

Project 07061 Final Report

A Controlled Test of the LURR Hypothesis And its Implications for the Physics behind Accelerated Moment Release

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This project was undertaken during a time period when there was considerable discussion about the validity of the LURR procedure for prediction of large earthquakes, an idea put forth by Chinese researchers. Although our previous work had demonstrated, at least to our satisfaction, that the method lacked the robust statistical strength necessary in order to be taken seriously as an earthquake prediction tool, there remained enough controversy in the field, together with at least one new Chinese claim of a successful prediction, that we decided to revisit the problem with a set of large shallow earthquakes that had occurred in regions where tidal stresses, including ocean loading, should have been large enough to produce a noticeable effect. We began the effort by looking carefully at the two most critical features of the LURR method, the selection of events from catalogs, and the calculation of tidal stresses.

Previous LURR post-prediction studies had utilized seismicity in circular regions of fixed radius, typically 100km, centered on the epicenter of the large earthquake at which the post-prediction effort was directed. As we studied the catalogs of seismicity two critical issues emerged. First, the size of the region considered and the criterion for choosing it, and second the impact of including all seismicity in each catalog versus using declustered catalogs in which an attempt is made to remove aftershocks.

In studying the catalogs it became clear that small changes in the size of the region considered could have large effects on the results, because the inclusion of a single moderate earthquake near the boundary of the region could totally control the LURR result, particularly when the measure of activity depended on the magnitude of the of each earthquake. We thought we might address this problem by using an objective method to choose the region for which the seismicity would be analyzed, and had thus decided to use the accelerated moment release technique to define both the dimensions and the shape of the region for analysis. Although it is an objective method to choose the region, it carries with its own set of assumptions that would need to be defended, and it does not necessarily solve the problem of isolated events occurring near the boundary of the selected region. In the LURR case where the measure of activity used is the number of earthquakes occurring without consideration of their magnitude, it became clear that some sort of declustering would have to be used to eliminate the aftershocks related to the moderate earthquakes which seem to control the LURR results. Experimenting with different ideas for declustering showed that again, the LURR result would depend strongly on the assumptions made in data analysis.

With regard to tidal stresses, our work indicated that for shallow earthquakes, at which the LURR method is directed, the stress from ocean tide loading significantly exceeds that of the solid Earth tides, because the ocean load is a surface load whereas the solid tide is a body force distributed from the surface to the center of the Earth. Furthermore, the ocean tides exhibit local dynamic effects including significant amplitude and phase

variations. A separate problem arises for oceanic earthquakes and near coastal events, which includes all of the candidate earthquakes we proposed to use. It appears that existing stress calculations due ocean tide loading are not valid within the loaded region, which includes all the oceanic earthquakes in our sample. In addition, the sharp gradients and bending effects just outside the ocean loaded region may not be adequately handled with existing ocean loading software, which would be a concern for all the other events we would have liked to include in the study.

As we considered the various uncertainties and problems associated with this study we concluded that no matter what our result, even if it turned out to be negative, it was unlikely to provide a convincing conclusion either confirming the LURR hypothesis or denying it. As a result, it appeared that with the effort we had proposed, we would be unable to present a significant conclusion to the study, and hence abandoned it in favor of more productive efforts.