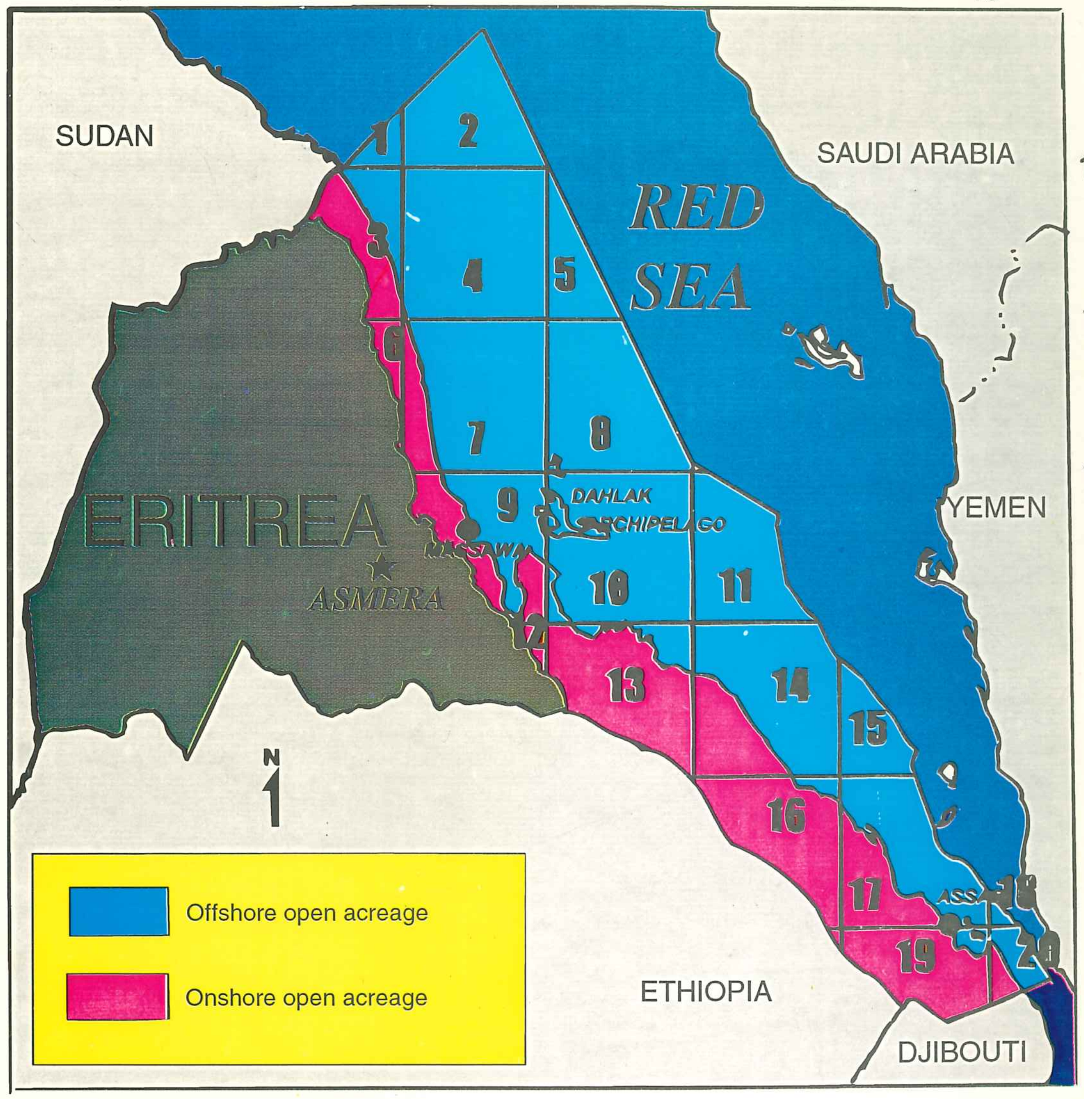
EXPLORATION BLOCKS, ERITREAN RED SEA



This map is not an authority for international boundaries.

