Ambient noise tomography of Peninsular Malaysia: New insight to regional geological characterization

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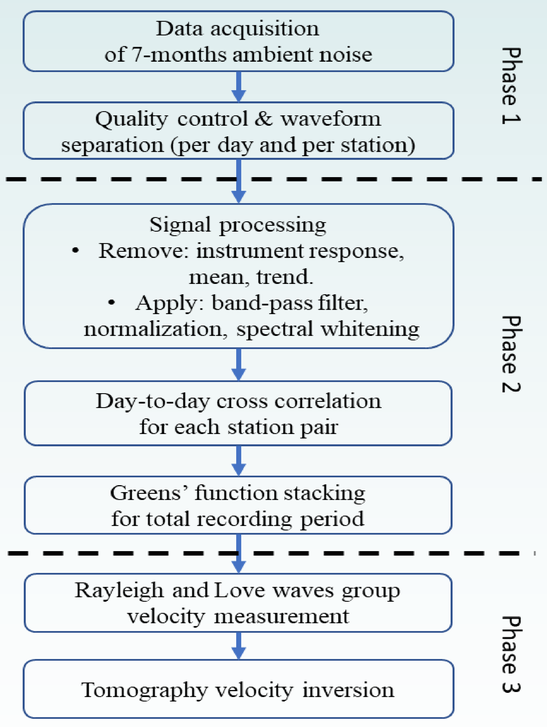
Introduction

- Subsurface tomographic analysis by incorporating surface wave group velocity travel time information derive from the interferometry of ambient noise data.
- 7-months noise data recorded from 7 weak-motion sensors located within the Peninsular Malaysia.
- Cross correlation between a long enough ambient signal will yield the surface wave dispersion signal, which reliable for the surface wave tomography analysis.
- Green's functions can be extracted and yield Rayleigh and Love waves velocity for the tomography analysis.
- Ambient noise data was processed according to procedure describe by Bensen et al., (2007)
- Dispersion analysis was conducted using multiple filter technique.
- Fast-marching method (FMM) was incorporated for arrival time's forward and inverse modelling tomographic algorithm.

Methodology



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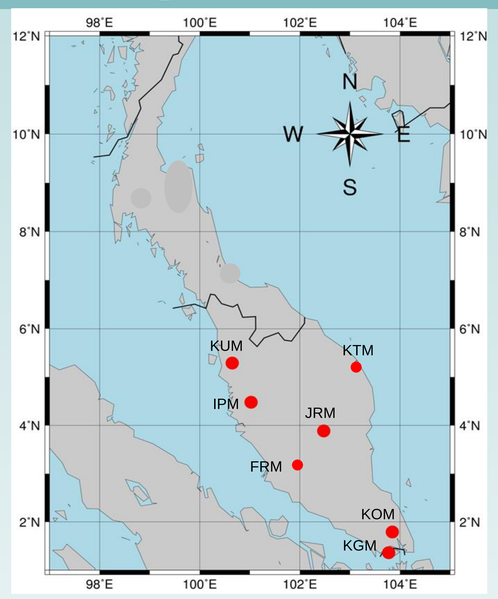
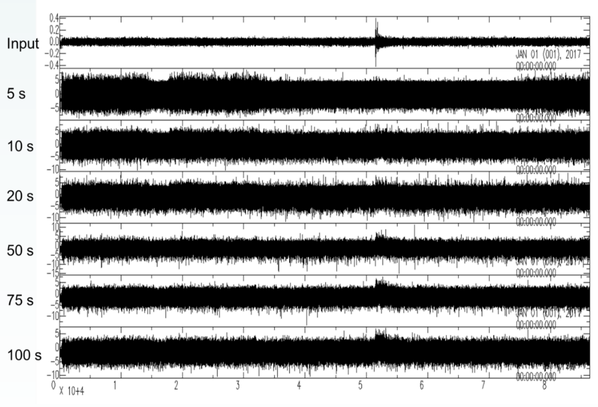
Location Map



Phase 1: Data Acquisition

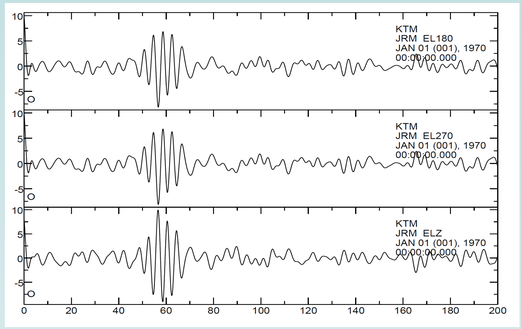
Station	IPM	KUM	KOM	JRM	KTM	FRM	KGM
%	75.6	91.6	89.2	95.8	79.3	76.1	79.3

- Amount of daily waveform that passes the quality checking (without a sudden surge of amplitude) for all seven stations use in the analysis.



