Electronic Supplement to

THE FIRST EARTHQUAKE SITE ASSESSMENTS IN ALBERTA, CANADA

By Joseph J. Farrugia
Table S1 – Geographic coordinates for seismic station sites visited during the July 2016 fieldwork site characterization campaign.

<table>
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<tr>
<th>Station</th>
<th>Degrees Latitude</th>
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Figure S1 – Fundamental mode dispersion curve procedure for station EDM. (a-b) HRFK dispersion histograms of utilized array apertures and corresponding dispersion picks (black rings); (c) Interpreted fundamental mode dispersion estimates (grey circles).

Figure S2 – Fundamental mode dispersion curve procedure for station HON. MSPAC-based phase velocity-frequency histograms (a) with symbols corresponding to the ring size, r; (b-d) HRFK dispersion histograms of utilized array apertures and corresponding dispersion picks (black rings); (e) Interpreted fundamental mode dispersion estimates (grey circles).
Figure S3 – Fundamental mode dispersion curve procedure for station PER. (a-c) HRFK dispersion histograms of utilized array apertures and corresponding dispersion picks (black rings); (d) Interpreted fundamental mode dispersion estimates (grey circles).

Figure S4 – Fundamental mode dispersion curve procedure for station RDEA. MSPAC-based phase velocity-frequency histograms (a) with symbols corresponding to the ring size, r; (b-d) HRFK dispersion histograms of utilized array apertures and corresponding dispersion picks (black rings); (e) Interpreted fundamental mode dispersion estimates (grey circles).
Figure S5 – Fundamental mode dispersion curve procedure for station RW2. (a) HRFK dispersion histogram of utilized array aperture and corresponding dispersion picks (black rings); (b) Interpreted fundamental mode dispersion estimates (grey circles).

Figure S6 – Fundamental mode dispersion curve procedure for station RW3. MSPAC-based phase velocity-frequency histograms (a) with symbols corresponding to the ring size, r; (b-d) HRFK dispersion histograms of utilized array apertures and corresponding dispersion picks (black rings); (e) Interpreted fundamental (grey circles) and higher mode (grey squares) dispersion estimates.
Figure S7 – Fundamental mode dispersion curve procedure for station SNUFA. (a-c) HRFK dispersion histograms of utilized array apertures and corresponding dispersion picks (black rings); (d) Interpreted fundamental mode dispersion estimates (grey circles).

Figure S8 – Fundamental mode dispersion curve procedure for station STPRA. MSPAC-based phase velocity-frequency histograms (a) with symbols corresponding to the ring size, r; (b-c) HRFK dispersion histograms of utilized array apertures and corresponding dispersion picks (black rings); (d) Interpreted fundamental mode dispersion estimates (grey circles).
**Figure S9** – Fundamental mode dispersion curve procedure for station SWHSA. MSPAC-based phase velocity-frequency histograms (a) with symbols corresponding to the ring size, r; (b-c) HRFK dispersion histograms of utilized array apertures and corresponding dispersion picks (black rings); (d) Interpreted fundamental mode dispersion estimates (grey circles).

**Figure S10** – Fundamental mode dispersion curve procedure for station TD06A. MSPAC-based phase velocity-frequency histograms (a) with symbols corresponding to the ring size, r; (b) HRFK dispersion histogram of utilized array aperture and corresponding dispersion picks (black rings); (c) Interpreted fundamental mode dispersion estimates (grey circles).
Figure S11 – Fundamental mode dispersion curve procedure for station TD007. (a-c) HRFK dispersion histograms of utilized array apertures and corresponding dispersion picks (black rings); (d) Interpreted fundamental mode dispersion estimates (grey circles).

Figure S12 – Fundamental mode dispersion curve procedure for station TD008. MSPAC-based phase velocity-frequency histograms (a) with symbols corresponding to the ring size, r; (b) Interpreted fundamental mode dispersion estimates (grey circles).
**Figure S13** – Fundamental mode dispersion curve procedure for station TD13A. (a-b) HRFK dispersion histograms of utilized array apertures and corresponding dispersion picks (black rings); (c) Interpreted fundamental mode dispersion estimates (grey circles).

**Figure S14** – Fundamental mode dispersion curve procedure for station TD028. (a-b) HRFK dispersion histograms of utilized array apertures and corresponding dispersion picks (black rings); (c) Interpreted fundamental mode dispersion estimates (grey circles).
Figure S15 – Fundamental mode dispersion curve procedure for station TD029. MSPAC-based phase velocity-frequency histograms (a) with symbols corresponding to the ring size, r; (b-c) HRFK dispersion histograms of utilized array apertures and corresponding dispersion picks (black rings); (d) Interpreted fundamental mode dispersion estimates (grey circles).

