Abstracts of Oral and Poster Presentations at the 1997 AAPG Mid-Continent Section Meeting

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ORAL PRESENTATIONS

AL-SHAIEB, ZUHAIR, and PUCKETTE, JIM, Oklahoma State University, Stillwater, OK

Sequence Stratigraphy and Reservoir Evolution in the Hunton Group, Anadarko Basin

The Late Ordovician-Devonian-age Hunton Group is a major oil and gas reservoir in the Anadarko Basin. The Hunton carbonates were deposited on a gentle ramp in an epeiric sea. Supratidal, intertidal and subtidal facies can be recognized in core and outcrop and are distributed subparallel to bathymetric contours.

Sequence-stratigraphy concepts are directly applicable to the exploration for oil and gas in the two types of Hunton reservoirs. The first type (Type 1) forms during shallowing (progradational phase) associated with the highstand systems tract of the Henryhouse-Haragan/Bois d'Arc sequence. The second (Type 2) is associated with the intra-Hunton sequence boundary at the top of the Chimneyhill Subgroup and the pre-Woodford sequence boundary.

Type 1 reservoirs are common in the Henryhouse Formation where grain-rich intertidal facies were burrowed and dolomitized. Burrowing generated a pore fluid network in the sediments. Dolomitizing fluids permeated the carbonate and preserved porosity and permeability. Subsequent dissolution removed nondolomitized fossils, creating moldic porosity. Type 2 reservoirs were impacted by meteoric diagenesis associated with sequence boundaries. In this case, the spatial relationship of the reservoir to the unconformity and flow regime were critical. Diffuse flow dissolution generated moldic porosity in grain-rich intertidal facies. Typical karst features usually developed in areas where focused flow occurred along fractures in relatively impermeable rocks.

By integrating a precise understanding of the sequence stratigraphy with facies analysis and distribution, it is possible to predict the anticipated reservoir types in a prospective area and improve reserve estimates.

BRADY, LAWRENCE L., Kansas Geological Survey, Lawrence, KS

Kansas Coal Resources and Their Potential for Coalbed Methane

Kansas has large amounts of bituminous coal in the subsurface of eastern Kansas. Preliminary estimates indicate at least 53 billion tons of deep coal (>100 ft.) determined from 32 coal beds. Most of this total is represented by coal beds in the Cherokee Group (Middle Pennsylvanian) in the eastern one-fourth of the state. Coal beds with the largest resource totals include the Bevier, Mineral, "Aw"(unnamed coal bed), Riverton, and Weir-Pittsburg coals, all within the Cherokee Group. Coals in the southeast part of the state are generally high-volatile A bituminous coal, while coals in the east-central and northeast part of the state are high-volatile B bituminous coal to possibly higher rank in the deeper parts of the Forest City basin. These rank assessments are based on chemical analyses. Published vitrinite reflectance values indicate possible lower maturation of the coals. The primary concern of Kansas coal beds are the thin (< 2 ft.) presence of most of the beds, although the coals tend to be widespread in distribution. Evaluation of over 600 geophysical logs in eastern Kansas indicate that 45 billion tons of the resource figure is less than 28 inches thick and only two billion tons of coal is in beds greater than 42 inches.

Present production of coalbed methane is centered mainly in the Wilson-Montgomery County area of southeast Kansas where methane is produced from the Riverton and Weir Pittsburg coals.

BROWN, WILLIAM G., Department of Geology, Baylor University, Waco, TX

Examples of Scale-Independent Structural Models from the Arbuckle Mountains as Examples for Subsurface Interpretations

Outcrop exposures of structural features in the Arbuckle Mountains are often used as "examples" for subsurface interpretations. If such examples are to be true models, it is critical to establish that such features are scale-independent. By recognition of scale independence, a structural geometry that is readily observed at one scale may be applied across several orders of magnitude.

A variety of fault and fold geometries which can be demonstrated to be scale independent, and are thus useful models for subsurface interpretations include the following:

1 - Ramp and flat geometry of thrust faults;
2 - Lateral ramps of major thrusts;
3 - Berg's fold-thrust model;
4 - Fault-propagation folding;
5 - Conical termination of folds.

Outcrop photographs as well as surface map analysis will be presented as techniques for interpretations of these and other features.

BUDNIK, ROY T., Roy T. Budnik & Associates, Inc., Poughkeepsie, NY

Strike-Slip Structural Framework of Amarillo-Wichita Uplift and Anadarko Basin, Texas Panhandle and Oklahoma*

The Amarillo-Wichita Uplift and related structures of the Texas Panhandle and southern Oklahoma are characterized by significant vertical basement offsets. However, stratigraphic and structural evidence indicate that this vertical offset formed in response to even larger lateral offsets.

Stratigraphic evidence of strike-slip deformation includes the juxtaposition of dissimilar basement terranes and inconsistent facies and isopach trends in pre-Pennsylvanian strata across the uplifts. Structural evidence includes en echelon folds and faults, simultaneous development of both extensional and compressional tectonics within the same structural belt, and abrupt vertical changes along faults.

Strike-slip faulting along the axis of the former or Southern Oklahoma Aulacogen formed during the Pennsylvanian. Erosional edges of older units, which sub-crop beneath the Mississippian, provide "piercing points" which demonstrate offset of 120 km in a left-lateral sense along the axis of the Amarillo-Wichita uplift, Pre-Mississippian units located in the Hardeman Basin of southwestern Oklahoma originally aligned with those in the western Anadarko Basin of the Texas Panhandle. Restoration to the pre-faulting configuration also realigns offset Precambrian basement terranes. Although there has been recurrent deformation along the structural trend since the Precambrian, the orientation of strike-slip and reverse faults and related folds indicate northeast-southwest directed compression during the Pennsylvanian.

* (Study conducted at University of Texas, Bureau of Economic Geology under contract to the U.S. Department of Energy)

BURFORD, MINNIE and GUCCIONE, MARGARET J., Geology Department, University of Arkansas, Fayetteville, AR; and KENDALL, JAMES D., Marathon Oil Co., Tyler, TX

Distributary Development of Shoe-String Sand Bodies Within the Backswamp, Northern Mississippi Alluvial Valley

The backswamp paradigm of a fluvial environment is commonly that of a thick, homogeneous clay which fines with distance from the channel and forms a flat surface gently sloping away from the natural levee and downvalley. Within the Mississippi Alluvial Valley this is an incomplete paradigm because numerous distributaries are present within the backswamp. These distributary channels usually begin as crevasse splays and a few of the larger ones have become avulsions of the Mississippi River, forming new meander belts. Pemiscot Bayou, the largest of 4 major distributary systems in the upper Mississippi Alluvial Valley, captured up to 25% of the Mississippi discharge 3-4 ka and flowed back into the Mississippi channel further downstream. It never became an avulsion, has ceased to be an active distributary, and the channel has largely infilled. While active, the bayou developed a meander belt 1.5-5 km wide with all of the deposits associated with a meandering system such as point bar, natural levee and other overbank deposits, as well as channel-fill of meander cutoffs. The distributary channel was 600 m wide and 12 m deep near its exit from the Mississippi channel. Fifty-eight kilometers downvalley the channel was reduced to a 200-300 m width and a 7-9 m depth. Overbank silt, up to 2 m thick and 2 km wide, was deposited as sheet flow and buried backswamp clay and point-bar deposits. Laminated fluvial silt and fine sand and lacustrine clay infilled the abandoned channel. Thus the fluvial architecture of the Mississippi River backswamp includes shoe-string sand bodies 10 m thick, up to 5 km wide, and tens of km long within backswamp clay and overbank silt.

CARDOTT, BRIAN J., Oklahoma Geological Survey, Norman, OK

Oklahoma Coal Database

Since 1984, the Oklahoma Geological Survey (OGS) has been developing a computerized GIS-based (geographic information system) database of information (location, quantity, and quality) on Oklahoma's coal resources, as part of the National Coal Resources Data System (NCRDS). The NCRDS, initiated in 1975, is a cooperative program of the U.S. Geological Survey and state geological surveys of coal producing states.

Geologists of the OGS collected stratigraphic and analytical data from every available source, including field investigations (mine and outcrop), coal-mining companies, state and federal agencies, well drillers, the OGS drilling program, individuals, and literature search. The database presently includes data from 12 counties (Craig, Creek, Mayes, McIntosh, Muskogee, Nowata, Okfuskee, Okmulgee, Rogers, Tulsa, Wagoner, and Washington) in the northeast Oklahoma shelf area.

Stratigraphic header and data tables contain 20,775 records of stratigraphic and geologic information from 4,457 locations.

Analytical header and data tables contain location, stratigraphic and geologic information, determined rank, and analytical (chemical and petrographic) data of 545 samples.

A production table lists Oklahoma coal production by county, percentage surface mined, and value from 1908 to the present.

Examples of queries, maps, and graphs, generated from the data, will be presented.

CHRISTIANSEN, MARK D., Crowe & Dunlevy, Oklahoma City, OK

Current Issues in Oil and Gas Royalty Litigation

This presentation will focus on the current wave of royalty owner lawsuits concerning issues such as (1) the impact of post-production or transportation-related expenses in computing gas royalty payments, (2) the use of posted prices in valuing crude oil, (3) the claims of royalty owners to a share of gas contract litigation settlements between producers and gas purchasers, and (4) challenges to certain transactions between producer lessees and their affiliated entities.

