University of Victoria | Graduate Studies

Notice of the Final Oral Examination for the Degree of Master of Science

of

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BSc (University of Victoria, 2014)

"Seismic Hazard Site Assessment in Kitimat, British Columbia, via Bernstein-Polynomial-Based Inversion of Surface-Wave Dispersion"

School of Earth and Ocean Sciences

Friday, December 9, 2016
8:00 A.M.
Bob Wright Centre
Room A319

Supervisory Committee:
Dr. Stan Dosso, School of Earth and Ocean Sciences, University of Victoria (Co-Supervisor)
Dr. John Cassidy, School of Earth and Ocean Sciences, University of Victoria (Co-Supervisor)
Dr. Jan Dettmer, School of Earth and Ocean Sciences, UVic (Member)

External Examiner:
Dr. Phil Cummins, Research School of Earth Sciences, Australian National University

Chair of Oral Examination:
Dr. Adam Ritz, Department of Physics and Astronomy, UVic

Dr. David Capson, Dean, Faculty of Graduate Studies

Abstract

This thesis applies a fully nonlinear Bayesian inversion methodology to estimate shear-wave velocity (V_S) profiles and uncertainties from surface-wave dispersion data extracted from ambient seismic noise. In the inversion, the V_S profile is parameterized using a Bernstein polynomial basis, which efficiently characterizes general depth dependent gradients in the soil/sediment column. Bernstein polynomials provide a stable parameterization in that small perturbations to the model parameters (basis function coefficients) result in only small perturbations to the V_S profile. The inversion solution is defined in terms of the marginal posterior probability for V_S as a function of depth, estimated using Metropolis-Hastings sampling with parallel tempering.

This methodology is validated via inversion of synthetic dispersion data as well as previously-considered data inverted using different parameterizations. The approach considered here is better suited than layered modelling approaches in applications where smooth gradients in geophysical parameters are expected, and/or the observed data are diffuse and not sensitive to fine-scale discrete layering (such as surface-wave dispersion). The Bernstein polynomial representation is much more general than other gradient-based models such that the form of the gradients are determined by the data, rather than by subjective parameterization choice.

The Bernstein inversion methodology is also applied to dispersion data processed from passive array recordings collected in the coastal community of Kitimat, British Columbia. The region is the proposed site of several large-scale industrial development projects and has great economic and environmental significance for Canada. The inversion results are consistent with findings from other geophysical studies in the region and are used in a site-specific seismic hazard analysis. The level of ground-motion amplification expected to occur during an earthquake due to near-surface VS structure is probabilistically quantified, and predicted to be significant compared to reference (hard ground) sites.