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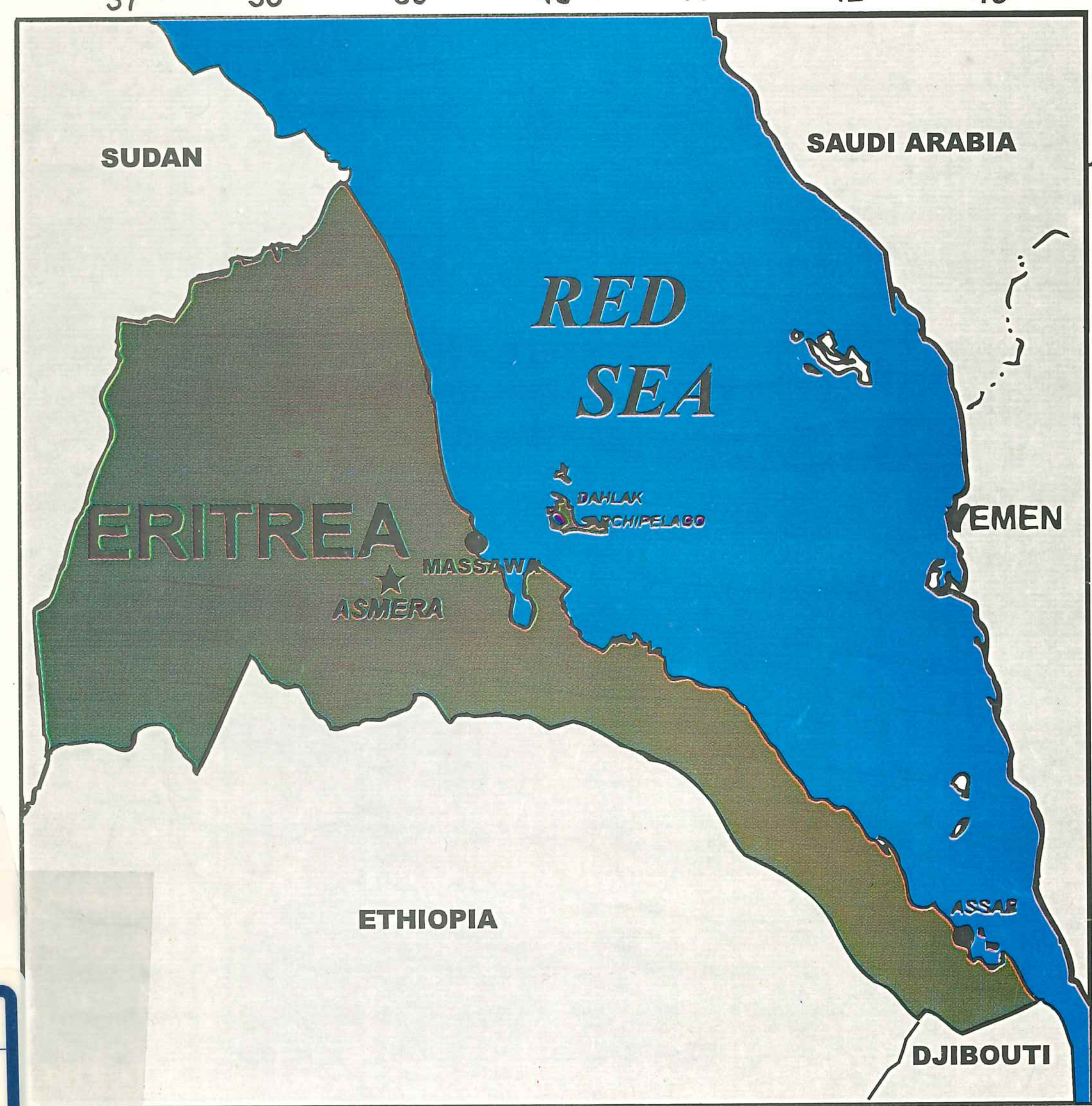
HYDROCARBON POTENTIAL AND EXPLORATION OPPORTUNITIES IN ERITREA



Introduction

The state of Eritrea shares borders with the Sudan to the north and west, Ethiopia to the south and Djibouti to the southeast. Its Red Sea coastline extends for about 1000 kilometers.

Ever since Eritrea became an independent state, it adopted a market economy in which a private sector plays a leading role in economic development.

Petroleum is one of the sectors which the Government has given priority to. The Government had enacted two relevant laws in July 1993:

i) A Proclamation to Govern Petroleum Operations (Proclamation 40/1993); and

ii) A Proclamation to provide for the Payment of Income Tax (Proclamation No. 41/1993).

These two proclamations were revised recently to give additional incentives to investors and are replaced by:

i) A Revised Proclamation to Govern Petroleum Operations (Proclamation No.108/2000); and

