Did a large late 19th century typhoon dramatically change the morphology of the Yangtze River mouth, China?

Wenlei Niu[1], Adam Switzer[2], and Zhanghua Wang[1]

[1]East China Normal University
[2]Nanyang Technological University

November 24, 2022

Abstract

A sediment core taken proximal to a large sunken ship in the north channel of the Yangtze delta suggests a dramatic change in sedimentation that is coincident with the sinking of the ship. We conducted AMS 14C and OSL dating and analysed the lithology, grain size, magnetic susceptibility and organic elemental geochemistry and combined these data with historical marine charts and historical data. A notable change in sedimentary environments implies a dramatic change to the geomorphological evolution of the environment at the location of the shipwreck. The sediments below the shipwreck layers suggest that the shipwreck occurred in a sheltered tidal channel developed at the north margin of the Tongsha Shoal of the Yangtze River mouth. The shipwreck layer containing the wood pieces of the sunken ship is composed of structureless silts and underlain by homogeneous mud separated by an erosional contact. The ship/storm layer is overlain by sandy facies reflecting a change to more open marine channel conditions. The sedimentary data implies that a large historical typhoon possibly on July 31, 1879 sunk several ships and caused significant geomorphological change to the Yangtze delta.

Did a large late 19th century typhoon dramatically change the morphology of the Yangtze River mouth, China?

Wenlei Niu[1] Adam D. Switzer[2,3] Zhanghua Wang[1]

[1.] State Key Laboratory of Estuarine and Coastal Research, East China Normal University, Shanghai,China ·
[2.] Earth Observatory of Singapore, and [3.] Asian School of the Environment, Nanyang Technological University, Singapore 639798, Singapore

Summary

A sediment core taken close to a sunken ship in the the Yangtze delta, China, suggests a dramatic change in sedimentation coincident with its demise. Here, AMS ^{14}C and OSL dating, sedimentology and geochemistry are combined with historical marine charts and historical data. We suggest that a notable change in sedimentary environment infers a dramatic change to the geomorphological evolution of the delta near the shipwreck. The sediments below the shipwreck suggest that it was in a sheltered tidal channel. In contrast, the muddy ship/storm layer is overlain by sandy mud facies reflecting a change to more open marine channel conditions. The data implies that a large typhoon possibly on July 31, 1879 sunk several ships and caused significant geomorphological change to the Yangtze delta.

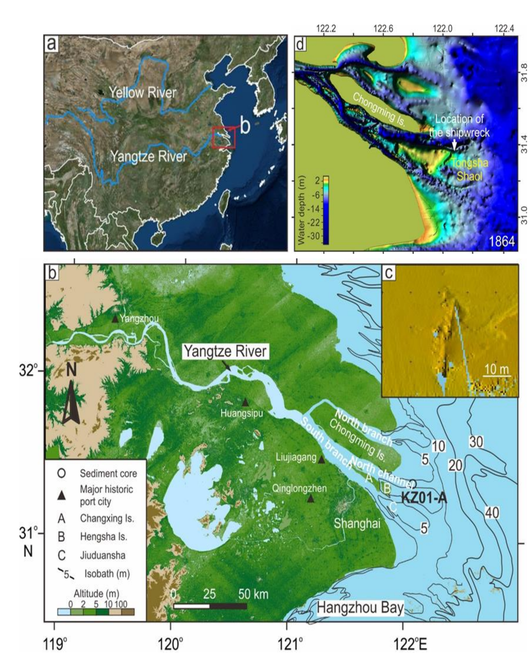

Figure 1: Location map showing study area in Yangtze Estuary (a) and core KZ01-A (b), detection of the sunken ship (c) and Yangtze Estuary distribution DEM in 1864 (d) .

The lower part of core KZ01-A (Fig. 1) is dominated by fine-grained homogeneous mud with marine algae and particulate organic carbon (POC) (Figs. 2 and 3) consistent with a sheltered tidal channel as indicated from the historical marine chart of 1864 AD (Fig. 1d).

