As I take keyboard in hand to continue this column, we are in the midst of a potential disaster in the Gulf of Mexico; a disaster not only to the environment and economy of the marine fisheries along the Gulf Coast, but to our industry and its ability to pursue a secure energy future for this country.

The little feedback I got to my last ramblings was all positive, so I’ll take that as a yes, and continue. We have talked about belief structure, and compromise, and being "purple," so I don’t need to beat that horse. If you tossed your past Quarterlies and need a refresher, they are available on the SIPES website - www.sipes.org. But I can’t help one last jab, a quote from Marilyn vos Savant, "The bigger the brainstorm you have, the more likely it is you’re all wet.”

(Continued on Page 18)

ClimateGate, Copenhagen, and the State of Climate Change 2010
by Robert M. Cluff, #1832 — Denver, Colorado

2009 may turn out to have been the turning point for the climate science community and proponents of anthropogenic global warming (AGW), although perhaps not in the direction they were hoping for. Flush with the Democratic election sweep of November 2008, control of the House, Senate, and White House, and high expectations for substantive climate change legislation in 2009, hopes were dashed against the successive debacles of ClimateGate in November, the failure to reach agreement at the December Copenhagen conference, and a cap and trade bill mired in the Senate with unlikely prospects for passage in 2010. Perhaps even more importantly, after a bitter 2008 Presidential election campaign promising a post-partisan, “let’s all talk and find the common ground” environment in Washington, the Democratic and Republican positions have hardened at the extremes and there is little or no appetite to reach across the aisle to seek solutions everyone can live with.

(Continued on Page 21)

Figure 1. World marketed energy use by fuel type, 1980-2030. (Source: EIA.)
The following reports on national and environmental issues will be presented to the SIPES Board of Directors at the Annual Meeting on June 21, 2010. Vice President of National Energy Kenneth J. Huffman, authored the National Energy Report, and J. R. Cleveland submitted the Environmental Committee Report. The views and opinions expressed are those of the authors. Some of the information presented is in the public domain and is available from a variety of sources; other references were selected by the authors, and are noted on their reports.

### NATIONAL ENERGY

Spring's arrival has once again ushered in changes in the weather and landscape that can be felt and seen. The changes not only make it feel comfortable to be outside, but also make it uplifting to one's spirit. This spring also brings some interesting changes in the way that the Energy Information Agency (EIA) reports natural gas production.

The EIA has used their Form EIA-914 since 2005 to collect monthly natural gas producing information from operators. These data are then compiled using a very complex methodology to generate monthly natural gas production estimates. The goal of the EIA is to "provide monthly accurate information not more than 60 days after the close of a report month."

The Independent Petroleum Association of America (IPAA), Marc Papa, chairman and CEO of EOG Resources, and other independent producers and analysts have been vocal in their attempts to point out the concerns with the EIA's method of reporting the natural gas market data. The IPAA wrote a letter to Richard Newell, EIA administrator, on March 8, 2010 requesting: 1) the Balancing Item needs to be reviewed monthly, 2) estimation of production use data that is 6 to 8 months old rather than 2 to 7 years old, and 3) make monthly rather than annual revisions.

Toby Shute (Motley Fool, 4-10-2010) reported that Mark Papa had predicted a 3.1 BCF per day decline (19%) for 2010. In a parallel article Carolyn Cui (Reuters, 4-5-2010, in the Wall Street Journal) wrote that the EIA data showed that gas supply rose 4% in 2009, despite a 60% decline in onshore gas rigs. The conflicting numbers have perplexed many analysts, and justifiably, as the error is estimated to be somewhere between a few percentage points up to 20%. The EIA acting director of the Form-914, Gary Long, led a review of the EIA methodology and has stated that the old model overstates production.

On March 29, 2010, the EIA reported that after conducting the review of their methodology used in EIA Form-914, they would use a new methodology for April 2010, reporting for February production. When this report is issued, their plan is to have revised the January production estimates, and there are expectations that some of these revisions will be significant. The new methodology greatly parallels changes sought by the IPAA and addresses their concerns, including: 1) Monthly-Sample, updating every month using recent information, 2) Estimation-estimation of non-sampled companies using data 6 to 18 months old, and 3) Timing-calibration will be monthly rather than annually.

The EIA's focus on surveying the major companies and extrapolating their data across the industry failed to pick up the changes in the industry itself. The majors in the onshore and offshore shelf have divested numerous older properties at a time when independents have expanded into and emphasized the shale gas plays. The contributions to the market by companies like Chesapeake, EOG Resources, Petrohawk Energy, Cabot, and many other independents into the shale gas plays have resulted in

(Continued)
increases and decreases to the supply and pricing for natural gas.

The significance of the contributions from the independents is well demonstrated by reviewing the top twenty (20) natural gas producers based on their daily rate (see Table 1). Many of this active group lost ground between the fourth quarter of 2009 versus the third quarter of 2009. El Paso and Petrohawk are the only companies that have increased the number of rigs drilling for gas in the six months prior to March of 2009. It will be interesting to watch for the results of the changes made based on the new EIA methodology and whether this reduces the errors many have noticed in the monthly production numbers.

**Markets**

The Gross Domestic Product, which represents the total value of goods and services over a specific time period, is on the way up in 2010 after a decrease in 2009. Currently the GDP is nearly $14.5 Trillion U.S. dollars annually. The economic recovery is increasing the demand for oil and gas resulting in an obvious increase in prices. January saw record consumption in natural gas of 2.836 TCF. Yet, due to a 12% increase in imports prices were held to a $5.53 per MCF (Henry Hub Spot Price) average for that month. February averaged $4.93 and March $4.27 with working storage hitting 1615 TCF the last week of withdrawals, March 12 to 18, 2010. Since that week the injection rate has exceeded withdrawals. The EIA predicts natural gas prices to remain low for several months. This is expected to affect the drilling activity negatively resulting in a production decline through 2010.

The good news is that West Texas Intermediate (WTI) crude oil spot prices are holding strong in the $80 to $85 per barrel range. Expectations are that with the improving economy worldwide the market should see some stability in the pricing through much of 2011. This has some of the shale gas players moving towards oil plays as Chesapeake announced a few weeks ago.

IEA reported a concern that the oil market may be currently overpriced. Global demand for 2010 is expected to grow by 1.7 million barrels a day on a year to year basis. This has been true for the first quarter, but global supply is up nearly 2.0 million barrels a day for the same period.

One of the big unknowns in the market this summer is whether the increase in demand for domestic transportation fuels will be offset by a higher cost to the consumer. Will they pay the increase or stay at home? A dollar increase per barrel in crude prices translates to about 2.4 cents per gallon at the pump.

(Continued)
ENVIRONMENTAL COMMITTEE REPORT

The balance between low-cost energy and protecting the environment is considered one of the greatest challenges facing mankind today. Most people agree on the need to move toward a lower-carbon future, but the transition will be difficult and expensive.

There is a great amount of interest in increasing the use of renewable energy sources, but the main drawback is the high cost associated with the development of these sources. Most renewables require large government subsidies and tax incentives to compete with fossil fuels.

The abundance of natural gas and coal keeps the price of fossil fuels relatively low. In order to force the nation to switch to renewable energy sources, the government will have to continue to subsidize renewables while placing more taxes on fossil fuels. The current administration's actions to limit drilling on federal leases and the congressional attempts to regulate hydraulic fracturing have been described as methods to limit future oil and gas production resulting in higher fuel cost.

In today's economy, the American public has no appetite for any climate change plan that involves more taxes, more regulation, and a possibly lower standard of living. In a recent Gallup Poll 51% of Americans see the weak economy and high unemployment as the nation's biggest concern. Only 3% mentioned the environment as the leading problem. Many see environmental action as a job killer or as a costly tax on energy.

Natural gas is the most environmental-friendly fossil fuel and will play a major role in the transition from high to low carbon energy production. Electrical power producers are projected to switch to natural gas from coal in order to reduce the emissions of greenhouse gases. Natural gas will also provide a stable backup energy supply for solar and wind energy providers, which depend on an unstable supply of sunlight and steady winds.

The Energy Information Agency predicts that in 2035 fossil fuels will provide 78% of U.S. energy, down only slightly from 84% today. Although there is a lot of talk and effort going into the transition to renewable energy sources, fossil fuels will continue to dominate the energy future.
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(Continued)
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LAFAYETTE

The Lafayette Chapter really enjoyed the guest speakers for our spring session. We started off with one of our own, Ken Huffman, #2936, from the New Orleans Chapter who gave a very informative talk on revitalizing the Louisiana State Lease 340 in Iberia and St. Mary Parishes.

A joint meeting with the Lafayette Geological Society was held in February with James Martin who serves as an Adjunct Professor at UL-Lafayette. His presentation on the Giant Fossil Reptiles from the Late Cretaceous of Antarctica was well received. The Lafayette Chapter also held the quarterly dinner meeting for the SIPES Board of Directors at the Petroleum Club on that same evening. I really enjoyed meeting Diane Finstrom as well as the directors whom I must commend for the time and effort that they put in for this great organization.

Alexander Economides was our March speaker. He discussed energy geopolitics across the globe. He has numerous publications on this issue and also presented his thoughts on the energy demand of China.

March guest speaker Alexander Economides (left) with Chairman Danny Frederick.

Our 25th Annual Sporting Clays Shoot is scheduled for May 12 with the 'Steak and Shrimp' dinner that night. We invite all potential candidates to both events to help increase interest in our local membership.

Danny Frederick
Chairman

MIDLAND

Our January program was presented by Tom Scott of Scott Bullock Scott, PC. Tom is a long time Midland attorney who spoke to our group about surface mineral issues in the state of Texas. His talk was titled "Limestone - Is it a mineral or a rock?" Tom provided a colorful and insightful historic perspective on the legal issues surrounding surface issues. The most recent case of many over the course of 100 years, involves the State of Texas Land office claiming ownership of surface mined limestone under state lands near El Paso. A cement company from Mexico has been mining limestone for a commercial cementing operation and the state has attempted to claim the company owes royalty payments for the sale of the rock. Tom has a degree in chemistry from Rice University and attended law school at the University of Texas in Austin. He began his career with Phillips Petroleum in Amarillo in 1958. In 1960 he moved to Fort Stockton, Texas to practice law with Maurice Bullock and James Kerr. After another stint in Amarillo with a different firm, Tom relocated to Midland in 1966 where he partnered again with Maurice Bullock and William Neely. The firm has had several iterations over the last 40+ years with Tom as a partner throughout. The January meeting sponsor was Griffin Petroleum Company.

Our meeting was saddened by the late December loss of our friend, professional acquaintance and fellow SIPES member, Mark Owen, #3085, who was killed in a car wreck just before Christmas. Mark was the geologist for Griffin Petroleum.

