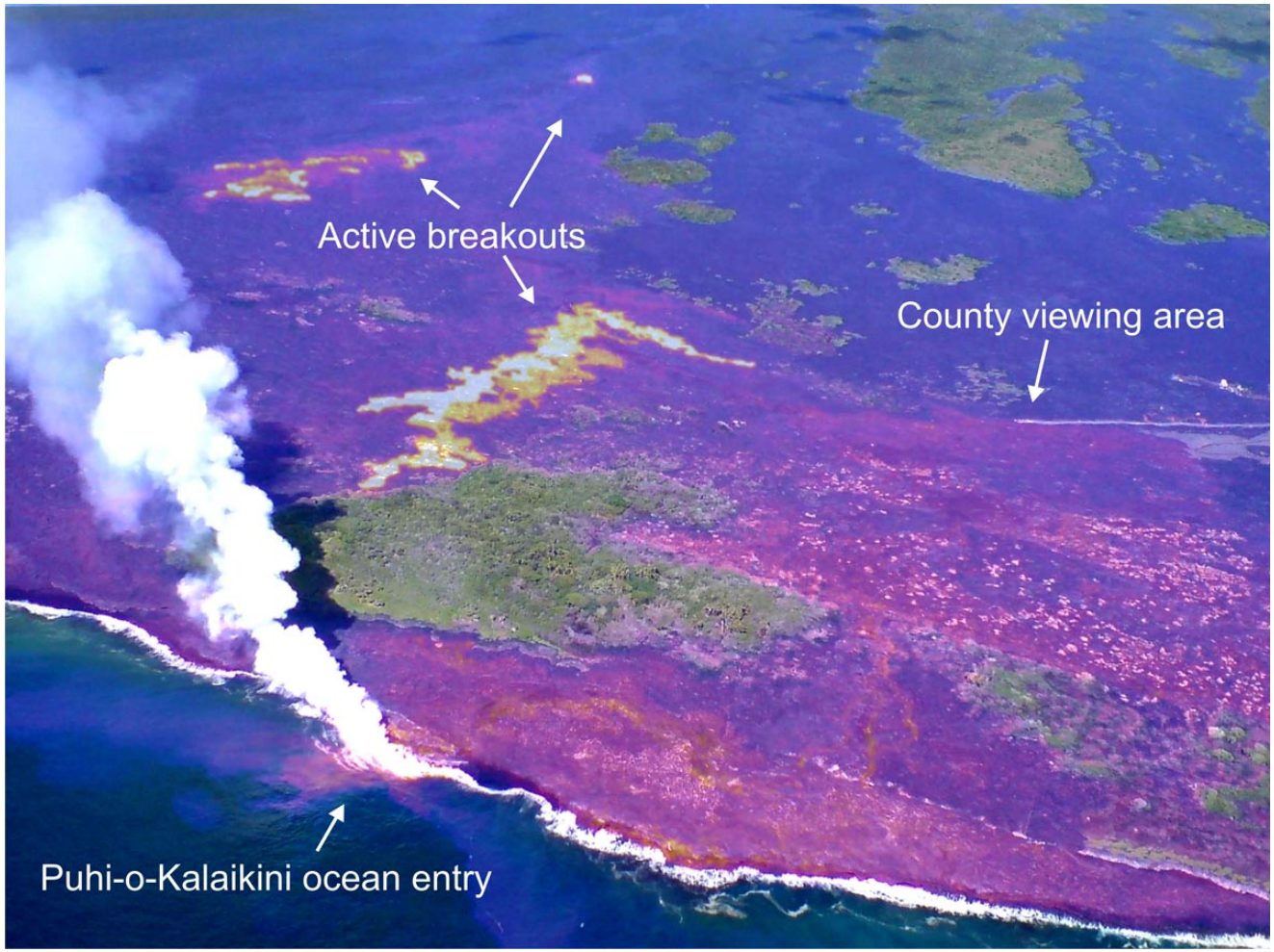
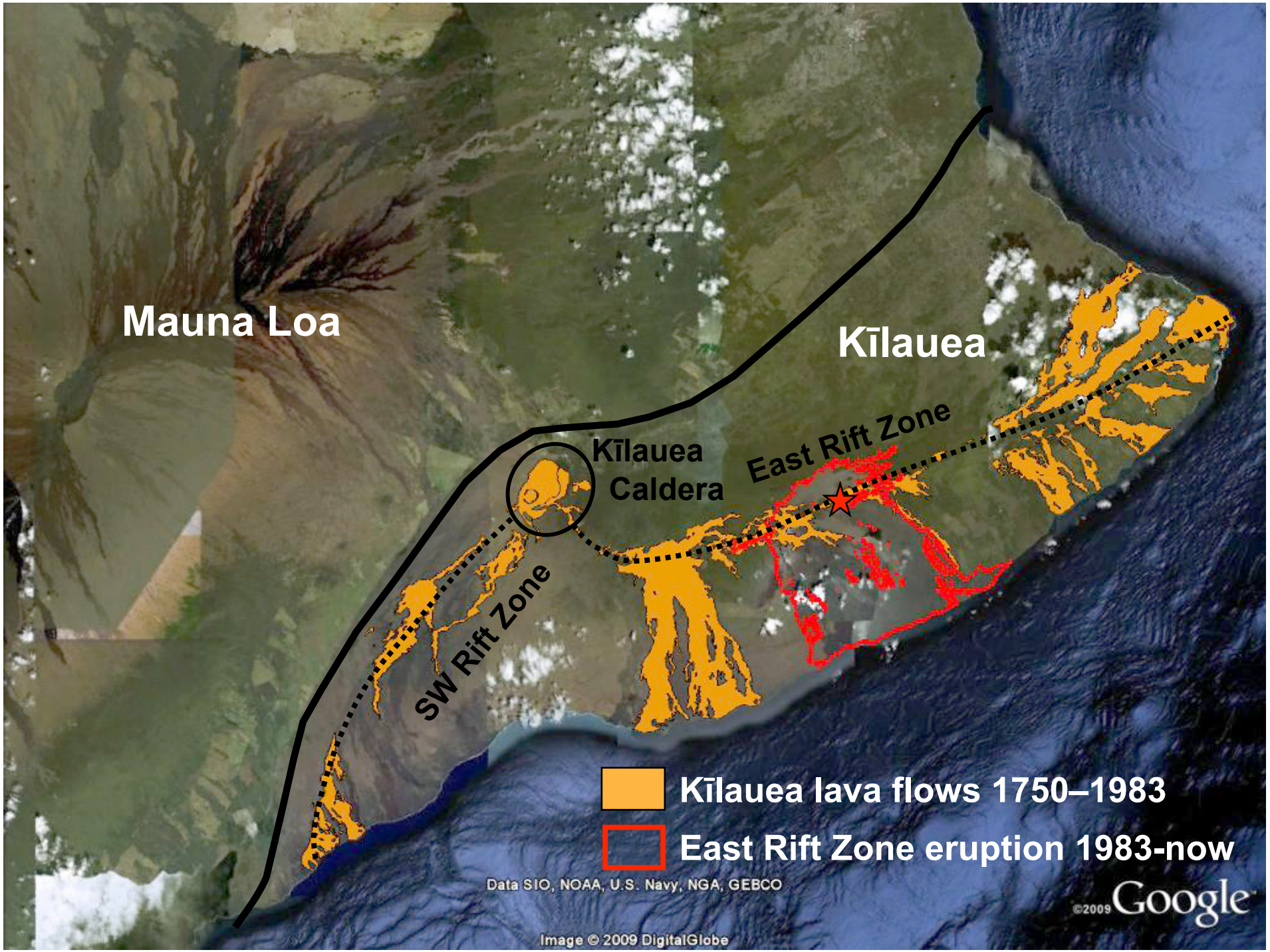
Monitoring Kilauea's summit and east rift zone eruptions with thermal cameras