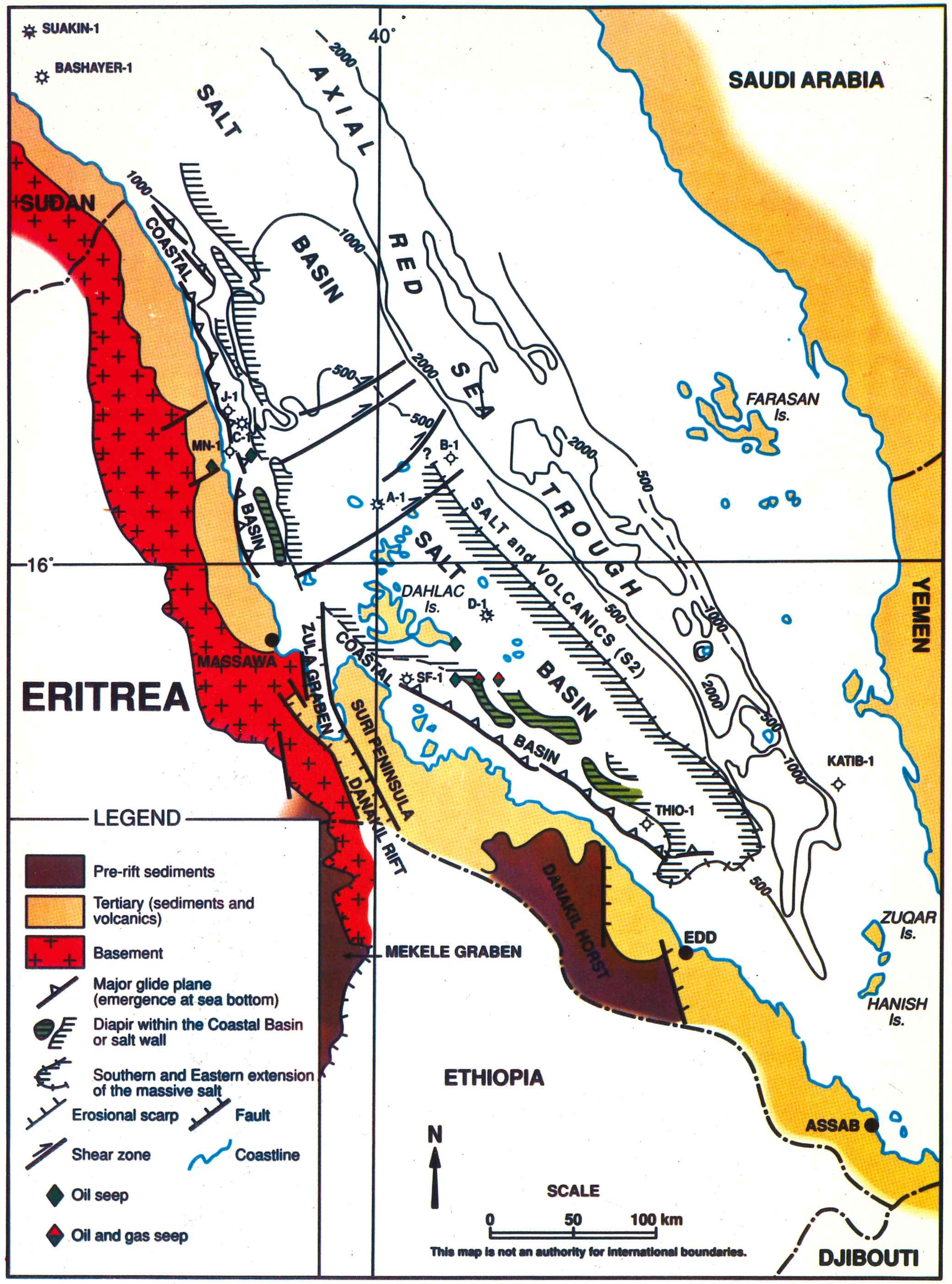
ii) A Revised Proclamation to provide for the Payment of Income Tax (Proclamation No. 109/2000).

The Minister of Energy and Mines represents the Government in its dealings with any legal person with whom the Government establishes a petroleum agreement. The Minister has issued Regulations on Petroleum Operations (Legal Notice No. 45/2000) and prepared a model Production Sharing Contract pursuant to the powers vested in him under Article 7 of the Revised Petroleum Operations Proclamation (Proclamation No.108/2000). There are a number of incentives in the legal documents. Recently, the Government has reduced the Income Tax from 50% to 35% to give additional incentive.

The Ministry of Energy and Mines has also compiled all technical information of the Eritrean Red Sea in two volumes and enclosures with the help of Robertson Research International Ltd. so as to help potential investors get the back ground information on the hydrocarbon potentiality of the Eritrean Red Sea and adjacent coastal area. The Eritrean Red Sea basin, covering about 125,000 km^2, is underexplored, and offers attractive exploration opportunities in pre-rift (Mesozoic), syn-rift (Miocene) and post-rift (Late Miocene to Early Quaternary) sedimentary units.

Towards this end, the Ministry of Energy and Mines has announced an invitation to all interested International Oil Companies (IOCs) to apply for a Production Sharing Contract on, near and offshore acreage in Eritrea.