CLEAVES, ARTHUR W., School of Geology, Oklahoma State University, Stillwater, OK

Depositional Systems and Sequence Stratigraphy of the Spiro Sandstone Interval, Arkoma Basin of Eastern Oklahoma

The basal Atokan Spiro Sandstone Interval of eastern Oklahoma was deposited as an assemblage of marine shelf, wave-dominated deltaic, incised valley-fill channel,-tidal flat, and estuarine environments during a eustatic cycle involving large-scale marine regression followed by a lengthy period of marine transgression. Spiro Interval sedimentation began with high-stand deposition of prodelta shale fed onto the Wapanucka distally steepened ramp by earliest Atokan deltas located in the Fort Smith area. This was followed by eustatic regression that brought about fluvial downcutting into the "pre-Spiro shale" by several channel complexes, collectively termed the Foster channels, that transported coarse-grained siliciclastics from a northerly, cratonic source to lowstand, perched deltas present along the ramp's outer margin.

The subsequent transgression involved both a eustatic rise in sea level and tectonic collapse of the ramp margin, indicating a change from a passive continental margin to collisional plate boundary. Terrestrial strandplain facies of the lowstand deltas were reworked westward parallel to strike along the middle shelf, while the Foster channel incised valleys backfilled with bayhead delta lobes, estuarine deposits, tidal flats, and lastly, bioturbated, inner-shelf marine sediment. Several temporary stillstands allowed local bayhead deltas to spill out onto the middle and inner shelf. Complete collapse of the ramp resulted in the deposition of crinoid-rich sheet sandstone across underlying valley-fill and delta-plain facies and ultimately brought about the retreat of deltaic sedimentation to a new shelf margin more than forty miles to the north.

COWDERY, ROBERT D., Consulting Geologist, Wichita, KS

An Overview of Exploration and Exploitation in the Mid-Continent

As we near the 21st century, our approach to exploration and exploitation is ever changing. New technology including, but not limited to, 3-D seismic and horizontal drilling is having a profound effect on exploration and exploitation in the Mid Continent. However, 3-D seismic is not the complete answer, and in some cases, such as areas in Southern Oklahoma, the geology is so complex it is not even applicable. In SW Kansas, a thorough knowledge of geomorphic principles is necessary in order to achieve success using the new technology. In all areas of the Mid-Continent, applied geology integrated with new technology is bringing success to the exploration and exploitation efforts of those geologists working the area.

DAILY, THOMAS A, Attorney, Daily Law Firm, Fort Smith, AR

Selected Recent Developments in Oil and Gas Law For Geologists, Engineers, and Geophysicists

Oil and gas law is constantly changing. Legislatures are currently in session in both Oklahoma and in Arkansas. These legislatures write new laws and rewrite old ones. Court decisions interpret both these laws and common law legal principles. All these changes impact our industry in ways which we all need to understand and appreciate.

The paper will survey selected recent developments in oil and gas law of interest to geologists, engineers, and geophysicists. Because many of these developments have yet to occur, it is not yet possible for the author to predict the exact content of the paper. The only certainties are that there will be changes which will affect our industry and that this paper is designed to help you stay abreast of these changes.

DONOVAN, R. NOWELL, and BUCHEIT, ANDREA, K., Department of Geology, Texas Christian University, Fort Worth, TX

Diagenetic Modification of Carbonates as a Result of Submarine Slumping, a Case History from the Jurassic Helmsdale Fault, Northern Scotland

The western margin of the Moray Firth, northern Scotland, follows the line of the major north-eastward trending Helmsdale Fault. During the upper Jurassic Kimmeridgian, the fault was active and formed a mobile submarine scarp. Slumps, debris slides, rock falls and density flows all contributed to a major stratigraphic unit, the Helmsdale Boulder Bed, that was deposited on the downthrown side of the fault. The fault formed a clear demarcation line between an oxygenated shelf to the west (in the direction of the modern Scottish Highlands) and an anoxic deep water basin to the east (beneath the waters of the modern Moray Firth). Rocks deposited in the latter setting constitute the principal source rock in the North Sea.

Nowhere are the rocks that represent the shelf facies preserved – their presence is inferred from clasts in the Boulder Bed. The clasts include a shelly fauna of molluscs, algae and echinoids together with the colonial coral, Isastraea. These carbonate fragments, together with the cements that hold them together, illustrate the profound diagenetic consequences of movement down the fault scarp into a reducing environment. Initial cementation, which presumably took place on the shelf, involved cementation by non-ferroan calcite and some non-ferroan dolomite, as well as limited replacement by chalcedony. Later cementation illustrates a progressive development of iron-rich cements and polymorph infillings. The history of individual fragments can be inferred: some moved rapidly down the scarp, others more slowly.

DOWD, TIMOTHY C., Waska Helms Dowd Underwood & Hasbrook, Oklahoma City, OK

Gas Balancing

Problems can arise when gas that has been jointly produced is not jointly marketed. Generally, the working interest owners independently market their share of the recoverable reserves. As it is impossible to determine the exact share of the recoverable reserves, it is also impossible to determine the exact amount of gas owned by each working interest owner in a well until all gas has been removed from the reservoir.

The paper will explore production imbalance and how it occurs. It will also look into the legal rationale for the three methods of balancing recommended by courts and commentators, i.e., 1) balancing in kind, 2) periodic cash balancing, and 3) cash balancing upon reservoir depletion.

The paper will also discuss recent court cases and statutes regarding gas balancing. One major issue of importance is the liability of successive leasehold owners for over-production by their predecessors-in-title.

EHINGER, ROBERT F., Consulting Geologist, Oklahoma City, OK

Application of Dipmeter Data to Structurally Complex Areas in the Mid-Continent

Dipmeter tools provide a practical method to determine the true strike and dip of strata within a single borehole. In a vertical borehole structural dips have to approach 20 degrees before they are recognized by stratigraphic expansion. If the borehole deviates in an updip direction, then the dips can approach 30 degrees before they produce observable stratigraphic expansion. By using dipmeter calculations with a reducing copy machine, expanded stratigraphic intervals can be corrected to a normal section even when the dips exceed 60 degrees. The corrected intervals can aid in stratigraphic correlations, identify fault blocks, and quantify the internal geometry of complex folds. "Stick plots" which can be generated from dipmeter data integrate effectively with other subsurface tools, especially seismic data. Various examples of dipmeter applications, types of data output, and factors that influence data quality will be presented. Even though dipmeters for the Mid-Continent area have been available for almost fifty years, they are still under- utilized on many exploration projects.

FREDERICK, JOHN B., Frederick & Associates LLC; DEAN, KAREN T., Dean Consulting; FRYBERGER, STEVEN G., Consultant; and WILCOX, TIM C., Key Production, Denver, CO

Donkey Creek North Minnelusa 3-D: Challenging Conventional Wisdom

Three dimensional (3-D) seismic data acquired in 1992 over the Donkey Creek North Minnelusa Upper B Sandstone Oil Field, Powder River Basin, Wyoming, significantly revised the existing reservoir interpretation. The 3-D survey not only provided a more accurate map of the reservoir distribution around the producing wells, but it also uncovered additional development locations. With porous Minnelusa Sandstones (low velocity, low density) encased by tight carbonates (high velocity, high density) the large acoustic impedance contrasts yield high amplitude seismic events. Seismic amplitude mapping of interpreted Minnelusa Sandstones correlates reasonably well with reservoir quality when the temporal resolution of the seismic data is sufficient to discriminate the individual sandstones. The 3-D seismic data volume allows a more accurate interpretation of the reservoir areal extent. Due to the small size of the survey (1.5 miles square) and a high effort dynamite source, the survey cost approximately $75,000 per square mile. In spite of this cost, the survey led to the drilling of two additional producing wells located in positions chosen to optimize secondary recovery efforts. These two new wells potentially doubled the field's recoverable reserves. 3-D provided the ability to map the reservoir extent and structural position, thereby significantly reducing drilling risk. 3-D mapping of the Upper B Sandstone altered all previous interpretations and challenged conventional wisdom regarding shape and lateral extents of Minnelusa reservoirs.

FRIEDMAN, SAMUEL A., Oklahoma Geological Survey, Norman, OK

Coal-Bed Methane Resources and Reserves of Osage County, Oklahoma

About 100 oil wells have been "recompleted" in and are producing gas from four Middle Pennsylvanian bituminous coal beds, 1,200-1,700 feet deep in eastern Osage County, since January 1, 1995. The present study applied the standard method of reliability to determine coal resources, and thence coal gas resources from geophysical logs in this county. Cored coal samples and coal-test well data were not available for accurate resource determination. The geophysical logs were not originally set up to detect coal, let alone thin coal beds one to three feet thick, thus making coal-bed thickness interpretation a hazardous procedure, with great potential for major errors in coal resource determination and subsequently in coal-bed methane resource determination.

To avoid the high likelihood of exaggerated quantities of coal resources , the author restricted the total area to seven and one-half townships, , the number of coals to three per well in five of these townships, and to two per well in two and one-half townships. All coal-beds were assumed to be only one foot thick and to contain only 150 cubic feet of gas per ton of coal.

Thus a minimum of 553 million tons of coal resources, and 83 billion cubic feet of coal-bed methane resources are estimated to be present in eastern Osage County, Oklahoma,

At a 50% recoverability factor, there are 41 billion cubic feet of coal-bed methane reserves present.

FRITZ, RICHARD D., Geological Consultant, Masera Corporation, KUYDENDALL, MICHAEL, Geological Consultant, Solid Rock Resources, Inc., Tulsa, OK

Sequence Stratigraphy of the Jackfork Sandstone in the Ouachita Mountains and Applications for Petroleum Exploration

Recent drilling activity for Jackfork reservoirs in southeastern Oklahoma has renewed interest in the structural and stratigraphic framework of the Ouachita Uplift. Structurally, the uplift can be divided into two areas - (1) a frontal imbricated zone north of the Ti Valley Fault and (2) the central thrust belt south of the Ti Valley Fault with the dominantly platform sediment to the north and basinal deposits to the south.

