Wednesday, March 27, 2002

Petroleum Club, 800 Bell (downtown)
Social 11:15 a.m., Lunch 11:45 a.m.

Cost: $25 Preregistered members; $30 Nonmembers & Walk-ups

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by Fred L. Stricklin, Jr.
Wilcox Exploration Enterprises
Houston, Texas

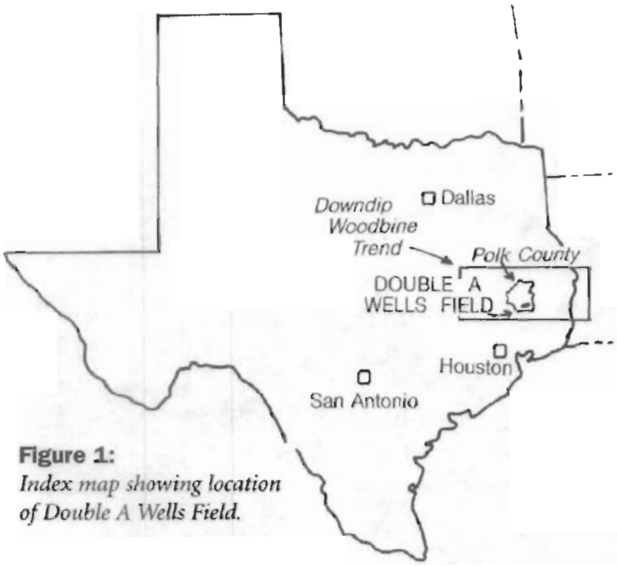

Figure 1:
Index map showing location of Double A Wells Field.

Evolution and High Dissolution Porosity of Woodbine Sandstones in a Slope Submarine Fan, Double A Wells Field, Polk County, Texas—*A Deep Water Gulf of Mexico Model Onshore*

Abstract

The subject field, a gas condensate giant located 75 miles NE of Houston, Texas (Figure 1) will eventually produce close to half a TCFG and 20 MMBC. The gas is trapped in lenticular sandstones that pinch out updip or have reduced permeability along thinned edges. Buried nearly 14,000', the slightly overpressured (0.7 gradient) fine-grained quartz sandstones have unusually good reservoir quality (cover inset, Figure 5), up to 23% porosity and 1 darcy permeability.

The sandstones are the terminal fill of a submarine canyon, initially 700–800' deep and 4 1/2 miles wide (Figure 2), which probably resulted from gravitational failure of oversteepened, progradational shales, seen as clinoform reflections on dip seismic lines, above the buried Sligo (LK) shelf margin (Figures 2, 3). The clinoform sequence is overridden by landward, onlapping deposits of a major marine transgression (late Cenomanian–Turonian) consisting of the Woodbine sandstone sequence, thin Rapides shale, and Austin chalk. As shown in Figure 3, the Woodbine sandstones, comprising the basal member of the transgression, are considered to be contemporaneous with and connected to producing sandstones of updip fields.

Sandstones of the submarine fan are encased in organic-rich source rocks including interfingering and underlying Eagle Ford shale, overlying Rapides shale, and basal Austin chalk. The organic content level of the shales has been established by previous workers, and the basal Austin chalk lime mudstone is a well-known producer from fractured reservoirs in the area (Brookland Field). The source rocks at Double A Wells Field are presently discharging gas at a temperature of 325-350° Fahrenheit.

The exceptional reservoir quality of multiple sandstones at Double A Wells Field (Figure 4) involves the early emplacement of pore-filling calcite cement after incipient quartz overgrowths, followed by cement dissolution by acidic waters during deeper burial. Note the calcite cement (orange) undergoing dissolution in the center of the cover photo. Acidic waters containing dissolved CO_2 (carbonic acid) are postulated from two sources: 1) organic-rich proximal source rocks; and 2) inorganic chemical reactions of kaolinite with other minerals in very thick, hotter shale sections downdip, connected to field reservoirs by sandstone "pipelines". The latter inorganic source is favored to supply the greatest volume of acidic waters needed for cement removal. Both the organic and inorganic sources have been documented by geochemists.

