Tuesday, February 20, 2007

The Sofitel Hotel • 425 Sam Houston Pkwy. East
Social 11:15 a.m., Luncheon 11:30 a.m.

Cost: $30 Preregistered members; $35 non-members & walk-ups

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Qualifies as 1.0 CEU for Texas State Geoscientists

HGS Northsiders Luncheon Meeting

by ***Andrew Mehlhop*** *and* ***Robert W. Stancil***
Anadarko Petroleum Corporation

Vernon Field—Catalyst for North Louisiana Exploration

Vernon gas field, in Jackson Parish, Louisiana, was originally discovered in 1967 with a Cadeville (Upper Cotton Valley) producer. A sub-commercial gas discovery in 1980 led to recognition of a vast resource in the Jurassic Lower Cotton Valley. Five different companies owned the field and 17 Lower Cotton Valley wells were drilled prior to Anadarko Petroleum Corporation's purchase of 8 MMCFD of production in late 1999. Anadarko's success in developing the Bossier Sand resource in East Texas and much improved product prices paved the way to increasing Vernon production to a peak rate of 350 MMCFD in 2004. Anadarko operated roughly 10 rigs continuously and drilled over 332 producing wells in the field between 2000 and 2006. Vernon is now one of North America's giant tight gas fields with over 4 Tcf of original gas in place with an estimated 1.8 Tcf recoverable.

The Lower Cotton Valley tight gas play will continue to be a focus for exploration along the northern Gulf Coast…as HTHP and other technological breakthroughs unlock additional reserves.

Vernon Field is a tight gas reservoir producing from Lower Cotton Valley sands at a depth of 12,000 to 15,500 feet along a growth-faulted anticlinal trap in Jackson Parish, Louisiana. The initial discovery well, Hodge-Hunt Co 3-1 was drilled in 1967 to a depth of 10,996 ft in the Upper Cotton Valley formation. From 1968 to 1988 the well produced 2.36 Bcf gas and 160,873 bbls of condensate from a 10-foot thick Cadeville sand. The Cadeville is the first sand below the tight Knowles limestone, a regional top seal for the over-pressured Cotton Valley below. Nine additional Cadeville tests were drilled in the vicinity of Vernon by 1979. In July 1980, Anschutz drilled the first Lower Cotton Valley test in the field, the Davis Brothers Lumber #1, which flowed 427 MCFD and 105 MCFD from two zones with no fracture stimulation. First production from the Lower Cotton Valley sands at Vernon field began in February 1982 when Crystal Oil & Gas drilled 12 Lower Cotton Valley producers from 1982–1984, reaching a peak production of 50 MMCFD. Only 3 additional wells were drilled in the field after prices dropped during the mid-1980s and the expensive fracture treatment costs burdened project economics.

With improved prices and improvements in High Temperature and High Pressure (HTHP)completion technology in the late 1990's, Anadarko purchased Vernon Field in December, 1999. At that time the field had 17 producing wells and a total production of 8 MMCFD with an estimated remaining potential of 230 Bcf. Since that time, the Lower Cotton Valley at Vernon has exceeded those early expectations with over 400 Bcf gas produced and over 1.5 Tcf of reserves added through drilling. The true potential of the over-pressured Lower Cotton Valley was unlocked allowing Vernon field to grow from 7400 acres in 1999 to 25,000 Held by Production acres today with individual peak well rates exceeding 25–30 MMCFD and Estimated Ultimate Recoveries of 1.5–27 Bcf/well.

So what makes Vernon such a prolific field? The key lies in the details revealed by analyses of data in the large modern geological, petrophysical, geophysical and geochemical database that identified trap and seal integrity as critical factors. The basal member of the Lower Cotton Valley formation includes the Jurassic Bossier shale which is a prolific oil-prone marine source rock of unknown thickness locally in the Vernon area. The Bossier source rock was rapidly buried under 1000 to 3000 feet of Cotton Valley prograding deltaic sequences and upper stacked shore facies or blanket sands. The rapid burial phase occurred in response to active salt withdrawal and associated growth faulting during the late Jurassic. Vernon is unusual in that the salt withdrawal and subsequent growth faulting ceased prior to deposition of its top-seal, the Knowles limestone. The structural trap, fault seal and top seal remained intact at Vernon while nearby structures probably leaked hydrocarbons due to continual salt withdrawal, fault reactivation and seal breaching throughout the Lower Cretaceous. At the end of the Lower Cretaceous, Vernon field was probably a 300 million barrel oil field with 20–30% porosity and a clearly defined oil-water structural contact. Vernon was subsequently buried to its current depth and the field passed into the gas window cracking the remaining

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kerogen in the Bossier source rock and the original oil in place to gas. Average porosity today in the Lower Cotton Valley at Vernon is 7% with streaks of 10–12 % locally. Vernon is structurally complex with two main growth faults and several satellite fault blocks that all deliver sweet gas production with no significant H_2S or CO_2. At a gradient of 0.9 psi/ft and greater, the extreme overpressure allows a high-rate of commercial gas production.

During the last five years, Anadarko increased its drilling efficiency from 200 to over 500 feet per day using new bit technology. Vernon is currently down-spaced to a 40 acre pattern; however, a six-well 20-acre pilot drilling program was conducted in 2005 with encouraging results. The well tests found original bottom-hole pressures in many zones and tested an average initial production rate of 4 MMCFD or about 70 % of the parent 40-acre offsets. The entire field is under central compression lowering line pressure from 1100 psi to 400 psi, reducing liquid loading and stabilizing the current production at 265 MMCFD. Further development plans for Vernon include over 100 20-acre infill drilling locations, over 200 probable or possible locations for further field delineation and over 100 Lower Cotton Valley re-frac opportunities. In addition to the prolific Lower Cotton Valley and Bossier sand reservoirs, Vernon has also produced gas and condensate from shallower zones in the field including the Upper Cotton Valley, Calvin, Hosston and James formations. The Lower Cotton Valley will continue to be a focus for exploration along the northern gulf coast from East Texas to Mississippi as this multiple TCF tight gas play unlocks additional reserves through HTHP technological breakthroughs in the future. ■

Biographical Sketch

Andrew Mehlhop received both his BS and MS degrees in Geology from the University of North Carolina at Chapel Hill. His master's thesis involved an outcrop study of the structural deformation in Devonian turbidites in Virginia and West Virginia. Upon graduation, Andrew worked in gold exploration for Appalachian Resources, Inc., in the Precambrian and Cambrian accreted terranes of the Carolina Slate Belt. In 1997 he joined Anadarko where he has worked a variety of projects including Hugoton, Deepwater GOM, Canada (McKenzie Delta and offshore Nova Scotia), and International (Africa, India and Indonesia). Andrew currently serves as Anadarko's manager of G&G for the Eastern Gulf Coast.