Seismic hazard implications of ETS - no canary in the gold mine yet

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The mechanism of ETS episodes remains inscrutable, but the tectonic implications are becoming clear. Slip is accumulating unsteadily on megathrust faults in the region downdip of their locked zones, and perhaps the volume above the megathrust is also deforming. Similar but less frequent tremor is seen beneath some strike-slip faults.

ETS deformation is bound to encourage earthquakes in the shallower locked portion of the faults, but the salient question is by how much. This question does not yet have a final answer, but I will guess here it is not by much. I'll use the Cascadia megathrust as an example because it runs directly beneath my backyard.

The limit on current probability gain is that ETS is active under Seattle 4% or 1/25th of the time. Since we expect to have M9 earthquakes every 500 years or so, the danger of an M9 only rises from 1/25,000 to at most 1/1000 during the weeks with tremor, which is not enough to justify extra hazard mitigation steps during tremor.

The probability gain is probably even less. A great Cascadia earthquake is expected to rupture across several megathrust segments with distinct tremor cycles, and we do not know in which segment such an earthquake would nucleate (Brudzinski). Thus, tremor just downdip of the Cascadia locked zone is active more than 4% of the time, reducing the probability gain.

Another factor working against tremor triggering quakes is the low stresses inferred for ETS deformation in combination with the possibility that subduction earthquakes might not start adjacent to regions slipping in ETS. It is more likely that earthquakes trigger tremor than the converse. Also, empirically, we have not seen a clear coincidence of earthquakes with ETS episodes, with the caveat that very large earthquakes in well-instrumented areas are scarce (Schwartz).

ETS can inform hazard mitigation, however. Tremor might provide a legible marker for the down-dip limit of the locked portion of megathrusts - such an interpretation for Cascadia brings the rupture zones of the dreaded M9 1700AD-repeat event alarmingly close to Puget Sound with Tacoma and Seattle (Wong). This interpretation is now being checked against geodetic data (Melbourne).

Also, spatiotemporal patterns that are heretofore unsuspected might emerge to show which tremor signals sensational increases in large earthquake probabilities - maybe tremor is louder or migrates closer to locked asperities later in the seismic cycle, maybe downdip slow slip even starts the process of great earthquakes, as has been suggested for the 1960 Chile earthquake. Maybe fluids are involved in tremor, migrate far enough up the megathrust fault plane to directly loosen locked zones, and do so in a distinctive way.

For these reasons, ETS requires intense scrutiny so we can unravel the mechanics of ETS and the connection between the locked, ETSing, and steadily deforming regions, but the timing of ETS is not yet known to meaningfully modulate earthquake risk.