COMPARING TESTS FOR STATIC STRESS TRIGGERING USING AFTERSHOCK SEQUENCES

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1 Abstract

Over the past several years, many investigators have argued that static stress changes caused by large earthquakes influence the spatial and temporal distributions of subsequent regional seismicity, with earthquakes occurring preferentially in areas of stress increase and reduced seismicity where stress decreases. Some workers have developed quantitative methods to test for the existence of such static stress triggering, but no firm consensus has yet been reached as to the significance of these effects. We have developed a new test for static stress triggering in which we compute the change in Coulomb stress on the focal mechanism nodal planes of a set of events spanning the occurrence of a large earthquake. We compare the statistical distributions of these stress changes for events before and after the mainshock to decide if we can reject the hypothesis that these distributions are the same; such rejection would be evidence for stress triggering. We have applied this test to the 24 November 1987 Elmore Ranch/Superstition Hills (ERSH) earthquake sequence and find that those post-mainshock events that experienced stress increases of at least 10–30 kPa (0.1–0.3 bar) or that occurred from 1.4–2.8 years after the mainshocks are consistent with having been triggered by mainshock-generated Coulomb static stress changes.

Several statistical methods have been developed to look for static stress triggering and have been applied to multiple events; these experiments have yielded mixed results, with triggering appearing to play a significant role following several recent large earthquake, but not following others. Multiple natural and artificial factors contribute to this scatter, but the relative magnitudes of such effects is as yet unclear. We have worked to quantify one such effect, catalog selection. We select two different catalogs of events surrounding the 1987 ERSH events, subsample these with different minimum distance to the mainshock fault, study region size, and limits on acceptable focal mechanism uncertainty, and apply our new statistical method to determine the significance of stress triggering in these subcatalogs. We find a factor of three difference in minimum stress threshold required for triggering using two different master catalogs, but that results are remarkably insensitive to master catalog subsampling. This might indicate that the scatter in stress triggering test results is not primarily due to the effects of catalog selection, but at this stage, with only a single set of experiments on a single event sequence, general conclusions are unwarranted.