Supplement of Nat. Hazards Earth Syst. Sci., 23, 1029–1044, 2023
https://doi.org/10.5194/nhess-23-1029-2023-supplement

Natural Hazards and Earth System Sciences
Open Access

Supplement of

Characterizing the evolution of mass flow properties and dynamics through analysis of seismic signals: insights from the 18 March 2007 Mt. Ruapehu lake-breakout lahar

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Table 1. Summary of all the parameters noted for the 18 March, 2007 lahar. PSF (peak spectral frequency), DR (directionality ratio), SCF (Spectral centroidal frequency), SS (Spectral spread), DNSA (Dominate normalized spectral range).

Station	Parameter	Streamflow	1 (Front)	2 (Head)	3 (Body)
RTMT E	PSF	20-40	5-10	30-40	30-40
Cross	DR	0.8-1.0	0.7	1.1	0.5-0.9
Channel	SCF	28-30	18-20	25-28	28
	SS	20-40	5-30	15-35	15-40
	DNSR	30-40	5-15	35-40	35-40
RTMT N	PSF	20-40	5-10	30-40	30-40
Flow	DR	0.8-1.0	0.7	1.1	0.5-0.9
Parallel	SCF	28	20	25-28	25-30
	SS	18-40	7-32	12-40	20-40
	DNSR	30-40	7-15	32-40	30-40
RTMT Z	PSF	30	5-10	20-40	30-40
Vertical	DR	0.8-1.0	0.7	1.1	0.5-0.9
	SCF	28	20-25	25-30	25-30
	SS	20-37	7-35	15-35	20-40
	DNSR	25-35	7-12	25-40	30-40
TRAN E	PSF	20-32	10	20-30	10-35
Cross	DR	0.8	0.7	1.0-1.1	0.6-0.9
Channel	SCF	25	20-25	25	22-25
	SS	15-35	10-28	18-35	15-35
	DNSR	15-35	10-25	25-35	15-35
TRAN N	PSF	20-32	10	20-30	10-35
Flow	DR	0.8	0.7	1.0-1.1	0.6-0.9
Parallel	SCF	20-22	17-22	25	22-25
	SS	15-35	10-30	15-35	10-35
	DNSR	20-32	10-20	20-35	10-35
TRAN Z	PSF	20-32	10	20-30	10-35
Vertical	DR	0.8	0.7	1.0-1.1	0.6-0.9
	SCF	20-22	18-20	20-25	20-25
	SS	12-32	10-28	15-32	10-32
	DNSR	20-32	10-20	20-32	10-32
COLL E	PSF	18, 25	18, 25	18	18, 25
Cross	DR	0.8-1.2	0.8-1	0.9-1.1	0.8-1
Channel	SCF	22	22-25	25	25
	SS	15-30	15-35	15-35	15-35
	DNSR	18	18, 22	18, 22	18
COLL N	PSF	12-30	22	20-30	20-30
Flow	DR	0.8-1.2	0.8-1	0.9-1.1	0.8-1
Parallel	SCF	21-25	23-25	25	25
	SS	12-30	15-32	15-35	15-35
	DNSR	12-25	20-22	20-28	20-28
COLL Z	PSF	22-30	27-29	25-32	25-30
Vertical	DR	0.8-1.2	0.8-1	0.9-1.1	0.8-1
	SCF	28	28-30	30	30
	SS	20-35	20-37	22-35	22-37
	DNSR	27-34	25-30	25-35	25-35

Results of section 4.1 frequency constraints

Figures S1-S3 show the normalized spectrograms along with the spectral spread and spectral centroidal frequencies (SCF) for each of the three seismic components for RTMT (Figure S1), TRAN (Figure S2), and COLL (Figure S3). The methods for estimating spectral spread and SCF are described in section 4.1.

