Platform-Edge, Shallow-Marine, Ooid Grainstone Shoals, Joulters Cays, Bahamas: A Modern Analog of Carbonate Hydrocarbon Reservoirs, in Coastal Depositional Systems in the Gulf of Mexico*

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Extended Abstract

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Introductory Statement

A detailed understanding of modern analogs of ancient grainstone facies can be critical in (1)(determining potential for trend extension from known reservoirs and (2) improving reservoir development. Both of these goals depend upon knowledge of internal depositional geometries of a grainstone body to determine patterns of internal heterogeneity or to predict the lateral extents of a carbonate sand belt. For example, improved understanding of the permeability distributions within reservoirs is essential to achieving the levels of description and quantification required to redesign recovery strategies in low-recovery reservoirs.

PLATFORM-EDGE, SHALLOW-MARINE, OOID GRAINSTONE SHOALS, JOULTERS CAYS, BAHAMAS: A MODERN ANALOG OF CARBONATE HYDROCARBON RESERVOIRS

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A detailed understanding of modern analogs of ancient grainstone facies can be critical in (1) determining potential for trend extension from known reservoirs and (2) improving reservoir development. Both of these goals depend upon knowledge of internal depositional geometries of a grainstone body to determine patterns of internal heterogeneity or to predict the lateral extents of a carbonate sand belt. For example, improved understanding of the permeability distributions within reservoirs is essential to achieving the levels of description and quantification required to redesign recovery strategies in low-recovery reservoirs.

The Joulters Cays ooid shoal and associated environments, located north of Andros Island, Great Bahama Bank (Fig. 1), was selected as an outstanding example of a wave/storm-dominated marine sand belt. The regional distribution of modern sediments in the Joulters Cays area has been documented by Harris (1979) through description of surface samples and shallow cores. The study by Harris was based on cores from locations averaging 1 mi apart and is considered regional in nature. In contrast, interwell heterogeneities have been documented in subsurface reservoirs to be on the scale of hundreds of feet or less (Tyler *et al.*, 1984; Bebout *et al.*, 1987; Ruppel and Cander, 1988; Bebout and Harris, 1990; Major *et al.*, 1990). The present study is intended to be a more detailed investigation of a portion of the Joulters sand shoals and is based on 39 cores and almost 200 probe sites from a 1 mi^2 area (Figs. 1 and 2). The objective of this study is to document textural and early diagenetic variations within the upper grain-dominated part of an upward-shoaling sequence at a scale of detail unmatched by previous studies of modern carbonate depositional environments and equivalent to documented reservoir heterogeneities.

Depositional facies geometries and early diagenetic alteration both contribute to fine-scale heterogeneities in the Joulters ooid shoal. Three depositional facies identified from cores taken through the ooid shoal complex (Figs. 3 and 4) are (1) well-sorted, crossbedded ooid, (2) burrowed ooid, and (3) poorly sorted ooid. All three facies occur within the ooid grainstone zone of Harris (1979). The well-sorted, crossbedded ooid facies is deposited in the active, high-energy bar crest; the coarsest average grain size (0.05 mm) occurs in this facies. Even, parallel, seaward-inclined laminations are the most common structures on the seaward side, but bankward-inclined avalanche bed sets occur locally in storm-washover deposits on the bankward side. Seaward of the bar crest, burrowed ooid facies accumulated below normal wave base. Sand of the burrowed ooid facies is finer grained (0.02 to 0.05 mm), and burrows are the dominant structures; this facies also occurs on the bankward side of the bar just beneath the poorly sorted ooid facies. The poorly sorted ooid facies, which is stabilized by Thalassia (seagrass) and Goniolithon (branching red algae), occurs just bankward of the bar crest and is fine grained (0.02 to 0.05 mm) and contains up to 5 percent carbonate mud. Differences between the three facies that potentially may