The February meeting was our annual Spouse’s Night held in the ballroom at Midland Country Club on February 18. Members and their spouses enjoyed cocktails and conversation prior to dinner. Incoming Executive Committee Chairman Don Eckerty and other members were introduced by outgoing Chairman David Overton. Upon assuming the role of chairman, one of Don’s first actions was to recognize the efforts and dedication of the outgoing chairman and the other members of the committee. After a few brief remarks, the members and spouses were all invited to enjoy the varied music provided by the DJ.

Our March meeting was held on Wednesday, March 17 and was hosted by Suttles Logging, Inc. Our speaker was Bob Trentham, director of the Center for Energy and Economic Diversification at the University of Texas of the Permian Basin in Odessa, Texas. Dr. Trentham’s topic was "Residual Oil Zones: From Science to Commercial Exploitation." His talk focused on recent studies of ROZs in carbonates of the Permian Basin that appear to be common in Leonardian and Guadalupian carbonates on the Central Basin Platform and Northwest Shelf. There is growing evidence that ROZs could contain potentially billions of barrels of oil that remain to be recovered in these zones. Following the talk, a lively and spirited question and answer session ensued.

Robert Wynne
Secretary
AUSTIN

The Austin Chapter’s regular lunch meeting is held the first Thursday of the month at the County Line on the Hill Restaurant.

In January, our speaker was Ryan Phelps, a Ph.D. student at the University of Texas at Austin. The topic of his talk was “Facies and Architectural Variability of the Albian Stuart City Margin.”

Patrick Nye, #3105, with American Shoreline in Corpus Christi, gave a talk entitled "Wind Energy – It’s Up in the Air" in February. He provided an overview of the wind energy business, and how American Shoreline, an oil and gas exploration company, has diversified into a second related business – wind farms. Some of this information was printed in the November 2009 SIPES Quarterly.

Our March speaker was Professor Earle McBride also with the Jackson School of Geosciences. The title of his presentation was "Patterns and Distributions of Quartz and Calcite Cements in Sandstone." He demonstrated that where quartz cement (controlled by time and temperature) can be predicted, calcite cement (influenced by biological and chemical reactions) is difficult to predict.

Ward Davenport
Chairman

DENVER

On January 28, the Denver Chapter of SIPES began its 2010 speaker series at the Wynkoop Brewery with a presentation from John Wright, #2497, consulting reservoir engineer from Golden, Colorado. The title of his talk was "U.S. Energy Independence a Fairy Tale?" John introduced his talk outlining how presidents starting with Richard Nixon in 1974 have continually pledged a goal of national energy independence by a stated date, and how these goals were almost never scheduled to be reached during that president’s term of office. He also reviewed in detail the historical consumption and production trends of various domestic energy sources, i.e., liquid petroleum, natural gas, coal, nuclear, hydro, wind and solar over the last 35 years. That analysis shows that coal, used primarily to generate electricity, has become an increasingly important component of the domestic energy mix since 1974. Liquid petroleum, used primarily for transportation purposes, is at the center of much of the nation’s energy and balance of trade problems over this same period. In spite of the politicians’ desires to move the nation away from dependence upon foreign sources of oil, the U.S. has steadily increased its imports of oil since 1974 from 35% to its present figure of 60%. This rise in imports is largely the result of the nation’s 50% drop in domestic oil production from 9 MMBO/day in 1974 to 6 MMBO/day presently, a decline that is not likely to be slowed any time soon. Natural gas, he explained, may be able to supplement liquid hydrocarbons for transportation needs over time if proper resources are dedicated to distribution infrastructure. John’s conclusions are not surprising to most SIPES members: 1) fossil fuels will continue to be the major source of energy for decades to come, 2) imports will continue to rise because of further expected declines in domestic production, 3) conservation and breakthroughs in energy technology will prove to be only marginally helpful, and 4) people will adjust and respond to market conditions if the markets are left undistorted by national and global politics.

On February 25, member Mike Austin, #2366, of Austin Oil, Broomfield, Colorado addressed our luncheon meeting on "Deal Selling Fundamentals." He discussed several critical subjects that need to be addressed by an independent in order to properly cover his bases in the course of any exploration or development venture. The first area he discussed was the various partner relationships one can nurture to build and fund prospect lease positions by way of royalty companies, industry savvy non-operators and repeat customers. He then followed with the pros and cons of whether or not to operate a drilling venture. Deal structures that safeguard your company’s ability to stay ahead of incoming AFE’s were outlined, as well as ways to keep your company’s cash flow intact by netting out investor’s revenue/expenses and collecting prepayments before drilling. Presentation of a prospect idea by “keeping it simple” and having a great productive analog is also considered critical. Finally, Mike gave an excellent example of how one of his own drilling successes was structured, and how the results would have varied under a cash and override scenario versus negotiating a working interest or a back in after payout.

At this meeting, acting chairman Jim Applegate announced that Travis Brown will assume the position of vice chairman in 2010 and that David Read and Tom Stander have agreed to continue in their respective posts of secretary and treasurer through 2010.

David Read
Secretary
DALLAS

The Dallas Chapter had a full first quarter 2010 with luncheon meetings at the Dallas Petroleum Club and the TEC Symposium at SMU. David Scull, our treasurer has been tireless in his efforts to streamline communications with our membership. The Dallas Chapter of SIPES has 127 paid members and chapter affiliates for 2010.

January’s luncheon speaker was Patrick Lowry. He is president-elect of DGS, and is a consultant and director of RPS Scotia. Patrick presented “Development Planning Using Integrated 3-D Visualization from Petrophysical and Seismic Data.” He demonstrated how subsurface and geophysical data are entered into a non-proprietary database for the management/analysis of large data volumes in a time efficient manner. A typical database may encompass 1,000 wells, have multiple pay intervals and dozens of reservoirs. Subsurface data needs to be digital as a LAS file for data entry. A user can prepare fence diagrams between wells, generate isopach slices of net pay intervals, identify and isolate remaining reservoir volumes, determine stratigraphic flooding surfaces, review T-R sequences and develop various deposition/engineering production models. The strengths of the modeling program are the creativity provided to the user and the display capabilities. Patrick Lowry is a geologist with B.S. and M.S. degrees in geology from Arizona State University. He has worked in the petroleum industry since 1979 for small producers, consulting companies and as an independent consultant.

Bo Henk of Matador Resources was our February luncheon speaker. His topic “The Stratigraphic Framework of the Haynesville Shale in NW Louisiana and NE Texas” was a stimulating paleo-depositional journey into the deepwater low energy environment of the organic material present at deposition. Mr. Henk had studied Smackover, Haynesville and Bossier cores in his derivation of the better producing reservoir characteristics. He verified that the 8300 psi, 25 mmcf/gpd Haynesville Shale wells are rare. One needs high TOC shale that is setting-specific. The Bossier Shale that is highly burrowed and light to medium grey is oxygenated and thereby forms the perfect seal for the Haynesville. In fact this seal is the cause of the geo-pressured characteristic of the Haynesville below it. Henk stated that a deep water anoxic environment was the depo-setting for the best Haynesville Shale reservoirs today. He believes the Haynesville was deposited in a sealed basin after the transgression post-Smackover filled the basin. When sea level fell, the resulting sealed basin was the setting for the Haynesville Shale. Bo Henk’s passion for his subject material is felt by all who were in attendance.

March 2nd was the 22nd Annual Energy Symposium hosted by the Texas Energy Council at SMU’s Hughes-Trigg Center. The topic was Global Energy: Today & Tomorrow. In addition to booths featuring political, legal and educational aspects of current energy issues, the symposium included speakers who urged our involvement as an industry. First, Pat French (senior vice-president of the Texas Alliance of Energy Producers) spoke about the importance of education and community outreach in programs of The Foundation for Energy Education. Emerging shale plays in their urban settings have necessitated both the study of benzene in the subsurface (Barnett Shale) and the Citizen Partnership that Schlumberger is putting together as a community outreach to familiarize the public with the natural gas industry. On the education front, the Offshore Energy Program has a MOBLOU (Mobile Learning Unit) for 5th graders and the Foundation has funded a program called Natural Gas Advantage to inform the public about the merits of natural gas in power generation.

Bruce Bullock, director of the Maguire Energy Institute in the Cox Business School at SMU and former director of corporate communications for FMC Technologies spoke about technological advances in deep water drilling technology. David Blackwell of the SMU Geothermal Laboratory spoke about the feasibility of geothermal energy and the importance of education and good energy policy in developing the Enhanced Geothermal System Resource Base for the U.S. Deborah Swanstrom of Patton Boggs, LLP spoke on energy policy and its effect on the construction of much needed transmission lines across the U.S. She stated that rate incentives provided by the FERC in EPAct 2005 of a 12-14% rate of return and the allowance for recovery of prudently incurred project development costs should stimulate new transmission projects. Sterling Burnett gave an animated talk on the substance of “Cap and Trade.” His personal familiarity with energy and environmental policy causes him to state that science is “beside the point.” He urged the audience to recognize the carbon tax essence of the Waxman Markey Bill and the “Climate Gate” tendencies of Federal Climate Policy. Texas Railroad Commissioner Michael Williams further sought energy industry involvement to “keep the Federal Government at bay.” He cautioned that the federal policies are encroaching on our state responsibilities particularly in intrastate pipelines.

Carol Shiel
Secretary
CORPUS CHRISTI

The Corpus Christi SIPES Chapter has enjoyed a busy 2010 first quarter with guest speakers discussing an array of interesting topics pertinent to the membership interests.

The January guest speaker was Phil Plant of Herndon Plant Oakley Ltd., a broker dealer and registered investment advisor firm. His topic was "Outlook 2010." His discussion touched upon many facets of the current world economic conditions. A comparison of the national debt of various countries was presented, including the United States, Japan and European nations. The U.S. consumer real estate market was analyzed in the context of mortgage debt. He noted the need in the U.S. for GDP buildup without government assistance. In the current economic situation he advocated the sale of most stocks and the purchase of treasury notes. He addressed the subject of international finance and the need for diversification of investments. Numerous charts and graphs were presented throughout his discussion. His summary remarks made a startling and somewhat negative case for a re-write of world economic history.

The February guest speaker was Todd Hunter, who previously served as Director from Corpus Christi. Mr. Hopkins was instrumental in establishing the Maps in Schools program and has enjoyed a busy 2010 first quarter with guest speakers discussing an array of interesting topics pertinent to the membership interests. His topic was "Austin Update." He presented an informative update regarding local, state, and national political issues relative to the oil and gas industry. Other matters of discussion included water rights, public transportation funding, and hurricane and windstorm insurance.