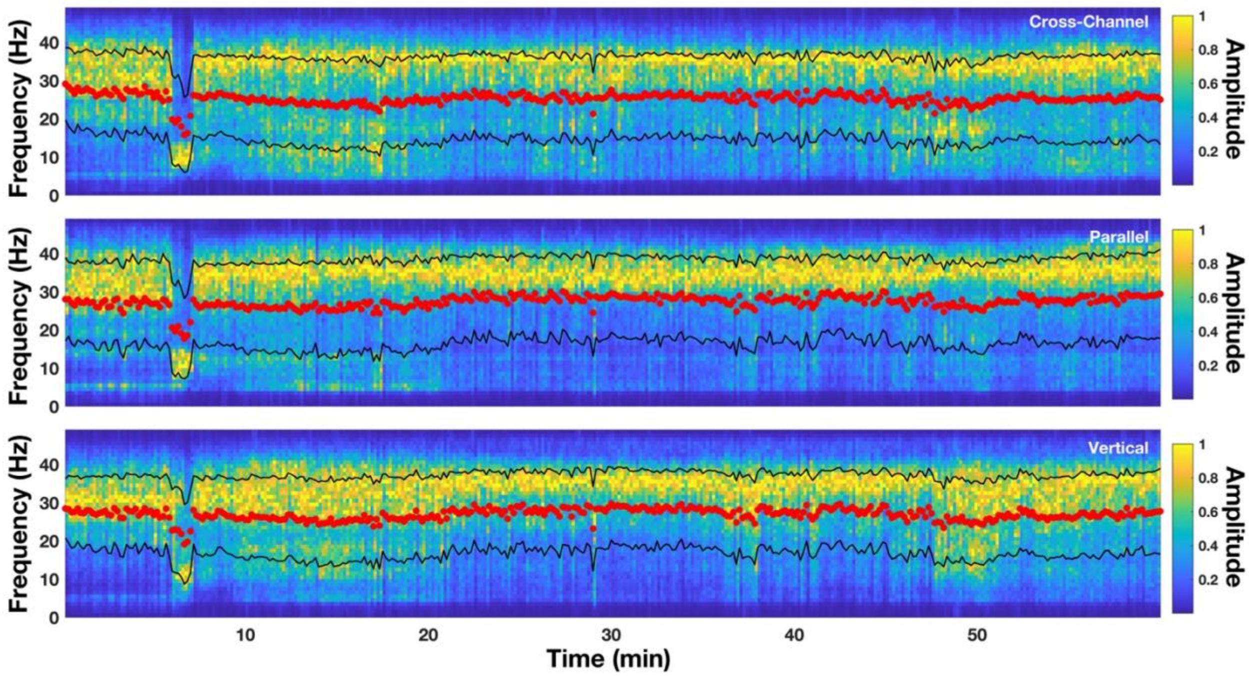

Figure S1. Normalized spectrograms for RTMT. Red dots represent the spectral centroidal frequency and black lines show the range of the spectral spread.

