVO      V      V   613 D        052 95    82.
  USE  1961  09 25 06 24 21.9H 19.400N 155.100W 003                         -4.10ML HVO      V      V   613 F        052 95    82.
  USE  1961  09 25 06 38 27.0H 19.356N 155.100W 003                          3.20ML HVO             V   613 F        052 95    83.
  USE  1961  09 25 23 12 37.5H 19.356N 155.100W 003                          3.20ML HVO             V   613 F        052 95    83.
  USE  1961  09 28 07 24 38.0H 19.358N 155.100W 003                          3.30ML HVO             V   613 F        052 95    23.
  USE  1961  09 28 07 24 41.0H 19.358N 155.100W 003                         *3.40ML HVO             V   613 F        052 95    83.
  USE  1961  10 04 16 38 27.0H 19.727N 155.540W 013                          3.00ML HVO                 613 F        052 95    48.
  USE  1961  11 10 15 3  21.4H 19.433N 155.313W 013                          3.40ML HVO                 613 F        052 95    60.
  HVO  1961  11 14 14 51 27.0H 19.423N 155.322W 003                          3.30ML HVO                 613 F        052 95     8.
  HVO  1961  11 18 08 55 43.5H 19.778N 155.860W 003                          3.00ML HVO                 613 F        052 95    31.
  HVO  1961  11 18 15  4 14.9H 19.438N 155.312W 003                          3.00ML HVO                 613 F        052 95     4.
  USE  1961  11 22 17 22 30.3H 19.400N 155.283W 030                          3.80ML HVO                 613 F        052 95    63.
  USE  1961  11 22 14 44 01.9H 19.400N 155.283W 030                          3.00ML HVO                 613 F        052 95    63.
  USE  1961  11 22 20 55 55.5H 19.400N 155.283W 030                          3.20ML HVO                 613 F        052 95    63.
  USE  1961  11 24 02 27 30.5H 19.400N 155.283W 030                          3.60ML HVO                 613 F        052 95    63.
  USE  1961  11 24 03 34 55.7H 19.400N 155.283W 030                          3.30ML HVO                 613 F        052 95    63.
  USE  1961  11 24 02 14 30.6H 19.400N 155.283W 030                          3.80ML HVO                 613 F        052 95    63.
  USE  1961  11 25 23 32 10.0H 19.400N 155.283W 030                          3.70ML HVO                 613 F        052 95    67.
  USE  1961  11 27 14 31 24.5H 19.400N 155.283W 030                          3.40ML HVO                 613 F        052 95    63.
  USE  1961  12 05  4 57 55.5H 19.400N 155.283W 030                          3.00ML HVO                 613 F        052 95    63.
  USE  1961  12 12 07 55 31.5H 19.400N 155.283W 030                          3.00ML HVO                 613 F        052 95    63.
  USE  1961  12 15 21 17 57.4H 19.400N 155.283W 030                          3.20ML HVO                 613 F        052 95    63.
  HVO  1961  12 17 17 57 50.5H 19.630N 155.833W 013                          3.40ML HVO                 613 F        052 95    18.
  USE  1961  12 31 16 03 23.2H 19.783N 155.533W 038                          3.00ML HVO                 613 F        052 95    51.
  USE  1961  12 31 18 52 09.9H 19.400N 155.283W 030                          3.90ML HVO                 613 F        052 95    63.
  USE  1962  01 07 12 57 53.4H 19.408N 155.752W 005                         *4.30ML HVO     IV          613 F        052 95    87.
  USE  1962  02 07 20 06 30.2H 19.400N 155.285W 030                          3.50ML HVO                 613 F        052 95    63.
  USE  1962  03 13 14 45 10.3H 19.727N 155.838W 015                         *4.00ML HVO                 613 F        052 95    37.
  USE  1962  03 24       06 40.5H 19.400N 155.285W 030*                     *4.40ML HVO                 613 F        052 95    63.
  USE  1962  03 31 14 15 55.1H 19.402N 155.918W 030*                        *4.50ML HVO                 613 F        052 95     8.
  USE  1962  04 24 13 04 57.1H 19.400N 155.617W 015                         *4.00ML HVO                 613 F        052 95    29.
  USE  1962  05 17 15 56 14.9H 19.402N 155.285W 030*                        *4.30ML HVO                 613 F        052 95    63.
  USE  1962  05 11 16 17 23.4H 19.402N 155.285W 030                          3.70ML HVO                 613 F        052 95    63.
  USE  1962  05 23 21 17 05.3H 19.542N 155.425W 012                          3.50ML HVO                 613 F        052 95    10.
  USE  1962  05 24 19 50 06.9H 19.352N 155.365W 045                          3.70ML HVO                 613 F        052 95    57.
  USE  1962  05 30 07 11 08.7H 19.387N 155.500W 008                          3.60ML HVO                 613 F        052 95    41.
  USE  1962  06 09 09 35 21.7H 19.217N 155.217W 005                          3.90ML HVO                 613 F        052 95    75.
  USE  1962  06 09 07 43 16.5H 19.400N 155.417W 005                          3.50ML HVO                 613 F        052 95    49.
  USE  1962  06 14    34 53.3H 19.417N 155.285W 030*                        *4.30ML HVO                 613 F        052 95    63.
  USE  1962  06 28 13 38 56.7H 19.400N 155.417W 005                          3.70ML HVO                 613 F        052 95    49.
  USE  1962  07 14 14 40 41.3H 19.200N 155.631W 005                          3.50ML HVO                 613 F        052 95    36.
01/07/17.                                                           PAGE    2
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SOURCE YEAR  MO DA HR MN SEC      LAT     LONG   DEPTH ---------MAGNITUDES---------           INT PHENOM  RN CE Q/S  MAR DG   DIST
                                                 (KM)   BODY  SURF   OTHER   LOCAL            MAX DTSVVO                         (KM)
***I INDICATES A POSSIBLE DUPLICATE
  USE  1962  07 14 17 37 53.1H 19.740N 155.637W 010                          *4.00ML HVO                 613 F       052 95    40.
  USE  1962  07 24 09 52 41.1H 19.492N 155.987W 005                          *4.50ML HVO                 613 F       052 95    11.
  USE  1962  07 31 12 46 43.0H 19.425N 155.000W 005                           3.50ML HVO                 613 F       052 95    93.
  USE  1962  07 31 13 24 15.6H 19.333N 155.082W 005                           3.70ML HVO                 613 F       052 95    85.
  USE  1962  08 16 09 30 06.5H 19.160N 155.533W 006                         **4.00ML HVO                 613 F       052 95    49.
  USE  1962  08 19 00 56 41.9H 19.303N 155.195W 008                          *4.60ML HVO                 613 F       052 95    74.
  USE  1962  09 06 11 56 58.0H 19.338N 155.142W 008                          *4.10ML HVO                 613 F       052 95    91.
  USE  1962  09 11 05 11 15.0H 19.333N 155.105W 003                           3.60ML HVO                 613 F       052 95    83.
  USE  1962  09 11 17 22 49.6H 19.477N 155.233W 003                           3.70ML HVO                 613 F       052 95    68.
  USE  1962  09 11 17 25 27.5H 19.477N 155.233W 004                           3.60ML HVO                 613 F       052 95    66.
  USE  1962  09 20 00 02 37.3H 19.083N 155.076W 012                           3.70ML HVO                 613 F       052 95    55.
  USE  1962  09 25 23 22 50.4H 19.252N 155.503W 008                           3.50ML HVO                 613 F       052 95    46.
  USE  1962  10 19 16 43 29.5H 19.668N 156.100W 012                           3.60ML HVO                 613 F       052 96    32.
  USE  1962  10 31 23 30 50.0H 19.197N 155.550W 003                           3.70ML HVO                 613 F       052 95    46.
  USE  1962  11 22 11 36 55.2H 20.000N 155.190W 012                          *3.70ML HVO                 613 F       066 05    55.
  USE  1962  11 30 05 16 21.7H 19.333N 155.263W 005                          *4.10ML HVO                 613 F       052 95    65.
  USE  1962  12 14 06 21 31.7H 19.322N 155.353W 007                           3.50ML HVO                 613 F       052 95    62.
  USE  1962  12 24 07 36 15.7H 19.402N 155.295W 030                           3.70ML HVO                 613 F       052 95    63.
  USE  1962  12 26 11 04 10.1H 19.376N 155.013W 006                          *4.10ML HVO                 613 F       052 95    66.
  USE  1962  12 31 03 47 19.0H 19.233N 155.596W 003                          *4.00ML HVO                 613 F       052 95    40.
  USE  1963  01 19 19 34 44.0H 19.411N 155.285W 030*                         *4.30ML HVO                 613 F       052 95    63.
  USE  1963  01 29 11 41 06.2H 19.411N 155.295W 030*                         *4.20ML HVO                 613 F       052 95    63.
  USE  1963  03 13 00 57 26.9H 19.413N 155.500W 005                           3.50ML HVO                 613 F       052 95    41.
  HVO  1963  03 22 20 54 40.5H 19.341N 155.131W 012                           3.60ML HVO                 613 F       052 95    10.
  USE  1963  03 26 06 31 51.8H 19.750N 155.563W 012                          *4.50ML HVO                 613 F       052 95    46.
  HVO  1963  03 25 17 16 35.0H 20.700N 155.333W 035                           3.90ML HVO                 613 F       066 06   147.
  HVO  1963  03 31 02 35 57.5H 20.017N 155.881W 008                           3.70ML HVO                 613 F       066 05    61.
  USE  1963  05 19 12 21 27.5H 19.245N 155.016W 006                           3.90ML HVO                 613 F       052 95    45.
  USE  1963  06 07 16 25 36.0H 19.196N 155.551W 003                          *4.20ML HVO                 613 F       052 95    46.
  USE  1963  06 24 21 17 57.0H 19.437N 155.279W 030                           3.70ML HVO                 613 F       052 95    63.
  USE  1963  07 11 12 43 57.5H 19.355N 155.166W 003                           3.80ML HVO                 613 F       052 95    79.
  USE  1963  07 11 15 10 14.7H 19.366N 155.235W 003                           3.50ML HVO                 613 F       052 95    69.
  CGS  1963  08 26 16 49 16.6  19.600N 155.600W 005  *4.90MB                 *                           613 F  012  052 95    47.
  USE  1963  09 13 02 54 32.6H 19.400N 155.401W 005                           3.60ML HVO                 613 F       052 95    51.
  HVO  1963  09 06 13 31 01.6H 19.495N 156.048W 003                           3.60ML HVO                 613 F       052 96    16.
  USE  1963  09 14 16 07 57.5H 19.548N 155.543W 012                           3.50ML HVO                 613 F       052 95    55.
  CGS  1963  09 21 15 24 24.1  19.210N 155.500W 005  *4.80MB                                              613 F  011  052 95    50.
  USE  1963  09 22 14 26 17.4H 19.410N 155.471W 005                           3.50ML HVO                 613 F       052 95    51.
  USE  1963  09 22 16 27 24.4H 19.410N 155.401W 005                           3.50ML HVO                 613 F       052 95    51.
  USE  1963  1  18 16 33 33.7H 19.275N 155.175W 005                           3.70ML HVO                 613 F       052 95    60.
  USE  1963  1  12 02 52 47.3H 19.139N 155.183W 008                           3.60ML HVO                 613 F       052 95    51.
  CGS  1963  1  23 20 24 15.5  19.400N 155.500W 005  *5.30MB                                              613 F  019  052 95    41.
  USE  1963  1  23 21 24 47.0H 19.400N 155.401W 005                           3.60ML HVO                 613 F       052 95    51.
  USE  1963  1  24 04 25 26.5H 19.400N 155.401W 005                           3.50ML HVO                 613 F       052 95    51.
  USE  1963  1  26 01 09 34.0H 19.400N 155.401W 005                           3.80ML HVO                 613 F       052 95    51.
  USE  1963  1  26 20 03 54.7H 19.400N 155.401W 00                            3.50ML HVO                 613 F       052 95    51.
  HVO  1963  11 14 07 23 25.4H 20.155N 155.450W 012                           3.75ML HVO                 613 F       066 05    69.
  USE  1963  11 15 19 01 26.5H 19.401N 155.285W 030                           3.60ML HVO                 613 F       052 95    63.
  USE  1963  11 30 04 12 59.0H 19.335N 155.130W 008                           3.60ML HVO                 613 F       052 95    60.
  USE  1964  01 07 11 06 25.0H 19.300N 155.225W 019                           3.70ML HVO                 613 F  009  052 95    71.
01/27/17.                                          PAGE   3
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SOURCE YEAR  MO DA HR MN SEC      LAT      LONG  DEPTH ----------MAGNITUDES---------.          INT PHENOM  RN CE Q/S  MAR DG  DIST
                                                 (KM)  BODY   SURF   OTHER  LOCAL              MAX DTSVNO                       (KM)
**N INDICATES A POSSIBLE DUPLICATE
  USE  1964  02 21 08 31 44.5H 20.700N 155.833W 012                          •4.30ML HVO                 613 F       088 05  137.
  USE  1964  03 10 16 54 38.0H 19.275N 155.182W 008                           3.60ML HVO                 613 F       052 95   76.
  USE  1964  03 12 05 30 56.4H 19.292N 155.397W 010                           3.70ML HVO                 613 F       052 95   85.
  USE  1964  04 01 12 28 53.0H 19.400N 155.417W 033                           3.90ML HVO                 613 F       052 95   49.
  USE  1964  06 04 18 34 31.9H 19.447N 155.280W 045                          •4.00ML HVO                 613 F       052 95   63.
  USE  1964  06 04 21 22 30.0H 19.320N 155.087W 008                           3.80ML HVO                 613 F       052 95   85.
  USE  1964  06 08 22 30 57.5H 19.630N 155.418W 008                          •4.10ML HVO                 613 F       052 95   52.
  USE  1964  07 01 20 43 34.5H 19.313N 155.115W 005                          •4.50ML HVO                 613 F       052 95   82.
  USE  1964  07 17 23 10 56.4H 19.592N 155.587W 013                          •4.50ML HVO                 613 F       052 95   49.
  USE  1964  07 29 04 05 50.2H 19.429N 155.260W 025                           3.50ML HVO                 613 F       052 95   65.
  USE  1964  08 03 20 36 08.7H 19.198N 155.558W 008                           3.50ML HVO                 613 F       052 95   45.
  CGS  1964  08 13 16 27 35.4  19.500N 155.400W 011 •4.10MB                  •4.50ML HVO                 613 F  014  052 95   51.
  USE  1964  08 26 15 30 45.5H 20.233N 156.150W 012                          •4.40ML HVO                 613 F       088 06   90.
  USE  1964  09 01 16 39 13.5H 19.452N 154.925W 005                           3.70ML HVO                 613 F       052 94  100.
  USE  1964  09 14 05 42 12.0H 19.442N 154.937W 003                           3.80ML HVO                 613 F       052 94   99.
  USE  1964  09 15 10 05 29.0H 19.315N 155.115W 005                          •4.90ML HVO                 613 F       052 95   82.
  USE  1964  09 19 12 07 56.4H 19.299N 155.122W 005                           3.60ML HVO                 613 F       052 95   82.
  HVO  1964  10 11 10 06 42.0H 19.700N 156.017W 013                          •5.50ML HVO                 613 F       052 66  111.
  USE  1964  10 19 02 20 17.0H 19.33 N 155.095W 005                           3.70ML HVO                 613 F       052 95   84.
  USE  1964  10 24 05 17 22.0H 19.118N 155.413W 030                           3.60ML HVO                 613 F       052 95   76.
  USE  1964  10 27 19 33 01.0H 19.400N 155.295W 030                           3.70ML HVO                 613 F       052 95   63.
  USE  1964  12 03 10 28 40.0H 19.401N 155.265W 030                          •4.70ML HVO                 613 F       052 95   63.
  USE  1964  12 03 14 31 43.3H 19.402N 155.265W 030                           3.50ML HVO                 613 F       052 95   63.
  USE  1964  12 03 15 58 00.5H 19.402N 155.265W 030                          •4.00ML HVO                 613 F       052 95   63.
  USE  1964  12 10 11 53 45.0H 19.778N 155.273W 010                          •5.00ML HVO                 613 F       052 95   73.
  USE  1964  12 14 05 30 19.7H 19.308N 155.925W 003                           3.80ML HVO                 613 F       052 95   10.
  USE  1965  01 01 14 27 45.4H 19.205N 155.423W 013                           3.90ML HVO                 613 F       052 95   61.
  HVO  1965  01 14 08 20 20.2  20.005N 155.442W 022                           3.60ML HVO                 613 F       088 05   70.
  USE  1965  01 25 08 08 13.0H 19.765N 155.578W 013                           3.90ML HVO                 613 F       052 95   47.
  USE  1965  02 19 19 40 31.0H 19.683N 155.590W 013                           3.70ML HVO                 613 F       052 95   56.
  HVO  1965  02 13 23 06 29.3  19.790N 155.067W 013                          •4.50ML HVO                 613 F       052 85  103.
  USE  1965  03 06 11 12 12.0H 19.059N 155.020W 005                          •4.00ML HVO                 613 F       052 95   73.
  USE  1965  03 31 05 37 15.0H 19.365N 155.412W 007                           3.70ML HVO                 613 F       052 95   51.
  USE  1965  03 22 17 33 12.9H 19.323N 155.538W 0 0                          •4.60ML HVO                 613         052 95   45.
  USE  1965  04 17 02 17 27.9H 19.360N 155.278W 031                           3.70ML HVO                 613 F       052 95   64.
  HVO  1965  05 16 14 27 30.7  19.700N 156.039W 008                           3.50ML HVO                 613 F       052 96   33.
  USE  1965  05 18 19 09 40.4H 19.337N 155.445W 008                           3.50ML HVO                 613 F       052 95   48.
  USE  1965  05 25 08 17 30.4H 19.302N 155.100W 020                           3.60ML HVO                 613 F       052 95   82.
  USE  1965  06 08 01 40 43.0H 19.377N 155.023W 025                           3.50ML HVO                 613 F       052 95   59.
  HVO  1965  07 07 01 31 36.0  20.727N 156.500W 013                           3.60ML HVO                 613 F       088 06  133.
  USE  1965  07 15 23 32 04.1H 19.300N 155.038W 0 0                           3.80ML HVO                 613         052 95   6 .
  USE  1965  07 22 02 27 04.2H 19.335N 155.510W 003                          •4.30ML HVO                 613 F       052 95   42.
  USE  1965  08 11 22 18 10.5H 19.095N 155.107W 003                           3.70ML HVO                 613 F       052 95   91.
  USE  1965  08 23 21 25 07.9H 19.290N 155.197W 010                           3.60ML HVO                 613 F       052 95   75.
  USE  1965  08 25 11 34 17.0H 19.320N 155.163W 008                           3.60ML HVO                 613 F       052 95   77.
  USE  1965  08 25 12 59 35.3H 19.317N 155.152W 005                           3.50ML HVO                 613 F       052 95   78.
  USE  1965  08 31 04 00 57.0H 19.363N 155.333W 032                           3.80ML HVO                 613 F       052 95   59.
  USE  1965  09 02 11 42 40.0H 19.285N 155.163W 003                           3.70ML HVO                 613 F       052 95   90.
  USE  1965  11 23 19 09 59.3H 19.350N 155.328W 031                           3.90ML HVO                 613 F       052 95   59.
  USE  1965  12 02 12 38 17.7H 19.779N 154.940W 045                           3.80ML HVO                 613 F       052 94  105.
81/07/17.                                               PAGE    4
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SOURCE YEAR  MO DA HR MN SEC      LAT       LONG   DEPTH ----------MAGNITUDES----------          INT FFENOM  RN CE G/S  MAR DG   DIST
                                                   (KM)   BODY   SURF    OTHER   LOCAL        MAX DTSVNO                        (KM)
**% INDICATES A POSSIBLE DUPLICATE
   CGS  1965  12 26 09 35 37.3   19.400N 155.200W 003  *4.30MB                                           613 F  011  052 95    72.
   USE  1966  01 08 23 43 57.3H  19.438N 155.478W 008                          3.50ML HVO                613 F       052 95    42.
   USE  1966  01 19 12 44 10.2H  19.405N 155.328W 013                         *4.00ML HVO                613 F       052 95    58.
   USE  1966  01 20 00 01 37.4H  19.397N 155.558W 013                         *4.10ML HVO                613 F       052 95    35.
   HVO  1966  01 22 07 02 26.9   19.465N 155.678W 008                          3.80ML HVO                613 F       052 95     0.
   USE  1966  02 13 05 56 16.3H  19.372N 155.310W 030                          3.70ML HVO                613 F       052 95    61.
   HVO  1966  02 22 01 59 33.3   19.845N 155.670W 033                          3.70ML HVO                613 F       052 95    48.
   USE  1966  03 01 06 00 11.0H  19.412N 155.453W 010                         *4.00ML HVO                613 F       052 95    45.
   HVO  1966  03 13 18 03 23.3   19.793N 155.767W 008                          3.70ML HVO                613 F       052 95    37.
   USE  1966  03 15 00 04 53.6H  19.317N 155.442W 008                         *4.10ML HVO                613 F       052 95    49.
   USE  1966  03 16 00 43 02.7H  19.377N 155.300W 032                          3.50ML HVO                613 F       052 95    62.
   USE  1966  05 27 11 05 46.0H  19.218N 155.060W 040                          3.70ML HVO                613 F       052 95    91.
   HVO  1966  06 19 07 21 26.9   19.352N 155.752W                              3.50ML HVO                613 F       052 95    15.
   USE  1966  07 01 15 04 28.5H  19.325N 155.455W 010                          3.70ML HVO                613 F       052 95    47.
   USE  1966  07 31 10 58 20.3H  19.417N 155.420W 008                         *4.30ML HVO                613 F       052 95    49.
   USE  1966  08 07 06 57 37.1H  19.4  N 154.  3W 03                           3.70ML HVO                613 F       052 94   103.
   USE  1966  08 15 07 15 41.2H  19.423N 154.918W 033                          3.50ML HVO                613 F       052 94   101.
   USE  1966  09 19 05 21 43.2H  19.3 3N 155.  8W 039                          3.50ML HVO                613 F       052 95    61.
   USE  1966  09 05 16 33 21.9H  19.363N 155.427W 008  *4.70MB                *4.50ML HVO                613 F       052 95    48.
   USE  1966  09 28 22 07 21.4H  19.473N 155.418W 005                          3.50ML HVO                613 F       052 95    49.
   USE  1966  10 03 13 47 17.2H  19.375N 155.992W 025                          3.50ML HVO                613 F       052 95    63.
   USE  1966  10 31 04 49 25.5H  19.320N 155.467W 009                         *4.90ML HVO                613 F       052 95    46.
   HVO  1966  11 05 19 42 30.0   19.830N 155.773W 003                          3.80ML HVO     V          613 F       052 95     4.
   USE  1966  11 17 15 17 03.1H  19.440N 154.933W                              3.50ML HVO                613 F       052 94   100.
   USE  1966  11 27 01 54 51.5H  19.302N 155.230W 010                          3.60ML HVO                613 F       052 95    71.
   HVO  1966  12 12 05 44 11.0   19.475N 155.573W 008                          3.70ML HVO                613 F       052 95     1.
   HVO  1966  12 13 15 41 15.0   19.266N 156.073W 008                          3.90ML HVO                613 F       052 96    48.
   USE  1966  12 26 17 01 32.0H  19.335N 155.117W 008                          3.50ML HVO                613 F       052 95    81.
   USE  1967  01 01 13 04 51.5H  19.392N 155.300W 022                          3.50ML HVO                613 F       052 95    61.
   USE  1967  01 21 05 13 19.6H  19.392N 155.333W 027                          3.50ML HVO                613 F       052 95    58.
   CGS  1967  02 22 01 37 41.5H  19.563N 155.092W 005  *4.60MB                *4.50ML HVO                613 F  042  052 95    84.
   CGS  1967  05 04 05 00 33.5H  19.374N 155.453W 008  *4.40MB                *4.50ML HVO                613    036  052 95    46.
   USE  1967  05 26 15 47 28.4H  19.485N 155.401W 007                          3.40ML HVO                613 F       052 95    77.
   USE  1967  06 03 20 22 16.4H  20.018N 155.267W 007                          3.10ML HVO                613 F       088 05    82.
   USE  1967  06 14 00 50 55.7H  19.716N 155.394W 005                          3.60ML HVO                613 F       052 95    72.
   USE  1967  06 24 17 49 05.5H  19.866N 155.568W 006                          3.20ML HVO                613 F       052 95    55.
   USE  1967  07 01 08 31 54.1H  19.361N 155.915W 02                           3.10ML HVO                613 F       052 95    64.
   CGS  1967  07 01 15 07 48.2   19.500N 155.300W 030  *4.20MB                *                          613    013  052 95    61.
   USE  1967  07 10 01 05 40.3H  19.450N 155.212W 025*                        *4.50ML HVO                613 F       052 95    71.
   USE  1967  07 13 01 10 03.0H  19.366N 155.355W 009                          3.50ML HVO                613 F       052 95    53.
   USE  1967  07 30 12 51 10.9H  19.383N 155.435W 009                         *4.10ML HVO                613 F       052 95    48.
   USE  1967  07 10 03 14 17.9H  19.552N 155.385W 020                          3.00ML HVO                613 F       052 95    63.
   USE  1967  07 12 02 54 23.0H  19.481N 155.617W 002                          3.20ML HVO                613 F       052 95    28.
   USE  1967  07 22 07 34 27.0H  19.351N 155.416W 008                          3.20ML HVO                613 F       052 95    50.
   USE  1967  08 14 05 27 09.6H  19.218N 155.545W 007                          3.30ML HVO                613 F       052 95    42.
   USE  1967  08 05 15 51 51.2H  19.745N 155.268W 026                          3.20ML HVO                613 F       052 95    65.
   USE  1967  08 15 05 23 32.6H  19.967N 155.384W 008                         *4.00ML HVO                613 F       052 95    76.
   USE  1967  08 18 06 41 21.7H  19.983N 155.368W 009                          3.90ML HVO                613 F       052 95    79.
   USE  1967  08 19 01 11 32.4H  19.960N 155.352W 003                          3.20ML HVO                613 F       052 95    79.
   USE  1967  08 19 02 07 39.4H  19.917N 155.384W 003                          3.30ML HVO                613 F       052 95    72.
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SOURCE YEAR  MO DA HR MN SEC       LA          L  G    DEPT  ---------MAGNITUDES---------              INT FFENOM  RN CE G/S  MAR DG   DIST
                                                       (KM)   BODY    SURF   OTHER    LOCAL           MAX DTSVNO                        (KM)
**N INDICATES A POSSIBLE DUPLICATE
    USE  1967  08 22 08 02 58.3F 19.150N 155.518W 008                          3.40ML HVO                  613 F        052 95      52.
    USE  1967  08 27 17 46 13.2F 19.302N 155.218W 008                          3.50ML HVO                  613 F        052 95      72.
    USE  1967  08 31 17 56 23.5F 19.318N 155.416W 009                          3.20ML HVO                  613 F        052 95      52.
    USE  1967  09 02 19 33 52.1H 19.352N 155.267W 030                          3.30ML HVO                  613 F        052 95      66.
    USE  1967  09 07 05 11 05.9H 19.255N 155.301W 030                          3.10ML HVO                  613 F        052 95      64.
**1 CGS  1967  09 08 12 22 29.9  19.300N 155.600W 017  •4.10MB                 •                           613     019  052 95      35.
**2 USE  1967  09 08 12 22 32.5F 19.417N 155.285W 013                          •4.00                       613 F        052 95      35.
    USE  1967  09 23 16 37 23.5F 19.283N 155.367W 010                          3.65ML HVO                  613 F        052 95      58.
    USE  1967  09 26 22 59 26.4F 19.350N 155.168W 045                          3.40ML HVO                  613 F        052 95      76.
    USE  1967  09 28 10 05 55.0H 19.423N 155.219W 025                          3.20ML HVO                  613 F        052 95      70.
    USE  1967  10 10 09 43 38.0F 19.383N 155.483W 010                          3.20ML HVO                  613 F        052 95      43.
    USE  1967  10 15 15 57 58.7F 19.417N 155.468W 005                          3.70ML HVO                  613 F        052 95      44.
    USE  1967  10 27 22 42 32.0F 19.333N 155.251W 032                          3.00ML HVO                  613 F        052 95      68.
    USE  1967  10 29 13 34 37.2  19.394N 155.552W 019                3.80                                  613 F        052 95      67.
    USE  1967  11 01 04 16 56.3F 19.350N 155.353W 025                          3.10ML HVO                  613 F        052 95      64.
    USE  1967  11 05 13 20 16.8F 19.400N 155.285W 005                          3.40ML HVO                  613 F        052 95      63.
    USE  1967  11 21 06 59 14.6F 19.350N 155.416W 010                          3.20ML HVO                  613 F        052 95      51.
    USE  1967  11 26 16 39 43.5F 19.338N 155.383W 009                          3.30ML HVO                  613 F        052 95      64.
    USE  1967  12 08 22 14 12.9F 19.334N 155.002W 010                          3.10ML HVO                  613 F        052 95      73.
    USE  1967  12 09 23  7 02.2F 19.415N 155.419W 005                          3.10ML HVO                  613 F        052 95      49.
    USE  1968  01 10 04 14 15.7F 19.118N 155.335W 007                          3.00ML HVO                  613 F        052 95      65.
    USE  1968  01 15 17 10 47.7F 19.300N 155.133W 010                          3.00ML HVO                  613 F        052 95      60.
    USE  1968  01 17 05 05 13.0H 19.287N 155.367W 040                          3.50ML HVO                  613 F        052 95      58.
    USE  1968  01 25 07 43 44.3F 19.350N 155.019W 008                          3.70ML HVO                  613 F        052 95      92.
    USE  1968  02 02 03 32 34.6F 19.434N 155.119W 039                          3.50ML HVO                  613 F        052 95      81.
    USE  1968  02 15 15 07 47.8F 19.350N 155.302W 034                          3.10ML HVO                  613 F        052 95      62.
    USE  1968  04 04 01 56 11.1H 19.393N 155.457W 008                          3.70ML HVO                  613 F        052 95      46.
    USE  1968  04 10 11 00 24.8F 19.358N 155.269W 027                          3.70ML HVO                  613 F        052 95      65.
    USE  1968  04 15 20 30 29.5F 19.250N 155.417W 016                          3.00ML HVO                  613 F        052 95      54.
    USE  1968  04 14 06 13 42.8F 19.366N 155.268W 029                          3.20ML HVO                  613 F        052 95      65.
    USE  1968  04 28 14 28 59.0F 19.365N 155.285W 030•                         •4.50ML HVO                 613 F        052 95      64.
    USE  1968  04 28 16 35 25.1H 19.412N 155.435W 008                          3.40ML HVO                  613 F        052 95      47.
    USE  1968  05 27 21 42 34.3F 19.417N 155.268W 032                          3.70ML HVO                  613 F        052 95      65.
    USE  1968  05 23 07 17 25.4F 19.335N 155.117W 009                          3.10ML HVO                  613 F        052 95      82.
    USE  1968  06 03 15 27 58.9F 19.366N 155.285W 030                          3.00ML HVO                  613 F        052 95      64.
    USE  1968  06 19 14 34 16.7F 19.400N 155.264W 005                          3.00ML HVO                  613 F        052 95      63.
    USE  1968  07 02 20 55 08.3  20.000N 155.817W 008                3.40                                  613 F        086 05      69.
    USE  1968  07 10 07 22 17.2F 19.217N 155.218W 013                          3.50ML HVO                  613 F        052 95      72.
    USE  1968  07 22 07 15 24.0F 19.448N 155.055W 010                          3.30ML HVO                  613 F        052 95      88.
    USE  1968  07 29 16 21 11.9F 19.333N 155.065W 009                          3.30ML HVO                  613 F        052 95      64.
    USE  1968  07 30 05 35 44.7F 19.350N 155.101W 010                          3.70ML HVO                  613 F        052 95      63.
    USE  1968  08 01 16 34 37.8H 19.333N 155.102W 010G •4.00MB                 •4.00ML HVO                 613 F   022  052 95      83.
    USE  1968  08 03 04 36 55.4F 19.859N 155.916W 040G               3.80                                  613 F   017  052 95      43.
    USE  1968  08 05 20 37 19.0  19.900N 155.883W 005                3.10                                  613 F        052 95      48.
    USE  1968  08 07 20 58 25.0  19.316N 155.300W 003               •4.40      •.                          613 F        052 95      19.
    USE  1968  08 09 11 04 53.4F 19.354N 155.283W 030G••4.10MB                 3.70ML HVO                  613 F   018  052 95      63.
    USE  1968  08 18 23 14 00.4F 19.400N 155.283W 015                          3.20ML HVO                  613 F        052 95      63.
    USE  1968  08 17 02 23 37.6F 19.853N 155.369W 008                          •4.10ML HVO                 613 F        052 95      71.
    USE  1968  08 21 02 29 47.9H 19.353N 155.416W 009                          3.30ML HVO                  613 F        052 95      50.
    USE  1968  09 21 21 29 56.0F 19.133N 155.601W 008                          3.00ML HVO                  613 F        052 95      43.
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SOURCE YEAR  MO DA HR MN SEC       LAT      LONG  DEPTH ----------MAGNITUDES----------          INT FFENOM  RN CE Q/S  MAR DG   DIST
                                                  (KM)   BODY   SURF   OTHER    LOCAL         MAX DTSVNO                     (KM)
**N INDICATES A POSSIBLE DUPLICATE
   USE  1968  08 22 14 09 56.0H 19.367N 155.233W 004                           3.00ML HVO                   613 F      052 95    69.
   USE  1968  09 03 00 56 23.4H 19.350N 155.450W 006                           3.10ML HVO                   613 F      052 95    47.
   USE  1968  09 05 16 12 43.7H 19.952N 155.365W 008                           3.20ML HVO                   613 F      052 95    75.
   USE  1968  09 08 23 38 44.3H 19.433N 155.268W 020                           3.70ML HVO                   613 F      052 95    64.
   USE  1968  09 24 04 11 53.3  20.167N 155.801W 008                  *4.10    *                            613 F      068 05    78.
   USE  1968  10 26 00 47 09.9H 19.152N 155.501W 006                           3.70ML HVO                   613 F      052 95    53.
   USE  1968  11 10 20 28 45.4H 19.401N 155.484W 007                           3.30ML HVO                   613 F      052 95    42.
   USE  1968  11 19 09 52 59.0H 19.217N 154.966W 007                          *4.30ML HVO                   613 F      052 94   100.
   USE  1968  11 20 06 43 21.1H 19.368N 155.300W 030                           3.70ML HVO                   613 F      052 95    62.
   USE  1968  12 17 02 33 03.5H 19.319N 155.205W 010                          *4.70ML HVO                   613 F  037 052 95    73.
   USE  1968  12 20 08 15 11.1H 19.333N 155.102W 009                           3.50ML HVO                   613 F      052 95    83.
   USE  1969  01 06 03 25 00.2H 19.318N 155.217W 010                           3.60ML HVO                   613 F      052 95    72.
   USE  1969  01 15 07 37 06.0H 19.785N 155.502W 009                           3.80ML HVO                   613 F      052 95    53.
   USE  1969  01 23 15 55 26.0H 19.367N 155.465W 008                           3.20ML HVO                   613 F      052 95    43.
   USE  1969  01 28 17 34 37.1H 19.470N 155.452W 006                          *3.20ML HVO                   613        052 95    51.
  *USE  1969  02 07 08 53 51.1H 19.270N 155.350W 045                           3.50ML HVO                   613 F      052 95    63.
   USE  1969  02 07 11 49 56.5H 19.380N 155.383W 030                           3.50ML HVO                   613 F      052 95    54.
   USE  1969  02 09 05 55 42.3H 19.334N 155.150W 012                           3.30ML HVO                   613 F      052 95    76.
   USE  1969  02 10 12 04 42.2H 19.133N 155.133W 010 *4.50MB                  *4.10ML HVO                   613 F  018 052 95    60.
   USE  1969  02 17 11 42 06.6H 19.571N 155.016W 010                           3.30ML HVO                   613 F      052 95    72.
   CGS  1969  02 22 22 24 15.1  19.434N 156.025W 013  3.90MB                   3.50ML HVO                   613    013 052 96    61.
   USE  1969  02 23 17 33 35.0H 19.312N 155.401W 010                           3.70ML HVO                   613 F      052 95    54.
   USE  1969  03 01 13 41 41.9H 19.413N 155.433W 008                           3.70ML HVO                   613 F      052 95    47.
   USE  1969  03 05 04 15 10.3  18.914N 155.414W 035                   3.60                                 613 F      052 95    68.
   USE  1969  03 11 13 35 07.6H 19.314N 155.269W 027                           3.50ML HVO                   613 F      052 95    65.
   USE  1969  03 12 20 11 12.2H 19.217N 155.452W 008                           3.70ML HVO                   613 F      052 95    53.
   USE  1969  04 13 07 31 57.0H 19.573N 155.435W 006                           3.40ML HVO                   613 F      052 95    47.
   USE  1969  04 23 14 45 25.1H 19.402N 155.451W 008                           3.20ML HVO                   613 F      052 95    46.
   USE  1969  05 05 11 07 13.6H 19.414N 155.619W 006                           3.70ML HVO                   613 F      052 95    28.
   USE  1969  05 13 01 35 27.6H 19.366N 155.169W 011 *4.90MB                  *5.00ML HVO                   613 F  049 052 95    86.
   USE  1969  05 13 14 51 43.9H 19.300N 155.017W 019                           3.10ML HVO                   613 F      052 95    93.
   USE  1969  05 17 05 39 46.0H 19.935N 155.065W 047                           3.00ML HVO                   613 F      052 95    96.
   USE  1969  05 17 22 32 51.4H 19.235N 155.417W 034                           3.60ML HVO                   613 F      052 95    55.
   USE  1969  05 23 13 07 26.6H 19.034N 155.034W 012                           3.60ML HVO                   613 F      052 95   101.
   USE  1969  05 25 03 59 59.0H 19.318N 155.118W 005                           3.80ML HVO                   613 F      052 95    82.
   USE  1969  05 25 13 43 15.1H 19.315N 155.533W 009                           3.70ML HVO                   613 F      052 95    38.
   USE  1969  05 26 14 21 49.7H 19.334N 155.118W 004                           3.30ML HVO                   613 F      052 95    81.
   USE  1969  05 27 19 17 20.0H 19.414N 155.264W 015                           3.30ML HVO                   613 F      052 95    63.
   USE  1969  06 03 03 23 51.0H 19.333N 155.119W 011                           3.30ML HVO                   613 F      052 95    61.
   USE  1969  06 04 13 32 50.0H 19.311N 155.201W 017                           3.70ML HVO                   613 F      052 95    74.
   USE  1969  06 05 00 43 41.3H 19.317N 155.216W 009                           3.70ML HVO                   613 F      052 95    72.
   USE  1969  06 06 19 41 46.9H 19.416N 155.450W 011                          *4.40ML HVO                   613 F      052 95    46.
   CGS  1969  06 26 21 55 31.0  19.350N 155.288W 010 *4 00MB                  *4.20ML HVO                   613 F  012 052 95    63.
   USE  1969  06 27 11 41 26.2H 19.267N 155.163W 017                          *4.00ML HVO                   613 F      052 95    77.
   USE  1969  07 01 05 04 53.1H 19.945N 155.102W 061                           3.40ML HVO                   613 F      052 95    97.
   USE  1969  07 01 10 00 44.4H 19.351N 155.050W 007                           3.80ML HVO                   613 F      052 95    88.
   USE  1969  07 03 16 57 30.6H 19.382N 155.200W 005                           3.00ML HVO                   613 F      052 95    73.
   USE  1969  07 05 21 37 24.2H 19.325N 155.351W 032                           3.50ML HVO                   613 F      052 95    58.
   USE  1969  07 13 11 22 33.0H 19.200N 155.565W 009                          *4.20ML HVO                   613 F      052 95    44.
   USE  1969  07 20 14 47 13.1  19.365N 155.902W 010                   3.60                                 613 F      052 95     9.
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SOURCE YEAR  MO DA HR MN SEC      LAT      LONG   DEPTH ---------MAGNITUDES---------           INT PHENOM  RN CE Q/S  MAR DG   DIST
                                                   (KM)   BODY   SURF   OTHER   LOCAL         MAX DTSVNO                        (KM)
**N INDICATES A POSSIBLE DUPLICATE
   USE  1969  09 07 04 42 17.2  19.685N 156.035W 004                3.50                                 613 F      052 96    29.
   USE  1969  09 13 19 40 29.4H 19.333N 155.416W 031·                     •4.30ML HVO                    613 F      052 95    51.
   USE  1969  10 11 22 00 07.2  20.333N 155.050W 005                3.00                                 613 F      088 05   130.
   USE  1969  10 14 22 55 31.9H 19.369N 155.067W 008                      •4.00ML HVO                    613 F      052 95    86.
   USE  1969  10 22 13 26 30.0H 19.368N 155.384W 011                       3.30ML HVO                    613 F      052 95    53.
   USE  1969  11 05 15 21 24.6H 19.969N 155.351W 009                       3.60ML HVO                    613 F      052 95    79.
   USE  1969  11 10 05 12 12.2H 19.166N 155.501W 006                      •4.50ML HVO                    613 F      052 95    52.
   USE  1969  11 11 07 20 25.7H 19.952N 155.350W 010                       3.10ML HVO                    613 F      052 95    78.
   USE  1969  11 23 00 05 44.0H 19.551N 155.083W 017                       3.60ML HVO                    613 F      052 95    64.
   USE  1969  11 23 23 34 16.0H 19.883N 155.516W 032                       3.20ML HVO                    613 F      052 95    60.
   USE  1969  11 24 19 12 22.9  19.685N 156.051W 035•              •4.50                                 613 F      052 96    30.
   USE  1969  12 01 09 56 23.3H 19.952N 155.334W 009                       3.50ML HVO                    613 F      052 95    79.
   USE  1969  12 07 08 34 29.9H 19.333N 155.130W 010                       3.10ML HVO                    613 F      052 95    83.
   USE  1969  12 23 05 39 34.1H 19.510N 155.135W 025                       3.20ML HVO                    613 F      052 95    78.
   USE  1969  12 25 13 23 26.7H 19.351N 155.263W 032                       3.30ML HVO                    613 F      052 95    64.
   USE  1969  12 26 12 37 44.0H 19.316N 155.285W 019                      •4.10ML HVO                    613 F      052 95    70.
   USE  1969  12 27 14 [illegible] 52.7H 19.333N 155.469W 010                       3.60ML HVO                    613 F      052 95    46.
   HVO  1970  01 02 12 00 32.5  19.416N 155.835W 007                       3.3 ML HVO                    613        052 95    26.
●  USE  1970  01 02 22 30 32.6H 19.343N 155.601W 011                       3.30ML HVO                    613 F      052 95    31.
   HVO  1970  01 03 15 36 23.4  19.308N 155.111W 007                       3.2 ML HVO                    613        052 95    84.
   HVO  1970  01 07 05 57 29.0  19.375N 155.117W 008                       3.1 ML HVO                    613        052 95    82.
   HVO  1970  01 27 09 09 10.1  19.321N 155.115W 007                       3.6 ML HVO                    613        052 95    82.
●  USE  1970  01 27 19 19 09.1H 19.264N 155.185W 004                       3.80ML HVO                    613 F      052 95    86.
   HVO  1970  02 03  6 37 23.7  19.488N 155.863W 009                       3.3 ML HVO                    613        052 95     3.
   HVO  1970  02 03 07 07 17.2  19.346N 155.475W 011                       3.4 ML HVO          F         613        052 95    44.
   HVO  1970  02 04 16 16 28.2  19.4 0N 155.170W 029                       3.1 ML HVO          E         613        052 95    61.
●  USE  1970  02 04 16 18 35.2H 19.347N 155.310W 028                       3.10ML HVO                    613 F      052 95    62.
   HVO  1970  02 15 [illegible] 53.8  19.356N 155.477W 009                       3.4 ML HVO          E         613        052 95    44.
●  USE  1970  02 15 10 20 53.3H 19.354N 155.467W 008                       3.50ML HVO                    613 F      052 95    46.
   HVO  1970  02 17 20 40 35.0  19.347N 155.252W 029                       3.3 ML HVO          E         613        052 95    67.
●  USE  1970  02 18 06 42 35.2H 19.367N 155.267W 027                       3.40ML HVO                    613 F      052 95    65.
   HVO  1970  02 23 16 08 41.0  19.435N 154.793W 003                       3.4 ML HVO                    613        052 94   114.
   HVO  1970  02 28 16 59 21.8  18.967N 156.144W 045                       3.4 ML HVO                    613        052 86    64.
   HVO  1970  03 02 14 33 17.2  19.513N 154.935W 041                       3.9 ML HVO                    613        052 94    99.
   HVO  1970  03 02 19 30 11.5  19.372N 155.274W 030                       3.0 ML HVO          E         613        052 95    65.
●  USE  1970  03 03 00 30 02.7  20.039N 155.651W 008              •4.00   •                             613 F      086 05    71.
   HVO  1970  03 07 02 17 01.4  19.489N 154.860W 001                       3.1 ML HVO                    613        052 94   107.
   HVO  1970  03 15 [illegible] 41.0  19.37 N 155.348W 008                      •4.0 ML HVO                    613        052 95    88.
●  USE  1970  03 16 18 33 30.7H 19.349N 155. 61W 007                      •4.10ML HVO                    613 F      052 95    88.
   USE  1970  03 17 18 46 20.0H 19.734N 155.268W 030                       3.00ML HVO                    613 F   -  052 95    66.
   HVO  1970  03 30 02 30 26.9  19.550N 155.257W 024•                     •4.0 ML HVO          E         613        052 95    66.
●  USE  1970  03 31 22 35 26.7H 19.513N 155.051W 028•                     •4.30ML HVO                    613 F      052 95    66.
   HVO  1970  03 31 22 3  [illegible] 19.333N 155.056W 008                       3.7 ML HVO                    613        052 95    88.
●  USE  1970  04 01 08 30 02.3H 19.314N 155.055W 007                       3.80ML HVO                    613 F      052 95    69.
   HVO  1970  04 06 01 10 11.0  19.324N 155.155W 009                       3.0 ML HVO                    613        052 95    78.
   HVO  1970  04 12 09 13 43.8  19.402N 155.433W 010                      •4.2 ML HVO          E         613        052 95    48.
●  USE  1970  04 12 19 13 43.7H 19.349N 155.417W 011                      •4.30ML HVO                    613 F      052 95    50.
   HVO  1970  04 13 01 09 48.4  19.415N 155.423W 009                       3.0 ML HVO          E         613        052 95    48.
   HVO  1970  04 14 11 07 57.5  19.433N 155.334W 021                       3.5 ML HVO          E         613        052 95    68.
   HVO  1970  04 14 11 38 25.1  19.088N 156.167W 039                       3.1 ML HVO                    613        052 96    52.
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SOURCE YEAR  MO DA HR MN SEC       LA        LONG  DEPT  ---------MAGNITUDES---------          INT PHENOM  RN CE Q/S  MAR DG   DIST
                                                   (KM)  BODY   SURF   OTHER    LOCAL          MAX DTSVNO                       (KM)
