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Latent seismicity driven by aseismic creep and enhanced pore-fluid pressure in NE British Columbia

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The global pandemic of COVID-19 furnished an opportunity to study seismicity in the Kiskatinaw area of British Columbia, noted for hydraulic-fracturing induced seismicity, during a period of anthropogenic quiescence. A total of 389 events were detected from April to August 2020, encompassing a period with no hydraulic-fracturing operations during a government-imposed lockdown. During this time period, observed seismicity had a maximum magnitude of M_L 1.2 and lacked temporal clustering that is often characteristic of hydraulic-fracturing induced sequences. Instead, seismicity was persistent over the lockdown period, similar to swarm-like seismicity with no apparent foreshock-aftershock type sequences. Hypocenters occurred within a corridor orientated NW-SE, just as seismicity had done in previous years in the area, with focal depths near the target Montney formation or shallower (<2.5 km). Based on the Gutenberg-Richter relationship, we estimate that a maximum of 21% of the detected events during lockdown may be attributable to natural seismicity, with a further 8% possibly due to dynamic triggering of seismicity from teleseismic events. The remaining ~70% cannot be attributed to direct pore pressure increases induced by fluid injection, and therefore is inferred to represent latent seismicity i.e. seismicity that occurs after an unusually long delay following primary activation processes, with no obvious triggering mechanism. We can exclude pore-pressure diffusion from the most recent fluid injection, as is there is no clear pattern of temporal or spatial seismicity migration. If elevated pore pressure from previous injections became trapped in the subsurface, this could explain the localization of seismicity within an operational corridor, but it does not explain the latency of seismicity on a timescale of months. However, aseismic creep on weak surfaces such as faults, in response to tectonic stresses, in addition to trapped elevation pore-pressure could play a role in stress re-loading to sustain the observed pattern of seismicity.