Christopher J. Modica of Pioneer Natural Resources was the guest speaker in March. His topic was "Characterization of the Sligo (Lower Cretaceous-Aptian) Platform Margin in South Texas." The presentation was a technical one regarding the stratigraphy and regional characterization of the Sligo platform margin with geologic and geophysical examples and models.

Eldon West
Secretary

SAN ANTONIO

In January, the San Antonio SIPES chapter began the new year with a presentation of "Bones in Schools" educational project from Owen R. Hopkins, #2986, a current SIPES Director from Corpus Christi. Mr. Hopkins was instrumental in establishing the Maps in Schools program that was very successful and the January presentation was a continuation of the effort to educate kids in schools about the earth sciences.

Mr. Hopkins’ enthusiasm was obvious from the beginning and he certainly set the audience attention to a high level - I even stayed awake during the whole presentation! Owen presented many slides and had various handouts available for the members to use in a school presentation. Thank you again, Owen.

During February, the local SIPES chapter attended a joint meeting with the South Texas Geological Society (STGS) to attend a presentation by Shirley P. Dutton with the Bureau of Economic Geology at the Jackson School of Geosciences, The University of Texas at Austin.

The title of Ms. Dutton’s presentation was "Reservoir Quality and Fore-Type Evolution in Tertiary Wilcox Sandstones of the Northern Texas Gulf of Mexico Coast During Burial from 0.2 to 6.6km." The discussion centered on lithic composition, burial history and porosity development, and deep water Gulf of Mexico environments.

Shirley Dutton received a Ph.D. from the University of Texas at Austin, and has worked at the Bureau since 1977. She is the principal investigator of the Bureau’s Deep Shelf Gas Consortium.

After the highly technical presentation by Shirley Dutton in February, our March speaker was a departure from the typical earth science technical presentations. Sir Oliver Smith, a speaker from the Master Gardeners (a Bexar County horticultural organization) gave a presentation on plants that thrive in the San Antonio and Bexar County area. After the most severe summer on record, audience interest was very high.

Mr. Smith presented a list of plants that thrive in the climate and soil conditions around San Antonio. As each plant was discussed on the list, slides were shown of the plant. One full hour was spent reviewing the plants and discussing the particular aspect of each. Again attendee attention and participation were high. Sir Oliver Smith also handed out three very useful references regarding the plants that thrive in San Antonio, their photos, planting times, sun/partial shade requirements, etc. There was a lengthy question and answer session and again we wish to thank Mr. Smith for his time and effort making our lives more knowledgeable and productive.

Sir Oliver Smith is a retired California Orange County high school English teacher who moved to San Antonio in 1995 upon retirement. In order to cope with the difficult soil and growing conditions in San Antonio, Mr. Smith became a Master Naturalist, Master Pruner, and Master Gardener of the year in 2000.

J. L. Jones
Chairman

MAY 2010
FORT WORTH

Our January meeting was held at the Fort Worth Petroleum Club. Twenty-nine members attended. Chairman Russ Hensley opened the meeting and welcomed the attendees, who all introduced themselves.

Russ introduced the speaker, Lee Petersen, #2838, of Oro Quay Corporation and Palo Pinto Exploration, Inc. Lee Petersen has served in many SIPES officer roles in both the Fort Worth Chapter and at the national level of SIPES. His presentation was a part of the SIPES 2008 Annual Convention in New Orleans. His talk was entitled “Finding Oil Without Use of Computers, Remote Sensing, Seismic, and Non-conventional Methods, Part II.” Oil is found in the minds of men. While “hot” plays may be beyond the independent, there exist innumerable opportunities to extend existing fields and find new reserves by applying observation, deduction, and rational thinking – even where large oil companies expended their best at-the-time efforts. The humblest individual oil and gas prospector probably already observes, deduces, and thinks, and these attributes can give him an edge over larger, better-funded competitors as he can overcome incorrect assumptions, miscorrelation of reservoirs, and erroneous geologic models in West Texas.

Lee illustrated his ideas as applied to existing fields in the Midland Basin and the Eastern Shelves; all examples of finding more oil in existing, said-to-be depleted fields. In Terry County (Midland Basin), he showed how an additional 4.5 million barrels were found. In Schleicher County (Eastern Shelf), the leases were cheap and there was some production from a large strat trap. Although lots of holes had been drilled already, thirty-seven additional producers were brought on line at an average of 440 BOPD. In Stonewall County, a large strat trap (with some unimportant closures and a slope wedge) was observed a second time: channels were mapped, the first well came in at 99 BOPD with 100 MCF, and additional wells average 35 BOPD.

In summary:
- don’t compete with the Big Dogs for leases
- focus on quiet areas, where leases are about to expire
- use available technology, but guide it carefully; apply it with critical thinking
- capitalize on pitfalls made by previous workers, and
- strategic partnerships compliment and magnify your skills

In February, Chairman Russ Hensley introduced two new members: Dan Earl Duggan and Jay Moore. The Fort Worth Chapter is pleased to have these two individuals in our organization.

Vice Chairman Terri Mayfield-Cowan introduced our speaker, Josh Stark. Mr. Stark works at XTO here in Fort Worth and his investigative techniques in understanding the distribution of coal bed methane gas gives thoughtful guidance to application methods to other reservoirs and their contents. The following is a subject and abstract of Josh Stark’s presentation. His talk was entitled “Factors Controlling Coalbed Methane Production from Helper, Drunkard Wash and Buzzard Bench Fields, Carbon and Emery Counties, Utah.”

CBM production occurs within non-volumetric heterogeneous compartmentalized reservoirs. Gas content for high-volatile B bituminous coals is anomalously high, displaying an isotopically mixed character of biogenic and thermogenic signatures. Gas content is variable throughout the trend, exhibiting a general decrease to the updip, southeastern portion of the coal belt. Correlation is noted between gas content, EUR, and salinity of formation fluids. In portions of the trend, updip saline formation fluids grade updip into fresh water.

An inclined potentiometric surface is developed between the deeper western area (Wasatch Plateau) and the shallower eastern region (San Rafael Uplift), resulting in minor arsian overpressuring in portions of the field. Fresh water and anaerobic bacteria enter the updip portion of the coal belt via major Basin and Range collapse grabens that were emplaced about 15 mya. Subsurface fresh water inflow to the Ferron Member has been measured at 2.4 ft³/sec, with a C-14 date of 28,000-31,000 years. Reservoir heterogeneity and compartmentalization were created by varying structural styles, forming permeability conduits and baffles that channeled arsian fresh water flow through the Ferron coals. Areas of high EUR are characterized by high rates of fluid flow, high gas content, low salinity and an increase in the fraction of isotopically light biogenic methane. Poor permeability with low fluid flow, low gas content, high salinity and a dominance of thermogenic methane characterize areas of low EUR.

It is suggested that initial thermogenic gas content within the coal was reduced as a result of disequilibrium induced by uplift of the Colorado Plateau, which raised Ferron coals from a maximum burial depth of about 11,100 ft to as shallow as 1,000 ft. Facies equivalent Ferron marine sandstones crop out about six miles to the east of the subsurface coal belt.

(Continued)
Spontaneous methane degasification resulted in undersaturated coals near this margin. Original formation fluid ($R_w = 0.08$) is retained in this updip region. Subsequent Basin and Range extension introduced fresh water and anaerobic bacteria into the system, re-saturating coals with isotopically light biogenic methane along avenues of enhanced permeability and within faulted compartments of the CBM trend.

At our March meeting, Vice Chairman Terri Mayfield-Cowan, filling in for Chairman Russ Hensley, opened the meeting and welcomed the attendees. Our speaker, Allyson B. Baumeister, CPA, with Sanford Baumeister & Frazier, PLLC, spoke on “Tax Transformations from the New Administration.” Taxes and how they change are on the minds of everyone. Allyson’s remarks dealt with the structure of business and taxation relating to the oil and gas industry.

Highlights from her talk included:

- The American Recovery & Reinvestment Act: was designed to stimulate the economy and provide tax incentives and breaks for businesses. Section 529 education plans were expanded; first-time homebuyer credits were offered, and “long time residents” can be treated as 1st time buyers.

- Roth IRA Conversions: 2010 is the first year that taxpayers can convert traditional IRAs (which are subject to lifetime RMB rules) to Roth IRAs (not subject to lifetime RMD rules) with no income limitation. It makes sense to start an IRA in 2009 and convert it to a Roth in 2010 (and traditional IRAs are taxable to heirs; Roth IRAs are not).

- Texas Franchise Tax Update: for FY 2007, franchise tax receipts were $4.45 Billion.

There have been no changes to the home office deduction, where the number of square feet devoted to an office divided by the total square feet of the home gives the percentage one uses to calculate office expenses for mortgage, utilities, interest, taxes and the like.

Russ Hensley
Chairman

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## SIPES Chapter Meeting Information

<table>
<thead>
<tr>
<th>Chapter</th>
<th>Chairman</th>
<th>Secretary</th>
<th>V-Chrmn</th>
<th>Secretary</th>
<th>Treasurer</th>
<th>Meetings</th>
</tr>
</thead>
<tbody>
<tr>
<td>AUSTIN</td>
<td>Ward Davenport</td>
<td>TBA</td>
<td>Dwight Cassell</td>
<td>The County Line</td>
<td>1st Thursday</td>
<td></td>
</tr>
<tr>
<td>CORPUS CHRISTI</td>
<td>Stephen Thomas</td>
<td>Eldon West</td>
<td>David Desenberg</td>
<td>Town Club</td>
<td>Last Tuesday</td>
<td></td>
</tr>
<tr>
<td>DALLAS</td>
<td>Doug Essler</td>
<td>Carol Shiels</td>
<td>David Scull</td>
<td>Dallas Petroleum Club</td>
<td>3rd Tuesday</td>
<td></td>
</tr>
<tr>
<td>FORT WORTH</td>
<td>Jim Applegate</td>
<td>Dave Read</td>
<td>Travis Brown</td>
<td>Wynkoop Brewing Co.</td>
<td>4th Thursday</td>
<td></td>
</tr>
<tr>
<td>DENVER</td>
<td>Russ Hensley</td>
<td>TBA</td>
<td>Terri Mayfield-Cowan</td>
<td>TBA</td>
<td>Variable dates</td>
<td></td>
</tr>
<tr>
<td>HOUSTON</td>
<td>Steve Hartzell</td>
<td>Paul Babcock</td>
<td>Scott Daniel</td>
<td>Petroleum Club</td>
<td>3rd Thursday</td>
<td></td>
</tr>
<tr>
<td>MIDLAND</td>
<td>Don Eckerty</td>
<td>Robert Wynne</td>
<td>John Kullman</td>
<td>Midland Country Club</td>
<td>3rd Wednesday</td>
<td></td>
</tr>
<tr>
<td>NEW ORLEANS</td>
<td>Louis Lemarie’</td>
<td>Al Baker</td>
<td>Reese Pinney</td>
<td>Andrea’s Restaurant</td>
<td>3rd Tuesday</td>
<td></td>
</tr>
<tr>
<td>OKLAHOMA CITY</td>
<td>James Jackson</td>
<td>Mike Pollok</td>
<td>Victor Cooper</td>
<td>The Petroleum Club</td>
<td>1st Wednesday</td>
<td></td>
</tr>
<tr>
<td>SAN ANTONIO</td>
<td>J. L. Jones</td>
<td>TBA</td>
<td>Joe Finger</td>
<td>Petroleum Club</td>
<td>3rd Thursday</td>
<td></td>
</tr>
</tbody>
</table>
OKLAHOMA CITY

The main events for the Oklahoma City Chapter of SIPES during the quarter were noon luncheons in January, February, and March. As of February 2010, our chapter had 98 active members, and we are currently receiving applications from several individuals for full membership. On March 18, our chapter participated in Geology Day at the state capitol along with other geological groups located in Oklahoma. Our chapter’s goal of placing a framed USGS Geological Map of the U.S. in every school that teaches earth science in Oklahoma is active. We were happy to have SIPES Foundation Earth Science Scholarship recipient, Jonathan Funk, attend a second noon luncheon this quarter. Mr. Funk is working toward a master of science degree in geology at the University of Oklahoma. Vic and Dorothy Cooper have been preparing a new membership directory for the Oklahoma City Chapter. Unlike previous directories, this one will be a pictorial directory. The final product should be available some time in the very near future.

