THE DEPARTMENT OF ENVIRONMENTAL QUALITY

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INDEX TO *MISSISSIPPI GEOLOGY*, VOLUMES 1-10

compiled by
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This issue of *Mississippi Geology* completes ten volumes of publication. The Index to *Mississippi Geology*, Volumes 1-10, contains an author index and a title index to the articles appearing in all 40 issues. Also included is a list of the back issues, showing which are available or out of print. These indexes indicate the diversity of subjects and authors contained within the journal's first decade of publication. They include some 100 articles written by 75 authors representing 31 different institutions in 11 different states and 2 foreign countries. The number of articles contributed by outside authors and the steadily increasing subscription list are indications of the success of the journal. We are proud of this success and appreciate our many authors and subscribers.

The Author Index is an alphabetical listing of authors, including junior authors, of all articles for which an author's name was printed. The Title Index is an alphabetical listing of article titles; it can be used to locate an article or subject of interest. The numbers at the end of each entry in the indexes give the volume, number, and page numbers for that article. For example: 1(2), 1-3 signifies Volume 1, Number 2, pages 1 through 3.

The list of back issues, in addition to showing availability, gives the date each issue was actually mailed (bulk mailing) and the number of copies mailed. The original mailing list developed in 1980 was continuously added to as people and libraries requested subscriptions. After several years the distribution exceeded 2000, but many copies were going to old addresses of people who had moved and there was some duplication. In 1988 we updated the mailing list by printing a subscription renewal notice in the June issue. The old list was discarded and a new list created from those renewal notices that were returned. We accomplished our purpose of paring down the mailing list to those who truly wished to receive the journal. The number of subscribers is steadily increasing.

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Format for Articles Submitted

The editors of *Mississippi Geology* invite contributions of short articles pertaining to the geology, paleontology, and mineral resources of Mississippi. Preference is given to technical articles, overview articles and general articles of wide appeal to geologists, non-specialists, and the interested lay public.

Text

Articles submitted to *Mississippi Geology* may include an abstract, introduction, previous investigations, methods, discussion, conclusions, acknowledgments, and references cited. Article length should be approximately 1500 to 2500 words; brevity and conciseness are stressed. Those papers having less than 1500 words need not include an abstract.

Manuscripts should be typed on good quality white bond paper with wide margins on all sides. The references and figure captions should be typed on separate pages. References must be cited in the manner shown in the examples below: i.e., author, date, title of article, journal, volume, and pages. Submit the original and one copy of the paper. Double space *everything*.

Illustrations

Photographs accompanying the text should be black-and-white glossy prints with good contrast. Photographs, tables, maps, diagrams, and other illustrations should be clearly numbered on the back; do this carefully to avoid indentations or smeared ink. Do not attach captions to illustrations.

Photographs and other illustrations should be submitted at the correct size for printing: page length 9"; page width 7"; width of one column 3.3". Tables and illustrations *must be* camera-ready and require no additional drafting work. Borders around figures are not required.

Style for References

Article:

Frazier, M. K., 1980, Archaeocetes: whale-like mammals from the Eocene of Mississippi: Mississippi Geology, v. 1, no. 2, p. 1- 3.

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MISSISSIPPI'S FIRST HORIZONTAL WELL COMPLETIONS

Jack Moody
Mississippi Bureau of Geology

Perhaps the biggest buzzword in the oil patch these days is horizontal drilling. The application of this technology is being utilized in a number of geographical areas of the U. S. and throughout the world. The biggest domestic play at present would have to be the Austin Chalk of Texas. Here the advantage of drilling sideways has allowed operators to encounter multiple fracture zones. These fracture zones parallel each other and each is a separate producing reservoir. Thus horizontal drilling allows for multi-zoned completions within the same stratigraphic horizon. With vertical wells one could easily drill in between fracture systems or just catch a few fractures and either end up with a clean dry hole or, worse, a very poor completed well.

An unusual quirk in the Austin Chalk play is the fact that the well is allowed to produce while the well is continuing to drill. This is a result of drilling the wells with an underbalanced mud weight. When the bit cuts through an oil-bearing fracture, the pressure in the fracture is greater than the hydrostatic head and the zone flows into the bore hole. This not only solves lost circulation problems but it can yield some early production. A number of wells have produced 6000 to 7000 barrels of oil before the well reached total depth! Of course an operator has to be very safety conscious when drilling and producing at the same time. The first serious blow-out and fire in a horizontal Austin Chalk well occurred on May 8, 1990. The rig was lost and three men were injured but fortunately there were no fatalities.

