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Temporal Evolution of Seismicity around the hypocenter of the 23 October 2011 Van earthquake deduced from seismic b-value estimates, Eastern Anatolia

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The October 23th, 2011 Van earthquake (Mw 7.1), eastern Anatolia, significantly affected the stress state, lowered the general shear stress and increased complexity in the focal area. This research reports on the detection of seismic b-values, temporal variation by statistical assessment of large groups of aftershocks (≈6000 events) from KOERI catalogue 2011-2012, Turkey, to achieve high-quality results and show the stress state.

Temporal variations in b values illustrate significant seismic variability for different intervals. The resulted variation of the b value exhibits two dramatic changes in the b value, one (b > 1) during the first 100 days of the mainshock, and the other (b < 1) in the last 70 days of the mainshock. The constant b (b=1) indicates a seismically active time interval and a transitional variation in the b-value. High b-values suggest that a large number of the small or same-sized aftershocks of the Van event are dominant and correlated with lowering the effective stress level. This indicates increased material heterogeneity and reduced shear stress.

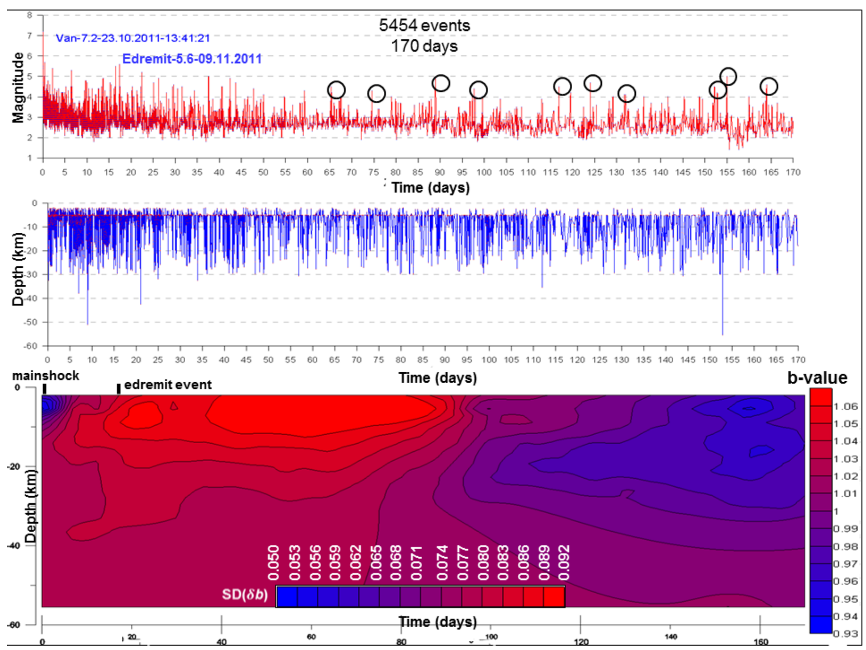

Figure 1: Temporal Evolution of Seismicity with b-value estimates

The magnitude characteristics of the aftershocks, including the high b-values are evidence of them being caused by extreme crustal heterogeneity. The large number of smaller events with magnitudes of Mc (2.5) ≤ Mw ≤ 4.0 can be interpreted as indicating a decrease in shear stress, increasing the b-value. Low b-values suggest a relative decrease in the smaller magnitudes of events and an increase in the medium magnitudes of individual events (Mw ≥ 4.0). The dramatic drop in the b value is correlated with rising effective stress level prior to major medium-sized earthquakes. This indicates high stress accumulation and an increase in shear stress. The magnitude characteristics of the aftershocks, including the low b-values are strong evidence of the cause resulting from high stress accumulation. The individual events with magnitudes of Mw ≥ 4.0 can be interpreted as indicating the potential zones of locked faults, reducing the b-value. The high b-values indicate a general decrease in shear stress and increasing complexity in and around the focal zone. There is a slight variability in the b-value from high to low. This suggests an increase in the stress level, from low shear to high effective stress. The stress is transferred from the interval dominated by high material heterogeneity and fracture energy to the interval dominated by high stress accumulation and strain condensation. These results indicate that the strong clustering of aftershocks with time and variable b-values over 170 days fits with an inhomogeneously stressed crust with high fracture energy. The high fractured energy reduces the strength, causing low shear stress (high b-value) and allows the stress to be released, but the fracture energy can also create locked seismic zones (low b-value) (Mw ≥ 4.0). The results suggest that remarkable physical and mechanical changes occurred in the seismic deformation potential of the crust beneath the Lake Van basin.