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Jack-2 and the Lower Tertiary of the Deepwater Gulf of Mexico

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[editor's note, by Dave Cohen] Fellow TOD contributor Bubba is co-author of this report. He is an industry insider. It seemed important for those of us concerned about peak oil to respond to the Jack-2 test well result and all the publicity it has spawned. I also had conversations about this piece with Byron King at Whiskey And Gunpowder. Byron writes frequently about peak oil issues. I take full responsibility for this post's contents since I did the final editing.

With the successful test drilling of Jack-2 in the ultra deepwater Gulf of Mexico, there has been a media blitz proclaiming the good news. The "peak oil" theory is under attack. From Business Week's September 7, 2006 article Plenty of Oil--Just Drill Deeper The discovery of reserves in the Gulf of Mexico means supply isn't topping out, we learn

> You can tune out all the scare talk about Peak Oil for a while--probably a long while. Peak Oil is the theory, on the verge of becoming conventional wisdom, that the world's petroleum supply is topping out and will not be able to meet global demand soaring along with the economies of China and India. But a successful test in a mammoth field deep beneath the Gulf of Mexico, announced on Sept. 5 by Chevron (CVX), Devon Energy (DVN), and Norway's Statoil (STO), should help put that scary scenario on hold for decades....
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> Cambridge Energy Research Associates predicts world oil and natural gas liquids capacity could increase as much as 25% by 2015. **Says Robert W. Esser, a director of CERA: "Peak Oil theory is garbage as far as we're concerned."**

Let's take a closer look at the prospectivity, geology, economics, technology, reservoirs, hydrocarbons and logistics of the Lower Tertiary play in the Gulf of Mexico (henceforth the *LTGOM*).

There is no doubt that the successful Jack-2 test well is a technological achievement as Chevron's September 5 press release announces. This well test set many deepwater drilling records.

> More than a half a dozen world records for test equipment pressure, depth, and duration in deepwater were set during the Jack well test. For example, the perforating guns were fired at world record depths and pressures. Additionally, the test tree and other drill stem test tools set world records, helping Chevron and co-owners conduct the deepest extended drill stem test in deepwater Gulf of Mexico history.

More importantly, it demonstrated that these reservoirs are capable of producing at rates that are potentially economic. But in the end, what did Jack-2 prove and what how significant is it relative to the future of exploration and production in the Lower Tertiary of the Gulf of Mexico? What has been missing is a realistic appraisal of the discovery that goes beyond the public hyperbole.

Summary of Findings

Sections below describe the *LTGOM* play in some depth. For those who want to skip the details, here is a summary of our conclusions.

- Large estimated recoverable reserves (EUR) numbers have been quoted in the business and popular press—anywhere from 3 to 15 billion barrels (Gb). Many of these articles have given the public the misperception that all of these billions of barrels were demonstrated by and will shortly flow from the Jack discovery alone. This report is meant to enlighten TOD readers on the true significance of the Jack discovery, the Lower Tertiary play in general, and what can truly be expected from it.

  The *LTGOM* play consists of a number of fields as shown in *Figure 1* below. All of these fields have a EUR in the 350 million to 500 million-barrel range according to Rigzone and other unpublished sources. The production capacity of the various fields and the types of fluid they can deliver vary considerably. Aside from their great depth, the reservoirs and fluids present many challenges. Some of these fields will get produced, others will not. **It is important for everyone to understand that the large EUR numbers quoted do not apply to any one field but rather represent the entire Lower Tertiary region**.

- The Jack-2 well test indicated a flow of 6000 barrels per day. This one data point encourages further appraisal but does not guarantee flow rates that will justify the massive (billions of dollars) investment required to put the *LTGOM* into full-scale production. Whether the economics of commercial exploitation is favorable for the various fields remains an open question.

- Implementing development plans, where they exist, for these fields pushes the limits of deepwater technology. A myriad of questions exist about completion and production of the wells. Unanswered logistical concerns include securing rigs, transporting produced oil to market and what to do with associated natural gas.