Our January speaker was our Oklahoma City Chapter Secretary Mike Pollok, #2512. He received a B.S. in geology from the University of Oklahoma in 1986 and works as a non-consulting independent petroleum geologist. His company, Map Exploration, is most active in oil and gas exploration and development activities in northern Oklahoma and southern Kansas.

His topic was “Mississippian Subcrops or How to Find ‘Buried Treasure’ in Your Own Back Yard.” The treasure mentioned lies geologically on the northeast shelf of the Anadarko Basin and has been right under the author’s nose the whole time he has been exploring the area. The shelf can be referred to as a gentle south-southwest dipping monocline with few structural features. One of the more pronounced features is the Pratt Anticline, which plunges south into Oklahoma from the Central Kansas Uplift. This talk was generated anticipating that other geoscientists might glean ideas, thoughts and concepts that would help them in finding their own backyard “treasure.”

Our February speaker was Oklahoma’s new state geologist and director of the Oklahoma State Geological Survey, Professor Randy Keller. Dr. Keller teaches in the School of Geology and Geophysics at the University of Oklahoma. He holds the Edward Lamb McCollough Chair in Geophysics. Randy, his students, and colleagues have conducted many studies of the structure and evolution of the crust using gravity, magnetic, remote sensing, and seismic measurements integrated with geological data, often as part of large international cooperative efforts.

The topic was “Tectonics, Basement Structures, and Earthquakes in the Oklahoma Region.” Oklahoma lies at the intersection of several major tectonic features that are of Late Precambrian and Paleozoic age. These features are globally significant, and the resulting deep structures are large and complex. The Oklahoma region was affected by two major rift zones, The Mid-Continent Rift (MCR) system and the Southern Oklahoma Aulacogen (SOA). The MCR is traditionally viewed as ending in central Kansas and the SOA can be interpreted as ending in the Texas panhandle. However, new seismic data and public-domain compilations of gravity and aeromagnetic data for the U.S. have been employed to construct a series of maps using a variety of digital filtering techniques in order to better delineate anomalies and interpret regional-scale structures.

March’s speaker was Stephanie Gaswirth, a research geologist with the USGS at the Central Energy Resources Science Center in Denver, Colorado. She earned a B.A. in geology from Franklin & Marshall College in 1997 and was granted an M.S. in geology from Rutgers University in 1999. Dr. Gaswirth was granted a Ph.D. from the University of Colorado in 2004 and spent several years working for Exxon Mobil Upstream Research Company.

The topic was “Reservoir Characterization of the Hunton Group in the West Edmond Field, Oklahoma.” West Edmond Field is located in central Oklahoma, and is one of the largest Hunton Group oil accumulations in the Anadarko Basin. Oil and gas are stratigraphically trapped to the east against the Nemaha Ridge, to the north by a regional wedge-out of the group, and in intraformational diagenetic traps. Hunton Group reservoirs are the Bois d’Arc and Frisco Formations, with lesser production from the Chimneyhill limestone, and Haragan and Henneyhouse Formations. Field production exceeds 170 million barrels of oil (MMBO) and 400 billion cubic feet of gas (BCFG).

James Jackson
Chairman

IN MEMORIAM

We regret to note the passing of the following members:

Edgar B. Krider, #248
of Houston, Texas
who died on March 28, 2010

William J. Malin, #1958
of New Orleans, Louisiana
who died on March 1, 2010

John J. Taylor, #1675
of Odessa, Texas
who died on February 12, 2010
NEW ORLEANS

The New Orleans Chapter kicked off 2010 with its January luncheon at Andrea's Restaurant in Metairie. Local Chapter Affiliate, Randy Brunet, who is a certified public accountant, presented his talk entitled "2010 IRA and IRS Changes That May Affect You." Randy discussed the opportunity that applies only to 2010 to convert the traditional IRA and retirement plan accounts to the Roth IRAs. During prior years, there were income limitations on the eligibility to make such conversions. Randy very ably explained the Roth IRA mechanics along with the potential fiscal benefits for making the conversion this year. In addition, Randy spent time explaining some of the ramifications of the 2011 expiration of the Bush-era estate tax cuts that have been in place over the past decade. He presented a brief history of the estate tax legislation showing the evolution of the estate tax and its ultimate impact on accumulated personal wealth.

At the February luncheon meeting, our guest speaker was David Koger, Fort Worth Chapter Affiliate, who gave his presentation, "Low-Cost Prospecting and Seismic Planning with Remote Sensing Photogeology." This talk was presented at the 2009 SIPES Convention and is available for rent from the SIPES Foundation Earth Science Film Library.

David showed how remote sensing can be geologically useful by providing low-cost prospect leads. Space-borne scanners can deliver detailed structures, drainage patterns and tonal anomalies of which the latter may result from microseepage of hydrocarbons from subsurface reservoirs. David cited various uses of remote sensing technology such as site identification for construction of well pads, planning seismic surveys, and identifying surface fracture patterns especially in shale regions. David stated that in some shale regions the stress-strain relationships that are visible at the surface may reflect the orientation of fractures in the subsurface and thus the wellbore. This methodology could aid in the determination of the azimuth for the laterals to be drilled and where in the wellbore to maximize potential flow rates through fracturing techniques. Applications in the Marcellus, Fayetteville and Barnett shale gas areas were shown.

During the March meeting, Steve Anderson gave his talk entitled "Section 28 Field Redevelopment – New PUD Opportunities for a Choppy Market." Steve is a principal in Penta Resources which has entered into an agreement with Termo Oil Company to redevelop the Section 28 Field. This field is a long-producing salt dome that is located approximately 15 miles north of Lafayette, Louisiana in St. Martin Parish. Termo Oil had acquired the north flank of the Field from Amoco, and the northeast and east flanks of the field from Gulf Oil. Penta Resources and Shelf Energy are providing Termo Oil with geological, geophysical and reservoir engineering to locate new reserve potential. Penta Resources acquired and reprocessed the Seitel 3D seismic data that encompasses the salt dome. Through a detailed field study, Penta Resources identified several potential projects on the north and east flanks which will result in a six-well drilling program. The primary drilling targets include the Marg. tex. and Bol. mex. Sands. The proposed wells are designed to drilled updip from production for the attic reserve potential. The Bol. mex. Sand has solid water drive support, whereas the Marg. tex. Sand is a combination water drive-pressure depletion reservoir. Thus far, the initial drilling has been initiated with mixed results, but reevaluation is underway with additional drilling being planned.

Al Baker
Secretary
HOUSTON

In January, John Lee of the Harold Vance Department of Petroleum Engineering at Texas A&M University presented his talk titled "Update on Implementation of the Modernization of SEC Oil & Gas Reporting Requirements" to a sold out audience of 120 people at the joint SIPES/SPEE meeting. Last January, Dr. Lee presented the new SEC rule changes. Now that the new rules are in effect, this presentation provided us with an insider's update.

In late 2008, the SEC enacted new rules for reporting oil and gas reserves. These new rules went into effect January 1, 2010, and have generated numerous questions from the industry. The SEC therefore issued guidance on both technical and accounting issues to assist in the implementation of these new rules in October 2009. The major parts of this guidance can be divided into four basic issues: (1) clarification on the "five-year" rule for development of undeveloped reserves, (2) the determination of prices and costs to calculate the economic limit of reserves, (3) the classification of reserves below the lowest known hydrocarbon limit, and (4) how to determine what is a "reliable technology."

The "five-year" rule states that resources can be classified as proved undeveloped reserves only if a development plan has been adopted which calls for the drilling of those reserves within the next five years. The implication of this rule is that if the resources are not to be drilled within five years, the resources would have to be classified as either contingent resources, or, possibly, as probable or possible undeveloped reserves. Dr. Lee stated that the SEC recognizes that there are extenuating circumstances that might make development within five years impractical (e.g., urban, environmentally sensitive areas and deep offshore developments) but such exceptions would be very limited.

The product price used for the determination of the economic limit of reserves will be the average price of that product for the 12-month period prior to reporting. No computational procedure has been dictated for costs but the historic costs in the area or the latest contract costs will probably be acceptable.

Resources below the lowest known hydrocarbon limit can be classified as probable or possible reserves, if they meet all the other criteria for reserves. Also, it is possible to have probable and/or possible reserves without having any proved reserves in a specific project.

The use of "reliable technology" to justify reserve classification is a controversial point. The SEC will not be publishing a listing of "reliable technology" but may provide to the industry, on a case-by-case basis in redacted comment letters, technology applications that it does not consider reliable technology. The burden of establishing that a technology is reliable rests with the applicant. In general, the technology must be field tested and proven to consistently lead to correct conclusions.

In response to questions from the audience, Dr. Lee stated that (1) there is nothing in the SEC regulations that state that press releases must abide by SEC definitions of reserves categories beyond proved if those unproved reserves have not been disclosed in filings with the SEC, and (2) probabilistic methods for the estimation of reserves are acceptable to the SEC but are not the preferred methodologies.

On February 18, McMoRan chairman James R. "Jim Bob" Moffett presented his "Going Deep: McMoRan's High Impact Deep Exploration Play" to an enthusiastic, record crowd (325+), including five news organizations. McMoRan has been extremely active and committed to the exciting, costly, rank wildcat, exploration play found in the ultra-deep shelf, Gulf of Mexico (GOM).

