Petroleum Geology and Hydrocarbon Potential of Somaliland

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P283 Petroleum Geology and Hydrocarbon Potential of Somaliland

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Fewer than 10 exploration wells have been drilled in Somaliland (Northern Somalia), mostly in the northern onshore and offshore areas, making it one of the least explored countries in the world. Although tectonic developments have controlled the accommodation space available for sediment deposition since Early Jurassic, the wells drilled on both onshore and offshore have encountered source, reservoir and seal rocks.
In this study seismic, well and outcrop data have been used to determine the petroleum system of the country. The results show that Upper Jurassic and Cretaceous units, and possibly Oligocene-Miocene units in the offshore area, show potential for hydrocarbon generation. Traps are provided by rollover anticlines associated with listric growth faults and rotated basement fault and horst blocks. These are controlled by Upper Jurassic to Lower Cretaceous tentional stresses. Basins which have potential for hydrocarbons include Berbera (Bihendual) basin (conjugate side of the Balhaf basin in Yemen), Las Dureh, Raguda, and Al Mado basin between Eragavo and Puntland (conjugate side of the Masilah basin in Yemen).

1. Introduction

Somaliland is situated on the northern side of the horn of Africa. Gulf of Aden lies in the North, Somalia in the east, Ethiopia in the south and west, and Djibouti in the north-west (Fig.1).The major features of the topography of Somaliland are controlled by the geological structure. The morphology of the country is typical of areas in extension, with basins plateaux and mountains up to 2000 m (Fig. 1). There is little folding, but much normal faulting, and some of the faults have very great throws. Highlands and lowlands are a direct result of the numerous faulting movements which have affected the country.
Somaliland is one of the least explored countries in the world. Petroleum exploration in the country began in 1912 when oil seep at Dagah Shabell, 38 km southeast of Berbera was reported (SOEC, 1954). However, less than 10 exploratory wells have been drilled in the country and no commercial oil or gas discoveries have been made so far in country, but the surveys showed evidence of substantial potential of hydrocarbons.

2. Stratigraphy

In Palaeozoic time, the whole region of the horn of Africa and Southern Arabia underwent considerable erosion. The first advanced of Mesozoic sea began in the Early Jurassic during which tensional forces associated with the separation of India led to the development of NW-SE trending grabens in the region. The earliest deposits were interbedded sandstones and conglomerates which vary considerably in age within short distances. In the Early Cretaceous times, these successions underwent erosion as a result of uplift in the area. However, the transgression and regression in the Cretaceous period deposited alternating sandstone-limestone beds in the area. During Eocene the sea flooded the exposed land covered by the Cretaceous deposits, depositing the Auradu limestone. The sea retreated gradually during the Middle Eocene, when an evaporatic environment prevailed depositing the Anhydrite Series. A transgression in the Upper Eocene caused the deposition of marine cherty limestone of Karkar formation. The uplifting of the area and the beginning of the rifting of the Gulf of Aden during the Miocene restricted sedimentation to a narrow coastal belt. This is the when the Daban Series were deposited. The presence of coral reefs at various elevations along the narrow coastal belt indicated that the area has been subjected to a recent consistent uplifting. A summary of the stratigraphy of Somaliland is given in Table 1.

