Abstract

The western Prerif area, located in northern Morocco, constitutes the most external structural unit of the Rif Alpine domain which includes essentially Mesozoic and Cenozoic folded sediment overlaying the Paleozoic basement.

Sedimentary deposits, within this zone, resulted essentially, from the relative sea level changes during the complex successive tectonic phases of continental collision and plate divergence inducing the deposition of various facies ranging from continental and lagoonal carbonate and clastic to open marine deposits.

From tectonic point of view, normal faults initiated during the rifling period were reactivated into high to medium angle reverse faults, during Late Cretaceous to Early Tertiary times, inducing the formation of various imbricates and structures within the Prerif area.

Geochemical analyses carried out on samples from drilled wells in neighboring Prerif Ridges and outcrops show that rich and mature source rocks are developed within L. Jurassic and Cretaceous series. Combination of structural assessment with geochemical results and seismic interpretation permitted to define new play concepts within viable petroleum systems. The western Prerif is located in northern Morocco, constitutes the most external structural units of the Rif Alpine domain which includes essentially Mesozoic and Cenozoic folded sediments overlaying the Paleozoic basement.

Recent integrated studies using new acquired seismic profiles show that more oil and gas to be discovered in prospects similar to the producing ones and in plays which have not as Triassic salt structures, sub thrusts and Tertiary folded sandstones.

Introduction

The western Prerif area, located in northern Morocco, is developed within the southwestern most portion of the Rif Alpine fold belt. This area consisting of imbricates which forms the westernmost portion of the southern Alpine mountain chain (fig. 1).

Sedimentary fill consists of about 6000 m of Mesozoic and Cenozoic sediments which is covered by the complex of nappes itself is overlain by Tertiary clastic sediments.

Geological setting
The Prerif area corresponds to the most external structural units of the Rif fold belt which is the southern segment of the Gibraltar arc located in the western Alpine Mediterranean system. To the south, this domain is limited by thin Cretaceous section in the Mamora and thin Jurassic-Triassic section in Saiss basin that overlies the Paleozoic basement. The Rif chain is structurally divided into three geological sub-domains (figures 2 & 2 bis); the Internal Domain, the Flysch Nappes Domain and the External Domain. The internal domain is formed with elements coming from the Alboran plate and comprises: the Sebtides (Paleozoic/Triassic epimetamorphic succession), the Ghomarides (essentially Paleozoic material) and the limestone chain (a thick Triassic carbonate series, Liassic limestone and condensed Middle Jurassic to Eocene-Oligocene series).

The flysch nappes domain is formed by a large allochtonous unit spread across the Intra-Rif zone away from the limestone chain. The External domain consists of Mesozoic series represented by Triassic shaly-lagoonal formations, Liassic limy and dolomitic series and by Bajocian limestone formations made of Ammonitico Rosso facies overlain by Bathonian marl and by a thick Flysch type Jurassic (Upper Bathonian to Kimmeridgian sandy-Shale).

Petroleum Geology

From geochemistry point of view, many mature source rocks exist within the Prerif area as proven by hydrocarbon productions, shows and oil seeps. The Lower Jurassic marls and shale (Domerian-Toarcian) and the Upper Cretaceous shale seam to be the main source-rocks in the area. TOC values taken from wells data are up to 2 % for the Lower Jurassic source rock. The outcropping Upper Cretaceous formations have TOC values up to 12 %. Modeling studies using Basin Mod program indicates that maturation of the lower Jurassic source rock and generation of hydrocarbons in the Prerif area, started after the emplacement of the complex of nappes. However, this formation may have reached the oil window as early as end of Jurassic-Lower Cretaceous within troughs. Maturation of the Upper Cretaceous source-rock have occurred recently during the Mio-Pliocene time.

Play concepts

The newly acquired seismic data and recent integrated studies have permitted to develop three new play concepts within the western Prerif area. The defined play concepts consist of Lower Jurassic and Middle Jurassic subthrusts in Ouezzane area and Jurassic and Tertiary folded sandstones an carbonates in the Acilah-Larache area.

Jurassic play of Ouezzane area:

In Ouezzane area, the developed play concept is related to a saliferous ramp structure similar to the producing Boudraa and Tselfat in the Prerif ridges (Fig. 3). The main objectives are represented by Lower Jurassic limestone, Middle and Upper Jurassic sandstones. Hydrocarbons are interpreted to be sourced from Lower and Middle Jurassic shales. Cretaceous series located within the accretion wedge represents additional potential source rocks. In term of timing maturation started after the emplacement of the accretionary wedge which is synchronous to the structuration.

Jurassic play of Acilah area:

In the Acilah-Larache area, the developed Jurassic play is related to a southwestward verging ramp structure similar to the saliferous structure developed in Ouezzane area. Expected reservoirs within are L. Jurassic limestone and M. Jurassic sandstones. The source rocks are represented by both Cretaceous and Lower Jurassic shales. Maturation and migration of hydrocarbons started after the emplacement of the Habit unit.
Tertiary play of Acilah area:

The developed Tertiary play in Acilah area is located at the top of the same southwestward verging structure. Expected reservoirs are Eocene and Oligocene turbiditic sandstones (Sidi Mrait sandstones). The source rocks are represented by both Cretaceous and Lower Jurassic shales. Maturation and migration of hydrocarbons started after the emplacement of the Habit unit which means that additional Eocene and Oligocene sandstones (Acilah sandstones) from the Habit unit could represent potential objectives for hydrocarbon exploration.

Conclusion

The Prerif area is considered to be of high potential for hydrocarbon exploration. From the thirties to the fifties, a number of oil and gas fields were discovered and produced within the southern edge of this area. Since then, only a limited exploration activity was undertaken by SCP and ONAREP. Recent geological investigations and newly acquired seismic program show that more oil to be discovered in plays similar to the producing ones and in plays which have not been tested yet such as sub thrust folded Jurassic and folded Tertiary traps. These new concepts have to be controlled by additional seismic profiles before to be tested.

In the light of the developed concepts and considering the poor seismic coverage, the forthcoming exploration programs should focus on:

- Acquire additional seismic data by using long cable and high energy source.
- Structural modeling to understand the geometry of the different structural units.
- Integrate all available data to define drillable prospects within viable petroleum systems.

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Fig. 1: Structural Map of the Gibraltor Arch (in Flesh 19933)

Fig. 2: Rif Fold belt Geological Setting

Fig. 2 bis: Geological cross section of the Rif Fold belt
After Sutter (1980) and Flinch (1993), Modified