AAPG Annual Meeting
March 10-13, 2002
Houston, Texas

Champlain: A Subsalt Discovery in the Deepwater Gulf of Mexico

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The Champlain discovery is located in Atwater Valley Block 63, Central Gulf of Mexico, in 4400' of water and beneath 7000' of allochthonous salt (Figure 1). The acreage was acquired in 1991 for a suprasalt amplitude play; at that time the subsalt play was not well imaged. As 3D seismic data became available over the acreage in 1999, hints of a poorly defined salt-cored detachment anticline below the allochthonous salt sheet began to emerge. Subsequent PrSDM processing revealed the Oligocene-aged structure that sets up the play (Figure 2). Similar salt-cored anticlines had proven to be hydrocarbon bearing in the Green Canyon Mississippi Fan fold belt trend (MFFB), however structures that had been tested in the central Atwater Valley MFFB had not enjoyed the same success.

Pre-drill risk assessment identified presence of reservoir as the critical risk element of the play. The Champlain structure was believed to have been a positive feature throughout the lower and middle Miocene, potentially precluding sand deposition. Trap definition was limited by the image quality of available seismic. Hydrocarbon risk was relatively low due to the presence of neighboring discoveries and the focusing effect of the long-lived structure. Seal was expected to be provided by hemipelagic shale drape and condensed sections.

In the first quarter of 2000, Texaco and partner Agip drilled the Champlain #1 discovery well. Technical challenges in the initial drilling of the salt included sub-salt overpressure and bit direction control in the salt section. Three reservoir penetrations were drilled from this well and high quality Miocene oil and gas reservoirs were encountered between 20,000' and 24,000'MD. As a result of this drilling success, a semi-regional Kirchhoff PrSDM was executed over a 67 in/26 out area covering northern Atwater Valley and southern Mississippi Canyon. This step dramatically improved the image quality and confidence in the structural integrity. However, several poorly imaged areas still existed beneath areas of complex geometry in the salt canopy. Therefore, a second PrSDM utilizing a wave equation shot record migration algorithm was performed by Texaco's depth imaging group. These complimentary PrSDM datasets, coupled with the drilling results, have enabled the Champlain project team to comprehensively re-evaluate this asset.

The structure was initiated as a NE – SW trending salt cored detachment fold in the late Oligocene (Figure 3). Progressive updip loading of sediment resulted in a break forward basinward vergent thrust system with successively younger structures basinward. The trap style is a crestal four-way with a larger three-way dip closure with updip salt truncation. The structure has been divided by keystone faulting associated with a Middle and Late Miocene phase of compression (Figure 4). High quality shales that appear to support the measured hydrocarbon column, corroborated by reservoir pressure information and mercury injection pressure analysis, provide seal. A series of good quality Miocene turbidite sands act as reservoirs with varying degrees of lateral continuity. Both biogenic and thermogenic hydrocarbons have been encountered at substantial overpressure. Oil quality is of an intermediate gravity and is similar to other oils produced to the north in the Mississippi Canyon area. Four rooted salt stocks to the north, east and southeast of the Champlain structure passively grew through the Tertiary and coalesced to form an allochthonous salt canopy that is regionally 0 to 20,000' thick and is 7000' thick in the vicinity of the well penetration. Where these individual salt sheets coalesced, sutures can be identified on the seismic that can cause potential hazards for drilling. The timing of salt emplacement locally is late Miocene.

The next challenge facing Champlain will be the appraisal and development of the structure. As the current seismic data can not fully resolve the structural and stratigraphic complexities of these reservoirs, initial development will not be able to rely on well locations articulated by 3D seismic. Hopefully, as more wells are drilled and incorporated in the seismic volumes a better subsurface picture will emerge. If not, field development will have to proceed with constant refining of a model driven interpretation. Of course, most oil field developments in the Gulf of Mexico have not had the onerous cost of high pressure deepwater drilling to contend with. Some of this cost can be abated if a platform is ultimately installed with drilling capability. However the areal distribution of the Champlain accumulation will still warrant multiple subsea wellheads for complete development. Hence the optimum development of Champlain will necessitate an iterative process of interpretation and well placement.

