The Divergent Evolution of Tropical vs. Subtropical Carbonate Platforms is Related to Their Winter Waters

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9.29.2020 - 10.1.2020 – AAPG Annual Convention and Exhibition 2020, Online/Virtual

Abstract

Modern shallow-water carbonate platforms in the tropics tend to be rimmed with reefs while their interiors collect skeletal detritus. Platforms in the subtropics are quite different and the modern Bahamas provides the quintessential morphotype. These platforms lack well-developed reefal margins and their interiors, while not devoid of skeletal material, have meaningful accumulations of non-skeletal grains. For instance, ooid shoals form where tidal currents are sufficiently focused and lime mud is produced abundantly via whitings in their quiescent platform interiors. The lack of margin reefs in the subtropics has historically been ascribed to the development of chilled winter bank-top waters which are colder than that which can be tolerated by stony corals. So goes the 'inimical bank-water' effect. We believe that this effect stretches far beyond the stunting of margin reefs, however. It exerts substantial control on the sedimentology of subtropical platform interiors and by doing so, wields broad sway on their evolution and architecture. To substantiate this hypothesis we meld fieldwork, remote sensing, machine learning, and facies mapping with hydrodynamic and chemical modelling to contrast the subtropical Bahamian platforms with a similar suite from the tropical South Pacific. In the subtropics, we build a case that pronounced on- to off-platform winter temperature differentials provide a kinetic trigger which boosts copious production of whitings mud. The same trigger might be as important for ooid production. The Bahamas and Arabian Gulf both demonstrate that depositional systems boasting ooid fairways also possess productive whitings factories. On this, a comparison between the sedimentology of the Bahamian Cay Sal Bank and the Little and Great Bahama Banks is particularly informative. The latter pair are large, shallow, and, as revealed by their sea surface temperature climatologies, develop widespread inimical winter waters.

They also produce plentiful whitings and ooids. Cay Sal produces neither. Because it is comparatively small and deep, neither do inimical waters develop atop the Cay Sal Bank. Our study substantiates the view that appropriately sized sub-tropical platforms are predisposed to copious mud production through whitings, a phenomenon which will incline them towards non-rimmed ‘Bahamian-type’ morphologies, quite unlike the underfilled and reef-rimmed platforms of the tropics. Ancient platforms are likely to have been similarly controlled.

AAPG Datapages/Search and Discovery Article # 91200 © 2020 AAPG Annual Convention & Exhibition Online, Sept. 29- Oct. 1.