

Appendix C. Supplementary Material to Support Chapter 3

Table C1 contains earthquakes of magnitudes between 5 and 6 for the same time periods as text table 3.1.

Table C2 contains Whitney tilt data to support text figure 3.2.

Figures C1 and C2 show time series plots of earthquakes associated with eruptions and intrusions at Kilauea from 1925 to 1953.

Appendix table C1. Additional earthquakes M 5-6, 1925-1953

Date begin	Date end	Loc. ⁱ	Type ⁱⁱ	Comment	References
7/31/1927	7/31/1927	kcal?	EQ	M 4.58 30 km deep	(Klein and Wright, 2000)
1/4/1928	1/4/1928	2035	EQ	M 4.48 30 km deep beneath Kilauea caldera?	(Klein and Wright, 2000)
2/5/1929	2/5/1929	kcal?	EQ	M 5.36 30.4 km deep	(Klein and Wright, 2000)
5/25/1930	5/25/1930	sf	EQ	M 4.55	(Klein and Wright, 2000)
9/28/1930	9/28/1930	kcal	EQ	M 4.53 25.6 km deep	(Klein and Wright, 2000)
10/20/1930	10/20/1930	kcal	EQ	M 5.25 30.1 km deep	(Klein and Wright, 2000)
1/29/1931	1/29/1931	kcal	EQ	M 4.40 22 km deep?	(Klein and Wright, 2000)
7/7/1932	7/7/1932	sf	EQ	2 events M 4.2	(Klein and Wright, 2000)
2/4/1933	2/4/1933	sf	EQ	40 km deep offshore	(Klein and Wright, 2000)
1/13/1934	1/13/1934	sf	EQ	40 km deep offshore	(Klein and Wright, 2000)
1/13/1935		sf	EQ	M 5.28 40 km beneath offshore south flank	(Klein and Wright, 2000)
6/28/1935		sf	EQ	M 5.76	(Klein and Wright, 2000)
4/9/1937		sf	EQ	M 4.42	(Klein and Wright, 2000)
5/15/1939		sf	EQ	M 4.90	(Klein and Wright, 2000)
5/31/1939		sf	EQ	M 4.67	(Klein and Wright, 2000)
7/14/1939		sf	EQ	M 5.04	(Klein and Wright, 2000)
8/17/1939		sf	EQ (2)	M 4.36, 4.0 21 minutes apart	(Klein and Wright, 2000)
3/12/1945		sf	EQ	M 4.38	(Klein and Wright, 2000)
7/13/1945		sf	EQ	M 4.79	(Klein and Wright, 2000)
6/11/1951		erz	EQ	M 4.01	(Klein and Wright, 2000)
12/6/1951		sf	EQ	M 4.53	(Klein and Wright, 2000)
9/2/1952		kcal	EQ	M 4.10 30 km beneath Kilauea caldera	(Klein and Wright, 2000)
11/16/1952		sf os	EQ	M 4.27 off south coast	(Klein and Wright, 2000)
11/22/1952		kcal	EQ	M 3.95 20.8 km beneath Kilauea's summit	(Klein and Wright, 2000)

ⁱ Location abbreviations: Kīlauea caldera (kc); Halema'uma'u crater (hm); East rift zone (erz); Southwest rift zone (swr); seismic southwest rift zone (sswr); Koa'e fault zone (koe); South flank (sf)

ⁱⁱ Eruption (E); intrusion (I); Earthquake ≥ M5 (EQ); Earthquake swarm (EQS); Collapse of Kilauea's summit (C)

