Geochemistry, Geophysics, Geosystems

Supporting Information for

Quantification of eruption dynamics in the northern rift at Axial Seamount, Juan de Fuca

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Introduction

This supporting information provides a waveform example of impulsive signal, as well as figures illustrating the horizontal bias between the bathymetric and the hydroacoustic data and method used to measure the flow front advancement speed.

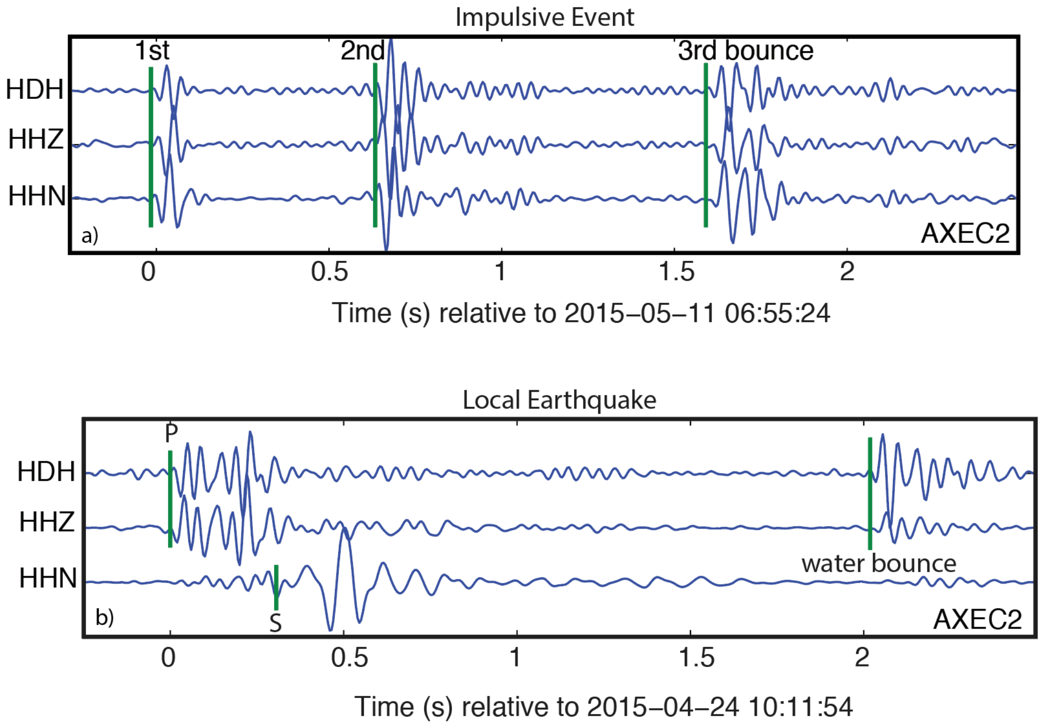

Figure S1. a) Typical arrival pattern for impulsive signals sourced from along the north rift and recorded by the OOI network. Labels mark the arrival of the first sea-surface reflected phase, and later arriving signals that reflect multiple times from the sea-surface and sea-floor. b) Typical arrival pattern associated with a microearthquake beneath the summit caldera, which include P- and S- body waves and a sea-surface reflection arriving two seconds after the P-wave arrival. Examples recorded on station AXEC2: HDH (hydrophone), HHZ (vertical seismic) and HHN (north oriented horizontal seismic) channels. All waveforms high-pass filtered at 5 Hz.