After cement dissolution the restored, born-again "surrogate" pores, mimicking early primary porosity, were invaded by oil

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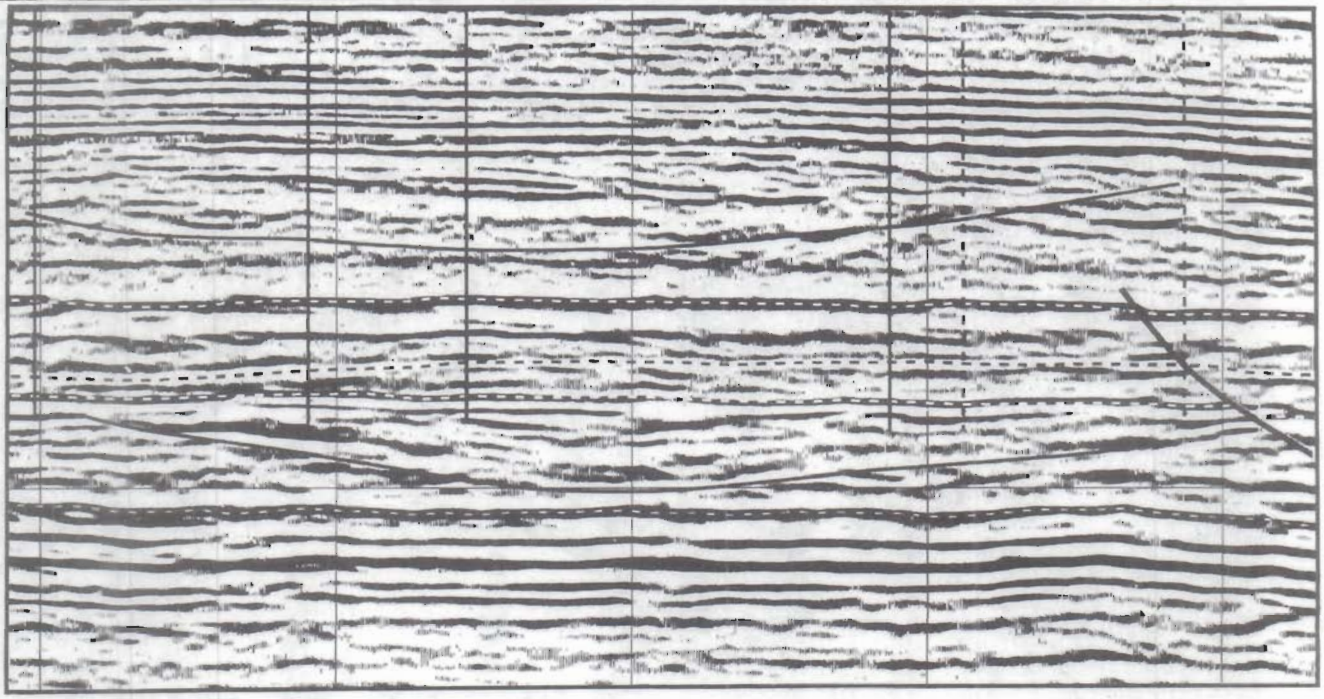
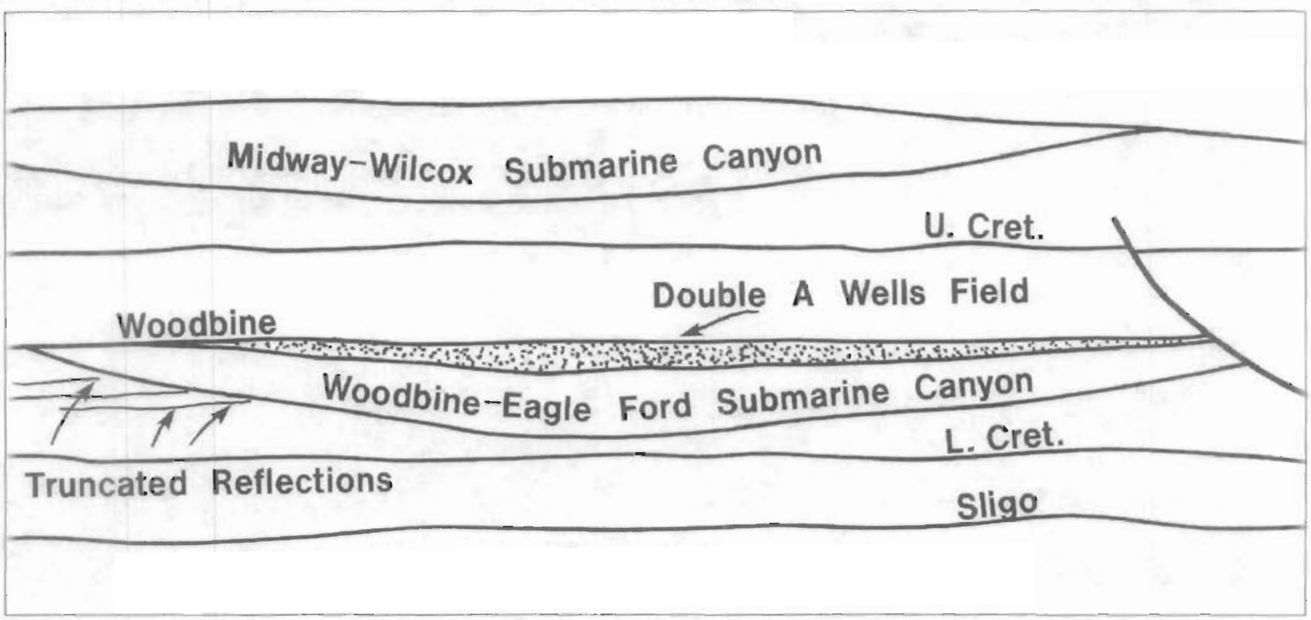


