AAPG Search and Discovery Article #90016©2003 AAPG Hedberg Conference, February 18-20, 2003, Algiers, Algeria.

AAPG HEDBERG CONFERENCE
"Paleozoic and Triassic Petroleum Systems in North Africa"
February 18-20, 2003, Algiers, Algeria

Development of the Hassi Berkine South (HBNS) Field – Case Study

Joel THILLIEZ, Abdessalem HADJAZ, Djamel GUERGOUR, Mike VICKERS
Groupement Berkine, Hassi Messaoud, Algeria

The HBNS reservoir was discovered in January of 1995. It is located in the Berkine Basin, approximately 200 km to the South East of Hassi Messaoud. The reservoir is of Triassic age, consisting of a recurrent sequence of vertically stacked and laterally contiguous fluvial channel sands. The main producing intervals are the Upper and Middle Triassic Argilo-Gréseux Inférieur (TAGI) sands, with reservoir depths ranging between 3000 and 3100 metres TVDSS. Virgin formation pressure was approximately 5050 psia and the reservoir temperature is approximately 197 ºF. The rock properties of the TAGI sands are generally very good. Average net reservoir porosity is in the order of 17.0 % and ranges between 10.0 and 24.0 %. Average net permeability to air is around 300 mD and ranges between 1.0 and 2000 mD. Irreducible water saturation is dependent on rock quality but typically ranges between 5.0 and 25.0 %. The HBNS reservoir fluid is undersaturated oil with a bubblepoint pressure of approximately 2930 psia. The stock tank fluid has a density of 0.81 g/cc (42 ºAPI) and the GOR is approximately 1130 MSCF/STB.

Initial production at HBNS began in May 1998 with over 100 MMBO produced to 1 August 2002. The Reservoir Development Plan (RDP) calls for crestal reinjection of all produced gas with a peripheral waterflood. The current injection gas is multicontact miscible with the reservoir oil with a Minimum Miscibility Pressure (MMP) of between 3750 and 4000 psia. Current operating practices do not allow the reservoir pressure to fall below the bubblepoint pressure in the waterflood area or below the MMP in the gas flood area. Future field development may include the installation of a full-field Water Alternating Gas (WAG) flood and the extraction of the Natural Gas Liquids (NGL) from the produced gas stream. Currently, a WAG Injectivity Test and a WAG Pilot are ongoing in the field.

From discovery to current day, the development of HBNS has employed an integrated approach where Sonatrach and Anadarko staff of all disciplines work together in the subsurface team with a common goal of maximising the value of the asset. The integrated nature of the development of HBNS covers many disciplines: geophysics, geology, sedimentology, petrophysics, petroleum engineering, reservoir engineering and reservoir simulation. One of the main responsibilities of the subsurface team is to construct reservoir models – both static geological models and dynamic fluid flow models – that will be used to optimise the development of the HBNS field. This presentation will focus on the integrated multidisciplinary approach to the collection and interpretation of data that is used to evaluate reservoir compartmentalisation at HBNS. Understanding the compartmentalisation has been instrumental in optimising the RDP for the field.

The decision to drill in the HBNS area was based upon 2-D seismic data shot in the early 1990's. Once the initial discovery was made, the decision was made to shoot a 3-D seismic survey in order to get a higher quality data set. The 3-D seismic survey was performed in the second half of 1996. Integration of the seismic data with well results has enabled a high definition picture of the subsurface structure of the reservoir to be constructed. This defines both the reservoir surface and the associated faulting. These data are critical in gaining an understanding of the communication within the reservoir and/or any compartmentalisation. The reservoir surface and faulting define the gross structure of the reservoir simulation models.

Investigating possible reservoir compartmentalisation was a focus of the HBNS data acquisition program very early in the appraisal program. Before the field was put on production a number of pre-production tests were performed. These included both “build-up” tests to evaluate nearby faulting and other “local” behaviour in the environs of a particular well and “interference” tests to determine interwell connectivity and behaviour. Both these types of tests provided invaluable data for tuning the performance of the reservoir simulation model prior to field production. Of particular importance from these tests was the high degree of connectivity seen in the main area of the field, with communication over distances of approximately 7 to 10 kilometers observed. This data provided confidence that the RDP, which included a peripheral water flood and well spacings of 1.5 kilometers, would be effective in maintaining reservoir pressure at target values and provide effective areal sweep. These data also indicated that the westernmost area of the field was in a separate compartment, a fact that was incorporated into the development plan from a very early stage.

Since the field has come on production the assessment of reservoir compartmentalisation, both horizontally and vertically, has greatly benefited from taking openhole wireline pressure measurements in all development wells. This data has been used to evaluate differential depletion, the continuity of vertical barriers/baffles and injection support efficiency within the various TAGI layers. This data has also been history matched in the fluid flow model for reservoir management purposes and to optimise future well locations. Since first production the openhole wireline pressure data has been among the most useful information for facilitating integration of geologic and reservoir engineering disciplines.

As development of the HBNS field has matured, other techniques to evaluate compartmentalisation at HBNS are expected to offer similar benefits. These include the Expansion Index Technique, a powerful, quick-look method to illustrate the timing and magnitude of structural movement which, when integrated with seismic and production data, provides improved definition of faulting. A full-field gas and water injection tracer program has also been initiated at HBNS. The provenance and residence time information obtained from the tracer program will provide the geophysicists, geologists and reservoir engineers invaluable information for reservoir characterisation and simulation history matching with the ultimate goal of determining future infill drilling locations to optimize field recovery.

Groupement Berkine made an early and continued effort to determine the level of reservoir compartmentalisation within the HBNS field. This characterisation effort has benefited greatly from having an integrated multi-disciplinary team of Sonatrach and Anadarko geoscientists and engineers working together toward a common goal. The result has been the successful implementation of the HBNS Reservoir Development Plan and a template for other field developments currently being undertaken by Groupement.