- Realistically, initial production of some fields (eg. Great White and Cascade) may happen by 2009 or 2010 at the earliest. The other fields that do get developed, including Jack, will likely not achieve first production before the 2012 to 2014 period. Delays are likely given that many technical problems are being solved for the first time. Under most forecasted scenarios, production from the *LTGOM* will likely only offset declines in US production that will have occurred by then.

  In comments relating the Great White field [Marvin] Odum [Shell's executive vice president of exploration and production in the Americas] said:

  > [Marvin] Odum [Shell's executive vice president of exploration and production in the Americas] said while the Gulf of Mexico will remain a key producing region of

> the world's biggest energy consumer, it was unclear if new discoveries could counter decline rates at existing fields.
>
> "It's going to continue to be very important from a total output standpoint, whether there is real growth potential meaning to grow above volumes we have today or if it is just replacement volumes," the Shell official said.

I return to this last point in the final section. The other findings are discussed in more detail below.

Prospectivity

Going back to May of 2005, Emergence of the Lower Tertiary Wilcox trend in the deepwater Gulf of Mexico provides a window on the geology of the area.

> The Wilcox stratigraphic section has long been recognized as an important petroleum resource in Southeast Texas to Southwestern Louisiana, producing primarily gas from fluvial, deltaic and shallow marine sandstone reservoirs since the 1930s. The total estimated ultimate recovery for the onshore Wilcox is 24 Tcf gas or 4 BBoe. Not until the drilling of the BAHA 2 well in March 2001, was the linked depositional system of the Wilcox from shelf fluvial deltaics to basin deepwater turbidites, a distance greater than 250 mi (403 km), tested by the drill bit.
>
> Although this wildcat, drilled in 7,790 ft (2,375 m) of water in the Alaminos Canyon area of the Northwest GoM was noncommercial, it established a working petroleum system in the Perdido Fold Belt (PFB), Fig. 1. The soon-to-follow nearby discoveries, Trident in July 2001 and Great White in June 2002, proved the significant hydrocarbon potential of the PFB by documenting oil accumulations in a variety of turbidite deposits from sheet sands to amalgamated and leveed channel systems.

Figure 1 -- Discoveries in PFB of the Wilcox
Click to Enlarge

As *Figure 1* indicates, the *LTGOM* play contains a number of fields. Not shown is the Anadarko's Kaskida in the Keathley Canyon area—see Oil discovered at Kaskida prospect from the Houston Business Journal, August 31, 2006. From the World Oil paper cited above:

> More than 12 Bbbl of oil in place have been discovered to date [May, 2005]. Potential recoverable reserves per discovery range from 30 to 400 MMboe, with a 69% success rate, i.e., 9/13 [4 dry holes]. Trend-potential ranges from 3 to 15 Bbbl of recoverable oil.

So, you can readily see the origin of the EUR numbers thrown around in the press. The reserves estimate applies to the entire Lower Tertiary play, not just to the Jack discovery as has been implied by press reports. More on this below.

The Geology, Reservoirs and Fluids

It is always a useful exercise when evaluating hyped new discoveries to ask a simple question: *What hasn't been discussed?* In the case of the Jack-2 test, no news source has addressed the characteristics of the Jack-2 reservoir and what kind of oil flowed from the well at a rate of 6000 barrels per day.

- The *LTGOM* play contains oil of highly variable quality. Some of it is high gravity condensate (40+ ° API) Some of the oil is low gravity, highly viscous sour crude with upwards of 4% sulfur content. Generally speaking, the oil in the western fields (Great White etc.) is better than the eastern fields (Chinook, Stones, Cascade).

- Given their great depth, many of these reservoirs are at very high pressure, about 20,000 psi. Thermal cracking of immature oil into lighter fractions is incomplete in some fields, indicating that the oil was formed only a short (geological) time ago and has not migrated far. As for associated gas, the Gas-to-Oil Ration (GOR) is low. However, some gas will be produced.