The Jackfork Group represents an elongate submarine fan complex that extends from Alabama to Oklahoma. The sandstones are composed of slumps, debris flow and turbidites, which were primarily derived from a non-volcanic landmass east of the present-day Black Warrior Basin. Secondarily, these sediments were derived from the north from Simpson outcrops and from a large drainage basin to the northeast, which terminated with advancing deltas through the Reelfoot Rift area. Some sediment may also be derived from the south from the emergent advancing Ouachita thrust belt. Multiple fan models have been used to explain Jackfork deposition. A combination of the Walker and Vail models appears to be most applicable to Jackfork deposition Recent study of Jackfork sequence stratigraphy indicates that the submarine fan may be subdivided into intervals which represent pulses during third-order sea-level changes.

The central Ouachita thrust belt is a largely unexplored zone of over four million acres in Oklahoma and Arkansas, Sohio initiated an exploration program from 1980 to 1988 during which they drilled a large "channel" identified from seismic in a syncline. Although there were multiple gas shows, the well was not economic. In 1990 H&H Star began drilling for Spiro along Ti Valley Faults and found several wells with productive Spiro. This resulted in a marginally economic gas play. Most recently Vastar, Texaco, and Chevron have drilled along the Windingstair Fault to evaluate Jackfork potential.

GILBERT, M. CHARLES, and HOGAN, JOHN P., School of Geology and Geophysics, The University of Oklahoma, Norman, OK

What's New in Oklahoma's Old Basement

Ham, Denison and Merritt (1964) laid the groundwork for trying to understand the importance and control of the basement in the development of subsequent stratigraphy and structure of the Mid Continent. The map of the Geologic Provinces of Oklahoma produced by Northcutt and Campbell (1996) prompts a new look at the character of the basement. What are the cover rock-basement relationships? Can we read something about the basement from the Geologic Province Map? Can we "predict" Paleozoic structure and stratigraphy from a knowledge of the basement? It is clear that basement features are involved in definitions of the major provinces, the most profound being the contact between the younger basement of the Southern Oklahoma Aulacogen and the older basement of the northern Arbuckles. This boundary, well-defined on the north of the SOA, splits the Arbuckle Uplift in two and separates the Wichita Uplift and Anadarko Basin. New dating of this younger basement reveals a compressed time interval for its formation (~525-540 Ma), and implies substantial erosion before deposition of the Upper Cambrian Timbered Hills Group and the Arbuckle Group. The extent of the dense fin of new rock defines the core of the SOA and determined the positions of some of the major Pennsylvanian thrust faults. Some are presumably reactivated Cambrian normal faults. There is evidence from gravity that the Anadarko Basin lies across an extension of the older Mid-continent Rift (1.1 Ga). This may have a relation to the largest overhang or the Mountain View Fault, and the placement of the Cyril Basin, Cement Fault, etc. Puzzling questions remaining are; Why the Nemaha Uplift; and Where is the other half of the Arbuckle basement?

GRAVES, CODY L., Oklahoma City, OK

It's Time for a New Sheriff, or Why States Should Regulate Gas Gathering

It used to be so simple. Producers of natural gas sold their gas to the nearest interstate pipeline. Interstate pipelines bought, processed, transported and then sold enough natural gas to meet their large long-term supply contracts with local distribution companies (LDCs) and the occasional industrial customer. LDCs signed long-term supply contracts with several interstate pipelines and then resold the gas to captive residential, commercial and industrial customers. Finally, individual customers just picked up the phone, called the LDC and told it to turn on the gas. Thanks to sweeping legislative and regulatory policies flowing from Washington, the natural gas industry has undergone dramatic change. Interstate pipelines no longer perform the merchant function of the past. Pipelines have restructured their businesses to offer their customers only the specific services they request. However, regulation of gathering has fallen through the cracks. This paper will explore why it is important to employ the state regulatory agencies as the institutions available to protect against unfair conduct by gatherers. Further, this paper will summarize Oklahoma's gathering law, with its broad flexible framework. The law authorizes the Oklahoma Corporation Commission (OCC) to conduct a hearing and grants the OCC authority to order the remediation of any unjustly or unlawfully discriminatory fee for gathering to the extent necessary.

HATCH, JOSEPH R., U.S. Geological Survey, Lakewood, CO; and NEWELL, K. DAVID, Kansas Geological Survey, Lawrence, KS

Geochemistry of Oils and Hydrocarbon Source Rocks, Forest City Basin, Northeastern Kansas and Adjacent Areas in Missouri, Iowa and Nebraska

Comparisons of saturated hydrocarbon and terpane (m/z=191) distributions for 24 Forest City basin oils demonstrate three geochemically distinct groups. Group 1 oils (n=18) are produced from Middle Ordovician sandstones and limestones, and Silurian-Devonian dolomites in anticlines along the north-northeast south-southwest-trending basin axis close to the Humboldt fault, and from the Vassar and Easton-McClouth complex of fields on its eastern flank. Group 2 oils (n=5) are produced from stratigraphic and combination structural-stratigraphic traps in lenticular Middle and Upper Pennsylvanian sandstones in fields extending south-southwestward from the Kansas City region into the Cherokee platform, and from the Yaege field on the Nemaha uplift to the west of the Humboldt fault. The only group 3 oil is produced from the Kansas City Group in the Davis Ranch field along the axis of the basin.

Rock-Eval and organic carbon analyses of 122 core, sidewall core, cutting and mine samples show good hydrocarbon source-rock potential for intervals from the Middle Ordovician, Upper Devonian-Lower Mississippian, and Middle and Upper Pennsylvanian. Organic matter thermal maturity for all intervals generally increases from north to south. Organic matter in lower Paleozoic strata are generally marginally mature to mature, whereas, organic matter in Pennsylvanian strata are immature to marginally mature. Comparison of saturated hydrocarbon and terpane (m/z=191) distributions from rock extracts with those of the oils show that source rocks for the group 1 oils are shales in the Middle Ordovician Simpson Group; group 2 oils, the Upper Devonian-Lower Mississippian Chattanooga Shale, and group 3 oil, marine black shales within the Middle and Upper Pennsylvanian section.

HEMISH, LeROY A., Oklahoma Geological Survey, Norman, OK

Coal Geology of McIntosh and Muskogee Counties, Oklahoma

McIntosh and Muskogee Counties are located in the east-central part of the coal belt of eastern Oklahoma. Coal-bearing strata of Desmoinesian (Middle Pennsylvanian) age underlie nearly all of McIntosh County and ~500 square miles in the western two-thirds of Muskogee County. Prior to the investigations by the Oklahoma Geological Survey in recent years, the coal geology of the two-county area has been poorly understood. In McIntosh County eight coal beds have been shown to have commercial potential: Stigler (McAlester

Formation); Rowe (Savanna Formation); Lower Witteville, Secor, Peters Chapel (new name), and Wainwright (Boggy Formation); and Mineral and Croweburg (Senora Formation). Remaining resources of coal in the county total 36,319,000 short tons, and reserves total 5,437,000 short tons. In Muskogee County ten coal beds have been shown to have commercial potential: Hartshorne (Hartshorne formation); Keefton (new name), and Stigler (McAlester Formation); Spaniard and Rowe (Savanna formation); Secor, Peters Chapel, and Wainwright (Boggy Formation); and Tebo and Croweburg (Senora Formation). Remaining resources in the county total 95,557,000 short tons, and reserves total 11,141,000 short tons. Coals of the two-county area are predominantly of high-volatile A bituminous (hvAb) rank. In Muskogee County the Hartshorne, Keefton, and Secor coals have much lower sulfur contents than the others, averaging ~1.1%. In McIntosh County the Secor coal has the lowest sulfur content, averaging ~2.5%. The combined average sulfur content of all the other coals in the two counties averages ~5%. In the past coal has been mined by both underground and surface methods in the area. No coal is being produced in either county at the present time.

MAZZULLO, S.J., Wichita State University, Wichita, KS

Characterization of Lower Permian, Cyclic Carbonate Reservoirs (Chase Group) in the Mid-Continent Based on Outcrop Model-Analogs

95% of the original 80 TCFG reserves in the Midcontinent is from the Chase Group in the Hugoton-Guymon Fields. Outcrops in Kansas, Nebraska and Oklahoma are model-analogs of the occurrence and complex reservoir architecture in these fields. The rocks compose a glacio-eustatic and tectonically-forced section of 7 depositional sequences and higher frequency transgressive-regressive cycles deposited on a broad, ramp. Principal reservoir-analog facies are distal-ramp, subtidal lime sands and proximal-ramp, peritidal dolomudstones that compose the regressive systems tract within sequences. Multiple pore types characterize these facies, which are laterally and vertically heterogeneous in terms of porosity and permeability distribution. Bryozoan reef facies, present in outcrops, have not been reported as a reservoir facies in the subsurface. Architecture of porous facies was predictably controlled by the nature of hierarchal cyclicity and history of accommodation. Subtidal sands are the dominant reservoir-analogs in the lower Chase Group because of deposition during a time of relatively high-magnitude eustatic fluctuations that precluded peritidal deposition. Most of these reservoirs are associated with type-1 unconformities and forced regressive systems. In contrast, progradational peritidal facies of more extensive areal extent progressively replaced carbonate sands as reservoir-analog facies in the upper Chase Group. The normal regressive systems within which this facies occurs were deposited during a time of decreasing marine accommodation and lower-magnitude eustatic fluctuations

McCASKILL, Jr., JERRY GLEN, University of Oklahoma, Norman, OK

Multiple Stratigraphic Indicators of Major Strike-Slip along the Eola Fault, Subsurface Arbuckle Mountains, Oklahoma

The Eola fault bisects the deep portion of the Eola oil field (T. 1 N., R. 2 and 3 W., Garvin County, OK). At least 9 wells cut the fault and more than 200 wells within a mile of the fault define local stratigraphic relationships on either side. Within the eight miles of control in the Eola field, the fault is a linear steeply southwest dipping fault that trends N75°-80°W with 1500 feet of normal separation to the east and 2000 feet of reverse separation to the west. Juxtaposition of markedly different stratigraphy across the fault cannot be explained by pure dip-slip deformation, but are consistent with left-lateral displacement. More specifically offset of contour lines across the fault on isochore maps of units in the Sycamore, Hunton, and Tulip Creek Formations (based on a 650 well study) all indicate a left-lateral, strike-slip motion of 16 miles. Data presented here indicates that the Eola fault has 16 miles of left-lateral strike-slip and plunges 3° to the west, with less than 0.5 mile of either reverse or normal displacement, all of which makes interpretation of the fault consistent with a wrench fault model. Other fault models may also explain the large strike-slip component of displacement, but any model that fails to account for a large strike-slip component will automatically be inconsistent with the well-constrained data from the Eola field.

