Reservoir Characteristics of the Smackover Formation at the Little Cedar Creek Field, Conecuh County, Alabama

Ezat Heydari[1] and Lawrence R. Baria[2]

[1]Department of Physics, Atmospheric Sciences, and Geoscience,
Jackson State University, P.O. Box 17660, Jackson, MS 39217

[2]Jura-Search Inc., P.O. Box 320426, Flowood, MS 39232

EXTENDED ABSTRACT

The Little Cedar Creek Field appears to be the largest Smackover field discovered in the northern U.S. Gulf Coast in the last three decades (Fig. 1). By June 2006, the field demonstrated an oil column of at least 850 feet, and extended along strike over eight miles in length (Fig. 1). The goal of this short communication is to present characteristics of the reservoir lithofacies in this field.

Seven lithofacies were recognized (Heydari and Baria, 2005). From base to top they include the following: (1) laminated peloid wackestone (S-1); (2) bioturbated, peloid packestone (S-2); (3) microbial bindstone (S-3); (4) laminated peloid wackestone-packstone (S-4); (5) bioturbated peloid packstone (S-5); (6) peloid-ooid grainstone (S-6); and (7) wackestone, shale, and siltstone (S-7) (Fig. 2).

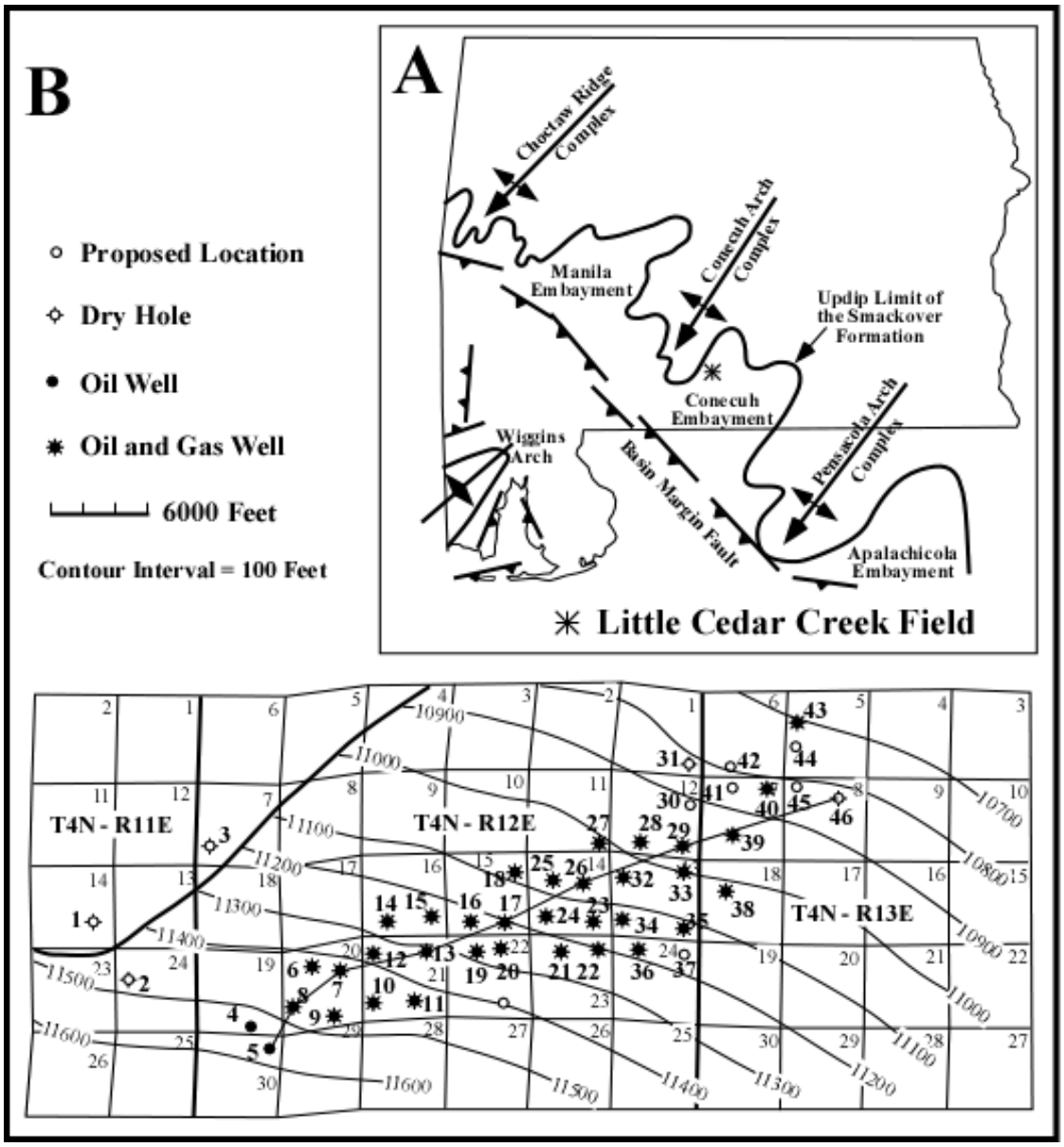
Characteristics of these lithofacies indicate deposition in a ramp environment (Fig. 3). The stacking pattern of these lithofacies suggests that the Smackover Formation in this field consists of one shoaling upward cycle (Fig. 2). The deposition of the cycle began with the laminated peloid wackestone lithofacies which overlays the conglomerate of the Norphlet Formation with a very sharp contact, indicating that a rapid transgression submerged dunes and alluvial fans of the Norphlet Formation (Fig. 2). A long-term progradation resulted in the deposition of the observed stacking pattern (Fig. 3). The deposition of this cycle was terminated by the grainstones of the beach (lithofacies S-6) and siliciclastics of tidal flat environments (lithofacies S-7).

