How important are unconventional resources to the future of our industry?

JL: Unconventional resources (tight/shale gas, tight oil, and oil sands) play an ever-increasing role in our energy supply and I only see that role increasing. The bottom line is this: The world will need more energy under all scenarios. Even if renewables play a larger role and conservation is taken seriously (and I hope it is), the world’s emerging economies will require sustained use of oil and gas for the foreseeable future. Because oil and gas from conventional reservoirs is declining (the “easy oil” is gone), the role of unconventionals in the future energy mix will be major.

GL: Our planet’s endowment of unconventional oil and gas is orders of magnitude larger than the conventional deposits that were the primary targets of exploration and production for the past 150 years. Unconventional deposits can be grouped into three general categories: 1) unconventional reservoirs, which comprise source rocks and ultratight sandstones and carbonates; 2) unconventional fluids, including heavy oil, bitumen, and sour/acid gases; and 3) hydrocarbons “locked in rocks,” such as methane hydrates and oil shale (an immature source rock). Today, the primary targets of exploration and development investment in North America are within categories 1 and 2, and these types of targets are also becoming increasingly important around the world.

How significant is the unconventional reservoirs revolution under way in North America?

JL: In my view, it is historic: Few people, if any, predicted 10 years ago that the United States would regain its position as the number one producer of natural gas in the world. Yet that is what happened because of advances in drilling and completion technology in tight/shale gas reservoirs with easy access to the largest natural gas market in the world.

GL: The extraction of oil and gas from source rocks and ultratight sandstones and carbonates represents a breakthrough on the scale of that achieved when our industry first went offshore shortly after World War II. Our newfound ability to extract hydrocarbons from source rocks has opened a vast new suite of opportunities that contains technically recoverable resources of thousands of billions of barrels of oil equivalent. While some still wonder about the commercial viability of unconventional reservoirs, it is worth noting that the Bakken formation in North Dakota and Montana today produces more oil on a daily basis than the Prudhoe Bay field in Alaska, which had been North America’s top oil producer for almost three decades. Also, the Eagle Ford Shale in south Texas may surpass the Bakken in the not-too-distant future to claim the top spot.

How will the unconventional reservoirs revolution change the outlook for the natural gas industry?

JL: Natural gas in North America is now abundant—we have about a 100-year supply; affordable—costing about USD 4 per Mcf; environmentally friendly—it is the cleanest burning fossil fuel and a swing-use fuel for supporting renewables (wind, solar, and hydro); available—98% of North American supplies are produced in North America; and economically advantaged—providing 3.5 million North American jobs (2008) and USD 1 billion in economic activity for every Bcf produced. With numbers like these, driven largely by the unconventional gas plays, natural gas will be a dominant player in North America’s future energy strategy.

GL: There has been much talk over the past decade about natural gas being a “bridge fuel” to an alternative energy future. This designation resulted from widespread perception that natural gas resources were insufficient to play a significant role in supplying mankind’s energy needs much past midcentury. However, we now know that this is not the case, given the enormous volumes of natural gas the industry will be able to recover from unconventional reservoirs. These volumes are sufficient to power the planet well into the 22nd century and perhaps for many centuries beyond.

Joe Leimkuhler

is offshore well delivery manager for international exploration and production (E&P) at Shell. Previously, he held a similar position in the company’s Americas E&P unit. Earlier, Leimkuhler served as project drilling engineer for the Mars development and as an instructor at Shell’s Bellaire Technology Center in Houston, where he taught drilling engineering. Before joining Shell, Leimkuhler worked for M-I Drilling Fluids in the Wyoming Overthrust Belt and for Arco in drilling and reservoir engineering in Bakersfield, California. He serves on the American Association of Drilling Engineers (AADE) National Board of Directors and was AADE president from 2007 to 2009. Leimkuhler is a 25-year member of SPE and serves on the American Petroleum Institute committees addressing post-Macondo deepwater drilling issues. He graduated from the University of Montana with BS degrees in geology and forestry in 1981, and earned an MS degree in petroleum engineering from the University of Wyoming in 1987.
This new knowledge about resource size and the fact that use of natural gas emits significantly less greenhouse gas than coal means that our industry is well positioned to continue playing a major long-term role in meeting the world’s energy needs.

What excites you from a technology perspective about unconventional resources?

**JL:** It is how we are progressing with technology to address the concerns with unconventional resources. In tight/shale gas, the greatest concern is around hydraulic fracturing operations. The key to addressing this concern is well integrity, and at Shell, we design, construct, and operate wells and facilities in a safe and responsible way. In that regard, we have introduced global onshore tight/shale oil and gas operating principles available to the public, with examples of how we are committed to responsible and safe production of this resource. Shell has a rigorous set of five global operating principles that provide a tested framework for protecting water, air, biodiversity, and the communities in which Shell operates.

On the oil sands front, I am excited about an agreement Shell recently announced with the governments of Alberta and Canada to secure CAD 865 million in funding for the Quest carbon capture and storage project, which would permanently store underground more than 1 million tonnes of CO₂ per year from the Shell Athabasca oil sands projects. This is an important milestone in our ongoing commitment to reduce the carbon footprint of our oil sands operations. Going forward, I am convinced that continued development of unconventional resources can only be accomplished if governments and the public are convinced it can be done in a safe and responsible manner. Sound operating practices and technology application are essential to meet this objective.