**N INDICATES A POSSIBLE DUPLICATE
● USE  1970  04 14 21 07 57.4H 19.451N 155.234W 024                        3.60ML HVO                 613 F      052 95    68.
  HVO  1970  04 15 04 28 31.9  20.033N 155.571W 011                        3.0 ML HVO                 613        088 05    71.
  HVO  1970  04 16 02 25 33.5  19.335N 155.248W 029                        3.0 ML HVO                 613        052 95    68.
● USE  1970  04 16 12 25 33.5H 19.302N 155.250W 028                        3.20ML HVO                 613 F      052 95    69.
  HVO  1970  04 17 12 12 13.6  19.558N 155.690W 009                       *4.0 ML HVO                 613        052 95    10.
● USE  1970  04 17 22 12 13.5  19.518N 155.916W 010              *4.10                                613 F      052 95     7.
  HVO  1970  04 19 05 39 35.8  19.273N 155.427W 027                        3.0 ML HVO                 613        052 95    52.
● USE  1970  04 19 15 30 35.8H 19.251N 155.418W 026                        3.20ML HVO                 613 F      052 95    54.
  HVO  1970  04 24 20 28 15.0  20.248N 156.375W 017                        3.2 ML HVO                 613        088 06   101.
  HVO  1970  04 26 02 26 07.0  19.417N 155.425W 009                        3.1 ML HVO              E  613        052 95    48.
  HVO  1970  04 26 15 23 02.0  19.401N 154.638W 002                        3.7 ML HVO                 613        052 94   131.
● USE  1970  04 29 01 23 25.3H 19.435N 154.902W 002                        3.50ML HVO                 613 F      052 94   103.
  HVO  1970  04 30 05 32 14.1  19.335N 155.098W 008                        3.1 ML HVO                 613        052 95    84.
  HVO  1970  04 30 06 27 01.1  19.378N 155.081W 011                        3.8 ML HVO                 613        052 95    85.
● USE  1970  04 30 16 07 01.6H 19.367N 155.118W 011                       *3.90ML HVO                 613 F      052 95    81.
  HVO  1970  04 30 21 13 33.7  19.227N 155.395W 037                        3.8 ML HVO                 613        052 95    58.
  HVO  1970  05 01 04 11 57.8  20.051N 155.463W 034                        3.6 ML HVO                 613        088 05    65.
● USE  1970  05 01 11 11 59.2  20.052N 155.483W 034               3.70                                613 F      088 05    65.
  USE  1970  05 02 08 47 33.9H 19.484N 155.084W 017                        3.00ML HVO                 613 F      052 95    63.
  HVO  1970  05 03 04 26 32.5  20.033N 155.409W 040                        3.1 ML HVO                 613        088 05    78.
  HVO  1970  05 06 05 21 39.9  19.318N 155.241W 039                        3.1 ML HVO                 613        052 95    69.
● USE  1970  05 06 16 21 38.3H 19.300N 155.250W 028                        3.20ML HVO                 613 F      052 95    69.
  HVO  1970  05 10 05 30 53.6  19.366N 155.051W 008                       *4.0 ML HVO                 613        052 95    88.
● USE  1970  05 11 10 30 53.2H 19.368N 155.052W 009                       *4.10ML HVO                 613 F      052 95    88.
  HVO  1970  05 13 15 12 57.4  19.416N 155.426W 039                        3.2 ML HVO              E  613        052 95    48.
● USE  1970  05 14 01 12 57.1H 19.384N 155.417W 039                        3.20ML HVO                 613 F      052 95    50.
  HVO  1970  05 14 11 12 21.7  19.404N 155.789W 010                        3.3 ML HVO                 613        052 95    20.
  HVO  1970  05 15 02 13 15.1  19.441N 155.814W 008                        3.4 ML HVO                 613        052 95     8.
  HVO  1970  05 15 05 55 57.8  19.582N 155.247W 009                        3.1 ML HVO              E  613        052 95    67.
  HVO  1970  05 15 06 52 15.2  19.385N 155.241W 003                        3.0 ML HVO              E  613        052 95    68.
  HVO  1970  05 15 11 04 20.7  19.335N 155.229W 011                        3.8 ML HVO                 613        052 95    71.
● USE  1970  05 15 15 55 57.9H 19.368N 155.234W 004                        3.20ML HVO                 613 F      052 95    69.
  HVO  1970  05 15 23 59 47.0  19.395N 155.046W 003                        3.4 ML HVO              E  613        052 95    67.
● USE  1970  05 16 09 57 44.3H 19.345N 155.234W 005                        3.60ML HVO                 613 F      052 95    69.
  HVO  1970  05 18 12 30 38.2  19.734N 154.743W 007                        3.0 ML HVO                 613        052 94   123.
  HVO  1970  05 19 05 06 33.9  19.395N 155.452W 008                        3.0 ML HVO              E  613        052 95    46.
  HVO  1970  05 25 16 59 12.2  19.275N 155.612W 013                        3.1 ML HVO                 613        052 95    22.
  HVO  1970  05 26 17 46 39.3  19.356N 155.157W 009                        3.3 ML HVO                 613        052 95    77.
  HVO  1970  05 28 02 31 35.8  19.417N 155.443W 010                        3.6 ML HVO                 613        052 95    46.
  HVO  1970  05 30 13 17 41.4  19.917N 154.681W 131                        3.1 ML HVO                 613        052 94   137.
  HVO  1970  06 06 06 30 46.9  19.420N 155.406W 012                        3.4 ML HVO                 613        052 95    50.
  HVO  1970  06 10 23 09 50.6  19.217N 155.604W 010                        3.0 ML HVO              E  613        052 95    40.
  HVO  1970  06 11 21 22 20.5  19.390N 155.284W 033                        3.6 ML HVO              E  613        052 95    63.
● USE  1970  06 11 21 22 22.4H 19.366N 155.269W 031                        3.60ML HVO                 613 F      052 95    65.
  HVO  1970  06 15 06 31 50.6  19.341N 155.122W 008                        3.1 ML HVO                 613        052 95    81.
  HVO  1970  06 17 14 57 32.2  19.336N 155.412W 039                        3.3 ML HVO              E  613        052 95    51.
  HVO  1970  06 17 21 34 47.9  19.505N 155.779W 009                        3.2 ML HVO              E  613        052 95    12.
● USE  1970  06 18 00 57 31.9H 19.316N 155.401W 039                        3.40ML HVO                 613 F      052 95    53.
  HVO  1970  06 19 12 44 27.1  20.036N 154.953W 007                        3.3 ML HVO                 613        088 04   116.
  HVO  1970  06 20 06 04 01.4  19.364N 155.010W 013                        3.0 ML HVO                 613        052 95    85.
01/07/17.
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SOURCE YEAR  MO DA HR MN SEC      LAT      LONG    DEPTH ---------MAGNITUDES---------          INT PHENOM  RN CE Q/S  MAR DG   DIST
                                                   (KM)   BODY   SURF   OTHER   LOCAL         MAX DTSVNO                       (KM)
••N INDICATES A POSSIBLE DUPLICATE
   HVO  1970  06 22 12 36 42.0  19.397N 155.462W 009                      • 4.3 ML HVO           E  613            052 95    45.
   HVO  1970  07 16 21 40 12.9  19.377N 155.363W 008                        3.2 ML HVO              613            052 95    86.
   HVO  1970  07 16 21 52 32.8  19.418N 155.072W 010                        3.1 ML HVO              613            052 95    85.
   USE  1970  07 11 07 40 12.5F 19.369N 155.066W 006                        3.20ML HVO              613 F          052 95    86.
   HVO  1970  07 11 12 32 21.5  19.392N 155.277W 031                        3.1 ML HVO           E  613            052 95    64.
   HVO  1970  07 15 16 12 20.3  19.346N 155.128W 009                        3.4 ML HVO              613            052 95    80.
●  USE  1970  07 16 02 12 19.6F 19.317N 155.101W 006                        3.50ML HVO              613 F          052 95    84.
   HVO  1970  07 22 16 15 56.5  20.104N 155.403W 008                        3.8 ML HVO              613            088 05    87.
●  USE  1970  07 23 02 15 58.1F 19.914N 155.400W 011                        3.80ML HVO              613 F          052 95    77.
   HVO  1970  08 03 12 02 55.5  20.058N 156.035W 018                        3.1 ML HVO              613            088 06    68.
   HVO  1970  08 07 10 23 07.7  20.036N 155.333W 008                        3.8 ML HVO              613            068 05    86.
   HVO  1970  08 07 17 46 35.9  20.070N 155.328W 008                        3.1 ML HVO              613            088 05    89.
●  USE  1970  08 07 20 23 08.5F 19.900N 155.368W 000                        3.70ML HVO              613 F          052 95    72.
   HVO  1970  08 16 07 41 54.0  19.407N 154.799W 041•                     • 4.2 ML HVO              613            052 94   114.
●  USE  1970  08 16 07 41 53.1F 19.418N 154.785W 051•                     • 4.40ML HVO              613 F          052 94   115.
   HVO  1970  08 17 23 24 08.6  19.303N 155.272W 032                        3.5 ML HVO              613            052 95    65.
●  USE  1970  08 18 09 28 00.3F 19.318N 155.268W 032                        3.50ML HVO              613 F          052 95    67.
   HVO  1970  08 30 17 03 22.8  19.885N 155.334W 009                        3.1 ML HVO              613            052 95    81.
   HVO  1970  08 31 16 55 16.4  19.794N 155.865W 012                        3.3 ML HVO              613            052 95    37.
   HVO  1970  09 07 17 34 53.1  18.117N 155.4 6W 044                        3.0 ML HVO              613            052 85   153.
   HVO  1970  09 13 01 52 23.5  19.834N 156.426W 035                        3.4 ML HVO              613            052 96    60.
   HVO  1970  09 14 11 48 53.0  19.872N 156.673W 007                        3.2 ML HVO              613            052 96    87.
   HVO  1970  09 17 20 02 47.2  19.471N 155.447W 011                        3.2 ML HVO           E  613            052 95    46.
   HVO  1970  09 20 10 20 17.7  19.973N 156.014W 027                        3.5 ML HVO              613            052 96    58.
   HVO  1970  09 21 01 28 36.0  19.344N 155.201W 010                      • 4.5 ML HVO              613            052 95    73.
●  USE  1970  09 21 11 26 36.1F 19.333N 155.200W 010                      • 4.50ML HVO              613 F          052 95    73.
   HVO  1970  09 21 22 35 26.7  19.271N 155.253W 009                        3.1 ML HVO              613            052 95    69.
   HVO  1970  09 25 02 20 14.3  19.746N 156.009W 001                        3.6 ML HVO              613            052 96   128.
   HVO  1970  09 26 14 37 17.5  19.435N 155.462W 010                        3.4 ML HVO           E  613            052 95    44.
●  USE  1970  09 27 00 37 17.7F 19.416N 155.450W 010                        3.40ML HVO              613 F          052 95    46.
   USE  1970  10 07 06 17 58.9F 19.352N 155.214W 032                        3.00ML HVO              613 F          052 95    64.
   HVO  1970  10 05 15 13 05.0  19.345N 155.135W 007                        3.2 ML HVO              613            052 95    79.
●  USE  1970  10 04 16 13 04.5F 19.350N 155.117W 004                        3.30ML HVO              613 F          052 95    81.
   HVO  1970  10 13 14 40 01.1  19.510N 155.248W 024                        3.3 ML HVO           E  613            052 95    67.
●  USE  1970  10 13 18 40 01.0F 19.454N 155.235W 027                        3.30ML HVO              613 F          052 95    68.
   HVO  1970  10 14 01 32 42.0  19.422N 155.547W 012                        3.5 ML HVO              613            052 95    35.
   HVO  1970  10 17 15 05 46.8  19.360N 155.257W 010                        3.1 ML HVO              613            052 95    66.
   HVO  1970  10 25 02 32 03.0  19.730N 155.247W 035•                     • 4.2 ML HVO              613            052 95    68.
●  USE  1970  10 25 02 32 52.4F 19.370N 155.234W 036•                     • 4.20ML HVO              613 F          052 95    70.
   HVO  1970  10 29 17 47 30.6  19.559N 156.417W 007                      • 4.0 ML HVO              613            052 96    57.
●  USE  1970  10 29 17 47 30.6  19.517N 156.433W 010           4.00                                 613 F          052 96    58.
   HVO  1970  10 31 15 50 56.2  19.334N 155.110W 009                        3.1 ML HVO              613            052 95    82.
●  USE  1970  10 31 14 50 57.4F 19.268N 155.063W 003                        3.20ML HVO              613 F          052 95    87.
   HVO  1970  11 07 22 41 01.8  19.033N 156.182W 038                        3.0 ML HVO              613            052 96    52.
   HVO  1970  11 11 17 12 41.6  19.213N 155.345W 036                        3.7 ML HVO              613            052 95    62.
●  USE  1970  11 12 03 12 41.4F 19.2   N 155.334W 037                        3.70ML HVO              613 F          052 95    65.
   HVO  1970  11 12 19 46 15.1  19.962N 155.792W 008                      • 4.3 ML HVO              613            052 95    56.
   HVO  1970  11 12 19 57 20.9  19.952N 155.772W 008                        3.1 ML HVO              613            052 95    55.
   HVO  1970  11 13 21 36 00.3  20.118N 155.811W 021                        3.2 ML HVO              613            088 05    73.
●  USE  1970  11 13 05 46 13.8  20.084N 155.834W 020          •4.30                                 613 F          088 05    69.
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SOURCE YEAR  MO DA HR MN SEC      LAT      LONG   DEPTH ---------MAGNITUDES---------          INT PHENOM  RN CE Q/S  MAR DG   DIST
                                                   (KM)   BODY   SURF   OTHER   LOCAL         MAX DTSVNO                        (KM)
**N INDICATES A POSSIBLE DUPLICATE
   HVO  1970  11 16 04 02 52.1  19.346N 155.119W 008                        3.4 ML HVO                  613          052 95    61.
   HVO  1970  11 16 04 23 52.2  19.788N 156.365W 009                        3.1 ML HVO                  613          052 96    62.
 ● USE  1970  11 16 14 02 51.6F 19.333N 155.101W 005                        3.30ML HVO                  613 F        052 95    63.
   HVO  1970  11 16 06 07 58.8  19.865N 155.765W 001                        3.4 ML HVO                  613          052 95    48.
 ● USE  1970  11 16 16 07 57.8  19.867N 155.768W 000               3.40                                 613 F        052 95    46.
   HVO  1970  11 25 10 02 13.2  19.115N 156.099W 004                        3.0 ML HVO                  613          052 96    45.
   HVO  1970  12 04 16 45 32.0  19.237N 155.364W 009                        3.2 ML HVO                  613          052 95    60.
   HVO  1970  12 04 21 52 40.7  19.226N 155.352W 008                        3.2 ML HVO                  613          052 95    62.
 ● USE  1970  12 05 02 45 31.1F 19.232N 155.352W 002                        3.30ML HVO                  613 F        052 95    63.
   HVO  1970  12 05 16 34 31.5  19.115N 155.710W 012                        3.0 ML HVO                  613          052 95    43.
   HVO  1970  12 05 17 59 45.2  19.401N 155.625W 011                        3.9 ML HVO           E      613          052 95    26.
 ● USE  1970  12 06 03 59 45.1F 19.363N 155.616W 012                       •4.00ML HVO                  613 F        052 95    29.
   HVO  1970  12 10 20 26 26.0  19.399N 155.376W 009                        3.7 ML HVO           E      613          052 95    54.
 ● USE  1970  12 11 06 26 05.9F 19.394N 155.366W 009                        3.60ML HVO                  613 F        052 95    55.
   HVO  1970  12 13 08 02 26.9  19.603N 156.041W 025                       •3.6 ML HVO                  613          052 96    30.
 ● USE  1970  12 13 18 02 26.4  19.634N 156.083W 017               3.60                                 613 F        052 96    32.
   HVO  1970  12 17 11 02 42.5  19.883N 155.451W 013                        3.3 ML HVO                  613          052 95    65.
   HVO  1970  12 20 17 55 27.2  19.245N 155.528W 033                        3.1 ML HVO                  613          052 95    44.
   HVO  1970  12 21 02 15 32.7  19.553N 155.623W 009                        3.6 ML HVO                  613          052 95    29.
   USE  1970  12 21 06 44 16.8  20.20 N 155.235W 011               3.00                                 613 F        068 05   106.
   HVO  1970  12 21 19 23 20.3  19.346N 155.552W 007                        3.0 ML HVO                  613          052 95    13.
   USE  1970  12 24 02 43 11.1F 19.473N 155.551W 005                        3.00ML HVO                  613 F        052 95    66.
   HVO  1970  12 27 15 01 30.2  20.013N 155.371W 009                        3.3 ML HVO                  613          068 05    81.
   HVO  1971  01 01 01 23 35.2  20.104N 156.537W 031                        3.9 ML HVO                  613          088 06   104.
   HVO  1971  01 02 14 11 18.3  19.016N 156.099W 037                        3.0 ML HVO                  613          052 96    45.
   HVO  1971  01 13 20 36 41.7  20.098N 156.036W 05                         3.0 ML HVO                  613          068 06    12.
   HVO  1971  01 14 07 26 45.3  19.757N 156.468W 069                        3.3 ML HVO                  613          052 96    69.
   HVO  1971  01 15 02 05 45.3  19.589N 157.288W 017                        3.5 ML HVO                  612          052 97   148.
   HVO  1971  01 18 18 11 15.9  20.136N 155.024W 038                        3.2 ML HVO                  613          088 05    95.
   HVO  1971  01 19 03 43 46.1  20.213N 155.434W 010                        3.5 ML HVO                  613          088 05    77.
   HVO  1971  01 21 07 26 21.6  19.447N 156.029W 029                        3.2 ML HVO                  613          052 96    16.
   HVO  1971  01 23 03 47 55.3  19.137N 155.791W 008                        3.0 ML HVO                  613          052 95    39.
   HVO  1971  01 24 02 12 33.0  19.344N 155.795W 009                        3.5 ML HVO                  613          052 95    16.
   HVO  1971  01 26 15 07 36.9  19.699N 155.594W 015                        3.3 ML HVO                  613          052 95    90.
   HVO  1971  02 01 13 43 44.3  19.813N 156.456W 039                        3.0 ML HVO                  613          052 96    71.
   HVO  1971  02 03 01 56 05.3  19.376N 155.024W 009                        3.8 ML HVO                  613          052 95    69.
   HVO  1971  02 06 07 55 24.2  19.545N 155.169W 026                        3.5 ML HVO                  613          052 95    75.
   HVO  1971  02 09 23 04 30.7  19.354N 155.123W 009                        3.2 ML HVO                  613          052 95    60.
   HVO  1971  02 13 04 50 35.9  19.345N 155.779W 013                        3.0 ML HVO                  613          052 95    17.
   HVO  1971  02 13 09 47 34.2  19.479N 155.401W 01                         3.6 ML HVO           E      613          052 95    50.
   HVO  1971  02 16 16 38 57.5  19.358N 155.420W 012                        3.2 ML HVO           E      613          052 95    50.
   HVO  1971  02 16 21 03 07.3  19.140N 155.634W 011                        3.3 ML HVO                  613          052 95    41.
   HVO  1971  02 18 04 34 26.5  19.130N 155.581W 010                        3.0 ML HVO                  613          052 95    49.
   HVO  1971  02 19 18 50 41.5  19.483N 155.982W 027                        3.5 ML HVO                  613          052 95     5.
   HVO  1971  02 19 21 44 54.0  19.885N 155.844W 029                        3.6 ML HVO                  613          052 95    48.
   HVO  1971  02 26 06 53 15.5  20.155N 156.244W 013                        3.6 ML HVO                  613          088 06    91.
   HVO  1971  02 27 09 53 50.7  19.324N 155.317W 033                        3.3 ML HVO           E      613          052 95    62.
   HVO  1971  03 08 14 23 32.1  19.019N 155.308W 037                        3.7 ML HVO                  613          052 95    79.
   HVO  1971  03 16 20 53 32.8  19.665N 155.540W 012                        3.4 ML HVO                  613          052 95    57.
   HVO  1971  03 27 23 34 51.9  19.791N 156.209W 029                        3.0 ML HVO                  613          052 96    49.
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SOURCE YEAR  MO DA HR MN SEC       LAT      LONG   DEPTH ----------MAGNITUDES----------           INT PHENOM  RN CE G/S  MAR DG   DIST
                                                   (KM)   BODY   SURF   OTHER   LOCAL             MAX DTSVNO                       (KM)
**N INDICATES A POSSIBLE DUPLICATE
   HVO  1971  03 26 17 02 57.4  19.339N 155.175W 010                            3.0 ML HVO                613          052 95     76.
   HVO  1971  03 30 04 37 34.9  20.108N 156.625W 037                            3.9 ML HVO                613          088 06    106.
   NOS  1971  03 31 11 08 56.0H 20.300N 156.217W 010                            3.60ML HVO                613 F  014   088 06     99.
   HVO  1971  04 05 05 52 05.1  19.392N 155.155W 037                            3.2 ML HVO              E 613          052 95     77.
   HVO  1971  04 12 03 14 39.9  19.340N 155.136W 010                            3.2 ML HVO              E 613          052 95     79.
   HVO  1971  04 14 10 02 32.0  19.164N 155.618W 009                            3.2 ML HVO                613          052 95     44.
   HVO  1971  04 17 01 09 30.9  18.863N 155.116W 036                            3.2 ML HVO                613          052 85    103.
   HVO  1971  04 21 00 06 23.0  19.189N 155.456W 006                            3.5 ML HVO                613          052 95     54.
   HVO  1971  04 25 08 03 01.4  19.396N 155.267W 013                           *4.1 ML HVO              E 613          052 95     65.
   HVO  1971  04 25 23 56 13.5  19.399N 155.291W 029*                          *4.5 ML HVO              E 613          052 95     62.
●  NOS  1971  04 26 09 56 12.8H 19.342N 155.263W 025*  4.40MB                  *4.50ML HVO              V 613 F  027   052 95     63.
   HVO  1971  04 27 18 06 18.1  19.693N 156.223W 027                            3.4 ML HVO                613          052 96     44.
   HVO  1971  05 02 19 16 05.7  20.062N 156.324W 062                            3.2 ML HVO                613          088 06     80.
   HVO  1971  05 06 21 05 05.3  19.929N 155.337W 009                            3.2 ML HVO                613          052 95     77.
   HVO  1971  05 08 03 10 54.6  19.391N 155.249W 031                            3.1 ML HVO              E 613          052 95     67.
   HVO  1971  05 12  7 5  06.7  19.211N 155.156W 037                            3.3 ML HVO                613          052 95     35.
   HVO  1971  05 13 00 27 05.9  19.945N 156.193W 046*                          *4.2 ML HVO                613          052 96     62.
●  NOS  1971  05 14 06 20 00.3H 19.900N 156.067W 017   3.70MB                  *4.10ML HVO                613 F  023   052 96     63.
   HVO  1971  05 17 19 03 44.5  19.432N 155.464W 009                            3.9 ML HVO              E 613          052 95     44.
   HVO  1971  05 26 12 56 09.8  19.439N 155.256W 047                            3.8 ML HVO                613          052 95     81.
   HVO  1971  05 27 07 14 10.3  19.323N 156.517W 031                            3.1 ML HVO                613          052 96     68.
   HVO  1971  06 09 05 32 24.1  18.977N 155.195W 040*                          *4.0 ML HVO                613          052 85     93.
   HVO  1971  06 16 16 23 37.7  19.640N 156.513W 008                            3.7 ML HVO                613          052 96     78.
   HVO  1971  06 16 16 50 53.7  19.725N 156.119W 009                            3.1 ML HVO                613          052 96     38.
   HVO  1971  06 19 22 34 29.1  19.340N 155.115W 009                            3.4 ML HVO                613          052 95     82.
   HVO  1971  06 23 22 10 07.0  19.363N 155.430W 011                            3.3 ML HVO                613          052 95     49.
   HVO  1971  06 26 10 12 43.4  20.157N 155.066W 032                            3.5 ML HVO                613          088 05     86.
   HVO  1971  06 26 16 40 29.5  19.300N 155.419W 013                            3.3 ML HVO                613          052 95     18.
   HVO  1971  06 27 02 20 54.6  19.409N 155.403W 004                            3.2 ML HVO              E 613          052 95     51.
   HVO  1971  06 27 22 57 08.1  20.076N 156.914W 011                            3.4 ML HVO                613          088 06    128.
   HVO  1971  07 02 20 03 11.6  19.242N 155.082W 015                            3.7 ML HVO                613          052 95     88.
   HVO  1971  07 03 09 16 15.6  19.422N 155.394W 011                            3.9 ML HVO              E 613          052 95     51.
   HVO  1971  07 03 12 15 47.4  19.693N 156.040W 001                            3.0 ML HVO                613          052 96     29.
   HVO  1971  07 04 04 45 13.3  19.376N 155.283W 002                            3.0 ML HVO              E 613          052 95     63.
   HVO  1971  07 05 00 15 44.5  19.312N 155.221W 010                            3.4 ML HVO              E 613          052 95     71.
   HVO  1971  07 07 20 16 45.9  19.654N 156.064W 031*                          *4.2 ML HVO                613          052 96     20.
   HVO  1971  07 11 12 43 22.8  19.155N 155.679W 008                            3.0 ML HVO                613          052 95     41.
   HVO  1971  07 22 02 10 38.2  19.843N 155.034W 016                            3.5 ML HVO                613          052 95     42.
   HVO  1971  07 24 17 25 31.7  20.193N 155.856W 031                            3.1 ML HVO                613          058 05     81.
   HVO  1971  07 26 15 18 51.5  19.468N 155.427W 017                            3.1 ML HVO              E 613          052 95     48.
   HVO  1971  07 29 22 15 39.7  19.358N 155.069W 008                            3.5 ML HVO                613          052 95     86.
   HVO  1971  07 29 17 17 23.2  20.127N 155.782W 023                            3.4 ML HVO              E 613          088 05     74.
   HVO  1971  07 31 11 37 53.9  19.364N 155.254W 013                            3.0 ML HVO              E 613          052 95     67.
   HVO  1971  08 01 01 58 23.3  19.514N 155.860W 009                            3.7 ML HVO              E 613          052 95      6.
   HVO  1971  08 02 04 07 56.0  20.442N 155.976W 012                            3.1 ML HVO                613          088 05    109.
   HVO  1971  08 03 14 09 15.0  19.319N 155.221W 010                            3.7 ML HVO              E 613          052 95     71.
   HVO  1971  08 04 01 36 45.0  20.143N 155.787W 025*                          *4.0 ML HVO                613          088 05     76.
●  ERL  1971  08 04 11 36 45.0H 20.100N 155.980W 010                           *4.00ML HVO                613 F  014   058 05     71.
   HVO  1971  08 10 00 12 25.8  19.350N 155.172W 003                            3.0 ML HVO                613          052 95     76.
   HVO  1971  08 11 21 00 41.5  19.309N 155.459W 071                            3.4 ML HVO                613          052 95     45.
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SOURCE YEAR  MO DA HR MN SEC      LAT       LONG    DEPTH ---------MAGNITUDES---------        INT PHENOM  RN CE Q/S  MAR DG  DIST
                                                    (KM)   BODY   SURF   OTHER   LOCAL    MAX DTSVNO                       (KM)
**N INDICATES A POSSIBLE DUPLICATE
   HVO  1971  08 15 15 36 08.7  19.362N 155.267W 035.                        .4.8 ML HVO       E   613          052 95    66.
   HVO  1971  08 15 22 18 37.3  19.314N 155.218W 010                          3.8 ML HVO           613          052 95    72.
   ERL  1971  08 16 01 35 08.5H 19.367N 155.263W 035.  .4.50MB              .4.50ML HVO           613 F   029  052 95    64.
   HVO  1971  09 05 13 16 24.2  19.791N 155.959W 043                          3.0 ML HVO           613          052 95    37.
   HVO  1971  09 05 05 03 43.4  20.206N 155.373W 107                          3.2 ML HVO           613          088 05    98.
   HVO  1971  09 07 19 56 07.5  19.317N 155.228W 010                          3.7 ML HVO       E   613          052 95    71.
   HVO  1971  09 10 20 53 48.0  19.933N 156.437W 008                          3.2 ML HVO           613          052 96    78.
   HVO  1971  09 19 13 00 48.3  19.234N 155.576W 039                          3.0 ML HVO       E   613          052 95    41.
   HVO  1971  09 22 11 46 31.3  18.755N 155.314W 013                          3.2 ML HVO           613          052 85    99.
   HVO  1971  09 24 23 53 33.1  19.345N 155.229W 009                          3.4 ML HVO           613          052 95    70.
   HVO  1971  09 25 13 39 30.5  19.426N 155.419W 008                          3.0 ML HVO       E   613          052 95    49.
   HVO  1971  09 25 22 41 59.4  19.391N 155.426W 010                          3.1 ML HVO       E   613          052 95    49.
   HVO  1971  09 26 02 56 49.2  19.390N 155.403W 005                          3.3 ML HVO       E   613          052 95    51.
   HVO  1971  09 28 02 24 05.6  19.252N 155.388W 008                          3.0 ML HVO           613          052 95    60.
   HVO  1971  09 28 04 [illegible] 54.1  19.39[illegible]N 155.411W 008                    .3.3 ML HVO       E   613          052 95    50.
   HVO  1971  09 30 01 28 25.0  19.248N 155.345W 005                          3.8 ML HVO           613          052 95    60.
   HVO  1971  10 02 20 17 35.3  19.379N 155.420W 013                          3.1 ML HVO       E   613          052 95    49.
   HVO  1971  10 04  4 43 21.4  19.140N 156.043W 028                          3.5 ML HVO           613          052 96    40.
   HVO  1971  10 11 23 04 14.6  19.935N 155.084W 011                          3.1 ML HVO           613          052 85    69.
   HVO  1971  10 12 11 58 55.7  19.954N 155.250W 019                          3.0 ML HVO           613          052 85    87.
   HVO  1971  10 12 08 49 20.5  18.917N 155.233W 014                          3.3 ML HVO           613          052 85    92.
   HVO  1971  11 06 04 38 00.4  20.677N 155.165W 007                          3.0 ML HVO           613          088 05   154.
   HVO  1971  11 14 12 27 11.4  19.338N 155.113W 009                          3.4 ML HVO           613          052 95    82.
   HVO  1971  11 15 18 [illegible] 51.2  18.914N 155.260W 014                          3.0 ML HVO           613          052 85    88.
   HVO  1971  11 25 18 08 01.4  20.135N 155.362W 008                          3.0 ML HVO           613          098 05    83.
   HVO  1971  11 28 23 42 54.3  20.041N 156.734W 011                          3.1 ML HVO           613          088 06   110.
   HVO  1971  11 29 22 41 17.5  19.345N 155.073W 009                          3.0 ML HVO       E   613          052 95    78.
   HVO  1971  12 02  5  4  8.7  19.323N 155.225W 011                          3.6 ML HVO       E   613          052 95    71.
   HVO  1971  12 05 14 47 11.2  19.352N 155.031W 029                          3.4 ML HVO       E   613          052 95    69.
   HVO  1971  12 07 17 56 19.7  19.991N 155.692W 008                          3.0 ML HVO           613          052 95    22.
   HVO  1971  12 08 12 17 56.9  19.341N 155.110W 009                          3.3 ML HVO           613          052 95    82.
   HVO  1971  12 09 02 13 01.5  19.393N 155.423W 011                          3.3 ML HVO           613          052 95    49.
   HVO  1971  12 10 02 15 57.2  19.329N 155.113W 009                         .4.3 ML HVO           613          052 95    87.
   HVO  1971  12 14 03 15 33.3  19.340N 155.393W 009                          3.3 ML HVO       E   613          052 95    53.
   HVO  1971  12 15 13 05 39.6  19.443N 155.319W 034                          3.2 ML HVO       E   613          052 95    60.
   HVO  1971  12 15 18 42 34.7  19.419N 155.478W 009                          3.2 ML HVO       E   613          052 95    43.
   HVO  1971  12 16 12 57 23.7  18.759N 155.272W 012                          3.2 ML HVO           613          052 85   101.
   HVO  1971  12 18 09 15 35.9  18.912N 155.244W 009                          3.0 ML HVO           613          052 85    96.
   HVO  1971  12 18 04 17 31.4  18.643N 155.323W 015                          3.1 ML HVO           613          052 85    91.
   HVO  1971  12 19 01 15 30.8  18.[illegible]1N 155.310W 009                          3.9 ML HVO           613          052 85    90.
   HVO  1971  12 19 21 01 34.4  18.780N 155.363W 025                          3.4 ML HVO           613          052 85    98.
   HVO  1971  12 20 01 19 23.4  18.737N 155.291W 011                          3.1 ML HVO           613          052 85   102.
   HVO  1971  12 20 01 45 10.0  18.829N 155.307W 007                          3.0 ML HVO           613          052 85    93.
   HVO  1971  12 20 01 49 12.6  18.741N 155.317W 046                          3.9 ML HVO           613          052 85   100.
   HVO  1971  12 20 01 54 33.5  18.915N 155.400W 013                          3.6 ML HVO           613          052 85    79.
   HVO  1971  12 20 04 12 54.5  18.820N 155.322W 012                          3.0 ML HVO           613          052 85    93.
   HVO  1971  12 20  5 43 06.4  18.793N 155.306W 018                          3.2 ML HVO           613          052 85    96.
   HVO  1971  12 20 09 43 17.9  18.592N 155.328W 043.                        .4.0 ML HVO           613          052 85   115.
   HVO  1971  12 20 22 10 49.4  18.862N 155.333W 012                          3.6 ML HVO           613          052 85    89.
   HVO  1971  12 21 03 37 43.5  18.834N 155.325W 013                          3.1 ML HVO           613          052 85    91.
81/07/17.
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SOURCE YEAR  MO DA HR MN SEC       LAT      LONG   DEPTH ---------MAGNITUDES---------            INT PHENOM  RN CE G/S  MAR DG   DIST
                                                   (KM)   BODY   SURF   OTHER   LOCAL            MAX DTSVNO                        (KM)
**N INDICATES A POSSIBLE DUPLICATE
   HVO  1971  12 21 09 34 00.2  18.864N 155.309W 009                        3.4 ML HVO                     613         052 85     90.
   HVO  1971  12 21 09 51 01.9  18.831N 155.319W 013                        3.0 ML HVO                     613         052 85     92.
   HVO  1971  12 21 10 43 50.5  18.841N 155.305W 012                        3.2 ML HVO                     613         052 85     92.
   HVO  1971  12 21 14 17 22.7  18.810N 155.317W 010                        3.0 ML HVO                     613         052 85     94.
   HVO  1971  12 22 14 40 56.1  18.694N 155.258W 041                        3.2 ML HVO                     613         052 85    106.
   HVO  1971  12 23 14 05 34.5  18.668N 155.271W 029                        3.4 ML HVO                     613         052 85    110.
   HVO  1971  12 23 20 29 16.5  19.250N 155.338W 007                        3.0 ML HVO                     613         052 95     62.
   HVO  1971  12 23 22 02 16.7  18.846N 155.325W 013                      . 4.0 ML HVO                     613         052 85     90.
   HVO  1971  12 24 08 00 56.5  18.772N 155.285W 011                        3.9 ML HVO                     613         052 85     99.
   HVO  1971  12 24 08 39 37.1  18.925N 155.296W 009                        3.1 ML HVO                     613         052 85     94.
   HVO  1971  12 24 16 11 13.1  19.191N 155.360W 009                      . 4.0 ML HVO                     613         052 95     63.
   HVO  1971  12 24 17 39 12.5  19.197N 155.357W 008                      . 4.1 ML HVO                     613         052 95     63.
   HVO  1971  12 24 19 54 44.4  19.192N 155.358W 008                        3.2 ML HVO                     613         052 95     63.
   HVO  1971  12 24 20 47 31.9  19.168N 155.326W 009                        3.1 ML HVO                     613         052 95     66.
   HVO  1971  12 25 10 34 13.4  19.137N 155.250W 013                        3.0 ML HVO                     613         052 95     76.
   HVO  1971  12 26 01 14 01.7  19.244N 155.364W 009                      . 4.1 ML HVO                     613         052 95     60.
   HVO  1971  12 26 02 37 30.3  19.234N 155.365W 004                        3.4 ML HVO                     613         052 95     60.
   HVO  1971  12 26 11 24 07.8  19.312N 155.355W 008                      - 4.0 ML HVO                     613         052 95     63.
   HVO  1971  12 26 12 25 01.7  19.199N 155.357W 010                        3.4 ML HVO                     613         052 95     63.
   HVO  1971  12 26 16 07 49.3  19.246N 155.360W 008                        3.5 ML HVO                     613         052 95     60.
   HVO  1971 '12 26 16 24 45.4  19.211N 155.353W 007                        3.1 ML HVO                     613         052 95     62.
   HVO  1971  12 26 16 37 35.4  19.279N 155.339W 009                        3.4 ML HVO                     613         052 95     61.
   HVO  1971  12 26 16 39 55.9  19.241N 155.361W 008                      . 3.3 ML HVO                     613         052 95     60.
   HVO  1971  12 26 21 31 20.4  19.234N 155.354W 008                        3.8 ML HVO                     613         052 95     61.
   HVO  1971  12 26 21 45 46.2  19.236N 155.349W 009                        3.6 ML HVO                     613         052 95     61.
   HVO  1971  12 26 22 31 44.9  19.229N 155.357W 016                        3.0 ML HVO                     613         052 95     61.
   HVO  1971  12 26 23 35 49.6  19.224N 155.339W 010                        3.5 ML HVO                     613         052 95     63.
   HVO  1971  12 27 07 22 38.8  19.219N 155.356W 003                        3.4 ML HVO                     613         052 95     62.
   HVO  1971  12 27 15 05 47.5  19.248N 155.376W 006                        3.0 ML HVO                 E   613         052 95     58.
   HVO  1971  12 27 15 11 52.3  19.257N 155.372W 001                      . 4.7 ML HVO                     613         052 95     59.
   HVO  1971  12 27 16 15 10.6  19.252N 155.384W 002                        3.5 ML HVO                     613         052 95     57.
   HVO  1971  12 27 17 09 54.6  19.267N 155.373W 008                      . 4.0 ML HVO                 E   613         052 95     58.
   HVO  1971  12 27 18 57 51.9  18.946N 155.331W 012                        3.4 ML HVO                     613         052 85     90.
   HVO  1971  12 27 19 33 53.4  19.276N 155.361W 009                        3.5 ML HVO                 E   613         052 95     59.
   HVO  1971  12 27 19 59 55.6  19.269N 155.341W 011                        3.1 ML HVO                     613         052 95     61.
   HVO  1971  12 28 16 20 06.6  19.248N 155.364W 008                        3.7 ML HVO                     613         052 95     60.
   HVO  1971  12 28 16 59 11.7  19.238N 155.373W 006                      . 4.6 ML HVO                     613         052 95     59.
   HVO  1971  12 28 17 09 29.9  19.262N 155.364W 009                        3.3 ML HVO                     613         052 95     59.
   HVO  1971  12 28 22 42 12.9  19.262N 155.378W 008                      . 4.1 ML HVO                     613         052 95     59.
   HVO  1971  12 29 01 39 42.8  19.246N 155.358W 008                      . 4.6 ML HVO                     613         052 95     60.
   HVO  1971  12 29 01 46 25.3  19.232N 155.366W 009                        3.0 ML HVO                     613         052 95     60.
   HVO  1971  12 29 04 01 08.2  19.204N 155.355W 002                        3.5 ML HVO                     613         052 95     63.
   HVO  1971  12 29 06 17 38.4  19.232N 155.361W 008                        3.2 ML HVO                     613         052 95     61.
   HVO  1971  12 29 10 23 10.6  18.837N 155.346W 012                        3.1 ML HVO                     613         052 85     90.
   HVO  1971  12 30 22 32 22.1  18.843N 155.344W 011                        3.5 ML HVO                     613         052 85     89.
   HVO  1972  01 09 08 00 24.7  18.937N 155.195W 038                        3.3 ML HVO                     613         052 85     94.
   HVO  1972  01 11 14 47 39.3  18.805N 155.297W 009                        3.7 ML HVO                     613         052 85     96.
   HVO  1972  01 13 06 44 56.0  18.896N 155.317W 009                        3.1 ML HVO                     613         052 85     91.
   HVO  1972  01 13 13 59 32.9  18.934N 155.303W 011                      . 4.3 ML HVO                     613         052 85     93.
   HVO  1972  01 13 20 07 51.8  18.808N 155.257W 009                        3.0 ML HVO                     613         052 85     94.
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SOURCE YEAR  MO DA HR MN SEC       LAT      LONG   DEPTH ----------MAGNITUDES---------            INT PHENOM  RN CE Q/S  MAR DG   DIST
                                                   (KM)   BODY   SURF   OTHER   LOCAL             MAX DTSVNO                       (KM)
**N INDICATES A POSSIBLE DUPLICATE
   HVO   1972   01 18 16 33 43.5  19.468N 155.464W 009                          3.0 ML HVO              E  613         052 95    42.
   HVO   1972   01 19 18 11 03.9  18.901N 155.127W 051                          3.1 ML HVO                 613         052 85   101.
   HVO   1972   01 19 20 37 23.7  18.812N 155.283W 012                          3.0 ML HVO                 613         052 85    96.
   HVO   1972   01 20 11 42 41.9  18.767N 155.293W 012                          3.0 ML HVO                 613         052 85    99.
   HVO   1972   01 20 12 14 59.2  18.791N 155.256W 007                          3.0 ML HVO                 613         052 85   100.
   HVO   1972   01 20 13 35 32.8  18.847N 155.306W 023                          3.0 ML HVO                 613         052 85    92.
   HVO   1972   01 21 09 26 21.7  18.926N 155.298W 013                          3.9 ML HVO                 613         052 85    94.
   HVO   1972   01 22 12 40 19.3  19.240N 155.393W 009                          3.1 ML HVO                 613         052 95    57.
   HVO   1972   01 22 15 46 20.4  18.783N 155.259W 007                          3.0 ML HVO                 613         052 85   100.
   HVO   1972   01 23 07 05 45.6  20.302N 155.930W 048                          3.1 ML HVO                 613         068 05    93.
   HVO   1972   01 23 19 23 17.8  18.845N 155.289W 013                          3.3 ML HVO                 613         052 85    93.
   HVO   1972   01 27 05 21 40.7  18.791N 155.257W 007                          3.2 ML HVO                 613         052 85   100.
   HVO   1972   01 29 02 14 49.7  18.801N 155.293W 011                        * 4.0 ML HVO                 613         052 85    96.
   HVO   1972   01 30 05 51 43.3  19.779N 156.023W 020                          3.0 ML HVO                 613         052 96    38.
   HVO   1972   02 12 05 53 30.9  19.217N 155.643W 012                         *3.3 ML HVO                 613         052 95    37.
   HVO   1972   02 14 10 05 33.4  19.396N 155.492W 013                          3.2 ML HVO              E  613         052 95    42.
   HVO   1972   02 16 11 14 47.4  18.880N 155.336W 013                          3.5 ML HVO                 613         052 85    89.
   HVO   1972   02 17 13 17 50.6  19.392N 155.423W 010                        * 4.1 ML HVO              E  613         052 95    49.
   HVO   1972   02 18 04 32 47.7  18.906N 155.340W 015                          3.4 ML HVO                 613         052 85    91.
   HVO   1972   02 18 18 32 25.9  20.137N 155.799W 028                          3.3 ML HVO                 613         068 05    75.
   HVO   1972   02 20 11 47 43.8  19.364N 155.430W 009                          3.1 ML HVO              E  613         052 95    48.
   HVO   1972   02 20 09 16 05.8  19.594N 156.469W 017                          3.2 ML HVO                 613         052 96    63.
   HVO   1972   02 21 01 03 51.3  19.337N 155.273W 008                          3.9 ML HVO                 613         052 85    57.
   HVO   1972   02 24 22 49 37.0  19.960N 155.7 3W 034                          3.8 ML HVO                 613         052 95    52.
   HVO   1972   02 28 10 16 09.1  18.759N 155.320W 013                          3.0 ML HVO                 613         052 85    98.
   HVO   1972   02 28 22 47 07.8  19.257N 155.523W 009                          3.0 ML HVO              E  613         052 95    44.
   HVO   1972   02 29 12 10 21.9  19.394N 156.525W 011                        * 4.9 ML HVO                 613         052 96    68.
   HVO   1972   02 29 12 50 50.1  19.305N 156.403W 040                          3.4 ML HVO                 613         052 96    56.
 ● ISL   1972   02 29 22 03 21.9F 19.293N 156.533W 015  *4.9CMB               * 4.9(ML HVO                 613 F  033  052 96    71.
   HVO   1972   03 01 03 30 19.2  19.362N 156.411W 033                          3.4 ML HVO                 613         052 96    57.
   HVO   1972   03 03 02 32 53.1  19.245N 156.287W 042                          3.7 ML HVO                 613         052 96    49.
   HVO   1972   03 03 08 01 02.7  18.795N 155.347W 013                          3.9 ML HVO                 613         052 85    93.
   HVO   1972   03 04 00 07 08.4  18.776N 155.354W 026                          3.2 ML HVO                 613         052 85    95.
   HVO   1972   03 08 07 11 26.9  18.752N 155.296W 007                          3.3 ML HVO                 613         052 85   100.
   HVO   1972   03 09 03 11 52.3  18.832N 155.316W 013                          3.4 ML HVO                 613         052 85    90.
   HVO   1972   03 10 03 13 02.3  19.339N 155.831W 008                          3.8 ML HVO                 613         052 95    15.
   HVO   1972   03 11 13 02 01.2  20.175N 155.390W 041                          3.1 ML HVO                 613         068 05    79.
   HVO   1972   03 20 14 30 25.3  19.345N 155.129W 009                          3.0 ML HVO                 613         052 95    73.
   HVO   1972   03 26 22 09 01.4  18.890N 155.301W 010                          3.4 ML HVO                 613         052 85    88.
   HVO   1972   03 30 14 07 02.2  18.939N 155.514W 022                          3.8 ML HVO                 613         052 85    70.
   HVO   1972   03 31 15 20 34.9  19.350N 155.075W 007                        * 4.1 ML HVO              E  613         052 95    86.
   HVO   1972   03 31 15 53 58.9  19.365N 155.098W 009                          3.1 ML HVO              E  613         052 95    83.
   HVO   1972   04 05 01 03 43.2  19.314N 155.227W 033                          3.8 ML HVO                 613         052 95    65.
   HVO   1972   04 08 08 23 16.3  19.316N 155.298W 033                          3.0 ML HVO              E  613         052 95    64.
   HVO   1972   04 09 11 29 17.7  19.307N 155.264W 033                          3.3 ML HVO                 613         052 95    65.
   HVO   1972   04 11 23 08 55.9  18.756N 155.354W 029                          3.0 ML HVO                 613         052 85   101.
   HVO   1972   04 14 01 05 42.9  18.892N 155.324W 029                          3.0 ML HVO                 613         052 85    87.
   HVO   1972   04 15 01 47 02.5  18.892N 155.294W 010                          3.0 ML HVO                 613         052 85    89.