Of the seven lithofacies of the Smackover Formation, two form excellent reservoirs. These are the microbial bindstone (S-3) and the peloid-ooid grainstone lithofacies (S-6) (Fig. 2). The two reservoirs are separated from one another by a non-porous and non-permeable horizon (Figs. 2 and 4).

The microbial lithofacies of the Smackover Formation has been the center of intense study due to its excellent porosity and permeability characteristics (Kopaska-Merkel, 1994; Kopaska-Merkel and Schmid, 1999; Parcell, 2002; Mancini *et al.*, 2004). The microbial bindstone reservoir at the Little Cedar Creek Field is 10 to 30 feet thick (Fig. 2). It consists of pellets, peloids, ostracods, and forams which were binded and cemented by a combination of microbial and abiotic processes resulting in the formation of reefal character (Fig. 5). The porosity of microbial lithofacies at the Little Cedar Creek Field ranges from 2 to 30%. Dominant porosity types are framework and intergranular (Figs. 2 and 5). The microbial reef reservoir is overlain by a bioturbated peloid packstone lithofacies with little porosity and permeability which forms the seal (Fig. 2). The dominant process which resulted in the preservation of porosity was marine diagenesis including microbial binding and cementation.

The upper reservoir consists predominantly of a cross-laminated peloid and ooid grainstone and ranges in thickness from 10 to 30 feet (Fig. 2). This reservoir grades upward into wackestones and then into green and red shales. Its dominant porosity types are intergranular, modic, vuggy, and intercrystalline (Fig. 6). Processes which resulted in the reservoir formation were meteoric in nature causing dissolution of originally aragonitic grains.

Unlike virtually all other Smackover fields in the Eastern Gulf, Little Cedar Creek does not possess a Buckner Anhydrite top seal immediately above the reservoir. Although these stratal geometries and facies are not uncommon throughout the Smackover trend of southwestern Alabama, Little Cedar Creek Field is unique in that both of its reservoirs are composed predominantly of limestone, not dolomite, as is the case in most Smackover fields in this region.



ACKNOWLEDGMENTS

This study was supported in part by the American Chemical Society – Petroleum Research Fund Grant # 37924-AC to Ezat Heydari, by Jura Search, Inc., and by Jackson State University. We are also thankful to Ms. Carolyn Morrison who provided generous assistance during the investigation.

