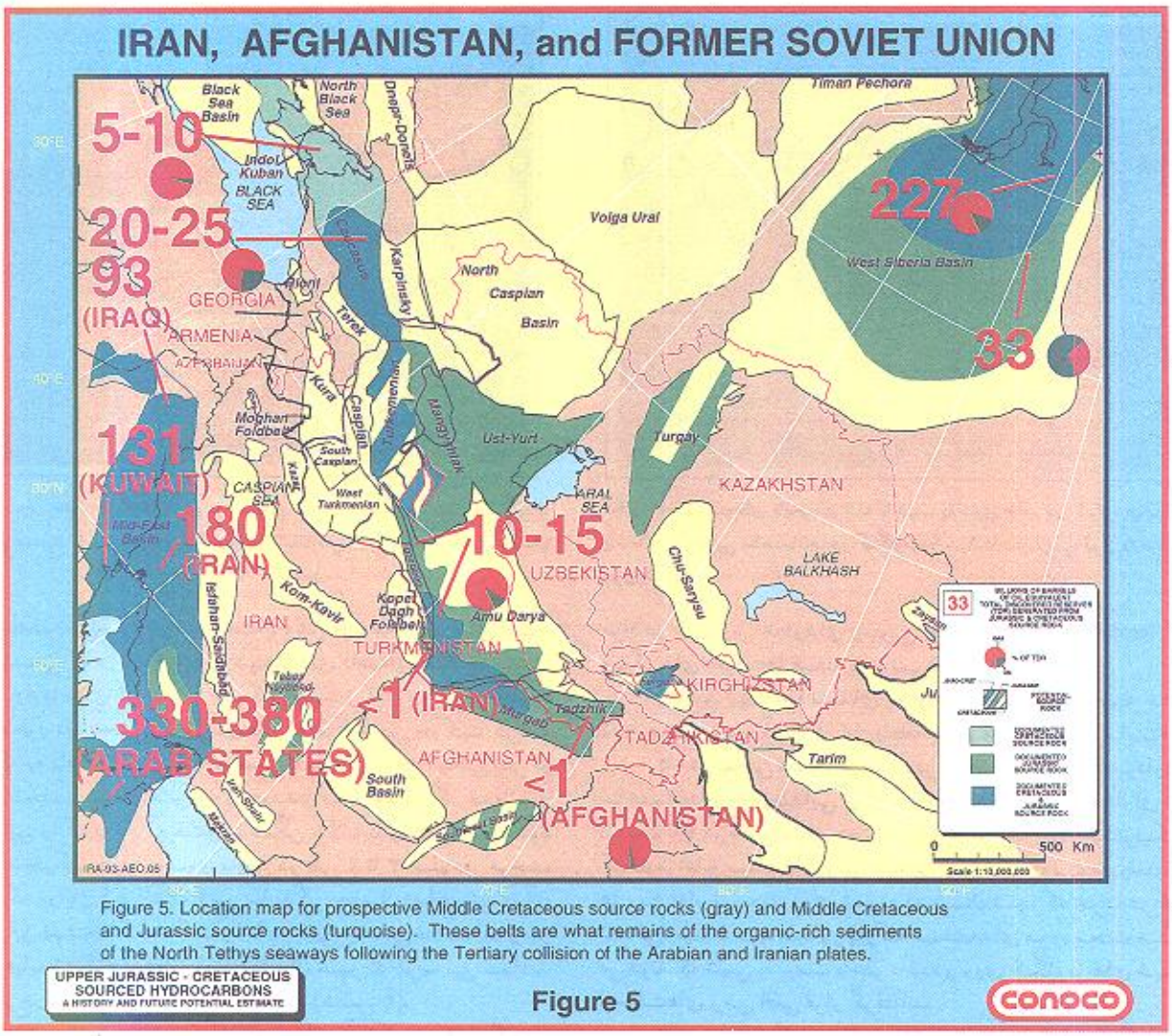

Figure 5. Location map for prospective Middle Cretaceous source rocks (gray) and Middle Cretaceous and Jurassic source rocks (turquoise). These belts are what remains of the organic-rich sediments of the North Tethys seaways following the Tertiary collision of the Arabian and Iranian plates.