MERRIAM, D.F., Kansas Geological Survey, University of Kansas, Lawrence, KS; and ANDREA FÖRSTER, GeoForschungs-Zentrum Potsdam, Potsdam, Germany

Origin, Development, and Distribution of 'Plains-Type Folds' (Compactional Features) in the Cherokee Basin of the American Mid-Continent

'Plains-type folds' occur in cratonic basin environments worldwide. They are small in size, increase in definition with depth, and occur in elongated trends in the sedimentary package overlying a crystalline basement. They are important structural features because they can control the location of mineral resources. In the Cherokee Basin in southeastern Kansas, the 'plains-type folds,' formed in Paleozoic sediments overlying a crystalline Precambrian basement, locally contain oil and gas. The folds were developed during the Ouachita Orogeny in the late Mississippian-early Pennsylvanian when fractured/faulted basement blocks moved differentially in response to outside stresses. Upper Pennsylvanian/Lower Permian sediments were deposited over these tilted fault blocks and differentially compacted as the overburden increased and the fault blocks continued to readjust to regional tectonic forces. The differential fault-block movement is recorded by computing a structural interval gradient for each block which can be interpreted to indicate reactivation time during the late Paleozoic. Mesozoic and Tertiary events are inferred from adjacent areas to be mainly regional tilting with reactivation locally of some 'plains-type folds.' The neotectonics of the region as recorded by historical earthquakes and recent microseisms indicate adjustment is continuing, at least locally, until the present. A major uplift, the Nemaha Anticline and associated Humboldt Fault, is active today as are several major northwest-trending faults in eastern Kansas. What effect this continued movement has on the 'plains-type folds' in the Cherokee Basin has yet to be determined because the basin itself seemingly is tectonically inactive at present.

MONTGOMERY, M.W., and MAZZULLO, S.J., Wichita State University, Wichita, KS

Analysis of Paleosols in Chase Group Strata (Lower Permian), South-Central Kansas

Stacked paleosols occur within the lowstand systems tracts of the seven carbonate-siliciclastic depositional sequences recognized in outcrops of the Chase Group in south-central Kansas. They are developed in unfossiliferous, silty mudrocks likely deposited by eolian and fluvial processes, and are overlain by transgressive shales. Many of the paleosols are only weakly to moderately developed, and include vertic paleosols and aridosols. Evidence of significant climatic change during exposure is present in the lowstand tracts of only the Wymore Member (Matfield Formation) and the Holmesville and overlying Gage Members (Doyle Formation). Stacked paleosols in the Wymore and Holmesville Members suggest the transition from relatively arid to seasonally wet/dry conditions. In contrast, paleosols in the Gage Member suggest an opposite shift from seasonally wet/dry to a more arid climate. Paleosols in the Blue Springs Member (Matfield Formation), and in the youngest lowstand tract in the Chase Group (the Odell Formation), record relatively long-term climatic stability. These interpretations suggest that systematic shifts in climate concurrent with eustatic cyclicity were not operative during the Early Permian as proposed by other workers. Instead, there is indication that spatial and temporal variations in paleosol types may reflect paleotopography to a greater extent than systematic climatic changes. The relatively limited degree of pedogenesis in these rocks likely is related to limited periods of subaerial exposure.

PUCKETTE, JIM, and AL-SHAIEB, ZUHAIR, Oklahoma State University, Stillwater, OK

Pressure Architecture of the Anadarko Basin: Implications For Exploration and Production

The evaluation of pressure data from the Anadarko basin indicates that the rock column is divided into three major pressure domains: 1) shallow normally pressured interval, 2) overpressured mega-compartment complex (MCC), and 3) deep normally pressured zone. This tiered pressure system demonstrates that there is no hydraulic continuity between them.

The overpressured interval is typically encountered in the upper Desmoinesian (around 8,000 to 10,000 ft) and extends to the Mississippian-Devonian Woodford Shale. The overpressured basin-scale compartment (MCC) is dominated by siliciclastic rocks with the textural variability and mineralogic diversity conducive to seal formation. Normally pressured reservoirs below the Woodford Shale are predominantly carbonates and sandstones in the Hunton, Simpson and Arbuckle Groups. These rocks have great lateral continuity and remain normally pressured over most of the basin. Therefore, abnormal pore pressure generated by various processes was not maintained as a result of the hydraulic continuity between outcrops and the subsurface reservoirs.

The basin-scale overpressured domain is highly compartmentalized. Most gas accumulations are independent of structural position and often require particular facies to be productive. Other compartments contain separate gas and brine columns or brine only. Normally pressured reservoirs below the basin-scale compartment have active water drives and gas accumulations occur primarily in anticlinal traps. The productive potential for the MCC is high across the basin. However, it decreases in the vicinity of the Wichita fault zone. On the other hand, the deep normally pressured rocks remain viable exploration targets up to and within the fault zone.

SAFLEY, L. EUGENE, BDM Petroleum Technologies, Bartlesville, OK; and SWINEHART, ROBERT, Nance Petroleum Corporation, Billings, MT

Effects of Heterogeneity in the Red River Formation, Bainville North Field, Roosevelt County, Montana

Various scales of heterogeneity control dolomite distribution and fluid flow in the Ordovician Red River Formation. The scale of the heterogeneity, and the resolution required to measure it, dictate the appropriate tools to be used. Analysis of reservoir heterogeneity plays an important role in developing reservoir models used to determine optimum recovery processes. Basin-scale heterogeneities define reservoir boundaries and control petroleum reserves. Tools used for characterizing basin-scale heterogeneities in the Bainville North field include 3-D seismic and analog field studies. Field-scale heterogeneities form internal barriers affecting interwell fluid communication and production behavior. Lateral discontinuities at this scale were estimated by drill stem tests, pressure build-up tests, fracture interpretations, fluid analyses, and geological correlations. Reservoir-scale heterogeneities occur within a genetic body and include bed boundaries and stratification type. Tools used at this scale include well log measurements and petrophysical analyses. Pore-scale heterogeneities promote the trapping of fluids in the pore spaces. Specialized core and log analyses were used to interpret heterogeneities at the pore-scale. The amount and type of data needed to characterize the reservoir is determined by the recovery processes being considered and economic sensitivity analyses. Selection of the optimum improved recovery process depends upon reservoir setting, recoverable reserves, and the type and scale of heterogeneities found in the reservoir.

SCHUMACHER, DIETMAR, TUCKER, JAMES D., and HITZMAN, DANIEL C., Geo-Microbial Technologies, Inc., Ochelata, OK

Surface Exploration in Mature Basins: Applications for Field Development and Production

Detailed geochemical surveys and research studies document that hydrocarbon microseepage from oil and gas accumulations is common and widespread, is predominantly vertical (with obvious exceptions in some geologic settings), and is dynamic (responds quickly to changes in reservoir conditions). These characteristics create a new suite of applications for surface geochemical surveys: field development, reservoir characterization, and monitoring patterns of hydrocarbon drainage. Combined with more established uses of surface geochemistry like high-grading leases, leads, and prospects, these new applications show great promise for the wider use of surface exploration methods in mature basins.

Because hydrocarbon microseepage is nearly vertical, the extent of an anomaly at the surface can approximate the productive limits of the reservoir at depth. Furthermore, the pattern of microseepage over a field can reflect reservoir heterogeneity and distinguish hydrocarbon-charged compartments from drained or uncharged compartments. Additionally, since hydrocarbon microseepage is dynamic, seepage patterns can change rapidly in response to production-induced changes. These applications require close sample spacing and are most effective when results are integrated with subsurface data, especially 3-D seismic data. The need for such integration cannot be overemphasized. Seismic data will remain unsurpassed for imaging trap and reservoir geometry, but only detailed geochemical surveys can image hydrocarbon microseepage from those same reservoirs.

High-resolution microseepage surveys offer a flexible, low-risk and low-cost technology that naturally complements more traditional geologic and seismic methods. Properly integrated, their use has led to the addition of new reserves, drilling of fewer dry or marginal wells, and optimization of the number and placement of delineation development, or secondary recovery wells.

SMITH, DAVID C., Missouri Division of Geology and Land Survey, Rolla, MO

Domestic Gas from Cherokee (Desmoinesian Series, Pennsylvanian System) Rocks in Bates County, Missouri; Coalbed Methane?

Driller's logs submitted to the Division of Geology and Land Survey from T. 38N., R. 32W. in Bates Country, Missouri, report domestic gas production during the 1930s and 1940s. Gas pressure of 52 pounds per square inch and estimated production of 50,000 cubic feet per day were reported for Watson No. 1 in Sec. 10. McGennis No. 1 reported 42 pounds per square inch gas pressure in Sec. 16. Pressures of 38 and 40 pounds per square inch were reported form the Joseph Propeck No. 1 in Sec. 21. This gas was produced from rocks assigned to the Cherokee Group (Desmoinesian Series, Pennsylvanian System).

