Normal Modes: Investigating Signal and Noise Phenomena Across Instrument Types and Deployment

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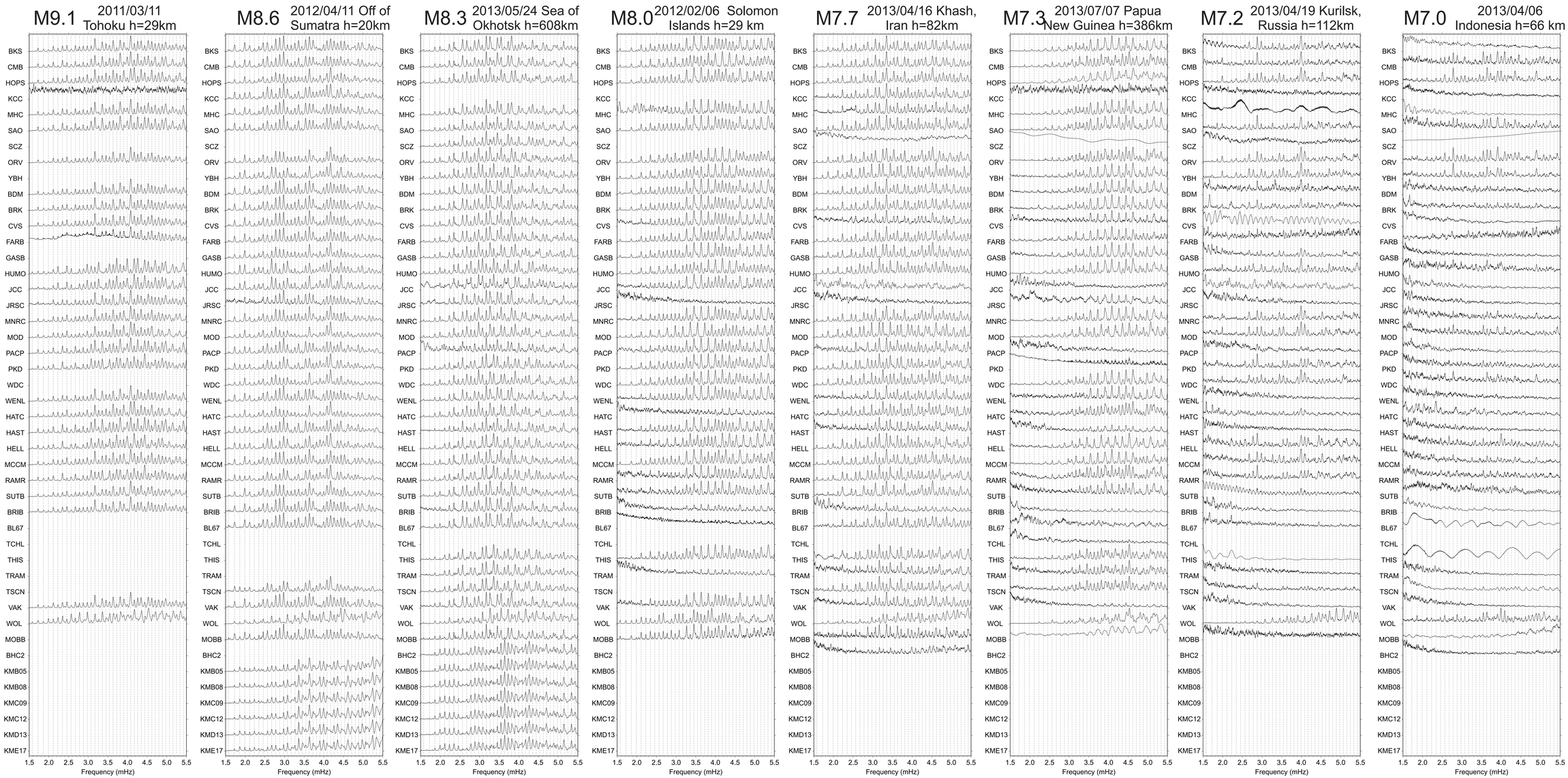
Station	Seismo-meter	Data Logger	Deployment
BKS	STS1	Q330	Tunnel
CMB	STS1	Q330	Vault
HOPS	STS1	Q330	Vault
KCC	STS1	Q330	Tunnel
MHC	STS1	Q330	Pier in buliding
SAO	STS1	Q330	Vault
SCZ	STS1	Q330	Old adit (10m)
ORV	STS1	Q330	Pier in building
YBH	STS1	Q330	Old adit (35m)
BDM	STS2	Q330	Old adit (150m)
BRK	STS2	Q330	Pier in building
CVS	STS2	Q330	Wine tunnel
FARB	STS2	Q330	Vault
GASB	STS2	Q330	Vault
HUMO	STS2	Q330	Old adit (100m)
JCC	STS2	Q330	Vault
JRSC	STS2	Q330	Vault
MNRC	STS2	Q330	Vault
MOD	STS2	Q330	Tunnel
PACP	STS2	Q330	Surface vault
PKD	STS2	Q330	Vault
WDC	STS2	Q330	Tunnel (50m)
WENL	STS2	Q330	Wine tunnel
HATC	STS2	Q330	TA vault
HAST	STS2	Q330	TA vault
HELL	STS2	Q330	TA vault
MCCM	STS2	Q330	Vault
RAMR	STS2	Q330	TA vault
SUTB	STS2	Q330	TA vault
BRIB	CMG-3T	Q330	Posthole (10m)
BL67	CMG-3T	Q330	Surface vault
TCHL	CMG-3T	DM-24	TS vault
THIS	CMG-3T	DM-24	TS vault
TRAM	CMG-3T	DM-24	TS vault
TSCN	CMG-3T	DM-24	TS vault
VAK	CMG-3T	Q330	Tunnel
WOL	CMT-3T	DM-24	Borehole (80m)
MOBB	CMG-1T	DM-24	OBS
BHC2	CMG-3T	DM-24	OB borehole (910m)
KMB05	CMG-3T	DM-24	OBS
KMB08	CMG-3T	DM-24	OBS
KMC09	CMG-3T	DM-24	OBS
KMC12	CMG-3T	DM-24	OBS
KMD13	CMG-3T	DM-24	OBS
KME17	CMG-3T	DM-24	OBS