REFERENCES CITED

Heydari, E. and Baria, L. R., 2005, A microbial Smackover Formation and the dual reservoir – seal system at the Little Cedar Creek Field in Conecuh County of Alabama: Gulf Coast Association of Geological Societies Transactions, v. 55, p. 294-320.

Kopaska-Merkel, D. C., 1994, Oncoids to reef: Rolling stones come to rest in the Smackover Formation: Gulf Coast Association of Geological Societies Transactions, v. 44, p. 347-353.

Kopaska-Merkel, D. C., and D. U. Schmid, 1999, New (?) bioherm-building tabular organisms in Jurassic Smackover Formation, Alabama: Gulf Coast Association of Geological Societies Transactions, v. 49, p. 300-309.

Mancini, E. A., J. C. Llina, W. C. Parcell, M. Aurell, B. Badensa, R. R. Leinfelder, and D. J. Benson, 2004, Upper Jurassic thrombolite reservoir play, northeastern Gulf of Mexico: American Association of Petroleum Geologists Bulletin, v. 88, p. 1,573-1,602.

Parcell, W. C., 2002, Sequence stratigraphic controls on the development of microbial fabrics and growth forms – implications for reservoir quality distribution in the Upper Jurassic (Oxfordian) Smackover Formation, eastern Gulf Coast, U.S.A.: Carbonates and Evaporites, v. 17, p. 166-181.

(FACING PAGE) Figure 1. (A) Map of the southern part of Alabama shows the updip limit of the Smackover Formation, major arches and basins, and the location of the Little Cedar Creek Field. (B) Map shows well location of the Little Cedar Creek Field as of June 2006 (modified after Heydari and Baria, 2005). Also shown is the location of the cross-section presented in Figure 4. The wells in the field are as follow: 1 = Hunt #1 Cedar Creek 14-9; 2 = Midroc #1 Cedar Creek 24-5; 3 = Group One #1 Cedar Creek 7-13; 4 = Midroc #1 Cedar Creek 19-15; 5 = Hunt #1 Cedar Creek 30-1; 6 = Midroc #1 McCreary 20-6; 7 = Midroc #1 Cedar Creek 20-7; 8 = Midroc #1 Cedar Creek 20-12; 9 = Midroc #1 Oliver 20-15; 10 = Midroc #1 Cedar Creek 21-12; 11 = Midroc #1 Cedar Creek 21-10; 12 = Midroc #1 Cedar Creek 21-4; 13 = Midroc #1 McCreary 21-1; 14 = Midroc #1 Cedar Creek 16-14; 15 = Midroc #1 Cedar Creek 16-16; 16 = Midroc #1 Overby 15-14; 17 = Midroc #1 Stuart 15-15; 18 = Midroc #1 Cedar Creek 15-8; 19 = Midroc #1 Pugh 22-3; 20 = Midroc #1 Pugh 22-2; 21 = Midroc #1 Johnson 22-15; 22 = Midroc #1 Findley 23-3; 23 = Midroc #1 Sanders 23-1; 24 = Midroc #1 Tisdale 14-16; 25 = Midroc #1 Price 14-12; 26 = Midroc #1 Whatley 14-6; 27 = Midroc #1 Horton 14-7; 28 = Midroc #1 Cedar Creek 11-16; 29 = Sklar #1 Craft-Evers 1-16; 30 = Midroc #1 McCreary 12-8; 31 = Midroc #1 Horton 12-14; 32 = Midroc #1 McCreary 12-16; 33 = Midroc #1 Tisdale 13-5; 34 = Midroc #1 Tisdale 13-1; 35 = Midroc #1 Tisdale 13-13; 36 = Midroc #1 McCreary 13-16; 37 = Midroc #1 Tisdale 24-3; 38 = Midroc #1 McCreary 24-1; 39 = Midroc #1 McCreary 18-6; 40 = Midroc #1 McCreary 7-11; 41 = Sklar #1 Craft-Mack 7-3; 42 = Sklar #1 Craft-Mack 7-2; 43 = Sklar #1 Craft-Mack 6-14; 44 = Sklar #1 Craft-Cedar Creek 5-5; 45 = Sklar #1 Craft-Mack 5-12; 46 = Sklar #1 Craft-Mack 8-4; 47 = Sklar #1 Craft-Mack 8-7.

