Offshore

Close

SUBSALT EXPLORATION US Gulf subsalt evolves into successful play

Over 40 subsalt wells allow detailed geoscience integration; multiple commercial discoveries now under development

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- *Significant discoveries in Gulf of Mexico subsalt exploration trend.*

The Mahogany platform being set.

Offshore explorers will continue to pursue the US Gulf of Mexico subsalt exploration play because of

the enormous profit potential, given the size of discovered and potential oil and gas reserves, the presence of existing infrastructure, advancing geoscientific technology, and economically attractive water depths.

Subsalt sandstone reservoir quality has been repeatedly found to be of high porosity, high permeability, and high pressure. These reservoir components set the stage for tremendous production capacity from future discoveries. Thick sequences of primarily Pliocene, Miocene, and even Pleistocene, clastic sandstone sections have revealed subsalt deepwater paleoenvironments, and continue to confirm deepwater depositional models.

Additionally, industry is discovering there is an important stratigraphic interval just below salt. The first 500-1,000 ft below salt is a less competent, shaley section referred to by some drillers as a "gumbo zone", or more accurately, a "non-competent" zone. As a result, over a dozen of the historical subsalt penetrations did not drill deep enough to see beneath this section.

Explorers should remember that future subsalt wells ought to be drilled roughly 4,000-5,000 ft below the base of this zone, so that adequate reservoir sandstone opportunities can be encountered through the predictive cycles of sequence stratigraphy.

It seems clear, that as advanced seismic acquisition and processing techniques provide improvements in seismic image resolution, and subsalt well control continues to refine geologic concepts, geoscientific integration should lead to giant discoveries in multiple style traps beneath the horizontal salt sheets.

Plio-Pleistocene leads to play

As is the case with many new plays, the geotechnical leads for today's subsalt play were hidden in the wells of the 1970-80 Plio-Pleistocene Play, in the same offshore Louisiana and southeast Texas region.

For many years, explorers had drilled to depths from 5,000-10,000 ft looking for oil and gas sands above salt, as the Plio-Pleistocene Play exploded across these south additions of the Outer Continental Shelf. In more than one hundred of these wellbores, drilling was stopped when salt was encountered at the bottom of the hole. Explorers also drilled around the flanks of these prominent salt structures targeting bright spots, or hydrocarbon indicators (HCI), that sometimes also proved to be salt.

Although these occurrences were economically disappointing, they provided geoscientists with many useful data points to better seismically image the depths and geometries of these underlying salt structures.

Beginning of play

Beginning in 1983, and extending throughout the 1980s, nearly one well a year was drilled through salt sheets in the US Gulf of Mexico. Between 1985 and the present, over 40 wells were drilled through or into varying thicknesses of salt, and a significant number of the early wells were unintentional subsalt tests.

Interestingly, Gulf Oil, in 1983, appears to have been the first operator to actively implement an organized effort to pursue subsalt and subweld reserves in the Gulf of Mexico. Two wells, both spudded in late 1983, were drilled without success, and after the company was acquired by another operator, the remaining prospect acreage was allowed to expire without further exploration. Other operators have actually leased some of this acreage in the lease sales of the 1990's, and have since drilled several wells

with at least one reported discovery at South Timbalier 260/259.

As early as 1985, some of the subsalt wells were beginning to reveal some significant rock properties. Diamond Shamrock's well on South Marsh Island 200 hit a 990-ft thick salt sheet while in pursuit of a bright spot target. After deciding to drill through the unexpected salt sheet, high pressure shales were encountered directly beneath the salt base. Additional casing had to be run, and the operator even drilled ahead toward the original 13,500-ft intended depth, as they quickly evolved their play concept.

Nearly 2,000-ft below the salt base, a 1,000-ft thick, highly porous and permeable, wet Pleistocene-aged sand was encountered, and thus the significant reservoir potential of subsalt sand was confirmed beneath the salt sheets of the Gulf.

For the next four years, only limited drilling occurred, with no success. Some operators found high permeability and porosity in subsalt sands while others, disappointed at encountering salt sections unintentionally, did not drill deep enough below the salt base to evaluate subsalt sediments at all. Not surprisingly, the absence of a commercial strike pushed the subsalt play into later years.