UPPER JURASSIC - CRETACEOUS SOURCED HYDROCARBONS
A HISTORY AND FUTURE POTENTIAL ESTIMATE

Figure 5

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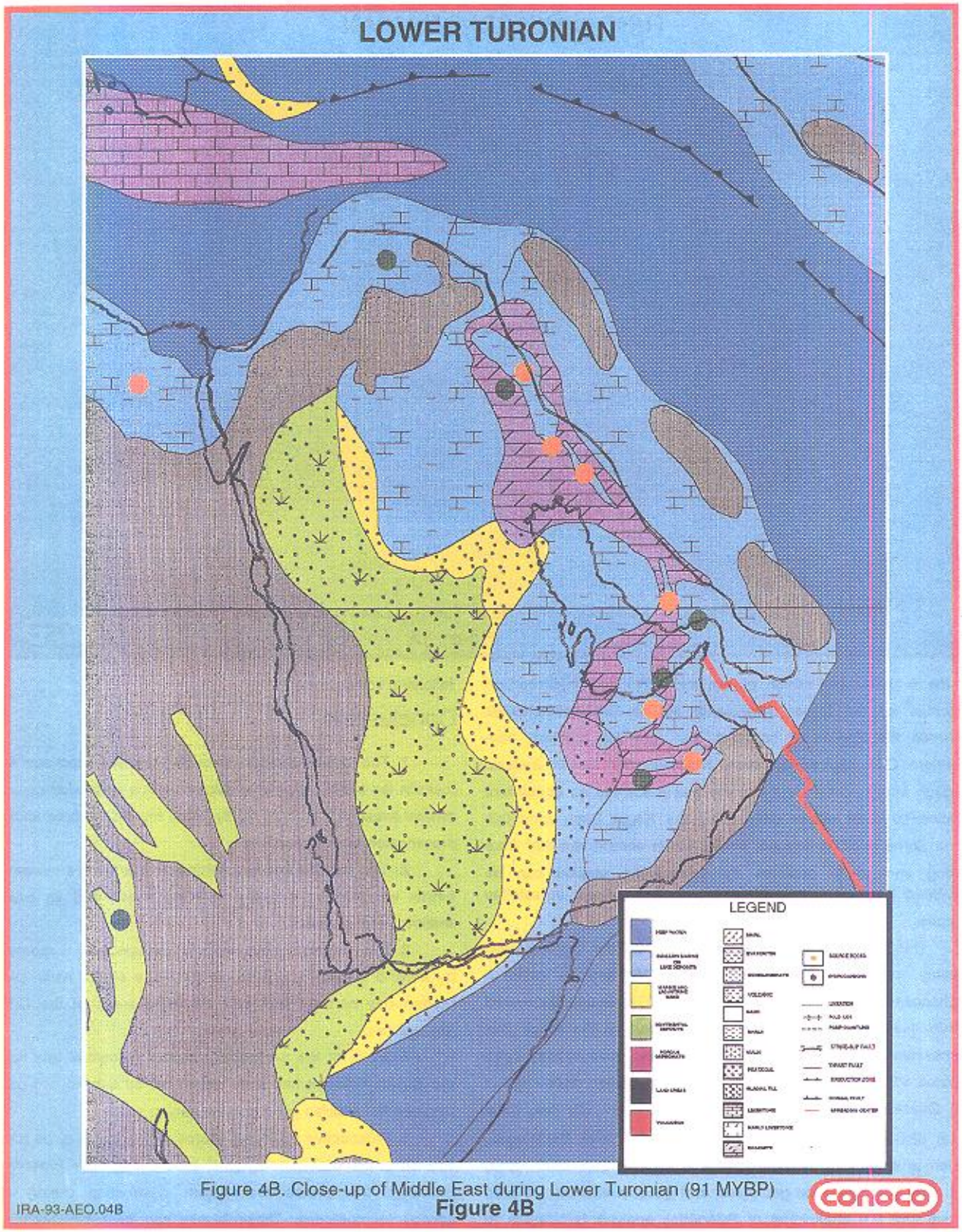