Matt Patrick, Tim Orr, Kelly Wooten




Mauna Loa
Kīlauea
Kīlauea Caldera
East Rift Zone
SW Rift Zone
Kīlauea lava flows 1750–1983
East Rift Zone eruption 1983-now
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
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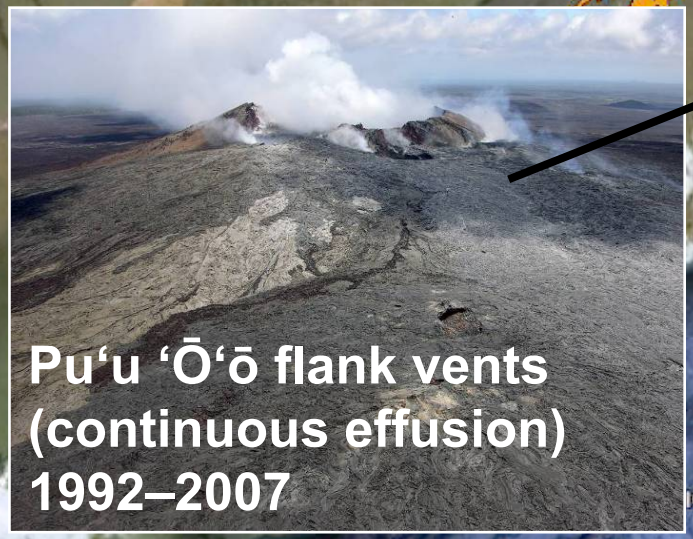
East rift zone eruption overview

Pu‘u ‘Ō‘ō
(episodic fountains)
1983–1986

Kupaianaha
(continuous effusion)
1986–1992



Pu‘u ‘Ō‘ō flank vents
(continuous effusion)
1992–2007

July 21st, 2007 eruption
(continuous effusion)
2007–ongoing

Thermal cameras have been used at Kilauea for monitoring since the mid-1990s (Kauahikaua et al. 2003)

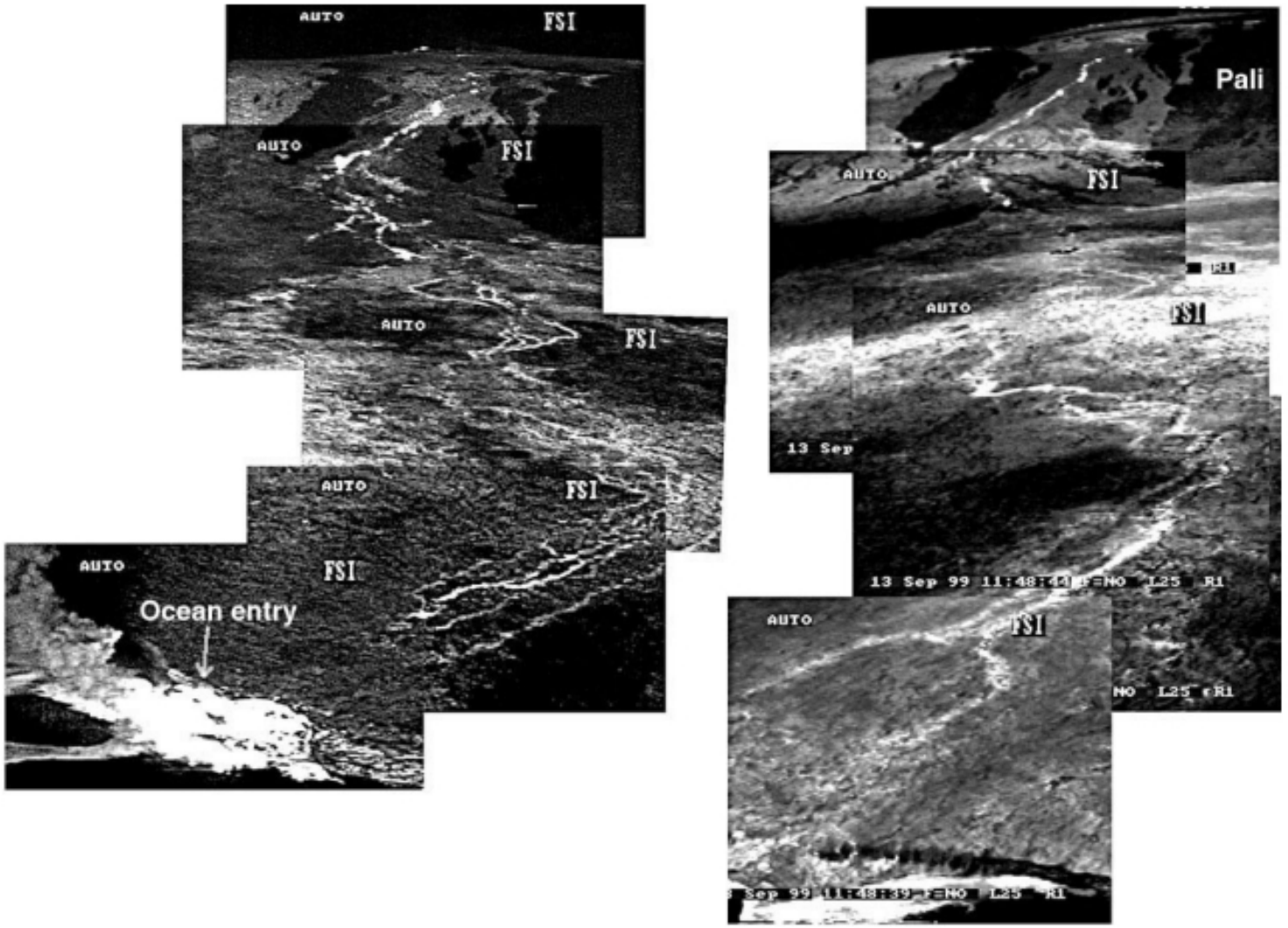
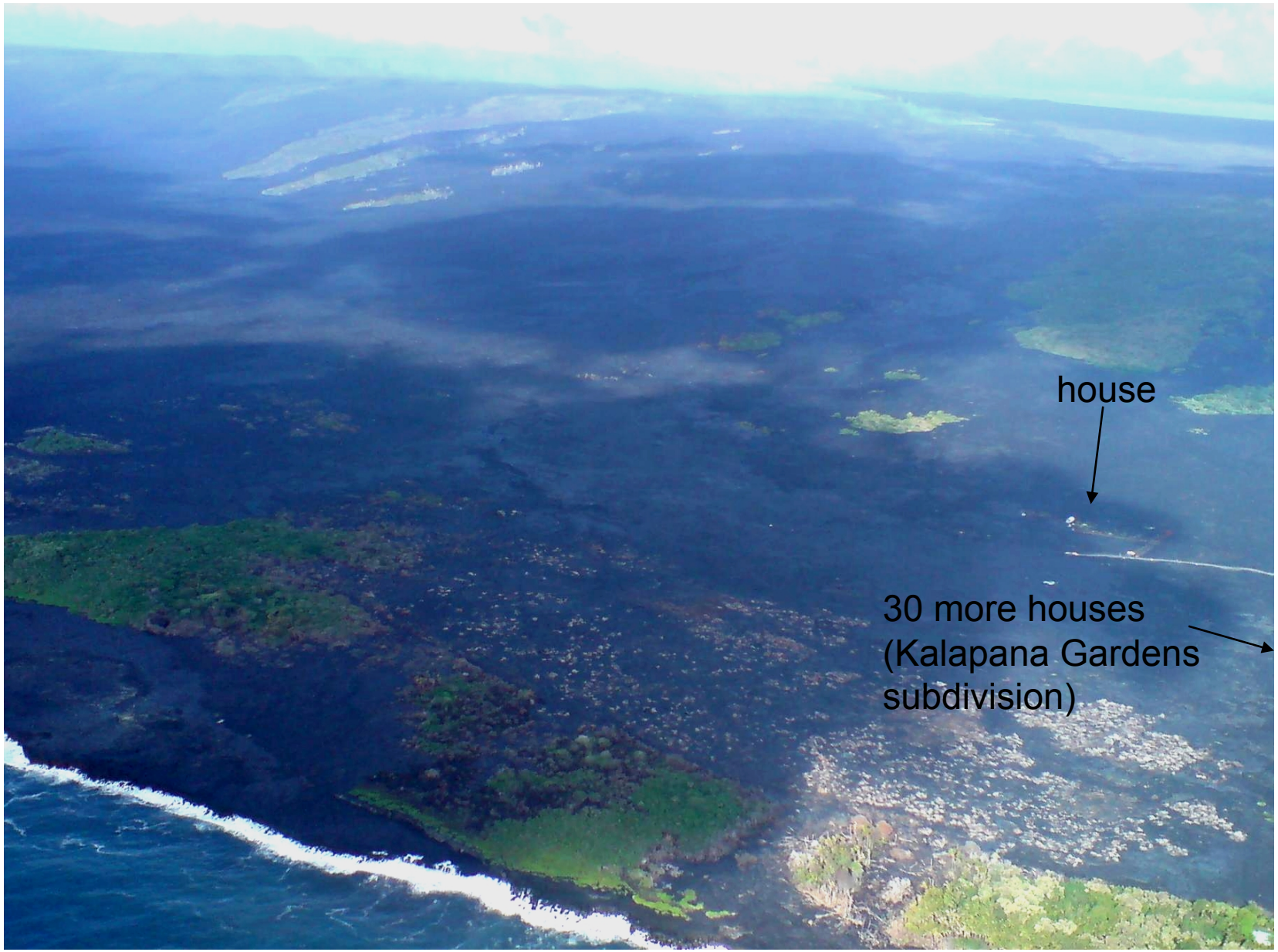


