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Geological evidence for Holocene earthquakes and tsunamis along the Nankai-Suruga Trough, Japan

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The Nankai-Suruga Trough, lying immediately south of Japan's densely populated and highly industrialised southern coastline, generates devastating great earthquakes (magnitude > 8). Intense shaking, crustal deformation and tsunami generation accompany these ruptures. Forecasting the hazards associated with future earthquakes along this >700 km long fault requires a comprehensive understanding of past fault behaviour. While the region benefits from a long and detailed historical record, palaeoseismology has the potential to provide a longer-term perspective and additional insights. Here, we summarise the current state of knowledge regarding geological evidence for past earthquakes and tsunamis, incorporating literature originally published in both Japanese and English. This evidence comes from a wide variety of sources, including uplifted marine terraces and biota, marine and lacustrine turbidites, liquefaction features, subsided marshes and tsunami deposits in coastal lakes and lowlands. We enhance available results with new age modelling approaches. While publications describe proposed evidence from > 70 sites, only a limited number provide compelling, well-dated evidence. The best available records allow us to map the most likely rupture zones of eleven earthquakes occurring during the historical period. Our spatiotemporal compilation suggests the AD 1707 earthquake ruptured almost the full length of the subduction zone and that earthquakes in AD 1361 and 684 were predecessors of similar magnitude. Intervening earthquakes were of lesser magnitude, highlighting variability in rupture mode. Recurrence intervals for ruptures of the a single seismic segment range from less than 100 to more than 450 years during the historical period. Over longer timescales, palaeoseismic evidence suggests intervals ranging from 100 to 700 years. However, these figures reflect thresholds of evidence creation and preservation as well as genuine recurrence intervals. At present, we have not identified any geological data that support the occurrence earthquakes of larger magnitude than that experienced in AD 1707; however, few published studies seek to establish the relative magnitudes of different earthquake and tsunami events. Alongside the paucity of research designed to quantify the magnitude of past earthquakes, we emphasise a number of other issues, including alternative hypotheses for proposed palaeoseismic evidence, the lack of robust chronological frameworks and insufficient appreciation of changing thresholds of evidence creation and preservation over time. These key issues must be addressed by future research.