   HVO   1972   04 15 02 19 20.8  19.333N 155.128W 009                          3.3 ML HVO                 613         052 95    80.
   HVO   1972   04 17 20 16 20.3  19.977N 155.026W 019                          3.2 ML HVO                 613         052 85    88.
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SOURCE YEAR  MO DA HR MN SEC       LAT     LONG   DEPTH ---------MAGNITUDES---------              INT PHENOM  RN CE Q/S  MAR DG   DIST
                                                  (KM)   BODY   SURF   OTHER  LOCAL             MAX DTSVNO                        (KM)
••N INDICATES A POSSIBLE DUPLICATE
    HVO  1972  04 19 10 16 40.0  18.980N 155.643W 042•                         •4.0 ML HVO               613        052 85   60.
    HVO  1972  04 21 11 20 59.5  18.882N 155.319W 010                           3.0 ML HVO               613        052 85   68.
    HVO  1972  04 26 07 10 15.8  18.909N 155.310W 010                           3.0 ML HVO               613        052 85   66.
    HVO  1972  04 29 19 39 53.7  18.922N 155.318W 018                           3.0 ML HVO               613        052 85   65.
    HVO  1972  05 02 07 39 54.2  19.456N 155.247W 031                           3.0 ML HVO           E   613        052 95   67.
    HVO  1972  05 14 06 22 06.0  20.097N 157.054W 051                           3.3 ML HVO               613        088 07  141.
    HVO  1972  05 15 04 05 35.7  19.527N 155.272W 027                           3.2 ML HVO           E   613        052 95   64.
    HVO  1972  05 18 22 27 14.0  19.357N 155.058W 008                           3.0 ML HVO               613        052 95   87.
    HVO  1972  05 27 12 36 11.4  18.974N 155.365W 012                           3.5 ML HVO               613        052 85   77.
    HVO  1972  05 30 19 22 12.2  19.221N 156.524W 046                           3.2 ML HVO               613        052 96   73.
    HVO  1972  06 11 10 34 52.3  19.365N 155.126W 009                           3.1 ML HVO           E   613        052 95   80.
    HVO  1972  06 21 11 38 25.5  19.357N 155.029W 009                           3.6 ML HVO               613        052 95   90.
    HVO  1972  06 24 09 33 59.1  19.467N 155.381W 008                           3.0 ML HVO           E   613        052 95   53.
    HVO  1972  06 25 06 19 59.6  19.379N 155.441W 009                           3.2 ML HVO           E   613        052 95   47.
    HVO  1972  06 29 12 15 17.4  19.044N 155.786W 032                           3.0 ML HVO               613        052 95   71.
    HVO  1972  07 03 02 43 06.2  19.637N 155.010W 055                           3.0 ML HVO               613        052 95  100.
    HVO  1972  07 12 20 31 49.1  19.174N 155.417W 010                           3.3 ML HVO           E   613        052 95   50.
    HVO  1972  07 14 09 36 57.5  19.218N 155.328W 036•                         •4.4 ML HVO               613        052 95   76.
    HVO  1972  07 14 18 [illegible] 30.7  18.609N 154.900W 043                  3.3 ML HVO               613        052 94  126.
    HVO  1972  07 14 22 [illegible] [illegible]  19.330N 156.344W 036           3.4 ML HVO               613        052 96   51.
    HVO  1972  07 17 20 17 23.3  18.924N 155.283W 010                           3.2 ML HVO               613        052 85   87.
    HVO  1972  07 17 22 11 17.3  18.897N 155.216W 009                           3.3 ML HVO               613        052 85   89.
    HVO  1972  07 18 07 17 07.6  18.931N 155.321W 011                           3.1 ML HVO               613        052 85   83.
    HVO  1972  07 19 05 23 36.9  18.866N 155.300W 021                           3.0 ML HVO               613  -     052 85   90.
    HVO  1972  07 18 09 07 55.1  18.934N 155.332W 018                           3.2 ML HVO               613        052 85   65.
    HVO  1972  07 18 09 14 18.2  18.812N 155.305W 008                           3.1 ML HVO               613        052 85   89.
    HVO  1972  07 20 17 39 [illegible]  19.452N 155.245W 031                    3.1 ML HVO           E   613        052 95   67.
    HVO  1972  07 25 23 33 33.5  20.244N 155.839W 038                           3.0 ML HVO               613        088 05   87.
    HVO  1972  07 29 17 20 33.5  20.270N 155.592W 037                           3.1 ML HVO               613        088 05   89.
    HVO  1972  07 30 00 46 59.9  19.356N 155.803W 010                           3.0 ML HVO               613        052 95   15.
    HVO  1972  08 03 17 49 16.4  19.132N 155.469W 033                           3.0 ML HVO           E   613        052 95   53.
    HVO  1972  08 25 02 18 27.1  19.342N 155.393W 019                           3.2 ML HVO               613        052 95   74.
    HVO  1972  08 29 17 11 13.9  19.474N 155.696W 009                           3.0 ML HVO           E   613        052 95   20.
    HVO  1972  09 15 11 31 33.6  19.336N 155.016W 010                          •5.1 ML HVO           E   613        052 95   72.
●   ERL  1972  09 15 11 31 33.4F 19.333N 155.200W 010  .4.40MB                 •4.50ML HVO               613 F  023 052 95   73.
    HVO  1972  09 15 23 41 06.2  19.344N 155.113W 039                          •4.1 ML HVO           E   613        052 95   62.
    HVO  1972  09 16 13 52 13.9  18.944N 155.088W 014                           3.1 ML HVO               613        052 85   85.
    HVO  1972  09 26 04 12 31.8  18.979N 155.787W 013                           3.4 ML HVO               613        052 85   66.
●   ERL  1972  09 26 04 41 [illegible]F 19.3[illegible]N 155.117W 010  3.70MB   4.00ML HVO               613 F  009 052 95   81.
    HVO  1972  09 27 01 45 05.8  19.347N 155.073W 013                           3.1 ML HVO               613  -     052 85   87.
    HVO  1972  09 27 04 37 00.5  19.239N 155.306W 011                           3.0 ML HVO               613        052 85   92.
    HVO  1972  09 27 15 59 13.9  19.844N 155.316W 012                           3.0 ML HVO               613        052 85   91.
    HVO  1972  09 27 11 28 55.2  18.863N 155.485W 033                           3.2 ML HVO               613        052 65   79.
    HVO  1972  09 29 22 39 03.1  18.916N 155.[illegible]84W 012                 3.0 ML HVO               613        052 85   88.
    HVO  1972  09 11 22 42 32.4  19.181N 155.596W 010                           3.3 ML HVO           E   613        052 95   44.
    HVO  1972  09 13 23 4[illegible] 01.1  19.412N 155.438W 011                 3.0 ML HVO           E   613        052 95   47.
    HVO  1972  09 16 20 03 15.6  19.774N 156.015W 008                           3.1 ML HVO               613        052 96   30.
    HVO  1972  09 13 15 56 26.2  19.411N 155.440W 009                           3.4 ML HVO           E   613        052 95   47.
    HVO  1972  09 26 16 16 25.3  19.495N 155.[illegible]38W 009                 3.0 ML HVO               613        052 95   11.
    HVO  1972  10 06 05 21 27.9  20.046N 155.367W 038                           3.2 ML HVO               613        088 05   84.
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SOURCE YEAR  MO DA HR MN SEC        LAT      LONG   DEPTH ----------MAGNITUDES---------                    INT FFENOM  RN CE Q/S  MAR DG    DIST
                                                    (KM)   BODY   SURF   OTHER   LOCAL                     MAX DTSVNO                              (KM)
**N INDICATES A POSSIBLE DUPLICATE
    HVO  1972  10 27 04 37 24.0  19.350N 155.113W 009                              3.1 ML HVO                     613          052 95     82.
    HVO  1972  11 02 17 25 32.6  19.562N 156.465W 012                              3.3 ML HVO                     613          052 96     65.
    HVO  1972  11 04 11 52 01.7  19.702N 156.103W 041                              3.9 ML HVO                     613          052 96     35.
**1 HVO  1972  11 17 09 28 34.2  19.345N 155.121W 009                              3.1                            613          052 95     81.
**2 HVO  1972  11 17 09 29 34.0  19.338N 155.118W 008                              3.8                            613          052 95     81.
    HVO  1972  11 18 05 53 35.0  19.205N 155.609W 009                              3.2 ML HVO                E    613          052 95     41.
    HVO  1972  11 19 07 47 38.0  19.192N 155.701W 008                              3.1 ML HVO                E    613          052 95     36.
    HVO  1972  11 19 17 39 53.2  19.281N 155.025W 041                              3.7 ML HVO                     613          052 95     92.
    HVO  1972  11 19 18 05 02.0  19.398N 155.676W 010                              3.1 ML HVO                E    613          052 95     52.
    HVO  1972  11 20 09 04 51.8  19.443N 155.393W 010                              3.2 ML HVO                E    613          052 95     51.
    HVO  1972  12 01 13 59 38.1  20.023N 155.585W 008                              3.0 ML HVO                     613          088 05     69.
    HVO  1972  12 04 14 55 11.3  19.355N 155.275W 034                              3.2 ML HVO                E    613          052 95     65.
    HVO  1972  12 07 10 25 25.5  19.445N 155.462W 009                              3.0 ML HVO                E    613          052 95     44.
    HVO  1972  12 08 04 34 53.3  19.199N 155.613W 009                              3.1 ML HVO                E    613          052 95     41.
    HVO  1972  12 11 02 29 36.0  19.725N 154.969W 052                              3.0 ML HVO                     613          052 94    100.
    HVO  1972  12 20 17 32 59.8  19.171N 155.701W 009                              3.3 ML HVO                E    613          052 95     38.
    HVO  1972  12 21 21 16 49.9  20.109N 155.819W 029                              3.1 ML HVO                     613          088 05     72.
    HVO  1972  12 21 22 42 33.5  19.475N 155.952W 010                              3.2 ML HVO                     613          052 95      7.
    HVO  1972  12 23 09 04 51.6  19.601N 155.966W 037 •                          • 5.2 ML HVO                     613          052 95     17.
    HVO  1972  12 23 09 11 59.4  19.605N 156.000W 050                              3.2 ML HVO                     613          052 96     22.
  ● ERL  1972  12 23 09 04 57.7H 19.547N 155.913W 045 • •4.9CMB                  • 4.9CML HVO                     613 F  040   052 95     17.
  ● ERL  1972  12 23 09 43 35.1H 19.517N 156.000W 045 •                          • 4.50ML HVO                     613    008   052 96     17.
    HVO  1972  12 24 10 43 05.9  19.591N 155.967W 039 .                          • 4.7 ML HVO                     613          052 95     17.
    HVO  1972  12 25 22 04 12.0  19.603N 155.976W 039                              3.4 ML HVO                     613          052 95     18.
    HVO  1973  01 02 20 20 11.1  19.165N 155.574W 008                              3.6 ML HVO                E    613          052 95     45.
    HVO  1973  01 03 06 07 00.3  19.202N 156.016W 035                              3.1 ML HVO                     613          052 96     40.
    HVO  1973  01 04 05 22 40.2  20.399N 155.001W 039                              3.1 ML HVO                     613          088 05    103.
    HVO  1973  01 10 10 31 54.3  19.645N 156.041W 045                              3.3 ML HVO                     613          052 96     26.
    HVO  1973  01 13 11 30 00.0  19.319N 155.500W 009                              3.7 ML HVO                E    613          052 95     18.
    HVO  1973  01 14 06 31 49.7  19.483N 155.560W 009                              3.1 ML HVO                     613          052 95     67.
    HVO  1973  01 14 06 40 16.9  19.487N 155.558W 009                              3.2 ML HVO                     613          052 95     67.
    HVO  1973  01 19 09 40 56.3  19.379N 155.414W 039                              3.5 ML HVO                E    613          052 95     50.
    HVO  1973  01 22 13 12 03.8  19.925N 155.625W 016 •                            3.1 ML HVO                E    613          052 95     58.
    HVO  1973  01 22 13 57 44.5  19.927N 155.626W 010                              3.3 ML HVO                E    613          052 95     58.
    HVO  1973  01 22 18 33 16.8  19.174N 155.690W 008                              3.0 ML HVO                E    613          052 95     38.
    HVO  1973  02 01 00 25 44.5  20.004N 155.543W 038                              3.0 ML HVO                     613          088 05     82.
    HVO  1973  02 02 18 23 33.5  19.453N 155.772W 038                              3.0 ML HVO                     613          052 95     12.
    HVO  1973  02 09 11 16 43.3  19.974N 155.463W 008                              3.0 ML HVO                E    613          052 95     49.
    HVO  1973  02 12 19 46 55.1  19.350N 155.342W 031                              3.9 ML HVO                     613          052 95     58.
    HVO  1973  02 13 01 21 39.2  20.739N 155.962W 069                              3.3 ML HVO                     613          088 05     96.
    HVO  1973  02 17 10 40 47.9  19.514N 155.623W 038                              3.0 ML HVO                     613          052 95     10.
    HVO  1973  02 19 05 11 05.4  19.321N 155.028W 010                              3.0 ML HVO                E    613          052 95     70.
    HVO  1973  02 19 06 26 38.7  19.637N 155.798W 011                              3.1 ML HVO                E    613          052 95     21.
    HVO  1973  02 22 22 16 10.9  19.567N 156.438W 011                              3.4 ML HVO                     613          052 96     59.
    HVO  1973  02 23 07 47 52.2  19.356N 155.595W 026 •                          • 4.0 ML HVO                     613          052 95     58.
    HVO  1973  02 25 13 44 07.5  20.003N 155.355W 019                              3.5 ML HVO                     613          088 05     79.
    HVO  1973  02 28 15 30 22.2  20.176N 156.065W 020                              3.4 ML HVO                     613          088 06     81.
    HVO  1973  03 06 18 49 45.9  19.421N 155.450W 010                            • 4.0 ML HVO                E    613          052 95     45.
    HVO  1973  03 07 06 51 45.7  19.310N 155.221W 010                              3.4 ML HVO                E    613          052 95     71.
    HVO  1973  03 07 17 32 43.6  19.308N 155.222W 010                              3.2 ML HVO                E    613          052 95     71.
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SOURCE YEAR  MO DA HR MN SEC       LAT      LONG   DEPTH ---------MAGNITUDES---------           INT PHENOM  RN CE Q/S  MAR DG   DIST
                                                   (KM)   BODY   SURF    OTHER   LOCAL          MAX DTSVNO                      (KM)
**N INDICATES A POSSIBLE DUPLICATE
  HVO  1973  03 08 17 54 00.6  19.355N 155.109W 009                            3.1 ML HVO             E  613           052 95    82.
  HVO  1973  03 11 13 49 15.1  19.517N 156.352W 013                            3.0 ML HVO                613           052 96    50.
  HVO  1973  03 13 17 06 56.2  20.134N 155.629W 025                            3.1 ML HVO                613           088 05    76.
  HVO  1973  03 14 19 20 01.5  19.395N 155.601W 011                            3.0 ML HVO                613           052 95    12.
  HVO  1973  03 15 14 51 44.9  19.537N 155.521W 046                            3.0 ML HVO                613           052 95    39.
  HVO  1973  03 15 22 16 07.1  19.046N 156.266W 061                            3.1 ML HVO                613           052 96    62.
  HVO  1973  03 23 14 39 08.2  19.414N 155.416W 009                            3.0 ML HVO             E  613           052 95    49.
  HVO  1973  03 26 09 56 45.5  19.753N 155.756W 012                            3.5 ML HVO             E  613           052 95    34.
  HVO  1973  04 02 18 12 53.5  19.319N 155.786W 010                            3.1 ML HVO             E  613           052 95    19.
  HVO  1973  04 09 04 41 47.1  19.386N 155.406W 011                            3.0 ML HVO                613           052 95    51.
  HVO  1973  04 15 00 59 38.9  19.331N 155.123W 009                          . 4.3 ML HVO                613           052 95    81.
  HVO  1973  04 16 14 29 57.8  19.343N 155.106W 008                            3.0 ML HVO                613           052 95    83.
  HVO  1973  04 18 13 41 44.3  19.193N 156.164W 066                            3.5 ML HVO                613           052 96    42.
  HVO  1973  04 19 12 51 05.9  19.335N 155.138W 008                            3.1 ML HVO                613           052 95    79.
  ERL  1973  04 23 07 07 53.2H 19.957N 154.667W 033* .4.20MB                   4.70ML HVO                613 F  019    052 94   139.
  HVO  1973  04 24 06 16 23.1  19.854N 155.686W 012                            3.9 ML HVO                613           052 95    52.
  ERL  1973  04 24 16 15 21.9H 19.917N 155.733W 042*                        .. 4.20ML HVO                613 F  016    052 95    53.
  HVO  1973  04 26 13 56 07.5  19.757N 155.171W 036                            3.2 ML HVO                613           052 95    79.
  HVO  1973  04 26 14 53 17.7  19.942N 155.078W 056                            3.1 ML HVO                613           052 95    98.
  HVO  1973  04 26 17 25 15.3  19.913N 155.148W 037                            3.4 ML HVO                613           052 95    92.
  HVO  1973  04 26 17 49 15.3  19.471N 155.069W 038                            3.1 ML HVO                613           052 95   102.
  ERL  1973  04 26 20 26 26.3H 19.933N 155.100W 059* .6.00MB  6.1MS6.30FAS . 6.20ML HVO    VIII        613 C  243    052 95    97.
  HVO  1973  04 26 23 33 38.5  19.544N 155.601W 010                          . 4.0 ML HVO                613           052 95    61.
  HVO  1973  04 28 12 07 56.5  19.735N 155.123W 042                            3.4 ML HVO                613           052 95    95.
  HVO  1973  04 28 13 15 45.7  19.916N 155.088W 036                            3.2 ML HVO                613           052 95   103.
  HVO  1973  04 28 22 52 18.2  19.931N 155.154W 035                            3.0 ML HVO                613           052 95    92.
  HVO  1973  04 30 19 26 56.2  20.026N 155.248W 007                            3.0 ML HVO                613           088 05    96.
  HVO  1973  05 01 16 14 03.0  19.937N 155.115W 043                            3.1 ML HVO                613           052 95    96.
  HVO  1973  05 05 09 32 25.7  19.397N 155.236W 001                            3.2 ML HVO             E  613           052 95    68.
  HVO  1973  05 05 10 01 30.8  19.384N 155.245W 000                            3.0 ML HVO                613           052 95    67.
  HVO  1973  05 05 10 07 29.2  19.912N 155.075W 043                            3.8 ML HVO                613           052 95    98.
  HVO  1973  05 05 10 11 18.3  19.373N 155.238W 003                            3.4 ML HVO             E  613           052 95    68.
  HVO  1973  05 05 10 41 55.0  19.374N 155.239W 000                            3.2 ML HVO             E  613           052 95    68.
  HVO  1973  05 05 11 27 43.9  19.376N 155.236W 001                            3.3 ML HVO             E  613           052 95    68.
  HVO  1973  05 05 11 49 51.5  19.375N 155.241W 000                            3.2 ML HVO                613           052 95    68.
  HVO  1973  05 05 12 55 53.9  19.368N 155.241W 001                            3.0 ML HVO             E  613           052 95    68.
  HVO  1973  05 05 23 50 29.6  19.955N 155.118W 037                            3.7 ML HVO                613           052 95    97.
  HVO  1973  05 06 [illegible] 26 [illegible]  19.361N 155.277W 000                            3.1 ML HVO                613           052 95    65.
  HVO  1973  05 06 16 27 36.5  19.919N 155.145W 044                            3.3 ML HVO                613           052 95    92.
  HVO  1973  05 07 17 2  10.1  19.913N 155.168W 041                            3.4 ML HVO                613           052 95    90.
  HVO  1973  05 08 02 54 08.6  19.317N 155.220W 012                            3.2 ML HVO                613           052 95    60.
  HVO  1973  05 10 06 32 08.3  19.675N 155.111W 036                            3.1 ML HVO                613           052 95    94.
  HVO  1973  05 11 17 49 17.8  19.176N 155.454W 036                            3.1 ML HVO                613           052 95    55.
  HVO  1973  05 12 05 10 10.9  19.963N 155.223W 011                            3.3 ML HVO                613           052 95    76.
  HVO  1973  05 12 10 50 11.6  19.954N 155.270W 010                            3.4 ML HVO                613           052 95    84.
  HVO  1973  05 13 22 51 37.5  19.467N 155.675W 010                            3.0 ML HVO                613           052 95     2.
  HVO  1973  05 16 13 02 04.4  20.064N 155.648W 034                            3.0 ML HVO                613           088 05   106.
  HVO  1973  05 19 03 12 24.1  19.924N 155.201W 039                            3.2 ML HVO                613           052 95    88.
  HVO  1973  05 19 19 18 21.9  19.358N 155.246W 027                            3.2 ML HVO             E  613           052 95    68.
  HVO  1973  05 29 15 22 01.4  19.466N 155.282W 016                            3.4 ML HVO                613           052 95    63.
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SOURCE YEAR  MO DA HR MN SEC      LAT     LONG    DEPTH ---------MAGNITUDES---------          INT PHENOM  RN CE O/S   MAR DG   DIST
                                                   (KM)   BODY   SURF   OTHER   LOCAL        MAX DTSVNO                      (KM)
**N INDICATES A POSSIBLE DUPLICATE
  HVO  1973  05 29 23 10 18.6  19.429N 155.480W 009                             3.0 ML HVO                E  613            052 95    42.
  HVO  1973  05 30 20 43 00.0  19.949N 155.187W 037                             3.2 ML HVO                   613            052 95    90.
  HVO  1973  06 01 03 48 11.4  19.903N 155.101W 013                             3.4 ML HVO                   613            052 95    95.
  HVO  1973  06 02 11 15 43.9  19.223N 155.095W 009                             3.0 ML HVO                   613            052 95    87.
  HVO  1973  06 04 13 06 10.2  19.616N 155.169W 044                             3.2 ML HVO                   613            052 95    77.
  HVO  1973  06 09 20 03 22.3  19.158N 155.609W 009                             3.0 ML HVO                E  613            052 95    42.
  HVO  1973  06 09 20 38 23.9  19.319N 155.225W 010                             3.2 ML HVO                   613            052 95    71.
  HVO  1973  06 10 19 36 27.0  19.363N 155.328W 031                             3.0 ML HVO                E  613            052 95    59.
  HVO  1973  06 15 01 09 25.2  19.537N 155.693W 009                             3.0 ML HVO                E  613            052 95    21.
  HVO  1973  06 16 11 09 50.3  19.572N 155.613W 010                             3.0 ML HVO                E  613            052 95    31.
  HVO  1973  06 20 19 12 50.7  19.341N 155.116W 009                             3.4 ML HVO                E  613            052 95    61.
  HVO  1973  06 21 14 26 06.0  19.285N 155.264W 010                            *4.1 ML HVO                E  613            052 95    68.
  HVO  1973  06 22 16 44 12.7  19.624N 156.035W 008                             3.0 ML HVO                   613            052 96    41.
  HVO  1973  06 22 22 37 55.9  19.359N 156.598W 044                             3.2 ML HVO                   613            052 96    76.
  HVO  1973  06 24 01 35 07.2  19.675N 156.242W 013                             3.0 ML HVO                   613            052 96    44.
  HVO  1973  06 24 02 41 25.1  19.979N 155.307W 039                             3.3 ML HVO                   613            052 95    82.
  HVO  1973  06 24 23 21 25.5  20.198N 156.162W 074                             3.7 ML HVO                   613            088 06    87.
  HVO  1973  07 01 01 02 26.4  19.524N 155.310W 010                             3.2 ML HVO                   613            052 95    72.
  HVO  1973  07 01 05 12 57.9  19.263N 155.022W 013                             3.6 ML HVO                   613            052 95    74.
  HVO  1973  07 04 13 08 25.9  18.927N 155.152W 046                             3.0 ML HVO                   613            052 85    97.
  HVO  1973  07 04 08 59 02.9  19.911N 155.126W 039                             3.6 ML HVO                   613            052 95    93.
  HVO  1973  07 09 19 17 40.6  19.977N 155.495W 035                             3.7 ML HVO                   613            052 85    68.
  HVO  1973  07 08 19 45 23.6  19.566N 156. 42W 041                             3.0 ML HVO                   613            052 96    48.
  HVO  1973  07 11 13 43 21.5  20.034N 155.464W 039                             3.3 ML HVO                   613            088 05    77.
  HVO  1973  07 14 14 23 04.4  19.961N 155.576W 037                             3.6 ML HVO                   613            052 95    64.
  HVO  1973  07 17 10 34 53.9  19.640N 156.024W 038                             3.2 ML HVO                   613            052 96    24.
  HVO  1973  07 19 14 12 56.7  19.944N 155.475W 010                             3.0 ML HVO                   613            052 95    77.
  HVO  1973  07 20 04 27 49.1  19.915N 155.409W 015                             3.5 ML HVO                   613            052 95    76.
  HVO  1973  07 27 01 31 51.9  19.327N 155.416W 009                             3.0 ML HVO                   613            052 95    51.
  HVO  1973  07 29 19 37 15.9  19.596N 155.269W 039                             3.1 ML HVO                   613            052 85    91.
  HVO  1973  07 31 06 33 23.3  19.343N 155.009W 010                             3.2 ML HVO                   613            052 95    73.
  HVO  1973  08 01 02 59 05.6  19.979N 155.4-6W 035                             3.1 ML HVO                   613            052 95    70.
  HVO  1973  08 05 08 49 30.4  20.085N 156.244W 072                             3.6 ML HVO                   613            088 06    79.
  HVO  1973  08 11 03 15 54.5  19.965N 155.493W 035                             3.6 ML HVO                   613            052 95    69.
  HVO  1973  08 13 05 46 01.7  19.359N 155.253W 010                             3.2 ML HVO                   613            052 95    67.
  HVO  1973  08 14 23 49 40.6  19.433N 155.462W 010                             3.2 ML HVO                E  613            052 95    44.
  HVO  1973  08 15 22 24 18.1  19.922N 155.190W 040                             3.0 ML HVO                   613            052 95    88.
  HVO  1973  08 15 17 45 15.0  20.214N 155.741W 009                             3.3 ML HVO                   613            088 05    84.
  HVO  1973  08 27 12 06 40.1  19.293N 154.877W 044                             3.2 ML HVO                   613            052 94   138.
  HVO  1973  08 30 10 45 53.5  19.469N 155.002W 010                             3.0 ML HVO                   613            052 95     3.
  HVO  1973  08 31 13 09 24.0  19.532N 155.037W 039                             3.2 ML HVO                   613            052 95    97.
  HVO  1973  09 03 04 05 37.3  19.735N 156.029W 010                             3.3 ML HVO                   613            052 96    34.
  HVO  1973  09 06 14 17 49.5  19.818N 156.036W 011                             3.2 ML HVO                   613            052 96    42.
  HVO  1973  09 14 06 27 10.1  19.219N 155.592W 009                             3.3 ML HVO                E  613            052 95    41.
  HVO  1973  09 14 17 31 51.5  19.256N 155.366W 039                             3.1 ML HVO                E  613            052 95    58.
  HVO  1973  09 15 23 49 10.3  19.377N 155.266W 032                             3.9 ML HVO                E  613            052 95    65.
  GS   1973  09 16 09 47 11.48 19.383N 155.283W 027  3.70MB                     3.70ML HVO                   613   020      052 95    63.
  HVO  1973  09 19 12 29 01.9  19.291N 155.548W 008                             3.6 ML HVO                E  613            052 95    46.
  HVO  1973  09 19 19 22 39.8  19.646N 155.593W 013                             3.0 ML HVO                   613            052 95    52.
  HVO  1973  09 21 03 59 21.7  19.543N 155.617W 010                             3.6 ML HVO                E  613            052 95    29.
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SOURCE YEAR  MO DA HR MI SEC        LAT      LONG   DEPTH ----------MAGNITUDES---------       INT FFENOM  RN CE Q/S  MAR DG   DIST
                                                    (KM)   BODY   SURF   OTHER   LOCAL       MAX DTSVNO                          (KM)
**N INDICATES A POSSIBLE DUPLICATE
  HVO  1973  09 29 04 40 42.5   19.422N 155.412W 009                        3.0 ML HVO              E  613          052 95     50.
  HVO  1973  10 01 06 43 06.6   20.109N 155.917W 031                        3.9 ML HVO                 613          088 05     72.
  HVO  1973  10 02 06 51 15.2   20.218N 155.480W 006                        3.4 ML HVO                 613          088 05     94.
  HVO  1973  10 02 07 18 14.4   20.222N 155.479W 007                        3.2 ML HVO                 613          088 05     94.
  HVO  1973  10 04 17 53 21.3   19.156N 155.119W 018                        3.1 ML HVO                 613          052 95     87.
  HVO  1973  10 08 13 17 42.4   19.343N 155.138W 009                        3.3 ML HVO                 613          052 95     79.
  HVO  1973  10 09 01 53 45.0   19.333N 155.264W 031 .                    . 4.7 ML HVO              E  613          052 95     66.
  HVO  1973  10 09 02 01 02.2   19.332N 155.272W 032 .                    . 4.3 ML HVO              E  613          052 95     66.
● GS   1973  10 09 11 53 45.0H  19.333N 155.283W 027* .4.80MB             . 5.00ML HVO                 613 F  048   052 95     65.
● GS   1973  10 09 12 01 00.6H  19.333N 155.283W 027* .4.80MB             . 4.50ML HVO                 613 F  022   052 95     65.
  HVO  1973  10 13 06 11 12.1   20.516N 156.069W 013                      . 4.3 ML HVO                 613          088 06    118.
● GS   1973  10 13 16 11 13.4H  20.625N 155.915W 002  .4.30MB             . 4.40ML HVO                 613 F  023   088 05    129.
  HVO  1973  10 14 11 42 28.8   19.764N 155.797W 012                        3.0 ML HVO                 613          052 95     34.
  HVO  1973  10 15 22 47 29.5   20.228N 156.081W 020                        3.1 ML HVO                 613          088 06     87.
  HVO  1973  10 16 05 40 40.3   19.924N 155.123W 040                        3.3 ML HVO                 613          052 95     94.
  HVO  1973  10 17 06 53 25.8   19.880N 155.163W 037                        3.0 ML HVO                 613          052 95     89.
  HVO  1973  10 18 02 31 49.8   19.357N 155.180W 028                        3.7 ML HVO              E  613          052 95     67.
  HVO  1973  10 21 14 04 33.9   19.351N 155.418W 010                        3.4 ML HVO              E  613          052 95     51.
  HVO  1973  10 24 12 35 45.0   18.923N 155.421W 026                        3.4 ML HVO                 613          052 85     86.
  HVO  1973  10 26 07 03 14.7   19.019N 155.[illegible] 009               . 4.3 ML HVO              E  613          052 95     48.
  HVO  1973  11 03 11 10 41.7   19.398N 155.443W 009                      . 4.0 ML HVO                 613          052 95     47.
  HVO  1973  11 10 23 31 58.2   20.344N 155.416W 022                      . 4.2 ML HVO                 613          088 05    110.
● GS   1973  11 11 09 44 58.1H  20.317N 155.417W 048                        3.90ML HVO                 613 F  013   088 05    106.
  HVO  1973  11 23 01 36 46.2   19.167N 155.707W 009                        3.0 ML HVO              E  613          052 95     38.
  HVO  1973  11 24 04 23 38.7   18.966N 155.651W 040                        3.5 ML HVO                 613          052 85     66.
  HVO  1973  11 28 02 39 14.9   19.318N 155.222W 012                        3.8 ML HVO                 613          052 95     71.
  HVO  1973  11 28 19 31 46.0   19.408N 155.443W 036                        3.2 ML HVO                 613          052 95     46.
  HVO  1973  11 29 13 37 13.2   19.451N 155.363W 009                        3.1 ML HVO              E  613          052 95     52.
  HVO  1973  12 04 22 15 27.6   18.944N 155.553W 040                        3.0 ML HVO                 613          052 85     68.
  HVO  1973  12 13 04 26 55.9   19.367N 155.293W 034 .                    . 4.7 ML HVO                 613          052 95     63.
● GS   1973  12 13 14 26 56.1H  19.357N 155.292W 033 . .4.40MB            . 4.00ML HVO                 613 F  028   052 95     63.
  HVO  1973  12 14 16 45 41.9   19.515N 155.226W 009                        3.6 ML HVO                 613          052 95     71.
  HVO  1973  12 17 23 27 47.9   19.862N 155.550W 039                        3.4 ML HVO                 613          052 85     66.
  HVO  1974  01 01 06 57 01.7   19.403N 155.442W 009                        3.0 ML HVO                 613          052 95     47.
  HVO  1974  01 02 06 27 51.7   19.242N 155.476W 011                        3.5 ML HVO              E  613          052 95     49.
● GS   1974  01 02 06 27 51.6H  19.230N 155.480W 010                        3.60ML HVO   III           613          052 95     51.
  HVO  1974  01 05 15 17 15.1   19.594N 154.927W 012                        3.1 ML HVO                 613          052 94     97.
  HVO  1974  01 08 04 54 43.6   19.316N 155.223W 010                        3.4 ML HVO                 613          052 95     71.
● GS   1974  01 08 04 54 43.5H  19.31[illegible] 155.[illegible]                 3.70ML HVO   III           613          052 95     72.
  HVO  1974  01 09 17 47 56.4   19.407N 155.452W 011                        3.2 ML HVO              E  613    --    052 95      1.
  HVO  1974  01 12 06 04 34.1   19.333N 155.123W 009                      . 4.7 ML HVO              E  613          052 95     81.
● GS   1974  01 12 16 04 33.9H  19.343N 155.134W 007  .4.90MB             . 4.70ML HVO   III           613     49   052 95     90.
  HVO  1974  01 13 00 46 29.3   19.493N 155.740W 010                        3.0 ML HVO              E  613          052 95     15.
  HVO  1974  01 13 14 53 13.9   19.370N 155.483W 010                        3.0 ML HVO                 613          052 95     43.
  HVO  1974  01 15 22 05 45.5   19.865N 155.601W 033 .                    . 4.2 ML HVO              E  613          052 95     48.
● GS   1974  01 16 08 04 46.5H  19.780N 155.600W 036 .                      4.40ML HVO   III           613          052 95     46.
  HVO  1974  01 17 15 15 43.4   19.359N 155.455W 009                        3.0 ML HVO              E  613          052 95     46.
  HVO  1974  01 19 13 06 17.7   19.630N 155.[illegible]5W 016               3.2 ML HVO                 613          052 95    100.
  GS   1974  01 20 20 27 51.2H  19.193N 155.690W 006                        3.20ML HVO   III           613          052 95     41.
  HVO  1974  01 21 12 28 09.5   19.334N 155.138W 009                        3.6 ML HVO                 613          052 95     79.
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SOURCE YEAR  MO DA HR MN SEC      LAT      LONG   DEPTH ----------MAGNITUDES----------          INT PHENOM  RN CE Q/S  MAR DG   DIST
                                                  (KM)   BODY   SURF   OTHER   LOCAL           MAX DTSVNO                         (KM)
**N INDICATES A POSSIBLE DUPLICATE
   HVO  1974  01 31 04 05 34.3  19.406N 155.422W 008                         3.3 ML HVO                      613         052 95    49.
   HVO  1974  01 31 21 15 49.1  19.252N 156.168W 061                         3.3 ML HVO                      613         052 96    38.
   HVO  1974  02 04 13 15 54.6  19.559N 155.916W 009                       • 4.2 ML HVO                      613         052 95    11.
   HVO  1974  02 04 19 18 15.2  19.542N 155.920W 010                         3.1 ML HVO                      613         052 95     9.
●  GS   1974  02 05 04 16 54.0F 19.540N 155.900W 008  •4.1CMB              • 4.30ML HVO      V               613 F   25  052 95     8.
   HVO  1974  02 05 06 01 25.0  19.156N 155.682W 009                         3.1 ML HVO               E      613         052 95    40.
●  GS   1974  02 05 16 31 27.4H 19.150N 155.670W 003                         3.70ML HVO      III             613         052 95    42.
   HVO  1974  02 06 04 39 24.5  19.597N 156.232W 025                         3.4 ML HVO                      613         052 96    39.
●  GS   1974  02 06 14 39 25.0H 19.667N 156.000W 030                         3.50ML HVQ      III             613 F   23  052 96    26.
   HVO  1974  02 08 21 56 39.3  19.513N 155.265W 024                         3.1 ML HVO                      613         052 95    65.
●  GS   1974  02 08 11 55 39.5F 19.490N 155.260W 024                         3.30ML HVO      III             613         052 95    65.
   HVO  1974  02 16 13 49 16.0  19.291N 155.310W 031                         3.2 ML HVO               E      613         052 95    63.
   HVO  1974  02 23 12 54 12.2  18.976N 155.482W 034                         3.4 ML HVO                      613         052 85    69.
   HVO  1974  03 02 09 59 27.3  19.337N 155.202W 010                         3.0 ML HVO                      613         052 95.   73.
   HVO  1974  03 05 08 04 12.3  19.474N 155.676W 010                         3.1 ML HVO               E      613         052 95     1.
   HVO  1974  03 07 20 37 32.7  20.065N 155.346W 005                         3.3 ML HVO                      613         088 05    87.
   HVO  1974  03 09 05 10 52.1  20.097N 155.444W 022                         3.3 ML HVO                      613         088 05    83.
   HVO  1974  03 15 01 36 30.6  19.906N 156.066W 009                         3.2 ML HVO                      613         052 96    53.
   HVO  1974  03 18 02 51 34.6  19.275N 154.900W 043                         3.2 ML HVO                      613         052 94   104.
   HVO  1974  03 20 10 05 30.5  19.413N 155.437W 015                         3.1 ML HVO                      613         052 95    47.
   HVO  1974  03 23 23 33 06.1  19.275N 155.139W 006                         3.2 ML HVO                      613         052 95    75.
●  GS   1974  03 24 09 33 17.7F 19.240N 155.100W 007                         3.50ML HVO      III             613         052 95    75.
   HVO  1974  03 27 22 58 54.2  18.952N 155.553W 039                         3.6 ML HVO                      613         052 85    67.
●  GS   1974  03 28 18 58 53.6F 18.910N 155.540W 042 •                     • 4.00ML HVO      III             613         052 85    72.
   HVO  1974  04 04 11 42 15.3  19.373N 155.275W 027                         3.5 ML HVO                      613         052 95    64.
●  GS   1974  04 04 11 42 15.3F 19.350N 155.270W 02  •                     • 4.00ML HVO      III             613         052 95    65.
   HVO  1974  04 08 16 20 04.5  18.852N 155.351W 015                         3.0 ML HVO                      613         052 85    86.
   HVO  1974  04 08 18 01 02.2  19.219N 155.625W 008                         3.3 ML HVO               E      613         052 95    33.
   HVO  1974  04 22 22 01 52.3  19.417N 155.428W 008                         3.6 ML HVO               E      613         052 95    48.
   HVO  1974  04 23 03 44 23.7  19.140N 155.694W 011                         3.0 ML HVO               E      613         052 95    47.
   HVO  1974  04 24 07 46 51.8  19.272N 155.240W 009                         3.0 ML HVO                      613         052 95    70.
   HVO  1974  04 25 02 56 55.2  19.319N 155.224W 010                         3.8 ML HVO                      613         052 95    71.
●  GS   1974  04 25 12 06 58.1H 19.320N 155.220W 009                       • 4.00ML HVO      III             613         052 95    71.
   HVO  1974  04 30 02 45 46.2  19.362N 155.045W 008                         3.1 ML HVO                      613         052 95    89.
   HVO  1974  04 30 12 04 51.4  19.790N 155.156W 035                         3.1 ML HVO                      613         052 95    84.
   GS   1974  04 30 12 44 00.4F 19.360N 155.680W 000                         3.20ML HVO      III             613         052 95    85.
●  GS   1974  04 30 12 45 46.2F 19.360N 155.080W 005                         3.30ML HVO      III             613         052 95    85.
   HVO  1974  05 03 01 40 14.5  19.024N 155.182W 005                         3.3 ML HVO                      613         052 95    78.
   HVO  1974  05 05 11 37 25.9  19.590N 155.260W 014                       • 4.2 ML HVO                      613         052 95    66.
●  GS   1974  05 05 11 37 23.9F 19.340N 155.260W 013  •4.4 MB               • 4.50ML HVO      III             613 F   29  052 95    67.
   HVO  1974  05 06 20 45 38.6  19.807N 154.880W 038                         3.3 ML HVO                      613         052 94   112.
   HVO  1974  05 08 23 50 07.1  19.464N 155.599W 002                       • 4.0 ML HVO               E      613         052 95    31.
   HVO  1974  05 09 04 47 25.9  19.472N 155.588W 000                         3.0 ML HVO               E      613         052 95    31.
   HVO  1974  05 15 06 30 01.5  19.439N 155.613W 004                         3.2 ML HVO                      613         052 95    28.
   HVO  1974  05 16 02 45 30.1  20.349N 155.499W 008                         3.1 ML HVO                      613         088 05   127.
   HVO  1974  05 16 03 24 19.1  20.574N 155.512W 007                         3.4 ML HVO                      613         088 05   129.
   HVO  1974  05 17 13 54 45.4  19.743N 155.762W 013                         3.4 ML HVO               E      613         052 95    33.
   HVO  1974  05 22 02 36 00.3  20.465N 155.617W 032                         3.1 ML HVO                      613         088 05   114.
   HVO  1974  05 23 13 11 36.5  19.342N 155.767W 019                         3.6 ML HVO               E      613         052 95    16.
   HVO  1974  05 23 14 57 57.5  19.219N 155.122W 010                         3.1 ML HVO                      613         052 95    85.
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  SOURCE YEAR  MO DA HR MN SEC        LAT      LONG    DEPTH ---------MAGNITUDES---------            INT PHENOM  RN CE Q/S  MAR DG   DIST
                                                       (KM)   BODY   SURF  OTHER   LOCAL             MAX DTSVNO                      (KM)
**N INDICATES A POSSIBLE DUPLICATE
    HVO  1974  05 24 19 39 55.4   19.217N 155.367W 008                         3.1 ML HVO                    613          052 95    61.
    HVO  1974  05 24 23 49 10.6   19.229N 155.369W 006                         3.7 ML HVO                    613          052 95    60.
    HVO  1974  05 25 13 38 02.3   20.151N 155.805W 036                         3.6 ML HVO                    613          068 05    77.
    HVO  1974  06 02 13 44 51.5   19.175N 155.069W 036                         3.0 ML HVO                    613          052 95    96.
    HVO  1974  06 03 13 22 29.1   19.438N 155.441W 009                       . 4.1 ML HVO               E  613          052 95    46.
 ●  GS   1974  06 03 23 02 09.1H  19.420N 155.430W 008                       . 4.10ML HVO    III           613          052 95    48.
    HVO  1974  06 04 19 30 29.3   19.295N 155.222W 007                         3.4 ML HVO               E  613          052 95    72.
    HVO  1974  06 10 23 59 41.7   19.911N 155.768W 029                         3.2 ML HVO                    613          052 95    51.
    HVO  1974  06 19 05 05 42.4   19.379N 155.419W 010                         4.8 ML HVO                    613          052 95    50.
    HVO  1974  06 19 05 11 13.9   19.382N 155.435W 007                         3.6 ML HVO               E  613          052 95    48.
    HVO  1974  06 19 05 33 03.7   19.384N 155.422W 009                         3.6 ML HVO                    613          052 95    49.
    HVO  1974  06 19 06 07 51.6   19.374N 155.419W 009                         3.1 ML HVO               E  613          052 95    50.
 ●  GS   1974  06 19 15 05 42.4H  19.360N 155.430W 008  .5.10MB              . 4.90ML HVO    V             613 D  58    052 95    52.
 ●  GS   1974  06 19 15 11 13.5H  19.350N 155.420W 005                         3.80ML HVO    III           613          052 95    50.
 ●  GS   1974  06 19 15 33 03.6H  19.350N 155.410W 007                         3.70ML HVO    III           613          052 95    51.
    HVO  1974  06 [illegible] 53.3   19.375N 155.436W 008                         3.1 ML HVO               E  613          052 95    48.
    HVO  1974  06 20 20 [illegible] 26.5   19.337N 155.212W 009                       . 4.3 ML HVO                    613          052 95    72.
 ●  GS   1974  06 21 06 [illegible] [illegible].4H  19.330N 155.214W 007  .4.30MB              . 4.40ML HVO    III           613 F  20    052 95    72.
    HVO  1974  06 22 [illegible] 17.6   19.[illegible]N 155.120W 010                         3.1 ML HVO               E  613          052 95    72.
    HVO  1974  06 27 15 44 43.4   19.416N 155.262W 002                         3.0 ML HVO               E  613          052 95    63.
 ●  GS   1974  06 29 01 44 42.9H  19.410N 155.[illegible]W 001                         3.10ML HVO    III           613          052 95    63.
    HVO  1974  07 02 02 51 06.7   19.419N 155.3[illegible]W 010                         3.2 ML HVO                    613          052 95    52.
    HVO  1974  07 09 14 42 35.0   19.712N 155.023W 032                         3.1 ML HVO                    613          052 95    94.
    GS   1974  07 12 10 17 17.6H  19.470N 155.440W 008                         3.20ML HVO    III           613          052 95    46.
    HVO  1974  07 12 15 32 59.1   19.455N 155.728W 009                         3.0 ML HVO               E  613          052 95    16.
 ●  GS   1974  07 13 01 32 [illegible]H  19.460N 155.730W 009                         3.60ML HVO    III           613          052 95    16.
    HVO  1974  07 13 06 37 45.6   19.36[illegible]N 155.256W 01[illegible]                         3.1 ML HVO                    613          052 95    67.
 ●  GS   1974  07 13 16 37 46.5H  19.[illegible]N 155.250W 008                         3.40ML HVO    III           613          052 95    68.
    HVO  1974  07 13 20 42 12.9   19.456N 155.597W 003                         3.2 ML HVO               E  613          052 95    30.
    HVO  1974  07 19 11 22 03.5   19.391N 155.257W 004                         3.4 ML HVO                    613          052 95    66.
    GS   1974  07 19 14 33 49.3H  18.540N 155.290W 008                         3.40ML HVO    III           613          052 85   120.