Figure 14. Composite infrared video images of lava-tube system, showing young system with braided streams. In right image, braids have consolidated into a few main braids. Note the redirection of the lower extent of the two braids near coastline. Videos taken December 29, 1998 (left), and September 13, 1999 (right).

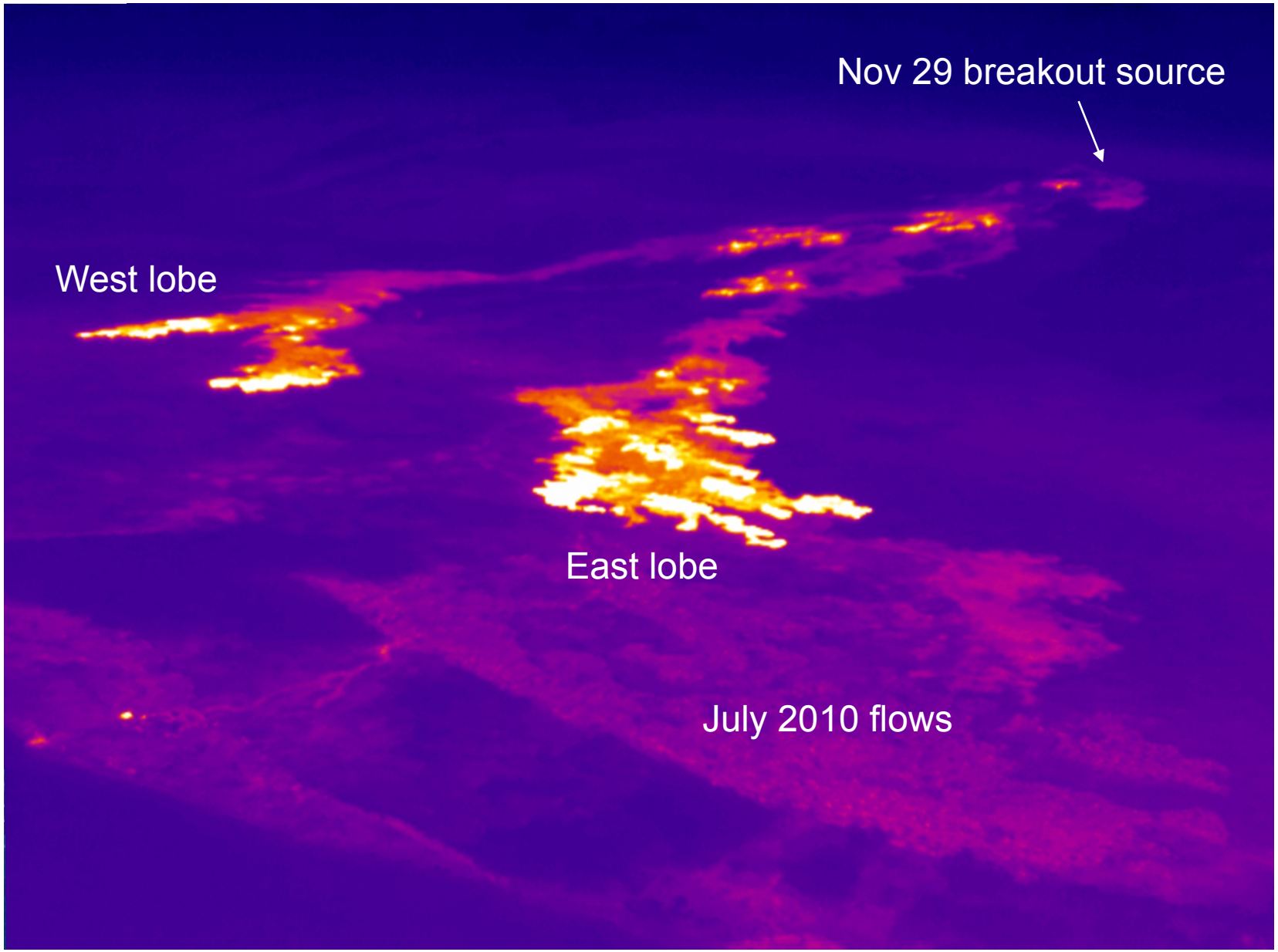
Monitoring of East Rift Zone flow field with thermal camera done mostly by weekly helicopter flights

- FLIR Systems SC620 (640 x 480 pixels, 8-14 microns)
- 45 dg lens (wide angle) – very important!
- 0-550 Celsius temperature setting
- 1 fps periodic save rate (custom firmware upgrade by factory)
- Also occasionally do simultaneous visible-thermal images (SC620 has visible camera built in)
- Purchased in March 2010 (thanks to Federal Stimulus Money) – price ranges from $40-65,000 depending on lenses and features

Dec 30, 2010 overflight: where are the active flows?