Appendix table C2. Whitney tilt and seismic swarms 1925-1953 keyed to figure 3.2

Date Beg.	Date end	eqs ¹ No.	Tilt ⁱⁱ		Comment	Reference ⁱⁱⁱ
			Mag.	Az.		
5/13/1927 7/6/1927 7/7/1927	7/26/1927 7/20/1927	7	6.83	44.6	Precursory inflation continues during eruption Precursory seismicity 1927 Halema'uma'u eruption	(Bevens and others, 1988, v. 3, p. 989-1007)
11/24/1928 11/24/1928	11/29/1928	20	3.82	202.1	Summit deflation/seismicity; intrusion?	(Bevens and others, 1988, v. 3, p. 1173)
2/21/1929	2/25/1929		1.23	223.0	2/1929 Halema'uma'u eruption; tilt mixed	(Bevens and others, 1988, v. 3, p. 1184-1189)
7/25/1929 7/25/1929	7/29/1929	6			Precursory seismicity 7/1929 Halema'uma'u eruption; tiltmeter out	(Bevens and others, 1988, v. 3, p. 1209-1217)
11/16/1930 11/19/1930 11/23/1930	11/19/1930 12/8/1930 12/9/1930	10	4.28	55.9	Precursory seismicity 1930 Halema'uma'u eruption mixed; net inflation during eruption	(Fiske and others, 1987, VL 309, p. 2-4)
12/17/1931 12/23/1931 12/23/1931	12/22/1931 1/6/1932	5	3.52	42.9	Precursory inflation Precursory seismicity; 5-20 km depth 1931-32 Halema'uma'u eruption	(Fiske and others, 1987, VL 366-367)
7/9/1933 7/13/1933	7/30/1933 7/26/1933	27	2.98	205.0	Elevated shallow seismicity Summit deflation/seismicity; intrusion?	(Fiske and others, 1987, VL 401)
2/2/1934 2/1/1934 2/28/1934	2/6/1934	48 28	2.18	37.18	tiny ("tremor") Earthquake swarm; intrusion? inflation tiny ("tremor") Earthquake swarm; tilt flat	(Fiske and others, 1987, VL 408)
9/5/1934 9/6/1934 9/14/1934	9/14/1934 10/9/1934 10/12/1934		3.48 5.86	227.8 46.7	deflation 1934 Halema'uma'u eruption inflation during eruption	(Fiske and others, 1987, VL 415-416)
7/6/1936 1/17/1937 1/28/1937 3/15/1937 3/17/1937	1/17/1937 2/21/1937 2/10/1937 3/22/1937 3/25/1937	13 ^{iv} 14 ^{iv}	10.60 9.31 5.74	193.1 207.2 214.4	deflation; deflation Puhimau hot area formed by intrusion into east rift; no east rift eq or ground cracking deflation	(Fiske and others, 1987, VL 443-445)
3/6/1938 5/28/1938 5/29/1938 6/1/1938	5/15/1938 5/31/1938	>88 M4.3	9.79 1.27	26.6 199.29	May 1938 east rift intrusion: Precursory inf. Many felt Deflation acc intrusion South flank	(Fiske and others, 1987, VL 443-445)
8/1/1938 8/7/1938 8/8/1938 8/15/1938 8/25/1938 10/11/1938	8/10/1938 8/8/1938 8/13/1938 8/25/1938 10/11/1938 4/11/1939	>353	2.16 3.89 4.42 11.09	223.9 208.5 47.2 218.9	August 1938 east rift intrusion: Precursory def Many felt Ground cracking Post-intrusion deflation inflation continued deflation and crack widening	(Fiske and others, 1987, VL 443-445)
9/20/1944 11/12/1944 12/5/1944 12/6/1944	12/5/1944 12/6/1944 12/7/1944 12/7/1944	29	3.45 0.98	44.3 42.5	December 1944 intrusion: precursory inf scattered eq at decreasing depth after 11/15 continued inflation during earthquake swarm (16 stronger than tremor); shallow beneath Kīlauea caldera; some felt; erz intrusion? continued deflation	(Finch, 1944; Fiske and others, 1987) (Klein and Wright, 2000)
12/7/1944	12/17/1944		3.92	230.0		
3/5/1950 9/15/1950 12/8/1950	9/15/1950 12/8/1950 12/12/1950	>195	22.99 2.83	32.7 218.1	December 1950 eqs and Koa'e? int. Slow deflation preceding earthquake swarm 9 events of M 4 recorded on Oahu; epicenters cross Koa'e fault zone between Kōko'olau and Kamakai'a Hills major deflation during earthquake swarm	(Finch, 1950; Fiske and others, 1987)
12/8/1950	12/16/1950		16.28	210.0		
12/16/1950 4/22/1951	10/31/1951	M6.2	15.60	41.7	post-1950 inflation 35 km beneath Kīlauea caldera; one foreshock and many aftershocks deflation interval precursory inflation	(Fiske and others, 1987, VL 512; Macdonald, 1951)
10/31/1951 12/16/1951 3/17/1952	12/16/1951 6/27/1952 3/31/1952	>600	6.28 12.79	218.3 27.5	precursory inflation M 6 (2), M 5-6 (19), M 4-5 (36); offshore sf	(Fiske and others, 1987, VL 515;

Date Beg.	Date end	eqs ⁱ	Tilt ⁱⁱ		Comment	Reference ⁱⁱⁱ
4/3/1952	4/12/1952	15			Beneath east rift zone (onshore)	Macdonald, 1952)
6/27/1952	11/7/1952				eruption in Halema'uma'u crater	(Fiske and others, 1987, VL 516-518;
6/27/1952	6/30/1952		2.16	212.8	initial deflation	Macdonald, 1952)
6/27/1952	11/7/1952		6.65	196.5	net deflation during eruption	

ⁱ Seismic swarms are defined as 5 or more events occurring at a rate of greater than 1/hour with no gap more than 2 hours. Locations are assumed to be at 0-5 km depth beneath Kilauea caldera.