    GS   1974  07 19 15 00 02.7H  19.3[illegible]N 155.250W 001                         3.00ML HVO    III           613          052 95    67.
    HVO  1974  07 19 16 41 48.2   19.613N 155.571W 015                         3.2 ML HVO                    613          052 95    50.
 ●  GS   1974  07 19 21 22 02.9H  19.3[illegible]N 155.250W 002                         3.70ML HVO    III           613          052 95    67.
 ●  GS   1974  07 20 02 41 48.[illegible]H  19.8[illegible]N 155.560W 026.                      . 4.00ML HVO    III           613          052 95    50.
    HVO  1974  07 21 1[illegible] [illegible]7 52.4   19.345N 155.214W 032                         3.4 ML HVO               E  613          052 95    71.
 ●  GS   1974  07 22 04 07 51.5H  19.330N 155.210W 030                         3.90ML HVO    III           613          052 95    72.
    HVO  1974  07 23 10 46 33.[illegible]   19.42[illegible]N 155.597W 003                         3.2 ML HVO               E  613          052 95    30.
    HVO  1974  07 23 1[illegible] 1[illegible] 03.2   19.477N 155.[illegible]6W 015                         3.4 ML HVO                    613          052 95    63.
    HVO  1974  07 24 [illegible]2 [illegible] 15.2   19.384N 155.[illegible]W 00[illegible]                         3.0 ML HVO               E  613          052 95    64.
 ●  GS   1974  07 24 04 13 [illegible].5H  19.3[illegible]N 155.260W 014                         3.90ML HVO    III           613          052 95    64.
    HVO  1974  07 30 07 24 18.1   19.397N 154.818W 038                         3.5 ML HVO                    613          052 94   112.
    HVO  1974  08 07 16 05 14.1   19.5[illegible]4N 155.671W 009                         3.1 ML HVO               E  613          052 95    23.
    HVO  1974  08 09 01 12 59.4   19.375N 155.376W 009.                      . 4.2 ML HVO               E  613          052 95    61.
    GS   1974  08 09 06 44 36.3H  19.477N 155.670W 008                         3.40ML HVO    III           613          052 95    22.
 ●  GS   1974  08 08 11 12 59.5H  19.3[illegible]N 155.300W 027.  4.20MB              . 4.30ML HVO    III           613 F  27    052 95    62.
    HVO  1974  08 09 15 2[illegible] 15.7   19.921N 155.[illegible]81W 041                         3.0 ML HVO                    613          052 95    98.
    HVO  1974  08 12 11 26 23.6   19.3[illegible]1N 155.449W 009                         3.5 ML HVO                    613          052 95    46.
 ●  GS   1974  08 12 21 26 20.5H  19.370N 155.430W 008                         3.80ML HVO    III           613          052 95    49.
    HVO  1974  08 13 2[illegible] [illegible]2 55.7   19.432N 155.[illegible]6W 004                         3.6 ML HVO               E  613          052 95    29.
81/07/17.                                               PAGE   22
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SOURCE YEAR  MO DA HR MN SEC        LAT      LONG  DEPTH ---------MAGNITUDES---------          INT FHENOM  RN CE G/S  MAR DG   DIST
                                                   (KM)   BODY   SURF   OTHER   LOCAL          MAX DTSVNO                          (KM)
**N INDICATES A POSSIBLE DUPLICATE
   HVO  1974  08 13 22 45 30.3  19.431N 155.603W 004                        3.1 ML HVO                  E  613           052 95    30.
   HVO  1974  08 14 13 27 07.2  19.465N 155.627W 006                        3.0 ML HVO                     613           052 95    27.
   HVO  1974  08 16 21 59 29.6  19.297N 156.329W 038                        3.1 ML HVO                     613           052 96    51.
   HVO  1974  08 17 23 04 16.3  19.523N 155.670W 007                        3.1 ML HVO                  E  613           052 95    23.
   HVO  1974  08 17 22 52 21.3  19.804N 156.101W 024                        3.6 ML HVO                     613           052 96    44.
 ● GS   1974  08 18 08 52 20.1H 19.790N 156.170W 039                        3.80ML HVO        III          613           052 96    47.
   HVO  1974  08 18 14 01 25.1  19.379N 155.072W 006                        3.1 ML HVO                     613           052 95    65.
   GS   1974  08 21 08 39 23.4H 19.550N 155.950W 006                        3.30ML HVO        III          613           052 95    12.
   HVO  1974  08 23 16 15 02.0  19.314N 155.221W 010                        3.7 ML HVO                     613           052 95    71.
 ● GS   1974  08 24 04 15 01.9H 19.310N 155.220W 008                        3.90ML HVO        III          613           052 95    72.
   HVO  1974  08 25 12 22 18.6  19.339N 155.310W 007                        3.3 ML HVO                     613           052 95    62.
   HVO  1974  08 27 21 49 49.8  19.333N 155.206W 010                      • 4.5 ML HVO                     613           052 95    72.
 ● GS   1974  08 28 07 49 40.7H 19.333N 155.210W 007  •4.80MB             • 4.60ML HVO        III          613 F    34   052 95    72.
   HVO  1974  09 03 11 43 13.6  19.372N 155.563W 025                        3.1 ML HVO                     613           052 95    35.
   GS   1974  09 18 07 56 34.2H 19.390N 155.870W 010                        3.30ML HVO        III          613           052 95     9.
   HVO  1974  09 19 15 51 57.7  19.503N 155.504W 029                        3.3 ML HVO                  E  613           052 95    53.
 ● GS   1974  09 20 01 31 37.3H 19.780N 155.530W 039                        3.50ML HVO        III          613           052 95    51.
   HVO  1974  09 24 21 10 13.9  19.401N 155.437W 009                        3.5 ML HVO                     613           052 95    47.
   HVO  1974  09 25 02 26 25.2  19.427N 155.213W 009                        3.6 ML HVO                  E  613           052 95    75.
   HVO  1974  09 25 20 16 50.2  20.151N 155.529W 028                        3.6 ML HVO                     613           066 05    65.
 ● GS   1974  09 28 06 15 41.7H 20.160N 155.560W 040                        3.90ML HVO        III          613           066 05    65.
   HVO  1974  10 09 01 44 20.7  19.373N 155.508W 011                        3.3 ML HVO                     613           052 95    41.
   HVO  1974  10 09 12 37 55.1  19.370N 155.493W 010                        3.0 ML HVO                     613           052 95    43.
   HVO  1974  10 10 22 08 36.9  19.407N 155.567W 022                        3.1 ML HVO                     613           052 95    63.
   HVO  1974  10 11 17 50 40.8  18.959N 155.460W 035                        3.0 ML HVO                     613           052 85    71.
   HVO  1974  10 15 08 34 05.4  19.437N 155.498W 010                        3.5 ML HVO                     613           052 95    40.
   HVO  1974  10 15 14 10 12.4  19.393N 155.273W 026                        3.0 ML HVO                     613           052 95    69.
   HVO  1974  10 15 14 49 41.2  19.915N 156.571W 023                        3.2 ML HVO                     613           052 96    86.
 ● GS   1974  10 15 18 36 05.3H 19.420N 155.490W 008                      • 4.00ML HVO        III          613           052 95    41.
   HVO  1974  10 17 15 17 33.4  19.719N 154.940W 009                        3.3 ML HVO                     613           052 94   103.
   HVO  1974  10 24 06 14 54.7  19.370N 155.477W 010                        3.0 ML HVO                     613           052 95    44.
   HVO  1974  10 26 13 23 07.3  19.331N 155.189W 010                        3.4 ML HVO                     613           052 95    74.
 ● GS   1974  10 26 23 20 17.1H 19.330N 155.190W 009                        3.70ML HVO        III          613           052 95    74.
   HVO  1974  10 29 12 02 34.8  19.523N 155.663W 009                        3.1 ML HVO                  E  613           052 95    24.
   HVO  1974  10 29 18 57 32.3  19.410N 155.422W 009                        3.4 ML HVO                  E  613           052 95    45.
 ● GS   1974  10 30 14 57 30.2H 19.390N 155.410W 006                        3.70ML HVO        III          613           052 95    50.
   HVO  1974  10 30 18 10 43.0  19.372N 155.502W 011                        3.2 ML HVO                     613           052 95    41.
   HVO  1974  10 31 10 01 41.8  19.304N 155.044W 009                        3.9 ML HVO                     613           052 95    69.
   HVO  1974  10 31 1  45 22.1  19.366N 155.042W 009                        3.7 ML HVO                     613           052 95    65.
 ● GS   1974  10 31 21 41 40.9H 19.370N 155.460W 005                      • 4.00ML HVO        III          613           052 95    85.
 ● GS   1974  10 31 21 45 22.1H 19.360N 155.070W 006                        3.80ML HVO        III          613           052 95    86.
   HVO  1974  11 01 03 42 28.4  19.594N 155.771W 004                        3.0 ML HVO                     613           052 95    18.
   HVO  1974  11 09 04 46 18.7  19.360N 155.134W 009                        3.0 ML HVO                  E  613           052 95    79.
 ● GS   1974  11 09 14 45 15.7H 19.370N 155.140W 007                        3.20ML HVO        III          613           052 95    79.
   HVO  1974  11 10 11 53 14.7  19.415N 155.425W 010                      • 4.2 ML HVO                     613           052 95    48.
 ● GS   1974  11 10 11 53 14.7H 19.400N 155.410W 008                      • 4.10ML HVO        III          613           052 95    50.
   HVO  1974  11 12 18 59 04.3  19.422N 155.265W 001                        3.1 ML HVO                  E  613           052 95    63.
 ● GS   1974  11 13 04 59 04.1H 19.420N 155.260W 002                        3.50ML HVO        III          613           052 95    63.
   HVO  1974  11 13 22 59 22.5  20.291N 155.636W 002                        3.0 ML HVO                     613           066 05    94.
   HVO  1974  11 15 09 19 01.5  19.960N 155.479W 035                        3.3 ML HVO                     613           052 85    70.
01/07/17.
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SOURCE YEAR  MO DA HR MN SEC      LAT      LONG    DEPTH ----------MAGNITUDES----------            INT PHENOM  RN CE Q/S  MAR DG   DIST
                                                   (KM)    BODY    SURF    OTHER   LOCAL          MAX DTSVNO                         (KM)
**N INDICATES A POSSIBLE DUPLICATE
   HVO  1974  11 16 05 12 39.2  19.212N 156.364W 031                                3.4 ML HVO                     613         052 96    58.
   HVO  1974  11 16 07 50 23.8  19.502N 155.656W 008                                3.0 ML HVO                     613         052 95    24.
 ● GS   1974  11 16 15 12 41.0H 19.190N 156.220W 018                                3.60ML HVO      III            613         052 96    47.
   HVO  1974  11 21 21 49 14.6  19.357N 155.311W 031 •                            • 4.4 ML HVO                     613         052 95    61.
 ● GS   1974  11 22 07 49 14.7H 19.340N 155.317W 029 » .3.90MB                    • 4.50ML HVO      III            613 F    26 052 95    61.
   HVO  1974  11 30 03 54 23.7  19.438N 155.418W 006                                5.5 ML HVO                 E   613         052 95    49.
   HVO  1974  11 30 04 07 37.9  19.485N 155.376W 008                                3.6 ML HVO                     613         052 95    53.
   HVO  1974  11 30 04 34 04.6  19.400N 155.451W 006                                3.0 ML HVO                 E   613         052 95    46.
   HVO  1974  11 30 04 46 54.9  19.456N 155.403W 009                                3.4 ML HVO                 E   613         052 95    50.
   HVO  1974  11 30 04 55 28.5  19.415N 155.428W 006                                3.0 ML HVO                 E   613         052 95    48.
   HVO  1974  11 30 06 02 44.1  19.404N 155.436W 008                                3.1 ML HVO                 E   613         052 95    47.
   HVO  1974  11 30 06 11 14.5  19.416N 155.425W 009                                3.0 ML HVO                     613         052 95    48.
   HVO  1974  11 30 06 40 27.8  19.394N 155.429W 009                                3.3 ML HVO                     613         052 95    48.
   HVO  1974  11 30 06 47 20.1  19.378N 155.478W 006                                3.3 ML HVO                 E   613         052 95    43.
   HVO  1974  11 30 07 13 20.5  19.491N 155.387W 005                                3.4 ML HVO                 E   613         052 95    52.
   HVO  1974  11 30 10 06 30.4  19.437N 155.394W 006                                3.0 ML HVO                     613         052 95    51.
   HVO  1974  11 30 13 10 43.5  19.387N 155.430W 009                                3.7 ML HVO                     613         052 95    48.
 ● GS   1974  11 30 13 34 23.4H 19.417N 155.408W 007  .5.10MB 5.5MS               • 5.30ML HVO      III            613      75 052 95    51.
 ● GS   1974  11 30 14 07 37.7H 19.430N 155.366W 009                                3.60ML HVO      III            613         052 95    55.
 ● GS   1974  11 30 14 46 54.8H 19.440N 155.350W 008                                3.40ML HVO      III            613         052 95    53.
   HVO  1974  11 30 18 28 39.0  19.419N 155.420W 012                                3.5 ML HVO                     613         052 95    49.
   HVO  1974  11 30 23 14 52.2  19.460N 155.403W 007                                3.3 ML HVO                 E   613         052 95    50.
   HVO  1974  12 01 03 32 54.2  19.390N 155.443W 008                                3.1 ML HVO                 E   613         052 95    47.
   HVO  1974  12 01 15 59 11.1  19.410N 155.434W 009                                3.1 ML HVO                     613         052 95    47.
   HVO  1974  12 02 12 40 32.6  19.030N 155.505W 040                                3.3 ML HVO                     613         052 95    62.
   HVO  1974  12 03 14 47 40.7  19.447N 155.397W 009                                3.1 ML HVO                     613         052 95    51.
   HVO  1974  12 07 02 13 44.2  19.420N 155.627W 003                                3.1 ML HVO                     613         052 95    27.
   HVO  1974  12 07 07 39 55.5  19.424N 155.414W 010                                3.0 ML HVO                     613         052 95    49.
   HVO  1974  12 07 15 14 27.9  19.407N 155.447W 009                              • 4.1 ML HVO                     613         052 95    46.
   HVO  1974  12 08 10 26 52.5  19.783N 156.860W 029                                3.3 ML HVO                     613         052 96   108.
 ● GS   1974  12 08 01 14 27.6H 19.400N 155.440W 008                              • 4.30ML HVO      III            613         052 95    47.
   HVO  1974  12 09 06 46 31.9  19.453N 155.401W 005                                3.5 ML HVO                 E   613         052 95    50.
   HVO  1974  12 10 12 39 13.3  19.366N 155.425W 010                                3.1 ML HVO                 E   613         052 95    49.
 ● GS   1974  12 10 16 45 31.9H 19.420N 155.380W 007                                3.80ML HVO      III            613         052 95    53.
   HVO  1974  12 10 06 43 17.1  19.437N 155.613W 004                                3.4 ML HVO                     613         052 95    28.
   HVO  1974  12 11 00 39 35.4  19.420N 155.588W 010                                3.1 ML HVO                 E   613         052 95    31.
   HVO  1974  12 11 02 32 25.6  19.439N 155.619W 002                                3.1 ML HVO                     613         052 95    28.
   HVO  1974  12 11 07 27 54.4  19.440N 155.417W 009                                3.0 ML HVO                     613         052 95    49.
 ● GS   1974  12 11 10 34 36.3H 19.440N 155.520W 001                                3.60ML HVO      III            613         052 95    38.
   GS   1974  12 11 13 47 52.7H 19.430N 155.560W 006                                3.30ML HVO      III            613         052 95    34.
   HVO  1974  12 12 04 11 19.0  19.365N 155.591W 006                                3.6 ML HVO                 E   613         052 95    64.
 ● GS   1974  12 12 14 41 19.1H 19.360N 155.110W 006                                3.60ML HVO      III            613         052 95    82.
   HVO  1974  12 14 00 11 10.4  19.419N 155.422W 009                                3.6 ML HVO                     613         052 95    49.
   HVO  1974  12 14 06 52 24.2  19.435N 155.613W 003                                3.7 ML HVO                     613         052 95    29.
   HVO  1974  12 15 06 37 38.7  19.402N 155.431W 010                                3.1 ML HVO                 E   613         052 95    48.
   HVO  1974  12 15 09 07 20.4  19.464N 155.597W 011                                3.0 ML HVO                 E   613         052 95    30.
   HVO  1974  12 15 13 53 47.9  19.475N 155.601W 002                              • 4.7 ML HVO                 E   613         052 95    29.
 ● GS   1974  12 15 21 53 47.4H 19.450N 155.590W 004  ..4.30MB                    • 4.80ML HVO      III            613 F    32 052 95    31.
   HVO  1974  12 15 23 17 27.6  19.417N 155.432W 009                              • 4.8 ML HVO                     613         052 95    48.
   HVO  1974  12 15 23 33 30.9  19.403N 155.437W 009                                3.1 ML HVO                 E   613         052 95    47.
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 SOURCE YEAR  MO DA HR MN SEC       LA        L   G  DEPT ----------MAGNITUDES----------         INT FFENOM  RN CE G/S  MAR DG   DIST
                                                     (KM)   BODY   SURF   OTHER   LOCAL          MAX DISVNO                         (KM)
**N INDICATES A POSSIBLE DUPLICATE
   HVO   1974  12 16 09 00 55.1  19.407N 155.429W 009                          3.8 ML HVO                   613          052 95     48.
●  GS    1974  12 16 09 17 29.4F 19.390N 155.420W 008  .5.0MB                . 4.90ML HVO    V             613 F    61  052 95     49.
●  GS    1974  12 16 09 30 35.7F 19.390N 155.420W 008                          3.70ML HVO    III           613          052 95     49.
   HVO   1974  12 16 16 33 24.0  19.425N 155.607W 004                          3.2 ML HVO              E  613          052 95     29.
●  GS    1974  12 16 19 00 55.0H 19.400N 155.420W 009                          3.90ML HVO    III           613          052 95     49.
   HVO   1974  12 17 06 34 18.3  19.385N 155.463W 006                          3.2 ML HVO              E  613          052 95     45.
   HVO   1974  12 18 22 30 52.6  19.420N 155.273W 016                          3.1 ML HVO                 613          052 95     64.
   HVO   1974  12 21 08 18 34.0  19.395N 155.448W 010                        . 4.1 ML HVO              E  613          052 95     46.
   HVO   1974  12 21 16 19 49.9  19.449N 155.614W 005                          3.0 ML HVO                 613          052 95     28.
●  GS    1974  12 21 18 18 03.9  19.380N 155.440W 008                        . 4.20ML HVO    III           613          052 95     47.
   HVO   1974  12 23 07 45 53.3  19.319N 155.422W 003                          3.6 ML HVO              E  613          052 95     51.
   HVO   1974  12 23 17 07 35.1  19.321N 155.419W 009                          3.0 ML HVO              E  613          052 95     51.
   HVO   1974  12 25 05 59 45.9  19.220N 155.312W 008                          3.1 ML HVO                 613          052 95     66.
   HVO   1974  12 25 07 47 43.3  19.349N 155.281W 031                        . 4.6 ML HVO                 613          052 95     64.
   HVO   1974  12 25 12 13 44.9  19.356N 155.285W 032 •                        3.4 ML HVO              E  613          052 95     64.
●  GS    1974  12 25 17 47 49.6F 19.320N 155.  3W 028 . .4.50MB              . 4.70ML HVO    III           613 F    39  052 95     65.
   HVO   1974  12 25 18 13 21.1  19.226N 155.300W 008                        . 4.2 ML HVO                 613          052 95     67.
   HVO   1974  12 25 18 17 11.6  19.227N 155.294W 008                          3.8 ML HVO                 613          052 95     67.
   HVO   1974  12 25 18 24 14.5  19.223N 155.305W 008                        . 4.3 ML HVO                 613          052 95     66.
   HVO   1974  12 26 00 56 19.5  19.217N 155.311W 008                          3.4 ML HVO                 613          052 95     66.
●  GS    1974  12 26 04 13 20.6F 19.220N 155.290W 005                        . 4.30ML HVO    III           613          052 95     68.
●  GS    1974  12 26 04 17 10.3H 19.230N 155.290W 005                        . 4.10ML HVO    III           613          052 95     67.
●  GS    1974  12 26 04 24 14.1F 19.220N 155.300W 005                        . 4.40ML HVO    III           613          052 95     67.
   HVO   1974  12 26 22 18 48.4  20.152N 154.826W 109                          3.2 ML HVO                 613          088 04    134.
   HVO   1974  12 28 17 02 39.9  19.753N 156.019W 036                          3.7 ML HVO                 613          052 96     35.
   HVO   1974  12 28 19 04 27.3  21.125N 155.387W 045                          3.0 ML HVO                 613          088 05     88.
   HVO   1974  12 28 19 24 23.6  19.348N 155.267W 039                          3.9 ML HVO              E  613          052 95     67.
●  GS    1974  12 29 03 22 38.1F 19.740N 156.050W 004                          3.90ML HVO    III           613          052 96     35.
●  GS    1974  12 29 05 24 23.5F 19.350N 155.290W 007                        . 4.20ML HVO    III           613          052 95     64.
   HVO   1974  12 29 07 54 16.2  19.513N 155.372W 012                          3.4 ML HVO                 613          052 85    119.
   HVO   1974  12 29 10 35 57.5  19.395N 155.405W 010                          3.2 ML HVO                 613          052 95     51.
   HVO   1974  12 29 11 39 35.5  19.441N 155.617W 004                          3.3 ML HVO              E  613          052 95     28.
   HVO   1974  12 29 17 22 10.4  19.342N 155.284W 031                          3.9 ML HVO              E  613          052 95     64.
   HVO   1974  12 30 02 51 44.0  19.419N 155.428W 009                          3.3 ML HVO              E  613          052 95     48.
●  GS    1974  12 30 03 22 10.6H 19.320N 155.290W 029 •                      . 4.10ML HVO    III           613          052 95     65.
●  GS    1974  12 30 12 51 45.9F 19.450N 155.410W 007                          3.60ML HVO    III           613          052 95     50.
   HVO   1974  12 31 09 37 55.6  19.317N 155.339W 004                          3.2 ML HVO              E  613          052 95     59.
   GS    1974  12 31 1  3  27.0F 19.390N 155.380W 005                          3.40ML HVO    III           613          052 95     64.
   GS    1974  12 31 11 12 50.3H 19.36  N 155.430W 021                          3.50ML HVO    III           613          052 95     49.
   HVO   1974  12 31 12 14 03.2  19.246N 155.367W 026                          3.0 ML HVO              E  613          052 95     58.
   HVO   1974  12 31 12 25 24.6  19.318N 155.368W 005                          3.2 ML HVO              E  613          052 95     56.
   HVO   1974  12 31 12 40 48.2  19.3  N 155.364W 005                        . 5.5 ML HVO              E  613          052 95     57.
   HVO   1974  12 31 13 26 45.4  19.278N 155.365W 007                          3.0 ML HVO              E  613          052 95     58.
   HVO   1974  12 31 13 56 37.7  19.34 N 155.334W 014                          3.5 ML HVO                 613          052 95     59.
   HVO   1974  12 31 14 39 22.1  19.322N 155.372W 005                          3.4 ML HVO              E  613          052 95     56.
   HVO   1974  12 31 14 49 15.0  19.270N 155.367W 006                        . 4.1 ML HVO              E  613          052 95     58.
   HVO   1974  12 31 14 59 14.3  19.273N 155.361W 003                          3.6 ML HVO                 613          052 95     59.
   HVO   1974  12 31 15 2  59.6  19.  9N 155.197W 035 •.                     . 4.4 ML HVO                 613          052 95     88.
   HVO   1974  12 31 15 51 17.2  19.336N 155.331W 001                          3.3 ML HVO              E  613          052 95     60.
   HVO   1974  12 31 16 45 13.4  19.337N 155.338W 004                          3.1 ML HVO              E  613          052 95     59.
01/07/77.                                                    PAGE  25
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SOURCE YEAR  MO DA HR MN SEC        LAT      LONG    DEPTH ---------MAGNITUDES---------          INT PHENOM  RN CE Q/S  MAR DG   DIST
                                                     (KM)   BODY   SURF  OTHER  LOCAL          MAX DTSVNO                       (KM)
**N INDICATES A POSSIBLE DUPLICATE
   HVO  1974  12 31 17 10 53.4  19.311N 155.361W 004                       3.2 ML HVO               E  613          052 95   55.
   HVO  1974  12 31 18 02 17.4  19.290N 155.378W 005                       3.2 ML HVO               E  613          052 95   56.
   HVO  1974  12 31 18 12 21.3  19.312N 155.379W 007                       3.1 ML HVO               E  613          052 95   55.
 ● GS   1974  12 31 19 30 56.2H 19.310N 155.330W 005                       3.20ML HVO          III     613          052 95   60.
   HVO  1974  12 31 19 51 30.9  19.280N 155.397W 007                       3.4 ML HVO                  613          052 95   55.
   HVO  1974  12 31 20 43 55.4  19.300N 155.386W 004                     * 4.2 ML HVO               E  613          052 95   55.
   HVO  1974  12 31 20 53 25.0  19.262N 155.359W 007                       3.4 ML HVO                  613          052 95   59.
   HVO  1974  12 31 21 24 43.5  19.272N 155.402W 006                       3.4 ML HVO               E  613          052 95   55.
   HVO  1974  12 31 21 41 54.3  19.263N 155.362W 007                     * 4.3 ML HVO                  613          052 95   59.
 ● GS   1974  12 31 22 14 02.6H 19.290N 155.360W 006                       3.00ML HVO          III     613          052 95   58.
 ● GS   1974  12 31 22 25 29.1H 19.300N 155.370W 003                       3.20ML HVO          III     613          052 95   57.
 ● GS   1974  12 31 22 40 47.5H 19.290N 155.360W 10 * *5.5 MB  5. MS    * 5.30ML HVO          I       613 D  79  052  5   [illegible]
 ● GS   1974  12 31 23 06 45.0H 19.270N 155.360W 006                       3.00ML HVO          III     613          052 95   59.
 ● GS   1974  12 31 23 56 37.3H 19.340N 155.330W 006                       3.50ML HVO          III     613          052 95   60.
   HVO  1975  01 01 00 24 25.6  19.239N 155.435W 005                       3.5 ML HVO               E  613          052 95   53.
   HVO  1975  01 01 01 02 07.3  19.175N 155.348W 005                     * 4.1 ML HVO                  613          052 95   65.
**1 GS  1975  01 01 01 25 59.0H 19.1[illegible]N 155.4[illegible]W 047* *4.00MB      * 4.20                    613 F  15  052 95   65.
**2 HVO 1975  01 01 01 29 17.0  19.269N 155.364W 005                       3.2                      E  613          052 95   65.
   HVO  1975  01 01 01 55 47.6  19.236N 155.420W 006                       3.0 ML HVO               E  613          052 95   54.
   HVO  1975  01 01 02  2 18.1  19.275N 155.368W 007                       3.1 ML HVO               E  613          052 95   56.
   HVO  1975  01 01 02 41 11.9  19.214N 155.355W 006                     * 4.6 ML HVO                  613          052 95   62.
   HVO  1975  01 01 03 25 45.9  19.231N 155.373W 009                       3.5 ML HVO                  613          052 95   60.
   HVO  1975  01 01 03 44 16.3  19.247N 155.416W 008                       3.3 ML HVO               E  613          052 95   55.
   HVO  1975  01 01 04 35 25.6  19.263N 155.350W 004                       3.4 ML HVO                  613          052 95   56.
   HVO  1975  01 01 04 48 21.5  19.292N 155.415W 002                       3.1 ML HVO                  613          052 95   53.
   HVO  1975  01 01 05 19 13.0  19.241N 155.358W 007                       3.4 ML HVO                  613          052 95   58.
   HVO  1975  01 01 05 52 16.2  19.275N 155.354W 008                       3.1 ML HVO                  613          052 95   62.
   HVO  1975  01 01 05 53 20.6  19.277N 155.351W 007                       3.3 ML HVO                  613          052 95   62.
   HVO  1975  01 01 06 13 10.7  19.237N 155.411W 001                       3.2 ML HVO                  613          052 95   53.
 ● GS   1975  01 01 06 43 54.0H 19.300N 155.350W 005  *4.50MB            * 4.10ML HVO                  613 F  17  052 95   64.
   HVO  1975  01 01 06 47 45.5  19.249N 155.375W 007                       3.0 ML HVO                  613          052 95   56.
 ● GS   1975  01 01 07 41 55.0H 19.370N 155.400W 005  *4.20MB            * 4.10ML HVO                  613 F  14  052 95   54.
   HVO  1975  01 01 07 54 44.5  19.272N 155.394W 008                       3.3 ML HVO               E  613          052 95   57.
   HVO  1975  01 01 07 59 51.0  19.2[illegible]3N 155.366W 005                       3.1 ML HVO                  613          052 95   60.
   HVO  1975  01 01 09 11 35.4  19.241N 155.377W 009                       3.5 ML HVO                  613          052 95   59.
   HVO  1975  01 01 09 46 45.7  19.247N 155.405W 006                     * 4.3 ML HVO                  613          052 95   56.
   HVO  1975  01 01 10 27 05.2  19.208N 155.371W 003                       3.6 ML HVO                  613          052 95   61.
   HVO  1975  01 01 10 33 47.7  19.319N 155.232W 011                       3.4 ML HVO               E  613          052 95   70.
   HVO  1975  01 01 10 46 49.4  19.277N 155.400W 009                     * 4.4 ML HVO               E  613          052 95   55.
 ● GS   1975  01 01 11 02 07.0H 19.200N 155.400W 005 **4.7 MB            * 4.40ML HVO                  613 F  19  052 95   59.
   HVO  1975  01 01 11 26 54.5  19.183N 155.363W 008                     * 4.1 ML HVO                  613          052 95   63.
 ● GS   1975  01 01 12 41 11.0H 19.200N 155.400W 005  *4.70MB            * 5.10ML HVO                  613 F  43  052 95   59.
   GS   1975  01 01 13 [illegible] 59.6* 19.[illegible]N 155.599W 010G *4.50MB                                 613 F  27  052 95   45.
   GS   1975  01 01 13 2[illegible] 54.5* 19.475N 155.580W 010G *5.10MB *5.3MS                         613 F  37  052 95   32.
**1 HVO 1975  01 01 13 44 29.8  19.334N 155.366W 003                       3.0                         613          052 95   56.
●**2 GS 1975  01 01 13 44 36.2* 19.171N 155.654W 010G *4.70MB            * 4.90                        613 F  20  052 95   56.
   HVO  1975  01 01 14 1[illegible] 58.6  19.330N 155.356W 003                       3.1 ML HVO                  613          052 95   57.
   HVO  1975  01 01 15 35 18.9  19.295N 155.234W 010                       3.7 ML HVO               E  613          052 95   71.
   HVO  1975  01 01 16 30 48.5  19.247N 155.371W 009                       3.1 ML HVO                  613          052 95   59.
   HVO  1975  01 01 17 23 48.1  19.[illegible]N 155.306W 007                       3.0 ML HVO                  613          052 95   75.
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SOURCE YEAR  MO DA HR MN SEC      LAT     LONG    DEPTH ----------MAGNITUDES---------          INT PHENOM  RN CE Q/S  MAR DG   DIST
                                                  (KM)   BODY   SURF  OTHER    LOCAL          MAX DTSVNO                        (KM)
*** INDICATES A POSSIBLE DUPLICATE
● GS   1975  01 01 17 46 45.0H 19.200N 155.400W 005  •4.90MB              • 4.20ML HVO              613 F  22  052 95     59.
● GS   1975  01 01 20 46 49.0H 19.200N 155.400W 005  •4.50MB              • 4.30ML HVO              613 F  16  052 95     59.
  HVO  1975  01 01 21 03 55.8  19.200N 155.348W 009                         3.4 ML HVO              613        052 95     63.
  HVO  1975  01 01 21 17 52.7  19.291N 155.407W 002                         3.1 ML HVO              613        052 95     53.
  HVO  1975  01 01 21 37 20.4  19.473N 155.461W 010                         3.6 ML HVO            E 613        052 95     44.
  HVO  1975  01 01 23 26 58.1  19.234N 155.389W 006                       • 4.2 ML HVO              613        052 95     58.
  HVO  1975  01 01 23 56 50.0  19.295N 155.268W 010                         3.7 ML HVO            E 613        052 95     67.
  HVO  1975  01 02 02 39 09.7  19.201N 155.399W 011                         3.6 ML HVO              613        052 95     59.
  HVO  1975  01 02 03 27 43.1  19.217N 155.387W 006                       • 5.0 ML HVO              613        052 95     59.
  HVO  1975  01 02 03 39 53.4  19.185N 155.374W 010                         3.6 ML HVO              613        052 95     62.
  HVO  1975  01 02 03 41 47.6  19.267N 155.405W 008                         3.4 ML HVO              613        052 95     55.
  HVO  1975  01 02 03 49 07.9  19.311N 155.393W 006                         3.0 ML HVO            E 613        052 95     54.
  HVO  1975  01 02 04 08 23.1  19.277N 155.410W 009                         3.4 ML HVO            E 613        052 95     54.
  HVO  1975  01 02 04 26 47.2  19.234N 155.389W 010                         3.2 ML HVO              613        052 95     58.
● GS   1975  01 02 09 27 58.0H 19.200N 155.400W 001  •4. 0MB              • 4.10ML HVO              613 F  12  052 95     59.
  HVO  1975  01 02 12 19 58.9  19.194N 155.370W 009                         3.1 ML HVO              613        052 95     62.
  HVO  1975  01 02 12 44 22.5  19.303N 155.402W 005                         3.0 ML HVO            F 613        052 95     54.
  HVO  1975  01 02 13 15 47.7  19.314N 155.392W 006                         3.1 ML HVO            E 613        052 95     54.
● GS   1975  01 02 13 27 45.0H 19.200N 155.400W 005  •4.50MB 4.2MS        • 5.10ML HVO              613 F  37  052 95     59.
  HVO  1975  01 02 15 44 34.9  19.197N 155.370W 008                         3.5 ML HVO              613        052 95     62.
  HVO  1975  01 02 16 44 13.5  19.270N 155.394W 010                         3.1 ML HVO            E 613        052 95     56.
  HVO  1975  01 02 20 43 51.2  19.427N 155.636W 001                         3.0 ML HVO              613        052 95     26.
  HVO  1975  01 02 20 52 16.0  19.315N 155.356W 008                         3.2 ML HVO            E 613        052 95     54.
  HVO  1975  01 02 23 33 19.1  19.226N 155.350W 009                         3.0 ML HVO              613        052 95     62.
  HVO  1975  01 03 01 45 53.4  19.170N 155.385W 010                         3.9 ML HVO              613        052 95     62.
  HVO  1975  01 03 03 05 39.7  19.245N 155.377W 004                         3.2 ML HVO              613        052 95     58.
  HVO  1975  01 03 03 33 39.8  19.219N 155.407W 009                         3.4 ML HVO              613        052 95     57.
  HVO  1975  01 03 05 15 36.7  19.172N 155.391W 010                         3.1 ML HVO              613        052 95     62.
  HVO  1975  01 03 07 37 49.3  19.224N 155.362W 010                       • 4.9 ML HVO              613        052 95     62.
  HVO  1975  01 03 07 43 43.2  19.236N 155.393W 003                         3.2 ML HVO              613        052 95     57.
  HVO  1975  01 03 08 12 42.4  19.244N 155.391W 009                         3.4 ML HVO              613        052 95     57.
  HVO  1975  01 03 08 14 46.1  19.217N 155.383W 010                         3.5 ML HVO              613        052 95     59.
  HVO  1975  01 03 09 39 35.3  19.282N 155.375W 010                         3.3 ML HVO            E 613        052 95     57.
  HVO  1975  01 03 10 27 09.5  19.241N 155.378W 006                         3.5 ML HVO              613        052 95     58.
  HVO  1975  01 03 11 17 28.9  19.247N 155.368W 010                         3.8 ML HVO              613        052 95     59.
  HVO  1975  01 03 11 49 51.7  19.258N 155.371W 010                         3.1 ML HVO              613        052 95     58.
  HVO  1975  01 03 11 55 10.1  19.321N 155.355W 003                         3.1 ML HVO            E 613        052 95     58.
  HVO  1975  01 03 12 41 03.7  19.243N 155.272W 004                         3.5 ML HVO              613        052 95     59.
  HVO  1975  01 03 13 15 37.1  19.249N 155.380W 001                         3.0 ML HVO              613        052 95     58.
  HVO  1975  01 03 16 31 09.4  19.291N 155.719W 016                         3.7 ML HVO              613        052 95     26.
● GS   1975  01 03 17 32 48.1H 19.142N 155.716W 010G •4.70MB              •                         613 F  19  052 95     38.
  HVO  1975  01 03 20 35 52.4  19.338N 155.129W 009                       • 4.4 ML HVO            E 613        052 95     60.
  HVO  1975  01 03 20 59 31.5  19.122N 156.223W 014                         3.1 ML HVO              613        052 96     52.
  HVO  1975  01 04 02 13 28.1  19.241N 155.398W 005                         3.7 ML HVO              613        052 95     58.
  HVO  1975  01 04 03 40 10.7  19.239N 155.388W 004                         3.1 ML HVO              613        052 95     58.
● GS   1975  01 04 06 35 52.0H 19.300N 155.100W 008  •4.30MB              • 4.50ML HVO              613 F  18  052 95     64.
  HVO  1975  01 04 15 02 26.6  19.241N 155.371W 010                         3.7 ML HVO              613        052 95     59.
  HVO  1975  01 04 15 32 05.2  19.249N 155.373W 010                       • 5.0 ML HVO              613        052 95     59.
  HVO  1975  01 04 15 42 13.1  19.279N 155.380W 007                         3.1 ML HVO            E 613        052 95     57.
  HVO  1975  01 04 16 10 31.6  19.222N 155.385W 005                         3.4 ML HVO              613        052 95     59.
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 SOURCE YEAR  MO DA HR MN SEC      LAT      ONG   DEPTH ----------MAGNITUDES----------          INT PHENOM  RN CE Q/S  MA  DG   DIST
                                                  (KM)   BODY   SURF   OTHER   LOCAL           MAX DTSVNO                        (KM)
**N INDICATES A POSSIBLE DUPLICATE
   HVO  1975  01 04 16 13 18.2  19.232N 155.366W 007                           3.5 ML HVO                613        052 95    60.
   HVO  1975  01 04 16 22 58.0  19.286N 155.382W 009                           3.0 ML HVO             E  613        052 95    56.
   HVO  1975  01 04 16 24 53.9  19.259N 155.348W 005                           3.2 ML HVO                613        052 95    61.
   HVO  1975  01 04 16 50 36.8  19.224N 155.370W 006                           3.0 ML HVO                613        052 95    60.
   HVO  1975  01 04 17 25 32.0  19.195N 155.364W 006                           3.0 ML HVO                613        052 95    62.
   HVO  1975  01 04 19 25 03.1  19.226N 155.416W 009                           3.9 ML HVO                613        052 95    56.
   HVO  1975  01 05 00 46 39.6  19.227N 155.368W 006                         • 4.1 ML HVO                613        052 95    58.
 ● GS   1975  01 05 01 32 06.8* 19.519N 155.689W 010G *5.10MB  5.3MS                                     613 F   43 052 95    21.
   HVO  1975  01 05 11 19 58.3  19.295N 155.394W 005                           3.0 ML HVO             E  613        052 95    55.
   HVO  1975  01 06 17 47 02.9  19.277N 155.401W 009                         • 4.5 ML HVO             E  613        052 95    55.
   HVO  1975  01 07 00 51 45.1  19.286N 155.405W 005                           3.1 ML HVO             E  613        052 95    54.
 ● GS   1975  01 07 03 47 03.0H 19.300N 155.400W 005  *4.40MB                • 4.40ML HVO                613 F   20 052 95    54.
   HVO  1975  01 07 23 30 27.2  19.450N 155.592W 006                           3.4 ML HVO                613        052 95    30.
   HVO  1975  01 08 05 52 50.2  19.255N 155.343W 008                         • 4.1 ML HVO                613        052 95    61.
   HVO  1975  01 09 06 13 31.3  19.244N 155.340W 008                           3.5 ML HVO                613        052 95    62.
   HVO  1975  01 17 05 14 04.6  19.242N 155.339W 041                           3.1 ML HVO                613        052 95    62.
   HVO  1975  01 17 13 09 09.1  19.299N 155.394W 005                           3.3 ML HVO             E  613        052 95    54.
   HVO  1975  01 28 10 54 54.1  19.152N 155.571W 031                           3.2 ML HVO             E  613        052 95    48.
   HVO  1975  02 05 21 11 27.9  19.423N 155.241W 028                           3.1 ML HVO                613        052 95    67.
   HVO  1975  02 07 04 39 44.5  19.974N 156.334W 011                           3.1 ML HVO                613        052 96    74.
   HVO  1975  02 07 06 45 52.4  19.248N 155.545W 009                           3.6 ML HVO             E  613        052 95    43.
   HVO  1975  02 12 00 35 27.9  19.595N 156.240W 015                           3.1 ML HVO                613        052 96    45.
   HVO  1975  02 19 15 42 48.7  19.376N 155.056W 010                           3.2 ML HVO                613        052 95    87.
   HVO  1975  02 20 14 43 44.9  19.406N 155.600W 003                           3.5 ML HVO             E  613        052 95    30.
   HVO  1975  02 21 11 19 41.5  19.359N 155.1[illegible]W 009                  3.4 ML HVO                613        052 95    82.
   HVO  1975  02 24 13 11 26.5  19.572N 155.761W 034                           3.1 ML HVO             E  613        052 95    66.
   HVO  1975  02 26 05 47 54.8  19.571N 155.693W 008                           3.0 ML HVO                613        052 95    20.
   HVO  1975  03 02 22 38 41.3  19.539N 155.660W 010                           3.3 ML HVO             E  613        052 95    24.
   HVO  1975  03 09 07 52 01.2  19.514N 155.646W 009                           3.0 ML HVO             E  613        052 95    25.
   HVO  1975  03 09 11 41 02.7  19.492N 155.651W 007                           3.0 ML HVO             E  613        052 95    24.
   HVO  1975  03 10 00 14 12.7  19.426N 155.472W 010                         • 4.0 ML HVO                613        052 95    43.
   HVO  1975  03 15 09 19 28.9  19.442N 155.503W 010                           3.2 ML HVO                613        052 95    40.
   HVO  1975  03 15 17 58 59.7  19.439N 155.612W 004                           3.2 ML HVO             E  613        052 95    28.
   HVO  1975  03 15 23 55 48.1  19.437N 155.613W 004                           3.0 ML HVO                613        052 95    28.
   HVO  1975  03 16 07 57 58.4  19.426N 155.244W 023                           3.1 ML HVO                613        052 95    67.
   HVO  1975  03 17 15 18 34.8  19.510N 155.669W 006                           3.2 ML HVO             E  613        052 95    23.
   HVO  1975  03 19 14 49 21.5  19.433N 155.637W 007                           3.2 ML HVO             E  613        052 95    26.
   HVO  1975  03 19 21 08 55.1  19.477N 155.772W 010                           3.0 ML HVO             E  613        052 95    12.
   HVO  1975  03 19 23 25 43.6  19.501N 155.651W 008                           3.1 ML HVO             E  613        052 95    25.
   HVO  1975  03 22 00 48 15.7  19.419N 155.672W 008                           3.1 ML HVO             E  613        052 95     3.
   HVO  1975  03 23 01 55 57.8  19.342N 155.117W 009                           3.0 ML HVO             E  613        052 95    81.
   HVO  1975  03 26 10 06 07.7  19.454N 155.591W 001                         • 4.4 ML HVO             E  613        052 95    31.
   HVO  1975  03 26 10 13 29.6  19.464N 155.597W 001                           3.3 ML HVO             E  613        052 95    30.
   HVO  1975  03 28 16 47 59.6  19.415N 155.613W 003                           3.2 ML HVO             E  613        052 95    30.
   HVO  1975  04 02 17 43 40.2  19.416N 155.664W 007                           3.0 ML HVO             E  613        052 95    23.
   HVO  1975  04 02 1[illegible] 27 53.5  19.500N 155.663W 007                 3.1 ML HVO             E  613        052 95    23.
   HVO  1975  04 04 13 09 55.9  19.321N 155.229W 011                           3.9 ML HVO                613        052 95    70.
   HVO  1975  04 04 13 35 17.4  19.320N 155.227W 010                           3.5 ML HVO                613        052 95    71.
   HVO  1975  04 05 08 38 03.2  19.278N 155.381W 007                           3.0 ML HVO             E  613        052 95    57.
   HVO  1975  04 05 10 24 04.9  19.277N 155.384W 008                           3.5 ML HVO             E  613        052 95    56.
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SOURCE YEAR  MO DA HR MN SEC      LAT      LONG   DEPTH ---------MAGNITUDES---------          INT PHENOM  RN CE Q/S  MAR DG   DIST
                                                  (KM)   BODY  SURF  OTHER   LOCAL            MAX DTSVNO                           (KM)
**N INDICATES A POSSIBLE DUPLICATE
   HVO  1975  04 05 11 56 58.3  19.284N 155.377W 007                         3.8 ML HVO              E  613          052 95    57.
   HVO  1975  04 06 12 15 55.4  19.312N 155.222W 010                         3.8 ML HVO                 613          052 95    71.
   HVO  1975  04 07 04 29 56.3  19.414N 155.602W 005                         3.9 ML HVO                 613          052 95    30.
   HVO  1975  04 07 14 39 29.3  19.275N 155.261W 010                         3.0 ML HVO              E  613          052 95    69.
   HVO  1975  04 07 22 32 16.0  18.995N 155.354W 048                         3.2 ML HVO                 613          052 85    76.
   HVO  1975  04 10 06 54 10.9  19.442N 155.607W 004                         3.0 ML HVO              E  613          052 95    25.
   HVO  1975  04 10 19 18 43.2  19.341N 155.139W 010                         3.3 ML HVO                 613          052 95    79.
   HVO  1975  04 11 06 22 24.9  19.338N 155.144W 010                         3.3 ML HVO              E  613          052 95    79.
   HVO  1975  04 12 23 24 01.2  19.473N 155.626W 005                         3.0 ML HVO                 613          052 95    27.
   HVO  1975  04 17 16 53 22.3  19.531N 155.562W 008                         3.1 ML HVO              E  613          052 95    24.
   HVO  1975  04 17 23 33 14.7  19.305N 155.221W 010                         3.5 ML HVO                 613          052 95    72.
   HVO  1975  04 18 00 57 11.6  19.492N 155.699W 010                         3.3 ML HVO              E  613          052 95    19.
   HVO  1975  04 18 03 22 29.0  19.309N 155.223W 010                         3.7 ML HVO                 613          052 95    71.
   HVO  1975  04 18 11 11 29.6  19.603N 155.816W 013                         3.2 ML HVO                 613          052 95    38.
   HVO  1975  04 18 13 03 19.9  18.919N 156.748W 046                         3.3 ML HVO                 613          052 86   110.
   HVO  1975  04 19 14 15 04.1  19.531N 155.644W 009                         3.0 ML HVO              E  613          052 95    24.
   HVO  1975  04 19 20 59 35.9  19.436N 155.612W 004                         3.0 ML HVO                 613          052 95    29.
   HVO  1975  04 20 15 37 20.3  19.126N 155.724W 007                         3.3 ML HVO                 613          052 95    41.
