

Coral-based paleoenvironmental interpretation and depositional history of the late middle Pleistocene Minatogawa Formation, southern Okinawa-jima, Japan

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Reef-complex deposits exposed in the Ryukyu Archipelago, southwestern Japan, offer a unique record of Quaternary reef growth and sea-level changes close to the northern limit of modern coral reef distribution. Among these deposits, the Minatogawa Formation belongs to the so-called “younger limestone” (<0.4 Ma), and crops out in southern Okinawa-jima and on nearby small islands. The deposition of the Minatogawa Formation marks a major change in depositional style in the Ryukyu Islands, from subsidence-dominated, aggrading and retrograding sequences (>0.4 Ma) to uplift-dominated deposits overlying older limestone (<0.4 Ma). Although their age has not been determined precisely yet, the limestones of the Minatogawa Formation are thought to have deposited during Marine Isotope Stage (MIS) 5 or the older MIS 7. The Minatogawa Formation is composed of two main lithologies: coral limestone (boundstone) and well-sorted detrital limestone (mainly foraminifer-rich grainstone). The coral limestones of the Minatogawa Formation contain abundant and diverse in situ fossil corals, but no detailed taxonomic study has been carried out so far despite their paleo-ecological importance. In this study, we examine the taxonomic composition and the spatio-temporal distribution of fossil coral assemblages in two stratigraphic units (Unit 2 and 3) of the Minatogawa Formation exposed in the Horikawa quarry, southern Okinawa island, and reconstruct their depositional history. Five coral assemblages are identified in the coral limestone, each indicating a particular reef environment. The depositional history of Unit 3, inferred from the analysis of coral assemblages and of the boundary between the coral boundstone and adjacent well-sorted detrital limestone in this unit, reveals at least two transgressive/regressive cycles of sea-level change, several meters in amplitude, resulting in an unconformity (dissolution surface) between the coral boundstone and adjacent well-sorted detrital limestone. In contrast, the coral limestone and well-sorted detrital limestone in Unit 2 formed concomitantly in the same reef setting, a lower reef slope, or perhaps a shallower but turbid environment. In addition, the discovery of a syn-depositional fault suggests that small-amplitude relative sea-level changes were caused by tectonic activity and may have influenced reef growth and community structure during the deposition of the Minatogawa Formation.

Keywords: fossil coral communities, late middle Pleistocene, environmental and sea level changes, tectonic uplift, Minatogawa Formation, Okinawa-jima