Figure 4B. Close-up of Middle East during Lower Turonian (91 MYBP)
Figure 4B

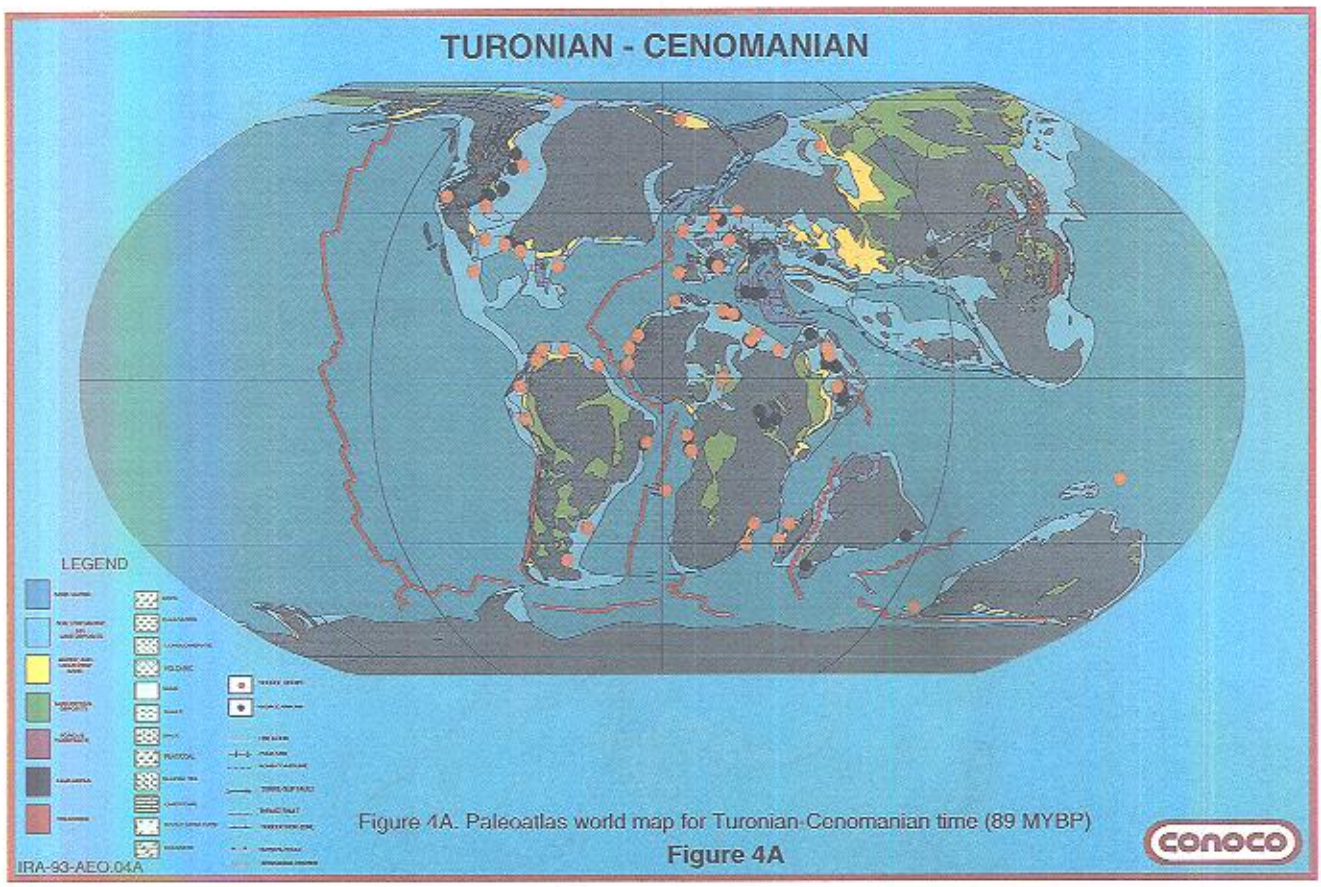


Figure 4A. Paleoatlas world map for Turonian-Cenomanian time (89 MYBP)

Figure 4A

of the Arabian and Iranian plates, such that little hydrocarbon potential for the Upper Jurassic or Middle Cretaceous exists between the Zagros of southern Iran and the northern Iran-southern CIS- Afghanistan area. However, the Upper Jurassic through Middle Cretaceous seaway was preserved on competent continental crust edges defined by the Kopet Dagh mountain front. Some microcontinental blocks within central Iran that were strong enough to preserve the prospective section can be identified by regional gravity and magnetic surveys or satellite images.