The Port of Massawa



Structural map of the Eritrean Red Sea.
after Savoyat et al, 1989

TECTONIC EVOLUTION OF THE ERITREAN RED SEA

Major rifting began in the Red Sea about 25-30 Ma ago in the Mid to Late Oligocene. Rifting was transtesional and involved block faulting with both normal and strike-slip faults, which generally trend NW-SE to NNW-SSE. By the Late Miocene – Early Pliocene, about 5 Ma ago, small pull-apart basins along the axis of the Red Sea and Gulf of Aden were developing oceanic crust. As extension continued, these coalesced to form a continuous strip of oceanic crust, and the passive margins seen today developed on the flanks of the deep-water axial trough.

STRATIGRAPHY AND SEDIMENTATION OF THE ERITREAN RED SEA

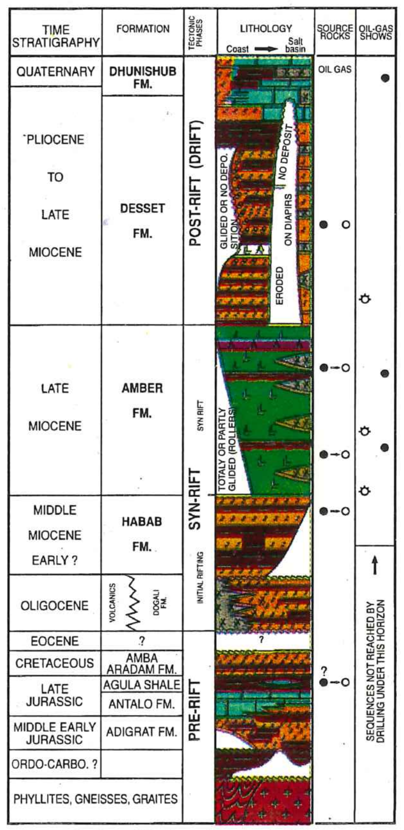
The Eritrean Red Sea stratigraphy can be divided into three megasequences: Pre-rift units deposited before the major rifting, Syn-rift units deposited during the major rifting of the Red Sea and Post-rift units deposited after the major faulting has ceased outside the axial trough.

Pre-rift Sequence

During the period of the Late Precambrian/Eocambrian, the Afro-Arabian craton was peneplaned and tilted to the north and east. Onto the eroded Precambrian / Eocambrian basement Complex was deposited a sequence of Middle to Upper Paleozoic glacial deposits and the Upper Paleozoic to Mesozoic sequence of the continental Nubia Group. Mesozoic rifting in central Sudan, Kenya, Ethiopia and Eritrea allowed the accumulation of a thick sequence of marine to fluvio-lacustrine shales and sandstones, partially time equivalent to the Nubia. Deposition of marine shales and carbonates and of more marginal sandstones continued through the Mesozoic and into Cenozoic forming the Eritrean and Ethiopian Adigrat, Antalo, Agula Shale and Amba-Aradom Formations of Jurassic and Cretaceous ages.

Rift Sequences

Pre-rift arching and break-apart of the continental crust of the Afro-Arabian shield during Oligo-Miocene times led to the formation of the Red Sea in its present shape, with its marked block faulting on the flanks and strong subsidence in its central part.



Tectono-Stratigraphic chart of the Eritrean Red Sea

Sedimentation into the newly subsident Gulf of Suez-Red Sea graben commenced with fluviatile-lacustrine sandstones and shales of the Dogali Formation which were accompanied by an outpouring of Oligo-Miocene basalts. This earliest syn-rift sequence was followed by the fine and coarse clastics of the shallow marine Lower to Middle Miocene Habab Formation. Restriction of the Gulf of Suez-Red Sea system led to the deposition of the evaporitic / clastic /carbonate sequences of the Belayim Formation of the Gulf of Suez and the top most Habab Formation of the Eritrean Red Sea. Finally the Gulf of Suez-Red Sea Graben desiccated completely and the thick halites of the South Gharib (Gulf of Suez) and Amber Formations (Eritrean Red Sea) were deposited. Rifting continued throughout the latest Miocene, accompanied by horst-graben faulting and consequent fault block rotation.

Post-rift (drift) Sequence

Post-rift stage is marked by the separation of continental blocks and the generation of the oceanic crust in the axial trough. This stage resulted in an important subsidence during Upper Miocene – Quaternary time, with the Desset and Dhunishub Formations developed in the Coastal basin and restricted depocenters of the salt basin.

HYDROCARBON POTENTIAL OF THE RED SEA

The hydrocarbon potential of the Eritrean Red Sea is not known to date. However, oil exploration in the different countries, which have jurisdiction over certain portion of the Red Sea, indicate that there is a possibility of discovering commercial hydrocarbon resources.

