

Anthropogenic Anoxic History of the Tuvalu Atoll Recorded as Annual Black Bands in Coral

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Atoll islands are small, low-lying and highly vulnerable to sea level rise (SLR). Because these islands are fully composed of the skeletons from coral reef creatures, the healthy coral ecosystem plays a pivotal role in island resilience against SLR. The environmental deterioration of reefs caused by increases in the human population has been recently reported, but the timing and process are unknown. We investigated the annual black bands in a coral boring core from Fongafale Island, the capital of Tuvalu, which is a symbolic atoll country that is being submerged due to SLR. The iron redox state and microbial gene segments in the coral skeleton might be new environmental indicators that reveal the linkage between anthropogenic activity and coral reef ecosystems. Our findings provide the first demonstration that iron sulfide has formed concentrated black layers since 1991 under the seasonal anoxic conditions inside coral annual bands. Since the 1990s, increasing domestic waste-induced eutrophication has promoted seasonal algae proliferation, resulting in sulfate reduction by anaerobic bacteria. With the recent climate variability, these anthropogenic effects have induced the mass mortality of branching corals, deteriorated the coral reef ecosystem and deprived the resilience of the island against SLR.

Keywords: Tuvalu Atoll, Coral annual bands, Black bands, Anoxic condition, Anthropogenic pollution, iron sulfide