Driller's logs of water wells, mineral tests, ant gas wells indicate that gas shows and production were primarily from black, carbonaceous shales, with occasional oil and gas shows from sandstone that occurs from 130 to 422 feet below the surface. In general, these logs fail to record the depth and thickness of coal beds that define the tops of many Cherokee formations. Logs from seven coal tests drilled during the late 1800s or early 1900s record the stratigraphic positions and thickness of black shales in the Pawnee, Little Osage, Excello, Verdigris, Croweburg, Fleming, Robinson Branch, Scammon, and Riverton Formations. These holes also record the thickness and position of sandstones in the Weir, Bluejacket, Drywood, Rowe, and Warner Formations. Formational thicknesses derived from coal test logs permit estimation of formational tops and correlation of strata in the water wells, gas wells, and mineral tests.

SMITH, MICHAEL P., Advanced Hydrocarbon Stratigraphy, Inc., Tulsa, OK

Fluid Inclusion Well Logs: Migration, Seals, and Proximity to Pay

Fluid Inclusion Well Logging is a new technology for mapping petroleum migration, seals, and proximity to pay. The data are fluid inclusion volatile mass spectra of normal washed drill cuttings, taken at an interval of about 10 meters from surface to TD. Various aspects of the fluid inclusions' compositions are plotted versus depth. Multiple gas analyses of different fluid inclusion populations are performed for each sample. The compositions of the various fluid inclusion gas aliquots on a single sample can be quite different. All lithologies and geologic ages are analyzed. There is no difference in data based on age of the samples. The technique works equally well on samples from wells drilled with oil-based or water-based muds. Cores and outcrop samples can also be analyzed.

Migration is documented as petroleum inclusion bearing strata. Migration compartments can be either vertically extensive or focused. Insight is provided into product type, i.e. Dry Gas, Wet Gas, Oil, or Biodegraded Oil.

Seals are documented as boundaries of petroleum-inclusion bearing strata with strata lacking petroleum inclusions, or as boundaries between strata bearing markedly different types of included petroleum.

Proximity to pay is sometimes inferred by inclusions dominated by water soluble hydrocarbons, i.e. benzene, toluene, methane, and ethane, but lacking the less soluble petroleum constituents, i.e. paraffins and naphthenes.

SMITH, PAUL W., HENDRICKSON, WALTER J., WILLIAMS, CRAIG M., and WOODS, RONALD J., Dwights Energydata, Oklahoma City, OK

Effects of Depth on Reservoir Characteristics and Production in Morrow and Springer Well Completions in the Anadarko Basin

A recently published report by the Gas Research Institute entitled "Gas Well Recovery -vs- Depth in the Anadarko Basin of Western Oklahoma" (GRI Report # 96/0196) suggests that the observed increase in gas well recovery with increased depth is more influenced by increased reservoir volume than by increased pressure. The GRI conclusions are based upon the physical volumes at depth required to contain the produced gas. The study did not include an investigation into the physical reservoir parameters (i.e. thickness or porosity). Trends in well recovery (and required reservoir volumes) versus depth resulting from the GRI study will be presented.

Independent of the GRI study, detailed reservoir characteristics studies for numerous fields producing from Morrowan and Springeran have been conducted. Approximately 300 wells producing from Springeran Sandstones and 375 wells producing from Morrowan Sandstones were evaluated. The distribution of wells represents a wide spectrum of depth ranges. The results of the reservoir characterization studies will be presented to include trends in reservoir thickness, reservoir porosity, water saturation, and well spacing. These factors can be used to determine the reservoir volume and demonstrate trends in physical reservoir volume with depth. Using original bottom hole pressure and temperature, one can then derive an expansion coefficient for each completion. This method can be used to make estimates of original gas in place for each completion. The original gas in place for each well was calculated using the perforated porosity and perforated thickness; the same was done using saturated thickness and saturated porosity. An interesting set of plots and data resulted. These can be used to expedite exploration strategies, exploitation strategies, and/or acquisition strategies. Guidelines for estimating the productivity of the specific reservoirs resulting from the reservoir characterization studies were generated and will be presented.

SMITH, W. HOXIE, M.S. GeoSpectrum, Inc., Midland, TX; REEVES, JAMES J., Ph.D., P.E., P.G., GeoSpectrum, Inc., Midland, TX; WEINBRANDT, RICHARD, Ph.D., P.E., Consultant, Jackson Hole, WY, and TRENTHAM, ROBERT, D.G.S., Muskoka Consultants, Midland, TX

An Integrated Study of the Grayburg/San Andres Reservoir, Foster and South-Cowden Fields, Ector County, Texas

A cooperative study of the Grayburg/San Andres reservoir is being conducted in response to the United States Department of Energy's (DOE) Class II Oil Program. The project is cost shared by industry and the DOE.

Production problems associated with shallow shelf carbonate reservoirs are being evaluated by a technical team integrating subsurface geological, reservoir engineering, and 3-D seismic data. The results of the integrated effort are recommendations for infill drilling and work-over locations and the design of an effective waterflood. The study demonstrates a methodology for reservoir characterization and subsequent development of the Grayburg and San Andres reservoirs that is feasible for independent operators. Furthermore, it provides one of the first public demonstrations of enhanced reservoir characterization of a small area (880 acres) using reservoir simulation and high resolution 3-D seismic data.

Results of the reservoir simulation indicate significant potential remains study wide in the lower Grayburg, and in limited areas in the upper Grayburg and San Andres. Work-over and new drill recommendations based on the simulation results have, to date, led to the discovery of significant additional reserves. The simulation demonstrated that without this effort all wellbores in the study area would have been abandoned in seven (7) years.

STEINCAMP, CHARLES C., Depew and Gillen, LLC, Wichita, KS

Trends in Environmental Liability for the Oil and Gas Industry

Recent court decisions pose risks for oil and gas companies, whether they are involved in exploration, production, refining or marketing of petroleum.

The oil and gas industry has been sheltered from the overwhelming environmental liabilities that have faced other industries. As a result of successful lobbying efforts, a petroleum exclusion was enacted in the Comprehensive Environmental Response Compensation and Liability Act (CERCLA), and a drilling fluids exemption was enacted in the Resource Conservation and Recovery Act (RCRA). The result of these exemptions left the petroleum industry relatively sheltered from liability.

Recent decisions in the federal courts have made significant inroads into the protections afforded to the petroleum industry under federal environmental law. As a result of these decisions there has been a recent expansion in lawsuits against oil companies and retail petroleum marketers as a result of spills or leaks of petroleum-based products.

This paper will survey some of the new case law developments and offer some suggestions for minimizing or avoiding liability.

STOECKINGER, W.T., Consulting Geologist, Bartlesville, OK

A Newly Recognized Upper Cherokee Channel Sand Complex Meanders Through SE Kansas

Shallow gas pockets (some converted to storage) were found in the early 1900s in thick sands of upper Desmoinesian age. Enigmatic trapping mechanisms, unique light green oil, mostly methane gas, rejuvenating formation pressures, and exceptional recoveries are explained by proving for the first time the Squirrel-Cattleman sands are encased in a "U" shaped channel, one mile wide and 150 feet deep which gently meanders north-south through eastern Montgomery, Wilson, and Woodson Counties.

The channel can only be recognized on geophysical logs where it slices down through a half dozen cyclothems of the Cabaniss formation. Regional west dip and east facing meanders form perfect stratigraphic traps. Sand is distributed within the channel as classic point bars. Splaying is common only near the Oklahoma border, east of Coffeyville. Often the channel is 100% clay filled. However, when sand dominates, differential compaction domes the overlying Fort Scott limes, generating early anticlinal closure for the lucrative Mulky-Shale gas reserves first tapped in the 1920s. Thin coals, capping each lithic cycle, abut the channel and sourced gas into it, even repressuring it.

Channel recognition will, on a sounder footing, rejuvenate development in this very mature oil and gas province.

STROUD, JOHN and DONOVAN, R. NOWELL, Geology Department, Texas Christian University, Fort Worth, TX

Depositional and Diagenetic Environment of the Sonora Sands, Ozona Field, Crockett County, Texas

The Sonora Sands were deposited on the southern margin of the Ozona Arch within the Permian Val Verde Basin, a northwest trending peripheral foreland basin. Sandstone deposition in the eastern part of the basin took place during the final episode of the Marathon Orogeny during the Middle Wolfcamp. Sediment transport into the area by fluvio/deltaic systems was initially from the east, rotating to the northwest through time and onlapping underlying Pennsylvanian strata. The Sonora Sands were deposited as submarine fans in and along two large north-south trending submarine erosional pathways that were carved into the underlying Strawn topography by a catastrophic shelf margin slumping episode. Slope-onlap and upward-fining stratigraphic patterns suggest a sea level lowstand during which sand-rich basin-floor submarine fans were overlain by turbidite slope wedges. Sonora facies are stacked submarine fans and mud/sand-rich turbidites with incomplete Bouma sequences that are distal in the upper packages and proximal in the older Sonora intervals. Slump, debris-flow deposits and fan-lobe deposits are common. The sands are fine to medium grained sublitharenites and litharenites with grain-rimming siderite. Siderite enhancement is concentrated along the onlap surface with some linear distribution throughout the sand intervals. Although primary porosity is limited due to cementation by mixed layer clays, sandstone porosity ranges from 2-7%. Fractures in the Sonora Sands are common and may affect reservoir properties; they are short, healed, random strikes with limited vertical conductivity.