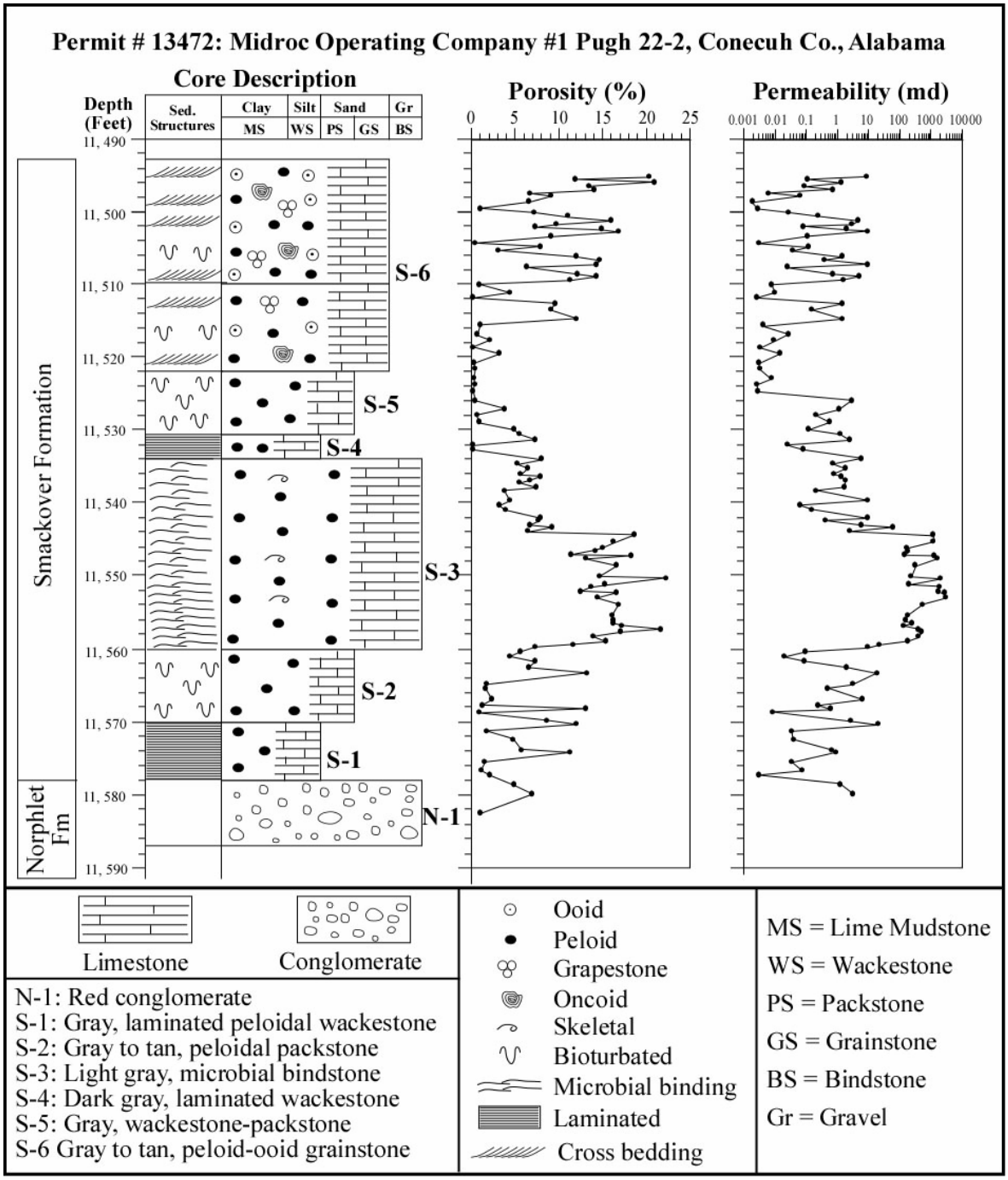


Figure 2. Stratigraphic column shows lithofacies characteristics of the well permit #13472 core (Midroc #1 Pugh 22-2, well #20 in Figure 1B). The core encompasses the entire thickness of the Smackover Formation at the Little Cedar Creek Field. Porosity and permeability of this core clearly show two distinct reservoir horizons (modified after Heydari and Baria, 2005).