Dec 30, 2010 thermal image



“Composite” images are helpful to Civil Defense and a big hit with the public

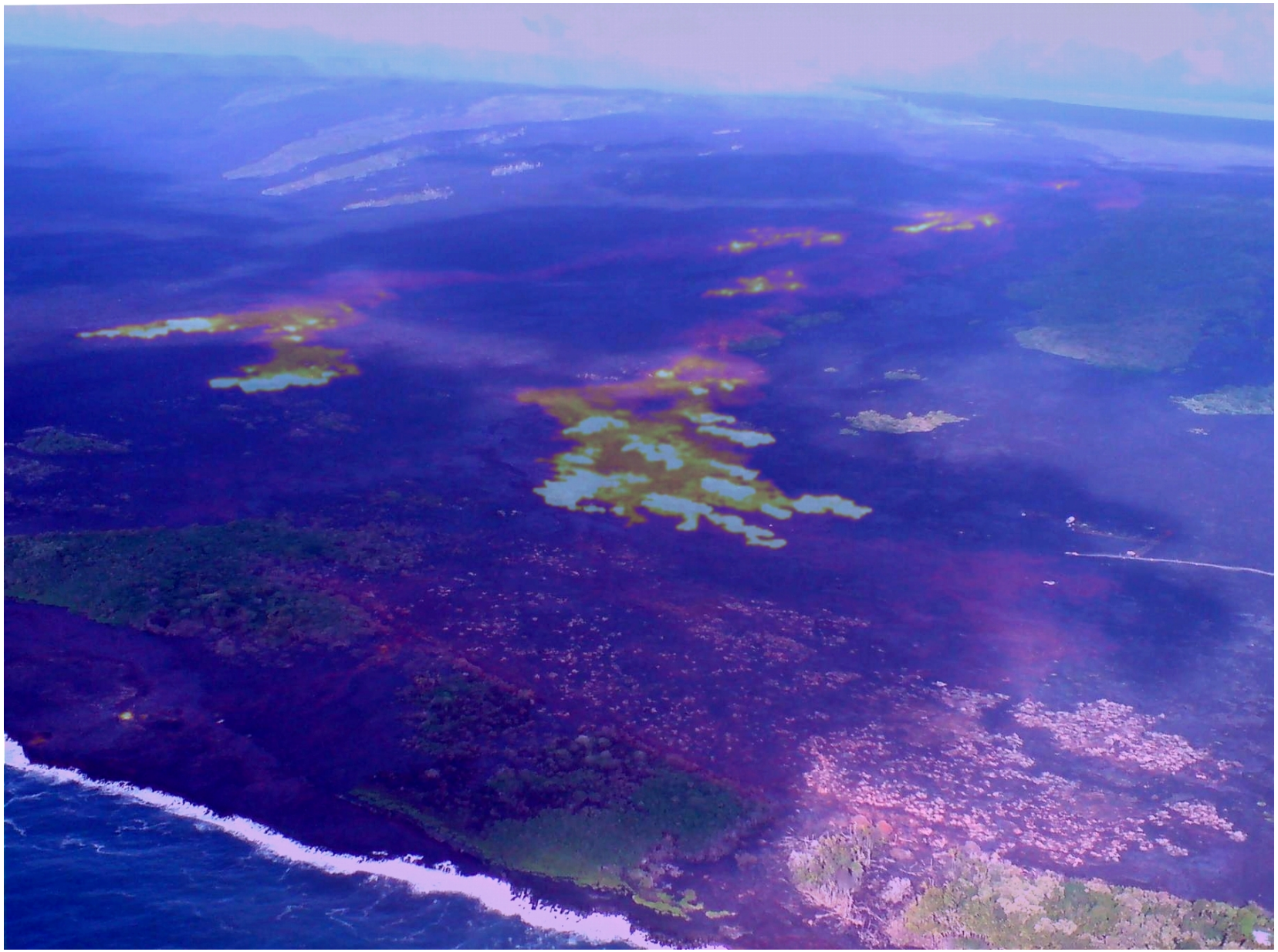
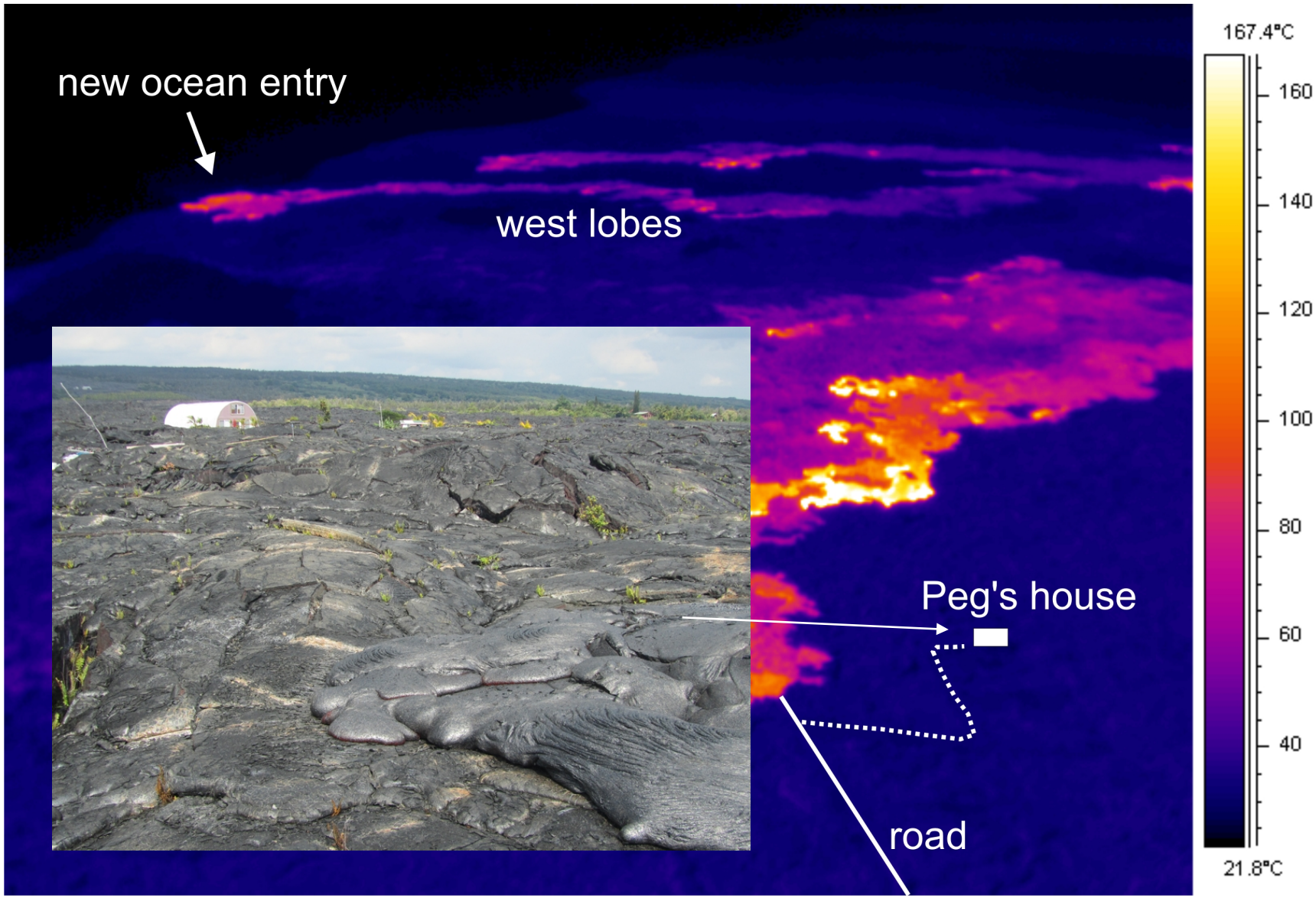
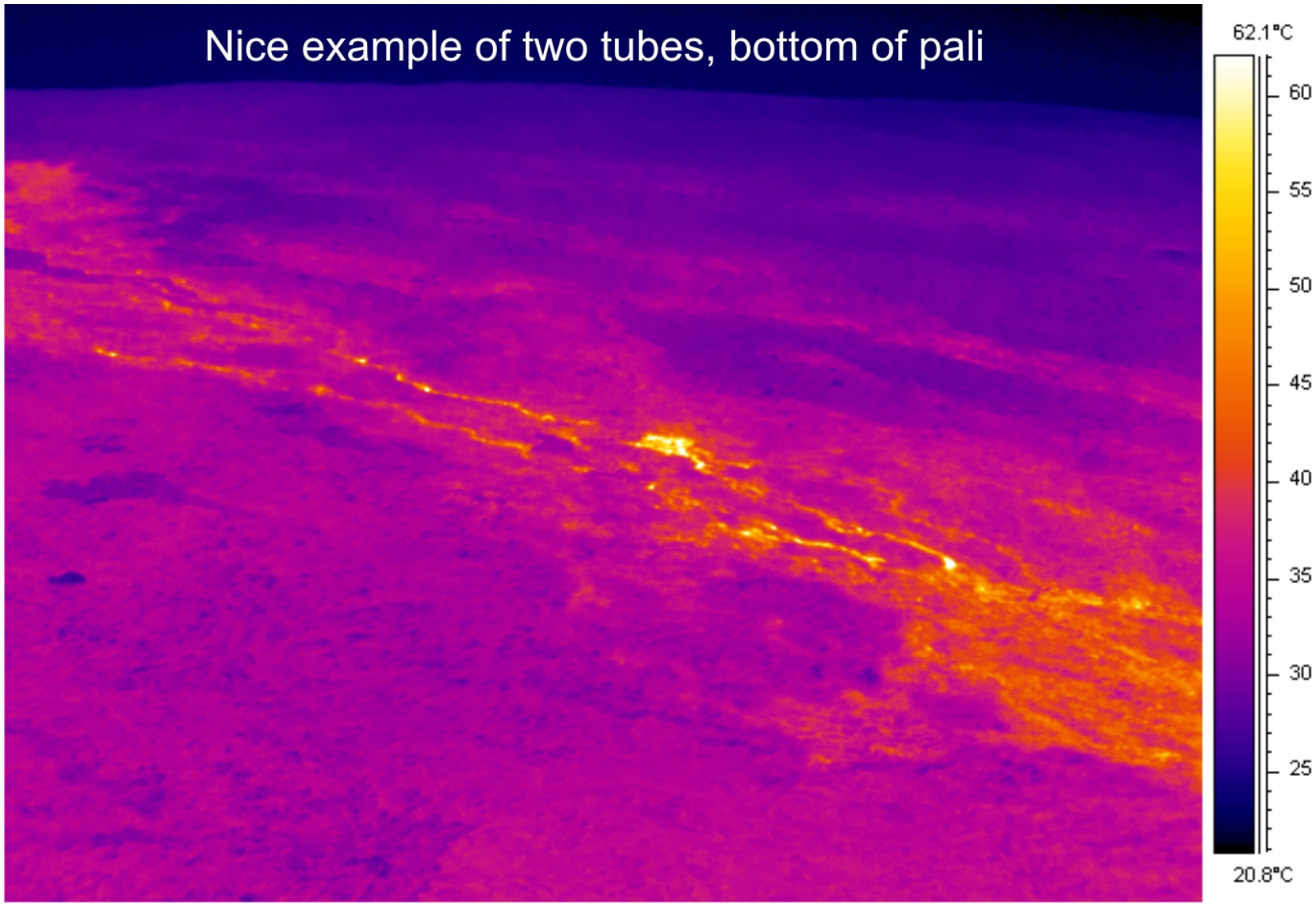