Figure S16 – Fundamental mode dispersion curve procedure for station TONYA. MSPAC-based phase velocity-frequency histograms (a) with symbols corresponding to the ring size, r; (b-d) HRFK dispersion histograms of utilized array apertures and corresponding dispersion picks (black rings); (e) Interpreted fundamental mode dispersion estimates (grey circles).
Figure S17 – Interpreted simplified $V_s$ profiles for 23 wells with DSI logs.
Figure S18 – EDM dispersion curve inversion results. (a) Empirical dispersion estimates (black circles) and the corresponding minimum misfit dispersion curve models for the 1 and 2 layer parameterizations; (b) Corresponding $V_s$-depth profiles and potential resolution limit (dashed black line).
Figure S19 – Calculated $V_{S_{avg}}$ profiles with $V_{S30}$-based NBCC Site Class divisions (B, C, D, and E) for station EDM.
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Figure S21 – Calculated $V_{Savg}$ profiles with $V_{S30}$-based NBCC Site Class divisions (B, C, D, and E) for station HON.
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Figure S23 – Calculated $V_{\text{Savg}}$ profiles with $V_{S30}$-based NBCC Site Class divisions (B, C, D, and E) for station RDEA.
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Figure S25 – Calculated $V_{S\text{avg}}$ profiles with $V_{S30}$-based NBCC Site Class divisions (B, C, D, and E) for station RW3.
Figure S26 – SNUFA dispersion curve inversion results. (a) Empirical dispersion estimates (black circles) and the corresponding minimum misfit dispersion curve models for the 1 and 2 layer parameterizations; (b) Corresponding $V_S$-depth profiles and potential resolution limit (dashed black line).
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Figure S28 – STPRA dispersion curve inversion results. (a) Empirical dispersion estimates (black circles) and the corresponding minimum misfit dispersion curve models for the 1 and 2 layer parameterizations; (b) Corresponding $V_s$-depth profiles and potential resolution limit (dashed black line).
Figure S29 – Calculated $V_{\text{avg}}$ profiles with $V_{S30}$-based NBCC Site Class divisions (B, C, D, and E) for station STPRA.
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Figure S31 – Calculated $V_{S_{avg}}$ profiles with $V_{S30}$-based NBCC Site Class divisions (B, C, D, and E) for station SWHSA.
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Figure S33 – Calculated $V_{\text{avg}}$ profiles with $V_{S30}$-based NBCC Site Class divisions (B, C, D, and E) for station TD028.
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Figure S35 – Calculated $V_{\text{Savg}}$ profiles with $V_{S30}$-based NBCC Site Class divisions (B, C, D, and E) for station PER.
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Figure S37 – Calculated $V_{S_{avg}}$ profiles from Rayleigh-wave ellipticity-inversion results in Figure S36b with $V_{S30}$-based NBCC Site Class divisions (B, C, D, and E) for station RW2. The 1 power law over half-space and 2 uniform layers over half-space models displayed in this figure are not consistent with $V_S$ profiles determined through dispersion-inversion, thus were omitted when calculating $V_{S_{avg}}$ for RW2.
Figure S38 – RW2 dispersion curve inversion results. (a) Empirical dispersion estimates (black circles) and the corresponding minimum misfit dispersion curve models for the 1 and 2 layer parameterizations; (b) Corresponding $V_s$-depth profiles and potential resolution limit (dashed black line).
Figure S39 – Calculated $V_{\text{Savg}}$ profiles from dispersion curve inversion results in Figure S38b with $V_{S30}$-based NBCC Site Class divisions (B, C, D, and E) for station RW2.
Figure S40 – TD007 joint-inversion results. (a) Empirical dispersion estimates (black circles) and the corresponding minimum misfit dispersion curve models for the 1 and 2 layer parameterizations; (b) Measured mHVSR curve (black circles) and the corresponding optimal model solutions for 1 and 2 layer parameterizations. The grey shaded region is ±1 standard deviation; (c) Corresponding $V_S$-depth profiles.
Figure S41 – Calculated $V_{S\text{avg}}$ profiles with $V_{S30}$-based NBCC Site Class divisions (B, C, D, and E) for station TD007.
Figure S42 – TD008 joint-inversion results. (a) Empirical dispersion estimates (black circles) and the corresponding minimum misfit dispersion curve models for the 1 and 2 layer parameterizations; (b) Measured mHVSR curve (black circles) and the corresponding optimal model solutions for 1 and 2 layer parameterizations. The grey shaded region is ±1 standard deviation; (c) Corresponding Vs-depth profiles.