There are two oil fields in the Red Sea; both located at its north most margins. Hurghada Field, in the Egyptian Sector, was discovered in 1913 and produced 22° API oil until 1969 at rates of up to 5000 BOPD. Recoverable reserves have been estimated at 44 MMSTBO. Barqan Field located in the Saudi Arabian sector in approximately 180′ of water. Barqan was discovered by Auxerap-Tenneco in 1969 and has tested hydrocarbons from sandstones at approximately 2000m within the Lower Miocene Habab Formation (Barquan-2 flowed gas and condensate at rates of between 11.6 and 100 MMCFGD and 650 BCPD). Halbouty (1970) places reserves at up to 3.5 TCF of gas and up to 500 MMSTB of condensate.

In the Sudanese Red Sea two discoveries have been made. The Suakin-1 gas-condensate discovery flowed 1158 BCFPD, 52°API and 6.9 MMCFGD from 28′ thick sandstone in the uppermost Amber/lowermost Desset formation of uppermost Miocene age. The Bashayer-1A also tested hydrocarbons.

HYDROCARBON POTENTIAL OF THE ERITREAN RED SEA

From the very limited exploration activities carried out in the Eritrean Red Sea encouraging results have been obtained. A number of prospects have been identified both in the syn-rift and post-rift formations. Hydrocarbon shows have been observed in both post-rift and syn-rift units. These include gas shows in Desset Formation in Secca-Fawn-1 well, Oil and gas shows in Amber Formation in the Adal-1 and 2, Suri-1, Dhunishub-1, Amber-1 and B-1 wells and gas show in the boundary between Amber and Habab Formations in Secca-Fawn-1 and C-1 wells. The 55-day blowout of well C-1 which occurred at 9865′ is the most important occurrence in the Eritrean Red Sea. The zone was not cored, tested or logged. The blowout zone is interbedded in the lower part of the massive salt or located at the top of Habab. The gas consists of C1(91%), C2(5.5%), C3 (2%) and C4 (1.5%) hydrocarbons, combined with small amount of distillate, and was produced at an estimated pressure of 7700 psi and volume of 5-20 MMCFGD. Gas shows were recorded at the Secca Fawn-1 well in the Amber Formation near TD. Oil and gas shows were also recorded at one of the recent wells – Bulissar #1.

Flat spots have been observed in some of the seismic lines. Moreover, several surface oil seepages were recorded in the reefal limestone of Dhunishub Formation, on Dahlac Island and along the Eritrean Coast north of Massawa and Defnin Islands.

Source Rocks

Oil and gas seeps on and around Dahlac Islands, as well as oil impregnated sands on Difnein Island and the Red Sea Coastline of Eritrea are conclusive proof that hydrocarbon generating systems are or have been working in this area. Shows encountered during drilling have confirmed this.

The Late Jurassic organic rich shales and marls of the Antalo limestone and Agula Shale represent the pre-rift potential source rocks.

The results of rock eval analysis revealed several organic rich horizons in a number of offshore Eritrean wells in both syn-rift Habab and Amber Formations. Some intervals with fair to good TOC were encountered in wells J-1 and Thio-1. A 305 m thick source rock within the syn-rift sediments with a TOC of 3 to 8.65 kg HC/tone, kerogen type II, oil prone source rock was encountered in well J-1.

BEICIP had predicted, from the results of seismic interpretation, the presence of shaley inter-beds displaying the qualities of source rock within Desset Formation. This prediction has been proved by the recent wells drilled by Anadarko Petroleum Corporation. The wells encountered alternating layers of salt and shales which are highly quality source rocks.

Maturity

Geothermal gradients in the Eritrean Red Sea vary from 2.56 ^{0}C/100m in Du Rig Rig #1 well to 6.18 °C /100m in well Secca-Fawn-1.

Savoyat et al. (1989) has calculated geothermal gradients using corrected log-derived bottom hole temperatures. Regionally, geothermal gradient shows a tendency to increase form the Red Sea rift margins to its center (Axial trough). However, geothermal gradients measured at a point location are probably local phenomena and are affected by local salt tectonism and structural setting. Thus, the geothermal gradient maps prepared with only eleven wells' data in such a vast area can not be reliable.

The highest geothermal gradients are found in wells with volcanic intercalation within the syn-rift or post-rift sequences, e.g. B-1 has volcanics within the Amber Formation which appear to be related to volcanism in the axial trough. Secca Fawn-1 has volcanics in the Desset Formation which may be related to normal faulting between the Danakil block and the salt basin.

The geothermal gradient is affected by the type of sedimentary fill, especially by salt and anhydrite which have high conductivities, e.g. Amber-1 has a modest geothermal gradient even though it has high heat flux.