McMoRan has put together a regional, ultra-deep, exploration play addressing the sub-listric fault/salt-welds on the GOM shelf. Slightly over forty-eight thousand wells have been drilled on the GOM shelf. McMoRan's ultra-deep exploration play is taking place below 25,000', where only seven wells have been drilled by industry. It targets large deep compressional features that lie below the regional listric detachments, above which, the historical GOM fields are found. McMoRan has identified numerous large structural features that target lower Miocene, Eocene/Paleocene (Yegua/Wilcox) as well as potential Cretaceous Woodbine and Tuscaloosa objectives. Industry's deepwater success in the GOM, has provided an analog for these deep hydrocarbon-bearing structures and objectives, and aided McMoRan in constructing their conceptual models for this play. Mr. Moffett illustrated their models utilizing diagrammatic cross-sections, and depositional fairways.

Mr. Moffett shared information on their currently drilling, Davey Jones discovery well which is evaluating a

(Continued)
20,000-acre structural closure offset by large fetch areas. Their Davey Jones well encountered Wilcox section below 26,000’ and found 200’ of pay in six zones, all hydrocarbon filled to the base of sands. Well logging is challenged by the extreme temperatures (440 degrees), but the logs indicate porosities of 13-22%. Flow testing is deemed critical to confirm productivity and rates. Deepening to Cretaceous objectives is possible in the current well or certainly will be tested in a planned appraisal well to be drilled 2.5 miles from the discovery. Costs and technical challenges are extremely significant as industry has to contend with great drill depths, temperatures, geo-pressure and regressions. Long lead times are required for tubulars, trees, valves and test equipment.

Mr. Moffett fielded numerous questions from the audience who truly enjoyed hearing the story from the wildcatter himself.

On March 18, Mark Gregg, #2883, immediate past chairman of SIPES-Houston, presented his "Developing an Exploration Tool in a Mature Trend: a 3D AVO Case Study in South Texas" to an attentive SIPES audience of 103. The paper was co-authored by Charles Bukowski, #3116. This paper was originally authored ten years ago when an onshore AVO approach to exploration in the south Texas Vicksburg was novel and fairly innovative for the time frame. Mark reviewed the play background, and used seismic examples of the early drilling that demonstrated the problems that led to marginal overall exploration (Ps= 20%) results.

The full-stack seismic data was not able to distinguish between commercial gas sands and water sands. Their challenge was to see if they could use the 3D data set to improve their overall risk assessment of the play. At that time, there was nothing in the literature that provided a roadmap to a better approach. When they went back to the rock characteristics ("Know your Rocks"), they were able to recognize the large Poisson ratio contrast associated with a gas sand versus a water sand. Modeling work convinced them that with the right data set, they should expect a classic Class 2 AVO anomaly. Reprocessing that included anisotropy-based, non-hyperbolic moveout, to render the far-offsets usable, coupled with analogue calibrations and work with different angle stacks, yielded an effective tool to differentiate between the water sands and the gas sands. Subsequent exploratory drilling with this new technique resulted in a commercial success rate of 75%.

The presentation was excellent and the important point to take away from Mark’s discussion was the actual process itself. It included, "Know your Rocks," don’t be afraid to look beyond conventional techniques, validate with known analogies, and take what you learn and expand upon it. Mark’s examples and subsequent results of their 3D-based exploration program provide support for this. The AVO approach allowed them to rapidly identify prospects and also identify a stratigraphic trap (subsequent discovery) thus opening up a new play variation. Finally, more quantifiable risk assessments allowed their company to successfully target smaller accumulations.

Mark’s presentation will be presented at the upcoming SIPES 2010 Convention and 47th Annual Meeting in Colorado Springs.

Paul Babcock
Secretary
ENERGY MAKES THE WORLD GO ROUND

So where is all this taking us? It's all about the energy. Life is energy, we need it to live, and as long as it's cheap, we'll continue to "live it up." Yes it's true we use more than our "fair" share, but we produce more than our share as well. Our appetite for "things" provides jobs in China and India and many other places around the world, and they would be worse off without our appetite. (As would we, but that's a different rant.)

Now the rest of the world is rapidly expanding a middle class, and beginning to adapt our consumptive "bad" habits. This will lead to increased demand for limited resources. And it's not just the middle class, but population growth in general. There are now more than 6.7 billion (6,700,000,000) people on Earth, and we are increasing that number (net gain after deaths) by about 227,000 individuals every day. Of that figure, about 5,000 are gained in the "developed" countries, while the rest (do the math) are gained in the "undeveloped" Third World.

It is estimated that 16.7% (1/6th) of the world population go to bed every night hungry. That's about 1.12 billion, including about 1/8th of the people (over 41 million) in the U.S. We are supposedly producing enough food to feed the world, but we cannot seem to get it where it is needed most. This is partly due to infrastructure (that is why they are called Third World countries), but mostly due to politics (which tends to keep them Third World, which is another rant). We heavily subsidize our food industry to be able to produce this cornucopia, which keeps food prices down. Except this means a burger is cheaper than a healthy alternative for poor people in this country, so we end up creating an unhealthy overweight and diabetic generation (which will need that health insurance we just passed), and Third World subsistence farmers in Mexico can't compete with our prices, so they go out of business and look for work in this country (becoming illegal aliens), and there aren't any more independent farmers in this country. Yes, you're right, this is also another rant, but check out the relevance below.

So more people equals more pressure on resources we need for life: food, water, minerals, and energy. I wonder if food production could be considered an earth science, we could use some of that political clout on our side for a change. Besides, they need us for fertilizer, transportation, etc., etc., etc. But I'll concentrate on energy, in particular, hydrocarbons.

AGW

The energy we humans consume in such profusion comes from a variety of sources, some renewable like wood, and some not like coal (not fast enough to matter anyway). But the majority of the sources produce pollution (OK, really they all do) which today includes CO₂. And according to the current wisdom, this is catastrophically bad because of Anthropogenic Global Warming (or AGW). So what is pollution and AGW?

Pollution is the introduction of contaminants into an environment that causes instability, disorder, harm or discomfort to the ecosystem. Pollutants, the elements of pollution, can be foreign substances or energies, or naturally occurring; when naturally occurring, they are considered contaminants when they exceed normal levels.

Anthropogenic (from the Greek meaning manmade) effects, processes or materials are those that are derived from human activities, as opposed to those occurring in biophysical environments without human influence.

Beginning with global warming (we call it climate change these days) we tend to forget that the earth is a dynamic system, i.e., it changes. We haven't been around long enough, nor collected enough data, to define normal (except within our limited data set). Yes, temperatures are increasing; CO₂ is increasing; ecosystems are changing in ways unfamiliar to us, but not the geologic record; and CO₂ is a greenhouse gas (not the only one, nor the most potent). But, the leap to CO₂ as the cause of temperature rise and the deterioration of the environment doesn't really fit the data I've seen. And since we can't define "natural levels" for the earth environment, this (Continued)
causation seems even more suspect. (See “ClimateGate, Copenhagen, and the State of Climate Change 2010” article on Page 1).

Is the increasing volume of CO₂ we are pumping into the atmosphere by burning fossil fuels anthropogenic, or are we only contributing to a natural rise toward a new “normal?” Only time will tell, but we are contributing to CO₂ levels, and will continue to do so in increasing quantities for the foreseeable future.

So we're going to "solve" the AGW problem with Cap and Trade legislation (they don't call it that anymore) by taking money from the polluters and giving it to the poor countries to encourage carbon sequestration projects (planting trees, etc.). To oversee that this is all done properly we will need twenty-one new government agencies, with an overhead of about $8,000,000,000. And oh, by the way, our buddies at AIG will get a handling fee of 10% for transferring the funds. Except for the resulting closure of old electric power plants unable to afford the "fees," this solution hasn't reduced any CO₂ emissions yet.

Since the real polluter is us (not the power plant or refinery who struggle to keep up with demand) we need to burn less gasoline and electricity. So let's convert our 250 million cars to all electric. With a domestic productive capacity of about 25 million cars that should take only 10 years. Of course we have to convert production over to only electrics, and keep foreign makers out unless they make electric also. As more cars become electric, our electricity demand will increase (more not less) while we are shutting down coal fired power plants and coal mining in favor of greener technologies. The renewable energy sources of wind and solar currently provide less than 1% of our electricity, so it would take massive incentives and investment in technology as well as decades to replace the current power generating facilities. Then we would need huge quantities of lithium for the batteries in these cars. Most of the lithium comes from South America; no wonder China is so friendly to Chile and Bolivia. The list goes on and on, and the costs get higher and higher. Frankly, I do not see CO₂ emissions decreasing by any activity we humans can do until we are willing to change our consuming habits, dramatically. But that would hurt the economy.

**HAIL THE HYDROCARBON HUNTER**

So we bought into the American dream, and believed consumption was good, and it drove a booming economy that is still the defining standard for the world. But that only worked because of capitalism with its profit motives. Meanwhile, energy drove the train, and as one energy source became scarce, our free market system was able to find replacements; coal for wood, oil and gas for coal, nuclear, renewable. But wait, nuclear and renewable haven't replaced anything yet, and we still use wood and coal. Seems like every time we get oil prices high enough to make alternatives competitive (or worth investing in) we get a "correction" (recession) and oil is cheap again.

We haven't, in my opinion, really given enough credit to the petroleum industry for their efforts to maintain our access to this cheap oil. Consider that 25% of domestic production comes from the Gulf of Mexico, and since the beginning of this century the majority of that oil has come from deepwater projects. I talked about Shell's Auger field as your vice president of national energy last year, and recently learned about their Perdido facility in 8000' of water. After watching fluctuating oil prices for the 14 years during fabrication and development of the Perdido facilities (this had to be an investment north of $25 billion), they finally turned on first production on 3-31-10. That's gutsy, especially when you consider at today's oil price ($85/bbl, or about $60/bbl after royalty) they have to produce nearly 400 MMBO (yes, million) to get their money back. At 100,000 bpd (reported capacity of the production facility) that will take about eleven years. So twenty-five years to recoup your investment. Imagine the time line if prices hadn't recovered from the recent low of $35/bbl, not to mention it would then take about 1 billion BO to do it.

But we're not done yet. We are talking new technology in platform and production techniques. The platform is a Spar design as tall as the Eiffel Tower and will handle production from three fields. With some of the reservoirs low pressure and being at record depths, water production will be separated from the gas and oil on the sea floor, thus reducing the hydrostatic head by 2,000 pounds. Without incentives like royalty relief for deep water production, and the expectation of huge reserves, no one would make these investments in technology and exploration. As it is, only the majors can do so. The public decry the excessive profits made by the oil companies, but without that revenue there wouldn't be this kind of investment, and we would be paying a lot more for energy from insecure sources. And speaking of revenue, the MMS gets about $10 billion in royalty from this project.

