

Preliminary Studies on the Holocene Geology of Taiping Island

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Taiping Island measures 0.5 km² in area above high tide. The island is a sand cay sitting on top of Holocene coral reefs, and protected by modern coral reefs encircling it and beach rocks along its northern coast. The island has a permanent freshwater lens.

A drill core of 523.35 m in depth was taken at the island in 1981 by Government of Republic of China (Taiwan) and was studied by the authors (Gong et al., 2005). Field survey was conducted in summer of 2005. Short cores (~30 cm in length) were taken on reef flat surrounding the island and corals were dated by accelerated mass spectrometry carbon-14 dating (AMS C-14). The results indicate that Taiping Island is a sand cay that consists of entirely bioclastic sands, developed on Holocene coral reefs. The bioclastic sands measures 9 m thick in the core. Under the sands, Holocene coral reefs occurred from 21 to 9 m (Figure 1). The top of coral reef under the sands was dated to be 4761±115 calendar years before present (cal yrBP) (Gong et al., 2005). Field survey reveals that Taiping Island is surrounded by reef flat with living coral reef along the outer margin (Figure 2). The top of reef flat surrounding the sand cay is dated to range from 3718±92 near the island to 1193±71 cal yrBP toward the margin of reef flat (Figure 2) (Gong et al., 2006 and unpublished data). As illustrated in Figures 1 and 2, the sand cay started about 4700 years ago overlying coral reefs, and the reef flat surrounding the island continued to expand outward for at least 4000 years, indicating the sand cay has been stable and expanding during the period. The age of Taiping Island formation is consistent to the period when reef islands in the western Pacific emerged with falling sea level after the mid-Holocene sea-level highstand, and became habitable for Austronesian (Dickinson, 2001; 2003).

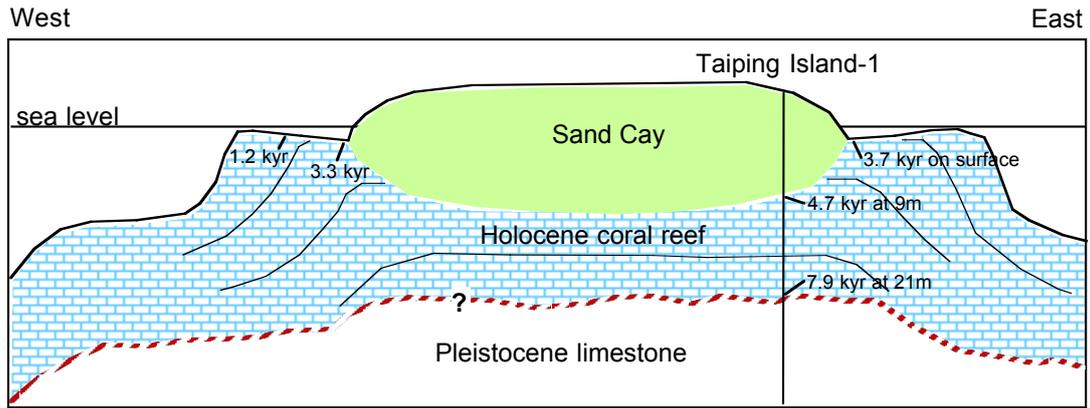


Figure 1: Reconstructed geological profile of Taiping Island. The vertical line represents the core drilled in 1981. kyr: age in thousand years.

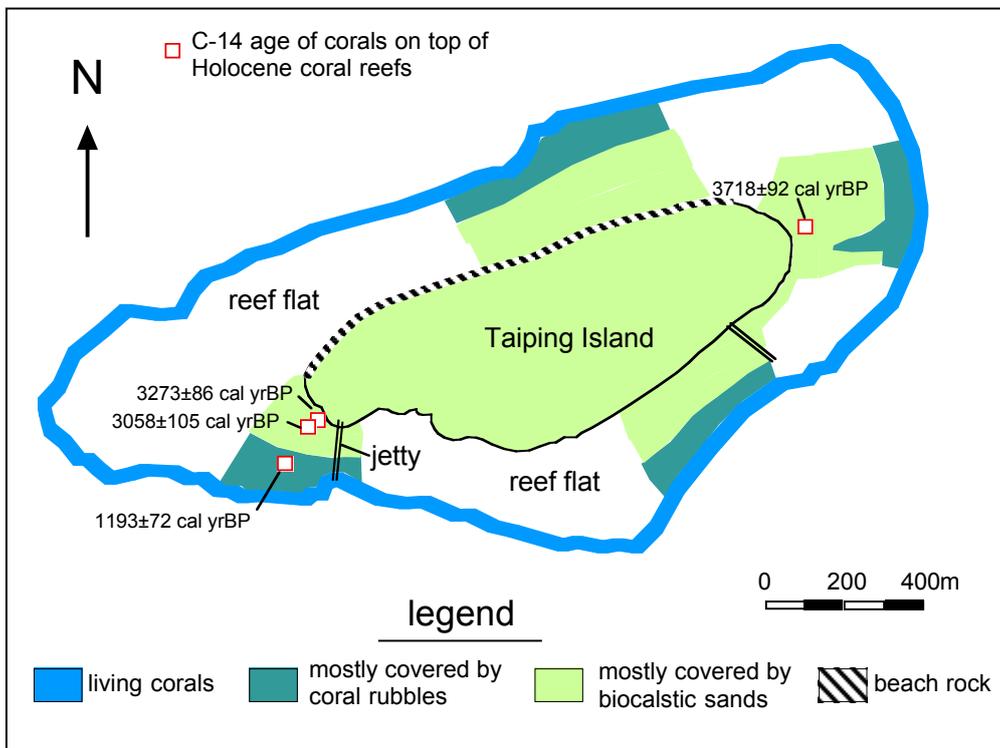


Figure 2: Sedimentary facies map of reef flat surrounding Taiping Island. The vertical line represents the core drilled in 1981. kyr: age in thousand years.



Figure 3: Beach rocks along the northern coast of Taiping Island. The occurrence of beach rocks indicates that Taiping Island has been stabilized and emerged for over [4,000] years.

That Taiping Island has been emerged and stabilized are supported by additional evidences. First, well lithified beach rocks of several tens of centimeters in thickness occurred along the northern coast of the island at high tide water level (Figures 2 and 3). Beach rock formed when beach sands became stabilized, then cemented by calcium carbonate (CaCO_3) in the seawater. Second, Taiping island is covered by guano and humus, indicating the island has been emerged for long period of time. There was once plenty of guano on the island, enough to support of phosphate mining during 1930's. Remnant guano can still be observed on the ground surface.

Due to the porous nature of biocalstic sands and coral reef underneath, a permanent freshwater lens existed on the island. The density of seawater averages 1.025 kg/l and is slightly greater than that of freshwater (1 kg/l), thus the thickness of freshwater column below sea level will be 40 times of its elevation above sea level; i.e. if the freshwater surface is 1 meter above sea level, there will be 40 meters of freshwater below. For decades, more than 100 marines or coast guards have lived on the island relying on groundwater because the freshwater is easily replenished by rain precipitation that averages 1800-2200 mm per year. It is estimated that annually there is 0.9-1.1 million cubic meter of rainwater falling on the island.

Reference

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