THOMPSON, THOMAS L., GeoDiscovery, Inc., Boulder, CO, and HOWE, JAMES R., Consulting Geologist, Boulder, CO

Structural Inversion in Southern Oklahoma by Late Paleozoic Transpression, a Working Hypothesis

The tectonic history of southern Oklahoma, guided by Precambrian structural trends, includes massive rifting accompanied by a thick accumulation (about 6 miles or 10 km) of early to middle Cambrian mafic igneous rocks and associated clastic sediment overlain by a 1 mile (1.6 km) thickness of late Cambrian rhyolite. Early Paleozoic thermal subsidence allowed deposition of a 3 mile (5 km) thickness of preorogenic sediment.

Late Paleozoic transpression across rifted and subsided Precambrian basement blocks in southern Oklahoma (during the assembly of Pangaea) accounts for dominant structural styles along the Wichita-Marietta block, the Ardmore Basin block, and several blocks of the Arbuckle Mountains. Although complex in detail, the various structures and their mechanical linkages find common explanation in context of east-west to northeast-southwest compression and reactivation of northwest-trending basement faults. This fault reactivation and associated basin inversion resulted in structural relief of at least 6 miles (10 km) and accumulation of a 3 mile (5 km) thickness of synorogenic sediment, extensive thrusting, and left-slip faulting. Dip-slip shortening of the preorogenic rocks amounts to about 9 miles (15 km) whereas net left-slip displacement exceeds 18 miles (30 km).

Dynamic interplay among basement blocks under transpression inverted igneous-filled grabens and formed several types of mechanically linked structures in the overlying sedimentary sequences. 1. Northwesterly trending, left-reverse, oblique-slip faults vary in attitude depending on the attitude of basement block interfaces, with greater structural relief and imbricate faulting at confining bends in the basement block pattern, for example, the Wichita Uplift-Cyril Basin pair and the Criner Hills-Ardmore deep pair. 2. Northeasterly trending basement fractures apparently provided antithetic adjustment to the dominant northwest trending en echelon folds and faults, influenced the plunge of folds, and caused confining bends during slippage along basement block boundaries. 3. Flower structures formed at several scales, including the complex Cumberland Anticline and faulting above the Criner, Tishomingo, and Wichita-Marietta basement blocks.

USSEGLIO, J. MICHAEL, JM Usseglio Consulting Group, Grapevine, TX

The Dickens Project – Advances in Surface Geochemical Technology

Surface Exploration Technologies (SETs), specifically Surface Geochemical Technology, with low cost and quick data turn-around, are proving to be strong complements to traditional G&G in the more cost-effective oil and gas exploration of the 90's. A pragmatic discussion, with key case studies from the Eastern Shelf of the Midland Basin in West Texas, will cover the strengths, as well as weaknesses, of these tools when integrated with subsurface geology and seismic.

SET remains, at present, qualitative- almost an art. Issues and questions to be covered include: Why use surface geochem on our project? At what point in the exploration model should this technology enter? Is surface geochem better at finding oil and gas than seismic? Is the micro-seeping anomaly, as detected on the ground surface, near-surface, ocean bottom or ocean surface, a true 100% vertical projection of the shallow or deep trap? When do I use the reconnaissance versus detail tools? Why so many types of surface exploration methods? Why is the areal size of a survey more important than the sampling density?

WEIMER, BERT A., Weimer Consulting, Norman, OK

Remote Sensing Search and Prediction of Undeveloped Oil Production in the Panhandle Field, Texas

The Panhandle Field is a well-known major oil field with an extensive gas cap. The bottom of the oil field is not bound by a water contact, but by loss of reservoir quality strata. The ancient granite exposure of the buried Amarillo Uplift is generally considered to be the bottom of the Panhandle Field.

Upon the eroded granite topography are pockets of oil-productive Granite Wash to be found and produced.

Remote sensing, surface studies, and subsurface geology can be combined to visualize the historical erosion surface. Ten plus separate remote or subsurface indicators were studied at all points of the Panhandle Field to generate a map of structural features when eight or more indicators correlated a legitimate feature. Existing subsurface geology from wellbores confirms that Pennsylvanian age structural features did control reservoir creation in much of the Permian strata.

Once the controlling structural factors are understood and mapped, the probable reservoir deposition may be forecast. Many of these Granite Wash deposition sites, as found directly upon the ancient granite surface, were found during drilling the 75 year old field. It is through the use of multilayered remote sensing techniques that new productive strata may yet be developed.

An example of this type of new find was demonstrated in the late 1980's when newly drilled wells were demonstrating 100 BPD+ initial production rates. This discovery, when directly compared with the remote sensing data, demonstrates the validity of the above research. This research would be usable to explore for additional undeveloped production in what would appear to be a fully mature oil field.

WILKINSON, R. P., Consulting Petroleum Geologist, Ardmore, OK

Is the Washita Valley Fault a Strike-Slip Fault or a Thrust Fault, and Who Cares?

The Washita Valley Fault has been considered by many scholars to be a strike-slip fault with a left lateral movement of approximately 36 miles. A regional view of the sub-surface evidence, however, seems to indicate that the Washita Valley Fault may be composed of one or more thrust faults. If this is true, then the sub-thrust zone beneath the Washita Valley Fault may contain hidden structural traps in a very prolific oil producing environment.

The prolific nature of the sub-thrust objectives is demonstrated by the production history of two fields that are located on each end of the Washita Valley Fault Zone. The Eola Field is located on the west end, and the Cumberland Field is located on the east end of the fault zone. Each of these oil fields have now produced more than 800,000 barrels of oil per well.

Re-thinking the structural nature of the Washita Valley Fault may lead to the discovery of several more prolific oil fields. A seventy-mile prospective trend located between two giant oil fields should get serious consideration from any visionary exploration geologist.

YOUNG, ROGER A.; KUBERA, ERIC, and LEAVER, ALAN, School of Geology and Geophysics, The University of Oklahoma, Norman, OK

The AVO Response of a Pennsylvanian Age Channel Sandstone in the Arkoma Basin, Oklahoma

A seismic line imaging a gas-producing channel sand in the Pennsylvanian Hartshorne Formation was acquired in September 1994. The dataset was processed to retain relative amplitude fidelity and has been analyzed for anomalous amplitude behavior. Frequency domain filtering and CMP mixing were applied to improve the signal/noise ratio of the data. Despite this improvement, visual inspection of amplitude variations on trace gathers was not possible. Statistical determination of several amplitude attributes, however, provided an alternative procedure for interpretation of amplitudes. Attribute plots show that the channel sand does, indeed, have a distinctive AVO response. This signature is a positive normal incidence reflection of moderate relative amplitude which displays a strong increase in amplitude with offset.

POSTER PRESENTATIONS

BREVETTI, JOSEPH C., Schlumberger Wireline and Testing, Oklahoma City, OK; and HOLLRAH, TERRY L., Hollrah Exploration, Inc., Oklahoma City, OK

A Comparison of Core and Electrical Formation Images in Low Porosity Hunton Production

The Hunton Formation in some wells in Central Oklahoma has traditionally produced oil and gas at rates significantly better than should be expected from the crossplot porosity on the basic suite of logs. A well in an area of good producers was selected for both whole coring and electrical formation imaging in order to offer a geological and petrophysical explanation of this.

The analysis of this data yields a spectacular view of multiple aspects of secondary porosity and their interconnection to each other. The favorable comparison of the core and image information results in the explanation of the above through a well-developed vug system enhanced and interconnected with open natural fractures. In addition to refining conventional thinking on porosity and permeability relationships, the above study also presents the ability to orient and predict strike of these systems for use in future field development. Basic log and well production data is presented, along with the core and image data, for comparative purposes.

BROWN, RAYMON L., Oklahoma Geological Survey, Norman, OK

Gravity Anomalies Associated with Rift Faulting in Southern Oklahoma

Faulting during rifting can act to control the flow of intrusives into the shallow crust. As the intrusives migrate into the shallower sections of the footwall, laccoliths and/or sills can form in the shallow footwall sections of major rift faults. As a result, shallow intrusive bodies associated with a rift event may sometimes be indicative of where the footwalls of major rift faults were located. If the intrusives are more dense than the crust into which they are injected, the intrusives will show up as gravity anomalies which can be used to locate the footwalls of the major rift faults.

The normal faults associated with the rifting that took place in southern Oklahoma during the Cambrian are difficult to identify because of tectonic overprinting. However, two gravity anomalies in southern Oklahoma are interpreted to be the results of major intrusions guided by rift faulting during the Cambrian rifting. One of the gravity anomalies is associated with a basalt zone along the southern rim of the Wichita mountains. The second anomaly is just north of the Arbuckle uplift. The implication is that the Anadarko and the Ardmore Marietta Basins were the sites of two opposing half-grabens formed by major rift faults. The grabens acted to confine and control the extent of extrusives while the fault geometry affected :he distribution of intrusives into the footwall. Later, the rift geometry ultimately influenced the Pennsylvanian tectonics and mountain building in southern Oklahoma.

CAMPBELL, JOCK, A., Oklahoma Geological Survey, Norman, OK; and XIANHONG YANG, School of Petroleum and Geological Engineering, University of Oklahoma, Norman, OK

Anatomy and Oil Recovery from Fluvial-Deltaic Reservoirs in the Cottage Grove Sandstone, Lake Blackwell Field, Central Oklahoma

Channel-fill and crevasse-splay or crevasse-channel sandstones form four separate oil reservoirs (zones A, B, C and D), in the Cottage Grove Sandstone (Osage-Layton sand), section 14, T. 19 N., R. 1E., western Payne County. Net reservoir sandstones range in thickness from 16 ft to 6 ft having ten or more percent log porosity. Hydrocarbon-saturated thickness is commonly ten or fewer feet of sandstone. Entrapment is structural/stratigraphic; the reservoirs are located on a westerly-plunging anticline.