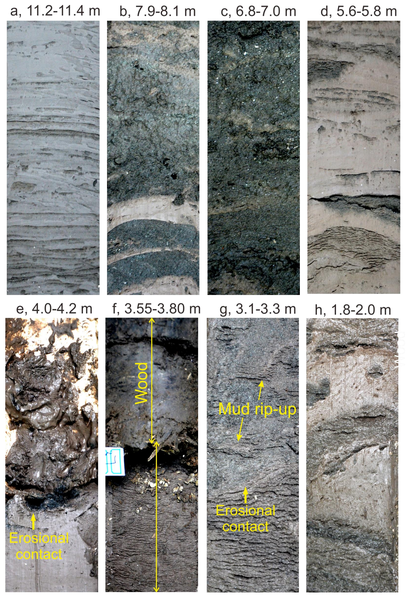

Figure 2: Photos of typical sedimentary facies in core KZ01-A.

Event layer

The muds are overlain by a structure-less silt which contains pieces of the sunken ship (Figs. 2f, 3) and is separated from the underlying homogeneous mud by an erosional contact (Figs. 2e, 3), inferred to be an event layer. It is then overlain by a muddy sand facies consistent with an abrupt return to estuarine/marine conditions (Fig. 2g).

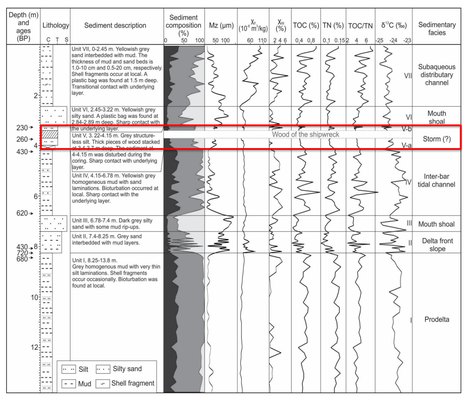

Figure 3: Composite depth profile of the core KZ01-A showing radiocarbon ages, lithology, mean grain size, stratigraphic divisions and interpreted sedimentary facies. The event layer was indicated by the red rectangle.

Evidence for geomorphological change

A comparison between the geomorphology and bathymetry of the Yangtze delta between 1864 and 1879 using historical bathymetric charts shows considerable changes in the system. The island to the south of the North Channel system is substantially smaller and the North Channel is both wider and deeper. The coring site for KZ01-A appears to be much more open. This supports our hypothesis for that the significant change in the morphology was likely caused by a large typhoon.

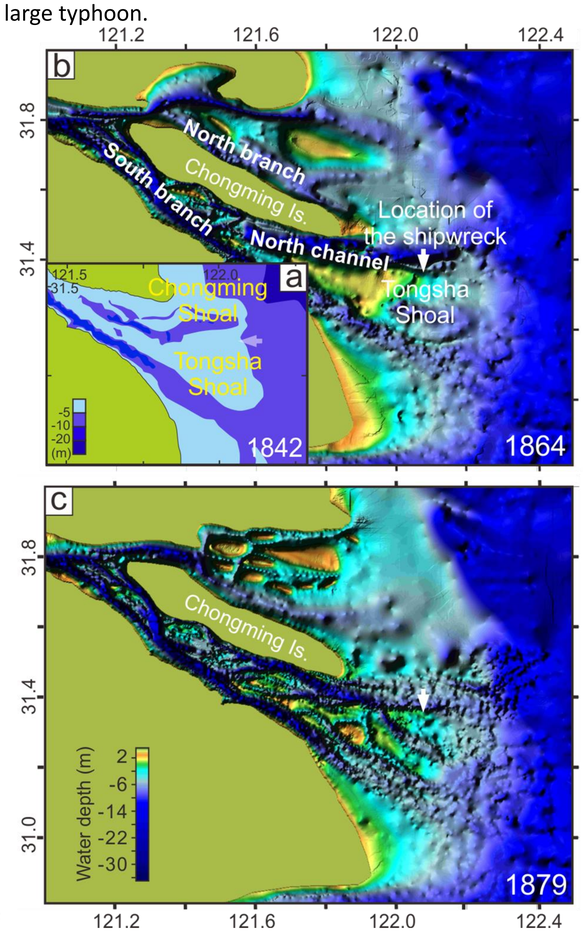

Figure 4: The morphology of Yangtze Estuary in a) 1842, b) 1864 and c) 1879 (after Li et al., 2011). Location of the shipwreck was indicated by the white arrow.