- Most of the oil-bearing reservoirs are low-permeability very-fine-grained turbidite sandstones. Some are so fine-grained that they are almost siltstones. These reservoirs, due to their deep burial depths, are also well lithified, and will be challenged to flow their oil at the necessary rates to pay out the required investments. That was the main reason for the Jack 2 well test - to prove that oil could be produced at sufficiently-high rates to warrant further development work.

Thus, the fields are not uniform across the *LTGOM* region. Moreover, four appraisal wells have been dry holes. Although the Great White reservoir (link above) in the western part of the *LTGOM* contains light, sweet crude, even now Shell has not committed to its development.

> Shell Exploration and Production Co. expects to make an investment decision on a potentially large deepwater oil and natural gas field in the U.S. Gulf of Mexico this year, a company official said.
>
> The Great White field could eventually pump 130,000 barrels of oil equivalent per day of natural gas and crude for the U.S. market, according to figures from Shell....

The St Malo, Jack and Kaskida fields are also promising. According to Business Week, the Jack-2 test flowed light, sweet crude. However, the low permeability and high viscosity of the heavy, sour crude in some of the other fields—Stones, Das Bump, Cascade and Chinook—present well flow rate challenges, especially at such great depths.

The Economics and Technology

Assuming commercial oil discoveries, the economics of producing the *LTGOM* depends on many factors and can not be divorced from technology concerns.

> Key technical challenges for trend commerciality are: 1) reservoir quality and flow capability; 2) drilling and completion technology; and 3) development of infrastructure. Continued discoveries in the trend and successful flow tests planned in early 2006 could very well transform the Lower Tertiary Wilcox into a world-class petroleum system in the deepwater GoM.

> Several inherent technical challenges need to be addressed to ensure economic feasibility of the Lower Tertiary Wilcox trend. These range from the cost-effective drilling of complex salt canopies and evaluating deep structural targets to the completion and production of reservoirs in water depths that have not occurred to date.
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> Understanding the oil chemistry, reservoir quality and associated flow capability will determine the drilling/ completion technology, and ultimately the creation of infrastructure needed to transform the Lower Tertiary Wilcox into a world-class petroleum system in the deepwater GoM.

The Jack-2 test well contributed to understanding "the oil chemistry, reservoir quality and associated flow capability" for that particular field. The "cost-effective drilling of complex salt canopies and evaluating deep structural targets to the completion and production of reservoirs in water depths that have not occurred to date" presents a different set of problems as do the related well costs. Schlumberger's Chevron Oil Test Raises Gulf Deepwater Profile provides some details. The article relates some remarks Stephen Hadden, Devon's senior exploration and production vice president, made during a conference call with investors.

> Devon's Cascade project, scheduled for startup in 2009, is poised to become the first deepwater lower tertiary discovery to come on line, he [Hadden] said. But first, the results of Jack's test must be used generate designs for wells and facilities. Lower tertiary wells may cost between $80 million and $120 million each, while producing facilities may cost between $600 million and $1.5 billion.

The start-up costs are very high and likely will be subject to inflation down the road, given the rising capital commodity costs of almost everything. Concerning marginal costs, a reasonable guess is that it is likely that unit technical costs will be $20 to $50 per barrel. At $20/bbl these projects will fly economically. At $30 and up, they will struggle to attract investment capital. It will all depend primarily on the well rates, per well EURs, and well costs, including completion & production. The higher the rates and EUR, the fewer wells that will be needed to drain the reservoirs. From Just Dig Deeper (cited at the very top), we learn that

> Pioneering isn't cheap. Steel and skilled labor rates are going through the roof, as are rental rates for state-of-the-art offshore rigs. BP (BP), for example, will be paying $520,000 per day starting late next year for the same rig it is now getting for $190,000 per day. That's because these fancy rigs, which house 200 people and rise 415 feet into the air, are in short supply with drilling picking up. Still, energy experts believe that producing oil from ultra-deep wells can be profitable as long as oil, selling for $67 per barrel today, stays at or above $40 to $45.

All this gives us some rough idea of where the profit margin lies.

