What controls the location where large earthquakes nucleate along the North Anatolian Fault ?

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We review several sets of observations which suggest that the location of the epicenters of the 1939-1999 sequence of large earthquakes along the NAF obeys some remakably simple mechanical logic. The 1999 Izmit earthquake nucleated in a zone of localized crustal extension oriented N10E (Crampin et al., 1985; Evans et al., 1987), nearly orthogonal to the strike of the NAF, thus releasing the normal stress on the fault in the area and facilitating rupture nucleation. The 1999 Duzce epicenter, located about 25km from the end of the Izmit rupture, is precisely near the start of a simple linear segment of the fault (Pucci et al., 2006) where supershear rupture occurred (Bouchon et al., 2001). Aftershock locations of the Izmit earthquake in the region (Gorgun et al., 2009) show that Duzce, at its start, was the first significant Izmit aftershock to occur on this simple segment. The rupture nucleated on the part of this simple segment which had been most loaded in Coulomb stress by the Izmit earthquake. Once rupture of this segment began, it seems logical that the whole segment would break, as its simple geometry suggests that no barrier was present to arrest rupture. Rupture of this segment, in turn, led to the rupture of adjacent segments. Like the Izmit earthquake, the 1943 Tosya and the 1944 Bolu-Gerede earthquakes nucleated near a zone of localized crustal extension. The long-range delayed triggering of extensional clusters observed after the Izmit/Duzce earthquakes (Durand et al., 2010) suggests a possible long-range delayed triggering of the 1943 shock by the 1942 Niksar earthquake. The 1942, 1957 Albant and 1967 Mudurnu earthquake nucleation locations further suggest that like what is observed for the Duzce earthquake, the previous earthquake ruptures stopped when encountering geometrically complex segments and nucleated again, past these segments.