Figure S43 – Calculated $V_{\text{Savg}}$ profiles with $V_{S30}$-based NBCC Site Class divisions (B, C, D, and E) for station TD008.
Figure S44 – TD029 joint-inversion results. (a) Empirical dispersion estimates (black circles) and the corresponding minimum misfit dispersion curve models for the 1 and 2 layer parameterizations; (b) Measured mHVSR curve (black circles) and the corresponding optimal model solutions for 1 and 2 layer parameterizations. The grey shaded region is ±1 standard deviation; (c) Corresponding $V_s$-depth profiles.
Figure S45 – Calculated $V_{S_{avg}}$ profiles with $V_{S30}$-based NBCC Site Class divisions (B, C, D, and E) for station TD029.
Figure S46 – TD06A joint-inversion results. (a) Empirical dispersion estimates (black circles) and the corresponding minimum misfit dispersion curve models for the 1 and 2 layer parameterizations; (b) Measured mHVSR curve (black circles) and the corresponding optimal model solutions for 1 and 2 layer parameterizations. The grey shaded region is ±1 standard deviation; (c) Corresponding $V_S$-depth profiles.
Figure S47 – Calculated $V_{savg}$ profiles with $V_{s30}$-based NBCC Site Class divisions (B, C, D, and E) for station TD06A.
Figure S48 – TD13A joint-inversion results. (a) Empirical dispersion estimates (black circles) and the corresponding minimum misfit dispersion curve models for the 1 and 2 layer parameterizations; (b) Measured mHVSR curve (black circles) and the corresponding optimal model solutions for 1 and 2 layer parameterizations. The grey shaded region is ±1 standard deviation; (c) Corresponding $V_S$-depth profiles.
Figure S49 – Calculated $V_{S\text{avg}}$ profiles with $V_{S30}$-based NBCC Site Class divisions (B, C, D, and E) for station TD13A.
Figure S50 – TONYA joint-inversion results. (a) Empirical dispersion estimates (black circles) and the corresponding minimum misfit dispersion curve models for the 1 and 2 layer parameterizations; (b) Measured mHVSР curve (black circles) and the corresponding optimal model solutions for 1 and 2 layer parameterizations. The grey shaded region is ±1 standard deviation; (c) Corresponding $V_S$-depth profiles.
Figure S51 – Calculated $V_{\text{savg}}$ profiles with $V_{30}$-based NBCC Site Class divisions (B, C, D, and E) for station TONYA.
Figure S52 — Earthquake and microtremor station-average horizontal-to-vertical spectral ratios ($eHVSR$s and $mHVSR$s, respectively). A * indicates sensor coupling issues during ambient vibration testing at that station site.
Figure S52 Continued
Figure S53 — (a) Difference between local maxima ($A_{peak}$) observed in the $H/V_{SR}$ and the bandwidth mean of the $H/V_{SR AVG}$ plotted versus peak frequency ($f_{peak}$) for up to two local maxima for each site (circles). Squares represent the binned average with ±1 standard deviation and the dashed line is the average of $A_{peak} - H/V_{SR AVG}$ for all data points; (b) Histogram of data points shown in (a) with the average of $A_{peak} - H/V_{SR AVG}$ shown as a dashed line at roughly 0.2.
Figure S54 — Procedure for determining $f_{\text{peak}}$ from $e\bar{HVSRS}$ (solid black line) for two sample stations. The dashed line represents the bandwidth average ($\bar{HVSRS}_{AVG}$); (a, d) Identified local maxima (inverted triangles); (b, e) Significant peaks (squares) with amplitudes greater than $\bar{HVSRS}_{AVG} + 0.2$ and greater than 0.3 units overall; (c, f) Fitted Gaussian function [see equations (5) and (6); small white circles] and $f_{\text{peak}}$ estimate (large circle). For station LGPLA there is one peak that meets the significant peak criteria, whereas for station TD08A two significant peaks are identified with no discernible trough between them; they are fit with a single Gaussian curve.
Figure S55 — (a, c, e) Examples of station-event distance dependency in $\bar{eHVSR}$s at frequencies greater than 10 Hz for eight equally spaced distance bins with ±1 standard deviations; (b, d, f) Corresponding station and event locations (triangle and circles, respectively).
**Figure S56** — (a) calculated SRI amplifications of four individual model parameterizations (see legend; LOH = layers over half-space) for station TD002; (b) $V_s$ profile of the top 50 m; (c) $V_s$ profile of the top 2 km.