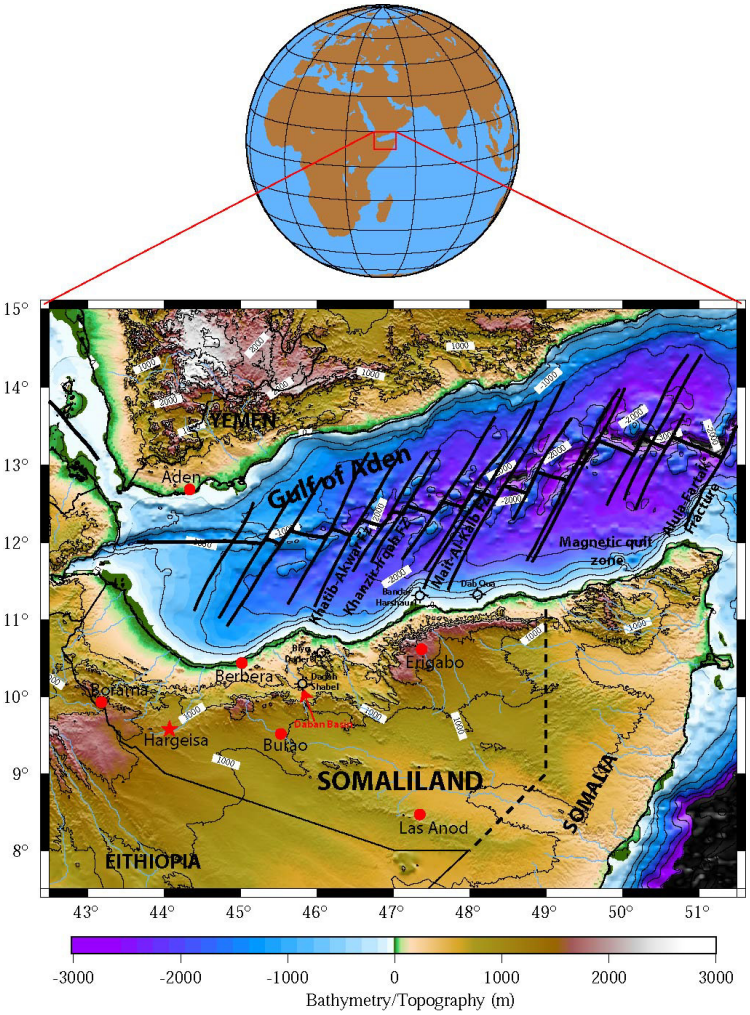

Fig. 1 Location map of Somaliland.

3. Hydrocarbon plays

3.1 Source rocks

Both onshore and offshore (Gulf of Aden) of Somaliland contains numerous good quality source rocks which have potential for hydrocarbon generation.

Jurassic

Numerous excellent quality source rocks of Jurassic age are known in outcrop along the coastal margin, including Bihendula area SE of Berbera. Shales in the Daghani Formation are most likely source for the 28 barrels of 32.2° API oil tested from the Wanderer Limestone in the onshore Dagal Shabel-1 well. Offshore wells have also indicated good source rocks of Jurassic in age. For example, Dab Qua-1 well intersected shales of Daghani Formation that had TOC's in the range of 0.53-1.16%.

Cretaceous

The Upper Cretaceous shales of Jesomma Formation contain fair-good source potential. Both in Bandar Harshau-1 and Dab Qua-1 wells shales in the Jesomma Formation had good source potential with TOC of up to 5.00%.

Palaeocene-Eocene

In Dab Qua-1 a very good potential source rock which had TOC of 30.00% was encountered. The interval was only 15 m thick, but it may thicken down-flank.

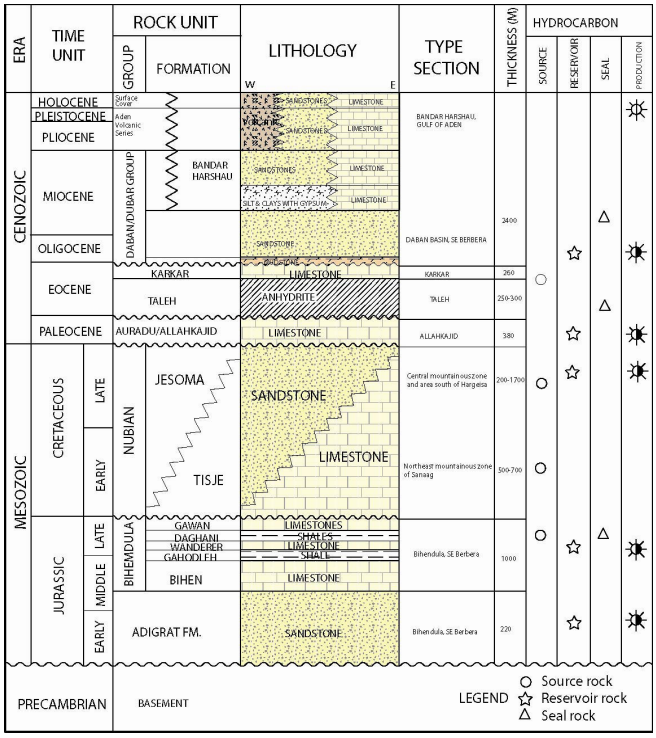

Table 1. Stratigraphic and hydrocarbon distribution in Somaliland

3.2 Thermal Maturation and Migration

Maturity levels of the source rocks vary from early to post-mature. Thermal modelling for the Gulf of Aden has identified a number of offshore kitchen areas with excellent source potential (Bott et al., 1992). Mature Cretaceous depocentres are present within offshore Al Medo basin east of Dab Qua-1 and offshore Berbera basin. However, the thermal modelling studies have shown that the Eocene source-intervals are likely to be immature to early-mature for the majority of the offshore areas of Somaliland.

3.3 Reservoir rocks

Numerous reservoirs are possible within the pre-syn- and post-rift rocks of the Gulf of Aden. Reservoir rocks for the pre-rift sequence include both carbonate (Palaeogene and Cretaceous-Jurassic) and sandstones (Cretaceous and basal Jurassic). Reservoir rocks in syn-and post-rift sequences are principally sandstone with secondary carbonate reservoirs.

Jurassic:

Two onshore wells, Dagah Shabel-2 and Biyodader-1 in Somaliland, intersected 191 m and 160m of gross sand in the Adigrat, respectively (Fig.2). At Dagah Shabel-2, just 15 km from basement outcrop, they were porous and yielded fresh water. Porosity of the sandstones was variable, but it was as high as 15%. The reservoir potential of the offshore Jurassic deposits is also good.