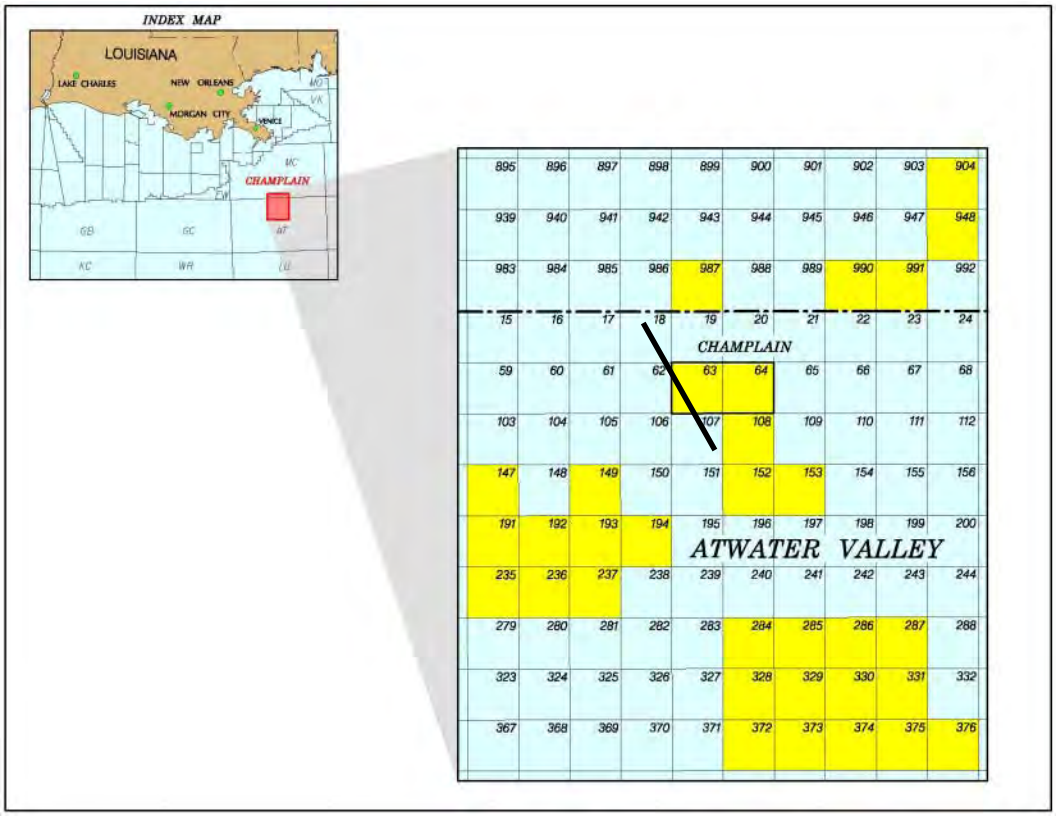

Figure 1- Deepwater Gulf of Mexico, Champlain area map with location of line shown in Figure 2.

