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Statistical analysis of tidal effect on non-volcanic earthquake swarm activity in Wakayama Prefecture, southwest Japan

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Earthquakes occur when the fault stress accumulates to the critical level. External forces such as tidal forces may contribute to the triggering of earthquakes reaching the critical state. For example, in the case of 2011 Tohoku Earthquake, it is reported that there is a correlation between tidal forces and the earthquakes prior to the mainshock. Earthquakes with smaller magnitude are also affected by tidal forces and expected to show correlation with tidal forces.

Tidal triggering of non-volcanic seismic swarm has not been well documented. So, we choose the Wakayama Prefecture as a targeting region. The cause of the earthquakes occurring in the region is considered to be the presence of the water below the seismogenic depth. The swarm activity continues from 1980s. We analyzed the shallow earthquakes in the northern part of Wakayama Prefecture from 1998 to 2016. We used statistical method called Schuster test to analyze correlation between earthquakes and tidal stress.

The result of the analysis shows that the earthquakes have a correlation with tidal forces which have the periodicity near the half of the lunar day and the amplitude of the seismicity-rate variation is about 16% of the average earthquake frequency. Correlation between the earthquakes and tidal forces is stronger at the periods when larger number of earthquakes occur. From tidal stress calculation, it is found that both solid tide and oceanic tide are important at this region. This study confirms that most of the earthquakes larger than M_w 4 in the region occur in the rising period of tidal normal stress or just after the maximum of tidal normal stress. Therefore, tidal observation gives information about the criticality of rocks and temporal heterogeneity of the earthquake occurrence.