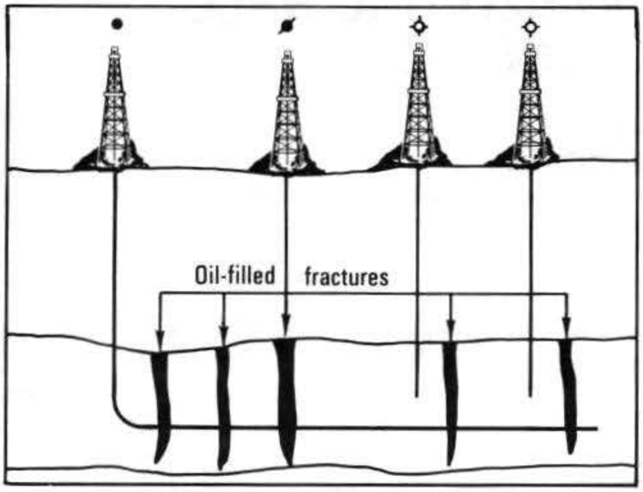
Another big play is in the Bakken Shale of North Dakota. The Bakken is a fractured shale. There are some very nice completions being made, e.g. 1362 BOPD (barrels of oil per day) in an area where nearby vertical wells produce around 50 BOPD. Both the Austin Chalk and the Bakken Shale are producing from natural fractures. Due to the publicity these plays have received, there is a national search for plays which would apply horizontal drilling techniques to fractured reservoirs.

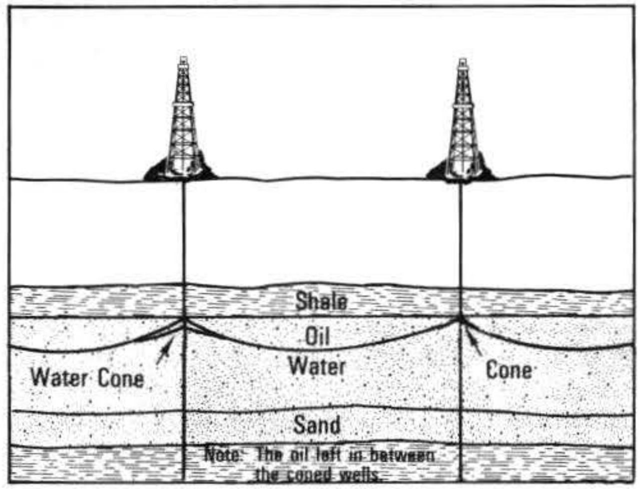
All the excitement surrounding the horizontal completions is a refreshing and needed encouragement to the oil patch. Yet, amid all this excitement one must remember that the whole idea of exploring and drilling is to make money. Horizontal drilling is not cheap. In the Austin Chalk trend one can expect to pay $1,000,000 for a completed 7000 foot vertical/2500 foot horizontal well. The rule of thumb in that trend is horizontal wells cost about twice that of vertical wells. The cost can start off even higher, and problems can jump the expense substantially. Once some experience is gained the cost can be reduced; some cases have resulted in horizontal drilling cost only 1.3 times that of vertical wells. Also remember that horizontal wells do not change the reservoirs; they are a way to reach those reservoirs. If you drill into a depleted zone you'll get a well performance which reflects the degree of depletion. In other words, horizontal drilling is not magic as I am sure some promoters will portray it.

In areas where the conditions are right the use of horizontal drilling is and will be rewarding. It can be the "right tool for the right job."

Not everyone is thinking just fractured reservoirs for this technology. Take for instance Mississippi's first horizontally completed wells, the Amoco #17 USA-McKenna and the #18 USA- McKenna. These two Amoco wells were not drilled in the chalk, they were in the Wilcox. Now one needs to understand that the Wilcox is about as far away in rock quality from fractured chalk as one can get. So what was Amoco doing in the Wilcox? This is a case where a new technology is being applied to varying problems. In the Wilcox the problem is the coning of water around vertical wells. The Wilcox reservoir quality is about as good as it gets. There is very high porosity and permeability so the fluids move easily to the bore hole. The bane of this situation is the fact that water will move more easily than oil. As a well is being produced a cone of water may develop near the perforations. If the water reaches the perforations the well will experience an increase in water relative to the oil. If the water volume becomes too high the operator may have to abandon the well. Abandonment under this scenario would leave unrecovered reserves between the old producing wells. If you happen to have a field where there is oil on water and your wells are making 98% water and 2% oil, you are probably close to either plugging the production or trying something in hopes of improved recovery.

This was the situation which Amoco recently studied





at Clear Springs Field in Franklin County, Mississippi. There they had 14 feet of oil on the top of a 200-foot sand. The field was making 200 BOPD and 12,000 BWPD from ten wells. If one believed that water coning was a problem in this field then perhaps some experimentation could be financially justified. With such a case in Clear Springs Field, Amoco chose to apply horizontal drilling in what would otherwise appear to be a depleted field. The plan was to drill a medium radius well with approximately 500 feet of horizontal section. The true vertical depth would be about 4700 feet but the drilled depth would approach 5300 feet. Amoco drilled and completed two horizontal wells, the #17 USA-McKenna and the #18 USA-McKenna. While in the horizontal phase of drilling Amoco was able to keep the vertical drift or high-low to 5 feet in one well and 3 feet in the other. In other words, they could drill right across the top 5 feet of the zone in one well and the upper 3 feet in the other well. The wells were perforated through cemented casing.