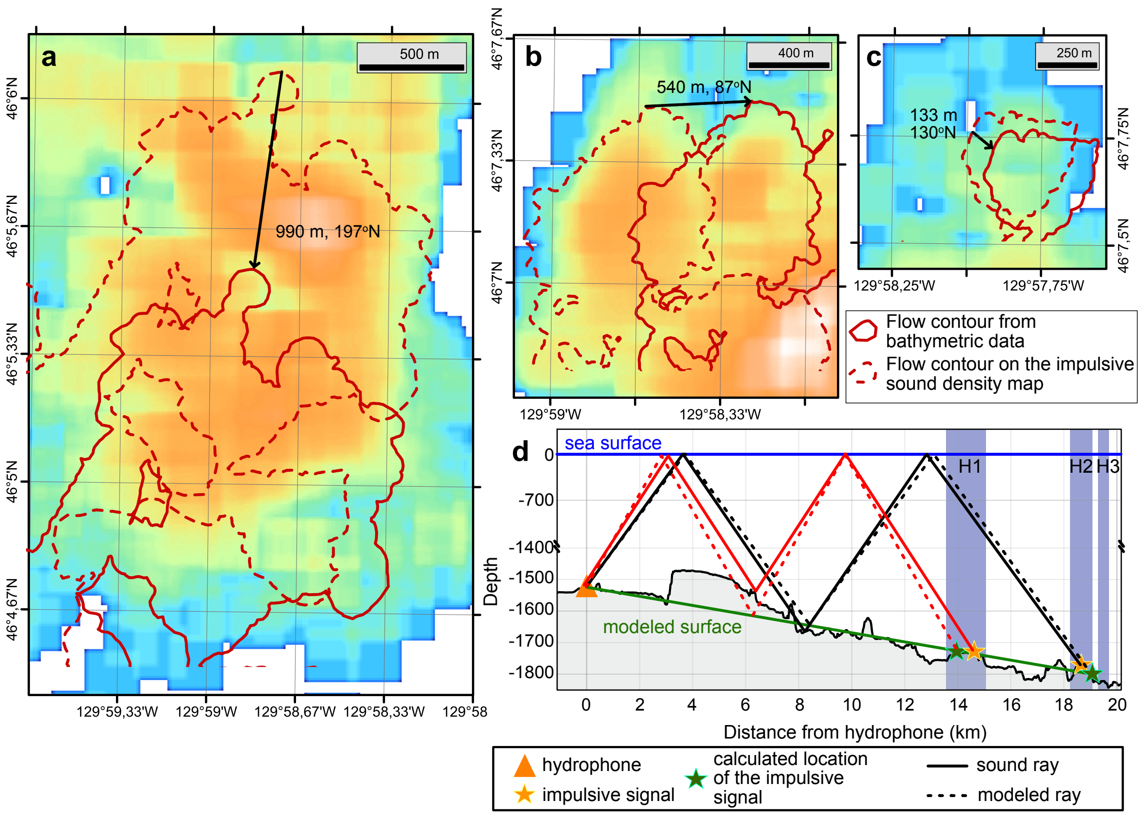

Figure S2. Correction for location bias. (a), (b) and (c) Explosion density maps of edifices H1, H2 and H3 showing the location bias of the impulsive sounds due to anomalies in the water column velocity structure and unmodeled topographic effects. The bold red lines show the lava flow contours determined using the bathymetric difference before and after the eruption. The dashed red lines mimic the lava flow contours, and correspond to the shift required for the impulsive sound density maps to fit the bathymetric maps. The black arrows indicate the direction and distance of the shift (e.g., the location bias) for each edifice. (d) Cartoon showing the sound rays of the 2nd arrival from impulse signals (at H1 and H2) to the hydrophone. The continuous lines represent the sound reflecting on the topography, and the dashed lines the sound reflecting on the model planar surface. For similar timing, the location of the impulsive sound can vary by several hundred meters. The difference in bias between the edifices can be explained by the variation between the modeled planar surface and the real bathymetry. The variation in bias is minimal for neighboring impulsive sounds that bounced at similar places but can become more significant as the distance between two impulsive signals increases. The effect of the variation in sound velocity through the water column is subtle at the scale of the cartoon and not represented here.