Figure 2: *Interpretation of 3-D seismic line across Double A Wells Field. The canyon was formed in late Woodbine-Eagle Ford time as indicated by truncated seismic reflections along its upper wall. Note the superposed Midway-Wilcox canyon.*



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(left as part of the black stain around grains, cover inset, Figure 5) then replaced by gas with increasing burial temperature. The gas contains 4 to 6% CO_2.

Hopefully, the geological model presented here, combined with 3-D seismic data, will lead to the discovery of other Woodbine sandstone "sweet spots" containing future giants waiting to be found in this heavily explored trend.

Biographical Sketch

Fred L. Stricklin, Jr. graduated from Louisiana State University just after the middle of the last century with a PhD in geology. After working 21 years with Shell as a research and exploration geologist, achieving the rank of Senior Staff geologist, Fred left Shell during the "Great Boom" of the 1970s to become an independent geologist. For the past 21 years, he has worked primarily conducting exploration analyses of Texas oil and gas trends for sale to industry under his company names of Exploration Trend Analyses and Wilcox Exploration Enterprises.

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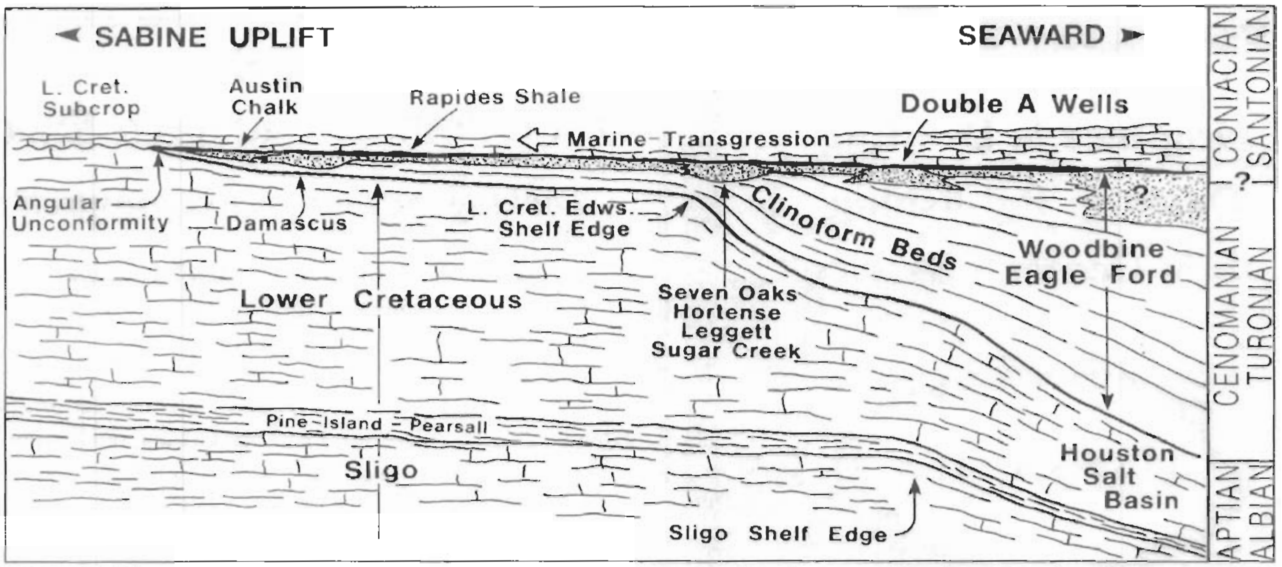

Figure 3: *Diagrammatic dip section showing Woodbine-Eagle Ford stratigraphic relations and location of Woodbine fields. Note the clinoform beds in the Eagle Ford shale that reflect seaward growth of the slope.*

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Acknowledgements

I wish to gratefully thank Dr. John T. Smith, retired "Professor Emeritus" formerly of Shell Development Company, who spent 35 years working on geochemical problems related to oil and gas exploration. John patiently helped me to understand the role of circulating subsurface fluids involved in pore preservation and destruction. Appreciation is also extended to Dr. Michael Lloyd, likewise retired from Shell and now President of Roxanna Petroleum, who assisted in the same capacity. Many thanks are also due Tom Carter, CEO of Black Stone Energy, the company that discovered Double A Wells Field, for permission to use the data presented in the paper and talk. ☐

References Available Upon Request.

