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# Insights from Seismicity, Hydrology, and Displacement Relationships in the Eastern Tennessee Seismic Zone

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Causes of seismicity in the eastern Tennessee seismic zone (ETSZ), the second most active intraplate seismic zone in the U.S.A., remain unclear. Hydroseismicity posits that intraplate seismic events result from surface-driven pore-fluid pressure transients triggering failure in pre-stressed crust. Alternative explanations to hydrology-seismicity correlations invoke crustal loading. Seismic strain (the square root of energy) in the ETSZ was evaluated for relationships with river discharge using 1,580 seismic events from 1977 to 2015 located within the 55,430 $km^2$ watershed of a Tennessee River streamgage near Chattanooga. Calculating and comparing long-term residual time series using monthly totals for discharge, strain, and vertical displacement (with improved methods for the latter), previous results (which used daily interpolated values) are both clarified and contradicted; while previous findings of anti-correlation between strain and discharge are reconfirmed (albeit with a weaker relationship here, r = -0.34), previous findings regarding displacement are challenged in that no obvious relationship is found between displacement and either of strain and discharge in the ETSZ for the long-term series, with negligible improvements obtained via cross-correlation (r = -0.42 when discharge leads strain by $\sim$2 years). From 2008 (when displacement data begin) to 2015, displacement is found to correlate positively with discharge (r = 0.23) and negatively with strain (r = -0.25); yet, for residual and non-residual seasonal (i.e. monthly) averages, respectively, discharge and strain negatively correlate (r = -0.28, -0.10) as do strain and displacement (r = -0.44, -0.97), with no clear relationship found between discharge and displacement (r = -0.01, 0.21). However, the absolute extrema of cross-correlation of non-residual seasonal averages show discharge leading strain (r = 0.46) and displacement (r = -0.56) by $\sim$6 months. One possible explanation for the differences between the long-term and short-term series is that in the long-term, lower discharge could correspond to lower groundwater levels and thus greater subsidence; another is that displacement due to crustal loading could occur in an east-west or north-south direction rather than vertically. A third option is that rates of change of discharge or displacement control seismicity; however, first derivatives of monthly averages did not reveal any obvious patterns. Finally, displacement data may be too short to be meaningful. Overall, the results still suggest that hydroseismicity is an implausible control on seismicity in the ETSZ, but evidence for the crustal loading hypothesis, which was previously suggested to be a controlling factor on seismicity in the ETSZ, remains inconclusive and requires further research.