Then there are the independent producers (like us) accounting for about half of all domestic production. We get to come in behind the majors and pick the bones. For us the risk is the same, just scaled down with lower costs but lower potential. Every barrel we produce is a barrel we don't have to import. But without the current incentives, (and they are about to eliminate some of them because they need the money), the game will be different. We will end up shutting in a lot of production, and a lot of people will lose jobs for work we aren't generating. Hopefully they can retrain to run wind farms and install solar panels.

**AFTER THE SPILL**

The worst disaster to befall this industry is a spill. So far, this one has a lot of headlines and hype, but only one oiled bird. (They were letting the prisoners out to be trained to capture oiled birds, and the National Guard was asking where to be dropped off so they could do the same. Guess no one told them we don't have beaches in this part of Louisiana.) Everyone is eager to act so there is no repeat of a Katrina-style emergency response. They have already closed the fisheries on the coast. Shrimp and oysters just got more expensive.

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BP has a history in the GOM, and has producing fields nearby. This one was reportedly a billion barrel find. This well had been cased off at TD, and the BOP’s failed while the well was being prepared for completion. This was simply an accident, and it will likely be a long time before we know any more about it.

Questions will come up about the need to risk our coastline for this resource. The MMS is already working on new rules to “eliminate human error,” like that worked for the Hubble Telescope. Leaking about (they’re guessing) 1 million gallons every five days, it will take until mid June to equal the volume of oil spilled by the Exxon Valdez. On the other hand, the Amoco Cadiz spilled about 1.6 million barrels off France. We import twice this volume each day, so a tanker spill could be a greater risk. Better to produce our own oil than to import it.

Nevertheless, new legislation and regulation will come out of this. If it is too onerous, the majors will go elsewhere leaving the independents to fend for ourselves, which means we will shut in production we can no longer afford to operate. As domestic production declines and we become more dependent on foreign sources, there will be a push to bring back the majors. Only then there won’t be any independents, and all the incentives will go to the only game in town. We’ll be dinosaurs like the independent farmer. Heck, it might be fun to be a dinosaur, with an electric car, a good health plan and a healthy retirement from social security. Don’t pinch me, I might wake up. Or maybe I’m just all wet.

The above graphs and others can be found on the NOAA website: noaa.gov - click on Tracking the Gulf Oil Spill, then click on Factsheets Publications to locate the Cumulative Trajectory Maps. Further images are available at http://earthobservatory.nasa.gov/NaturalHazards/event.php?id=43733
The Democrats take-no-prisoners approach to passage of health care legislation in early 2010 set the scene in concrete, with everyone now looking ahead to the November elections and their talking points for what could be one of the most brutal campaign seasons ever.

**Just the facts, ma'am . . .**

Let's start with a review of a few things we know about climate change. Although AGW proponents like to claim they have an unassailable array of facts to build their case, while climate change skeptics reply it's all horse, uhmmm, excrement, the reality, as usual, lies somewhere in between. So here are a few points where there may be agreement:

1. Burning fossil fuels results in significant CO₂ emissions. The basic chemistry of hydrocarbon oxidation is well established and the reaction products include heat, water vapor, and CO₂. Probably not much to argue about here.

2. We burn a lot of fossil fuels, and our consumption has been increasing, not decreasing. As China, India, and other Third World economies expand, their demand for electricity and transportation fuels exploded. Fossil fuels are the cheapest and most efficient means to meet those demands. Current projections by EIA are for 73% increase in non-OECD energy demand by 2030, most of which will be met by oil, natural gas, and coal (Figure 1), as compared to a 15% total increase by the OECD countries. i Again, hard to argue.

3. All that CO₂ has to go somewhere, and initially at least, it goes straight up into the air. From there, it gets a little murky (a word you will read again in this essay, many times.) The best estimates are that about 43% of the CO₂ emissions remain in the atmosphere, and the balance is naturally sequestered by the oceans and the biosphere. ii The mass balance between oceans, forests, soils, etc. is rather tricky to measure, but the difference between total CO₂ emitted and CO₂ remaining in the atmosphere is very clear. It helps that we sell oil, gas, and coal, so we know to a high degree of accuracy just how much is being burned each year. In fact I've concluded it is the best-known number in all of climate science.

4. CO₂ content of the atmosphere has been increasing since at least the start of the industrial revolution, when substantial burning of coal began, and atmospheric measurements since the late 1950s show a steady progression with a seasonal fluctuation as the biosphere "breathes" CO₂ (Figure 2). iii Some people will argue this one. In particular, there has been some noise concerning the location of the measurement stations, but by and large this is firmly established.

**Does it feel warm in here to you?**

Is that all? Won't everyone also agree that the planet is warming? The climate science community says all "serious scientists" agree that human activities are causing global warming (thereby neatly placing any scientist who disagrees with them in the "not serious" bucket, thanks to George Will for pointing that one out.) So, why haven't I listed warming as the 5th bullet? The answer is the record is, (and here's that word again), somewhat murky. There are two problems, the first being there are problems with the temperature data itself, and the second being exactly how do we separate natural variations in global temperature from anthropogenic induced changes? In other words, is it anthropogenic global warming, or just plain global warming, or is it not really changing at all and everything that has been observed is within normal statistical limits of variation from year to year?

Starting with the hard data, temperature records have been kept since the invention of the modern thermometer in 1709, initially at just a few urban locales, then as the global network of weather stations expanded at an increasingly large number of surface rural and urban localities, then ships at sea, and for the last thirty years by satellite sensors looking down at the temperature of the upper atmosphere. Unfortunately, the nature of those temperature records have not remained static for the last 300 years; sensor technology and accuracy have changed; the sensor locations have been moved; the environment around those sensors has changed as cities and towns have grown; and even what is being measured has changed (e.g., surface air temperature vs. atmospheric temperatures as seen by satellites looking down). Another problem is climate change is, by definition, considered to be the long term variation in climate over large areas, as opposed to weather, which we all know to be extremely variable on both
ClimateGate Continued

are trying to do the same thing (well, actually the underpaid graduate assistants are doing it). But whether they have accomplished their goal in an unbiased manner or not is very much in doubt. It will be some time before we know.

It turns out the record keeping when it comes to all these temperature stations and measurements over the years has been rather sloppy, which is not surprising considering it is a highly distributed network over the entire globe, run by a variety of agencies with different standards and protocols. Some, like the U.S. National Weather Service, have been relatively diligent, whereas others were somewhat less so. Climate change skeptics investigating the source of the temperature records have been less than impressed with what they find, documenting numerous changes and

moves in temperature gauge locations — often from sites out in the middle of an undisturbed field to a location next to a building, by a road or a parking lot, next to a large air conditioning unit, etc. It turns out that the change from an analog thermometer in one of those whitewashed wood shelters to a digital thermometer might not have been such a good thing — the former required some poor slob shuffling through the snow and rain to record the measurement twice each day whereas the latter can be monitored from the comfort of a computer screen in an office, but it also requires a cable running out to the thermometer. Armed only with a shovel and a post hole digger to install the new contraption, people tended to dig as short a trench as necessary to the new location and in no cases did they want to tunnel under a road, or a driveway, or a sidewalk. Hence in the 1970s-1990s the temperature recording location tended to move closer to buildings, cars, and machinery as the old system was phased out.

Other tidbits that tend to reduce confidence in the entire picture include the following: in the Soviet Union vodka rations for small towns and rural areas were based on average temperature records turned into the central planners in Moscow. So somebody manning a weather station in the depths of Siberia turns out to be responsible for the amount of vodka allocated to his close friends and family based on the numbers produced that winter. As economists are fond of pointing out, people respond to incentives. Somewhat unsurprisingly, the records imply Siberia was colder before 1991 than it is now, but is this really climate science, or is it political science and economics?

In response to widespread criticisms of these sorts, plus specific allegations of improper statistical manipulation of the datasets and poor handling of proxy data for the pre-1850 period, (specifically tree rings, corals, and ice cores) a National Research Council committee was convened in 2005 to evaluate the entire underpinnings of the temperature record of the last 2000 years, sometimes referred to as “the hockey stick” of Figure 3. Their work resulted in a report thick that largely, but not entirely, supported the prior conclusions of the climate science community. They found the warming in the 20th century amounted to about 0.6°C, and that the late 20th century was the warmest period over the last 400 years. The record prior to 1600 is sufficiently imprecise, so that statements like “the 1990s were the warmest decade in the last 2000 years” are unsupportable. It could have been warmer during the Medieval Warm Period (or Climatic Optimum, as some call it) shown on Figure 3, and many skeptics cite historical records that it probably was. They also made a point that the attribution of warming to man largely rests on the conclusion that the temperature rise of the last 30 years “...stands out above the natural variability in mean surface temperature over the last 2,000 years ...”, despite the poor confidence in temperature reconstructions prior to 1600.

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ClimateGate and the Barbarians at the Gate

Sometime on November 17, 2009, “a miracle just happened” in the words of one AGW skeptic. Someone posted on an anonymous Russian FTP server over 160 MB of “randomly selected” emails, spreadsheets, computer codes, and notes taken from the computers at the Climate Research Unit (CRU) of the University of East Anglia in the UK. By November 20th the file had been discovered by the greater blogosphere, was immediately dubbed “ClimateGate” by some wag (now who would have thought of that), and Google hits began to climb exponentially. Initially attributed to a data theft by an unknown hacker, speculation later turned to an insider release, probably one of the climate scientists or IT specialists at CRU. The CRU is one of the four primary sources of global temperature records relied upon by the IPCC and most climate science researchers to discern instrumental record temperature trends (the others being our own NASA GISS, NOAA GHCN, and the JMA Tokyo Climate Center). The original “hockey stick” graph is partly based on the CRU temperature dataset. The emails released largely focus on the correspondence of a few key individuals at CRU, most notably its director, with other prominent climate researchers around the globe.

Reactions to the ClimateGate release were 100% predictable. Initially reviled by AGW supporters as a “criminal act,” with denials that any of it was even authentic, sites like RealClimate.org took the position of a traffic cop at an accident scene: “Nothing to see here folks, let’s move along . . .” The talking points for climate scientists became:

- nothing in the correspondence means anything
- it’s all just shop talk
- there is no smoking gun
- the science is still solid
- everybody who understands the science agrees and, of course,
- there is no real scientific debate, anyone who disagrees is just politically motivated or paid by Big Oil or Big Coal

Some AGW extremists went so far as to say whoever posted the data should be “tried for crimes against humanity” if it derailed an agreement at the forthcoming Copenhagen talks. Within a few days, however, it became apparent (and was eventually admitted) the files were genuine; they did not appear to have been edited or altered in any significant way, and are a true (perhaps biased) sampling of the actual goings on behind the scenes at CRU and their colleagues at other climate research institutes.