The prospectivity of the area that was the North Tethys seaway, stretching from modern- day Moldova to northern Afghanistan, is highlighted by the 35- 40 BBOE already discovered within this vast region. In the northern part of the Black Sea somewhere between 5 and 10 BBOE in gas have already been discovered; 20 to 25 BBOE, mostly gas, have been discovered in the Caucasus range, and 10-15 BBOE, again mostly gas, have been discovered in the East Caspian- Amu Darya Basin area, which is shared by northern Iran's Khangiran field basin area. Thus, by combining the geological and geochemical factors cited above and the application of PaleoAtlas analysis techniques to review and overlay source and reservoir fairways, we come to the following conclusions:

Conclusions

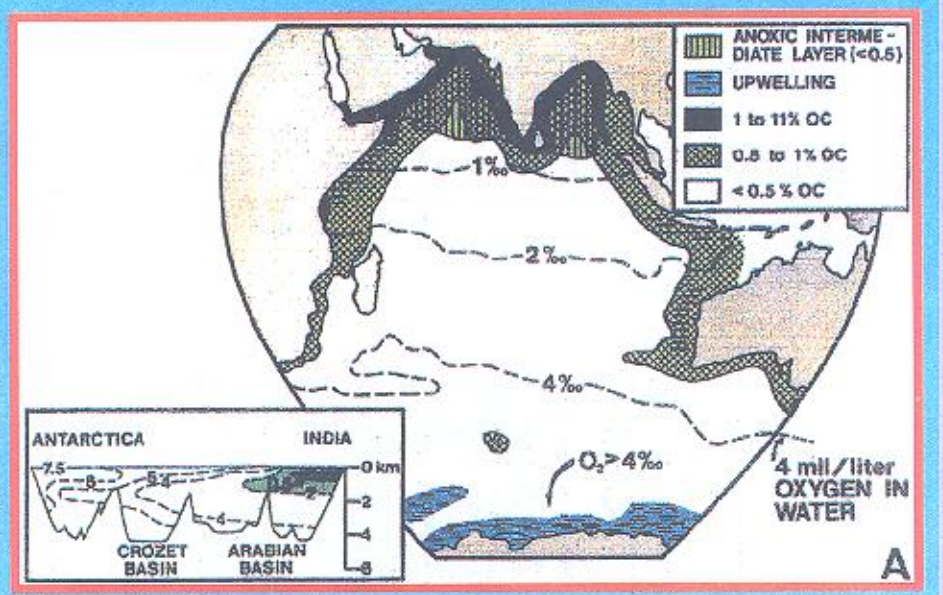
1. The Upper Jurassic through Middle Cretaceous source rocks in the Middle East were deposited in a worldwide network of coastal seaways that were highly prone toward the production and preservation of organic carbon.

2. The Middle Eastern portion of the Tethys seaway was further enriched by a partly restricted ocean and an extensive shallow water platform.

3. The northern Tethys region of prospectivity is represented by a band of basins located on the edge of the Asian plate in modern-day northern Iran and adjoining areas of the CIS and Afghanistan.

4. Much of the prospective section in central Iran north of the Zagros Foldbelt has been destroyed by subsequent collision between the Arabian plate and the Iranian plates.

5. Prospective Mesozoic source rock areas may be found in Iran on small, stable continental blocks that have preserved or protected the source rocks from destruction during recent continental collisions. These blocks can best be identified on regional gravity, magnetic or satellite imagery.