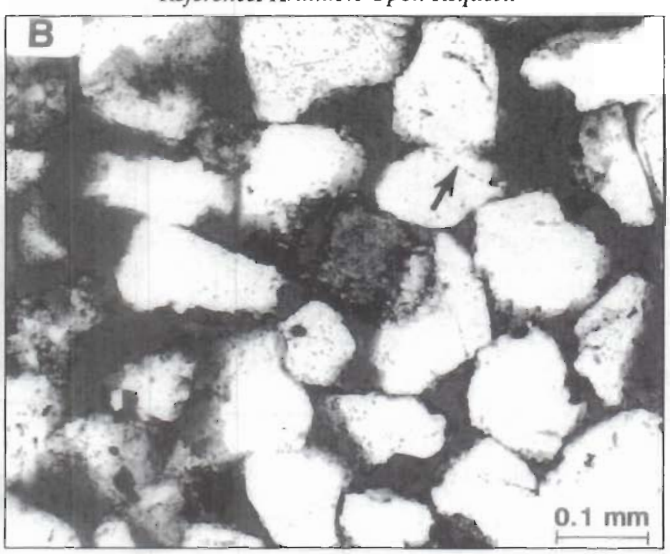

Figure 5: *Thin section photograph of dissolution porosity (blue) in fine-grained Woodbine sandstone gas reservoir at 13,946' in Double A Wells field, Polk County, Texas (see also cover inset). Porosity 21%, Perm. 931 md, Mag. X 125. Photo by George Bolger, PetroTech Assoc.*

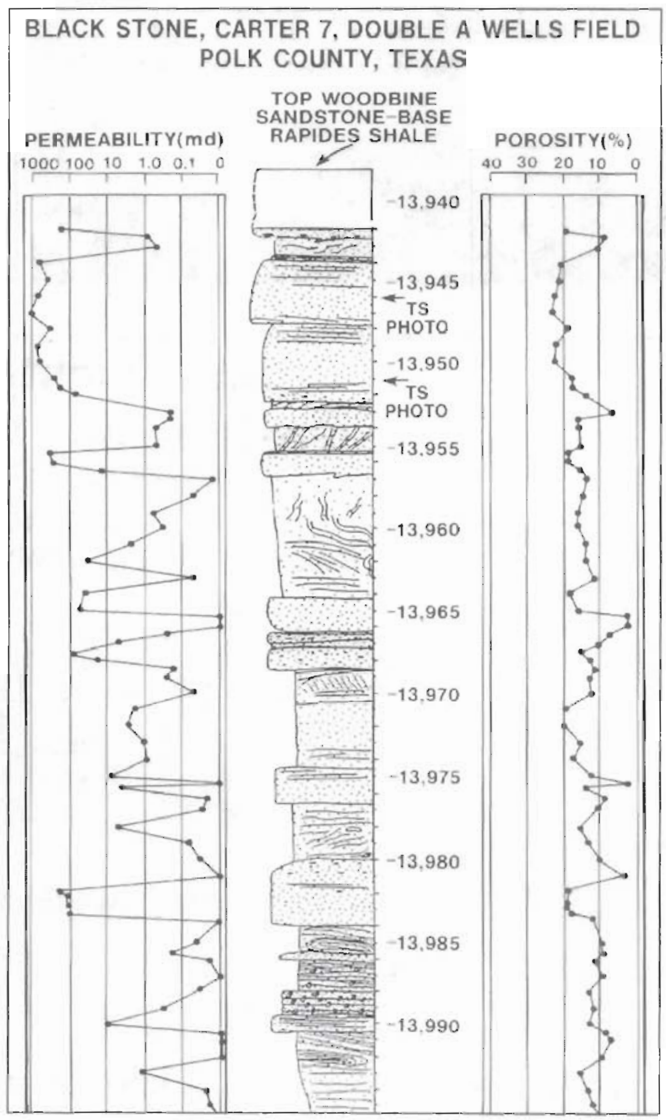

Figure 4: *Core depiction and porosity-permeability plots of upper Woodbine sandstones in the "sweet spot" of the field. Modified after George Bolger, PetroTech Associates, who analyzed the core for Black Stone Energy.*