INTERNATIONAL BRIEF

Spotlight on . . . MOROCCO

By George Tappan

Morocco’s new hydrocarbon law, approved by Parliament May 22, 1991, offers a number of incentives to concessionaries who begin commercial production within ten years of the date of publication of the new law.

- Amortization at 200% of all costs and expenses incurred in drilling exploration and evaluation wells:
  - during a 3-year period from the effective date of the law for existing exploration permits and exploitation concessions;
  - during a 4-year period from the granting date of new exploration permits.
- Government interest can be limited to 35%.
- No royalty on first 4MM tons production.
- No obligation to contribute production to the domestic need.
- Exemption from Petroleum Duty (surtax) for three years from initial production.
- Exemption from Surface Tax for all exploration permits granted within 10 years.

In addition, the concession agreement has no signature bonus obligation, tax rates are low and negotiable, materials and equipment unavailable locally may be imported duty-free, and produced oil and gas may be exported freely. There is no currency control, and profits may be repatriated. (See International Exploration Newsletter, June 11, 1990.)

Morocco imports almost all its oil, about 5MM tons/year (36.7MM barrels/year). Oil, gas, and condensate have been produced from a number of small fields in the Rharb Basin and Pre-Rif Areas onshore northwestern Morocco, and from the Essaouira Basin to the south, but local production is no more than 60,000 barrels per year. Two major refineries, one at Mohammadia, near Casablanca, and the other at Sidi Kacem, process imported oil and have ample capacity for larger volumes of throughput.

Petroleum exploration has reached all of Morocco’s onshore sedimentary basins to some extent, but none have been fully explored. All onshore permits currently in force are held by the government petroleum entity, Office National de Recherches et d’Exploitations Pétrolières (ONAREP). Of these, nine are under contract with Société Cherifienne de Petrole (SCP). Maxus Energy also has a non-exclusive technical evaluation agreement on a 44,500 sq km study area between the High and Middle Atlas, east of Marrakech.

Texaco/Maroc Casablanca, Inc., AGIP Africa, Ltd., Shell, and Walter International Morocco Inc. hold Atlantic offshore permits in conjunction with ONAREP. Mobil, Philips, Conoco, SNEAP, and Amoco have explored offshore in the past, but to date only 28 wells have been drilled offshore. Three found oil shows. Three had shows of gas, and 22 were dry. Five were drilled by JOIDES as part of the Deep Sea Drilling Project. Present exploration activity is concentrated in the Moroccan Meseta Platform and the northern part of the Aaiun-Tarfaya Basin.

The Moroccan Atlantic offshore is comprised of several geologically distinct areas which are seaward extensions of their onshore counterparts. All were developed as part of the passive continental margin following the Jurassic opening of the Atlantic. Shelf-margin sediments overlie continental clastics and evaporites accumulated in the early rift system which was developed on the Paleozoic.

Rif and Rharb Domain

The northernmost area, the Rif tectonic domain, is an Alpine fold belt superimposed on a Pre-Rif nappe. The complex tectonics and related sedimentation are the result of the Tertiary collision and subduction of the African and Eurasian plates. These events formed a massive accretory wedge with southwestward thrusting and folding along the Alpine front. The southwestern portion, the Rharb Basin, is a late Miocene-Pleistocene foreland which escaped major Tertiary deformation, but received massive late

---

Miocene slides along its northern margin. Only one well, LAR-1-1 was drilled offshore. It was abandoned at 2325m after penetrating a supra-nappe Mio-Neogene sequence. One hundred ten wells have been drilled in the Pre-Rif ridges and western Rhôf Basin onshore since 1923. Production, reaching a maximum of 1979 b/d in 1954, is from Paleozoic, Triassic, Jurassic, and Miocene in the Pre-Rif, and supra-nappe Miocene clastics in the Rhôf Basin. Possible source rocks include Paleozoic, Early Jurassic, Cretaceous, and Miocene shales. Potential plays with reservoirs in fractured Paleozoic, Early Jurassic carbonates, mid-Jurassic deltaic sands, and Miocene limestones and sandstones will be found in structural, stratigraphic, and combination traps.

**Meseta Platform**

The Moroccan Meseta Platform, offshore Rabat-Casablanca, has not been drilled, but Texaco and Moroc have permits on three 2000 sq km blocks on which they have proposed a US$57MM seismic and drilling program. The northern half consists of Paleozoic folded flysch, overlain by as much as 3000m of Jurassic-Cretaceous continental passive-margin sediments, and a Tertiary basin with Alpine deformation. Under the southern half, a thin cover of interbedded marine and continental Mesozoic-Tertiary sediments lies unconformably on at least 6000m of folded and faulted Paleozoic. The Tuorfon, Cenomanian, and Miocene are thought to contain important source rocks in the north. In the south, geochemical interpretation suggests the Ordovician, Silurian, and Lower Devonian shales are within the oil window. The best reservoirs are expected to be in Jurassic carbonates, Triassic conglomerates, and Cretaceous sandstones. Broad, faulted traps are expected in the Rabat area, large anticlines in the Lower Paleozoic related to listric faults offshore Casablanca.

**Safi Area**

No wells have been drilled in the Safi area, offshore extension of the Doukkala basin, but 12 oil and 3 potash exploration wells were drilled onshore. The thickness of the undifferentiated Paleozoic is unknown, but gravity and magnetics suggest thick Permo-Triassic volcanics. The Jurassic is assumed correlative to the onshore platform carbonate and shale section, and a thin Cretaceous probably consists of fine clastics and thin carbonates. Marine Silurian and Devonian shales are likely source rocks, and mid-Devonian carbonates, Permo-Carboniferous and Triassic continental sandstones, and Jurassic carbonates and clastics are potential reservoirs. Although much is inferred, the available seismic data indicates structural traps in the form of anticlines and rotated fault blocks, and erosional pinchouts in the Paleozoic and Triassic.