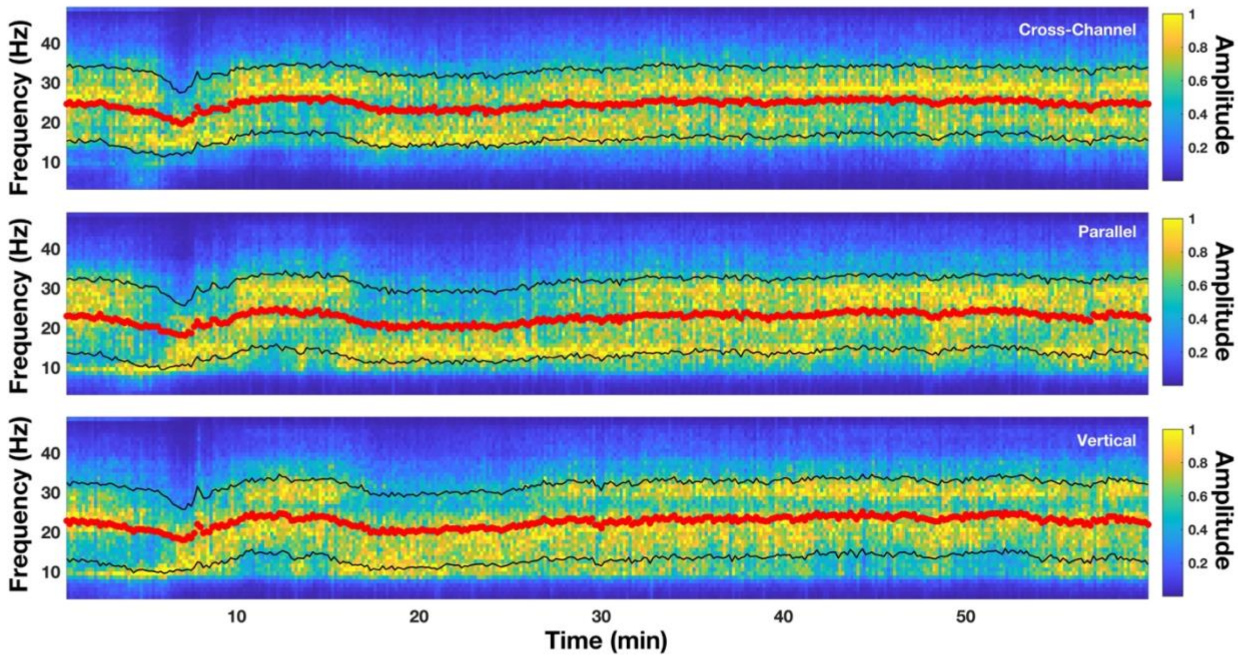

Figure S2 Normalized spectrograms for TRAN. Red dots represent the spectral centroidal frequency and black lines show the range of the spectral spread.

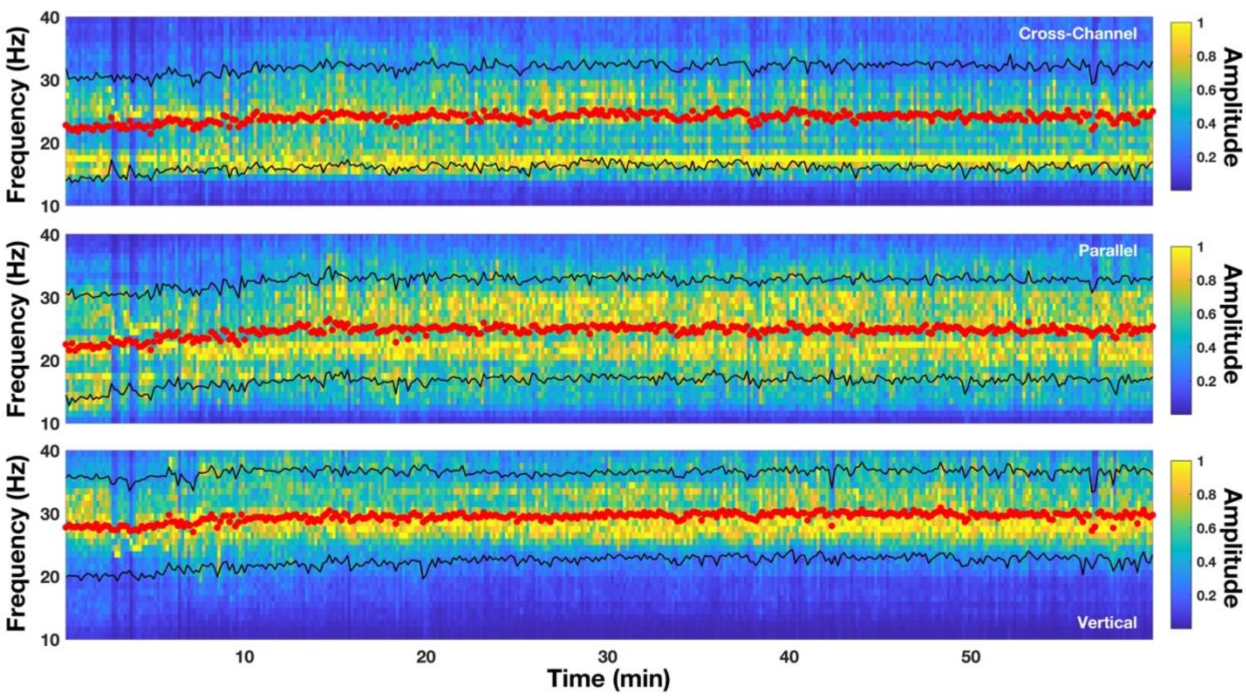

Figure S3 Normalized spectrograms for COLL. Red dots represent the spectral centroidal frequency and black lines show the range of the spectral spread.

Estimation of H/V ratios for site response and amplification

In order to estimate the site response for each of the three seismometer locations, a H/V spectral analysis method was used (i.e. Nakamura, 1989). To process the data, we followed steps taken by Lermo and Chavez-Garcia (1993) and Konno and Ohmachi (1998), where ambient noise (streamflow dominant) from the previous day was split up into 10 s time windows with 50% overlap. The data was then converted to the frequency domain, and spectral amplitudes were smoothed using the Konno and Ohmachi (1998) method and a bandwidth coefficient of 20. After the smoothing, the horizontal components were averaged using quadratic means, then were divided by the vertical component. The results of the H/V process are shown in Figure S4, where the solid line represents the average H/V ratio of all the time windows.