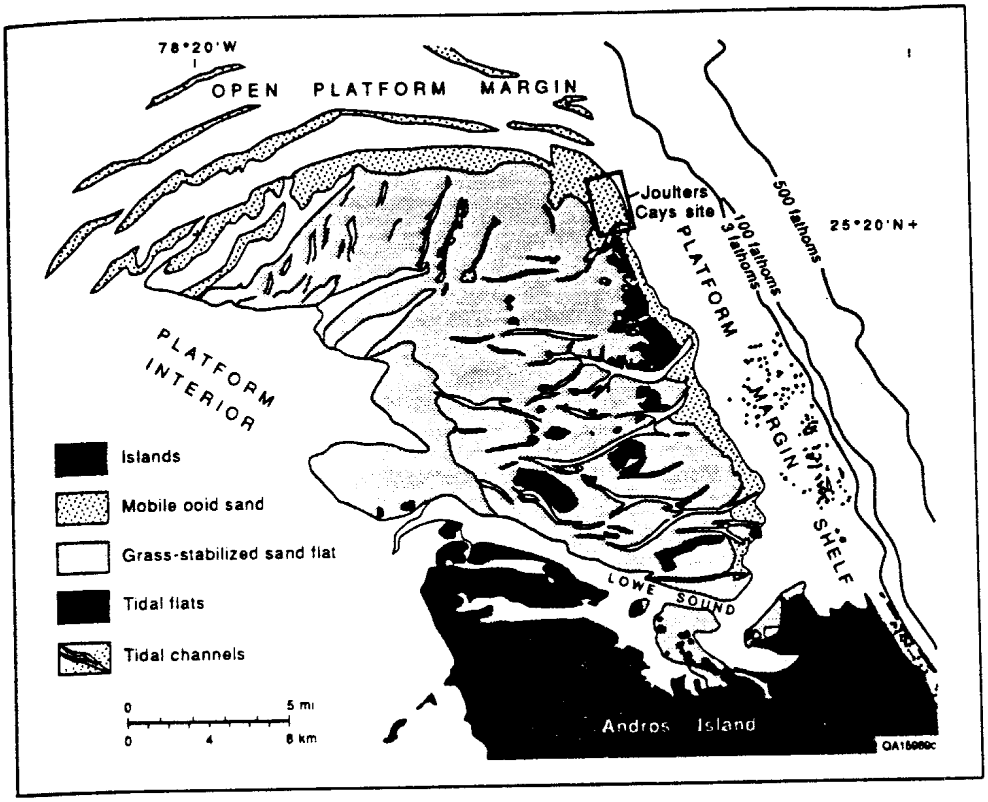

Figure 1. Joulters Cays ooid shoal, north of Andros Island, Great Bahama Bank. The area of detailed study is indicated by the small rectangle in the wave/storm-dominated marine-sand belt.