Of the five wells analyzed for thermal maturity, three (MN-1, J-1 and Thio-1) enter the oil window in the middle or lower Habab, while the other two (Secca Fawn-1 and C-1) enter the oil window in the Desset and Amber Formations respectively. Wells closer to the Axial trough which have not been analyzed for thermal maturity (Amber-1, B-1 and Dunshb-1) have evidence, in the form of shows, that the Amber Formation is in the oil window.

Reservoir Rocks

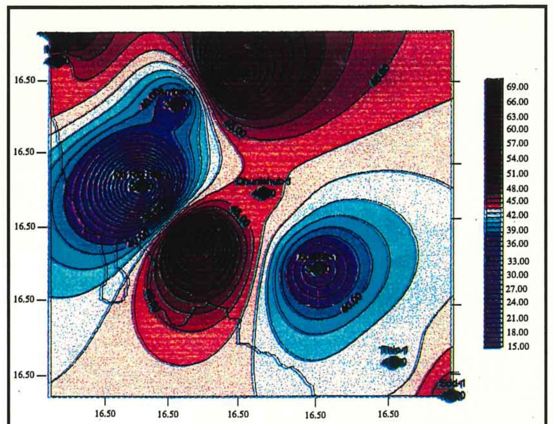
The main potential reservoirs in the Eritrean Red Sea are in clastic successions, but potential carbonate reservoirs have also been identified. Potential reservoirs occur in all three megasequences.

Pre-rift:

All potential pre-rift reservoirs are unproved by drilling in the offshore, but are likely to occur on the downdip areas of tilted fault blocks, where they have avoided erosion. They include the fluvio-glacial sandstones of the Paleozoic Enticho sandstone, fluvio-deltaic to shallow marine sandstones of the Jurassic Adigrat sandstone and fluvial sandstones of the Cretaceous Amba Aradom sandstone. Potential reservoirs may also occur in the Jurassic Antalo Limestone, especially where it is fractured and/or dolomitised. Of these potential reservoirs, the best are likely to be in the Adigrat sandstone, which has good porosity when seen at outcrop.

Syn-rift:

Potential syn-rift reservoirs occur both in the pre-salt Habab and Dogali Formations and in the salt-bearing Amber Formation.



TEMPERATURE GRADIENT MAP OF THE ERITREAN RED SEA

Legend

Thio-1

4■80 Well location and temperature gradient value in °C/km.

Contour interval 1°C/km

Sandstones in the transgressive Habab Formation are generally thin, and the sandstones commonly contain a high proportion of volcanic fragments. However, some thicker sandstones (20-60m) occur locally (e.g. in well J-1) and these have average porosities of approximately 14%. A blowout in well C-1 is thought to have been from sand near the top of the Habab Formation. At outcrop, the laterally equivalent Dogali Formation includes texturally and mineralogically mature lenticular sandstones, which are likely to have good reservoir quality. The overlying Amber Formation is dominated by evaporates, but also includes marginal clastics, which may have extended further into the basin during periods of evaporative drawdown. These clastics are likely to include fluvial, eolian and beach sandstones, some of which are likely to have good initial reservoir quality. The associated salt will form good intraformational seals, but it may also have led to the cementation of some of the sandstones by evaporite minerals. Sandstones of possible Amber Formation age may also occur in topographic lows on the top surface of the salt.

Post-rift:

The transgressive Desset Formation contains continental sediments near its base, which may have lenticular geometry. They have good interpreted log porosity (12-13%, possibly exaggerated due to caving problems). These lower sandstones are likely to extend further into the basin than higher sandstones. The laterally equivalent and overlying Dhunishub Formation consists mainly of limestones, with sandstones in the more proximal (i.e. western) areas. The limestones include local reefal limestones. Due to its shallowness, sealing may be a problem for potential reservoirs in the Dhunishub Formation.

Seal

For the pre-rift reservoirs Agula shale, the Upper Habab (silts and shales) and where the pre-rift succession has been intensively eroded the Upper Miocene evaporites can be good seals.

Amber salt can provide good reservoir seal for the underlying Habab and the intra-salt sand lens reservoirs.

Locally Upper Desset Formation could serve as seal for Upper Amber and Lower Desset Formations. The reef buildups in the Dhunishub Formation are also important seals.

Although liquid hydrocarbon seeps are quite widespread at the surface, both on and offshore of the Red Sea, and in particular of the Eritrean Red Sea, these seepages do not necessarily indicate widespread leakage from subsurface reservoirs. They could easily originate from organically rich, near surface intra-evaporite shales, heated quite locally by thermal conductivity through salt stocks.