Image from Jan 6, 2011 provide to Civil Defense



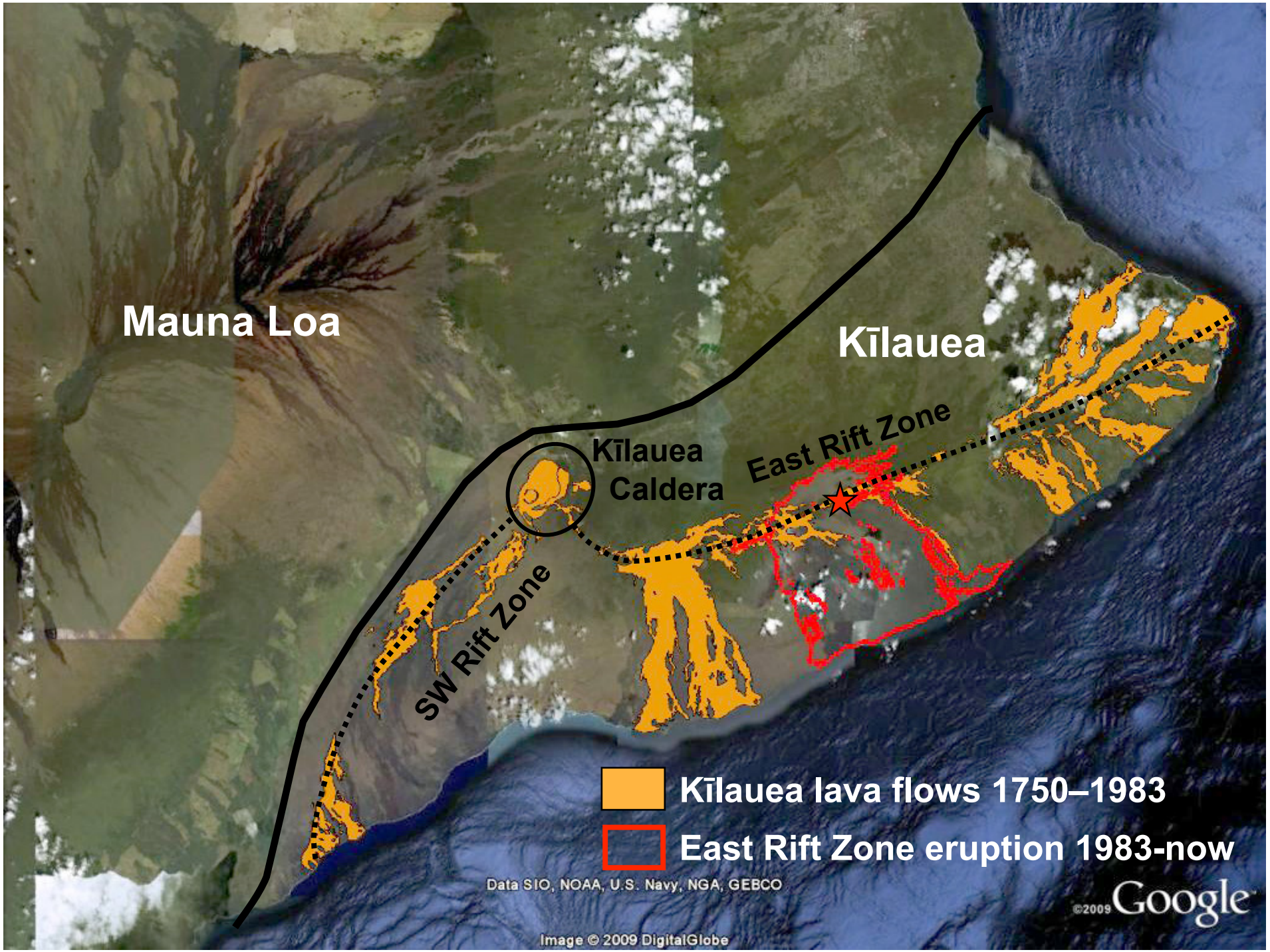
Lava tube systems can be mapped…



…but only after surrounding flow field has cooled sufficiently (month or more)