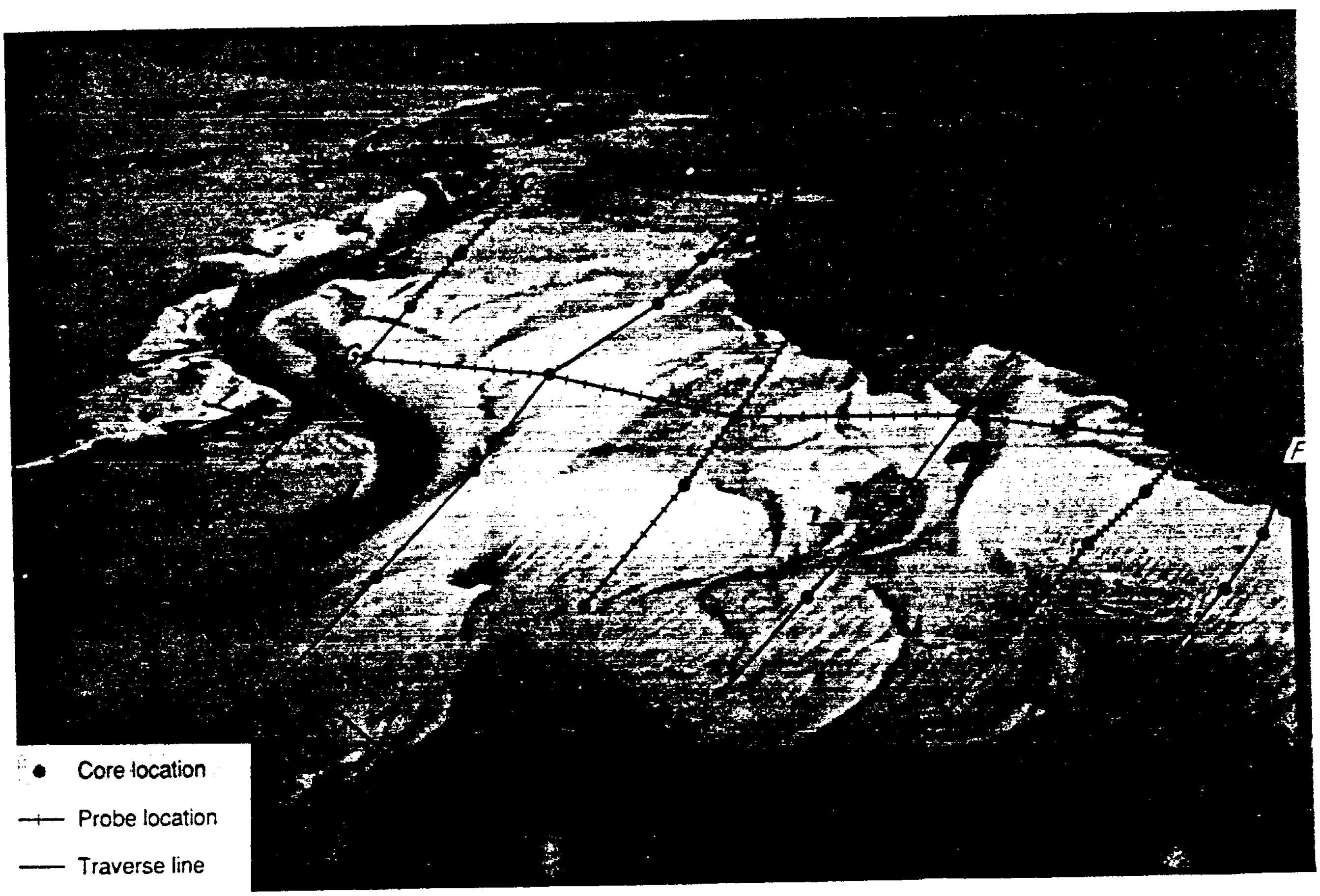

Figure 2. Oblique aerial view of the Joulters Cays wave/storm-dominated marine-sand belt with core (large dots) and probe (dashes) locations and lines of cross sections.