**Essaouira Area**

The Essaouira offshore is a Mesozoic-Cenozoic basin developed over Paleozoic with north-south Hercynian structural trends. A thick, modestly-deformed Mesozoic carbonate platform with parallel northeast-striking ridges extends northward into the Safi area. The Mesozoic-Cenozoic basin is continuous to the south, but the Essaouira area is separated from the Agadir offshore by a fragmented Paleozoic and the offshore extension of the high Atlas trend.

The northern part of the area is characterized by large seaward-dipping listric faults. Salt diapirs occur over most of the offshore as well as the adjacent onshore. The salt section is both in-place in Triassic-Early Jurassic salt-filled grabens, and mobilized. Salt tectonics is more pronounced toward the south where a thicker overburden has induced more active movement. The platform carbonate accumulated more or less continuously from Jurassic to Early Cretaceous after which it was sealed by thick Middle and Late Cretaceous shales with thin carbonate intervals. Organic-rich Oxfordian marl and shale, known from the onshore section, may provide source material offshore. The best reservoir rocks are porous Jurassic carbonates at the shelf margin. Another potential reservoir is a 50-100m sand body usually found on the contact between the salt and the Early Jurassic carbonate. The area has numerous possibilities for structural, stratigraphic, salt-related, and reef-debris traps.

Three offshore wells have been drilled to date. Two, drilled on a Jurassic carbonate bank, found traces of hydrocarbons. The third, drilled on a salt structure, penetrated Cenomanian and Albian clastics and terminated in Late Jurassic carbonate. Thirty-four exploration, and 45 development wells have been drilled onshore.

**Souss Domain**

The Souss-Agadir offshore area developed at the site of a failed arm of the Triassic-Early Jurassic rift system. The northern limit is represented by the South Atlas Fault. The earliest recognized unit, a Triassic salt of unknown thickness, is overlain by thick Jurassic platform carbonates, Cretaceous shale which thickens seaward, and Tertiary clastics.

Early Cretaceous shales, deeply buried in front of the Jurassic shelf edge, are important potential source rocks.

See next page
Triassic clastics, Jurassic carbonates, and Early Cretaceous and Tertiary sandstones are potential reservoirs. Five offshore exploration wells have been drilled, of which three found shows of oil and gas. Shows were found in a Late Cretaceous cap rock overlying Jurassic basin-edge carbonates. Nine wells have been drilled onshore.

**Infi Area**

This area was the recipient of over 10,000m of Mesozoic and Cenozoic sediment overlying Paleozoic basement. The Paleozoic is an offshore extension of the Anti-Atlas, developed during Hercynian compression. Thick Triassic and Early Jurassic alluvial fans and other clastics accumulated in grabens formed during Permo-Triassic riftning. Salt deposited in Triassic troughs was later mobilized along the basin margin during the Jurassic. Early Jurassic platform carbonates developed seaward contemporaneously with nearshore clastic facies, and prominent shelf-edge reef mounds, which may reach a thickness of 1500m, formed during Early and Middle Jurassic. An extensive lagoonal complex shoreward of the platform may have potential source rocks. The Jurassic is marked by a widespread erosional surface that enhanced porosity by karstification.

Numerous untested prospects in less than 150m of water include anticlines, salt-related structures, fault blocks, carbonate bank margins, reef mounds, and stratigraphic traps. Only one exploration well was drilled to date. Oil and gas shows were found in the Jurassic and Cretaceous. AGIP and Shell currently hold three blocks each in this offshore area.

**Tarlaya-Laayoune-Dakhla Areas**

This long stretch of continental shelf is similar in most respects to the areas to the north. It is a passive margin basin built on Late Triassic rifting, continental red beds, and Late Triassic to Early Jurassic evaporite-filled grabens, followed by gradual subsidence and development of extensive Jurassic carbonate platforms. Uplift of Cretaceous land areas to the east produced an increase of detrital material providing source and seal for the carbonate reservoirs.

Esso drilled 9 wells between 1962 and 1975. Mobil drilled the Cap Juby discovery in 1984. Amoco drilled Tan Tan-1 in 1985, and Walter International, which still holds a permit, drilled the Tarfaya-1 in 1990. Esso’s MO-2 tested 2377 b/d 11° API oil from a Late Jurassic carbonate margin at 2165m. A variety of structural and stratigraphic traps remain to be tested in this large offshore area. Twenty-nine wells have been drilled onshore.

Despite the concentration of drilling in Meseta Platform and the Tarfaya Basin the Atlantic offshore remains grossly under-explored. Many large structures and potential traps have been recognized from the regional seismic grid, yet fewer than 25 have been tested with the drill.

**CONTACTS:**
Mr. M'Barek Ali Mouhsine  
Petroleum Participants Director  
ONAREP  
17, Av. Mkhilien  
Agdal, Rabat, Morocco  
Telephone: 212-77-721-64 & 705-05  
Fax: 212-77-758-66, Telex: 317-15 M

Mr. Al Moundir Morabat  
Exploration Director, ONAREP  
Telephone: 212-77-757-12

**REFERENCES:**

Petroleum Exploration Opportunities in Morocco,  
Office National de Recherches et d’Exploitations Pétrolières, Rabat.

Petroleum Geology of the Atlantic Offshore of Morocco,  