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Creeping and locked segments along the Main Marmara Fault

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In the Marmara Sea region, the North Anatolian Fault poses a significant hazard for the large cities such as the megalopolis of Istanbul. Numerous scientists have been involved in the monitoring of the activity of the fault, using a large spectrum of techniques. But a major challenge is faced in the presence of the Marama Sea which is lying over the fault trace and significantly limiting the access to the fault zone. The principal target for the assessment of the seismic hazard in the region is to know which segments are locked and subsequently storing the strain energy that will be relaxed abruptly within the next major event. Alternatively as promoted by several recent studies, fault segments might relax their tectonic loading continuously without significant seismicity in a creeping mode. To resolve the mechanical behavior of each fault segment, one important technique is the high-resolution micro-seismicity monitoring. If geodetic records give long term and large scale information, seismic measurements, in particular micro-seismicity location, provide complementary useful information related to local in-situ processes. However, the typical bottleneck is the accuracy of the focal depth as largely demonstrated for the San Andreas fault. Numerous works on large strike faults such as the San Andreas Fault where this duality (creeping or locked) of fault behaviors is observed, show not only vertical variations but also strong lateral variations of the behavior. The present work is based on this approach which includes better depth constraints on the micro earthquake activity. A second goal is to interpret at a larger scale, the spatial distribution of in-situ micro-earthquake activity in terms of regional geodynamics and compare it to other approaches like geodesy. We show that local seismicity along the fault provides crucial indirect evidences on the locked and creeping segments of the fault. The western segment of the MMF is mostly creeping while the central Kumburgaz fault segment is entirely locked. Shallow parts of the Princess Island fault and/or the Tekirdag basin also exhibit locked domains with very little seismicity. Implications for regional seismic hazard are discussed.