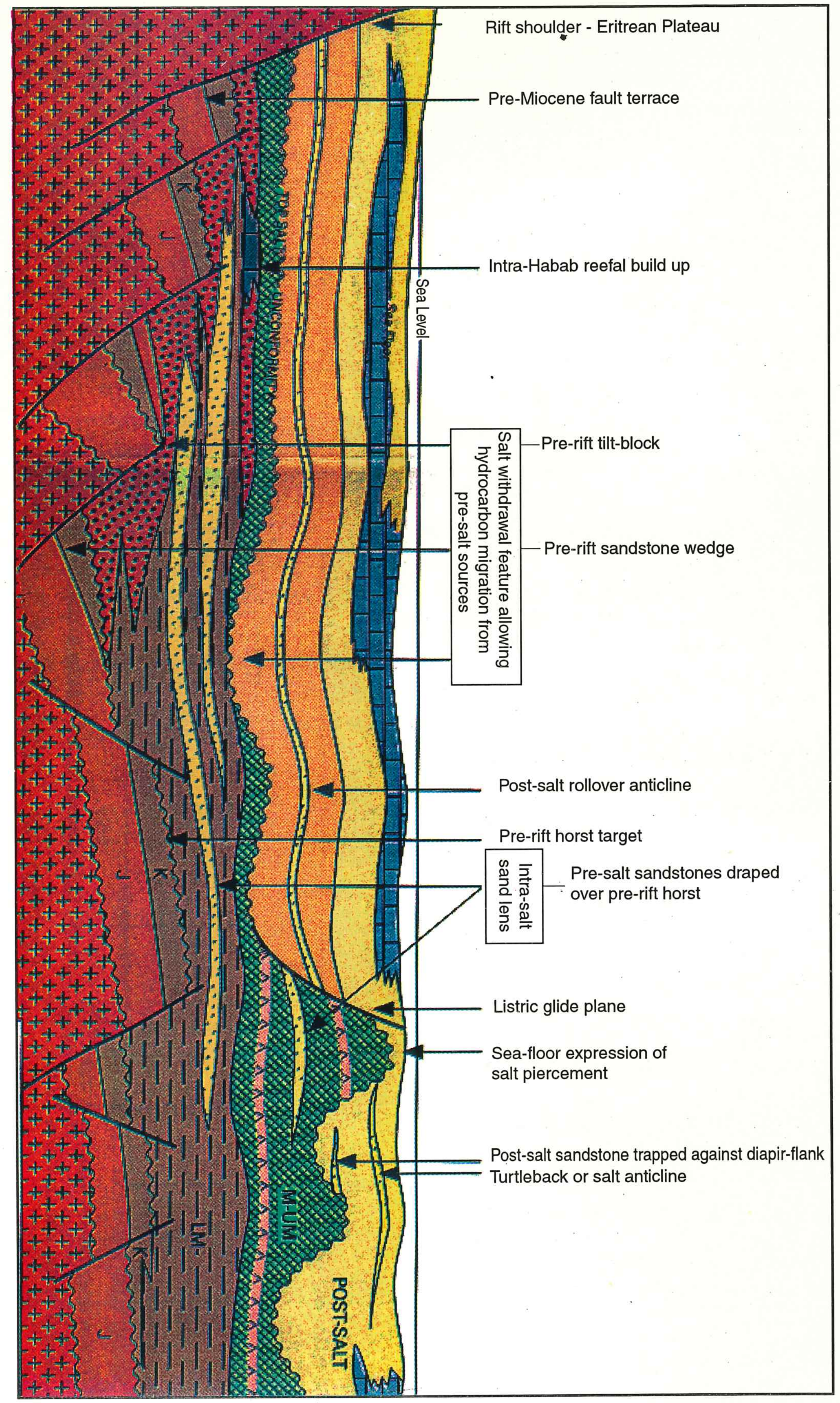
Trap styles

Two hydrocarbon play systems are clearly apparent, pre-and post-evaporite, and play types differ according to the system being targeted. Pre-evaporite of Suez, form the most attractive plays where geothermal gradients are moderate. Where increasing heat flow and higher sediment load generally result in an over-mature pre-evaporate section, maturation and halokinetic control of post-evaporite Miocene tilted fault blocks, similar to the Gulf sedimentation has resulted in a number of other play types.

Tilted fault blocks, rotated fault blocks, horsts and compactional drape are the most likely traps in both the pre-rift and syn-rift pre-salt units. Whereas structures related to the salt tectonics such as rollover anticlines, ramp anticlines, stratigraphic pinchouts, turtlebacks, salt diapirs and salt canopies or pillows prevalent in the salt basin are principal style traps for the post-rift units. Frequent glide planes and growth faults due to gravity tectonics are prominent along the basin borders, which could constitute likely traps in the post-rift units.

The facies changes in the syn-rift and post-rift units might also provide a possible stratigraphic trap. Moreover, regressive transgressive surfaces in the Mesozoic successions (pre-rift) and the regional Unconformity surface between the Mesozoic and rift sequences can also be considered as subordinate traps.