   HVO  1975  04 21 16 30 55.4  19.261N 155.595W 012                         3.0 ML HVO                 613          052 95    38.
   HVO  1975  04 24 14 46 55.9  19.254N 155.311W 009                         3.0 ML HVO                 613          052 95    57.
   HVO  1975  04 25 17 11 21.4  19.516N 155.663W 008                         3.1 ML HVO                 613          052 95    24.
   HVO  1975  04 26 09 05 35.1  19.442N 155.641W 001                         3.3 ML HVO              E  613          052 95    29.
   HVO  1975  04 27 20 41 33.9  20.064N 155.574W 014                         3.2 ML HVO                 613          088 05    74.
   HVO  1975  04 27 22 34 53.8  19.442N 155.636W 003                         3.0 ML HVO              E  613          052 95    29.
   HVO  1975  04 29 01 14 21.1  19.446N 155.601W 003                         3.2 ML HVO              E  613          052 95    30.
   HVO  1975  04 29 21 48 07.5  19.409N 155.278W 015                         3.4 ML HVO                 613          052 95    64.
   HVO  1975  04 29 19 23 12.0  19.398N 155.483W 009                         3.3 ML HVO                 613          052 95    43.
   HVO  1975  04 30 06 42 25.9  19.476N 155.586W 003                         3.5 ML HVO              E  613          052 95    31.
   HVO  1975  05 01 21 18 04.1  19.045N 155.728W 059                         3.0 ML HVO                 613          052 85   159.
   HVO  1975  05 05 21 34 30.5  19.434N 155.657W 004                         3.2 ML HVO                 613          052 95    29.
   HVO  1975  05 05 22 55 18.3  19.433N 155.601W 003                         3.0 ML HVO              E  613          052 95    30.
   HVO  1975  05 07 17 52 30.3  19.613N 156.732W 011                         3.7 ML HVO                 613          052 96    94.
   HVO  1975  05 07 21 33 05.6  19.474N 155.592W 001                         3.9 ML HVO                 613          052 95    30.
   HVO  1975  05 10 19 32 51.9  19.338N 155.126W 019                       * 4.5 ML HVO              E  613          052 95    81.
   HVO  1975  05 11 04 12 02.8  19.535N 155.664W 008                         3.0 ML HVO              E  613          052 95    24.
   HVO  1975  05 11 19 44 38.2  19.491N 155.631W 003                         3.4 ML HVO                 613          052 95    26.
   HVO  1975  05 14 03 18 51.3  19.592N 155.558W 021                         3.0 ML HVO              E  613          052 95    56.
   HVO  1975  05 14 16 53 51.2  19.424N 155.611W 003                         3.9 ML HVO                 613          052 95    30.
   HVO  1975  05 15 11 31 27.4  19.435N 155.548W 001                         3.1 ML HVO              E  613          052 95    30.
   HVO  1975  05 18 18 23 46.0  19.432N 155.605W 003                         3.3 ML HVO                 613          052 95    25.
   HVO  1975  05 19 06 13 16.4  19.423N 155.615W 004                         3.5 ML HVO              E  613          052 95    28.
   HVO  1975  05 19 08 42 27.3  19.449N 155.597W 011                         3.0 ML HVO              E  613          052 95    30.
   HVO  1975  05 21 22 32 58.2  20.312N 155.613W 023                       * 4.7 ML HVO                 613          088 05    58.
   HVO  1975  05 22 04 46 05.4  19.378N 155.469W 008                         3.2 ML HVO              E  613          052 95    45.
   US   1975  05 23 08 32 58.7F 20.302N 155.647W 022  *4.4 MB               * 4.70ML HVO                613 F    22  088 05    96.
   HVO  1975  05 24 02 24 45.9  19.415N 155.418W 011                         3.5 ML HVO              E  613          052 95    49.
   HVO  1975  05 25 05 13 37.3  19.664N 156.013W 028                         3.0 ML HVO                 613          052 96    26.
   HVO  1975  05 27 11 02 54.6  19.468N 155.552W 000                         3.1 ML HVO              E  613          052 95    31.
   HVO  1975  05 29 06 46 48.9  19.419N 155.608W 003                         3.6 ML HVO              E  613          052 95    29.
   HVO  1975  05 29 12 14 14.1  19.378N 155.361W 009                         3.9 ML HVO              E  613          052 95    65.
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SOURCE YEAR  MO DA HR MN SEC       LAT       LONG  DEPTH ---------MAGNITUDES---------                   INT PHENOM  RN CE Q/S  MAR DG   DIST
                                                   (KM)   BODY    SURF   OTHER   LOCAL                 MAX DTSVNO                          (KM)
**N INDICATES A POSSIBLE DUPLICATE
   HVO  1975  05 30 12 40 35.1  19.374N 155.464W 007                         3.0 ML HVO                     613          052 95    45.
   HVO  1975  05 30 22 45 37.0  19.454N 155.606W 003                         3.2 ML HVO                     613          052 95    29.
   HVO  1975  06 01 22 57 57.5  19.458N 155.593W 004                         3.2 ML HVO                   E 613          052 95    30.
   HVO  1975  06 02 05 10 14.5  19.379N 155.465W 008                         3.3 ML HVO                     613          052 95    45.
   HVO  1975  06 02 09 59 37.0  19.457N 155.600W 001                         3.1 ML HVO                   E 613          052 95    30.
   HVO  1975  06 03 10 19 46.2  19.480N 155.579W 001                         3.1 ML HVO                     613          052 95    32.
   HVO  1975  06 05 08 11 03.1  19.318N 155.615W 010                         3.6 ML HVO                     613          052 95    18.
   HVO  1975  06 07 06 02 11.7  19.394N 155.446W 010                         3.1 ML HVO                     613          052 95    46.
   HVO  1975  06 07 11 53 57.6  19.196N 155.608W 010                         3.6 ML HVO                   E 613          052 95    42.
   HVO  1975  06 08 05 32 29.0  19.343N 155.133W 010                         3.4 ML HVO                     613          052 95    60.
   HVO  1975  06 11 08 51 13.6  19.434N 155.609W 004                         3.2 ML HVO                   E 613          052 95    29.
   HVO  1975  06 11 15 16 44.7  19.437N 155.619W 004                         3.2 ML HVO                     613          052 95    28.
   HVO  1975  06 13 07 54 02.3  19.138N 155.100W 056                         3.0 ML HVO                     613          052 95    90.
   HVO  1975  06 17 16 34 05.0  19.452N 155.578W 000                         3.0 ML HVO                   E 613          052 95    32.
   HVO  1975  06 20 16 03 51.5  19.516N 155.654W 007                         3.2 ML HVO                     613          052 95    24.
   HVO  1975  06 21 19 22 21.0  19.412N 155.615W 002                         3.5 ML HVO                   E 613          052 95    29.
   HVO  1975  06 21 13 34 56.9  19.454N 155.480W 010                         3.5 ML HVO                     613          052 95    42.
   HVO  1975  06 25 02 34 41.8  19.474N 155.614W 003                         3.2 ML HVO                   E 613          052 95    30.
   HVO  1975  07 01 15 31 05.2  19.632N 154.463W 001                         3.0 ML HVO                     613          052 94   106.
   HVO  1975  07 03 11 52 40.1  18.997N 155.479W 037                         3.2 ML HVO                     613          052 85    68.
   HVO  1975  07 04 11 19 36.1  19.499N 155.471W 036                         3.0 ML HVO                     613          052 85    68.
   HVO  1975  07 04 17 40 54.9  19.373N 155.317W 033 *                     . 4.2 ML HVO                     613          052 95    60.
   HVO  1975  07 04 21 03 46.5  19.374N 155.317W 031                         3.4 ML HVO                     613          052 95    60.
●  GS   1975  07 05 23 40 55.1F 19.353N 155.315W 028 *                     . 4.20ML HVO                     613 F     20 052 95    61.
   HVO  1975  07 05 23 15 17.6  19.471N 155.640W 010                       . 4.3 ML HVO                     613          052 95    26.
   HVO  1975  07 05 23 25 45.2  19.469N 155.633W 007                       . 4.2 ML HVO                     613          052 95    26.
   HVO  1975  07 06 01 23 16.3  19.417N 155.560W 009                         3.0 ML HVO                     613          052 95    34.
●  GS   1975  07 06 04 11 11.3F 19.447N 155.635W 001                       . 4.30ML HVO                     613        5 052 95    29.
●  GS   1975  07 06 04 23 45.4F 19.432N 155.639W 004                       . 4.40ML HVO                     613        5 052 95    26.
   HVO  1975  07 06 16 59 22.5  19.518N 155.446W 002                         3.2 ML HVO                   E . 613        052 95    46.
   HVO  1975  07 06 23 48 56.1  19.542N 155.465W 001                         3.0 ML HVO                     613          052 95    42.
   HVO  1975  07 07 05 39 48.7  19.539N 155.463W 006                         3.6 ML HVO                   E 613          052 95    45.
   HVO  1975  07 07 08 11 27.6  19.534N 155.469W 006                         3.1 ML HVO                   E 613          052 95    44.
   HVO  1975  07 07 08 23 22.1  19.536N 155.461W 007                         3.6 ML HVO                     613          052 95    45.
   HVO  1975  07 07 14 47 42.5  19.540N 155.482W 003                       . 4.7 ML HVO                     613          052 95    42.
●  GS   1975  07 07 15 39 48.6F 19.513N 155.452W 007                         3.60ML HVO                     613       10 052 95    45.
●  GS   1975  07 07 15 39 22.0F 19.513N 155.455W 008                         3.50ML HVO                     613        6 052 95    45.
   HVO  1975  07 07 18 39 52.3  19.533N 155.460W 005                       . 4.2 ML HVO                   E 613          052 95    45.
   HVO  1975  07 07 19 57 56.3  19.544N 155.475W 006                         3.2 ML HVO                   E 613          052 95    44.
   HVO  1975  07 07 22 50 36.2  19.542N 155.463W 005                         3.5 ML HVO                   E 613          052 95    45.
   HVO  1975  07 07 22 33 41.1  19.535N 155.461W 006                         3.3 ML HVO                   E 613          052 95    45.
   HVO  1975  07 07 22 53 01.7  19.540N 155.461W 009                         3.0 ML HVO                   E 613          052 95    45.
   HVO  1975  07 07 23 33 28.0  19.535N 155.472W 007                         3.0 ML HVO                   E 613          052 95    44.
●  GS   1975  07 08 00 47 41.3F 19.513N 155.478W 001  3.9 MB              . 4.30ML HVO                     613       17 052 95    43.
   HVO  1975  07 08 03 52 47.5  19.536N 155.465W 009                         3.0 ML HVO                   E 613          052 95    44.
   HVO  1975  07 08 01 09 07.7  19.530N 155.473W 004                         3.6 ML HVO                   E 613          052 95    43.
   HVO  1975  07 08 04 06 31.4  19.532N 155.457W 006                         3.1 ML HVO                   E 613          052 95    45.
●  GS   1975  07 08 04 37 52.2  19.526N 155.462W 009                         4.20ML HVO                     613       19 052 95    45.
   HVO  1975  07 08 04 52 12.8  19.535N 155.467W 007                         3.0 ML HVO                   E 613          052 95    44.
   HVO  1975  07 08 16 32 03.9  19.532N 155.473W 006                         3.0 ML HVO                   E 613          052 95    43.
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SOURCE YEAR  MO DA HR MN SEC        LA          L   G   DEPT  ----------MAGNITUDES----------          INT FRENOM  RN CE Q/S  MAR DG   DIST
                                                        (KM)   BODY   SURF   OTHER    LOCAL          MAX DTSVNO                        (KM)
**N INDICATES A POSSIBLE DUPLICATE
  HVO  1975   07 08 13 56 35.2   19.525N 155.474W 006                            3.3 ML HVO                E  613        052 95     43.
  GS   1975   07 08 11 39 07.5H  19.517N 155.465W 007                            3.90ML HVO                   613      6 052 95     44.
  HVO  1975   07 08 20 07 02.7   19.535N 155.465W 007                            3.9 ML HVO                E  613        052 95     44.
  HVO  1975   07 08 21 09 21.4   19.530N 155.470W 006                            3.2 ML HVO                E  613        052 95     44.
  HVO  1975   07 08 23 33 43.4   19.540N 155.462W 005                            3.0 ML HVO                E  613        052 95     45.
  HVO  1975   07 09 03 49 27.6   19.536N 155.468W 006                            3.4 ML HVO                E  613        052 95     44.
  HVO  1975   07 09 05 47 42.7   19.543N 155.466W 009                            3.9 ML HVO                E  613        052 95     44.
  HVO  1975   07 09 05 57 48.6   19.541N 155.470W 006                            3.1 ML HVO                E  613        052 95     44.
  GS   1975   07 09 06 07 02.6H  19.512N 155.458W 006                            4.10ML HVO                   613     12 052 95     45.
  HVO  1975   07 09 07 04 34.0   19.530N 155.463W 006                            3.0 ML HVO                E  613        052 95     44.
  HVO  1975   07 09 08 40 03.5   19.531N 155.470W 006                            4.5 ML HVO                   613        052 95     44.
  HVO  1975   07 09 13 34 23.8   19.542N 155.458W 007                            3.4 ML HVO                E  613        052 95     45.
  GS   1975   07 09 13 49 27.5H  19.512N 155.462W 007                            3.60ML HVO                   613     11 052 95     44.
  GS   1975   07 09 15 47 42.7H  19.515N 155.465W 007                            4.30ML HVO                   613     12 052 95     45.
  GS   1975   07 09 16 45 53.4H  19.507N 155.465W 007                            4.50ML HVO                   613 F   10 052 95     44.
  HVO  1975   07 09 19 36 26.8   19.532N 155.462W 006                            3.1 ML HVO                E  613        052 95     45.
  HVO  1975   07 12 05 34 39.2   19.525N 155.471W 006                            3.0 ML HVO                E  613        052 95     44.
  HVO  1975   07 15 01 13 59.2   19.345N 155.115W 009                            3.4 ML HVO                   613        052 95     62.
  HVO  1975   07 22 15 19 36.5   19.653N 155.783W 019                            4.1 ML HVO                   613        052 95     22.
  HVO  1975   07 25 14 56 44.7   19.462N 155.517W 017                            3.0 ML HVO                E  613        052 95     31.
  HVO  1975   07 26 23 14 59.2   19.644N 155.564W 031                            3.7 ML HVO                   613        052 95     54.
  HVO  1975   07 29 12 53 04.9   20.324N 155.891W 023                            3.1 ML HVO                   613        068 05     96.
  HVO  1975   07 30 13 31 22.4   19.533N 155.610W 018                            3.9 ML HVO                E  613        052 95     30.
  HVO  1975   07 31 01 44 24.3   19.450N 155.942W 012                            3.2 ML HVO                   613        052 95      7.
  HVO  1975   08 03 01 19 29.5   19.465N 155.735W 010                            3.0 ML HVO                E  613        052 95     15.
  HVO  1975   08 05 07 36 39.7   19.267N 155.358W 008                            3.2 ML HVO                   613        052 95     55.
  HVO  1975   08 05 15 51 35.7   19.273N 155.343W 007                            3.0 ML HVO                   613        052 95     57.
  HVO  1975   08 06 16 57 51.3   19.272N 155.390W 007                            3.0 ML HVO                E  613        052 95     56.
  HVO  1975   08 18 07 08 57.1   19.443N 156.020W 037                            3.9 ML HVO                   613        052 96     24.
  HVO  1975   08 24 05 42 35.2   19.387N 155.279W 035                            3.6 ML HVO                E  613        052 95     64.
  HVO  1975   08 26 07 45 57.6   18.757N 155.245W 016                            3.0 ML HVO                   613        052 65    103.
  HVO  1975   08 27 07 34 44.2   19.449N 155.474W 010                            4.0 ML HVO                E  613        052 95     43.
  HVO  1975   08 27 13 24 31.4   19.672N 155.229W 015                            3.0 ML HVO                   613        052 65     95.
  HVO  1975   08 29 22 08 20.6   19.753N 156.033W 033                            3.0 ML HVO                   613        052 96     36.
  HVO  1975   09 01 04 41 01.4   18.650N 155.243W 039                            3.0 ML HVO                   613        052 65     93.
  HVO  1975   09 01 12 37 26.2   18.726N 155.252W 012                            3.1 ML HVO                   613        052 65     91.
  HVO  1975   09 02 20 15 40.3   18.803N 155.253W 012                            3.0 ML HVO                   613        052 65     93.
  HVO  1975   09 03 22 04 16.4   19.574N 155.251W 011                            3.0 ML HVO                   613        052 85     53.
  HVO  1975   09 07 08 31 41.1   18.775N 155.247W 010                            3.0 ML HVO                   613        052 85     91.
  HVO  1975   09 10 02 34 13.5   19.330N 155.143W 009                            3.6 ML HVO                   613        052 95     77.
  HVO  1975   09 11 04 43 55.3   19.332N 155.761W 012                            3.1 ML HVO                   613        052 65    127.
  HVO  1975   09 16 13 34 16.0   19.261N 155.498W 042                            3.1 ML HVO                E  613        052 95     46.
  HVO  1975   09 19 13 02 59.3   19.341N 155.111W 009                            3.0 ML HVO                   613        052 95     82.
  HVO  1975   09 19 19 24 28.6   19.242N 155.535W 010                            3.1 ML HVO                E  613        052 95     44.
  HVO  1975   09 21 19 46 35.2   19.337N 155.208W 019                            3.2 ML HVO                E, 613        052 95     72.
  HVO  1975   09 22 02 10 07.1   19.396N 155.435W 009                            3.4 ML HVO                   613        052 95     46.
  HVO  1975   09 25 01 39 00.0   19.258N 155.498W 041                            3.0 ML HVO                E  613        052 95     46.
  HVO  1975   09 26 08 39 30.7   18.987N 155.271W 015                            3.9 ML HVO                   613        052 65     83.
  HVO  1975   09 30 04 33 35.4   19.298N 155.656W 011                            3.0 ML HVO                E  613        052 95     30.
  HVO  1975   10 01 21 34 39.6   19.319N 155.225W 010                            3.7 ML HVO                   613        052 95     71.
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SOURCE YEAR  MO DA HR MN SEC       LAT      LONG   DEPTH ----------MAGNITUDES---------          INT FRENOM  RN CE Q/S  MAR DG  DIST
                                                   (KM)   BODY   SURF   OTHER    LOCAL          MAX DTSVNO                       (KM)
**N INDICATES A POSSIBLE DUPLICATE
   HVO  1975  10 02 14 17 49.9  18.445N 156.724W 073                            3.6 ML HVO                   613          052 86  144.
   HVO  1975  10 08 18 05 38.0  19.278N 155.399W 008                            3.4 ML HVO             E     613          052 95   55.
   HVO  1975  10 10 13 22 14.5  19.497N 155.666W 010                            3.0 ML HVO             E     613          052 95    3.
   HVO  1975  10 13 16 17 39.1  19.282N 156.205W 043                            3.2 ML HVO                   613          052 96   55.
   HVO  1975  10 19 01 05 46.5  19.142N 155.558W 031                            3.5 ML HVO             E     613          052 95   50.
   HVO  1975  10 22 12 39 13.9  19.769N 155.387W 017                            3.0 ML HVO             E     613          052 95   62.
   HVO  1975  10 22 16 52 54.9  18.923N 155.290W 012                            3.1 ML HVO                   613          052 85   87.
   HVO  1975  10 26 23 37 40.3  19.320N 155.472W 010                            3.3 ML HVO                   613          052 95   46.
   HVO  1975  10 27 19 23 37.8  18.916N 155.278W 012                            3.2 ML HVO                   613          052 85   88.
   HVO  1975  10 27 19 35 52.9  19.315N 155.223W 010                            3.7 ML HVO                   613          052 95   71.
   HVO  1975  10 30 17 47 34.9  18.919N 155.287W 021                            3.1 ML HVO                   613          052 85   87.
   HVO  1975  10 31 04 50 53.8  19.200N 155.642W 009                            3.8 ML HVO             E     613          052 95   39.
   HVO  1975  11 01 10 22 04.0  18.931N 155.294W 012                            3.2 ML HVO                   613          052 85   86.
   HVO  1975  11 02 19 25 31.2  18.909N 155.285W 016                            3.0 ML HVO                   613          052 85   88.
   HVO  1975  11 06 02 35 28.2  19.340N 155.312W 033 *                        * 4.6 ML HVO             E     613          052 95   61.
   HVO  1975  11 06 03 21 18.5  19.330N 155.311W 031 *                        * 4.1 ML HVO                   613          052 95   62.
   HVO  1975  11 06 04 02 56.3  19.334N 155.312W 030                            3.8 ML HVO                   613          052 95   62.
●  GS   1975  11 06 12 35 20.0H 19.400N 155.300W 025 * -4.4 MB               * 4.50ML HVO                   613 F   26   052 95   61.
●  GS   1975  11 06 13 21 19.0H 19.400N 155.300W 025 *                        * 4.00ML HVO                   613 F   15   052 95   61.
●  GS   1975  11 06 14 02 57.0H 19.400N 155.300W 025 *                        * 4.00ML HVO                   613 F   14   052 95   61.
   HVO  1975  11 07 19 12 14.4  19.365N 155.278W 028                            3.2 ML HVO                   613          052 95   64.
   HVO  1975  11 08 09 54 36.6  19.294N 155.679W 013                            3.6 ML HVO                   613          052 95   19.
   HVO  1975  11 09 14 23 49.5  18.968N 156.507W 054                            3.3 ML HVO                   613          052 86   66.
   HVO  1975  11 10 01 26 30.0  19.359N 155.036W 019                          * 4.3 ML HVO                   613          052 95   90.
●  GS   1975  11 10 11 24 27.7H 19.400N 155.000W 037                          * 4.00ML HVO                   613 F   13   052 95   93.
   HVO  1975  11 11 05 29 12.3  19.359N 155.259W 010                            3.1 ML HVO                   613          052 95   66.
   HVO  1975  11 13 23 02 04.9  19.358N 155.256W 009                            3.7 ML HVO                   613          052 95   67.
   HVO  1975  11 14 01 23 28.7  19.340N 155.241W 032                            3.7 ML HVO             E     613          052 95   58.
   HVO  1975  11 14 01 51 45.9  19.001N 155.489W 035                            3.2 ML HVO                   613          052 95   66.
   HVO  1975  11 14 07 52 45.9  18.946N 155.566W 038                            3.0 ML HVO                   613          052 85   67.
   HVO  1975  11 15 12 53 21.2  19.320N 155.024W 011                          * 4.4 ML HVO                   613          052 95   71.
   HVO  1975  11 18 13 10 02.0  19.378N 155.163W 009                            3.1 ML HVO             E     613          052 95   86.
   HVO  1975  11 20 13 41 44.2  19.530N 155.613W 009                            3.0 ML HVO             E     613          052 95   23.
   HVO  1975  11 23 01 43 14.3  19.428N 155.274W 014                            3.0 ML HVO                   613          052 95   64.
   HVO  1975  11 27 02 21 15.4  19.300N 155.271W 013                            3.2 ML HVO                   613          052 95   62.
   HVO  1975  11 27 07 33 34.6  20.040N 156.492W 010                            3.0 ML HVO                   613          068 06   10.
   HVO  1975  11 27 16 15 47.6  19.310N 155.472W 009                            3.6 ML HVO                   613          052 95   16.
   HVO  1975  11 29 06         .    19.144N 155.256W 006                          * 4.8 ML HVO                   613          052 95   75.
   HVO  1975  11 29 06 55 56.1  19.379N 155.387W 001                            3.7 ML HVO                   613          052 95   14.
   HVO  1975  11 29 08 42 12.6  19.340N 155.179W 006                          * 4.3 ML HVO             E     613          052 95   85.
   HVO  1975  11 29 09 13 20.2  19.257N 155.263W 005                            3.6 ML HVO                   613          052 95   68.
   HVO  1975  11 29 09 26 02.1  19.377N 154.955W 014                            3.3 ML HVO                   613          052 94   94.
   HVO  1975  11 29 09 35 24.3  19.360N 154.928W 000                            3.3 ML HVO                   613          052 94  101.
   HVO  1975  11 29 09 35 56.8  19.327N 155.350W 000                            3.0 ML HVO                   613          052 95   58.
   HVO  1975  11 29 09 51 10.1  19.349N 155.152W 010                            3.8 ML HVO                   613          052 95   78.
   HVO  1975  11 29 09 56 24.3  19.243N 155.376W 004                            3.0 ML HVO                   613          052 95   59.
   HVO  1975  11 29 10 00 45.5  19.391N 155.054W 006                            3.7 ML HVO                   613          052 95   87.
   HVO  1975  11 29 10 13 23.8  19.259N 155.331W 006                            3.3 ML HVO             E     613          052 95   61.
   HVO  1975  11 29 10 13 05.2  19.354N 155.259W 010                            3.7 ML HVO             E     613          052 95   66.
   HVO  1975  11 29 10 35 19.6  19.233N 154. 31W 083                            3.3 ML HVO                   613          052 94  103.
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SOURCE YEAR  MO DA HR MN SEC      LAT      LONG   DEPTH ---------MAGNITUDES---------       INT PHENOM  RN CE Q/S  MAR DG   DIST
                                                  (KM)   BODY   SURF   OTHER   LOCAL      MAX.DTSVNO                          (KM)
**N INDICATES A POSSIBLE DUPLICATE
    HVO 1975  11 29 10 45 01.0  19.322N 155.345W 001                          3.3 ML HVO               613       052 95    59.
    HVO 1975  11 29 11 01 09.1  19.322N 155.115W 008                          3.5 ML HVO            E  613       052 95    82.
    HVO 1975  11 29 11 09 58.7  19.128N 154.845W 019                          3.0 ML HVO               613       052 94   116.
    HVO 1975  11 29 11 38 17.9  19.435N 155.445W 026                          3.4 ML HVO            E  613       052 95    46.
    HVO 1975  11 29 11 51 38.9  19.340N 154.979W 001                          3.0 ML HVO               613       052 94    96.
    HVO 1975  11 29 12 05 52.9  19.394N 155.008W 012                          3.2 ML HVO               613       052 95    92.
    HVO 1975  11 29 12 22 27.5  19.267N 155.366W 008                          3.4 ML HVO               613       052 95    58.
    HVO 1975  11 29 12 24 27.0  19.279N 155.365W 007                          3.3 ML HVO               613       052 95    58.
    HVO 1975  11 29 12 28 12.9  19.329N 155.343W 003                          3.1 ML HVO            E  613       052 95    59.
    HVO 1975  11 29 12 40 54.2  19.398N 155.049W 008                          3.1 ML HVO               613       052 95    68.
    HVO 1975  11 29 13 29 23.1  19.081N 155.202W 010                          3.5 ML HVO               613       052 95    83.
    GS  1975  11 29 13 35 40.5P 19.360N 155.153W 009 *5.8 MB  5.1MS                                    613 F 197 052 95    88.
    HVO 1975  11 29 14 12 58.7  19.424N 154.974W 007                          3.1 ML HVO               613       052 94    95.
    HVO 1975  11 29 14 14 33.3  19.333N 155.062W 009                          3.4 ML HVO            E  613       052 95    67.
    HVO 1975  11 29 14 42 45.1  19.397N 155.022W 007                          4.1 ML HVO               613       052 95    91.
    GS  1975  11 29 14 47 40.4P 19.334N 155.024W 005 *6.0 MB  7.1MS7.20FAS~             I>   DT VL  613 C 288 052 95    91.
    HVO 1975  11 29 15 17 03.5  19.370N 155.052W 005                          3.4 ML HVO               613       052 95    88.
    HVO 1975  11 29 15 25 45.7  19.343N 155.072W 007                          3.0 ML HVO            E  613       052 95    66.
    HVO 1975  11 29 15 49 54.3  19.331N 155.362W 008                          3.0 ML HVO               613       052 95    57.
    HVO 1975  11 29 15 51 51.0  19.318N 155.005W 006                          3.5 ML HVO               613       052 95    92.
    HVO 1975  11 29 16 17 07.1  19.378N 155.019W 001                          4.0 ML HVO               613       052 95    91.
    HVO 1975  11 29 16 29 24.5  19.410N 155.400W 009                          3.5 ML HVO            E  613       052 95    51.
    HVO 1975  11 29 16 45 57.3  19.405N 155.359W 002                          3.0 ML HVO               613       052 95    67.
    HVO 1975  11 29 17 33 40.9  19.321N 155.108W 008                          3.5 ML HVO               613       052 95    83.
    HVO 1975  11 29 17 37 22.9  19.400N 155.003W 004                          3.4 ML HVO               613       052 95    92.
    HVO 1975  11 29 17 45 15.2  19.347N 154.914W 006                          3.9 ML HVO               613       052 94    94.
    HVO 1975  11 29 18 37 51.7  19.397N 154.958W 006                          3.7 ML HVO               613       052 94    94.
    GS  1975  11 29 18 43 59.8P 19.147N 155.285W 012 *4.9 MB                  4.6 ML HVO               613    19 052 95    70.
    HVO 1975  11 29 18 52 56.3  19.435N 155.118W 003                          3.9 ML HVO               613       052 95    81.
    HVO 1975  11 29 18 58 38.5  19.375N 154.881W 007                          3.8 ML HVO               613       052 94   105.
    HVO 1975  11 29 19 05 23.0  19.357N 155.152W 008                          3.0 ML HVO            E  613       052 95    78.
    HVO 1975  11 29 19 17 21.5  19.472N 155.413W 026                          3.1 ML HVO            E  613       052 95    49.
    HVO 1975  11 29 19 19 28.2  19.127N 155.225W 009                          3.3 ML HVO               613       052 95    75.
    HVO 1975  11 29 19 35 31.5  19.223N 155.385W 004                          3.5 ML HVO               613       052 95    59.
    HVO 1975  11 29 20 15 27.3  19.420N 155.374W 010                          4.5 ML HVO            E  613       052 95    54.
    HVO 1975  11 29 20 40 53.6  19.296N 155.476W 002                          3.3 ML HVO               613       052 95    87.
**1 HVO 1975  11 29 21 26 04.7  19.334N 155.316W 017                          3.1                      613       052 95    61.
**2 HVO 1975  11 29 21 26 13.5  19.279N 155.367W 007                          3.1                      613       052 95    61.
    HVO 1975  11 29 21 54 33.0  19.377N 155.058W 007                          3.0 ML HVO            E  613       052 95    83.
    HVO 1975  11 29 22 51 38.1  19.346N 154.860W 035                          3.0 ML HVO               613       052 94   107.
    HVO 1975  11 29 23 42 59.1  19.416N 154.916W 008                          3.1 ML HVO               613       052 94   102.
    HVO 1975  11 30 00 13 47.7  19.437N 155.402W 009                          3.1 ML HVO               613       052 95    50.
    HVO 1975  11 30 03 01 31.7  19.346N 155.153W 009                          3.7 ML HVO               613       052 95    78.
    HVO 1975  11 30 03 13 23.0  19.356N 155.138W 009                          3.1 ML HVO               613       052 95    79.
    HVO 1975  11 30 03 28 27.1  19.428N 154.909W 009                          3.5 ML HVO               613       052 94   102.
    HVO 1975  11 30 04 41 04.6  19.363N 155.018W 009                          3.0 ML HVO            E  613       052 95    91.
    HVO 1975  11 30 05 09 23.9  19.369N 155.061W 006                          3.4 ML HVO            E  613       052 95    87.
    HVO 1975  11 30 05 45 24.6  19.354N 155.064W 007                          3.0 ML HVO            E  613       052 95    87.
    HVO 1975  11 30 07 02 47.4  19.334N 155.334W 009                          3.0 ML HVO            E  613       052 95    59.
    HVO 1975  11 30 07 27 22.0  19.339N 155.111W 007                          3.1 ML HVO            E  613       052 95    82.
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SOURCE YEAR  MO DA HR MN SEC      LAT      LONG  DEPTH ---------MAGNITUDES---------          INT FHENOM  RN CE Q/S  MAR DG  DIST
                                                 (KM)   BODY  SURF  OTHER   LOCAL            MAX DTSVNO                      (KM)
**N INDICATES A POSSIBLE DUPLICATE
   HVO  1975  11 30 09 49 37.0  19.393N 154.960W 006                        3.1 ML HVO                   613         052 94     95.
   HVO  1975  11 30 10 04 45.1  19.453N 154.864W 009                        3.1 ML HVO                   613         052 94    107.
   HVO  1975  11 30 10 32 54.0  19.361N 155.255W 010                        3.2 ML HVO                   613         052 95     67.
   HVO  1975  11 30 13 47 14.5  19.360N 154.945W 003                        3.2 ML HVO                   613         052 94     99.
   HVO  1975  11 30 14 08 36.9  19.332N 155.211W 008                        3.6 ML HVO                   613         052 95     72.
   HVO  1975  11 30 14 13 11.0  19.403N 155.059W 001                        3.2 ML HVO                E  613         052 95     87.
   HVO  1975  11 30 17 20 24.4  19.363N 155.081W 008                        3.5 ML HVO                E  613         052 95     65.
   HVO  1975  11 30 19 21 09.5  19.357N 155.254W 010                        3.2 ML HVO                   613         052 95     67.
   HVO  1975  11 30 20 57 19.3  19.377N 155.050W 006                        3.7 ML HVO                E  613         052 95     88.
   HVO  1975  11 30 22 43 42.1  19.339N 155.059W 005                        3.7 ML HVO                   613         052 95     88.
   HVO  1975  11 30 22 51 00.8  19.365N 155.120W 008                        3.0 ML HVO                   613         052 95     61.
   HVO  1975  12 01 00 41 35.5  19.407N 155.058W 000                        3.1 ML HVO                   613         052 95     87.
   HVO  1975  12 01 02 30 54.3  19.420N 154.962W 006                        3.1 ML HVO                   613         052 94     95.
   HVO  1975  12 01 04 31 19.4  19.331N 155.125W 001                        3.1 ML HVO                   613         052 95     81.
   HVO  1975  12 01 07 56 58.2  19.350N 154.977W 008                        3.1 ML HVO                   613         052 94     96.
   HVO  1975  12 01 08 24 27.6  19.276N 155.101W 007                        3.2 ML HVO                E  613         052 95     83.
   HVO  1975  12 01 08 51 25.0  19.440N 155.477W 010                        3.4 ML HVO                   613         052 95     43.
   HVO  1975  12 01 10 39 55.2  19.391N 154.979W 009                        3.7 ML HVO                   613         052 94     95.
   HVO  1975  12 01 12 19 33.2  19.361N 155.124W 009                        3.3 ML HVO                   613         052 95     80.
   HVO  1975  12 01 16 37 37.5  19.398N 154.990W 008                        3.0 ML HVO                   613         052 94     54.
   HVO  1975  12 01 18 33 14.4  19.347N 155.115W 008                        3.5 ML HVO                   613         052 95     81.
   HVO  1975  12 02 00 15 44.1  19.362N 155.255W 009                        3.6 ML HVO                   613         052 95     67.
   HVO  1975  12 02 05 43 55.9  19.464N 154.872W 010                        3.1 ML HVO                   613         052 94    106.
   HVO  1975  12 02 06 21 29.0  19.270N 155.197W 009                        3.0 ML HVO                   613         052 95     75.
   HVO  1975  12 02 07 24 05.9  19.311N 155.347W 009                        3.3 ML HVO                E  613         052 95     59.
   HVO  1975  12 02 10 11 19.3  19.375N 155.109W 007                        3.2 ML HVO                   613         052 95     91.
   HVO  1975  12 02 11 12 45.4  19.355N 154.993W 009                        3.1 ML HVO                   613         052 94     94.
   HVO  1975  12 02 14 21 16.5  19.314N 155.303W 006                        3.2 ML HVO                E  613         052 95     54.
   HVO  1975  12 02 16 04 22.6  19.304N 155.323W 003                        3.0 ML HVO                   613         052 95     61.
   HVO  1975  12 02 22 32 45.4  19.351N 154.943W 006                        3.0 ML HVO                   613         052 94     99.
   HVO  1975  12 03 02 46 55.2  19.311N 155.347W 010                        3.3 ML HVO                   613         052 95     59.
   HVO  1975  12 03 04 55 59.6  19.430N 155.399W 010                        3.5 ML HVO                   613         052 95     52.
   GS   1975  12 03 05 07 07.74 19.375N 154.983W 001                     ** 4.10ML HVO                   613    7    052 94     95.
   HVO  1975  12 03 05 05 35.6  19.322N 155.170W 010                        3.8 ML HVO                   613         052 95      4.
   HVO  1975  12 03 05 38 01.0  19.394N 154.985W 006                      * 4.2 ML HVO                   613         052 94     94.
   GS   1975  12 03 06 27 56.6F 19.342N 155.065W 005                        3.60ML HVO                   613    9    052 95     65.
   GS   1975  12 03 06 43 53.3F 19.315N 155.337W 008                        3.10ML HVO                   613   10    052 95     60.
   HVO  1975  12 03 10 33 03.0  19.155N 155.306W 013                        3.1 ML HVO                   613         052 95     69.
   HVO  1975  12 03 11 17 43.3  19.467N 155.044W 008                        3.0 ML HVO                   613         052 95     89.
   HVO  1975  12 03 11 10 23.0  19.361N 154.983W 005                      * 4.0 ML HVO                   613         052 94     95.
   HVO  1975  12 03 12 33 46.6  19.340N 155.342W 005                        3.1 ML HVO                E  613         052 95     56.
   HVO  1975  12 03 12 51 23.0  19.372N 155.029W 017                      * 4.2 ML HVO                   613         052 95     90.
   HVO  1975  12 03 13 12 44.3  19.240N 155.410W 012                        3.0 ML HVO                   613         052 95     55.
   HVO  1975  12 03 17 48 26.5  19.396N 154.971W 006                        3.0 ML HVO                   613         052 94     96.
   HVO  1975  12 03 20 27 56.3  19.332N 155.082W 008                        3.5 ML HVO                E  613         052 95     65.
   HVO  1975  12 03 20 43 54.0  19.315N 155.342W 009                        3.2 ML HVO                E  613         052 95     59.
   HVO  1975  12 04 00 59 03.2  19.399N 154.961W 005                        3.8 ML HVO                   613         052 94     95.
   HVO  1975  12 04 01 13 08.3  19.379N 154.938W 009                     ** 4.0 ML HVO                   613         052 94     99.
   HVO  1975  12 04 01 41 35.7  19.332N 155.200W 009                        3.0 ML HVO                   613         052 95     73.
   HVO  1975  12 04 07 33 37.4  19.344N 155.345W 005                        3.0 ML HVO                   613         052 95     56.
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SOURCE YEAR  MO DA HR MN SEC       LAT      LONG  DEPTH ---------MAGNITUDES---------         INT PHENOM  RN CE Q/S  MAR DG   DIST
                                                   (KM)    BODY    SURF   OTHER   LOCAL       MAX DTSVNO                      (KM)
**N INDICATES A POSSIBLE DUPLICATE
  HVO  1975  12 04 10 35 11.3   19.394N 154.950W 005                           3.5 ML HVO                613          052 94     98.
  HVO  1975  12 04 11 19 46.8   19.360N 155.080W 007                           3.7 ML HVO                613          052 95     85.
  HVO  1975  12 04 11 39 10.1   19.350N 154.963W 006                           3.5 ML HVO                613          052 94     97.
  HVO  1975  12 04 14 21 32.8   19.441N 154.867W 009                           3.7 ML HVO                613          052 94    106.
  HVO  1975  12 04 17 32 17.3   19.350N 155.078W 008                           3.6 ML HVO              E 613          052 95     85.
  HVO  1975  12 04 21 04 31.3   19.379N 155.123W 008                           3.1 ML HVO                613          052 95     82.
  HVO  1975  12 04 21 56 54.3   19.366N 155.003W 006                           3.1 ML HVO                613          052 95     93.
  HVO  1975  12 05 10 09 06.5   19.367N 155.252W 010                           3.3 ML HVO                613          052 95     67.
  HVO  1975  12 05 12 20 47.2   19.361N 155.122W 009                           3.1 ML HVO                613          052 95     81.
  HVO  1975  12 05 19 11 55.2   19.289N 155.355W 009                           3.8 ML HVO              E 613          052 95     59.
  HVO  1975  12 06 01 37 59.1   19.397N 154.593W 007                           3.0 ML HVO                613          052 94     95.
  HVO  1975  12 06 03 50 26.3   19.335N 155.291W 006                           3.1 ML HVO                613          052 95     64.
  HVO  1975  12 06 13 10 46.4   19.379N 155.031W 007                           3.1 ML HVO                613          052 95     90.
  HVO  1975  12 06 19 1[illegible] [illegible]   19.337N 155.122W 010                           3.0 ML HVO              E 613          052 95     61.
  HVO  1975  12 07 03 47 20.9   19.361N 155.258W 010                           3.3 ML HVO                613          052 95     66.
  HVO  1975  12 07 13 [illegible] 22.[illegible]   19.275N 155.262W 006                           3.3 ML HVO                613          052 95     74.
  HVO  1975  12 07 17 50 43.3   19.496N 154.924W 008                           3.0 ML HVO                613          052 94    111.
  HVO  1975  12 08 01 [illegible] 33.4   19.475N 155.149W 028                           3.2 ML HVO                613          052 95     77.
  HVO  1975  12 08 02 24 51.1   19.312N 155.347W 010                           3.2 ML HVO              E 613          052 95     59.
  HVO  1975  12 08 08 35 53.6   19.477N 154.641W 008                           3.0 ML HVO                613          052 94    159.
  HVO  1975  12 08 [illegible] [illegible] 54.1   19.255N 155.259W 014                           3.4 ML HVO                613          052 95     66.
  HVO  1975  12 08 13 1[illegible] 39.6   19.372N 155.032W 008                           3.6 ML HVO              E 613          052 95     69.
  HVO  1975  12 08 15 06 43.7   19.335N 155.116W 005                           3.4 ML HVO                613          052 95     82.
  HVO  1975  12 08 19 47 31.9   19.365N 155.125W 013                           3.2 ML HVO                613          052 95     81.
  HVO  1975  12 08 22 38 45.7   19.334N 155.113W 009                           3.2 ML HVO              E 613          052 95     82.
  HVO  1975  12 09 02 54 13.1   19.371N 155.067W 006                           3.0 ML HVO              E 613          052 95     86.
  HVO  1975  12 09 07 02 00.1   19.361N 155.252W 010                           3.2 ML HVO                613          052 95     67.
  HVO  1975  12 09 09 32 41.7   19.336N 155.347W 009                           3.6 ML HVO              E 613          052 95     59.
  HVO  1975  12 09 10 18 01.3   19.357N 155.121W 008                         • 4.4 ML HVO                613          052 95     81.
  HVO  1975  12 09 13 10 52.9   19.344N 155.105W 010                           3.0 ML HVO              E 613          052 95     82.
  HVO  1975  12 09 13 34 37.0   19.346N 155.016W 011                           3.0 ML HVO              E 613          052 95     15.
  HVO  1975  12 09 13 55 54.5   19.361N 155.127W 009                         • 4.0 ML HVO                613          052 95     80.
  HVO  1975  12 10 11 18 37.0   19.366N 155.420W 011                           3.1 ML HVO                613          052 95     50.
  HVO  1975  12 10 11 53 30.7   19.350N 155.039W 010                           3.4 ML HVO              E 613          052 95     83.
  HVO  1975  12 10 15 43 16.9   19.334N 155.261W 010                         • 4.0 ML HVO                613          052 95     73.
  HVO  1975  12 11 03 57 11.3   19.351N 155.075W 009                           3.1 ML HVO              E 613          052 95     86.
  HVO  1975  12 11 05 41 17.1   19.365N 155.119W 009                           3.2 ML HVO                613          052 95     81.
  HVO  1975  12 11 10 15 50.6   19.351N 155.057W 009                           3.4 ML HVO                613          052 95     67.
  HVO  1975  12 11 13 10 43.1   19.357N 155.062W 007                           3.3 ML HVO              E 613          052 95     87.
  HVO  1975  12 12 15 30 54.5   19.353N 155.136W 009                         • 4.9 ML HVO                613          052 95     79.
  HVO  1975  12 12 16 51 07.7   19.375N 155.040W 007                           3.2 ML HVO              E 613          052 95     89.
  HVO  1975  12 13 00 53 36.3   19.374N 155.053W 008                         • 4.1 ML HVO              E 613          052 95     87.
  HVO  1975  12 13 11 17 43.0   19.667N 154.532W 007                           3.4 ML HVO                613          052 94    149.
  HVO  1975  12 14 10 46 49.3   19.344N 155.109W 009                           3.4 ML HVO              E 613          052 95     82.
  HVO  1975  12 14 11 47 37.4   19.365N 155.252W 009                           3.0 ML HVO                613          052 95     67.
  HVO  1975  12 14 14 09 27.2   19.312N 155.348W 010                           3.5 ML HVO              E 613          052 95     59.
  HVO  1975  12 15 14 25 00.8   19.395N 154.969W 007                           3.0 ML HVO                613          052 94     96.
  HVO  1975  12 16 05 43 17.2   19.416N 155.215W 007                           3.1 ML HVO              E 613          052 95     70.
  HVO  1975  12 17 01 40 25.2   19.445N 154.650W 008                           3.4 ML HVO                613          052 94    108.
  HVO  1975  12 17 05 45 59.5   19.363N 155.116W 009                           3.1 ML HVO                613          052 95     81.
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SOURCE YEAR  MO DA HR MN SEC      LAT       LON     DEPTH ---------MAGNITUDES------- -          INT PHENOM  RN CE Q/S  MAR DG   DIST
                                                     (KM)   BODY   SURF   OTHER   LOCAL        MAX DTSVNO                       (KM)
**N INDICATES A POSSIBLE DUPLICATE
   HVO  1975  12 17 09 54 33.2  19.363N 155.256W 009                          3.8 ML HVO                  613          052 95    67.
   HVO  1975  12 19 09 13 43.4  19.430N 155.473W 010                          3.8 ML HVO                  613          052 95    43.
   HVO  1975  12 19 16 42 22.4  19.308N 155.346W 009                          3.1 ML HVO              E   613          052 95    59.
   HVO  1975  12 19 16 04 16.3  19.434N 155.276W 017                          3.1 ML HVO              E   613          052 95    64.
   HVO  1975  12 20 14 14 57.3  19.359N 155.046W 009                          3.0 ML HVO              E   613          052 95    88.
   HVO  1975  12 20 23 30 44.5  19.381N 155.329W 007                          3.4 ML HVO                  613          052 95    50.
   HVO  1975  12 21 17 45 39.6  19.290N 155.353W 010                          3.1 ML HVO              E   613          052 95    59.