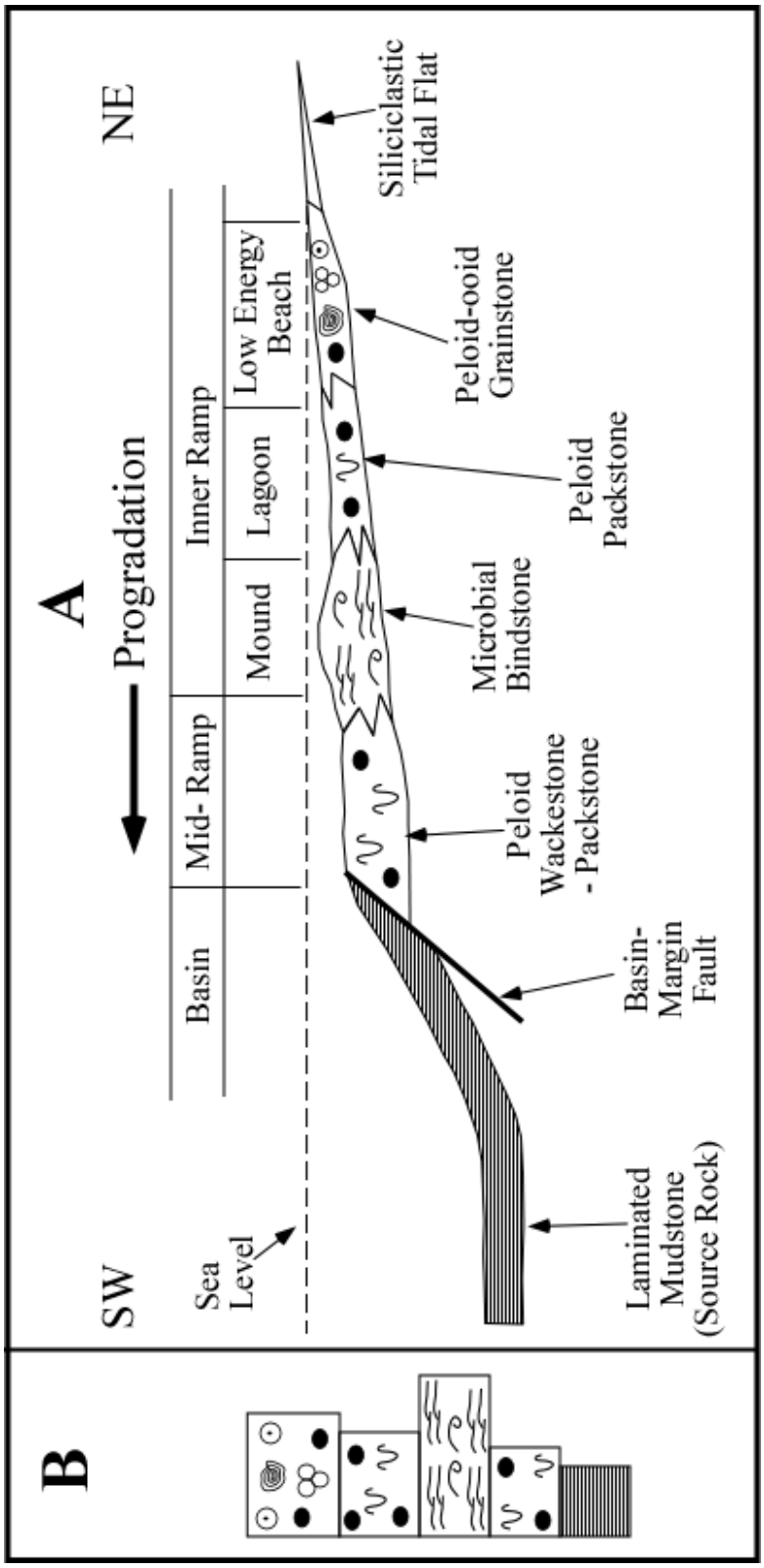


Figure 3. (A) Schematic diagram shows depositional setting of the Smackover Formation at the Little Cedar Creek Field. The peripheral fault system may have been responsible for the formation of a distally steepened ramp. Very gently-sloping mid- and inner ramp environments formed north of the fault system and a basin to the south of the fault. The peolidal wackestone – packestones (lithofacies S-1 and S-2) deposited in the mid-ramp environment. The microbial bindstone (lithofacies S-3) developed as a mound in the inner ramp. The