Decade of discovery

1990 truly proved to be the beginning of the decade of discovery for the subsalt play. Exxon's Mississippi Canyon 211 Mickey prospect, which was drilled that spring, was announced as a 100-200 million bbl discovery, and became the first significant subsalt discovery. Although to date, a decision on its commerciality has not been announced.

The drilling pace began to pick up soon thereafter, and several operators, armed with 3D seismic depth images and better depositional models of the subsalt and suprasalt sediments, began to drill their prospects.

Drilling thick, salt sections was no longer considered a difficult task, as proven in late 1991. Chevron drilled through a 6,950-ft thick salt sheet and then 5,200-ft of subsalt sediments in 724 ft of water at Garden Banks 165, proving that very thick salt sheets could be easily penetrated and even drilled to substantial depths below the salt base.

However, the presence of non-competent shales immediately beneath the salt have presented a far greater challenge to drillers than the salt sheets themselves. The differential between frac gradient and pore pressure can be fairly narrow in this zone, thus complicating drillers decisions involving optimal mudweight selection to control pore pressures and prevent lost circulation.

Play hits commerciality

These efforts all set the stage for the first major strike on the continental shelf in subsalt sediments. Operator Phillips Petroleum Co., and its partners Anadarko Petroleum Corp. and Amoco Production Co., drilled the Mahogany #1 well on Ship Shoal 349 in 1993, testing flows up to 7,256 b/d oil and 9.9 MMcf/d gas on a 32/64-in choke at 7,063# FTP, from its 180-ft thick "P" oil sand. The Mahogany # 2 well was announced as a successful appraisal well in late 1994 with flows from another sand at 4,366 b/d oil and 5.315 MMcf/d gas on a 20/64-in. choke at 6,287# FTP.

In April of 1995, encouraged by a third successful well at Mahogany, Phillips announced the commerciality of the Mahogany Field. A fourth well has also been announced as a successful test appraisal, and a fifth well has been partially drilled to the top of salt, but suspended for installation of the

platform this past summer.

First production from this significant new field was expected by yearend 1996, and is projected to reach 22,000 b/d oil and 30 MMcf/d gas in 1997. The platform production is expected to rise as more wells are drilled, and it has the capacity to produce 45,000 b/d oil and 100 MMcf/d gas from up to 20 wells. A new chapter in the prolific history of offshore Gulf of Mexico production is about to begin.

During the drilling of the second Mahogany well, Phillips and Anadarko announced their Teak discovery on South Timbalier 260. Although not indicated as commercial, this second discovery on the shelf, with its combined flow tests of 4,431 b/d oil and 7.7 MMcf/d gas from three zones, flowed from the third zone at 3,743 b/d oil and 5.988 MMcf/d gas on a 22/64-in. choke at 7,220# FTP. Encouraged by the news, other operators spudded several of their subsalt prospects toward the latter part of 1994.

Soon thereafter, 1995 saw the announcement of the second commercial subsalt discovery. Shell Oil, with partners Pennzoil and Amerada Hess, announced the commerciality of their Enchilada prospect, which includes Garden Banks blocks 128, 127, & 172.

When combined with supra-salt discoveries that they had made on adjoining blocks in blocks 83 & 84, reserve estimates of 400 bcf gas and 25 million barrels oil/condensate were indicated. Anticipated flow rates could ultimately reach 300 MMcf/d gas and 40,000 b/d oil & condensate, Shell reported.

1996 yields discoveries

1996 yielded three more announced discoveries, with the most significant perhaps being the Texaco/Chevron Gemini discovery. Located in Mississippi Canyon 292 in 3,393-ft of water, Texaco announced in June that the discovery, actually drilled in 1995, was now considered commercial, after conducting testing operations in the spring of 1996.

The well reportedly flowed from two intervals at a combined rate of 54 MMcf/d gas and 4,405 b/d condensate, from below a salt sheet reported to be 2,908-ft thick. The first interval flowed at 22 MMcf/d gas and 3,778 b/d condensate on a 36/64-in. choke at 3,892# FTP, but is estimated to be producible at rates up to 50 MMcf/d gas and 7,700 b/d condensate, and was restricted by test capacity limitations.

The second interval flowed at 32 MMcf/d gas and 627 b/d condensate on a 48/64-in. choke at 2,225# FTP, but is also estimated to be producible at higher rates, up to 80 MMcf/d gas and 1,500 b/d condensate. An appraisal drilling program is underway, and Texaco has stated that first production might be anticipated in the 1999-2000 time frame.