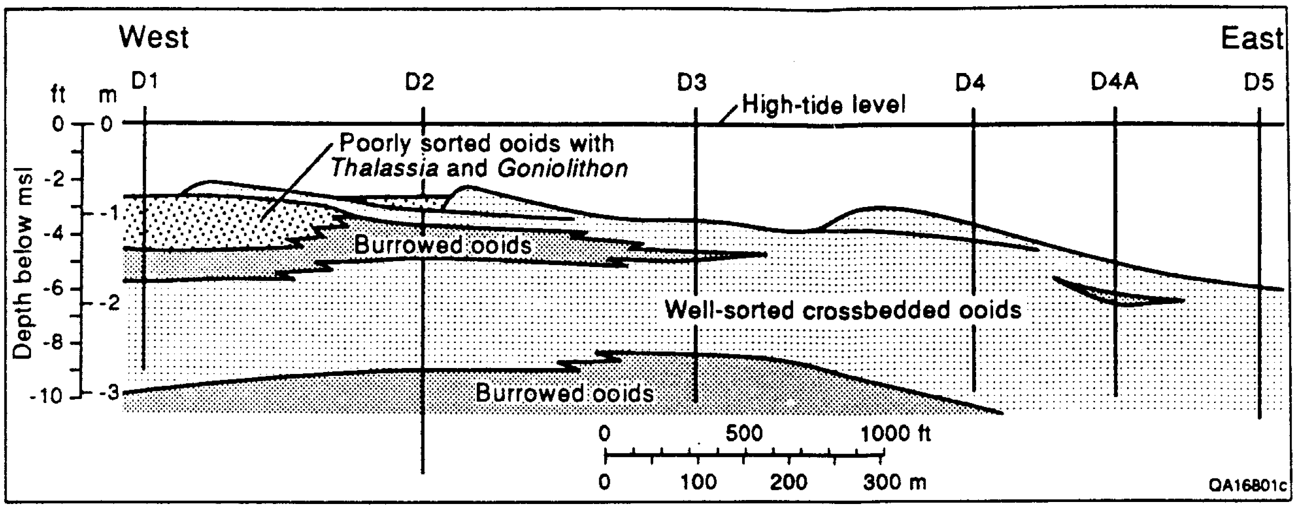

Figure 3. Cross section DD' showing the changes in textures and structures across the Joulters wave/storm-dominated marine-sand belt. Location of section is shown in Figure 2.

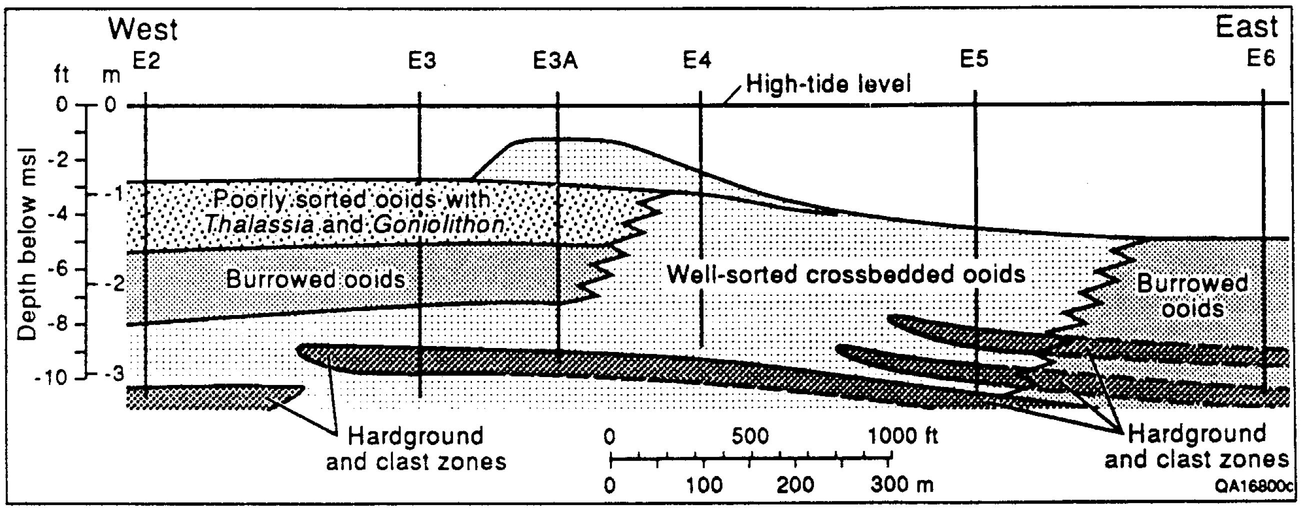

Figure 4. Cross section EE' showing the changes in textures and structures across the Joulters wave/storm-dominated marine-sand belt. Location of section is shown in Figure 2.

lead to heterogeneity are grain size, grain sorting, and sedimentary structures.

The early diagenetic alteration is represented by hardgrounds and clast zones (Fig. 4). These zones of early fibrous aragonite cementation are common as thin, seaward-offlapping layers near the base of the section, where they have been correlated laterally as far as 2,000 ft by probe transects. The hardgrounds and clast zones are particularly well developed in the northern two cross sections (EE' and FF') (Fig. 2). Porosity and permeability are not yet greatly reduced in these modern lithified zones, but with additional cementation these zones could form barriers to fluid flow.

Modern sand bodies in the Bahamas have been commonly used as analogs of ancient sand bodies in the subsurface. Reservoirs analogous to Bahama sand bodies occur in the West Texas Permian Basin, where production is dominantly from skeletal, pellet, and ooid grainstones of the San Andres and Grayburg Formations. The examination of modern sand bodies in greater detail will aid the progression beyond current capabilities in prediction and quantification of reservoir heterogeneity and reservoir extension in carbonate grainstone reservoirs worldwide.

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