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Mid Brunhes origin of modern atolls: a model developed in the Maldives and Mururoa atolls

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The Maldives archipelago includes 22 main atolls characterized by a marginal rim surrounding a lagoon commonly less than 50-60 m deep, though some lagoons reach depths of more than 80 m. The overall evolution of the carbonate system in the Maldives Archipelago clearly shows that the slow subsidence of hypothetical volcanic edifices buried under the atolls cannot explain their typical ringed morphology. On the contrary, the atolls in the Maldives, as most likely the majority of the modern atolls, are probably young (less than 0.5 My old) carbonate edifices. Our research in the Maldives was developed based upon the interpretation of two Elf-Aquitaine and Royal Dutch Shell MCS grids, groundtruthed by ODP Sites 714, 715, and 716 and two deep exploration wells.

Several seismic profiles across the modern atoll margins clearly illustrate a shift from middle Miocene-early Pliocene sigmoid lateral margin progradation of flat-topped carbonate banks to late Quaternary bank top vertical aggradation evolving into the modern atoll physiography. This well-marked transition is first illustrated by a regionally observed initial downward shift of the depositional system dated at 3.0-2.5 Ma. This downward shift of onlap and subsequent deposition in sedimentary wedges below the early Pliocene bank margins are explained by a late Pliocene-early Pleistocene (3.0-0.5 My) gradual sea level regression tied to the onset and successive expansions of major continental ice sheets in the northern Hemisphere. This regression is clearly defined in several Pliocene-Quaternary high resolution benthic isotope records, best proxy for ice volume variations in the past 5 My, at ODP sites such as 659, 677, 846, and 849.The early Pliocene flat-topped carbonate banks, exposed for about 2.5 My in the late Pliocene and early Pleistocene, were fully re-flooded for the first time at the

glacial MIS 12 to interglacial MIS 11 transition. This sea level transgression is unique by its highest amplitude among the multiple sea level transgressions in the past 5 My and by its occurrence directly after a 2.5 My-long sea level regression The unique character of the MIS 12 to MIS 11 sea level transgression is clearly shown in the Karner et al. stack of six tropical high resolution 18-O records (five of them are from ODP Sites 659, 664, 677, 846, and 849) from the Atlantic and eastern Pacific oceans.

In conclusion, the atolls in the Maldives and probably most of the modern atolls, such as the ones in Mururoa, are very young, less than 0.5 My old, edifices. Early Pliocene flat topped bank remained mostly exposed and were karstified during a late Pliocene to early Pleistocene 2.5 My.-long sea level regression. This karst morphology served as substratum and, therefore, template for the atoll development first during the unusually high amplitude MIS 12 to MIS 11 sea level transgression. Subsequently the successive exposures and floodings related to the series of late Brunhes, 120 m high amplitude, sea level transgressions and regressions, enhanced the initial mid Brunhes ring-shaped morphology, so typical of the modern atolls observed in the Maldives Archipelago.