Advantages of thermal camera on East Rift Zone

- Provides a complete, synoptic view of surface flows and breakouts that is not possible with the naked eye
- Often catches small breakouts that would be missed by naked eye during overflights
- Allows mapping of lava tube system (with some limitations)
- Provides views into Pu`u `O`o crater when it is fumed in and obscured to the naked eye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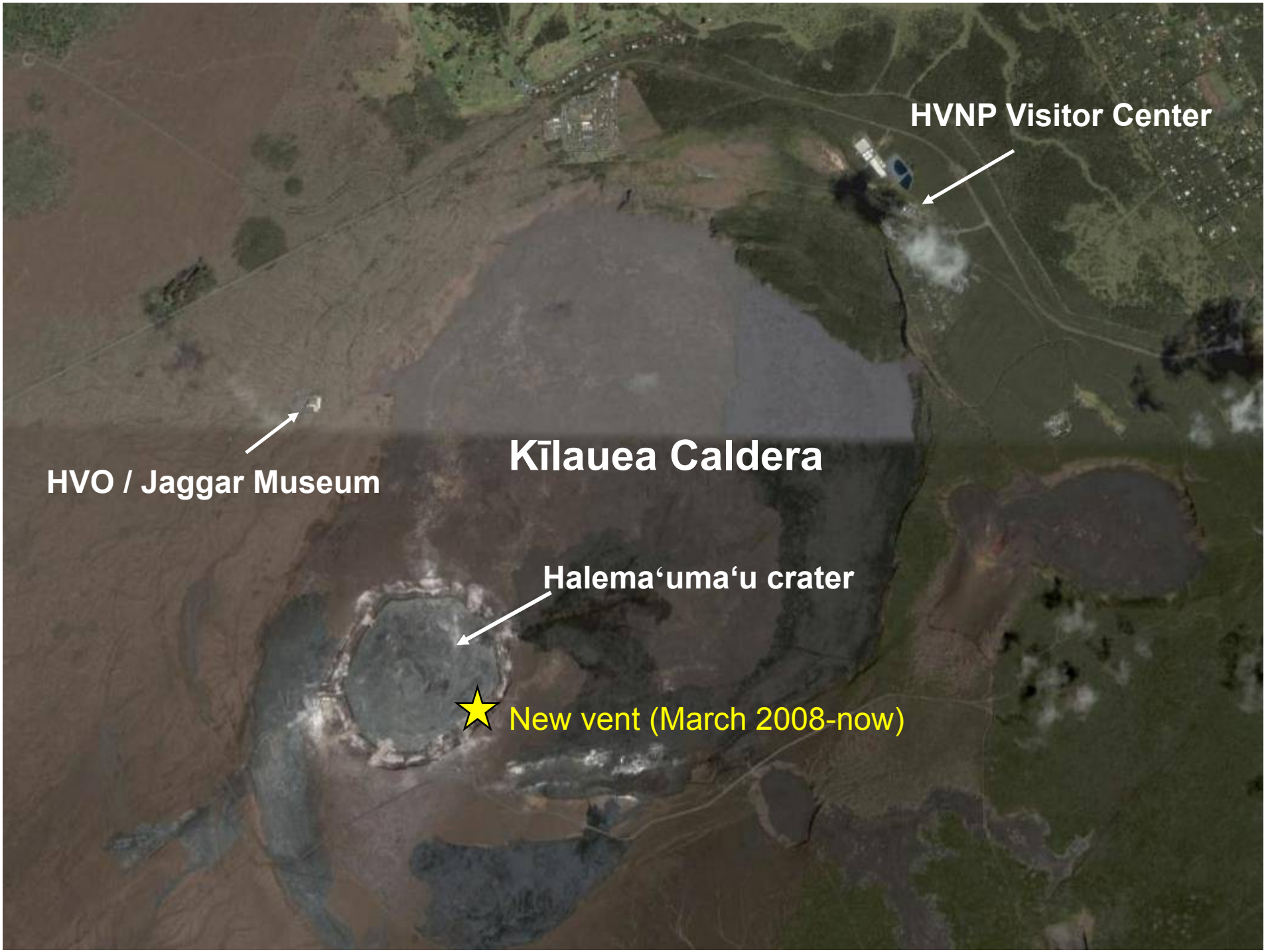
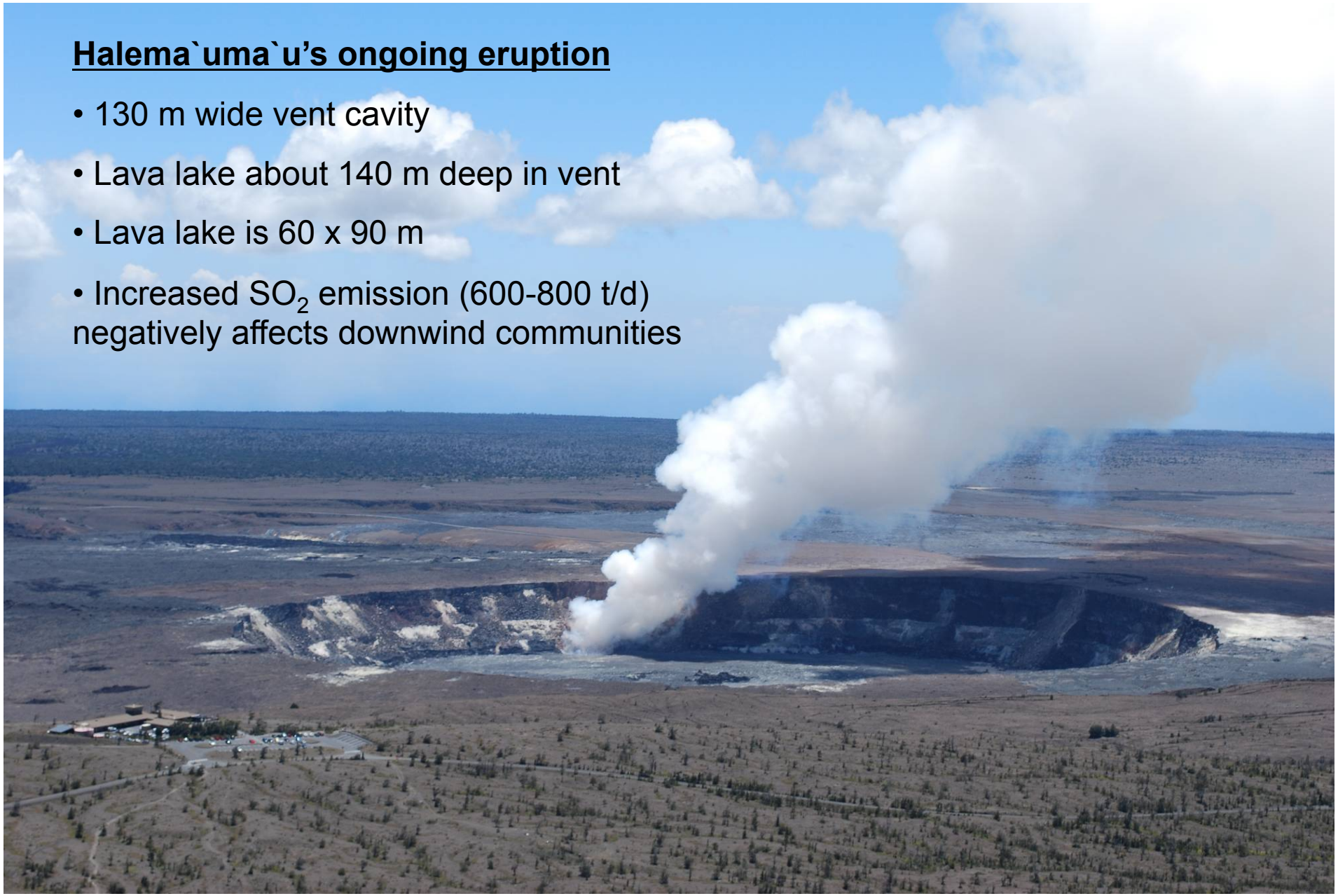
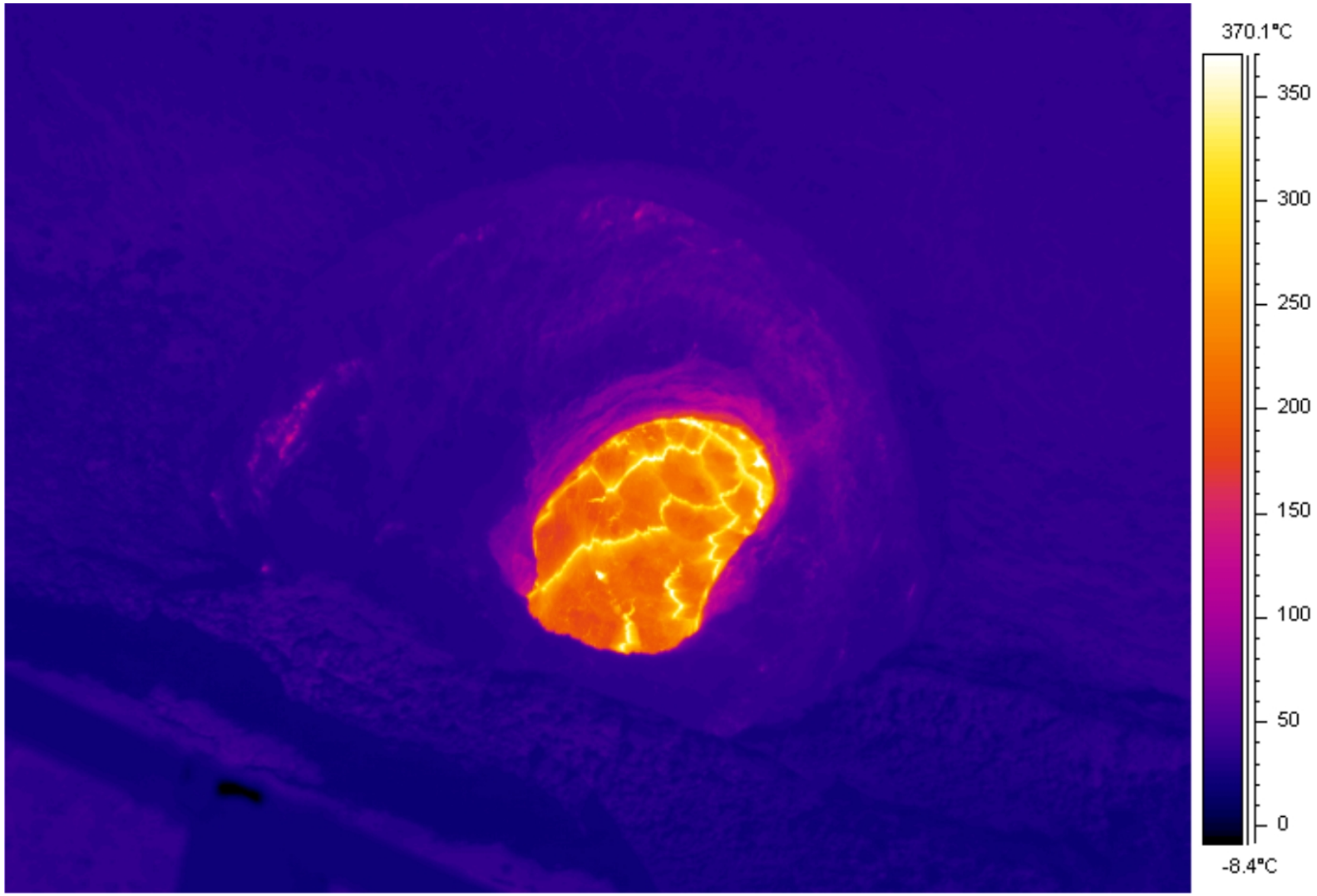