Cretaceous:

In the Upper Cretaceous, good clastic reservoirs have been recognised. Dagah Shabel-1 well intersected very thick (790 m) fine to coarse-graided fluvial sands of the Cretaceous Nubian (Jesomma) formation. The well encountered two highly porous sand units where small quantity (4 barrels) of good quality (33.6°API) oil was swabbed.

In the offshore, the Bandar Harshau-1 well penetrated 536m of Upper Cretaceous sediments of restricted shallow marine environment with coastal/swamp habitats. Sandstone porosities range up to 14%.

Tertiary (Oligocene-Eocene):
Clastics and carbonates of Oligocene-Eocene age also offer reservoir possibilities in syn-post-rift traps. In the offshore, the Dab Qua-1 well penetrated a total of 183 m of Auradu limestone that have oil shows in cuttings. Bandar Harshau-1 well also had shown minor oil and gas shows.

3.4 Traps

In Somaliland there is no evidence of large-scale compressive folding like that of Arabia. However, there are minor anticlines which are believed to have been caused either by rejuvenation of old fault blocks or drag along major faults that are parallel Gulf of Aden. The primary structural traps are rollover anticlines associated with major growth-faults that become listric above the pre-rift section (Fig. 2). The movement of faults was associated with the separation of the Africa and Arabia in early Miocene. Stratigraphic traps are also important, particularly in the offshore areas, where the succession is eroded.

Fig.2 is a regional seismic profile across Dagah Shabel/Daban basin area. The figure illustrates the trapping styles in the area. The dominant structural traps, as seen in the diagram, are rollover anticlines associated with major growth-fault that becomes listric.

3.5 Seal

Seals are comprised by interbedded shales for the pre-rift sequence with Eocene anhydrites also forming a regional seal.

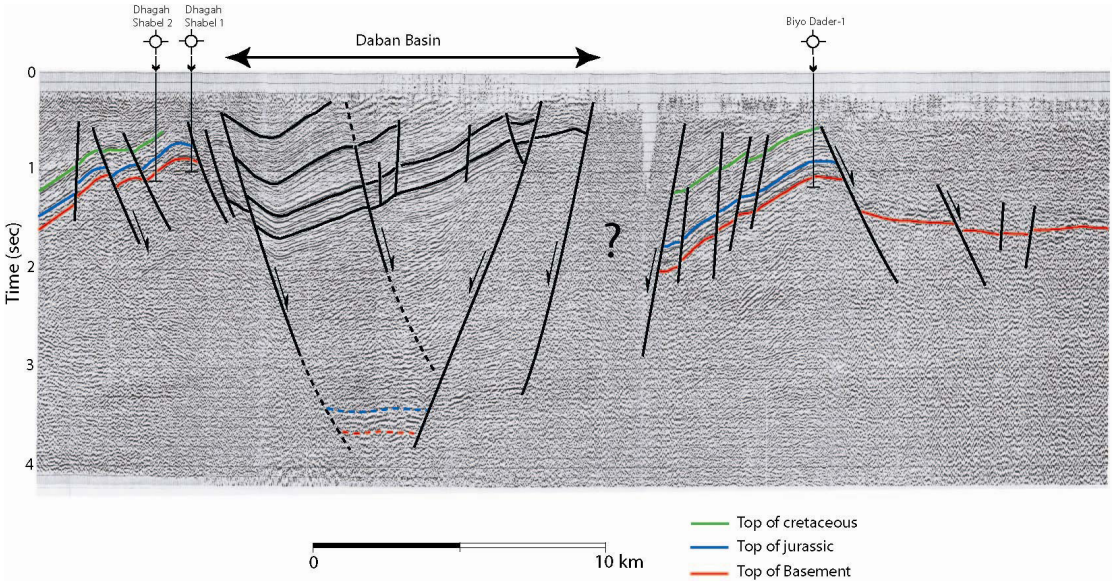

Fig. 2. Seismic profile crossing Daban basin, illustrating structural style of the area.

4. Conclusions

The available well, seismic and outcrop data show that Upper Jurassic and Upper Cretaceous units, and possibly Oligocene-Miocene units in the offshore, show potential for hydrocarbon generation. These data show that the hydrocarbons may have accumulated in numerous large, tilted, fault-blocks and isolated sub-basins both onshore and offshore. These include Berbera (Bihendual) basin (conjugate of the Balhaf graben in Yemen), Las Dureh, Raguda, and Al Mado basin between Eragavo and Puntland (a continuation of the Masilah basin in Yemen).

4. References

Bott, W.F., Smith, B.A., Oakes, G., Sikander, A.H., & Ibrahim, A.I., 1992. The tectonic framework and regional hydrocarbon prospectively of the Gulf of Aden.- J. Petrol. Geol., 15 (2), 211-243,

Somaliland Oil Exploration Co. (SOEC), 1954. A geological reconnaissance of the sedimentary deposits of the Protectorate of British Somaliland. Crown Agents, London, 1-42