The discovery well was drilled to test the "Wilcox" sand, but was completed in the Osage-Layton sand in 1987, for 20 BOPD (43° API) and 7 BWPD, at 3,300 ft. Twelve development wells were drilled and completed in the four reservoirs between mid-1990 and mid-1993. Eleven were completed in zone A, two with no initial water and three with minor production of gas. Three other reservoirs (zones B, C, and D) produce from one well each. Two of the twelve wells penetrated reservoirs below oil-water contacts and one well completed in zones A and C has been abandoned because of high water cut. The more continuous reservoirs (A, B, and C) appear to benefit from a weak natural water drive. At least three structurally high wells flowed oil from zone A prior to the installation of pumps.

The four reservoirs had produced nearly 320,000 BO from ten wells by September, 1995. We estimate that total recovery from the four reservoirs will be 421,000 BO by 12/31/2005, with no change in well status (base case). Reservoir simulation studies indicate two options for management that will maximize oil recovery, using the same date (12/31/2005) for comparison. Recompletion of wells, 6 of them in zone B, will improve oil recovery to an estimate 940,000 BO, or 223% of the base case. In addition, the drilling of four development wells, one to be completed in each of the four reservoirs, would provide for the recovery of an additional estimated 126,000 BO, or an additional 30%, compared to the base case.

CASTAGNA, JOHN P., University of Oklahoma; and SWAN, HERBERT W., ARCO Exploration and Production Technology

Principles of AVO Crossplotting

Hydrocarbon related "AVO anomalies" may show increasing or decreasing amplitude variation with offset. Conversely, brine-saturated "background" rocks may show increasing or decreasing AVO. Amplitude-versus-offset interpretation is facilitated by crossplotting AVO intercept (A) and gradient (B). Under a variety of reasonable geological circumstances, A's and B's for brine-saturated sandstones and shales follow a well-defined "background" trend. "AVO anomalies" are properly viewed as deviations from this background and may be related to hydrocarbons or lithologic factors. The common three-category classification of gas-sands developed by Rutherford and Williams is incomplete. We propose that an additional category (Class IV) be considered. These are low impedance gas-sands for which reflection coefficients decrease with increasing offset; they may occur, for example, when the shear-wave velocity in the gas sand is lower than in the overlying shale. Thus, many "classical" bright spots exhibit decreasing AVO. If interpreted incorrectly, AVO analysis will often yield "false negatives" for Class IV sands. Clearly, the conventional association of the term "AVO anomaly" with an amplitude increase with offset is inappropriate in many instances and has led to much abuse of the AVO method in practice. Similarly, interpretation of partial stacks is not as simple as looking for relatively strong amplitudes at far offsets. We recommend that all AVO analysis be done in the context of looking for deviations from an expected background response.

CHOUPAROVA, ELLI, University of Oklahoma, Norman, OK; PHILIP, R. PAUL, University of Oklahoma, Norman, OK; and ROTTMANN, KURT, Oklahoma Geological Survey, Norman, OK

The Effect of Water Flooding on Produced Oil Composition from Bartlesville Reservoir, Prairie Gem Field, Central Oklahoma

Water flooding is a commonly applied operation in many petroleum fields to increase oil production. The heterogeneities in the oil composition as well as in the reservoir are two main factors impeding the sweep efficiency of water flooding and causing unexpected field problems. The present study integrates geochemical characterization of oils collected before and after water flooding and production information of the studied field.

The oils are characterized by a number of geochemical parameters indicative for source rock type, maturity and mobility determined by GC and GC-MS. Prior to water flooding, the results suggest a uniform oil composition regarding the source and maturity of the oils within the reservoir. The oil produced from a group of wells in the SE part of the field, however, is distinguished by higher values of a very sensitive geochemical migration parameter, i.e., the ratio of C16 n-alkane and aromatic 2-methylphenanthrene. The comparison with the oils produced after the water flooding indicates smoothing of these differences. Observed distinctions in mobility parameter of the oils are related to higher recovery factor for the NW part compared to the SE part of the field, demonstrated by volumetric calculations. Further, significant changes in the ratio of hydrocarbon (saturate and aromatic) to non-hydrocarbon (resins and asphaltenes) fractions are found in oils produced from the SE part of the field before and after water flooding, mainly due to prominent variations in asphaltene content of the oils. These changes in oil composition are discussed in relation to production as causing short distance migration of the oil within the reservoir and the heterogeneities in reservoir permeability.

COLLINS, DAVID R., Kansas Geological Survey, Lawrence, KS

Desperately Seeking Leases, Furiously Finding Fields: Comparison Of Predictions Using Different Targets In Discovery Process Models

Discovery process models play an increasingly important role in the assessment of undiscovered petroleum resources at the regional and national level, most notably the 1995 National Oil and Gas Assessment. Based on analysis of the sequence and size distribution of field discoveries, with an associated exploration drilling history, estimates are generated for the size distribution and finding rates of remaining undiscovered fields. Recent research related to the 1995 National Assessment has concluded that where oil or gas fields are numerous and small, discovery process models are able to capture the statistical nature of the assessment problem far better than geologic based assessments. Discovery process models should thus be well suited to resource estimation in the Mid-Continent.

Growth in the size of fields following their discovery, if not suitably addressed by discovery process models, is known to be a leading source of negative bias in resulting estimates of undiscovered resources. In regions such as the Mid-Continent where land ownership is highly fragmented, field growth histories are strongly influenced by the process of land parcel acquisition and development activities of competing exploration interests. Petroleum finds at the lease level have been considered an appropriate basis for analysis of exploration potentials for the single exploration interest, but have not been applied as the exploration target of interest in discovery process modeling. Using the discovery sequence and size distribution of found leases, this report compares the size distribution and finding rates of undiscovered leases as the target of interest (and the implied undiscovered resource base) with traditional resource assessment results based on modeling of the field discovery process. Potential biases are evaluated.

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Hutton's First Unconformity Revisited, Newton Point, Arran, Scotland

Most of us are weaned on the notion that the first unconformity described by someone who knew what they were looking at, took place when Hutton, Hall and Playfair visited Siccar Point on the southeast coast of Scotland in 1788. In fact Hutton had seen and understood unconformities at two sites in the previous year – Jedbergh and, a little earlier, Newton Point on the Island of Arran. All three unconformities juxtapose steeply dipping low- to mid-grade metamorphic rocks, deformed by the Caledonian orogeny, and Upper Paleozoic (Devono-Carboniferous) alluvium. Hutton had long recognized that these two rock types were distinct and commonplace in the central part of Scotland. He found the Arran contact by accident, while looking for evidence of the intrusive nature of granite: "Here the schistus and the sandstone strata both rise inclined at an angle of about 45°; but these primary and secondary strata were inclined in almost opposite directions; and thus they met together like the two sides of a lambda, or the rigging of a house, being a little in disorder at the angle of their junction".

The "disorder" at the unconformity surface is the result of intensive fragmentation of the "schistus" by caliche. Displacive and replacive calcrete textures are strongly developed along schistosity planes. The overlying strata are conglomerates and sandstones that also contain evidence of calcareous pedogenesis.

FOWLER, KATHLEEN S., and NICK, KEVIN E., STIM-LAB, Inc., Duncan, OK

Diagenetic Clays as Pore-Lining Minerals in Coalbed Methane Reservoirs

Cleat surfaces from Mary Lee and Black Creek coal seams in the Black Warrior Basin and Fruitland coal from the San Juan Basin show significant amounts of diagenetic quartz, illite, kaolinite, carbonate minerals, barite, gypsum and iron sulfides and sulfates. Scanning electron microscopy was used to identify and describe diagenetic minerals and surface textures observed along permeable cleat surfaces.

SEM-EDS analysis reveals a variety of pore-lining minerals in the permeable cleats of preserved core and mine samples. Surface textures vary from smooth and vitreous to rough and irregular with embedded diagenetic minerals. The most abundant clay mineral is illite which occurs as surface coatings, aggregates, and authigenic crystals embedded in the coal surface. Kaolinite is also abundant and occurs as abraded platelets and loosely attached aggregates packed against steps, as meniscus shapes on smooth fracture faces, and as a thick crust of subhedral to anhedral crystals. Chlorite, the least abundant clay, appears as sheets of small crystals. Sulfate, sulfide and carbonate minerals are present in masses of euhedral crystals or concentrated as thick crusts. Diagenetic minerals often control surface texture which, in turn, impacts the distribution of mobile particles. Migrating coal fines and clays accumulate at surface irregularities such as steps, laminations of interbedded clays or sulfides, and areas of rough surface texture. Their distribution suggests mobility within the cleat system.

Identification of cleat lining materials is important when predicting fluid/rock interactions, therefore the use of scanning electron microscopy to examine cleat surfaces should be a routine part of completion design. Application of this technology when characterizing Mid-Continent coalbed methane reservoirs will minimize the likelihood of formation damage.