Schematic Cross Section showing Red Sea play types



MAJOR PROVISIONS OF MODEL PRODUCTION SHARING CONTRACT

Term of the Contract

The contract consists of exploration, development and production

- Exploration – up to 2 years with up to 4 years extension.
- Development and production – up to 25 years with up to 10 years extension.

Work Program

Minimum work program and expenditure obligations for each exploration period are negotiable.

Profit oil split

Negotiable, set on sliding scale calculated in calendar quarter on cumulative basis.

Cost recovery

Negotiable, sliding scale of daily production.

Royalty

Negotiable, sliding scale of daily production.

Income tax:

Thirty-five percent (35%).

Gas provision:

Good faith negotiations on gas discovery.

Customs:

A Contractor is entitled to import machinery and equipment necessary in operations, free of import duties, taxes, and imposts of any kind.

Export

A contractor is entitled to export petroleum produced free of export, duties taxes or imposts of any kind.

Foreign Exchange Control:

A Contractor can retain or dispose any funds out side Eritrea.

Stabilization clauses and Applicable law:

➢ The contract shall be construed under, governed by and interpreted in accordance with the laws of the State of Eritrea as of the effective Date.

➢ Economic benefit to be adjusted if affected by the promulgation of new laws and/or regulations of Eritrea.

➢ The capital expenditures of the Contractor as reflected in any facilities, discovered reserves, property, shall not be nationalized or confiscated, attached, seized, frozen, expropriated, or put under custody with out due process of law.

Resolution of dispute

Any dispute, to the extent possible, will be resolved through negotiations. In the event the dispute is not settled through negotiations, it will be settled through binding arbitration.

Assignment

A Contractor may assign all or any part of his rights and interests to any technically and financially capable other person with the prior written consent of the Minister.

Summary of Exploration History in the Eritrean Red Sea

YEAR	EXPLORATION ACTIVITIES
1921	• Societa Mineraria dell' Africa Orientale (SMAO) drilled one exploration well on Bu el Issar Island.
1935-1940	• Agip conducted field geological surveys and then drilled 11 shallow exploration wells on Dahlac Island.
1946	• Ethiopian Government awarded Sinclair a concession over the whole country. In 1947, Sinclair decided to concentrate its activities in the Ogaden and ceased operations in the Eritrean Red Sea.
1958-1960	• NAFTAPLIN conducted geological, gravity and magnetic survey in the coastal area under contract to the Ethiopian government.
1962	• Mobil acquired offshore acreage in Eritrean Red Sea.
1964	• Mobil ran shallow penetration seismic survey; • Gulf acquired offshore acreage and shot seismic.
1965	• Gulf drilled Dhunshub-1 well.
1966	• Mobil drilled Amber-1 well and Exxon farmed into Mobil's acreage. • Baruch-Foster acquired acreage and acquired magnetics and seismic.
1968	• Oil Organization Ltd. (Later Ethiopian Oil Corporation) acquired acreage. • Gulf drilled Secca Fawn-1 well.
1969-1970	• Mobil drilled B-1 and C-1 wells. C-1 encountered gas blowout. • Mobil and Gulf completely relinquished acreage.
1973	• GAO drilled J-1 and MN-1 wells.
1974-1975	• Shell acquired offshore acreage and shot seismic survey.
1977	• Shell drilled Thio-1 well and then relinquished acreage.
1984	• Ethiopian Ministry of Mines and Energy (MME) conducted seismic survey near Sudan border.
1985	• BEICIP report completed under auspices of Ministry and World Bank.
1988	• IPC acquired acreage, Amoco farmed in.
1989	• BP/IFC acquired acreage, shot seismic, shipborne gravity and ALF survey.
1990	• BP/IFC relinquish – Force Majeure.
1990-1991	• UNDP/World Bank Red Sea regional hydrocarbon project evaluated previously available data and prepared a report.
1995-1996	• Anadarko acquired acreage (Zula Block) and conducted aerogravity and aeromagnetics. • Ministry of Energy and Mines compiled all the existing reports with the help of Robertson Research International Ltd.
1997	• Anadarko conducted seismic survey. • Ministry of Energy and Mines of the State of Eritrea conducted seismic survey in the southern part of Eritrean Red Sea. • Anadarko acquired another acreage (Edd block) to the south of its first acreage. • Agip farmed in both Blocks.
1998-1999	• Burlington Resources farmed in both Blocks. • Anadarko drilled Bulissar #1 and Du Rig Rig #1 wells in Zula Block and Edd #1 on the Edd Block. • Anadarko relinquished both Zula and Edd blocks on December 31st 1999.
2000	• The Government of the State of Eritrea reduced the petroleum income tax to 35 %.