On the skeptics’ side, the responses were equally predictable and surprisingly restrained, with the moderators of ClimateAudit and WattsUpWithThat for the most part taking the high road, while leaving the gleeful chortling of “I told you it’s all a hoax” to the community of bloggers; to those elements of the blogosphere that claim the emails were conclusive proof of a vast liberal conspiracy to establish a communist world government. Mainstream media including the New York Times, Associated Press, Wall Street Journal, Financial Times, and Newsweek covered the story with varying levels of enthusiasm, ranging from barely disguised distaste on the left (Newsweek, for example, referred to skeptics as “a few remaining wingnuts”) to calls for congressional and parliamentary investigations on the right. Even the big science magazines, including Science and Nature, were forced to pick up the story and continue to run articles on the possible fallout from the release.

What the ClimateGate release very clearly revealed to me is a data reduction and correction process that is anything but transparent. CRU did not publish the raw data underlying their temperature database, citing confidentiality restrictions with the national weather services that contributed to their efforts. Instead they published (online) their “value added” dataset of normalized and gridded points, with only relatively generic explanations of the processing published in the literature. Leading skeptics including Steve McIntyre of ClimateAudit.org have fought for years to retrieve the raw temperature datasets in their attempts to reverse engineer the exact corrections that were applied to the data, resulting in the filing of numerous Freedom of Information Act requests in both the U.S. and the UK to pry the data from uncooperative researchers.

The CRU emails show an active hostility toward the skeptics and their requests for transparency, with pages of correspondence discussing ways to thwart the FOI requests; how to hide the details of what was done to the “value added” dataset; threats to destroy the raw data before giving it up; and researchers lamenting certain aspects of their data didn’t match up with their computer models therefore something needed to be done to fix the data so it did agree. A mindset of science as total war, (it’s us vs. them; you’re with us or you’re with the deniers), was revealed. It’s “Barbarians at the Gate,” raise the drawbridge, start boiling the pots of oil to pour down upon them because they are about to storm the walls. With very, very, few exceptions in the months since the email release there has been little public remorse shown. At most, weak admissions along the lines of “perhaps we could have been a little more careful keeping records of our work . . .,” and we should have taken the FOI requests more seriously.

Who ya gonna’ believe, me or your own lying eyes?

Climate scientists are quick to point out there are three other global temperature datasets that show the same big picture as the CRU dataset. So, even if the one dataset is compromised surely the others still stand. There is no grand, global conspiracy to “cook the books” (pun intended). They also point to independent lines of evidence such as the CRU dataset.
as retreating glaciers, rising sea levels, and diminishing summer ice packs in the Arctic Ocean to support their claims that the climate is rapidly warming, even if there might be significant uncertainty in the thermometer records. And of course the media sees in every extreme weather event, no matter where or when, further proof of AGW.

Let’s grant the climate science community that there may be multiple lines of evidence supporting global warming over the late 20th century, and that the warming is without a doubt coincidental with increasing oil, gas and coal consumption and a rise in atmospheric CO2 content. But as we all know, “correlation does not imply causation” and the coincidence does not prove AGW. The entire temperature record could just be the result of natural long term variation in climate. It is equally apparent we are in an interglacial period, and it has warmed A LOT over the last 20,000 years. So let’s dispense, for the moment, with fighting over cooking the books to make the case for warming over the last 150 years. Let’s assume it’s real, how can we tell if the warming is natural or due to fossil fuel combustion by our industrial society? Are we, in the oil and gas business, really the evil culprits they make us out to be?

It turns out the answer to this question cannot be directly determined, since the experiment is already running on a global scale and we don’t have a second Earth to use as a control. So the only way to run alternative scenarios (i.e., the Earth without increasing CO2 from combustion) is via computer modeling. General Circulation Models, or GCMs, build a representation of the Earth’s land, oceans, and atmosphere, and through a set of coupled non-linear equations attempt to predict the distribution of temperatures in 3D through time. Like oil and gas reservoir simulators, they take a set of initial conditions and variable inputs through time (including CO2 emissions) and try to track where it all goes and how it impacts the overall climate. If you history match the actual temperature records from the initial date to the present within some degree of accuracy, the model is considered to be a reasonable representation of the actual system and running the model forward in time should be predictive of what the climate will do given future trends in the input parameters. Then multiple scenarios are run to predict global response to different CO2 emission rates.

In our Denver Climate Study Group, we have a few modelers who have been vigorous in their defense of the current round of GCMs. An interesting but little known revelation is that the GCMs can replicate the observed temperature history up until almost 1975 using only two natural inputs: solar flux variations and volcanic eruptions. After the early 1970s, they are no longer able to track the temperature record without inserting another “forcing factor” into the models, CO2, and furthermore they have to assume certain couplings between CO2 and atmospheric water vapor. If just CO2 rises, they don’t get enough warming, there must be some kind of positive feedback effects with other greenhouse gases and water is #1. After the appropriate tweaks to their models and the equations, Voila!, everything matches up pretty well (Figure 4). So the conclusion is we understand the physics that drives the climate, and it has to be AGW because the computer models only match the observed record if they include an anthropogenic CO2 input.

Whether you buy any of this or think it’s all a bunch of hooey depends a lot on your trust in computer models, how you feel about the history match piece of their efforts (c.f. the prior discussion), and the sensitivity of non-linear systems to small changes in the initial conditions. It also says something about what you consider to be a “good match” and the time frame under consideration. The skeptical community has been quick to point out that evidence for global warming post-1998 has been anything but clear cut and, in fact, temperatures have been flat or even cooled slightly when all the GCMs predicted a steady increase (Figure 5). The modelers reply there is nothing wrong with the temperature data (there better not be, since the same groups put it out), but ten years is too short a time frame to consider because that’s just weather. Natural variability will always be superimposed on the long term trend, which the models say is up, up, up. Ah, you may naively ask: what’s the right time frame? Well, thirty years is about right they reply, and lo and behold they find a distinct

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decoupling of temperature due to natural influences alone around 1975. And you thought Goldilocks and the three Bears was just a children's story . . .

**Copenhagen blues**

In December, it was all supposed to come together in a Kumbaya moment for the climate change community with an agreement to reduce CO₂ emissions to levels that would hold the 21st century temperature rise to 2°C or less. The total amount of permissible CO₂ emissions would be determined by the GCMs, while the distribution of CO₂ reductions between nations and industries would be left to the messiness of the marketplace through some kind of carbon tax or trading system. Presumably there would also be a transfer of money from the industrially developed nations to the Third World to encourage them to move to a green energy future much quicker, and some say as guilt money for the prior 150 years of emissions that allowed the industrialized world to get so far ahead of the rest. The murkiness of the entire process comes in because CO₂ emissions in the developed world have already largely stabilized, in line with flat energy demand growth, whereas they are rapidly growing in the Third World as those countries industrialize.

Not surprisingly, an agreement failed to materialize. China, India, and the other rapidly growing Third World economies are unwilling to constrain their growth prospects by trading cheap and abundant fossil fuel energy for the uncertain promise of a green, alternative energy future. Wind and solar remain unpalatable choices for transportation needs, and are too expensive for electric power generation; biofuels redirect agricultural land and resources from growing food to fuel, when many people are still hungry. The green parties of Europe, although long on street theatre and political sway, seemed unable to grasp the complexity of energy use in the modern world. Having no real concept of the importance of fossil energy for today’s civilization they think it should simply be banned to save the planet from global warming. The industrial economies of the U.S., Europe, and east Asia all find it politically unacceptable to agree to deep emissions cuts at enormous expense when the developing world will continue to grow their emissions, effectively yielding future economic growth to the Third World. And because the UN process requires unanimous adoption by all 193 members, a few nations that preferred to use the forum for political theatre (Venezuela and Bolivia, in particular) were able to doom any serious efforts at compromise.

So here we are at the start of a new decade (or end of the last one, depending on how you count such things c.f. Y2K), with zero progress in reduction of CO₂ emissions since the Kyoto conference of 1997. Despite an active market for CO₂ emission credits in Europe, the cost of those tradable units is far below the actual cost of mitigation; it dropped even further in the wake of the Copenhagen collapse. (In early April, CO₂ credits traded for roughly $17/ton vs. mitigation costs of $60-100/ton). A recent study of hybrid vehicle economics cited in Oil and Gas Journal estimated hybrid SUVs will not be competitive with equivalent gasoline powered models until oil hits $230/bbl, illustrating just how wide the gap is between a low carbon future and current transportation economics. I’ve seen 2X-6X estimates for increases in the cost of retail electricity if zero CO₂ emission strategies are enforced, either through carbon capture and sequestration or via conversion to wind and solar on a massive scale. Consumers throughout the world are going to look at the bill to convert to a low carbon, green economy, and they are going to revolt. Politicians, beware . . .

**Where is this all headed?**

Over the past four months, since the release of the ClimateGate emails, the pendulum has clearly swung toward the climate change skeptics. Hardly a week passes without some new revelation concerning the bad behavior of various prominent scientists in the climate science community and allegations of conflicts of interest, scientific misconduct, or clear manipulation of data to support preconceived hypotheses. Scientists are losing ground with the public, with even AGW supporters admitting “Scientists are lousy communicators,” while at the same time lamenting that scientists who play “fast and loose with the facts are imperiling not just their profession but the planet.” Various polls show a steady erosion in confidence in the global warming story over the past several years across all political party lines, and the spring polls after the ClimateGate debacle will no doubt show another
sharp drop. A symposium at the 2010 AAAS meeting was hastily convened on the “recent attacks on an increasingly beleaguered climate science community.” Despite pleas to the climate science community to better connect with the public and lower the obvious level of arrogance in their communications, the climate scientists themselves have for the most part remained unrepentant and kept their waggons in a tight circle.

At some point, climate realists will take over the discussion from the alarmists. Hopefully, the intolerance of dissenting opinions and the revolutionary fervor that is so evident with the current management at the big climate research institutes will dissipate, or perhaps they will simply retire. When that happens, some kind of dialogue could emerge, probably along parallel lines of 1) reducing CO₂ emissions as far as possible, probably through conservation and energy efficiency more than anything else; 2) limited carbon capture and sequestration if economically feasible (it’s not currently); and 3) adaptation strategies to a changing world. Change has been a constant throughout geologic time and human history, and we have no reason to expect climate to remain constant now in some kind of Goldilocks, “it’s just right the way it is now” moment. On the other hand, if we are impacting the long term climate through CO₂ emissions, then it would also be prudent to back off and not push things too far; realists will seek strategies that lessen the potential impact without bankrupting the planet or sending us back to the energy consumption levels of the Middle Ages. But then perhaps I’m just an optimist and it’s those Hollywood disaster flick writers that really have it right.

