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Interseismic Strain Build-up on the Submarine North Anatolian Fault Offshore Istanbul

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Little is known about the movement of offshore faults because of the absence of direct, underwater geodetic measurements. Furthermore, satellite geodesy techniques such as GPS cannot be applied underwater due to the strong attenuation of electromagnetic signals. However, capturing fault movement is crucial to determine the state of locking which reveals whether a fault is creeping or accumulating elastic energy. Here we show that horizontal crustal strain on the seafloor can be continuously measured with mm-precision over periods of years and dozens of baselines allowing to resolve tectonic deformation quasi-in-situ on the seafloor. To this effect, we installed an acoustic ranging network across the central segment of the North Anatolian Fault in the Marmara Sea offshore metropolitan Istanbul. The seafloor observation shows that the fault is locked with an upper bound of the local creep rate of 2 mm/a. The absence of any significant fault displacement on the seafloor for 2.5 years together with sparse local seismicity from OBS observation reveal that the fault is currently locked and therefore is accumulating strain. The slip-deficit since the last known rupture in 1766 of at least 4 m is sufficient to trigger an earthquake up to magnitude 7.4. The rate of strain accumulation on the central segment of the North Anatolian Fault in the Marmara Sea had previously been extrapolated from onshore observations or inferred from the absence of seismicity, but results remained inconsistent. Our study for the first time fills part of this data gap through in-situ seafloor geodetic measurements and demonstrates the urgent need to conduct similar studies in regions with a high-hazard potential from active faults offshore.