

A long record of extreme wave events in coastal Lake Hamana, Japan

*Evelien Boes¹, Osamu Fujiwara², Yusuke Yokoyama⁷, Sabine Schmidt⁴, Svenja Riedesel³, Atsunori Nakamura², Vanessa M.A. Heyvaert⁵, Helmut Brückner⁶, Marc De Batist¹

1. Renard Centre of Marine Geology, Department of Geology, Ghent University, Belgium, 2. Geological Survey of Japan, AIST, Japan, 3. Department of Geography and Earth Sciences, Aberystwyth University, United Kingdom, 4. EPOC, University of Bordeaux, France, 5. Geological Survey of Belgium, Royal Belgian Institute of Natural Sciences, Belgium, 6. Institute of Geography, University of Cologne, Germany, 7. Atmosphere and Ocean Research Institute, University of Tokyo, Japan

Tidal Lake Hamana is located near the convergent tectonic boundary of the Nankai-Suruga Trough, which gives rise to repeated tsunamigenic megathrust earthquakes. Thanks to its accommodation space, Lake Hamana may represent a good archive for past tsunamis and tropical storms (typhoons), also referred to as “extreme wave” events. By applying a broad range of surveying methods, sedimentological analyses and dating techniques, we attempt to trace extreme wave event deposits in a multiproxy approach. Seismic imagery shows a vertical stacking of strong reflectors, interpreted to be coarser-grained sheets of beach and dune sand, deposited by highly energetic waves. Systematic sampling of lake bottom sediments along a transect from ocean-proximal to -distal sites enables us to evaluate vertical and lateral changes in stratigraphy. Ocean-proximal, up to a depth of 8 m into the lake bottom, we observe a sequence of 15 sandy layers, separated by silty background sediments. These sandy layers have a thickness that varies between 1 and 25 cm, and typically display an erosive base, a fining-upward grain-size trend, an increased magnetic susceptibility and density, and stronger X-ray attenuation. They are interpreted to be extreme wave event deposits. Overall, event layers quickly thin out and/or become finer-grained land-inward. Seismic-to-core correlations show a good fit between the occurrence of strong reflectors and sandy deposits, hence confirming presumptions based on acoustic imagery alone. Seven additional event layers appear further down the central lake basin, where the depositional record is less fragmentary and not as prone to sediment reworking and bypassing during e.g. the Yayoi sea-level lowstand, adding up to a total of 23 extreme wave event deposits. Radiocarbon dating and tephrostratigraphy (3090 BP Osawa Fuji scoria and 3150 BP Kawago-daira pumice) yield extreme wave event age ranges with recurrence interval modes of 70, 150, 450 and 650 years. The youngest event, dated as 2013-2015 AD, most likely corresponds to the 2014 AD Phanfone Typhoon. This long record of Lake Hamana provides new evidence of paleo-extreme wave events beyond 4 ka, with mean ages of 4280, 4430, 4830, 5690, 5780, 6020 and 7360 cal yr BP.