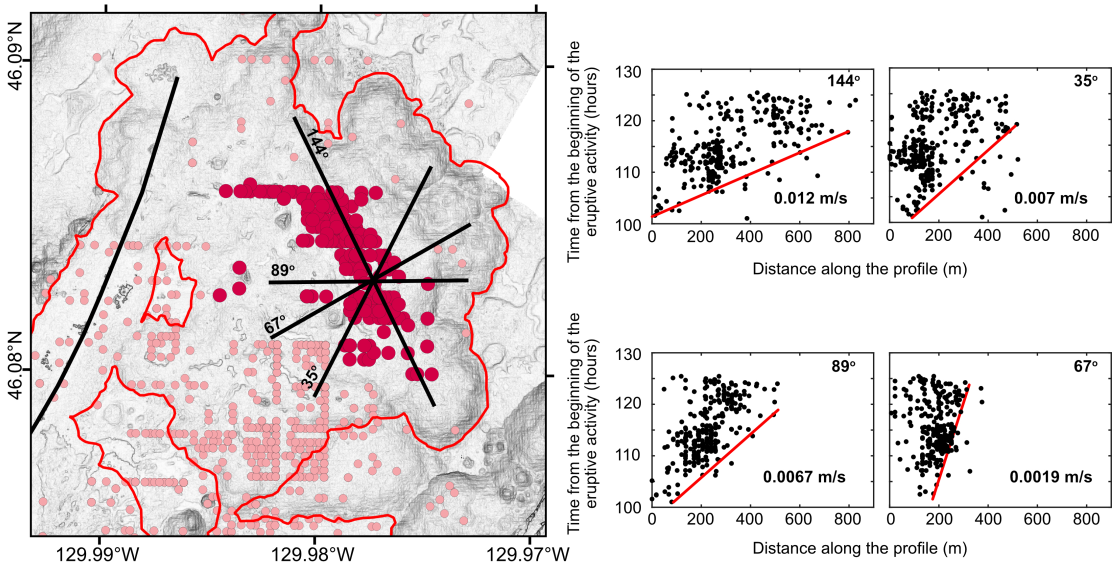

Figure S3. Example of the determination of the flow front velocity and flow axis. The grey-scaled bathymetric map shows the distribution of impulsive acoustic signals from 101 to 126 hours from the start of acoustic activity at 8:01 UTC on April 24th. The analyzed signals from one burst are shown by the darker and larger dots. The axes of a series of profiles and their orientations are indicated on the map. The four plots show the analyzed signals along the four profiles, as time of occurrence of the sounds as a function of distance along the profiles. The red lines illustrate flow front advancement, with lava flow velocity indicated in ms^{-1}. The likely axis of the flow is the one associated with the fastest flow front velocity (0.012 ms^{-1} along the 144° profile).

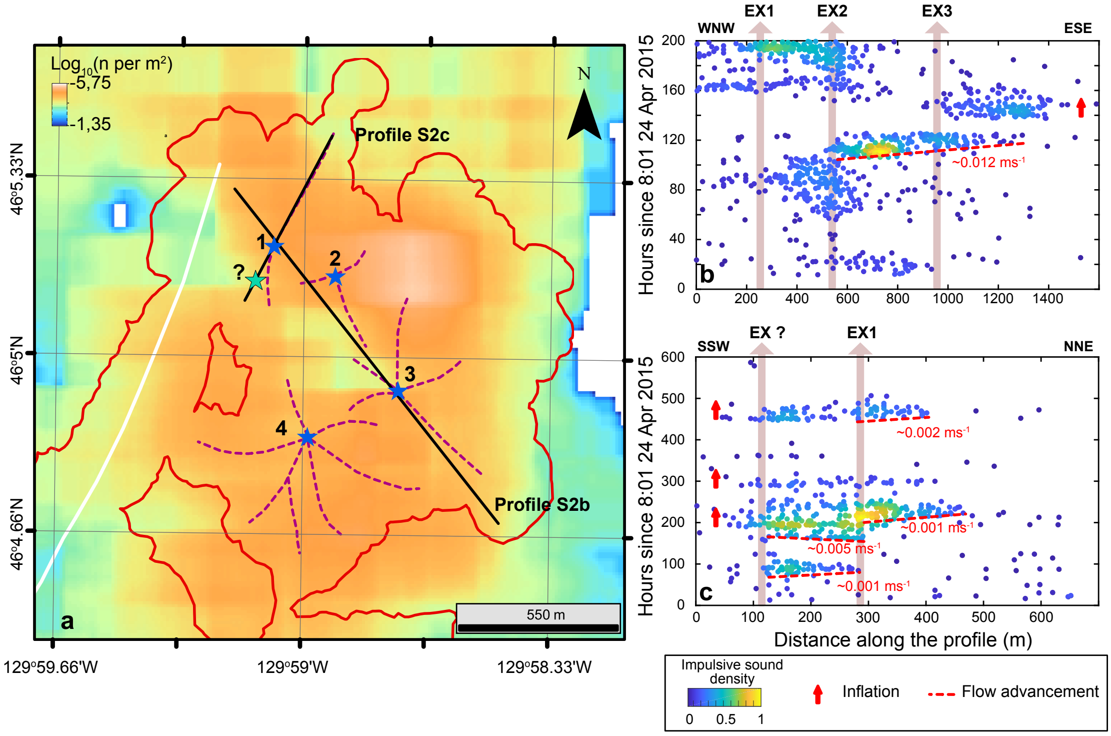

Figure S4. Examples of successive burst of acoustic events occurring at hummock H1 (a) Density map of the impulsive sounds in 25x25 m cell size represented by number of events per m^2 with a $\log_{10}$ color scale. The density map is shifted 990 m in a southerly direction to fit the flow contour (see Figure S1a). Profiles S2b and c are located by black lines. The centers of extrusion identified on the bathymetry are located by dark blue stars. The potential extrusion center evident on profile S2c is located by a light blue star. Flow axes are shown by dashed brown lines. (b) and (c) Plot of the time of occurrence of impulsive sounds as a function of the distance along the profiles in (a). Sound density is represented by the color code as a percent of the maximum density. The dashed red lines illustrate flow front advancement with lava flow velocity indicated in ms^{-1}. Clusters of sounds associated with lava flow inflation are indicated by red arrows. The sound time is represented in seconds from the beginning of the acoustic activity at 8:01 UTC on April 24th.