Other Logistical Challenges

Transportation infrastructure and associated natural gas present two crucial, related issues for producing the *LTGOM* fields. Schlumberger tells us that

> ... Distance from U.S. shores is also a major issue for producers, as there are no pipelines

> in place to carry hydrocarbons back onshore, said Zoe Sunderland, an analyst with Edinburgh-based consultancy Wood Mackenzie.
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> "It's just so far from anything," Sunderland said. Operators are considering using floating production, storage and offloading vessels instead of pipes. But any natural gas produced from the wells wouldn't be able to be transported that way and may have to be reinjected into the reservoir or released into the atmosphere via flaring.

The report goes on to say that the Mineral Management Service, from whom the operating companies lease these deepwater blocks, "frowns on gas flaring". Problems will mount if a lot of natural gas is produced. This may not be an issue, however, given the low GOR in these reservoirs based on current knowledge.

Reserves and Timing of Production Flows

Back to the hype. The reader should now be a position to properly evaluate these statements from Business Week.

> One huge oil reserve, even if it could rival the 1968 discovery of Prudhoe Bay and increase U.S. reserves by up to 50%, will not turn around the world's tight energy markets, of course. *It won't even bring the U.S. close to energy independence when oil and gas get into full-fledged production four or five years from now.*
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> But the capability to find and recover petroleum at extreme depths, temperatures, and pressures, as demonstrated by the Chevron team, *may indeed tip the balance of supply and demand in the long term. There will be a new frenzy of drilling at these depths in the Gulf of Mexico, where about a dozen promising exploration wells have already been drilled.*
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> ... Earlier drilling had established promising reserves in an area of the Gulf 300 miles long and 80 miles wide, but the Chevron project found a flow rate of more than 6,000 bbl. a day of light, sweet crude. *The discovery confirmed the area's commercial viability, strengthening hopes that as much as 15 billion barrels of oil could be recovered in the vicinity.*

Let's take the italicized statements one at a time.

First, the 15 billion barrels must be taken with a grain of salt. The low-end estimate of 3 billion barrels defines the actual range, reflecting the large degree of uncertainty in the *LTGOM* trend's EUR. Phrasing like "as much as 15 billion barrels" leads the reader to believe the high-end estimate. Devon Energy's Stephen J. Hadden, senior vice president of exploration and production states:

> "With 273 blocks under lease and 19 exploratory prospects already identified, Devon's lower Tertiary position *could more than double our current reserve base of about two billion equivalent barrels in the coming years*."

Devon has a 25% share in Jack, Kaskida and St Malo. They also have a 50% share in Cascade. It is

hard to see how Devon could double its current 2 billion barrels of oil equivalent reserves if the total EUR is anywhere close to the low-end of acknowledged range for the whole Lower Tertiary region.

Nonetheless, to recover 15 Gb of oil, one would need to drain an accumulaton covering 177,000 acres. This is equivalent to 276 square miles or 31 contiguous Gulf of Mexico lease blocks. Jack itself covers only two outer continental shelf blocks (Walker Ridge #758 and #759) or 18 square miles. The Jack-2 well (in #758) only tested 40% of the total net pay there according to Chevron's press release. Devon states that "the [original] Jack discovery on Walker Ridge block 759 was drilled in 2004. The discovery well encountered more than 350 net feet of pay. The Jack #2 well was drilled to delineate the discovery." The new well test represents one more piece of the puzzle, albeit an important one. Also look back at the Rigzone article cited in the **Quick Summary** above.

Second, what of Business Week's assertion that the *LTGOM* will "get into full-fledged production four or five years from now." Given all the factors covered above, this is a dubious statement. The Bloomberg update Chevron Well Tests New Gulf of Mexico Oil Deposit states:

> The partners [Devon, Statoil & Chevron] plan to drill another appraisal well at the site in the Walker Ridge Block in 2007. A decision whether to develop Jack may be made in 2007 or 2008, Statoil's Mellbye said. The [Jack] field would start production in 2013 if development goes ahead, he said...