Meanwhile, Phillips and its partner Anadarko announced another new discovery in the play at the Ship Shoal 361 # 1 Agate well. Tested from two separate zones in the same sand, the well yielded a combined flow of 4,125 b/d oil and 24 MMcf/d gas. The first zone tested at 2,738 b/d oil and 14.4 million cf/d gas on a 17/64-in. choke at 6,773#FTP, and the second zone flowed at 1,388 b/d oil and 9.67 MMcf/d gas on a 18/64-in. choke at 7,038# FTP. Plans for development have not been announced to date.

At the end of 1996, Anadarko, and its partners Phillips and BHP Petroleum, announced another subsalt discovery in Vermilion 375. The Monazite #1 well encountered multiple hydrocarbon bearing sands which were confirmed by well logs, core analyses, and production testing. All tested intervals flowed oil, but data obtained were largely inconclusive due to various problems encountered during test operations, including extensive sand production. Due to wellbore conditions, this well has been plugged and abandoned. Future appraisal drilling will be necessary to determine commerciality of the Monazite

discovery.

Again and again, subsalt wells are turning up good reservoir properties, especially high permeability, porosity, and pressures, and strong oil/gas producing zones. While the prospectivity of the play has gained momentum in the months following the Mahogany platform announcement, much less information is available from recent subsalt/subweld wells drilled by other operators, because the US Minerals Management Service maintains confidentiality of results for a period of two full years.

Four wells underway

As this article went to press at the end of 1996, at least four subsalt wildcat wells were underway, two of which were being drilled in water depths over 600 ft. This demonstrates the very large projected reserve potential of the subsalt play as it appears capable of justifying the significantly higher costs of deepwater development.

This is reflective of a fundamental fact of the geology: that the play will be pursued both on and seaward of the outer continental shelf, since the large horizontal salt sheets extend off the shelf into the deepwater areas of the slope, as well.'

Authors' Note:

This article summarizes and updates a technical paper entitled "The Evolving Exploration of the Subsalt Play in the Offshore Gulf of Mexico", by Dwight "Clint" Moore and Robert O. Brooks, presented as a keynote address to the Gulf Coast Association of Geological Societies in Baton Rouge, Louisiana, in October, 1995.

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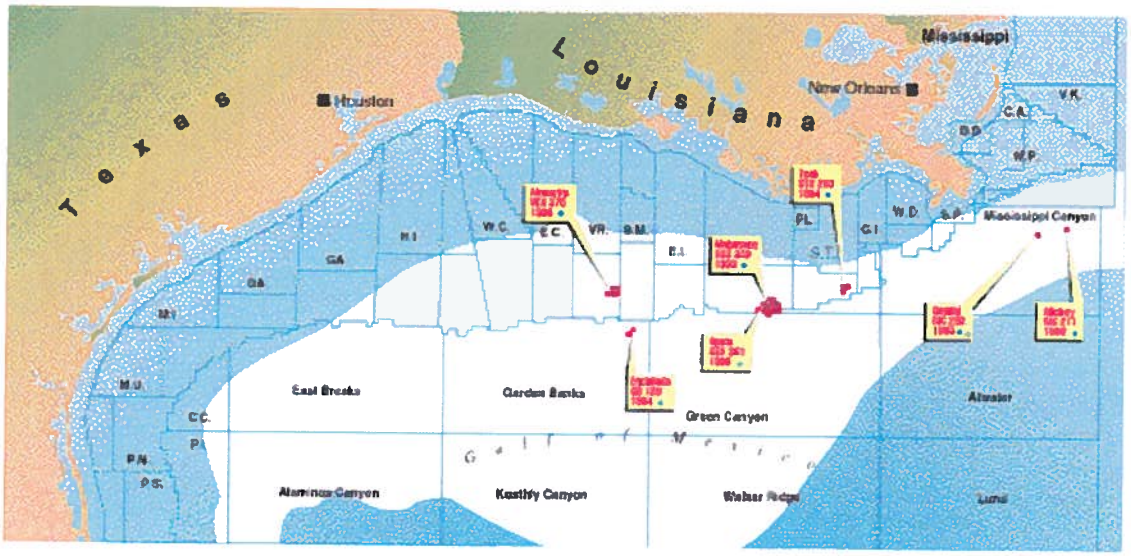
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