Throughout their operations, Amoco was performing a number of experimental procedures, which added to the very high cost of the initial wells. The wells were perforated, one over a 300- foot interval and the other over a 188-foot interval. The initial potentials were reported: #17 USA flowing 320 barrels of oil, 103,400 cu. ft. of gas and 20.9 barrels of water per day through a 18/64" choke; #18 flowed 472 barrels of oil and 43,500 cu. ft. of gas through a 15/64" choke. The *Southeastern Oil Review* reported on April 23, 1990, that "considerably higher flow rates were reported to have been gauged at both wells with rates in excess of 700 barrels of oil per day recorded." These initial potentials are certainly encouraging, but how have the wells performed over time? The better well of the two is the #17. It produced for two weeks before the water began to increase. After six weeks of production each well was being produced at a rate of about 300 barrels of fluid per day. The #17 had a 70-75% oil cut or approximately 210 BOPD and 90 BWPD. The #18 had a 45% oil cut or 135 BOPD and 165 BWPD. As of July 1990 the #17 well was flowing 140 BOPD (54% oil cut) and 120 BWPD on a 12/64" choke with 220# T.P. The #18 was down for a workover; it has been plagued with problems from the beginning. Although Murphy's law seems to have influenced the #18 well Amoco is pleased with the #17 well's performance. If it continues to produce well there will probably be a few more horizontal wells drilled in the field. The #17 well is a tremendous improvement over the vertical wells in the field.

There is another very important factor to consider, the cost. As mentioned before, Amoco did a lot of experimentation on these wells so their cost would not reflect normal horizontal drilling cost. In general, one might expect that the cost may run two to three times that of a vertical well. In the Clear Springs area, a vertical well might cost $200,000 so one would approximate $600,000 for a completed horizontal well. If one assumes a $600,000 well cost, 25% royalty, 7% severance tax, and 5% operating expense, it will take approximately 64,000 BO to reach payout. As one can see the jury will be out for a while before we know if Amoco's experiment proves to be commercial, i.e., makes money. Certainly the state should be grateful that companies like Amoco are willing to invest the necessary funds to experiment and develop the technology which will increase Mississippi's recoverable reserves. Let's hope that Amoco's efforts and investment are handsomely rewarded.

MMRI RESEARCH GRANTS

The Mississippi Mineral Resources Institute annually makes funds available in the form of small grants to further mineral resources investigations in Mississippi. The funded research listed below will be conducted at Mississippi State University, the University of Southern Mississippi, the Gulf Coast Research Laboratory, Jackson State University/Millsaps College, and the University of Mississippi.

MMRI Research Grants for FY 1990-1991

Establishing a Stratigraphic Framework and Mapping Potential Hydrocarbon/Ground Water Reservoirs and Aggregate-Rich Deposits, Coastal Mississippi; Groundwork for South Mississippi Portion of New Geological State Map - Dr. Ervin G. Otvos, Gulf Coast Research Laboratory.

Geologic and Economic Feasibilities of Selected Clay, Sand and Gravel, Heavy Mineral, and Associated Deposits in Mississippi - Dr. Bruce Davis, Jackson State University and Dr. Ed. Schrader, Millsaps College.

Characterization of Boracite Group Minerals Associated with the Subsurface Evaporite Formations in an Eight County Area in East - Central Mississippi and West-Central Alabama - Dr. Daniel Sundeen, the University of Southern Mississippi.

Engineering Geologic Evaluation of Surface and Near-Surface Clay Resources in South - Central Mississippi - Dr. David Patrick, the University of Southern Mississippi.

Development of a Model for the Transient Thermal Behavior for Fractured Dry Granite Beds During Geothermal Energy Extraction - Dr. B. K. Hodge, Mississippi State University.

Investigation of the Commercial Feasibility of Ash Removal from Lignite by Density Separation - Dr. W. Glenn Steele and Dr. Charles Bouchillon, Mississippi State University.

Development of Coalbed Methane in Mississippi Warrior Basin - Dr. Rudy Rogers, Mississippi State University.

Modeling Mississippi Oil Production - Dr. Rudy Rogers, Mississippi State University.

Assessment of Mississippi Clays - Dr. Nolan Aughenbaugh, the University of Mississippi.

Geographic/Geotechnical Engineering Data Base and Information System for the Mississippi Gulf Coast - Dr. Al VanBesien, the University of Mississippi.

Exploration for Heavy Minerals in Ancient Strand Line Sands of Mississippi - Dr. William Reynolds, the University of Mississippi.

Mineral Resource Potential of the Jackson Dome - Dr. James Saunders, the University of Mississippi.

Upgrading Mississippi Lignite by Hydrothermal/Chemical Pretreatment - Dr. Clint Williford, the University of Mississippi.

Natural Resources Law Program - Dr. Laura Howorth, the University of Mississippi.

Integrity without knowledge is weak and useless, and knowledge without integrity is dangerous and dreadful.
Samuel Johnson

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