Shipwrecks and 1879 typhoon

We suspect that the sinking of the ship is related to a typhoon event. The Yangtze delta region experienced several large typhoons in 1864, 1865, 1866, 1867, 1868, 1873, 1875, 1876, 1877, 1878 and 1879 AD (Zhang *et al*., 2012). Multiple shipwrecks dating to this period are found (Fig. 5). Of these storms the 1879 storm was particularly strong tracked offshore from Shanghai (Fig. 5) passing close (~60 km) to the coring site of KZ01-A (Fig. 5). The storm had a central pressure of around 744 mmHg/Torr or ~ 986 mb/hPa. Many ships and lighthouses reported gale force winds.

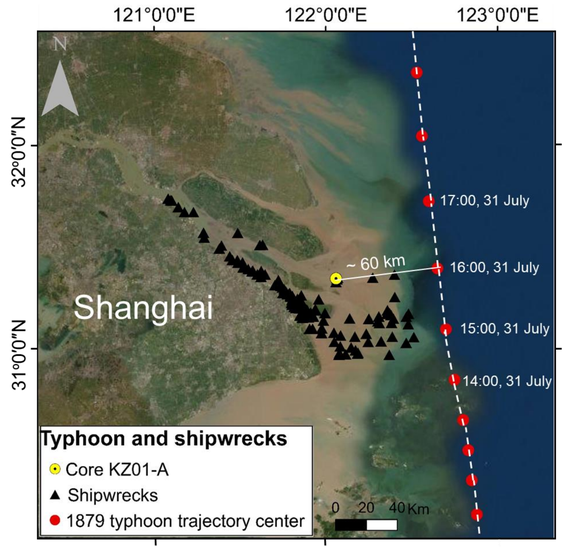

Figure 5 The track of the typhoon 31 July 1879 and distribution of shipwrecks in the Yangtze River delta (after Peng, 2019).

Conclusions

- Sedimentary evidence from core KZ01-A provides evidence for the timing of a considerable change in the sedimentary environment at the coring site.
- Historical bathometric charts and landform analysis show a coincident change in delta morphology around the end of the 19th century.
- We hypothesis that a particularly strong typhoon that tracked close to the coring site in 1879 may be responsible for the sinking of the ship and the large scale change in delta morphology recorded in the bathymetry and the sediment record.

REFERENCES

Li, M.T., Chen, Z.Y., Yin, D.W., Chen, J., Wang, Z.H., Sun, Q.L., 2011, Morphodynamic characteristics of the dextral diversion of the Yangtze River mouth, China: tidal and the Coriolis Force controls. Earth Surface Processes and Landforms. 36, 641-650.
Peng, Z.Y., 2019. Studies on the evolution of the Yangtze Estuary in the past 35 years and the underwater shipwreck space management system. East China Normal University Master Dissertation (in Chinese).
Zhang, X.P., Ye, Y., Fang, X.Q., 2012. Reconstruction of typhoons in the Yangtze River Delta during 1644–1949AD based on historical chorographies. Journal of geographical science. 5, 810-824

ACKNOWLEDGMENTS

This work was supported by Protection Center of Cultural Relics, Shanghai, China, the China Scholarship Council award to Wenlei Niu and a donation from Scor RE international for student research. We also acknowledge the assistance of Dr Fiona Williamson of Singapore Management University in accessing the historical data.

The EOS is funded by Singapore's National Research Foundation (NRF), the Ministry of Education (MOE) and Nanyang Technological University (NTU) as a Research Centre of Excellence, and is an autonomous institute at Nanyang Technological University (NTU).