Nankai Trough (Japan) palaeoseismology: progress since the 2011 Tōhoku earthquake

Ed GARRETT[1,*], Vanessa M.A. HEYVAERT[1,2], Osamu FUJIWARA[3], Marc DE BATIST[4], Philip GARRETT[5], Masanobu SHISHIKURA[3], Aurélia HUBERT-FERRARI[6], Helmut BRÜCKNER[7], Atsunori NAKAMURA[3], Yusuke YOKOYAMA[8], The QuakeRecNankai Project Team

[1] Royal Belgian Institute of Natural Sciences, Geological Survey of Belgium, Rue Jenner 13, 1000 Brussels, BELGIUM
[2] Ghent University, Department of Geology and Soil Science, Krijgslaan 281/S8, 9000 Gent, BELGIUM
[3] National Institute of Advanced Industrial Science and Technology (AIST), Geological Survey of Japan, 1-1-1 Tsukuba Central 7, Higashi, 305-8567 Tsukuba, Ibaraki, JAPAN
[4] Ghent University, Renard Centre for Marine Geology, Department of Geology and Soil Science, Krijgslaan 281/S8, 9000 Gent, BELGIUM
[5] Newcastle University, School of History, Classics and Archaeology, Armstrong Building, NE1 7RU Newcastle, UK
[6] University of Liège, Department of Geography, Alley August 6 (bat. B11), 4000 Liège (Sart-Tilman), BELGIUM
[7] University of Cologne, Institute of Geography, Albertus-Magnus-Platz, 50923 Köln, GERMANY
[8] University of Tokyo, Atmosphere and Ocean Research Institute, 5-1-5, Kashiwanoha, 277-8564 Kashiwa-shi, Chiba, JAPAN

*Corresponding author: egarrett@naturalsciences.be

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Abstract

The Nankai Trough, the subduction zone that lies immediately south of Japan's densely populated southern coastline, generates devastating great earthquakes, characterised by intense shaking, crustal deformation and tsunami generation. Historical records suggest recurrence intervals between inferred magnitude 8+ earthquakes average 115 ± 89 years. The limitations of developing seismic hazard assessments based solely on historical data are, however, well documented and were devastatingly illustrated by the Tōhoku earthquake and tsunami, which struck the Japan Trench, northeast Japan, in March 2011. Before 2011, Japanese seismic hazard assessments relied on source models developed from a small number of well-documented historical earthquakes. Less well understood historical earthquakes were largely disregarded if their seismic intensities or tsunami heights could not be reconciled with the chosen seismic sources. Following the unexpectedly large size of the Tōhoku earthquake, the Japanese Cabinet Office advocated renewed investigation of earthquake and tsunami occurrence over historical and longer timescales, with a particular focus on defining the largest possible magnitudes using geological data. The new guidelines pay close attention to the Nankai Trough, where the Philippine Sea Plate descends beneath the Eurasian Plate. The subduction zone features a well-known seismic gap along its eastern Tōkai segment and a full length rupture of this and the adjacent five seismic segments could generate a magnitude 9+ earthquake. Palaeoseismic approaches may increase the length and completeness of chronologies of past earthquakes, allowing investigations into the variability in past magnitudes, rupture zones and recurrence intervals. Here, we summarise the wealth of palaeoseismic research previously conducted along the Nankai Trough. Evidence for past earthquakes and tsunamis comes from wide variety of sources, including uplifted marine terraces, turbidites, liquefaction features, subsided marshes and tsunami deposits in coastal lakes and lowlands. More than 70 sites have been investigated, however the number of events recorded at each site varies depending on site-specific evidence creation and preservation thresholds. The palaeoseismic catalogue is also limited due to issues over alternative hypotheses for proposed palaeoseismic evidence, poor chronological control and sampling approaches insufficient to address the recurrence of the largest past earthquakes and tsunamis. We make recommendations for further investigations of this critical subduction zone and introduce the QuakeRecNankai project, a Belgian-led collaboration that seeks to develop new palaeoseismic records for the purpose of improved seismic hazard assessment.