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Paleoseismic evidence of earthquakes and tsunamis along the southern part of the Japan Trench

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The northern part of the Japan Trench has frequently generated tsunamigenic-earthquakes with magnitudes up to ∼M 8.0. In contrast, the middle and southern parts of the Japan Trench were considered relatively inactive until the 2011 Tohoku (M 9.0) event generated one of the largest tsunamis in recorded history. Geologic evidence from the Sendai plain revealed an event in CE 869 that could have forecast the severity of the Tohoku tsunami in 2011. Seismic models indicate that the Tohoku earthquake may have transferred stress southwards down the fault to the potentially locked southern part of the Japan Trench. This transfer of stress towards a locked section of the trench could produce an earthquake in the near future that would be comparable in magnitude to the Tohoku event.

Reconstructing the history of individual great earthquakes and accompanying tsunamis using geological records from the coastal zone adjacent to the southern part of the Japan Trench provides an assessment of the seismic hazard for metropolitan areas in east-central Japan. We have found two anomalous marine sand layers intercalated with muddy peat, which can be traced 3.8 km inland and 5.5 km along the present Kujukuri coastline, approximately 50 km east of Tokyo. Both sand layers have features consistent with tsunami deposits, such as a distinct erosional base, rip-up clasts, normal grading, a mud drape, and marine foraminifera. Results of radiocarbon dating constrain the age of the upper sand to 337 - 299 cal. yrs. BP, which likely corresponds to the only known southern Japan Trench rupture ever recorded, the Empo tsunami of CE 1677. The age of the lower sand is 979 – 903 cal. yrs. BP; marking an event for which there is no historical documentation at present. Preliminary tsunami simulation models indicate that a middle trench (Tohoku-style) rupture is not responsible for significant inundation of the Kujukuri coastline and would likely not have been capable of depositing either sand layer. Similarly, published simulation models of the Empo tsunami do not produce sufficient inundation to explain the occurrence of either sand, indicating that the historical Empo event may have been larger (i.e. in slip area and magnitude) than previously thought.