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Western Pacific mega wave: a 2-kyr-long geological record in northern Taiwan

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The western circum Pacific seismic zone is prone to tsunami, volcanic eruption, and typhoon that pose high risks of coastal geohazards through mega wave processes, including the island of Taiwan. Although Taiwan's recorded history is too short to better assess the risks, a composite geological record of borehole cores and rocky shore outcrops in northern Taiwan was established in the study and unveils a violent history dating back to two thousand years before present.

A total of eight mega wave events were identified by coarse-grained marine deposit layers that are intercalated with floodplain fines or talus deposits. The upper two marine layers are located in the boreholes of a coastal floodplain, extend 0.8 km inland, and are each composed of a fining-upward, sharp-based, quartzose sand within a andesitic sand and mud succession [1]. The quartzose sand is interpreted as the mega wave/tsunami deposit derived from coastal dunes that accumulate longshore drift from regional provenance of Oligocene-Neogene siliciclastic strata. The andesitic succession overlies a massive-bedded andesitic gravel and represents an abandoned channel fill that accumulated sediments from local provenance of Pleistocene arc volcanoes. The lower six marine layers are located in the talus outcrops in a rocky shore next to the coastal floodplain. The talus outcrop successions rest on a sedimentary rock basement of Oligocene quartzite and consist of poor-sorted, mottled silts, sands, and angular quartzite gravels. The six marine layers are 2 to 5 m in elevation, higher than the local maximum astronomic tide, and composed of gravels and gravelly sands that are rich in rounded quartzite cobble and boulder. The rounded gravels are attributed to the mega wave processes of tsunami or super typhoon that reworked the rocky shore sediments onto the talus tops beyond tidal reach to be buried and preserved by the following talus deposition. The lower three of the six layers are further characterized by an abundance of rounded pumice and scoria, which indicate a long-distant offshore source and a volcanic origin.

In addition, two rounded pumice gravel beds occur at 9 and 11 m above sea level in another distant talus outcrop and are age-coeval to the upper two of the lower six marine layers. The outcrop may suggest that the two events are also volcanic in origin, or that the two pumice layers simply record another two independent mega wave events.

According to the radio carbon dating of the basal talus, the new-established event stratigraphy approximately spans the last 2300 years. The uppermost marine layer is correlated to a historical tsunami in AD 1867 [2], while the other seven layers are dated at the approximate ages of 300, 500, 750, 1100, 1700, 1900, and 2100 years before present. The time periods between these layers are commonly in a range from 150 to 250 years and rarely reach 400 and 600 years. The commonly

short periods and the diverse mega wave origins evidently validate the high geohazard risks and well render the violent past of this western Pacific island.

References:

[1] Yu NT et al. (2016) Mar Geol 372: 1-16
[2] Okamoto Y (1913) Trans Nat Hist Soc Formosa 3(12): 168-172