Furthermore, Devon Energy "expects to drill one to three exploratory wells from this inventory [19 exploratory Devon prospects] in each of the next several years." None of this sounds much like "full-fledged production" four or five years from now.

Assuming there are no serious delays, what production can we expect in the 2013? Here is Schlumberger's analysis.

> The flow test, the first in the lower tertiary, indicates that the region's finds "will be most likely productive," said David Heikkinen, an analyst with Houston-based energy research firm Pickering Energy Partners. "That bodes very well for the industry as a whole."
>
> Production from the [presumably, the entire Lower Tertiary] area could add 300,000 to 500,000 barrels of oil a day to U.S. output, Heikkinen said. The Gulf currently has a production capacity of about 1.5 million.

It is hard to imagine given all the considerations mentioned here that the Jack discovery alone could produce 3 to 5 hundred thousand barrels per day.

Finally, let's consider Business Week's statement that new ultra-deepwater production "may indeed tip the balance of supply and demand in the long term." In order to evaluate this issue, it is necessary to look at the larger supply issues.

The Big Picture

On July 22, 2002, a press release MMS: Oil Production Offshore GOM to Rise Steeply stated that

> The Minerals Management Service (MMS), Gulf of Mexico Region, released new oil and gas daily production rate projections that encompass the year 2006. According to the new report, Daily Oil and Gas Production Rate Projections From 2002 Through 2006, Gulf of Mexico Outer Continental Shelf, MMS is forecasting a daily oil production rate of between 2.00 and 2.47 million barrels by the end of 2006.... These represent high case and low case estimates. MMS Director Johnnie Burton called the new projections "a healthy, sizeable increase in the range of possible oil production. Should the high case estimates be reached in 2006, we will see a 160-percent increase in oil production from the Gulf in the period 1995-2006."

Current Gulf of Mexico OCS production is approximately 1.5/mbd, down 25% from the MMS "low case" estimate of 2.0/mbd for 2006. It has yet to fully recover from the 2005 hurricanes. BP's Thunderhorse platform is still not operating and delayed until sometime in 2007 at current estimates. Did we fail to mention that the Lower Tertiary deepwater play in the Gulf of Mexico is prone to hurricanes?

The problem is bigger than that. US petroleum production averaged 5.093/mbd in the first 7 months of 2006. Assuming a generous future decline rate of about 5% for the US as a whole, production will be 4.149/mbd in 2010, a net decline of 0.944/mbd. Future production from the *LTGOM* might be 0.500/mbd sometime after that. If we add production from fields like Chevron's Tahiti, which is expected "to have a maximum daily production of 125,000 barrels", then it is reasonable to expect that Gulf of Mexico production will be a wash—declines will be offset six to eight years from now in the best case.

Business Week's assertion that really, really ultra-deepwater production from offshore regions like the *LTGOM* will "tip the balance of supply and demand in the long term" globally is unwarranted speculation. Believing that statement requires a large leap of faith and depends on many complex factors e.g. possible declines in the world's old elephant fields like Ghawar, existing declines in fields like Cantarell, the feasibility of commercial development in similar deepwater areas in other regions like West Africa's Gulf of Guinea, etc.

The current "peak oil" bashing going on in the media is more an indication of underlying concerns about the long term supply situation, not a refutation of peak oil theories. Those concerned about global oil depletion have never said that the world is running out of oil in the near-term or denied that advanced technology can increase recoverable reserves.

Regarding the big picture, one important question revolves around how people interpret these reserves estimates. Typically, there is a knee-jerk response that greets any large discovery because many, even some who should know better, believe that reserves and production flows are somehow equivalent. That is not the case. Another important question revolves around the use of extreme production measures in "final frontier" areas like the Walker Ridge deepwater. Rather than indicating continued abundance in oil supply, such measures may be viewed more accurately as indicating the great lengths oil producers must go to in order to find more oil to meet the world's insatiable demand. The "low-hanging fruit" is gone and so is the era of the cheap oil. Ultimately, this is the meaning of the Jack-2 test well and hopes for production from the Lower Tertiary of the Gulf of Mexico.