**GL:** The technologies to exploit unconventional resources are in many ways relatively immature and, therefore, can likely be enhanced with additional research and experimentation. For example, steam-assisted gravity drainage (SAGD), which is used to produce bitumen from Canada’s oil sands, was first commercially applied only about a decade ago and clearly can be improved. At ConocoPhillips, we are pursuing numerous technologies to reduce costs, enhance recovery, and/or minimize environmental impacts, compared with the current SAGD approach. Likewise, our industry’s understanding of shale and carbonate source rock reservoirs still has some fundamental gaps. Technology can and will play a major role in optimizing the development of these prolific, but complex reservoirs.

What are the next breakthroughs you foresee industry making once the current unconventional reservoirs revolution begins to mature?

**JL:** I see continued breakthroughs offshore in both the deepwater and Arctic operating areas. While these reservoirs may not be “unconventional,” the operating environments and required technology are just as impressive. Shell probably has the largest number of deepwater fields under multiple rounds of development drilling campaigns, and we are pushing forward with plans to drill in the offshore Beaufort and Chukchi seas in the US Arctic. Thus, we face the challenge of drilling deep, high-angle wells through depleted zones in deep water as well as new wells in the shallow waters of the Arctic. In the planning phase, 4D as well as ocean bottom seismic are enabling us to fully understand the subsurface and properly plan these wells.

Drilling the wells is enabled by the use of full rotary drilling systems with full measurement-while-drilling evaluation and pressure sampling capability; expandable casing systems to maintain hole size; and managed pressure drilling systems, coupled with low rheology, synthetic-based mud systems, to minimize, if not eliminate, costly loss of drilling fluid. On the completion side of the business, efficient frac-and-pack and high-rate water pack completions are keys to achieving low skin completions that can hold up and deliver the needed production rates and volumes.

**GL:** There are still enormous quantities of unconventional resources for which there are no viable commercial development options. For example, methane hydrate deposits, which are believed to contain hundreds of thousands to millions of trillion cubic feet of natural gas, are not today commercial, but could someday be developed if a technology breakthrough occurred. While commercialization is likely decades away, ConocoPhilips, in partnership with the US Department of Energy, will soon test an experimental technique on the North Slope of Alaska that pumps CO₂ into a hydrate reservoir—liberating the methane and sequestering the CO₂—which physically replaces methane molecules within the hydrate’s ice lattice. If this technology, or another method for extracting natural gas from hydrates, can be commercialized, then the age of hydrocarbons could be extended not just into the 22nd century, but perhaps to the year 3000 or beyond. We also expect considerable advances in converting organic matter in immature source rocks into oil, which would greatly expand the options available for producing liquid fuels.

What is your advice for young professionals (YPs) regarding unconventional resources?

**JL:** My advice is the same to any YP entering this business, onshore, offshore, or in the unconventional plays. Learn as much as possible from all the sources available. Many of the young staff entering the business have learned the bulk of their...
knowledge through the classroom, with a few internships over their summers. Going forward, this will change, and you will develop the majority of your skills and competence on the job and through broadening assignments. The most successful individuals will quickly determine the learning and development opportunities that exist within the senior staff of their organization. Personally, I learn better and develop faster if someone “shows me” vs. “tells me” a technology, technique, or procedure. Seek out the “mature staff” and leverage their knowledge and experience.

GL: I wish I could once again be a young scientist or engineer, because the future of our industry is brighter today than it has been for many decades. Not long ago, conventional wisdom was that natural gas and oil production in North America were in irreversible decline, which would have gradually diminished domestic employment as the continent’s energy needs would require increasing levels of imports. Today, we can see that yesterday’s conventional wisdom was pessimistic, as North American natural gas production is at an all-time high—thanks to the unconventional reservoir revolution—and liquids production has rebounded by almost 1 million B/D since 2008. So for YPs, I encourage you to find a way to secure an assignment related to unconventional resources. And then invest your time and energy in thoroughly learning the crafts needed to excel in this area.

What are your final thoughts about unconventional resources?

JL: When the topic of “unconventional resources” comes up, onshore oil and gas tends to dominate the conversation. However, an analogous “unconventional offshore” play is in the deepwater basins and sub-salt play along with the offshore Arctic. I feel that development of these areas will continue to pay dividends well into the future and throughout the careers of the next generation of oil and gas professionals.

GL: When I was in university some 27 years ago, source rocks, as their name implies, were considered important only because they were where oil and gas were generated. Nobody saw them as being viable reservoirs on a large scale. In 2000, while I was managing an asset team responsible for developing tight gas sands in south Texas, I remember participating in debates about whether to drill vertical fracture-stimulated wells or horizontal unstimulated wells. There was no option of drilling horizontal fracture-stimulated wells, because the downhole tools required were not reliable or readily available. Today, the majority of wells drilled in the US are horizontal fracture-stimulated wellbores in source rock reservoirs. This is an amazing result. However, it does not by any means represent the culmination of innovation in our industry. In the years ahead, I am convinced that many paradigms strongly held today will be found wrong or incomplete, and our industry will make further technological breakthroughs.

At ConocoPhillips, we are working hard to make the next big advancement. I challenge each of you to attempt to do the same. We, as an industry, have come a long way technologically since the Drake well was drilled in western Pennsylvania in 1859. However, the journey still has a long way to go. I therefore hope each of you finds a way to make your own contributions as a petroleum engineer or scientist and, in doing so, helps our industry continue to deliver the energy required to power our world. TWA