(UCB = UC Berkeley Seismological Laboratory; GSL = Guralp Systems Ltd; JAMSTEC = Japan Agence for Marine Earth Science and Technology)

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Whether a seismic signal in a certain frequency band can be detected in a recording depends primarily on four factors: the amplitude of the signal at the site, the conditions at the site which affect the ambient noise in that band, the sensitivity and self-noise of the sensor in the band, as well as the sensitivity and self-noise in the digitizer in the band. For the very long period band, between 1.0 and 5.5 mHz, the normal modes provide an excellent signal for exploring the effects of the latter three contributions, since after a large or great earthquake, their amplitudes are similar all over the earth. In the past, observatory equipment in an observatory setting were required to observe them. We observed normal modes in the 1.0-5.5 mHz band with good signal-to-noise ratio in the aftermath of the Mw 8.3 Sea of Okhotsk deep earthquake on 24 May 2013 at many stations of the Berkeley Digital Seismograph Network and at other stations in other networks. They are equipped with a variety of sensors, including those with a flat passband extending to frequencies lower than the normal modes, and digitizers. They are also deployed in a variety of geologic settings, including cabled ocean bottom stations, MOBB in California, from the Japanese cabled "Dense Ocean-Network for Earthquake and Tsunamis (DONET)" and the IODP seafloor borehole in the south of Japan. The sites have varying physical infrastructure and site preparation. We explore the factors contributing to the observation of the normal modes at a suite of amplitudes of excitation (based on several earthquakes of different magnitudes) to give different signal-to-noise ratios, and at the many different stations.

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