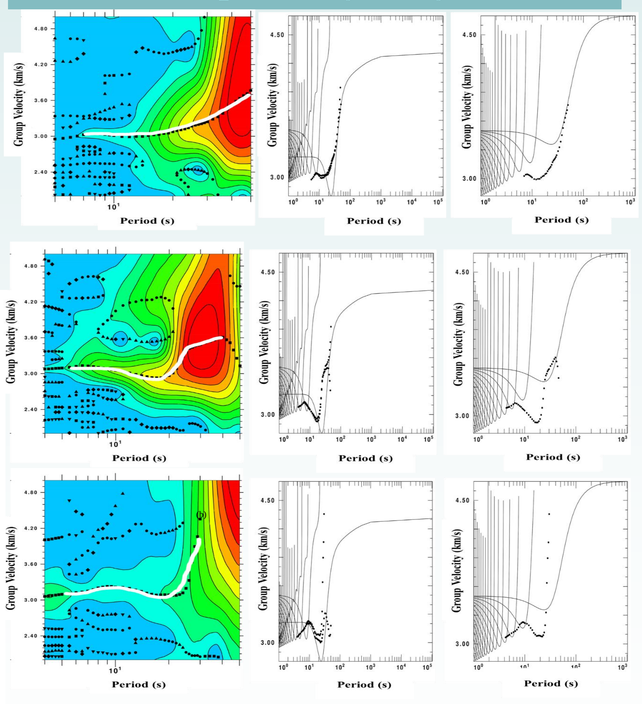
- Running absolute mean normalization (RAMN) window's test by using the input of 24-hours recording with earthquake occurrences after 5000 samples.
- Comparison between different time windows indicate that the 20 s window has the optimum normalize output.

Phase 2: Signal Processing



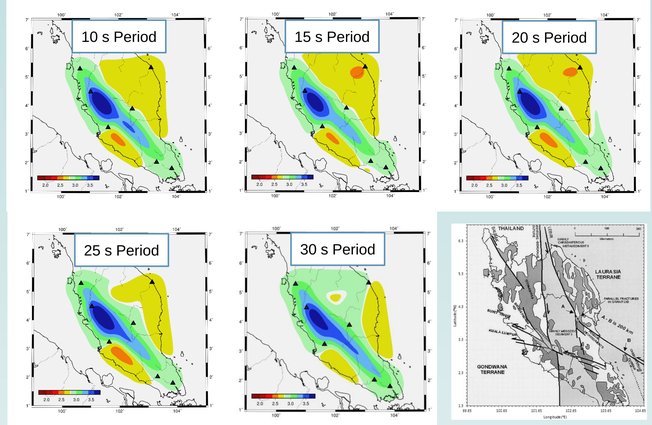
- Stack output for KTM-JRM station pairs after a 7-months cross correlation for N-S (top), E-W (middle) and vertical (bottom) components.
- The resultant waveforms shows good correlation signal which similar to an earthquake-source waveform.

Phase 3: Group Velocity Analysis



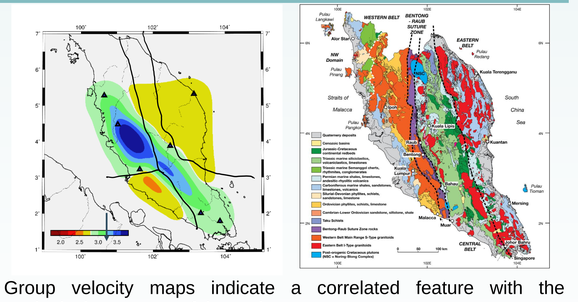
- Dispersion analysis for station pairs JRM-KOM (top), JRM-KUM (middle) and JRM-KTM (bottom).
- Using multiple filter technique, group velocity is measured as in the first column, with the corresponding group velocity comparison of Rayleigh wave (second column) and Love wave (third column).
- Travel times from one station to another are derived for the tomographic inversion analysis.

Tomography Maps



- High seismic velocity (4 km/s) recorded at the west side of Peninsular Malaysia, in between IPM and FRM stations → Attributed to the granitic block of Titiwangsa / Kledang ranges.
- Slightly slower velocity recorded near to KTM station → sudden velocity drop might due to subsurface suppression underneath the Kenyir hydro-electric dam, due to water pounding impact of large-scale water reservoir.
- Clearly and distinctive blocks separation between Sibumasu and Indochina at shorter period.
- Apparent Kuala Lumpur / Bukit Tinggi fault zone is evident as the velocity disparity is recorded nearby the FRM station → Slower velocity anomaly pass through Kuala Lumpur and Bukit Tinggi
- These findings are comparable with the surface geological map obtained from Malaysia's Mineral and Geoscience Department (MGD).

Conclusion



- Group velocity maps indicate a correlated feature with the geological structures of the region.
- Incorporation of passive seismic data can produce a 3-D subsurface geological maps through the forward and inversion solution.
- First-in-kind tomography analysis of the Malay Peninsula has provided the solution for the velocity ambiguity in the complex geological structure.
- Subsurface projection constructed from these available sources were good enough for geological interpretation that complementary the previous findings on the surface outcrop data.
- Interpretations on the various wave speed sections within the Malay Peninsula's geological belts have confirmed the rock characteristics of crust and uppermost mantle structure of the region.