D-18 REVIEW OF THE REMAINING POTENTIAL IN THE EASTERN SIRTE BASIN, LIBYA

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Abstract

In the Sirte Basin more than 1600 exploration wells drilled since 1956 have discovered an estimated total of 130 billion barrels of original oil-equivalent in place (Thomas 1995, Gras & Thusu 1996). The play types tested successfully in the Sirte Basin are both carbonate and siliciclastic plays. The first category are predominantly Paleocene carbonate buildups, occurring in the central and western parts of the basin, while Middle Eocene nummulite shoals are productive in the southeast Sirte Basin (e.g. Gialo field). The oilfields in the Sirte Basin with siliciclastic reservoirs are principally related to the consecutive Middle Triassic and Late Jurassic-Early Cretaceous rifting of the basin, and occur in the eastern part of the Sirte Basin (fig. 1).

Figure 1: Structural overview of the Sirte Basin. Study area is the Sarir area, east of the 21° E parallel

The 34 fields in the eastern Sirte Basin east of the 21° E parallel are estimated to hold 65 billion barrels of original oil in place. The limits of the productive and prospective play fairway area are as yet poorly defined, and the total area is estimated to cover approximately 80 000 km². Approximately 90 % of the OOIP is contained in the seven giant fields Sarir C-Main, Sarir L-Field, Messlah, Gialo, Nafoora-Augila, Abu Attifel, and Amal. The remaining 27 fields, on average, hold 200 million barrels OOIP. Estimates of the average expected recovery factors for the fields in the eastern Sirte Basin are in the range of 15-30% (Thomas 1995, Gras & Thusu 1998).

The reservoirs in the Eastern Sirte Basin occur in the pre-rift, syn-rift or post-rift sequences (Fig. 2). However, the most frequently proven and prospective reservoir intervals are the Middle Triassic and Late Jurassic-Early Cretaceous clastic reservoirs.

Figure 2: Schematic stratigraphy, eastern Sirte Basin

The Triassic syn-rift sediments in the eastern Sirte basin (Maragh Trough) are deep water turbidites. The best reservoir facies is to be found in the deep grabens close to the basin margins. The turbidite sandstones are embedded in a shales, acting as both source and seal. These reservoirs are a new type of exploration target in Libya, to be found in the deep basins off the structural highs (Klauser-Baumgartner & Kuehn, 1999). The Triassic rift related sediments have been named the Amal Formation, and have also been shown to locally contain oilprone organic matter (Thusu 1993).

The Late Jurassic-Early Cretaceous syn-rift reservoir is the prolific Sarir sandstone, hosting a number of giant oilfields. The Sarir sandstone is the principal reservoir in the eastern Sirt Basin. In this area the main phase of the rifting took place in the Late Jurassic-Early Cretaceous, during which time the Sarir sandstone was deposited as a non-marine, intra-continental clastic syn-rift sequence. The Sarir lithostratigraphic framework comprises four regionally correlatable members, linked to regional baselevel changes and comprising the main producing intervals (Ambrose 2000).

The siliciclastic play types are both structural traps, combined structural-stratigraphic traps, and stratigraphic traps. In the eastern Sirte Basin the distribution of oil fields mirrors the main structural trends. Traps on the E-W structural trend are fault dependant with both footwall and hanging wall plays. On the NW-SE trend fourway dip closures dominate. These dip closures together with stratigraphic plays make the NW-SE trend most important in terms of OIP and productivity. However, the E-W trend is more lightly explored and offers greater future potential.

Trap geometries are often influenced by E-W trending, basement-controlled fault systems, oblique to the NW-SE Sirt Basin trend. The E-W trending fault systems are frequently developed in en-echelon patterns, as a result of the NW-SE trending extension of the Sirt Basin superimposed upon the pre-existing structure. The fault systems were active during the Sarir sandstone deposition, giving rise to structural as well as combined structural-stratigraphic traps (Gras 1998). An increased understanding of trap architecture has led to re-evaluation of older fields, in addition to new discoveries and prospects.

The eastern Sirte Basin is in an immature stage of exploration, in comparison with the North Sea, a similar rift system. Both the Sirte Basin and the Central North Sea are multiphase rift systems with major extension taking place during the Late Jurassic to Early Cretaceous, and with world class oil reserves accumulated in the syn-rift siliciclastic sedimentary sequence. Comparison of exploration statistics in both basins supports the remaining potential of the Sirte Basin. This potential is expected to be reservoired in both combined structural-stratigraphic traps, complex structural traps, and deeper, as yet poorly tested deeper reservoirs such as the Triassic Amal Formation..

The major fields in the eastern Sirte Basin have been detected with gravity and magnetics and early 2D-seismic, however, 3D seismic data is utilised increasingly for exploration and development purposes. Implementation of new technology in land seismic acquisition, processing and integrated interpretation, as well as the use of the latest concepts of sequence stratigraphy and structural interpretation will lead to further discoveries in the 20-200 million OIP barrels range. El Ghoul & Hallett (1993) stress that to date relatively shallow targets have been explored, as only 10 % of the exploration wells in the Sirte Basin have drilled deeper than 10 000 ft. Only rarely have deviated or horizontal wells been undertaken in the Sirte Basin.

Advances in integrated reservoir management and enhanced oil recovery have the potential to dramatically increase recovery rates. The geological concepts and leading edge technology utilised in the appraisal, development, production and enhanced recovery schemes in the North Sea are expected to guide the future trends in the exploration and development of the eastern Sirte Basin.

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