bioturbated peloid packstone (lithofacies S-5) formed in a very shallow semi-restricted lagoon north of the reef. The ooid grainstone (lithofacies S-6) represented a beach. (B) Schematic stratigraphic column shows the stacking pattern of the lithofacies after the completion of the progradation (modified after Heydari and Baria, 2005).

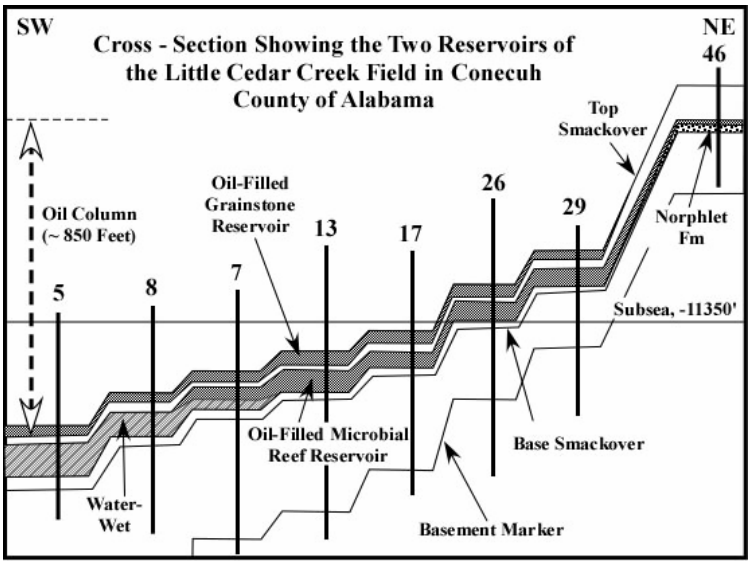


Figure 4. Northeast-southwest cross section shows two separate reservoirs of the Little Cedar Creek Field. The location of the cross section and the names of the wells are shown in Figure 1B.