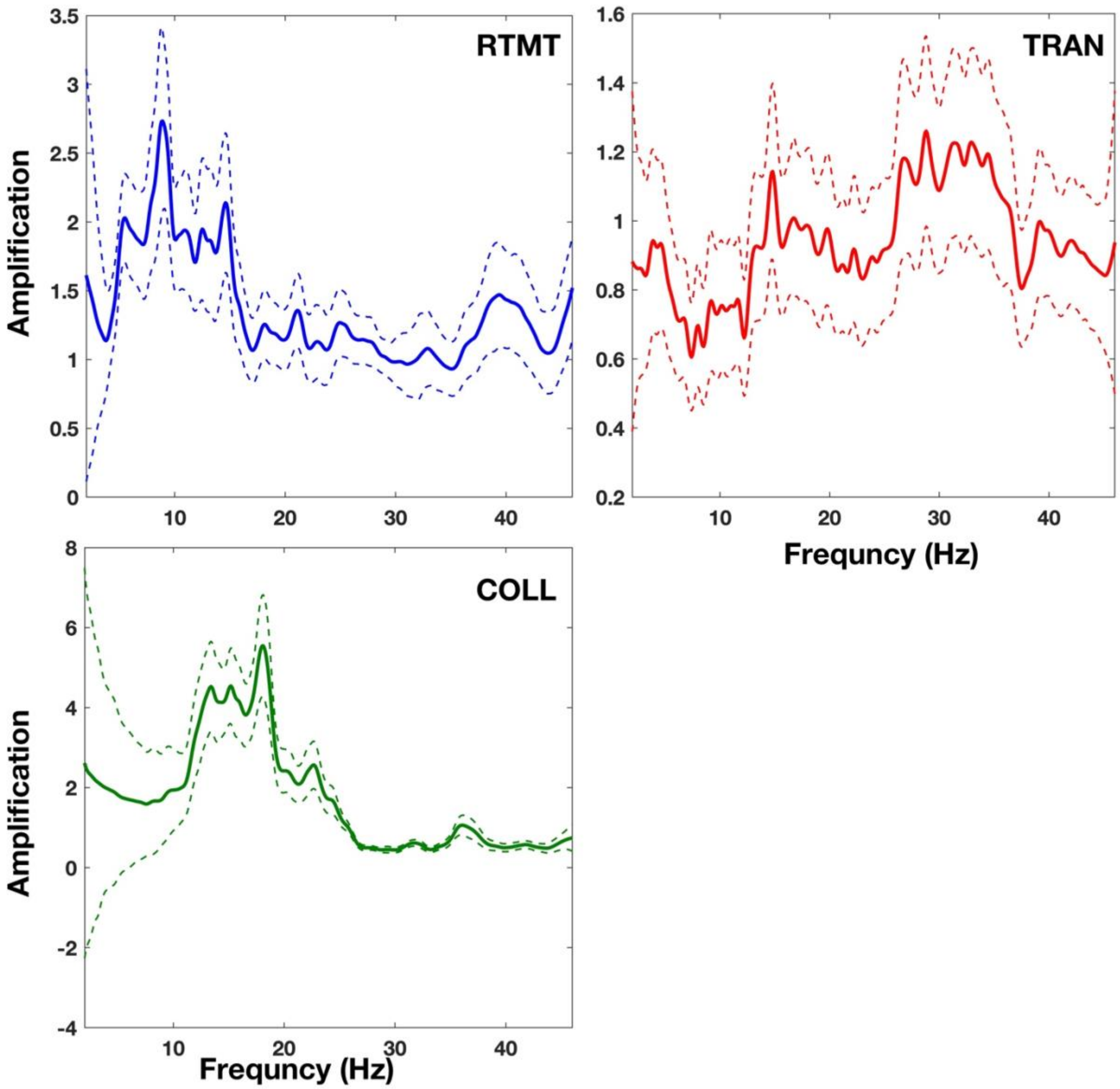

Figure S4. H/V ratios for each of the three stations along the Whangaehu channel. Solid lines represent the average H/V ratio from all computed time windows. Dashed lines represent the standard deviation of all the H/V time windows.

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