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Deformation mechanisms along the Main Marmara Fault around the ICDP-site GONAF

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The Main Marmara Fault (MMF) in NW Turkey south of Istanbul is a segment of the North Anatolian Fault Zone (NAFZ) that constitutes a right-lateral continental transform fault. Several well-documented strong (M7+) earthquakes indicate that the MMF poses a great risk to the Istanbul metropolitan region. A 150 km long stretch of the MMF has not ruptured since 1766 and the recurrence time of 250 yrs for M7+ events derived from historical records indicate that the fault is overdue. We introduce a new project addressing how the rheological configuration of the lithosphere in concert with active fluid dynamics within the crust and mantle influence the present-day deformation along the MMF in the Marmara Sea region. We test the following hypotheses: (1) the seismic gap is related to the mechanical segmentation along the MMF which originates from the rheological configuration of the crust and lithosphere; (2) variations in deformation mechanisms with depth in response to variations in temperature and (fluid) pressure exert a first-order control on the mode of seismic activity along the MMF, and, (3) stress and strain concentrations due to strength and structural variability along the MMF can be used as an indicator for potential nucleation areas of expected earthquakes. To assess what mechanisms control the deformation along the MMF, we use data from the ICDP GONAF observatory (International Continental Drilling Programme – Geophysical Observatory at the North Anatolian Fault) and a combined work flow of data integration and process modelling to derive a quantitative description of the physical state of the MMF and its surrounding crust and upper mantle. Seismic and strain observations from the ICDP-GONAF site are integrated with regional observations on active seismicity, on the present-day deformation field at the surface, on the deep structure (crust and upper mantle) and on the present-day stress and thermal fields. This will be complemented by numerical forward simulations of coupled thermo-hydraulic-mechanical processes based on the observation-derived 3D models to evaluate the key controlling factors for the present-day mechanical configuration of the MMF and to contribute to a physics-based seismic hazard assessment.