THURSDAY 18TH MAY 2006  ROOM B

SESSION: GREENFIELD – 2

1130 hours: 37. Balakhany Ix & X Integrated Studies -Shallow Water Gunashli, Caspian Sea

Kevin Sylvester, Pinnacle Energy Ltd, Dave Waldren, PCT Ltd, Bakhtiyar Bagirov, SOCAR RMC, Elshad Aleskerov, SOCAR RMC

Some 100 kms east-southeast of Baku in the Caspian Sea lays the mega field ACG (Azeri, Chirag and Gunashli, see Figure 1). Exceeding 5 billion barrels of recoverable reserves, these fields are being developed under a 25-year PSA between a consortium of 9 oil companies of the Azerbaijan International Operating Company (AIOC) and the State Oil Company of Azerbaijan Republic (SOCAR). Connected to the northwest of the PSA area is the Shallow Water Gunashli (SWG) field which is owned and operated by SOCAR and has been in production since 1980 (Figure 2). Chirag, the first of the ACG fields to be developed, has been in production since 1997. Start-up of production in Azeri and Deep Water Gunashli (DWG) will be phased from Q1 2005 to 2008 across 4 production centres, 3 in Azeri (Phases I and II), and 1 in DWG (Phase 3).

AIOC has a business need to understand the secondary reservoirs in ACG to fully optimise reservoir development plans. The adjacent and strategic location of the producing SWG field to ACG with some 223+ well penetrations provides a unique opportunity to undertake various joint subsurface studies with SOCAR to better understand and predict the dynamic behaviour of certain secondary reservoirs deemed materially important to Phase III development (DWG + West Chirag). The Phase III project is currently within the “Execute” stage having been sanctioned in 3Q 2004.

To utilize and leverage the SWG well data on the Phase III project, BP/AIOC contracted with the Reservoir Modelling Centre (RMC) of SOCAR to perform a series of joint subsurface studies on the secondary reservoirs of Balakhany VII, VIII, IX and X in 2001-2002. Later in 2002, a subsequent joint study, “Balakhany IX & X Integrated Studies”, was started with the primary objective to evaluate the production potential for these two reservoirs as if they had been developed from initial conditions using a typical Phase III type well spacing. This provided a reserves assurance and validation test to developing these same reservoirs in the adjacent DWG field.

More specifically, the “Balakhany IX & X Integrated Studies” required the preparation of static geological models for each the IX and X reservoirs and their subsequent use as input to building their respective dynamic simulation models. This objective was achieved through the traditional method of “hand contoured” (deterministic) geological mapping versus a “computer interpolation” derived mapping style (Figures 3 & 4). This “hands on” geological method leads to highlighting real depositional trends and incorporates geological meaning which in the case of the Balakhany reservoir sequence mapping, presents a real and recognizable channel architecture reflecting the palaeogeographic setting at the time of deposition. Incorporating the historical performance data (wells in SWG) from these Balakhany reservoirs with the geological property maps resulted in building two robust and verifiable dynamic reservoir models for history matching and prediction purposes.

Initially only 96 wells (Balakhany IX) were accessed for interpretation but later up to 174 wells were incorporated into these Balakhany studies. The impact of increased well control was
dramatic because the Balakhany IX & X are typically low net-to-gross reservoir systems (20-64% range). From a suite of geological "hand contoured" maps that included gross and net sand isochoires, isopachs, sandstone/shale ratio, net-to-gross and porosity maps for each reservoir sub-layer, the following conclusions and observations were noted:

1. Channel width appears to be key to resolving a match between mapped STOIIP to observed production behaviour
2. Channel positions approximate mapped faults at depth (could this represent subtle structural control to deposition?)
3. Channel "stacking" is coincident to mapped faults in "crunch zones"
4. Lateral shifting or channel switching/avulsion is evident
5. Multiple channel strike directions (NW-SE, N-S and NE-SW) are present
6. Composite channel widths range from less than 100m to 600m across and are a direct function of net-to-gross values.

All these characteristics defined the geological framework or architecture for the Balakhany IX & X depositional sequence in SWG and what is likely to be typical in neighbouring DWG.

The Balakhany IX reservoir model history match was very good when using the deterministic maps (based on only 96 wells), requiring only a minimum correction factor of 2 for a dynamic STOIIP match. However, when using the computer derived interpolation maps, the match was very poor, requiring a correction factor of between 4 to 5 to match the dynamic STOIIP (Figure 5).

For the Balakhany X reservoir model history match, the well control was significantly increased to 174 wells, which in itself inevitably improved the channel margin mapping definition (using sst/sh ratio of 0.7 vs 0.5 in Balakhany IX) and geological confidence. As a result, the model history match was excellent requiring no adjustment to the model STOIIP (Figure 6). This is in contrast to an earlier interpolation map input model of 2000 where the STOIIP value was approximately 4 times larger and hence required a significant STOIIP reduction to match actual field production characteristics.

In addition to improved property mapping, better history matching in Balakhany IX & X was in part achieved through the creation and use of a new geologically derived deterministic map referred to as, "Interface Transmissibility Map". Basically, this map shows by way of succeeding reservoir layers, areas where vertical transmissibility (pressure and fluids are transmissible) zones or "chimneys" exist (Figure 7). This commonly occurs between vertically successive and overlapping channel sand bodies that are in vertical pressure communication (direct contact and petrophysically exceed 10% porosity). For the first time, a set of geologically derived, deterministic maps provided an approximate 3-dimensional mapped boundary limits (lateral and vertical) representation and perspective on the Balakhany IX & X reservoir channel architecture for direct input and control into the dynamic models.

In the Balakhany X model, prediction runs were based on two different water flood development case plans; 1) a peripheral water flood plan, and 2) a full field pattern water flood development. Model simulation resulted in the pattern flood (33.1% oil recovery) being more efficient than the peripheral flood (28.3% oil recovery).

The utilisation and leveraging of SWG well data to traditional geological mapping methods ("hand contoured") and building dynamic reservoir models has proved important results in providing reserves assurance and validation for the Balakhany (IX & X) secondary reservoir development in DWG. Results of this work will assist in the planning and optimisation for DWG development well locations, all of which will help to deliver as efficiently and cost effectively possible, these significant secondary reservoir reserves in Phase III development.
BP operates ACG field on behalf of the shareholders of the Azerbaijan International Oil Company (AIOC) which include the following companies: BP 34.14%, UNOCAL 10.28%, SOCAR 10%, INPEX 10%, Statoil 8.56%, ExxonMobil 8%, TPAO 6.75%, Devon 5.63%, Itochu 3.92% and Amerada Hess 2.72%.