Spatial changes in inclusion band spacing as an indicator of temporal changes in slow earthquake recurrence intervals

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Repeated slow earthquakes downdip of the seismogenic zones may trigger megathrust earthquakes by transferring stress to the seismogenic zones. Geodetic observations have suggested that the recurrence intervals of slow earthquakes decrease toward a next megathrust earthquake. However, the temporal variation in recurrence intervals of slow earthquakes during megathrust earthquake cycles remains poorly understood due to the limited duration of geodetic and seismological monitoring of slow earthquakes. The quartz-filled, crack-seal shear veins in the subduction mélangé deformed near the downdip limit of seismogenic zone in warm-slab environments record the cyclic changes in the inclusion band spacing in the range of 5–65 μm. The two-phase primary fluid inclusions in quartz between inclusion bands show various vapor/liquid ratios regardless of inclusion band spacing, suggesting a common occurrence of fast quartz sealing due to a rapid decrease in quartz solubility associated with a large fluid pressure reduction. A kinetic model of quartz precipitation, considering a large fluid pressure change and inclusion band spacings, indicates that the sealing time during a single crack-seal event cyclically decreased and increased in the range of 0.2–2.7 years, with minimum one cycle duration estimated to be 31–93 years. The ranges of sealing time and one cycle duration may be comparable to the recurrence intervals of slow earthquakes and megathrust earthquakes, respectively. We suggest that the spatial change in the inclusion band spacing is a potential geological indicator of the temporal changes in slow earthquake recurrence intervals, particularly when large fluid pressure reduction occurred by brittle fracturing.