# *AAPG Studies in Geology #34 "Carbonate Concepts from the Maldives, Indian Ocean"*

by **E.G. Purdy and G.T. Bertram** , 56 pages, published by the American Association of Petroleum Geologists, Tulsa, Oklahoma, U.S.A. 74101, ISBN 0-89181-042-0, 1993.

## Review by **Christopher G. Kendall**

This slim pamphlet describes an interpretation of the sequence stratigraphy of the Maldives as derived from some 44 seismic lines, the Elf exploration well North Male 1 (NMA-1) and three three ODP sites, 714, and 716. The text is illustrated with figures of the stratigraphic column, maps of the various atolls, a number of detailed photographs of the atolls and their peripheral rims, some elegant idealized diagrams showing the development of the Maldive atolls, thirteen seismic lines with uninterpreted and interpreted cross-sections, and a really clear remote color image of the atolls.

This professionally put together volume represents a summary of the geology of this atoll system, which is situated off the south western end of the Indian Peninsula in the northern Indian Ocean. The authors establish that these atolls were initiated in the middle to late Eocene over volcanic ridge believed to be the product of a hot spot which moved southwards from central western India in the Deccan. In the Paleocene to the lower Eocene it reached the Maldives area. In the middle Eocene it lay beneath the Chagos Archipelago and by the lower Eocene was in the Saya de Malha Bank area.

In the Maldives during the middle and late Eocene and, following the extrusion of the basalt, nummulitic limestones accumulated as a shallow water platform which was flanked by probable shelf edge reefs, that rimmed the shelf edge. These reefs enclosed a shallow water carbonate platform was broken by a graben developed along the central backbone of the Maldive High. This graben was developed at the center of the basaltic ridge where local collapse parallels the Chagos fracture zones. Graben development ended in the earlier Oligocene and this feature was also filled by nummulitic limestones. Later thermal cooling seems to have caused the collapse of the center of Maldives, so that the edges of the shelf area become the highs about which carbonate deposition was centered. In the late Oligocene and early Miocene carbonate shelf progradation took place in a downslope direction, towards the center of the bank.

The authors interpret the character of the progradation as responses to sea level rises which caused carbonate deposition to slow, followed by progradation into the central lagoonal basin, during the consequent still stands in sea level. Though the authors recognize various episodic events in the progradational sequences were a response to sea level variations, they were unable to correlate these events either across the Maldives or to any of the published sea level charts. They were, however, able to tie the Elf NMA-1 well in a general way to the seismic section. However, because the different banks of the Maldive Atoll system are separated one another, they were unable to tie the sequence boundaries they identified in the well to the other banks in the Maldive trend. The lack of progradational geometries from the Maldives into the Indian Ocean off bank is explained as the product of water depths which were too great for carbonates to accumulate. The carbonates are thought instead to have bypassed both margins of the atoll into the Indian Ocean. The authors report that the centrally driven bilateral progradation of the atoll was finally interrupted by a glacially induced fluctuation in sea level in the Pliocene-Pleistocene. This produced karstfication of the atoll topography which occurred during the sea level low stands, and caused carbonate deposition during the following high stands. The senior author, Purdy, clearly feels that the karst-induced topography had a major effect on the geometry of the Maldive banks.

The authors recognized that the size of Maldive system was so great that, for instance, the Dolomite carbonate banks of the Dolomite Alps in northern Italy would fit within a single Maldive's platform reef. The Maldive atoll complex is over 1000 kilometers long and some 150 kilometers wide at its widest point. This major carbonate province has an importance which can not be underestimated. As further exploration and scientific studies are made of the area, so our understanding of carbonate deposition system will be improved.

Purdy has used this book to expand on his model which explains how karstified topography effects carbonate atoll development. Many of his concepts on this topic may be in part, if not wholly, correct. However, he has avoided committing himself too strongly with remarks like "If not drowned karst, what else could the honeycomb shoal pattern possibly represent" or "Considering their form and distribution, it is extremely difficult to believe these are anything other than drowned karst solution features. What else could reasonably account for their attributes?" Clearly Purdy believes that karst is responsible for these features but tends to avoid the issue with these dissembling statements! Others, like Graham Maxwell in his Atlas of the Great Barrier Reef, have interpreted similar features as the product of contemporary reef absorption. Similarly the honeycomb fabric seen in the Maldive atolls is reminiscent of the linear sinous bank topography which occurs in Florida Bay. These latter features are soft sediment ridges which do not appear to be strongly tied to any underlying topography. These honeycomb fabrics of Florida may be the product of constructional processes. Purdy skirts these problems by not considering other plausible solutions.

Another thing that flagged my attention was that the authors were loathe to tie the sequence stratigraphy they saw to any possible sea level curve. Their data base was probably no better or worse than the one that Eberli and Ginsberg used to interpret the sequences of the Bahamian Bank, but Purdy and Bertram were not willing to tie the Maldives to the Haq et al. sea level chart. I think it would have been more than an academic exercise to have made this tie. I would have been interesting to see even if the number of events seen in the Maldive lines matched the number events that Haq et al identified in their chart. Clearly this approach would have been highly speculative and even if the number of events in the Maldive matched the Haq curve, it doesn't mean that the curve necessarily would have explained all the events seen in the Maldives. My reading of this paper is that Purdy and Bertram wished to avoid confronting the issue of a specific sea level curve and its role in this area because they felt the data quality did not warrant such an approach. From a conservative and strictly scientific viewpoint, of course, they are right not to do this, but to an enthusiast like me the thrill of science is in making some dangerous assumptions. I felt they should have pushed the envelope further.

The tone of this book, the quality of the illustrations, and the writing are excellent and the information provided is comprehensive. People who are interested in carbonate modeling and particularly in Maldives will find this a really useful book to have in their library or on their own shelves. Purdy and Bertram should be congratulated on this publication, and the potential reader should ignore my pedantic chiding of the authors to have more courage, this latter is more a matter of style, rather than fact. This minor flaw does not detract from the quality of the work and its importance to carbonate geology. I am glad to have this book on my shelves.