Geomorphic Manifestations of the Damage Asymmetry Induced by Rupture Propagation Direction along the 1943 and 1944 Rupture Zones of the NAFS.

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The North Anatolian Fault (NAF) ruptured in a sequence of large earthquakes between 1939 and 1999, generally progressing from east to west. The 1943 rupture did not nucleate in the region of largest stress increase but rather at the opposite end of the final rupture. It propagated unilateraly eastward, opposite the propagation direction of the 1944 rupture. This anomaluos behavior may reflect the long term preferred propagation direction of ruptures on these fault sections. Here we analyze geomorphic properties that may express the damage structure of the fault along the 1943 and 1944 ruptures, testing whether correlative rock bodies across the fault have similar or distinct geomorphic expression. The study involved three scales of observations: 1) Large scale; thalveg adjustments of the rivers along the faults 2) Medium Scale; terrain analysis of topography and standart morphometric analysis on drainage basins with similar lithology 3) Small scale damage zone (<100m), generally expressed as fine textured badlands due to extremely high drainage density. The NAF perturbates drainage systems and forms fault valleys along its strike. Several valleys of various size follow the 1943 and 1944 ruptures. We found that along the 1943 rupture most of the river thalvegs are located south of the rupture, whereas along the 1944 rupture the locations are flipped and most of the river thalvegs are north of the rupture. On the medium scale we performed comparative morphometric analysis at two sites near Ismetpaşa with one north (N) and one south (S) of the fault. The two sites have the same lithology and similar morphometric controls. Morphometrical analysis were carried out to obtain information on the response of the erosional dynamics to the damage structure of the fault. Terrain analysis of the topography shows a clear difference especially of skewness of elevation on moment statistics. Morphometric analysis of the drainage basins shows closer bifurcations ratios revealing drainage basins with drainage patterns not heavily distorted by geology. Drainage density, stream frequency and ruggednes number values are higher at N side than S side of the fault. We also plot longitudinal profiles of the streams to show differences between the N and S sides of the fault. The analysis is consistent with more intense geomorphic work on the N side of the fault. At two locations along the 1943 rupture, highly eroded badlands south of the rupture have a higher gully density and frequency compared to the north. The drainage density gradually decreases as a function of distance from fault. Our observations include various expressions for more erosion on the S side of the 1943 rupture, and on the N side of the 1944 rupture, presumabely due to higher levels of rock damage. These results are consistent with a preferred direction of rupture of west to east for the 1943 segment, and east to west for the 1944 segment, as occurred in these historical earthquakes. The observations from the 1943 rupture are compatible with smaller scale data of damage asymmetry obtained in several cross-fault trenches (Dor et al., 2006).