   HVO  1975  12 23 03 50 55.8  19.342N 155.129W 010                          3.6 ML HVO                  613          052 95    60.
   HVO  1975  12 23 04 04 13.6  19.359N 155.041W 008                          3.4 ML HVO                  613          052 95    89.
   HVO  1975  12 23 06 19 33.3  19.392N 155.073W 009                          3.1 ML HVO              E   613          052 95    85.
   HVO  1975  12 23 09 58 37.4  19.211N 155.472W 011                          3.0 ML HVO                  613          052 95    52.
   HVO  1975  12 23 13 12 51.1  19.211N 155.470W 010                          3.4 ML HVO                  613          052 95    52.
   HVO  1975  12 23 16 41 42.1  19.428N 155.298W 013                          3.8 ML HVO                  613          052 95    61.
   HVO  1975  12 23 16 47 08.1  19.429N 155.301W 013                          3.6 ML HVO                  613          052 95    61.
   HVO  1975  12 23 18 41 47.1  19.365N 155.115W 009                          3.7 ML HVO                  613          052 95    81.
   HVO  1975  12 24 [illegible] 44 34.9  19.337N 155.277W 008                 3.1 ML HVO                  613          052 95    65.
   HVO  1975  12 24 04 31 39.4  19.276N 155.288W 010                          3.5 ML HVO              E   613          052 95    74.
   HVO  1975  12 24 10 43 45.8  19.435N 154.927W 008                          3.1 ML HVO                  613          052 94    99.
   HVO  1975  12 25 11 26 43.2  19.342N 155.054W 010                          3.2 ML HVO                  613          052 95    67.
   HVO  1975  12 26 04 37 21.4  19.452N 155.331W 011                          3.1 ML HVO              E   613          052 95     6.
   HVO  1975  12 26 09 27 08.4  19.342N 155.1[illegible]W 016                 3.5 ML HVO              E   613          052 95    82.
   HVO  1975  12 26 13 32 54.2  19.371N 155.[illegible]16W 009                3.7 ML HVO                  613          052 95    84.
   HVO  1975  12 26 20 53 57.2  19.365N 155.255W 010                          3.2 ML HVO                  613          052 95    67.
   HVO  1975  12 26 22 55 24.9  19.341N 155.8[illegible]2W 009                4.2 ML HVO                  613          052 95    53.
   HVO  1975  12 27 02 32 52.4  19.287N 155.367W 010                          3.7 ML HVO                  613          052 95    57.
   HVO  1975  12 27 07 13 37.3  19.378N 155.109W 008                          3.9 ML HVO              E   613          052 95    73.
●  GS   1975  12 27 0[illegible] 55 24.0F 20.0[illegible]N 156.[illegible]0W 030 *       4.1(ML HVO       613 F    11  088 06    61.
   HVO  1975  12 27 15 5[illegible] 3[illegible]  19.332N 155.110W 008        3.1 ML HVO              E   613          052 95    62.
   HVO  1975  12 27 16 3[illegible] 02.2  19.434N 155.4[illegible]6W 009      3.1 ML HVO                  613          052 95    50.
   HVO  1975  12 30 09 2[illegible] 4[illegible].8  19.377N 155.1[illegible]2W 009   3.6 ML HVO           613          052 95    62.
   HVO  1975  12 31 08 47 43.7  19.5[illegible]0N 155.273W 026                3.0 ML HVO                  613          052 95    64.
   HVO  1975  12 31 09 34 14.3  19.360N 155.240W 007                          3.2 ML HVO                  613          052 95    89.
   HVO  1976  01 01 0[illegible] 32 48.1  19.835N 155.[illegible]78W 017      3.6 ML HVO                  613          052 85   110.
   HVO  1976  01 01 06 54 19.9  19.674N 155.[illegible]47W 055 *              4.7 ML HVO                  613          052 85   124.
   HVO  1976  01 01 15 36 47.3  19.382N 155.251W 008                          3.5 ML HVO                  613          052 95    57.
   HVO  1976  01 05 23 17 44.8  19.309N 155.212W 007                          3.4 ML HVO              E   613          052 95    72.
   HVO  1976  01 06 [illegible] 43 37.6  19.3[illegible]N 155.396W 005        3.0 ML HVO              E   613          052 95    54.
   HVO  1976  01 0[illegible] 12 5[illegible] 52.[illegible]  19.44[illegible]N 154.[illegible]94W [illegible]09   3.2 ML HVO   613   052 94   104.
   HVO  1976  01 07 [illegible] 1[illegible] 3[illegible].4  19.[illegible]N 155.044W 01[illegible]   3.7 ML HVO     E   613          052 95    59.
   HVO  1976  01 07 [illegible]1 44 33.3  19.483N 154.887W 008                3.8 ML HVO                  613          052 94   104.
   HVO  1976  01 07 11 35 07.9  19.371N 155.395W 008                          3.1 ML HVO                  613          052 95    83.
   HVO  1976  01 08 [illegible]2 22 53.4  19.794N 156.[illegible]42W 008      3.3 ML HVO                  613          052 96    40.
   HVO  1976  01 10 [illegible]4 [illegible]7 04.3  19.346N 155.110W 009      3.0 ML HVO              E   613          052 95    62.
   HVO  1976  01 11 14 [illegible]5 40.2  19.513N 155.270W 024                4.2 ML HVO                  613          052 95    64.
   GS   1976  01 11 [illegible]2 26 10.0F 20.[illegible]N 155.5[illegible]W 010      3.3(ML HVO           613 F    10  088 05    72.
●  GS   1976  01 12 0[illegible] [illegible]5 39.0F 19.3[illegible]N 155.3[illegible]0W 033 * 4.5 MB  4.2MS   4.1(ML HVO   613 F 27  052 95   64.
   HVO  1976  01 12 [illegible]3 4[illegible] 32.9  19.365N 155.111W 009      3.0 ML HVO                  613          052 95    82.
   HVO  1976  01 12 23 [illegible]6 21.8  19.35[illegible]N 155.115W 009      3.2 ML HVO              E   613          052 95    81.
   HVO  1976  01 14 0[illegible] [illegible]3 27.6  19.77[illegible]N 155.[illegible]9W 009   3.2 ML HVO      613          052 95    62.
   HVO  1976  01 15 12 41 45.3  19.4[illegible]N 155.[illegible]43W 014       4.4 ML HVO                  613          052 95    62.
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SOURCE YEAR  MO DA HR MN SEC       LAT      LONG    DEPTH ---------MAGNITUDES---------                 INT PHENOM  RN CE Q/S  MAR DG   DIST
                                                    (KM)   BODY   SURF   OTHER   LOCAL                 MAX DTSVNO                        (KM)
**N INDICATES A POSSIBLE DUPLICATE
   HVO  1976  01 15 12 59 26.1  19.411N 155.293W 016                        4.5 ML HVO                           613              052 95     62.
 ● GS   1976  01 15 22 59 24.0F 19.300N 155.300W 030  4.8 MB                4.50ML HVO                           613 F    54      052 95     64.
   HVO  1976  01 16 19 29 13.8  19.375N 155.109W 008                        3.7 ML HVO                           613              052 95     82.
   HVO  1976  01 16 20 00 03.9  19.355N 154.994W 002                        3.2 ML HVO                           613              052 94     94.
 ● GS   1976  01 17 05 29 13.0F 19.300N 155.100W 005                        3.50ML HVO                           613 F    14      052 95     84.
   HVO  1976  01 18 04 49 29.4  19.362N 155.255W 010                        3.6 ML HVO                           613              052 95     67.
   HVO  1976  01 18 14 05 10.9  19.363N 155.117W 009                        3.6 ML HVO                           613              052 95     81.
   HVO  1976  01 18 14 13 37.9  19.361N 155.127W 007                        3.6 ML HVO                           613              052 95     80.
   HVO  1976  01 18 23 57 46.5  19.376N 155.099W 008                        3.6 ML HVO                           613              052 95     83.
   HVO  1976  01 21 05 22 17.7  19.365N 155.112W 008                        3.0 ML HVO                           613              052 95     82.
   HVO  1976  01 21 11 41 21.2  19.367N 155.120W 008                        4.1 ML HVO                           613              052 95     81.
   HVO  1976  01 23 02 47 40.1  19.361N 155.093W 009                        3.7 ML HVO                      E    613              052 95     85.
   HVO  1976  01 23 08 20 14.1  19.364N 155.132W 009                        3.2 ML HVO                           613              052 95     79.
   HVO  1976  01 26 10 55 58.7  19.470N 154.918W 008                        3.0 ML HVO                           613              052 94    102.
   HVO  1976  01 27 05 35 51.4  19.373N 155.173W 009                        3.6 ML HVO                      E    613              052 95     83.
   HVO  1976  01 27 22 26 29.2  19.356N 155.111W 009                        4.0 ML HVO                      E    613              052 95     82.
   HVO  1976  01 29 02 07 24.3  19.193N 155.626W 010                        3.0 ML HVO                      E    613              052 95     41.
   HVO  1976  01 29 05 00 54.2  19.344N 155.108W 009                        3.2 ML HVO                      E    613              052 95     82.
   HVO  1976  01 29 11 15 56.5  19.479N 154.994W 009                        4.7 ML HVO                           613              052 94     94.
 ● GS   1976  01 29 21 19 58.0F 19.4[illegible]N 155.[illegible]W 005  4.5 MB    4.50ML HVO                           613 F    27      052 95     53.
   HVO  1976  01 31 01 32 33.5  19.444N 155.376W 009                        3.1 ML HVO                           613              052 95     53.
   HVO  1976  01 31 20 07 27.0  19.368N 155.081W 008                        3.3 ML HVO                           613              052 95     85.
   HVO  1976  02 03 16 42 13.5  19.378N 155.099W 009                        3.4 ML HVO                           613              052 95     83.
   HVO  1976  02 03 23 50 55.5  19.361N 155.253W 010                        3.5 ML HVO                           613              052 95     67.
   HVO  1976  02 05 11 49 04.5  19.357N 155.135W 009                        3.1 ML HVO                           613              052 95     79.
   HVO  1976  02 05 19 13 37.7  19.341N 155.119W 009                        3.2 ML HVO                      E    613              052 95     81.
   HVO  1976  02 07 02 48 12.3  19.330N 155.124W 008                        3.2 ML HVO                      E    613              052 95     81.
   HVO  1976  02 12 06 18 26.2  19.341N 155.094W 007                        3.2 ML HVO                      E    613              052 95     87.
   HVO  1976  02 13 05 49 51.9  19.502N 155.462W 010                        3.6 ML HVO                           613              052 95     10.
   HVO  1976  02 20 19 51 14.9  20.410N 156.022W 032                        5.1 ML HVO                           613              088 06    107.
 ● GS   1976  02 21 05 51 13.8  20.288N 156.267W 033N  4.9 MB  4.0MS        5.00ML HVO             V             613 F    48      088 06     92.
   HVO  1976  02 23 09 45 43.5  19.360N 155.254W 009                        3.2 ML HVO                           613              052 95     67.
   HVO  1976  02 24 05 50 19.2  19.373N 155.111W 009                        4.2 ML HVO                           613              052 95     82.
   HVO  1976  02 24 14 43 32.6  19.386N 155.080W 008                        3.2 ML HVO                      E    613              052 95     85.
   HVO  1976  02 24 19 19 31.6  19.352N 155.133W 009                        3.1 ML HVO                           613              052 95     80.
   HVO  1976  02 25 13 48 20.4  19.370N 155.106W 009                        3.9 ML HVO                           613              052 95     82.
   HVO  1976  02 28 23 55 25.9  19.374N 155.176W 008                        3.3 ML HVO                           613              052 95     82.
   HVO  1976  02 29 19 41 58.9  19.334N 155.110W 009                        3.1 ML HVO                      E    613              052 95     82.
   HVO  1976  03 06 12 23 14.4  19.3[illegible]N 155. 33W 006                        3.5 ML HVO                      E    613              052 95     90.
   HVO  1976  03 07 07 49 14.1  19.3[illegible]N 155.2[illegible]W 010                        3.1 ML HVO                      E    613              052 95     73.
   HVO  1976  03 07 16 35 34.6  19.4[illegible]N 155.120W 008                        3.7 ML HVO                           613              052 95     81.
   HVO  1976  03 10 21 41 14.2  20.037N 155.552W 026                        3.1 ML HVO                           613              088 05     72.
   HVO  1976  03 11 04 02 42.2  19.365N 155.25 W 009                        3.1 ML HVO                           613              052 95     66.
   HVO  1976  03 12 21 10 17.3  19.571N 154.846W 009                        3.3 ML HVO                           613              052 94    109.
   HVO  1976  03 13 06 16 16.4  19.145N 155.512W 011                        3.5 ML HVO                           613              052 95     54.
   HVO  1976  03 13 20 22 02.8  19.224N 155.384W 012                        3.0 ML HVO                           613              052 95     40.
   HVO  1976  03 19 13 24 30.3  19.355N 155.057W 009                        3.9 ML HVO                      E    613              052 95     87.
   HVO  1976  03 20 13 13 19.9  19.331N 155.109W 009                        3.1 ML HVO                      E    613              052 95     82.
   HVO  1976  03 21 09 31 33.5  19.371N 155.254W 010                        3.3 ML HVO                           613              052 95     67.
   HVO  1976  03 21 20 31 24.6  19.337N 155.144W 008                        3.2 ML HVO                           613              052 95     79.
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 SOURCE YEAR  MO DA HR MN SEC       LAT      LONG    DEPTH ---------MAGNITUDES---------           INT PHENOM  RN CE Q/S  MAR DG   DIST
                                                     (KM)   BODY   SURF  OTHER   LOCAL         MAX DTSVNO                         (KM)
**N INDICATES A POSSIBLE DUPLICATE
   HVO  1976  03 22 20 48 26.9  19.364N 155.084W 009                     3.3 ML HVO               E  613         052 95    64.
   HVO  1976  03 22 21 19 56.7  19.341N 155.111W 010                     3.1 ML HVO               E  613         052 95    82.
   HVO  1976  03 23 15 06 03.2  19.314N 155.356W 009                     3.7 ML HVO                  613         052 95    63.
   HVO  1976  03 29 05 09 52.0  19.364N 155.253W 010                     3.7 ML HVO                  613         052 95    67.
   HVO  1976  03 29 08 31 29.8  19.401N 155.257W 013                     3.0 ML HVO                  613         052 95    66.
   HVO  1976  03 30 14 52 10.3  19.334N 155.122W 010                     3.4 ML HVO               E  613         052 95    81.
   HVO  1976  04 02 08 14 06.5  19.344N 155.108W 009                     4.6 ML HVO               E  613         052 95    82.
   HVO  1976  04 02 09 14 11.7  19.643N 155.999W 007                     3.4 ML HVO                  613         052 95    23.
   HVO  1976  04 02 09 55 03.3  19.331N 155.216W 008                     3.6 ML HVO                  613         052 95    71.
 ● GS   1976  04 02 18 14 06.0H 19.400N 155.100W 005  .4.5 MB            4.50ML HVO     V            613 F   24  052 95    82.
   HVO  1976  04 03 01 43 42.2  19.395N 155.224W 004                     3.0 ML HVO               E  613         052 95    63.
   HVO  1976  04 06 03 12 52.1  19.343N 155.209W 009                     3.4 ML HVO                  613         052 95    72.
   HVO  1976  04 08 10 54 22.2  19.148N 155.288W 005                     3.1 ML HVO                  613         052 95    72.
   HVO  1976  04 11 15 35 49.2  19.349N 155.094W 005                     3.4 ML HVO               E  613         052 95    87.
   HVO  1976  04 12 07 26 23.5  19.316N 155.359W 009                     3.0 ML HVO               E  613         052 95    57.
   HVO  1976  04 14 22 01 36.1  19.461N 154.865W 008                     3.3 ML HVO                  613         052 94   105.
   HVO  1976  04 20 07 11 03.1  19.312N 155.254W 010                     3.5 ML HVO                  613         052 95    67.
   HVO  1976  04 21 16 13 24.5  19.799N 155.005W 050                     4.6 ML HVO                  613         052 85   119.
 ● GS   1976  04 22 04 13 36.3  19.996N 155.170W 033N                    3.90ML HVO                  613 F   15  052 85    92.
   HVO  1976  04 22 05 54 34.9  19.525N 155.311W 012                     3.4 ML HVO                  613         052 95    63.
   HVO  1976  04 22 08 33 01.0  19.310N 155.344W 010                     3.4 ML HVO               E  613         052 95    59.
   HVO  1976  04 23 12 29 53.8  19.365N 155.066W 009                     4.2 ML HVO               E  613         052 95    84.
   HVO  1976  04 26 21 44 41.5  19.346N 155.283W 005                     3.1 ML HVO                  613         052 95    63.
   HVO  1976  05 01 18 52 54.9  19.307N 155.351W 007                     3.2 ML HVO               E  613         052 95    54.
   HVO  1976  05 02 20 40 57.4  19.115N 155.531W 060                     3.3 ML HVO                  613         052 95    54.
   HVO  1976  05 09 06 14 43.4  19.359N 155.123W 010                     3.4 ML HVO                  613         052 95    79.
   HVO  1976  05 10 08 27 04.5  19.398N 155.075W 008                     3.5 ML HVO               E  613         052 95    85.
   HVO  1976  05 12 05 35 11.6  19.339N 155.194W 009                     3.7 ML HVO                  613         052 95    74.
   HVO  1976  05 14 09 13 42.2  19.290N 155.505W 010                     3.1 ML HVO               E  613         052 95    44.
   HVO  1976  05 17 01 45 26.1  19.330N 155.271W 010                     3.6 ML HVO               E  613         052 95    66.
   HVO  1976  05 17 03 54 44.2  19.329N 155.143W 010                     3.0 ML HVO                  613         052 95    73.
   HVO  1976  05 17 21 36 19.6  19.340N 155.077W 007                     3.1 ML HVO               E  613         052 95    86.
   HVO  1976  05 18 06 16 41.3  19.329N 155.125W 009                     3.5 ML HVO               E  613         052 95    81.
   HVO  1976  05 19 17 12 05.5  19.330N 155.129W 009                     3.8 ML HVO               E  613         052 95    80.
   HVO  1976  05 21 14 39 49.0  19.353N 155.261W 011                     3.1 ML HVO                  613         052 95    15.
   HVO  1976  05 21 13 53 29.6  19.351N 155.101W 009                     3.2 ML HVO               E  613         052 95    83.
   HVO  1976  05 22 18 52 24.4  19.361N 155.252W 011                     3.7 ML HVO                  613         052 95    67.
   HVO  1976  05 23 17 31 20.2  19.341N 155.114W 009                     4.0 ML HVO               E  613         052 95    82.
   HVO  1976  05 26 02 33 07.5  19.423N 155.402W 010                     3.1 ML HVO                  613         052 95    50.
   HVO  1976  05 28 12 22 45.5  19.344N 155.061W 008                     3.3 ML HVO               E  613         052 95    84.
   HVO  1976  05 31 06 27 21.1  20.246N 155.893W 032                     3.6 ML HVO                  613         086 05    87.
   HVO  1976  05 31 08 32 10.0  20.264N 155.770W 003                     4.1 ML HVO                  613         088 05    90.
   HVO  1976  05 31 08 53 52.7  20.147N 155.813W 029                     3.0 ML HVO                  613         088 05    76.
   HVO  1976  05 31 09 55 53.3  20.114N 155.809W 025                     3.0 ML HVO                  613         088 05    73.
   HVO  1976  06 01 16 15 16.4  19.689N 155.949W 002                     3.0 ML HVO                  613         052 95    91.
   HVO  1976  06 04 22 53 51.3  19.359N 155.119W 009                     4.1 ML HVO                  613         052 95    61.
   HVO  1976  06 06 03 45 14.9  19.322N 155.273W 010                     3.1 ML HVO               E  613         052 95    66.
   HVO  1976  06 07 10 39 37.6  19.319N 155.261W 031                     3.5 ML HVO               E  613         052 95    67.
   HVO  1976  06 10 00 15 03.9  19.338N 155.122W 009                     3.3 ML HVO               E  613         052 95    61.
   HVO  1976  06 10 22 15 05.2  19.338N 155.142W 010                     3.2 ML HVO                  613         052 95    79.
81/07/17.
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 SOURCE YEAR  MO DA HR MN SEC       LAT       LONG   DEPTH ----------MAGNITUDES----------                 INT FFENOM  RN CE Q/S  MAR DG   DIST
                                                     (KM)   BODY   SURF   OTHER   LOCAL                 MAX DTSVNO                        (KM)
**N INDICATES A POSSIBLE DUPLICATE
   HVO  1976  06 12 12 42 15.6  19.338N 155.134W 009                          3.1 ML HVO                        613         052 95    60.
   HVO  1976  06 13 14 21 41.0  19.337N 155.137W 009                          3.0 ML HVO                        613         052 95    79.
   HVO  1976  06 14 14 17 15.2  19.404N 155.264W 004                          3.2 ML HVO                      E 613         052 95    65.
   HVO  1976  06 15 05 10 32.5  19.457N 155.480W 010                          3.4 ML HVO                        613         052 95    42.
   HVO  1976  06 16 09 17 15.9  19.364N 155.081W 008                          3.4 ML HVO                        613         052 95    65.
   HVO  1976  06 18 12 01 11.6  19.376N 155.101W 008                          3.4 ML HVO                        613         052 95    63.
   HVO  1976  06 20 00 25 11.3  19.392N 155.251W 005                          3.1 ML HVO                        613         052 95    67.
   HVO  1976  06 20 23 06 23.8  19.191N 155.547W 011                          3.1 ML HVO                      E 613         052 95    47.
   HVO  1976  06 21 18 16 27.2  19.369N 155.215W 005                          3.1 ML HVO                        613         052 95    71.
   HVO  1976  06 21 19 03 34.1  19.371N 155.219W 006                          3.4 ML HVO                        613         052 95    70.
   HVO  1976  06 21 19 36 29.9  19.368N 155.216W 006                          3.1 ML HVO                      E 613         052 95    71.
   HVO  1976  06 21 20 00 34.7  19.372N 155.221W 005                          3.3 ML HVO                        613         052 95    70.
   HVO  1976  06 21 20 13 12.0  19.330N 155.084W 009                          3.2 ML HVO                      E 613         052 95    84.
   HVO  1976  06 21 21 27 29.2  19.396N 155.247W 003                          3.0 ML HVO                        613         052 95    67.
   HVO  1976  06 21 23 55 31.1  19.475N 154.840W 008                          3.1 ML HVO                        613         052 94   109.
   HVO  1976  06 22 03 04 39.6  19.377N 155.241W 003                          3.2 ML HVO                      E 613         052 95    66.
   HVO  1976  06 22 03 41 09.9  19.388N 155.243W 005                          3.0 ML HVO                        613         052 95    66.
   HVO  1976  06 24 13 47 53.9  19.338N 155.166W 008                          3.6 ML HVO                        613         052 95    73.
   HVO  1976  06 24 23 48 53.0  20.121N 156.341W 013                          3.2 ML HVO                        613         086 06    67.
   HVO  1976  06 30 06 17 47.3  20.222N 155.659W 007                          3.2 ML HVO                        613         066 05    67.
   HVO  1976  07 05 21 4  43.5  19.421N 155.160W 008                          3.1 ML HVO                      E 613         052 95    16.
   HVO  1976  07 06 13 45 48.3  19.340N 155.055W 009                          3.2 ML HVO                        613         052 95    67.
   HVO  1976  07 09 17 32 19.7  19.342N 155.112W 006                          3.2 ML HVO                      E 613         052 95    82.
   HVO  1976  07 10 21 50 24.8  19.342N 155.227W 011                          3.0 ML HVO                        613         052 95    70.
   HVO  1976  07 11 23 28 10.8  19.352N 155.223W 009                          3.2 ML HVO                        613         052 95    70.
   HVO  1976  07 12 12 45 35.2  19.345N 155.246W 004                          3.0 ML HVO                        613         052 95    67.
   HVO  1976  07 13 16 41 55.7  19.155N 155.450W 047                          3.1 ML HVO                        613         052 95    54.
   HVO  1976  07 14 02 35 12.4  19.397N 155.243W 005                          3.3 ML HVO                        613         052 95    68.
   HVO  1976  07 14 14 14 38.1  19.378N 155.213W 005                          3.1 ML HVO                      E 613         052 95    71.
   HVO  1976  07 15 06 54 39.8  19.361N 155.128W 008                          3.3 ML HVO                      E 613         052 95    80.
   HVO  1976  07 16 01 11 29.9  19.175N 155.544W 009                          3.2 ML HVO                        613         052 95    46.
   HVO  1976  07 16 23 31 25.6  19.331N 155.127W 009                          3.4 ML HVO                      E 613         052 95    61.
   HVO  1976  07 19 01 51 16.0  19.332N 155.128W 010                          3.0 ML HVO                      E 613         052 95    80.
   HVO  1976  07 22 02 40 53.1  19.377N 155.07 W 009                          3.7 ML HVO                      E 613         052 95    65.
   HVO  1976  07 22 21 47 45.4  19.346N 155.248W 005                          3.2 ML HVO                        613         052 95    67.
   HVO  1976  07 23 19 36 17.1  19.334N 155.140W 010                          3.7 ML HVO                        613         052 95    79.
   HVO  1976  07 24 01 20 14.7  19.283N 155.592W 010                          3.4 ML HVO                      E 613         052 95    41.
   HVO  1976  07 24 03 40 31.0  19.418N 155.246W 005                          3.3 ML HVO                        613         052 95    27.
   HVO  1976  07 27 07 14 26.9  19.371N 155.242W 009                          4.0 ML HVO                      E 613         052 95    65.
   HVO  1976  07 27 21 37 12.7  19.372N 155.243W 005                          3.6 ML HVO                        613         052 95    66.
   HVO  1976  07 28 16 03 19.6  19.396N 155.399W 010                          3.5 ML HVO                        613         052 95    51.
   HVO  1976  07 30 05 03 43.7  19.347N 155.111W 008                          3.8 ML HVO                      E 613         052 95    62.
   HVO  1976  07 30 23 13 14.1  19.338N 155.213W 009                          3.0 ML HVO                        613         052 95    73.
   HVO  1976  07 31 09 03 24.0  19.391N 155.246W 005                          3.1 ML HVO                        613         052 95    67.
   HVO  1976  07 31 16 51 36.1  19.405N 155.264W 005                          3.3 ML HVO                      E 613         052 95    65.
   HVO  1976  07 31 21 51 33.5  19.397N 155.242W 002                          3.0 ML HVO                      E 613         052 95    68.
   HVO  1976  08 01 15 01 17.5  19.364N 155.088W 008                          3.4 ML HVO                        613         052 95    84.
   HVO  1976  08 01 16 59 18.0  19.333N 155.24 W 006                          3.6 ML HVO                        613         052 95    67.
   HVO  1976  08 02 06 57 31.4  19.359N 155.252W 010                          3.2 ML HVO                        613         052 95    67.
   HVO  1976  08 03 13 3  17.1  19.323N 155.210W 008                          3.0 ML HVO                      E 613         052 95    72.
81/07/17.
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SOURCE YEAR  MO DA HR MN SEC       LAT      LONG  DEPTH ---------MAGNITUDES---------        INT FFENOM  RN CE Q/S  MAP DG   DIST
                                                  (KM)   BODY   SURF   OTHER   LOCAL      MAX DTSVNO                          (KM)
**N INDICATES A POSSIBLE DUPLICATE
   HVO  1976  08 03 05 23  31.9  19.442N 154.895W 009                          3.0 ML HVO                  613         052 94  104.
   HVO  1976  08 06 03 39  55.4  19.379N 155.093W 00?                          3.2 ML HVO                  613         052 95   83.
   HVO  1976  08 07 01 31  45.4  19.355N 155.045W 007                          3.3 ML HVO               E  613         052 95   89.
   HVO  1976  08 07 11 42  19.3  19.320N 155.200W 009                          3.1 ML HVO               E  613         052 95   73.
   HVO  1976  08 09 13 09  33.5  19.390N 155.244W 005                          3.4 ML HVO                  613         052 95   67.
   HVO  1976  08 10 19 03  47.6  19.320N 155.222W 010                          3.5 ML HVO                  613         052 95   71.
   HVO  1976  08 14 17 01  50.4  19.357N 155.135W 008                          3.2 ML HVO                  613         052 95   79.
   HVO  1976  08 19 15 07  44.5  18.973N 155.378W 032                          3.1 ML HVO                  613         052 85   76.
   HVO  1976  08 26 03 19  43.6  19.363N 155.211W 010                          3.6 ML HVO                  613         052 95   61.
   HVO  1976  08 28 18 59  55.5  19.355N 155.223W 010                          3.0 ML HVO                  613         052 95   70.
   HVO  1976  08 31 10 41  08.5  19.390N 155.495W 010                          4.0 ML HVO                  613         052 95   41.
   HVO  1976  08 31 14 00  38.5  19.332N 155.117W 009                          3.4 ML HVO               E  613         052 95   82.
   HVO  1976  09 02 10 20  26.8  19.353N 155.053W 008                          3.5 ML HVO               E  613         052 95   88.
   HVO  1976  09 03 01 16  55.9  19.33?N 155.177W 009                          3.1 ML HVO               E  613         052 95   75.
   HVO  1976  09 03 22 03  41.4  19.482N 154.850W 008                          3.5 ML HVO                  613         052 94  108.
   HVO  1976  09 04 13 1?  54.0  19.33?N 155.072W 01?                          3.9 ML HVO               E  613         052 95   6?.
   HVO  1976  09 04 03 35  28.6  19.383N 155.997W 040                          3.1 ML HVO                  613         052 95   15.
   HVO  1976  09 05 ?6 ?4  ??.9  19.?23N 155.?74W 010                          3.2 ML HVO               E  613         052 95   66.
   HVO  1976  09 05 14 54  2?.7  19.7?9N 155.785W 012                          3.0 ML HVO                  613         052 95   35.
   HVO  1976  09 06 05 34  15.2  19.441N 154.9?4W 009                          3.5 ML HVO                  613         052 94  105.
   HVO  1976  09 06 19 1?  ??.4  19.?54N 155.26?W 005                          3.6 ML HVO               E  613         052 95   66.
   HVO  1976  09 07 21 24  4?.7  19.373N 155.?81W 009                          3.0 ML HVO                  613         052 95   65.
   HVO  1976  09 07 22 01  15.3  19.37?N 155.079W 00                           3.5 ML HVO               E  613         052 95   85.
   HVO  1976  09 09 ?4 21  55.5  19.3?9N 155.347W 010                          3.2 ML HVO               E  613         052 95   59.
   HVO  1976  09 10 02 13  10.7  19.45?N 155.673W 010                          3.0 ML HVO               E  613         052 95    2.
   HVO  1976  09 10 ?5 23  18.6  18.816N 155.226W 036                          3.2 ML HVO                  613         052 85  10?.
   HVO  1976  09 11 0? ?4  3?.5  19.369N 155.070W 008                          3.6 ML HVO               E  613         052 95   86.
   HVO  1976  09 15 ?2 ?1  21.7  19.365N 155.?84W 009                          3.6 ML HVO                  613         052 95   84.
   HVO  1976  09 21 ?7 ?5  48.8  19.346N 155.109W 009                          3.2 ML HVO               E  613         052 95   82.
   HVO  1976  09 25 15 54  55.9  19.446N 155.381W 01?                          3.0 ML HVO                  613         052 95   52.
   HVO  1976  09 28 ?5 14  53.4  19.333N 155.219W 010                          3.7 ML HVO                  613         052 95   71.
   HVO  1976  09 29 12 58  04.?  19.?65N 155.?85W 009                          3.3 ML HVO               E  613         052 95   84.
   HVO  1976  10 03 ?7 53  ??.6  19.332N 155.121W 009                          3.4 ML HVO               E  613         052 95   81.
   HVO  1976  10 03 17 21  45.5  19.339N 155.134W 010                          3.1 ML HVO                  613         052 95   80.
   HVO  1976  10 04 ?5 18  52.6  19.345N 155.109W 009                          3.0 ML HVO               E  613         052 95   62.
   HVO  1976  10 05 ?5 58  5?.6  19.335N 155.110W 009                          3.8 ML HVO               E  613         052 95   82.
   HVO  1976  10 05 ?9 55  39.5  19.37?N 155.?5?W 00?                          3.5 ML HVO                  613         052 95   85.
   HVO  1976  10 07 ?3 1?  3?.?  19.379N 155.?9?W 009                          3.5 ML HVO                  613         052 95   64.
   HVO  1976  1? 07 21 52  58.3  19.?24N 155.?75W 034                          3.3 ML HVO                  613         052 95   65.
   HVO  1976  1? 08 10 2?  27.8  19.5?3N 155.86?W 027                          3.3 ML HVO                  613         052 95   10.
   HVO  1976  1? 08 ?2 53  53.0  19.345N 155.112W 009                          3.2 ML HVO                  613         052 95   81.
   HVO  1976  10 22 12 43  23.9  19.349N 155.190W 010                          3.4 ML HVO               E  613         052 95   74.
   HVO  1976  10 22 14 11  25.9  19.753N 155.056W 008                          3.5 ML HVO               E  613         052 95   88.
   HVO  1976  10 25 ?7 37  23.4  19.362N 155.253W 010                          3.3 ML HVO                  613         052 95   67.
   HVO  1976  11 02 18 ?5  46.4  19.318N 155.224W 010                          3.7 ML HVO                  613         052 95   71.
   HVO  1976  11 ?2 19 35  16.1  19.375N 155.?98W 009                          3.3 ML HVO               E  613         052 95   83.
   HVO  1976  11 04 15 ??  49.7  19.351N 155.111W 008                          3.0 ML HVO                  613         052 95   82.
   HVO  1976  11 06 23 4?  47.3  19.393N 155.417W 010                          3.3 ML HVO                  613         052 95   49.
   HVO  1976  11 09 15 33  ?3.4  19.343N 155.?69W 008                          3.8 ML HVO               E  613         052 95   86.
   HVO  1976  11 10 18 1?  16.5  19.345N 155.196W 010                          3.1 ML HVO                  613         052 95   73.
61/07/17.
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SOURCE YEAR  MO DA HR MN SEC      LAT       LONG    DEPTH ---------MAGNITUDES---------              INT PHENOM  RN CE G/S  MA I DG  DIST
                                                     (KM)   BODY   SURF   OTHER   LOCAL             MAX DTSVNO                       (KM)
**N INDICATES A POSSIBLE DUPLICATE
   HVO  1976  11 12 16 54 46.5  19.356N 155.041W 007                           3.5 ML HVO                     613         052 95   89.
   HVO  1976  11 12 20 07 21.5  19.944N 155.600W 011                           3.5 ML HVO                     613         052 95   61.
   HVO  1976  11 13 11 14 03.4  19.366N 155.385W 009                           3.7 ML HVO                  E  613         052 95   64.
   HVO  1976  11 14 04 19 23.1  19.425N 155.275W 015                           3.0 ML HVO                     613         052 95   64.
   HVO  1976  11 16 02 23 35.4  19.377N 155.278W 009                           3.6 ML HVO                     613         052 95   85.
   HVO  1976  11 17 05 51 48.6  19.539N 155.236W 025                           3.7 ML HVO                  E  613         052 95   68.
   HVO  1976  11 18 22 24 43.8  19.395N 155.282W 004                           3.0 ML HVO                     613         052 95   63.
   HVO  1976  11 23 14 12 15.0  20.108N 155.835W 017                           3.0 ML HVO                     613         086 05   78.
   HVO  1976  11 25 10 15 58.5  19.404N 155.265W 004                           3.1 ML HVO                     613         052 95   65.
   HVO  1976  11 30 17 46 10.1  19.324N 155.190W 009                           3.3 ML HVO                  E  613         052 95   74.
   HVO  1976  11 30 18 16 45.3  19.322N 155.188W 010                           3.0 ML HVO                  E  613         052 95   75.
   HVO  1976  12 01 04 44 17.5  19.361N 155.254W 009                           3.1 ML HVO                     613         052 95   67.
   HVO  1976  12 04 03 50 50.8  19.334N 155.136W 009                           3.0 ML HVO                     613         052 95   80.
   HVO  1976  12 06 05 26 58.1  19.359N 155.127W 009                           3.8 ML HVO                     613         052 95   80.
   HVO  1976  12 07 14 00 17.8  19.405N 155.295W 015                           3.0 ML HVO                     613         052 95   62.
   HVO  1976  12 08 01 49 17.0  19.316N 155.444W 026                           3.4 ML HVO                     613         052 95   49.
   HVO  1976  12 09 15 23 49.7  19.308N 155.287W 013                           3.0 ML HVO                     613         052 95   63.
   HVO  1976  12 13 17 28 42.1  19.337N 155.124W 010                           3.4 ML HVO                  E  613         052 95   81.
   HVO  1976  12 17 03 31 43.3  19.333N 155.115W 009                           3.2 ML HVO                  E  613         052 95   82.
   HVO  1976  12 18 04 01 10.6  19.336N 155.117W 009                           4.8 ML HVO                  E  613         052 95   82.
●  GS   1976  12 18 04 01 [illegible]  19.337N 155.118W 009   5.0 MS          4.80ML HVO        V            613 F   45  052 95   81.
   HVO  1976  12 25 07 31 14.8  19.670N 156.046W 006                           3.3 ML HVO                     613         052 96   28.
   HVO  1976  12 27 04 15 20.5  19.394N 155.246W 005                           3.3 ML HVO                     613         052 95   67.
   HVO  1976  12 27 06 24 07.5  19.324N 155.276W 010                           3.1 ML HVO                  E  613         052 95   65.
   HVO  1976  12 27 12 13 54.0  19.130N 155.604W 010                           3.1 ML HVO                  E  613         052 95   42.
●  GS   1976  12 27 14 15 20.6H 19.333N 155.247W 005                           3.30ML HVO                     613 F    7  052 95   67.
   HVO  1976  12 28 19 37 04.9  19.320N 155.253W 010                           3.2 ML HVO                  E  613         052 95   73.
   HVO  1976  12 29 19 26 26.9  19.391N 155.242W 005                           3.0 ML HVO                     613         052 95   68.
   HVO  1976  12 30 00 47 41.5  18.453N 155.335W 012                           3.6 ML HVO                     613         052 85  126.
   HVO  1976  12 30 04 19 51.6  19.325N 155.[illegible]86W 010                           3.0 ML HVO                  E  613         052 95   66.
   GS   1977  01 01 14 26 35.3H 19.349N 155.120W 009                           3.70ML HVO                     613 F    5  052 95   81.
   GS   1977  01 05 00 25 13.2H 19.390N 155.250W 005                           3.60ML HVO                     613 F    9  052 95   67.
   GS   1977  01 08 10 02 35.0H 19.333N 155.133W 010                           4.10ML HVO                     613 F    9  052 95   80.
   GS   1977  01 12 13 05 59.3H 19.400N 155.290W 016                           3.90ML HVO                     613 F   10  052 95   63.
■  GS   1977  01 14 23 26 42.5H 19.330N 155.105W 010   4.2 MB                  4.60ML HVO        IV           613 F   21  052 95   84.
■  GS   1977  01 23 20 49 01.7H 19.340N 155.200W 005   4.8 MB                  4.00ML HVO                     613 F   14  052 95   73.
■  GS   1977  02 04 01 20 53.0H 19.400N 155.100W 005   4.5 MB                  4.50ML HVO        V            613 F   25  052 95   82.
   GS   1977  02 04 14 29 11.7H 20.11 N 155.47[illegible]W [illegible]                           3.70ML HVO                     613 F   12  088 05   24.
■  GS   1977  03 09 17 29 18.5H 19.313N 155.517W 053                           4.10ML HVO                     613 F   18  052 95   39.
■  GS   1977  04 21 04 49 23.0H [illegible] N 155.333W 016                           4.50ML HVO                     613 F   22  088 05   83.
■  GS   1977  06 06 19 42 19.7H 19.367N 155.[illegible]63W 009   4.8 MB                  4.80ML HVO        V            613 F   52  052 95   85.
■  GS   1977  07 05 17 59 42.0H 19.425N 155.453W 010                           4.10ML HVO                     613 F   12  052 95   45.
■  GS   1977  08 08 07 54 20.3H 19.340N 155.222W 010                           4.10ML HVO                     613 F   16  052 95   71.
   GS   1977  08 11 05 19 16.7H 19.322N 155.195W 009                           3.90ML HVO                     613 F   13  052 95   74.
■  GS   1977  08 19 18 19 13.4H 19.337N 155.132W 010                           4.20ML HVO                     613 F   14  052 95   81.
   GS   1977  08 30 12 46 21.3H 19.377N 155.455W 010                           3.90ML HVO                     613 F   12  052 95   46.
■  GS   1977  09 07 23 51 07.0H 19.367N 155.317W [illegible]                           4.50ML HVO                     613     25  052 95   60.
■  GS   1977  09 16 04 50 16.0H 19.350N 155.067W 008                           4.00ML HVO                     613 F   12  052 95   86.
■  GS   1977  09 19 09 01 45.0H 19.350N 155.117W 005                           4.10ML HVO                     613 F   13  052 95   81.
   GS   1977  09 23 12 05 44.0H 19.367N 155. 51W 010                           4.10ML HVO                     613 F   11  052 95   88.
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SOURCE YEAR  MO DA HR MN SEC      LAT       LONG  DEPTH ---------MAGNITUDES-------- --              INT PHENOM  RN CE G/S  MAR DG   DIST
                                                   (KM)   BODY   SURF   OTHER   LOCAL            MAX DTSVNO                         (KM)
**N INDICATES A POSSIBLE DUPLICATE
■  GS    1978  04 08 12 43 44.2H 19.635N 155.144W 029                         3.60ML HVO                   613 F  10  052 95    88.
   GS    1978  05 23 07 09 26.7H 19.310N 155.223W 010                         3.40ML HVO        IV         613 F  12  052 95    71.
   GS    1978  06 03 01 02 02.1H 19.667N 155.163W 014                         3.20ML HVO        IV         613 F  17  052 95    79.
   GS    1978  06 13 02 49 35.0H 18.930N 155.467W 015                         3.40ML HVO        IV         613 F   9  052 95    77.
   GS    1978  06 13 16 54 01.2H 19.340N 155.053W 006                         3.10ML HVO        IV         613 F  11  052 95    88.
   GS    1978  06 21 10 23 44.1H 19.323N 155.221W 010                         3.40ML HVO        III        613 F  12  052 95    71.
■  GS    1978  06 23 11 47 59.6H 19.323N 155.256W 011   4.9 MB                4.20ML HVO        V          613 F  29  052 95    68.
■  GS    1978  07 01 19 18 13.3  19.320N 155.120W 00                          3.90ML HVO        I          613 F   8  052 95    82.
■  GS    1978  08 31 23 37 21.4H 19.010N 155.481W 025   4.5 MB                4.00ML HVO        IV         613 F  13  052 95    66.
   GS    1978  09 05 20 26 46.9H 19.330N 155.226W 010                         3.70ML HVO        IV         613 F  13  052 95    70.
■  GS    1978  09 12 06 16 36.1H 19.338N 155.110W 010                         4.10ML HVO        V          613 F  10  052 95    82.
■  GS    1978  11 23 13 15 15.9H 19.233N 155.550W 011                         4.20ML HVO        IV         613 F  13  052 95    43.
■  GS    1978  12 14 14 13 44.9H 19.320N 155.220W 010                         4.10ML HVO        IV         613 F  11  052 95    71.
■  GS    1978  12 27 10 41 56.0H 19.331N 155.217W 010   4.6 MB                4.30ML HVO        IV         613 F  42  052 95    71.
   GS    1979  02 14  2 52 51.0H 19.340N 155.001W   9                         4.00ML HVO        III        613 F  15  052 95    66.
■  GS    1979  03 30 15 07 55.5H 19.315N 155.270W  35   5.0 MB  4.3MS         4.70ML HVO        V          613 F  89  052 95    64.
■  GS    1979  03 10 15 50 14.6H 19.331N 155.110W  12   4.8 MB                4.60ML HVO                   613 F  13  052 95    82.
   GS    1979  03 11 11 14 50.5H 19.291N 155.099W  11                         3.60ML HVO                   613 F   4  052 95    64.
■  GS    1979  03 22  6 43 59.6H 20.040N 155.957W  12   4.6 MB                4.50ML HVO        V          613 F  11  088 05    70.
■  GS    1979  04 02  7  5  1.9H 20.257N 155.821W   9   4.4 MB                4.40ML HVO                   613 F  17  088 05    56.
   GS    1979  07 26 19  5 41.7H 19.755N 155.374W  20                         3.60ML HVO        III        613 F  10  052 95    34.
   GS    1979  07 27 18 05 35.6H 19.327N 155.138W   9                         3.50ML HVO        IV         613 F   8  052 95    60.
■  GS    1979  07 31 13 33 51.4H 19.466N 155.433W  12   4.5 MB                4.30ML HVO        IV         613 F  12  052 95    47.
■  GS    1979  09 14 12 51 42.2H 20.417N 156.253W  25   4.1 MB                4.59ML HVO        V          613 F  15  088 06   156.
   GS    1979  09 16 23 04 14.4H 19.377N 155.454W  11                         3.90ML HVO                   613 F  11  052 95    46.
■  GS    1979  09 22  7 53 37.6H 19.347N 155.072W   5   5.7 MB  4.8MS         5.50ML HVO        V          613 F 142  052 95    66.
■  GS    1979  09 22  0 29 12.4H 19.343N 155.138W   9   4.8 MB                4.30ML HVO        IV         613 F   8  052 95    59.
■  GS    1979  09 27 15 35 45.5H 19.376N 155.129W  10   4.7 MB                4.40ML HVO        V          613 F  23  052 95    81.
■  GS    1979  11 14 17 37 17.5H 19.926N 155.191W  14                         4.00ML HVO        IV         613 F   9  052 95    67.
■  GS    1979  12 31  5 33 11.7H 19.874N 155.343W   1   4.1 MB                4.20ML HVO        IV         613 F  12  052 96    67.
   GS    1979  12 06  1 32 27.2H 19.4  N 155.471W  11                         4.00ML HVO        IV         613 F  10  052 95    44.
■  GS    1979  12 19  3 44 03.1H 19.414N 155.408W  11                         4.10ML HVO        IV         613 F   8  052 95    50.
   GS    1980  01 26 01 24 43.6H 19.312N 155.541W 027                         4.60ML HVO                   613 F  11  052 95    40.
   GS    1980  03 02 05 36 21.4  19.712N 156.195W 010                         4.20ML HVO                   613    18  052 96   110.
   GS    1980  03 12 12 57 52.7H 19.359N 155.236W 002   4.6 MB                4.30ML HVO                   613 F  21  052 95    69.
   GS    1980  05 05 09 07 37.7H 19.228N 155.552W 011                         4.00ML HVO                   613 F   9  052 95    44.
   GS    1980  05 23 04 58 39.7H 19.341N 155.284W 033                         3.90ML HVO                   613    11  052 95    64.
   GS    1980  08 10 06 49 35.1H 19.333N 155.109W 010                         4.30ML HVO                   613 F   9  052 95    82.
   GS    1980  09 14 07 27 14.7H 19.382N 155.420W 011                         4.10ML HVO                   613 F  14  052 95    50.
   GS    1980  09 20 16 06 23.0H 19.601N 156.149W 025                         4.00ML HVO                   613 F   8  052 96    32.
   GS    1980  10 22 07 40 15.7H 19.366N 155.113W 001                         4.05ML HVO                   613 F   8  052 95    61.
   GS    1980  10 30 20 09 14.0H 19.450N 155.310W 021                         4.00ML HVO                   613 F   9  052 95    70.
   GS    1980  11 23 11 31 55.9H 19.363N 155.350W 009                         4.20ML HVO                   613 F  10  052 95    66.