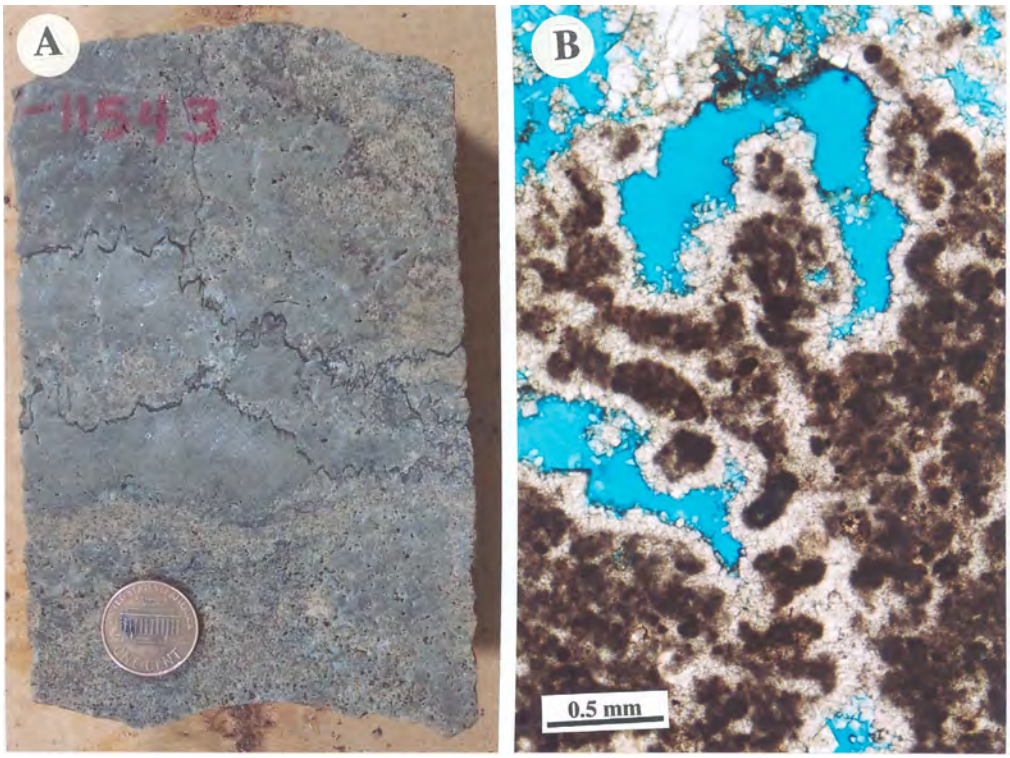


Figure 5. (A) Core photomicrograph of the microbial bindstone (lithofacies S-3) shows its monotonous character with irregular horizontal banding (well permit #13472, 11543 feet). (B) Thin-section photomicrograph (plane polarized light) of the microbial bindstone shows the pelleted nature of this lithofacies. Pellets have the typical microbially produced characteristics. Note the abundance of marine cements that occur as rinds around grains or fill intergranular pores. Porosity is framework type pores (well permit #13472, 11553 feet).

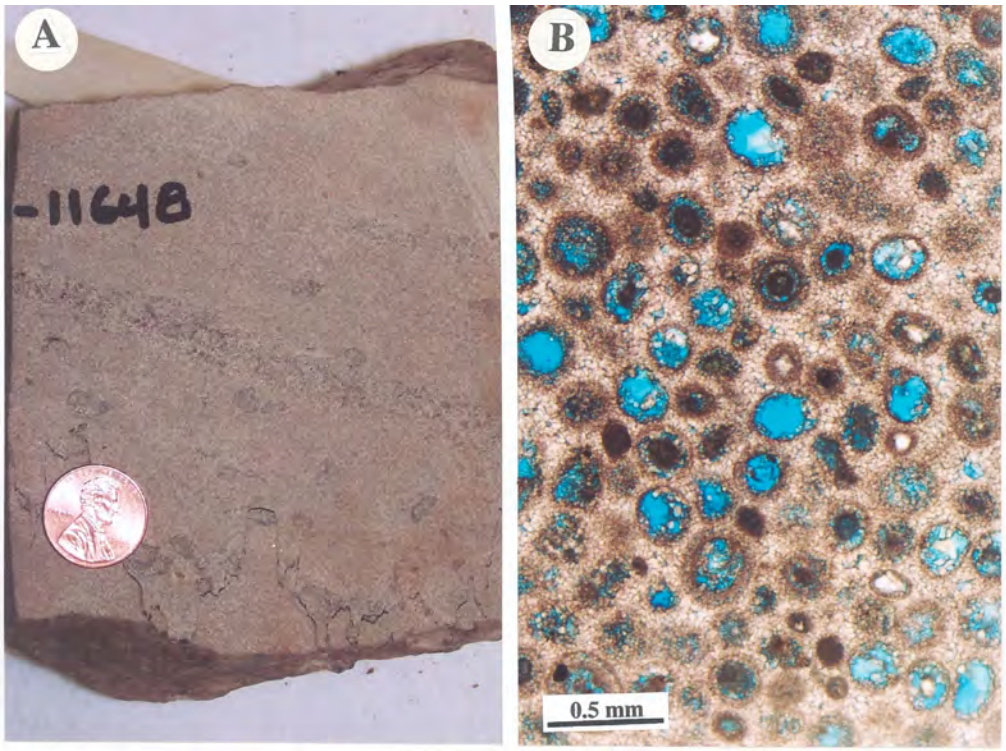


Figure 6. (A) Core photograph of the peloid-ooid grainstone (lithofacies S-6) shows cross lamination observed in this lithofacies (the well permit # 13301, 11648 feet). (B) Thin section photomicrograph of grainstone lithofacies shows moldic porosity formed after the leaching of originally aragonitic ooids (the well permit # 11963, 11867 feet).