Within the climate science community, we’re starting to see a little bit of hand wringing and some slight consideration that perhaps the path they are on is not the best way to go about things. The ClimateGate emails have caused a few people to pause and reflect on the peer review process, on their interaction with the skeptics’ community, the role of a strong adversary in keeping the science honest, and how a large number of interested non-specialists on the Internet might actually serve a useful function for vetting data and interpretations. It is also apparent that much greater data transparency will be demanded, especially where public funding is involved; if any good comes of the incident, it will be this. Whether an actual dialogue can be established between the skeptics and the true believers remains very much in doubt.

For those of us in the oil and gas business, we will continue to be painted as the evildoers. Get over it. For what it’s worth, here’s something to consider that might help you feel like one of the greenest people out there: the best case scenarios for carbon capture and sequestration at large electric power generation facilities project 90% emission reductions by 2050 at huge increases in electric power costs. Today, without inventing anything, by switching from coal fired to natural gas fired burners you get a 50-60% reduction in emissions per kWH, while changing to a combined cycle generation facility gets you even closer to the widely suggested 90% target. Combine that with a 40-year head start, since we can do it today, and we’re unbeatable. So if you are in gas E&P sector, feel good when you go home at night that you’ve done your part to reduce the CO₂ load in the world!

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Biography

Robert M. Cluff is an independent consulting petroleum geologist in Denver, Colorado, where he is a partner in the Discovery Group. He holds a B.S. degree in geology from the University of California (Riverside), and a master’s degree in geology from the University of Wisconsin (Madison). He can be reached by email at bobcluff@discovery-group.com
[My previous article, “Why Computers Can’t Contour Like Geoscientists” (SIPES Technology Corner, February 2010), prompted comments from several of our members who thought this was an important topic that deserved more attention. In response, I enlisted the support of Dick Banks, #2931, an expert in the field of computer mapping, to submit the following article elaborating on this subject for our benefit. - Larry Rairden]

Computers have altered the way we make contour maps. They allow us to quickly create a map without having to think about the surface that is being contoured. They give us the ability to generate a map which overlooks the geology. Computers have made it easy to skip long-tested techniques that ensure accurate maps because those techniques take too long or are not available in the computer program. This is the downside of computer contouring, the side that lacks the interpretive chemistry that occurs when a geoscientist draws contours by hand and thinks about the surface that is being contoured.

There is an upside to computer contouring as well. With the speed and power of computers, the geoscientist can quickly test many interpretations, easily check two surfaces to see if they cross, use colors to see if faults reverse direction along strike, and view the resulting surfaces in three dimensions. With computers, just as with hand contouring, if the correct methods and proper quality control are not used, the generated map probably will be wrong.

We start from a table of X, Y and Z, where X and Y define the locations of our samples and Z represents their value at that location. These values represent a surface that has been “sampled” at a limited number of locations, e.g., wells, bins, gravity or magnetic stations. The problem is to position the contour lines so that they depict a reasonable geologic surface. Mathematically, this is an interpolation problem.

Interpolation is the mathematical art of estimating. An interpolation process calculates the value of a surface at locations where it is unknown, based on the values at locations where it is known. Interpolation is an art in the sense that there is no limit to the number of mathematical formulae that may be conceived to make the

(Continued)
estimates, and the choice of formulae includes subjective and aesthetic criteria: Does the map look geologically reasonable? Does it come close to how you would do it by hand? Is it pleasing? Two approaches to deal with random data distribution on computers have emerged: indirect (gridded) and direct (non gridded).

**Indirect Technique (Gridding)**

Computer contouring methods that use the gridding technique typically start out by using the primary (original) data points to generate a set of secondary (calculated) points. These secondary points, which are along an orderly geometric pattern (grid), then replace the primary data in steps that generate the contour maps. All subsequent calculations to locate the position of the contour lines use the secondary data set (the grid). The purpose of using this technique is to simplify subsequent steps by making the geometry more manageable. It is easy to ensure that any contour line drawn through a data grid honors its given grid of data points. However, contour lines that honor the data grid cannot be guaranteed to honor the original (primary) data points.

**Direct Technique (Triangulation)**

The triangulation technique is the most common of the direct contouring techniques that interpolate values along a pattern which need not be regular but which is derived from the pattern of the original data. The pattern includes the locations of the original data, which are kept throughout the subsequent processing, thus providing the opportunity that all contour lines will honor all the original data.

For both techniques, gridding and triangulation, many ways exist to solve the basic problem. The goal is to choose a technique that most nearly fulfills the need of the user: geologist, geophysicist or engineer. In general, the computer contoured map is more acceptable to the user if it is geologically reasonable and looks as if it had been contoured by hand.

**Steps Involved in Gridding**

Gridding has come to mean using the original data points to estimate values at the calculated points, or grid nodes. Gridding always involves three steps:

1. Select a grid size and origin.
2. Select neighboring data points to be used in calculating a value at each grid node.
3. Estimate the value at that grid node using values from the neighboring points.

(Continued)
These last two steps is where numerous schemes have been developed to make maps that are aesthetically pleasing and that honor the data points as much as possible.

**Selecting Neighbors and Estimating Values at Grid Nodes**

When selecting neighbors around the grid node, two criteria are important: (1) neighbors should be evenly distributed around the grid node, and (2) only data points near the grid node should be considered neighbors. Certain data distributions will make it difficult to meet these criteria.

The following are several (of many) schemes to select neighbors:

- Nearest “n” neighbors
- Nearest “n” neighbors in a quadrant or octant
- Points within a “radius of influence”
- Natural neighbors. (On a flat surface that contains more than two data points, any three data points that lie on the circumference of a circle that contains no other data points for what is called a Delaunay triangle, or natural neighbor.)

**Estimating Values at Grid Nodes**

Once neighbors of a grid node have been selected, these neighbors are used to estimate a value (and perhaps a slope) at the grid node:

- Weighted average
- Least squares
- Spline
- Hyperbolic
- Minimum curvature
- Polynomial
- Etc., etc.

Each of these methods (and other schemes) has its advocates and adversaries. Any of them works well if the data points are well distributed and well behaved. Each method has problems under certain circumstances. Most gridded contouring programs give their users an opportunity to select the method of choosing neighbors and the method for estimating values at grid nodes.

**Pertinent points about indirect (gridded) techniques**

1. Gridding can never guarantee maps that honor all of the data points. On the other hand, the non-honoring of data may be acceptable if the data are noisy or if the calculated value and the observed value at a data point differ by an amount that is within the accuracy of the data.

2. Sparse data sets that contain clusters of closely spaced data can be troublesome for computer contouring systems, gridded or nongridded. An example of such clustered data distribution is in oil and gas exploration areas which include wildcat areas (sparse data) and some oil and gas fields (clustered data).

(Continued)
3. Changing grid size changes the map because the neighbors of grid nodes change with changes in grid size.

4. The user must choose a method of selecting neighbors and a method of estimating values at grid nodes (interpolation).

**Steps Involved in Triangulation**

Triangulation in contouring is almost instinctive. Most of us, consciously or subconsciously, were triangulating when we were learning to contour in college. We connected data points with straight lines and subdivided the lines according to contour intervals. At the end of the process the straight lines connecting the data points were a fairly good approximation of Delauney triangles. Thus it is not surprising that triangulation, which involves subdividing the map into triangles (leaving no gaps and creating no overlap), was the earliest proposed method of computer contouring.

As in gridding, triangulation requires the selection of neighbors for each data point. However, in triangulation the task of determining neighbors is finished when the data set has been triangulated. The resulting triangulation has the following characteristics:

1. The X-Y data set containing “n” data points has been broken down into a set of (2n-m-2) triangles, where “m” is the number of data points on the convex hull. The convex hull is defined as the smallest convex polygon that encloses all of the data.

2. If the triangles are Delauney triangles, they are as nearly equilateral as possible for any data distribution, and they are invariant under rotation.

3. In large data sets, each data point will have an average of six natural neighbors.

**Figure 1** is a sample data set with Delauney triangles connecting natural neighbors. If no interpolation were performed, and if the surface being contoured were treated as flat in each triangle, the map would have the characteristics of mechanical contouring and would look like **Figure 2**. Mechanical contouring, however, tends to be very angular and unrealistic. It is usually necessary to interpolate values within the Delauney triangles, i.e., create more and more smaller triangles, based on curved mathematical models, in order to overcome the angular appearance. **Figure 3** shows a set of triangles formed when each leg of the original Delauney triangle is divided into 16 segments. **Figure 4** shows the final contour map of the sample data set using triangulation.

**Pertinent points about triangulation are:**

1. Triangulation always honors every data point because the original data points always remain in the data set being contoured.

(Continued)
2. Interpretation is essentially the same, regardless of the number of triangles or smoothing.
3. The user does not have to worry about data distribution.

**Sample Data Set Contoured Using Gridding (Indirect) Methods**

Figure 5 shows the same sample data set contoured using a gridded (indirect) contouring program. In this case certain gridding parameters (e.g., adaptive fitting, radius of influence) were optimized in order to produce a geologically reasonable set of contours.

**Summary**

This information has introduced you to the fundamentals of contouring on a computer, comparing indirect (gridding) and direct (triangulation) methods. Mapping topics under consideration for future publications include multisurface contouring and fault handling.

Richard B. Banks can be reached by email at dbanks@scaitul.com.

If you have a Technology Corner article that you would like to submit for publication in the SIPES Quarterly, please email it to Larry Rairden at rairden@novageoscience.com.

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“Petroleum Geologic Framework of the Tucumcari Basin, East-Central New Mexico, With a Synopsis of Recent Exploratory Activity”

**Clayton Painter**  
“Hartzog Draw and the Shannon Sandstone: New Observations and Constraints Applied to Depositional Models”

**Charlie Bartberger**  
“Solution-Subsidence Control on Trends and Facies Architecture of Basal-Morrow Fluvial Valleys, Southwest Kansas”

**Alternate Energy**

**James Graham**  
“Renaissance of Nuclear Energy — From Well Field and Mine Production to the Nuclear Reactor”

**Lyle Johnson**  
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“Piñon Field Study, Implications for Texas Overthrust Natural Gas Exploration”

**Mark Gregg, #2883**  
“Developing an Exploration Tool in a Mature Trend: A 3-D AVO Case Study in South Texas”

**Sal Mazzullo**  
“The Lower Mississippian of the Midcontinent — Stratigraphic Architecture, Lithostratigraphy, and Petroleum Reservoirs”

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**Dan Jarvie**  
“Characteristics of Successful Shale Resource Plays, North America”

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“U.S. Unconventional Plays — Trends and Projections”

**Marv Brittenham**  
“‘Unconventional’ Discovery Thinking in Resource Plays: Haynesville Trend, North Louisiana”

**Brian Cardott**  
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