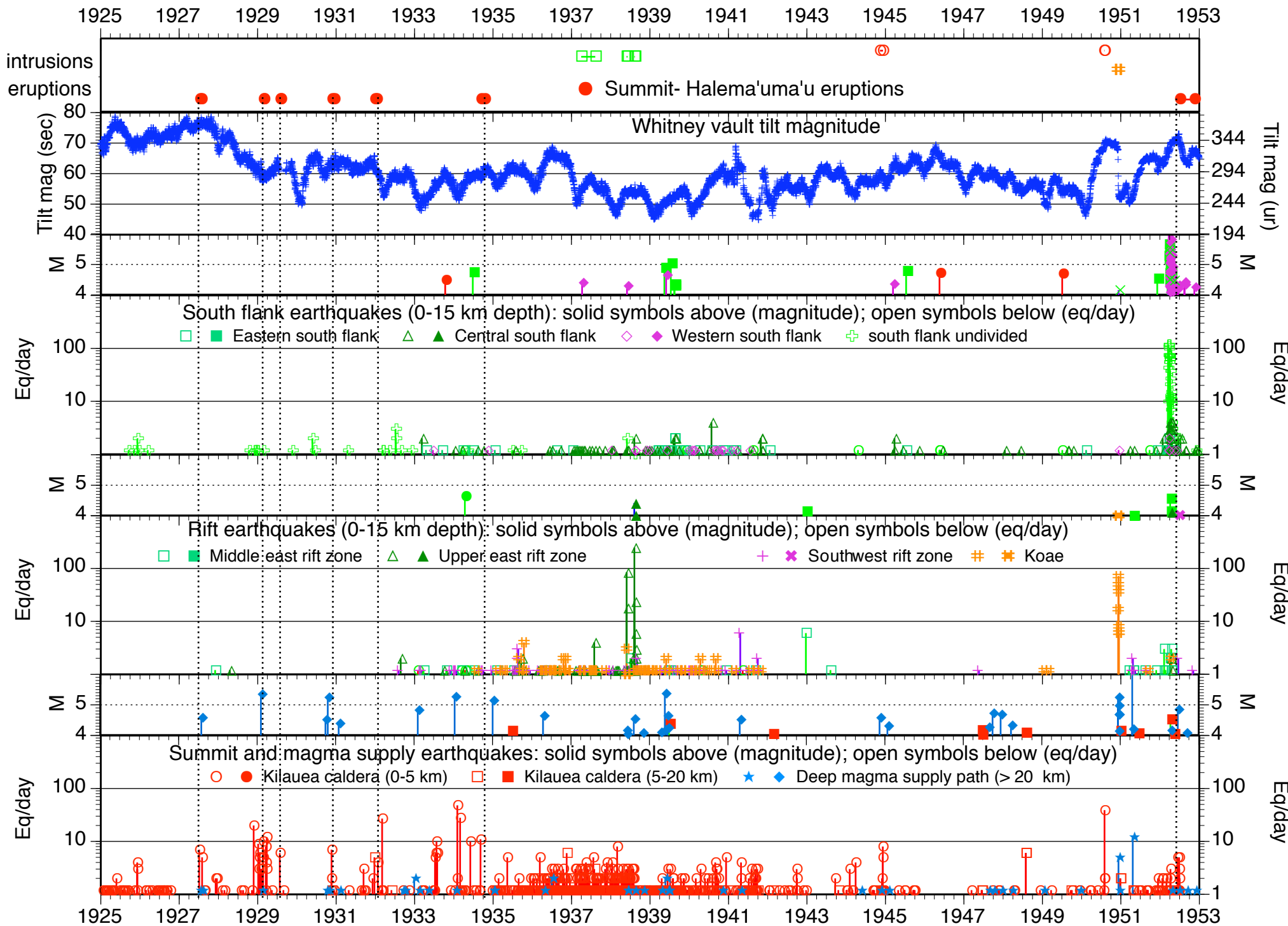
ⁱⁱ Tilt magnitudes are in seconds of arc as originally reported. 1 arc-second = 4.848 microradians. Deflation azimuths are between 180 and 270 degrees, normally between 190 and 235 degrees. Inflation azimuths lie between 0 and 90 degrees, normally between 10 and 55 degrees.

ⁱⁱⁱ References to seismicity are to the reprinted Early Serial Publications of the Hawaiian Volcano Observatory (Bevens and others, 1988), the reprinted Volcano Letter (Fiske and others, 1987) and the compilation of Hawaiian earthquakes before 1959 (Klein and Wright, 2000). A continuous record of tilt data obtained at Whitney vault are from an unpublished Hawaiian Volcano Observatory archive (HVO, unpub).

Figure C1. 1925–1953. Time-series summary of earthquakes in all regions of Kīlauea during this period plotted against times of eruption and intrusion (top panel) and Whitney tilt magnitudes (2nd panel from top) as in text figure 3.1. The bottom six panels show (from bottom to top) paired rows showing earthquakes per day (eq/day) and magnitudes >4 for earthquakes in the magma supply (bottom), rift and koae (middle) and south flank (upper) regions. Text figures 3.1–3.3 show shorter time periods that emphasize eruptions and intrusions in this period.

Figure C2. 1925–1953. Time series plots show heightened seismicity in all regions during this time period plotted against times of eruption and intrusion (top panel) and Whitney tilt magnitudes (2nd panel from top). Heightened seismicity is defined as earthquakes that occur with a frequency of less than six hours. We show three levels; the levels differ depending on the region. Background levels of south flank and deep magma-supply seismicity are higher and symbols are given for sequences of less than 5 events, 5–20 events, and greater than 20 events. For all other regions we plot sequences of less than 3 events, 3–10 events, and greater than 10 events.

Appendix C Figure C1



Appendix C figure C2

