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Dominant strike-slip faulting and near-constant stress drop of induced earthquakes in the Kiskatinaw area, northeastern British Columbia, Canada

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An increasing number of hydraulic fracturing (HF) operations in low-permeable tight shales in the Kiskatinaw area, northeastern British Columbia, have been associated with M3+ earthquakes in the last decade, including a M_L 4.5 on 11/30/2018 near Dawson Creek. Here, we use a catalog of 8285 events ranging from magnitude ML -0.5 to 4.5 between July 2017 and July 2020 to investigate their source parameters. We identify event families using waveform cross-correlation and event temporal correlation, and estimate the focal mechanism solutions (FMS) of the highest-magnitude event within each family using the probabilistic earthquake source inversion framework *Grond*. We also estimate FMS for events with a magnitude larger than M_L 2.5 that do not belong to a family (independent events). We compile a FMS catalog using the robustly constrained solutions for the largest events, and associate all smaller earthquakes with a cross-correlation coefficient (CCC) > 0.8 with the corresponding FMS. In addition, we estimate seismic moment and static stress drop values using spectral fitting methods on both single spectra and spectral ratios, and investigate their scaling relations.

In total, we constrain 65 FMS, of which 53 are clustered events, and the remaining 12 are independent events. An additional 4255 events have a CCC > 0.8 with one of the constrained FMS and are listed accordingly in the catalog. Of the total 4320 FMS, 93% are strike-slip events with one nodal plane at low angles to S_H, 3% are dominantly strike-slip with thrust-faulting components, and the remaining 4% have a dominantly thrust-faulting mechanisms perpendicular to $S_{H.}$ The thrust-style events comprise the relatively larger magnitudes contained in the catalog, and may indicate slip on pre-existing faults. Most strike-slip events are part of an event family with multiple matching waveforms, while most thrust-faulting events are isolated with a low number of matching waveforms.

We fit the spectral corner frequency of 2360 P-phases and 1981 S-phases using single spectra estimates, and 1031 P-phases and 919 S-phases using the spectral ratios. While results from spectral ratios suggest a roughly constant stress drop of ~1 MPa for all magnitudes, the constant

stress drop trend from single spectrum fitting breaks down at magnitudes smaller ~ M_L 2.0, as has commonly been observed for events recorded by surface stations. We do not observe significant dependence of stress-drop values with the faulting style, nor with event depth.