                                                       NUMBER OF HITS 2093
                                                     NUMBER OF SUSPECTED DUPLICATES     6
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Appendix B. Earthquakes with M_L greater than or equal to 4.0 from January 1, 1977, through December 31, 1979.

SOURCE	YEAR	MO	DA	HR	MN	SEC	LAT	LONG	DEPTH (km)	MAGNITUDE (M_L)
HVO	1977	01	14	13	26	42.38	19.33	155.12	9.93	4.6
HVO	1977	01	23	10	49	01.84	19.34	155.20	8.78	4.0
HVO	1977	01	29	22	48	49.72	19.36	155.08	9.07	4.1
HVO	1977	02	03	15	20	49.70	19.35	155.08	9.87	4.5
HVO	1977	03	09	00	29	17.40	19.42	155.50	44.21	4.0
HVO	1977	04	20	18	49	23.01	19.94	155.31	10.47	5.0
HVO	1977	04	22	09	44	00.12	19.32	155.26	10.10	4.0
HVO	1977	06	05	23	42	18.92	19.36	155.08	9.31	5.1
HVO	1977	07	05	07	59	42.03	19.44	155.45	11.89	4.1
HVO	1977	08	07	21	54	20.32	19.33	155.22	10.29	4.1
HVO	1977	08	13	12	24	28.46	20.16	155.61	4.61	4.1
HVO	1977	08	19	08	19	13.34	19.33	155.12	10.15	4.2
HVO	1977	09	07	13	51	06.71	19.38	155.32	31.26	4.5
HVO	1977	09	15	18	50	05.45	19.34	155.06	9.30	4.0
HVO	1977	09	19	09	01	45.11	19.36	155.13	8.77	4.0
HVO	1977	10	09	14	38	51.90	19.40	155.25	24.90	4.0
HVO	1978	04	07	16	43	43.29	19.87	155.13	39.27	4.0
HVO	1978	06	23	01	47	58.56	19.32	155.26	10.51	4.4
HVO	1978	07	01	09	18	13.27	19.31	155.11	7.97	4.2
HVO	1978	08	31	13	07	20.97	18.98	155.49	38.51	4.3
HVO	1978	09	11	20	16	06.11	19.33	155.11	9.60	4.1
HVO	1978	11	23	03	16	15.88	19.24	155.55	11.40	4.2
HVO	1978	12	14	04	12	45.04	19.31	155.22	10.49	4.1
HVO	1978	12	27	00	40	55.83	19.34	155.22	9.93	4.3
HVO	1979	03	06	05	07	58.54	19.52	155.27	27.43	4.7
HVO	1979	03	10	03	55	14.65	19.33	155.11	9.57	4.5
HVO	1979	03	21	20	46	59.79	20.10	155.84	16.22	4.5
HVO	1979	03	27	21	30	09.80	20.09	155.83	12.31	4.9
HVO	1979	07	31	03	30	51.28	19.47	155.43	11.65	4.3
HVO	1979	08	14	02	51	42.19	20.81	156.29	24.48	4.5
HVO	1979	09	21	21	59	37.62	19.35	155.07	9.19	5.5
HVO	1979	09	21	23	29	12.34	19.35	155.04	9.21	4.3
HVO	1979	09	27	05	35	45.49	19.33	155.12	10.05	4.3