HVNP Visitor Center
Kīlauea Caldera
HVO / Jaggar Museum
Halemaʻumaʻu crater
New vent (March 2008-now)

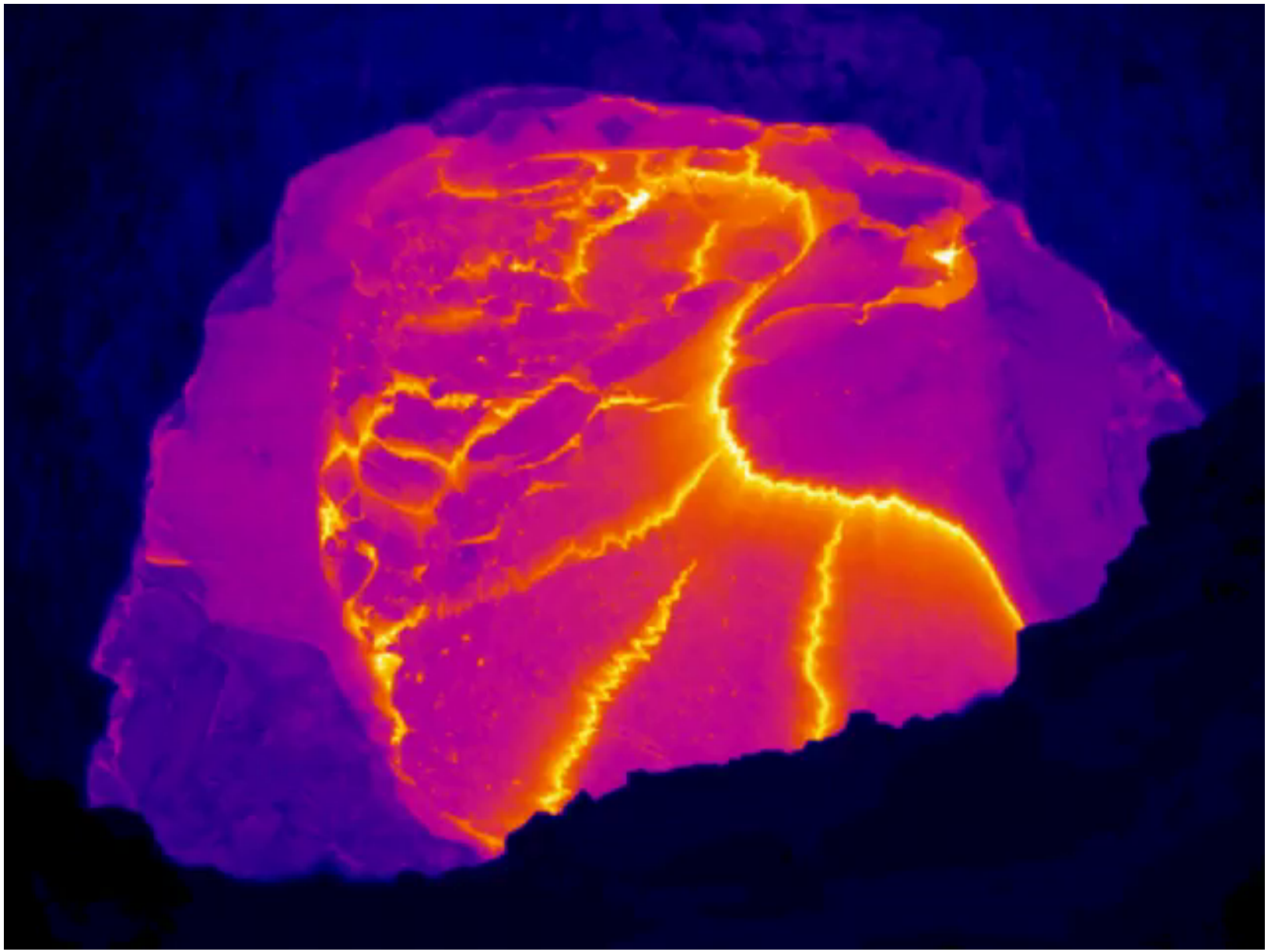

Halema`uma`u's ongoing eruption
• 130 m wide vent cavity
• Lava lake about 140 m deep in vent
• Lava lake is 60 x 90 m
• Increased SO_2 emission (600-800 t/d) negatively affects downwind communities

Typical view with the naked eye: no view inside vent whatsoever

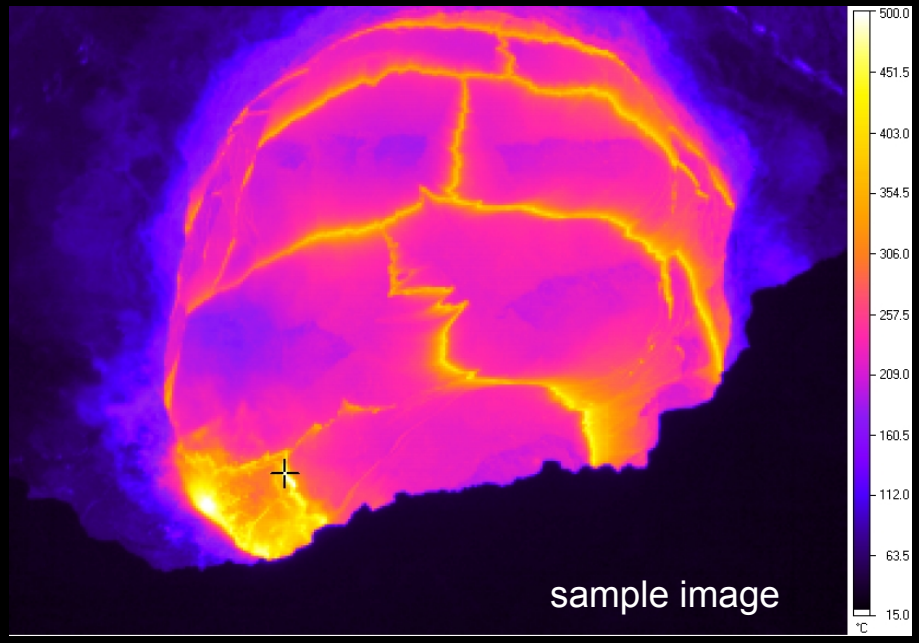
Thermal camera provides unobstructed view into vent: offers 24/7 monitoring capability not possible with normal cameras



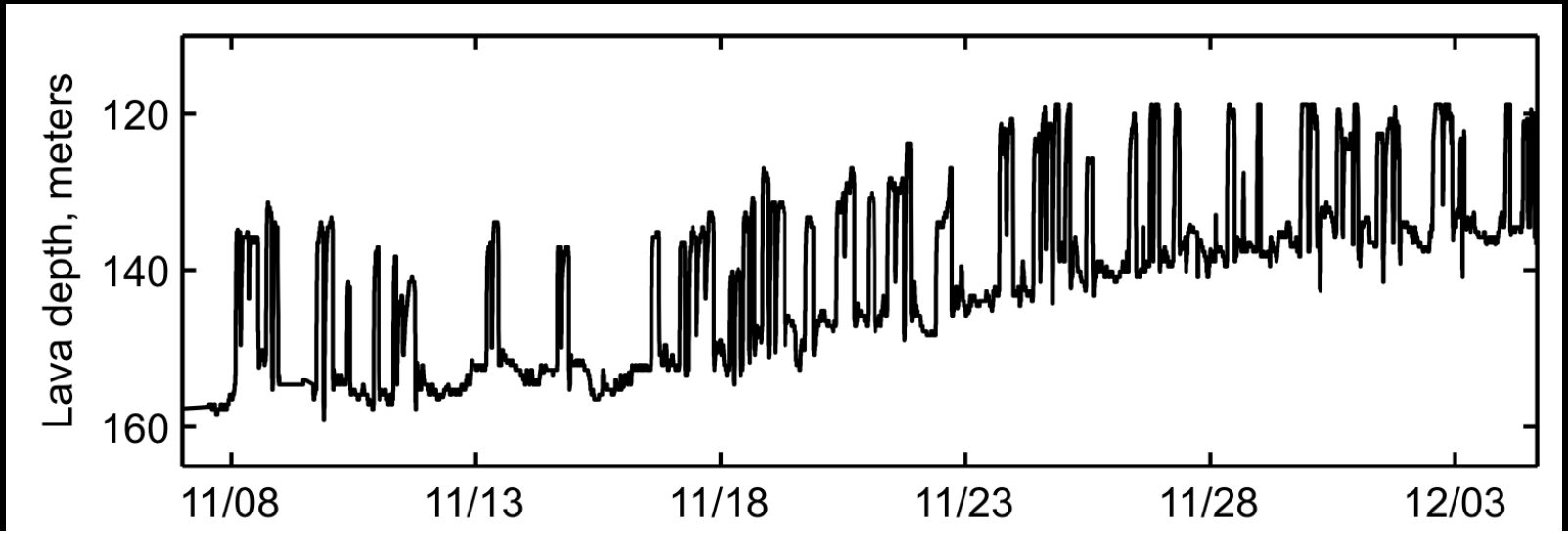
June 1, 2010: high frame rate view of Halema`uma`u draining with thermal camera



New fixed thermal camera provides continuous views of lava lake:



...and automated tracking of lava level:



Thermal camera use at Halema`uma`u

Weekly helicopter flights:

- FLIR SC620 (640 x 480 pixels), 45 dg wide-angle lens
- Two quick passes with camera running at 1 fps

Fixed thermal camera setup:

- Mikron 7500 (320 x 240 pixels), 23 dg normal lens
- Image every 5 seconds
- Running 24/7 since late October 2010

Advantages over visible cameras:

- Ability to see through fume: 24/7 observations in vent