

The initial development of coral reefs in non-carbonate paleoenvironments, SW Taiwan

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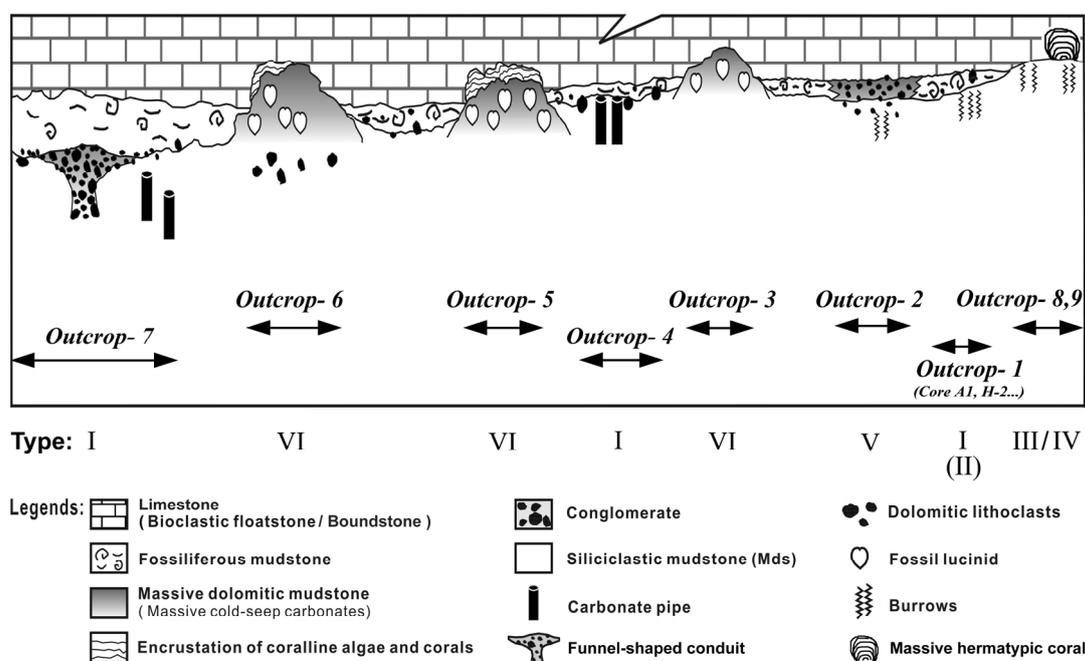
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Abstract

Pleistocene scleractinian reefs in southwestern Taiwan developed on several local structural highs that were closely associated with anticlines and thrust faults in a Plio-Pleistocene foreland basin. This study focused on the abrupt facies changes from the underlying terrigenous mudstone of the deep-water facies upward into the reefal limestones of coral reefs, including the Takangshan (TKS), Hsiaokangshan (HKS), Panpingshan (PPS), and Fengshan (FS). To reveal the initial mechanisms of reef development, we examined the lithologies and vertical facies changes of 17 outcrops and 43 borehole cores from quarries of these reefal limestones and performed petrographic, isotopic, and nannobiostratigraphic studies. In addition, 3 outcrops in the Chiahsien area were involved into this study, which including Ssutehsiang, Paiyunhsiangku, and Niupu. Purposes of this fieldwork have two folds. One is to compare the specific occurrences of carbonate-cemented mudstones in TKS, HKS, PPS, FS, and those in the Chiahsien area. The other is to recheck Hayasaka's descriptions (1932) about the unique occurrences of fossil lucinids bivalves and fossiliferous marls of Chiahsien and the southeastern Shoushan. Various occurrences of dolomitic mudstone were observed from 10 outcrops and in 17 borehole cores, containing massive dolomitic mudstones, carbonate pipes, dolomitic cobbles, and dolomitic pebbles. The $\delta^{13}\text{C}$ values of 149 samples ranged from -53.7‰ to -10.9‰ , indicating that the carbonate cements of these mudstones were all cold-seep carbonates in origin. Majorities of the cold-seep carbonates and funnel-shaped structure packed with dolomitic cobbles were precipitated and formed within the fine-grained siliciclastic mudstones. The wide occurrences of seep carbonates in the study area suggesting the hydrocarbon seeping occurred extensively. The compactness and association of large lucinid bivalves in massive cold-seep carbonates further indicate pronounced, long-lasting seepage of methane

occurred antecedently the development of Takangshan Reef. A schematic model was proposed to illustrate the occurrences of various lithologies and lithofacies associations (Fig.1). The erosional surfaces on siliciclastic mudstones, funnel-shaped structure, and the massive cold-seep carbonates might have been occurred concurrently during a tectonic unstable time in SW Taiwan. The deposition of fossiliferous mudstone interfingering with the conglomerate lithofacies, representing the rapid facies transition from siliciclastic (non-carbonate) into carbonate environment. The root of this rapid facies change was presumed to be tectonic movement, probably related to the westernward thrust migration in the Pleistocene foreland basin. The exposed massive cold-seep carbonates provided hardgrounds for the encrustations of corals as well as coralline algae and might have played a crucial role in the initial development of coral reefs in a non-carbonate paleoenvironment of active tectonic setting.



I, II, III, IV, V, VI: Types of vertical facies change from the underlying siliciclastic mudstone upward into the limestone facies

Fig. 1. A schematic model (not to scale) showing the occurrences of various lithologies and lithofacies associations. Modified from Wang *et al.* (2006).

References

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- Wang, S.W., S.Y. Gong, H.S. Mii, and C.F. Dai, 2006: Cold-seep carbonate hardgrounds as the initial substrata of coral reef development in a siliciclastic paleoenvironment of southwestern Taiwan, *TAO*, **17(2)**, 405-427.