

## Rectified tidal loading: Control on earthquakes manifested by deep tremors

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Earthquakes occur due to plate motion, but it remains unclear as to what controls the plate motion. A clue to this problem is provided by a recently discovered cluster of deep tectonic tremors or tiny earthquakes that are occurring in western Japan. Here we demonstrate that tremor activity is strongly correlated with tide levels observed at a nearby station. The correlation is interpreted as representing a nonlinear relationship between stress and slip, which is similar to the rate-dependent friction law. An empirical relationship and observed tide records explain the temporal changes in tremor activity over a period of nine years. The nonlinear fault rheology rectifies oscillating tidal stress and amplifies small changes in tidal amplitude. This mechanism of rectified tidal loading may control temporal changes in plate motion and earthquake occurrence. Remarkably, the background seismicity in the present study area matches the predicted tremor rate obtained from tidal observations over the past 50 years. This mechanism may also explain the weak periodicity of large earthquakes, and is likely to be helpful in probabilistic forecasting of future seismicity.

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