Appendix B. Page 2.

SOURCE	YEAR	MO	DA	HR	MN	SEC	LAT	LONG	DEPTH (km)	MAGNITUDE (M_L)
HVO	1979	10	14	07	37	16.92	19.91	155.18	40.57	4.0
HVO	1979	10	30	19	35	11.68	19.88	156.34	00.02	4.2
HVO	1979	12	13	17	44	03.08	19.41	155.41	11.44	4.0

EXPLANATION FOR REFERENCE COLUMN IN APPENDIX C.

BSSA - Bulletin of the Seismological Society of America

G-R, 1954 - Gutenberg, B., and Richter, C.F., 1954, Seismicity of the Earth and Associated Phenomena, 2d ed., Princeton Univ. Press, Princeton, N.J., 310 p.

Richter, 1958, Elementary Seismology, W.H. Freeman and Co., San Francisco, 768 p.

EQHUS - U.S. Department of Commerce, NOAA, Records of the Honolulu Observatory, Honolulu, Hawaii.

HVO L&S - U.S. Geological Survey, Hawaiian Volcano Observatory Summary (previously the Volcano Letters and published by the National Park Service), Hawaii Volcano Observatory, Hawaii.

Monthly Weather Review - U.S. Weather Bureau. The general reference to this source is sufficient because earthquakes are described in the issue for the month in which they occured, with few exceptions. Earthquake reports are very complete for the period 1915 to June, 1924.

ISS, Kew - Kew Observatory, International Seismological Summary, 1913 - 1963, Kew, England. This report became the Bulletin of the International Seismological Centre in 1964 and was printed through 1965 at Edinburgh, Scotland.

USEQ - United States Earthquakes. Annual publication of the U.S. Department of Commerce, Coast and Geodetic Survey from 1928 through 1968, the NOAA National Ocean Survey for 1969, and the NOAA Environmental Data Service, 1970.

Note: All times listed by NOAA, 1973 are Hawaiian Standard Time.

YEAR	DATE	TIME	AREA	LAT	LONG	FELT AREA	MAX INT	MAG.	REFERENCES
1834	2/19	-----	Island of Hawaii	----	----	----	----	----	BSSA v.2, 1912
1838	2/12	----	"	----	----	----	----	----	"
1868	4/2	±16:00	S. coast of Hawaii	19.0	155.5	----	X	----	" BSSA v.4, 1914 G-R, 1954 Richter, 1958
1909	3/13	----	Island of Hawaii	----	----	----	----	----	EQHUS
1912	10/13	----	Hawaii	----	----	----	----	----	"
1913	9/8	12:08	Kilauea area	----	----	----	V	----	HVO L&S
1913	10/25	01:28	Kilauea area	----	----	----	V	----	"
1918	11/2	00:03	Mauna Loa	----	----	----	VII	----	" ISS, Kew Monthly Weather Review
1919	1/28	17:53	Hawaii	----	----	----	V	----	"
1919	8/26	02:34	Island of Hawaii	----	----	----	V	----	HVO L&S
1919	9/14	17:50	Kilauea	----	----	----	VII	----	ISS, Kew HVO L&S
1923	1/14	02:58	Island of Hawaii	----	----	----	----	----	ISS, Kew HVO L&S
1923	2/9	21:11	"	----	----	----	----	----	"
1923	12/14	06:04	"	----	----	----	----	----	"
1923	12/25	19:16	Hawaii	----	----	----	----	----	"
1924	8/20	06:50	Island of Hawaii	----	----	----	----	----	"
1925	7/8	06:15	"	----	----	----	----	----	"
1926	2/28	07"11	"	----	----	----	----	----	"
1926	3/19	23:03	"	----	----	----	----	----	"
1926	4/22	05:02	Mauna Loa	----	----	----	----	----	"
1926	6/9	10:05	Island of Hawaii	----	----	----	----	----	"
1927	3/20	05:22	"	----	----	----	----	----	"
1927	8/3	10:12	"	----	----	----	----	----	"
1929	9/28	07:40	Hilo, Hawaii	----	----	----	VII	----	USEQ

Appendix C. Earthquakes of intensity V or greater in NOAA (1973) not listed in Appendix A or B.

YEAR	DATE	TIME	AREA	LAT	LONG	FELT AREA	MAX INT	MAG.	REFERENCES
1930	5/20	19:22	Hualalai area	----	----	----	V	----	USEQ
1930	5/25	20:47	Kilauea	----	----	----	V	----	"
1931	1/30	00:08	Waiohinu	----	----	----	V	----	"
1933	12/2	06:30	Hilo	----	----	----	VI	----	"
1934	5/10	10:39	near Hakalau	19.6	155.4	----	V	----	"
1935	1/2	07:17	Kilauea	19.4	155.3	----	V	----	"
1935	6/28	09:30	Mauna Loa	19.6	155.2	----	V	----	"
1935	9/30	23:06	"	19.4	155.7	----	V	----	"
1935	10/1	00:28	"	19.6	155.4	----	V	----	"
1935	11/21	01:41	"	19.5	155.5	----	V	----	"
1936	4/15	08:57	Kilauea	19.4	155.2	----	V	----	"
1938	2/17	02:48	Mauna Loa	19.6	155.4	----	V	----	"
1939	5/15	10:58	Kilauea	19.4	155.1	----	V	----	"
1939	5/23	14:44	Kilauea	19.5	155.4	----	V	----	"
1939	5/24	13:29	"	19.4	155.2	----	V	----	"
1939	5/31	21:21	"	19.6	155.2	----	V	----	"
1939	6/12	01:41	Kau Desert, Hawaii	----	----	----	V	----	"
1939	7/14	04:21	Kilauea	19.3	155.1	----	V	----	"
1940	9/1	22:45	N. of Island of Hawaii	21.0	155.3	----	V	----	" G-R, 1954
1941	11/6	10:11	near Waimea	----	----	----	V	----	USEQ
1941	11/18	03:26	"	----	----	----	V	----	"
1941	11/22	21:53	"	----	----	----	V	----	"
1943	11/10	16:52	southern Hawaii	----	----	----	VI	----	"
1944	11/12	05:26	SW of Halemaumau	----	----	----	V	----	"
1945	3/4	00:00	Mauna Loa	----	----	----	V	----	"
1945	5/19	01:48	"	----	----	----	V	----	"
1945	9/19	05:33	Saddle area, Hawaii	----	----	----	V	----	"
1947	3/19	23:06	Island of Hawaii	----	----	----	V	----	"
1947	9/30	04:04	"	----	----	----	V	----	"
1949	2/26	13:54	Mauna Loa	----	----	----	V	----	"
1949	5/2	05:02	"	----	----	----	V	----	"

Appendix C. Earthquakes of intensity V or greater in NOAA (1973) not listed in Appendix A or B.

YEAR	DATE	TIME	AREA	LAT	LONG	FELT AREA	MAX INT	MAG.	REFERENCES
1950	3/25	05:43	Mauna Loa	----	----	----	V	----	USEQ
1951	9/16	01:43	Kaoiki fault	19.2	155.5	----	V	----	"
1951	11/8	09:34	Mauna Loa	19.2	155.5	----	VI	----	"
1952	2/2	01:16	near Kaumana	----	----	----	V	----	"
1952	3/17	17:58	off coast of Hawaii	19.1	155.0	----	V	----	"
1952	7/12	13:53	Kona, Hawaii	----	----	----	V	----	"
1953	1/9	21:10	Mauna Loa	19.4	155.5	----	V	----	"
1953	1/15	02:05	"	19.3	155.4	----	V	----	"
1953	8/21	19:47	Hawaii	----	----	----	V	----	"
1954	7/3	11:53	Kilauea	20.5?	155.5	----	VI	----	"
1955	3/27	16:02	"	----	----	----	VII	----	"
1955	4/1	04:24	"	19.5	155.0	----	V	----	"
1955	8/7	07:18	off N coast of Hawaii	20.5	155.5	----	V	----	"
1955	8/14	02:28	Kileuea	19.5	155.5	----	----	----	"
1955	10/26	16:56	near Makauweoweo	19.5	155.5	----	V	----	"
1956	5/13	21:54	off N coast of Hawaii	20.3	155.3	----	V	----	"
1956	10/16	00:45	W of Hawaii	20	157	----	V	----	"
1962	6/27	18:28	Kaoili fault	19.4	155.4	----	VI	----	" BSSA v.56, 1966

Appendix C. Earthquakes of intensity V or greater in NOAA (1973) not listed in Appendix A or B.

SEISMIC VOLCANIC RISK ASSESSMENT, PUNA GEOTHERMAL PROSPECT AREA, HAWAII

by

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prepared for

THERMAL POWER COMPANY
DILLINGHAM
AMFAC

October 1981

CONTENTS

CONTENTS (CONT.)

CONTENTS (CONT.)

FIGURES

FIGURES (CONT.)

PLATES

(in pocket)

Plate 1. Epicenter map of earthquakes of $M_L \geq 4.0$ from 1929 to 1980 with focal depths greater than about 25 km.

Plate 2. Epicenter map of earthquakes of $M_L \geq 4.0$ from 1929 to 1980 with focal depths less than about 25 km.

1.0 EXECUTIVE SUMMARY

1.1 Introduction

This report summarizes the geologic, volcanologic, and seismologic data that relate to evaluation of the Seismic-Volcanic Risk Assessment (SVRA) for the Puna Geothermal Prospect (PGP) of the Lower East Rift Zone (LERZ) on the volcano, Kilauea, Hawaii. The basis for the assessment sections is developed in detail in the Geology Section (3.0), with the volcanic and seismic assessments discussed in Sections 4.0 and 5.0, respectively.

The Volcanic Risk Assessment leads to conclusions that the hazards and risk from volcanic activity and associated fissuring and faulting are high and diverse, but the risk to engineered structures and installations can be mitigated by proper procedures in siting and design. Recommendations are made as to the methods and factors that should be considered for mitigation. The Seismic Risk Assessment demonstrates that the hazard and risk from ground motion is of three general sources: frequent low magnitude volcanic earthquakes with epicenters near the site, infrequent earthquakes of deep focus, low to moderate magnitudes and generally from Kilauea, and tectonic earthquakes of about 6.5 to 7.2 magnitude from the Hilina fault zone with epicenters at distances of from 20 to 50 km (12 to 30 mi).

1.2 Volcanic Risk Assessment

The Puna Geothermal Project is sited in one of the most active eruptive centers of one of the most rapidly growing volcanoes in the world. Important eruptions of lava have affected the area in 1750, 1790, 1840, 1955, and 1960.

Evidence from the log of the HGP-A well indicates that, on a long term basis, an individual site is over-run by lava about once every 900 years, but on a shorter time scale, the frequency is strongly influenced by topography; low areas are covered by flows much more frequently than high areas.

Although eruptions are frequent, they are also quite regular in their behavior and can be predicted with a much higher degree of certainty than is possible in other volcanic regions of the world. Large explosions of ash or pumice are highly unlikely; almost certainly, future eruptions will be like earlier ones, i.e. voluminous discharges of very fluid lava preceded or accompanied by earthquakes and surface deformation.

Future eruptions will be preceded by volcanic and seismic activity in the summit region and by extension and faulting of the ground surface near the site of the eruptive outbreak. They will be accompanied by numerous earthquakes and will form new fissures, avoiding previously active vents in favor of new ground. Fissures will almost certainly be located within the well-defined boundaries of the rift zone. Vents outside that zone are highly unlikely. Fountaining to heights of three or four hundered meters will cover the surrounding region with scoriaceous material, but ejection of explosive debris rarely has a serious effect beyond a few hundred meters from the vent.

The principal volcanic hazards to facilities sited in the East Puna zone are surface rupture, ground motion, and inundation by lava. By comparison, all other hazards are relatively minor. These hazards can be greatly reduced by a modest amount of planning and consideration of a few simple precautions.

If at all possible, permanent installations should not be constructed in low areas where lava is likely to be channeled. Old cinder cones and other areas of relatively high ground are unlikely to be over-run within the next four or five decades. Diversion barriers, if well situated and properly constructed, can deflect lava into an alternative course, but they are ineffective as dams opposing the flow of lava directly.

By orienting buildings and other permanent structures with their shortest dimensions parallel to the axis of the rift, the longest effects of ground deformation and surface rupture can be materially reduced.

Close coordination with the Hawaiian Volcano Observatory and the Hawaiian Institute of Geophysics will help ensure timely warnings of impending eruptions.

1.3 Seismic Risk Assessment

The maximum earthquake that is probable for the next 40 year period is an assumed tectonic earthquake from the Hilina fault zone, with an estimated magnitude of 6.75 and an epicentral distance of 25 km (15 miles). An earthquake of this magnitude would have a mean peak horizontal acceleration of about 0.25 g, a mean peak horizontal velocity of 25 cm/sec, and mean peak horizontal displacement of 10 cm, with a duration of more than 0.05 g motion for about 15 to 25 seconds. This strength and duration of motion, is the strongest motion to be expected from a 100 year earthquake of about Ms = 7.2, and is within the range that can be readily mitigated by appropriate design.

The two earthquake hazards that may consitute a risk to future engineering structures and installations are primarily the strong ground motion from tectonic earthquakes, and to a minor amount, landsliding, slumping or other secondary ground failures of steep slopes near the epicenter of earthquakes of above 5 magnitude. Surface faulting may occur in the site area in response to volcanic related activity, as is discussed in the volcanic risk assessment section of the report. Other seismic hazards and risks, including liquefaction, tsunamis and seiches are considered to be unimportant for this siting area.