HENDRICKSON, WALTER J., SMITH, PAUL W., WILLIAMS, CRAIG M., and WOODS, RONALD J., Dwights Energydata, Oklahoma City, OK

Advances in Regional Geology: A Regional Stratigraphic Correlation and Production Allocation Project Within the Anadarko Basin and Shelf of Oklahoma with Emphasis on the "Washes"

As part of a regional study, the logs from every producing well in the majority of the Anadarko Basin and Shelf of Oklahoma were reviewed to verify the actual producing reservoir and assign a consistent nomenclature. Both detail and regional cross-sections were constructed and used to determine stratigraphic relationships and develop a stratigraphic nomenclature system that could be used across the area with accuracy, detail, and consistency. Correlations were made from the Heebner Shale (Cisco, Upper Pennsylvanian) to the deepest zones penetrated. Allocation of the production within the study area was made based on these correlations and the associated nomenclature system. Some of the end products of this study have been greater definition and accuracy in the production data. One: example of this is seen in the production from the mountain front "washes" found in the southwestern portion of the Anadarko Basin. Previously, in many instances, thousands of feet of washes had reservoir nomenclature indicated as "Granite Wash" or "Atoka Wash". Analysis indicated that often the reservoir rocks were neither granite wash (being chert or carbonate washes) nor Atokan (being either younger or older). With the regional correlations as indicated by cross-sections, it was possible to subdivide the washes and assign more accurate and definitive nomenclature. Cross-sections and other pertinent data will be presented that will demonstrate the regional correlations and the methodology used to arrive at them.

HITZMAN, DANIEL, TUCKER, JAMES, Geo-Microbial Technologies, Ochelata, OK, and SMITH, SAM, Geologist, Wichita Falls, TX

Integration of Geophysical and Surface Geochemical Data Leads to New Field Discovery, Montague County, Texas

The integration of hydrocarbon microseepage analysis with seismic data directed explorationists to a new play concept and resulted in a new field discovery in North Texas. In the northern portion of a three square mile area, 3-D geophysical surveys identified a prospective Ellenberger trap at approximately 7200 feet. A reconnaissance microseepage survey of the area was conducted in December, 1995, using the Microbial Oil Survey Technique (MOST). The seismic prospect possessed a weak and slightly offset hydrocarbon microseepage signature. A stronger and larger microbial anomaly was located in a structural trough bounded on both sides by large structures.

In February, 1996, additional MOST samples were collected in a tighter grid pattern over the area of interest. The original seismic prospect remained associated with a weak hydrocarbon anomaly oriented perpendicular to the structural trend of the prospect, while the strongest and largest hydrocarbon anomaly continued to be located in the seismic low south of the structure. Review of geologic play analogs for North Texas suggested that the trough might contain channel conglomerates, an additional exploration target found in Montague County.

The seismic prospect was drilled at the crest of the structure in February, 1996. The well encountered 6 feet of tight Salona sand in the Ellenberger section. Attempted completion efforts failed to recover commercial hydrocarbons. A well was drilled in the trough and encountered 2 separate conglomerate zones with 10 feet of pay each. Initial production in lower zone was 500 mcfpd and 5 bopd. The next well found 3 conglomerate zones including 22 feet of pay in the lower zone with initial production near 1mmcfpd. Additional development wells are scheduled for the Park Springs Conglomerate.

This project is a good example of the use of surface geochemistry to evaluate seismic prospects and the use of geology to evaluate a geochemical lead. The conglomerate play would not have been scrutinized nor pursued without the positive microbial anomalies.

ROGERS, SUZANNE M., Independent Geologist, Edmond, OK

Depositional and Diagenetic History of the Mississippian Chat, North Central Oklahoma

The Mississippian Chat, present at the unconformity between the Pennsylvanian and Mississippian, is a weathered and/or detrital interval of tripolitic chat or dense chert at the top of the Osagean.

The depositional environment of the Chat reflects uplift and both erosion and weathering-in-place of Osagean Mississippian cherty limestone. Fossiliferous clasts found in Chat cores were likely eroded in a high energy environment such as that found above wave base in Mississippian shallow seas. These clasts were transported by small scale debris flows into a lower energy environment and deposited in a lime mud matrix.

Examination of thin sections indicates late diagenesis partially replaced calcite shells and cement with silica subsequent to the debris flow. Well preserved original fossil structures suggest that "force of crystallization" was the method of molecule by molecule calcite replacement by silica. Dissolution of remaining calcitic fossils by intrusion of meteoric water created secondary porosity and a potential hydrocarbon reservoir.

The Chat appears on well logs as a low resistivity zone with low density and high porosity. Analysis of producing fields suggests production from structural highs, pinchouts and diagenetically formed stratigraphic traps. Trend analysis suggests a relationship between positive structural residual values and Chat production. Seismic reflections resulting from the porosity contrast of the Chat with adjacent zones indicate the presence of the Chat.

ROSS, JORGINA A., and CROUSE, ELIZABETH L., Kansas Geological Survey, Lawrence, KS

Development of Digital Geologic Map Databases from Published Geologic Maps: Historic Preservation or Information Collection?

In database development, understanding why is essential to the proper choice of how. Increased use of computers in all phases of development of regional exploration programs and analysis of local prospects has increased the demand for high quality digital maps of surface geology. Large sums of money are being invested by state and federal agencies developing digital geologic map databases. A large part of this investment has focused on new field mapping in areas where published geologic maps were unavailable or deemed inadequate. In these programs, digital databases are usually derived from large scale (1:24,000) base maps developed by the project geologist. The slow pace of database development from new field mapping, combined with budget constraints, requires that more cost-effective methods be used wherever possible to develop statewide or national databases. Where good quality published geologic maps are available, their conversion to digital form has been seen as a solution to the cost problem. Technology and dollars have focused on the precise preservation of geologic patterns printed on these maps. Given the cartographic generalization inherent in the smaller scales (1:63,360 or less) at which most of the maps have been published, the usefulness of the results is seriously limited. A simple but innovative procedure, requiring only modest interpretation of published geologic maps in relation to the topographic model presented on corresponding 1:24,000 scale maps, maximizes the capture of information presented in published geologic maps. The resulting digital databases compare favorably with the results of new field mapping, with significant reductions in development time and labor costs.

SAXON, C. P., Institute For Reservoir Characterization, Norman, OK

Fold-Thrust Deformation Along Portions of the Arbuckle Thrust System and Frontal Wichitas, Southern Oklahoma

The Wichita Uplift and Arbuckle Anticline are basement involved foreland structures which formed during late Mississippian to late Pennsylvanian time. These uplifts and their associated basins exhibit the typical style characteristic of fold-thrust deformation. Earliest stages of deformation involve folding of the basement to create an asymmetric anticline and a forelimb syncline. Volumetric crowding problems created by upward tightening from the forelimb syncline generated thrusts within the pre-Pennsylvanian sedimentary section. These thrusts were directed up the steep and shallow flanks of the foreland syncline. Thrusting along the shallow limb created detached basinal anticlines characterized by fault-propagation folds within the pre-Pennsylvanian section. These lower fault-propagation folds are separated from overlying growth structures by detachments within Springer shales which form cross-crestal folds. This style is evident in numerous producing fields in the Anadarko and Ardmore Basins, including Carter-Knox, Velma-Cruce, Elk City, and Cement. Deep levels of erosion, poor exposure, the subsurface nature of the uplifts, and poor seismic imaging complicate resolution of structural geometry of the mountain front. However, regional cross-sections which integrate seismic and well control can establish minimal values of shortening and clarify fault relationships. Examples are presented from the Arbuckle Anticline and portions of the Wichita Uplift and the Anadarko Basin.

WEBSTER, ROBERT J., Wichita State University, Wichita, KS

Stratigraphy, Structure, and Regional Trends of Incised Valley Systems Along the North Side of the Anadarko Basin, in Clark, Comanche, and Ford Counties, Kansas

New well control, accumulated since 1980, has enabled the redefinition of the Pre-Pennsylvanian erosional surface in Ford, Clark, and Comanche Counties Kansas. A fault has been discovered in adjacent Comanche County to the east, and new evidence from subsurface mapping in the area has revealed new subsequent stream patterns not before recognized. The sandstone bodies normally referred to as "Morrow" accumulated in these subsequent valleys, as well as in seemingly genetically unrelated deposits. The sands were later reworked and additionally accumulated in an estuarine environment during Early Pennsylvanian marine transgression. The age term "Morrow" that frequently is attached to the sands is probably incorrect. New correlations show that these sands are more likely Atokan to Cherokee in age. These new interpretations of the "Morrow" sands can be used to enhance the success of exploration for oil and gas fields in the area. Also, the presence of glauconite in the sands of the Atokan-Cherokee can be used to distinguish them from the sands of the Mississippian Chester, which are deficient in glauconite. Distinction between Mississippian and Pennsylvanian sands is important for defining the Absaroka-Kaskaskia sequence boundary.

WILLIAMS, CRAIG M., HENDRICKSON, WALTER J., SMITH, PAUL W., and WOODS, RONALD J., Dwights Energydata, Oklahoma City, OK

A Regional Stratigraphic Correlation, Reservoir Characterization and Production Allocation Project within the Anadarko Basin and Shelf of Oklahoma with Emphasis on the Springer Group

As part of a regional study, the logs from every producing well in the majority of the Anadarko Basin and Shelf of Oklahoma were reviewed to verify the actual producing reservoir and assign a consistent nomenclature. Both detail and regional cross-sections were constructed and used to determine stratigraphic relationships and develop a stratigraphic nomenclature system that could be used across the area with accuracy, detail, and consistency. Correlations were made from the Heebner Shale (Cisco, Upper Pennsylvanian) to the deepest zones penetrated. Allocation of the production within the study area was made based on these correlations and the associated nomenclature system. Some of the end products of this study have been greater definition and accuracy in the production data.

The Springer Group consists of the Boatwright, Britt and Cunningham, in ascending order. While the Cunningham was always found to be a sandstone, extensive correlations indicated that the Boatwright and Britt, which are sandstones in the southeastern portion of the basin, develop an equivalent carbonate facies to the northwest. Facies and production maps are presented for the individual members of the Springer Group as well as a comparative analysis of the reservoirs.

Cross-sections and other pertinent data will be presented that will demonstrate the regional correlations and the methodology used to arrive at them.

The preceding abstracts were reprinted courtesy of the AAPG.