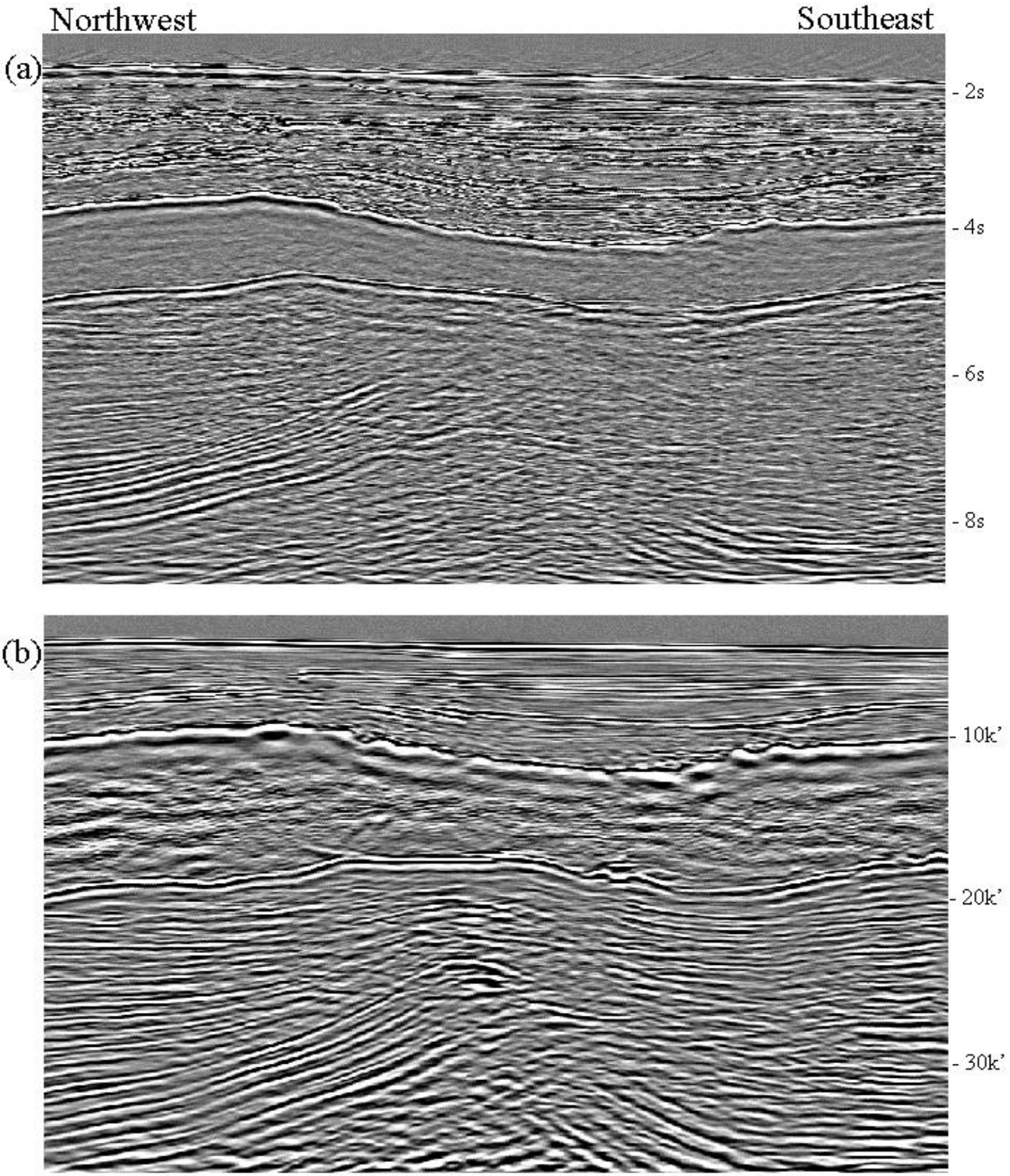

Figure 2- Seismic line over Champlain (courtesy of PGS) located in Figure 1. (a) 3D time migrated seismic line over Champlain. Note the poor illumination of the subsalt structure. (b) 3D PreStack depth migrated seismic line over Champlain. Note the improvement in image quality of the salt cored detachment anticline.

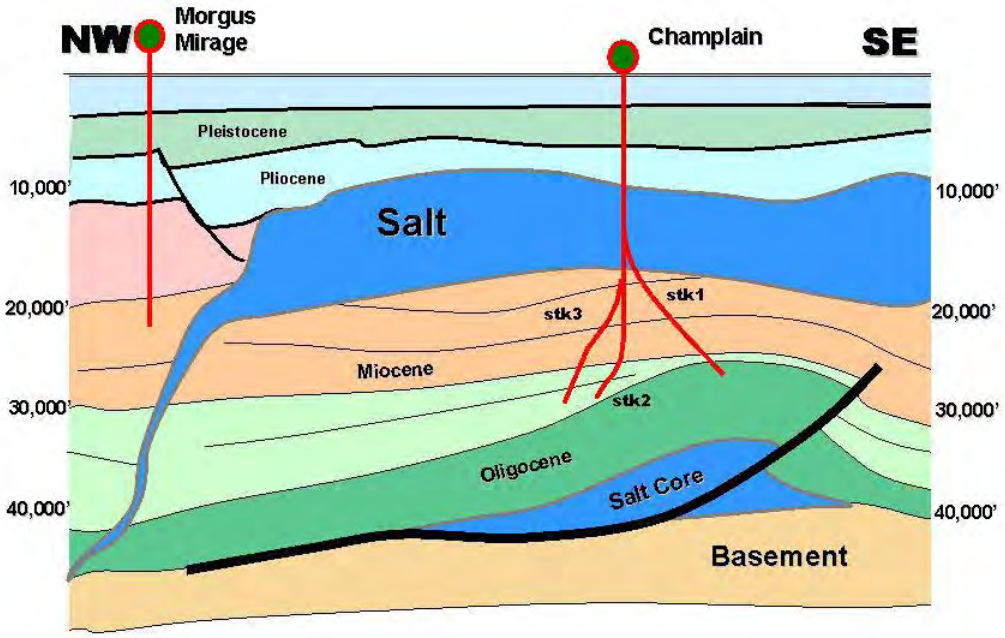

Figure 3- Schematic cross section over the Champlain Discovery.

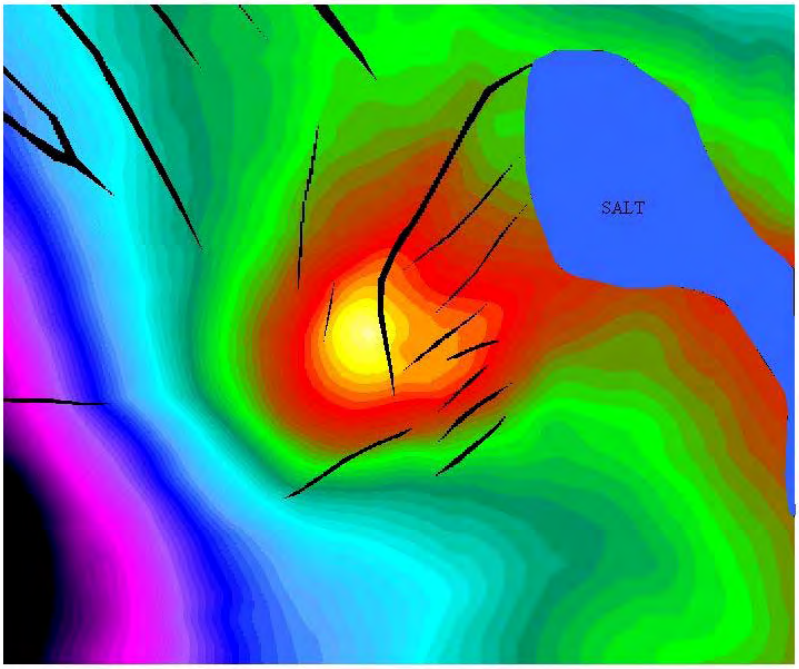

Figure 4- Depth structure map at main reservoir interval illustrating crestal four-way with larger three-way dip closure and keystone faulting.