Geophysical Research Abstracts
Vol. 14, EGU2012-8976, 2012
EGU General Assembly 2012

Micro-Seismicity and Large Earthquake nucleation in Marmara Sea Region

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The existence or observation of a detectable nucleation phase before earthquakes is a longstanding goal with implications for earthquake prediction and risk assessment. While it is well established that some earthquakes are preceded by foreshocks, nothing so far distinguishes these foreshocks from regular earthquake occurrences, so there is no objective way to identify these events as foreshocks until they are followed by a larger earthquake. However, foreshocks are still the most common precursory phenomenon to large earthquakes. On the other hand laboratory and theoretical models of earthquake nucleation predict that slip instability should occur before earthquakes. A key question is then to know how aseismic slip during large earthquake nucleation is related to foreshock sequences and to check if this link is observable.

To address this question, we study the nucleation of one of the best recorded large earthquakes to date, the 1999 Mw 7.6 Izmit (Turkey) earthquake, was preceded by a seismic signal of long duration which originated from the hypocenter. The signal consisted of a succession of repetitive seismic bursts, accelerating with time, and increased low-frequency seismic noise. These observations concur to show that the earthquake was preceded for 44 minutes by a phase of slow slip occurring at the base of the brittle crust. This slip accelerated slowly initially, and then rapidly accelerated in the two minutes preceding the earthquake. We also review the long term evolution of the seismicity in the eastern Marmara Sea over a decade, before and after the Izmit earthquake. Based on a continuous catalog we analyze large scale space-time variations of the seismicity in the region. We illustrate the long term evolution of local seismic swarm activity close to the nucleation zone. We compare the results to other large interplate earthquakes. Finally we discuss the link between slow aseismic slip and foreshocks on the basis of recent experimental
results.