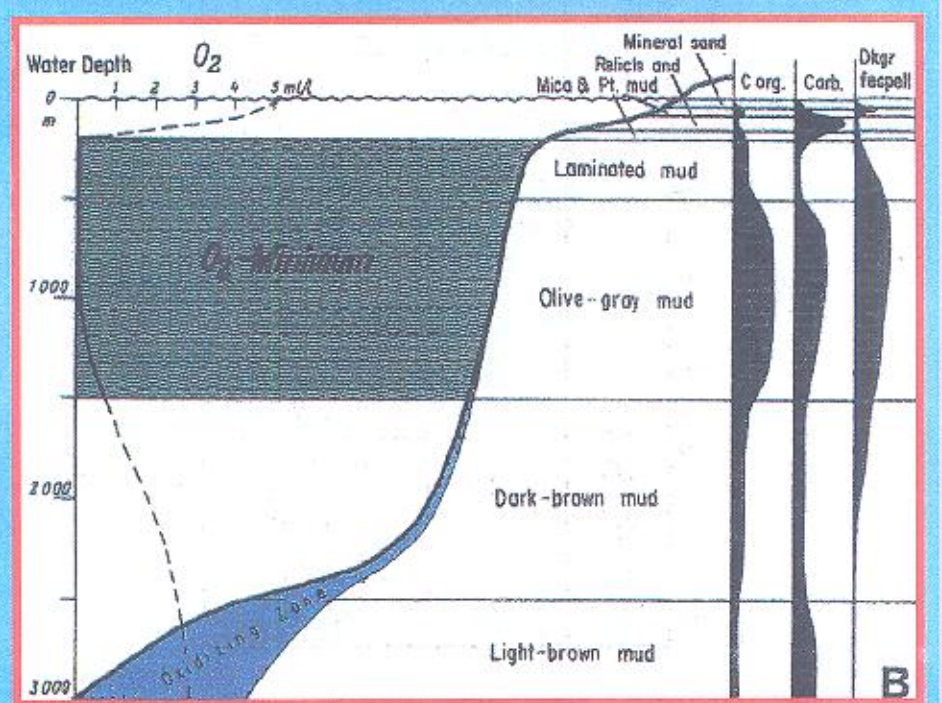


Figure 3A. TOC map of Indian Ocean.
3B. Diagrammatic profile of anoxic Ocean basin conditions (note the impingement of oxygen minimum zones. *From Demaison & Moore, 1980*).

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Figure 3

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PALEOATLAS SOURCEROCK INTERVALS
MESOZOIC

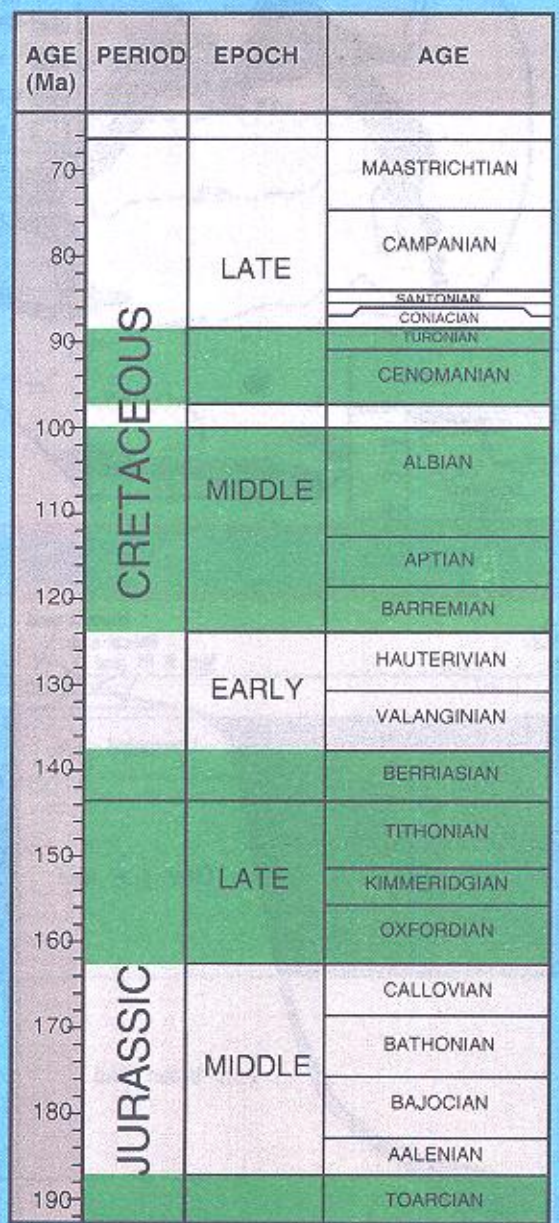

Figure 2. Four of the most petroliferous episodes in geological history. These intervals, from Toarcian through Turonian, have thus far yielded 56% of the world's discovered 2.5 trillion BOE, yet compromise only 9% of the Phanerozoic time.

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Figure 2

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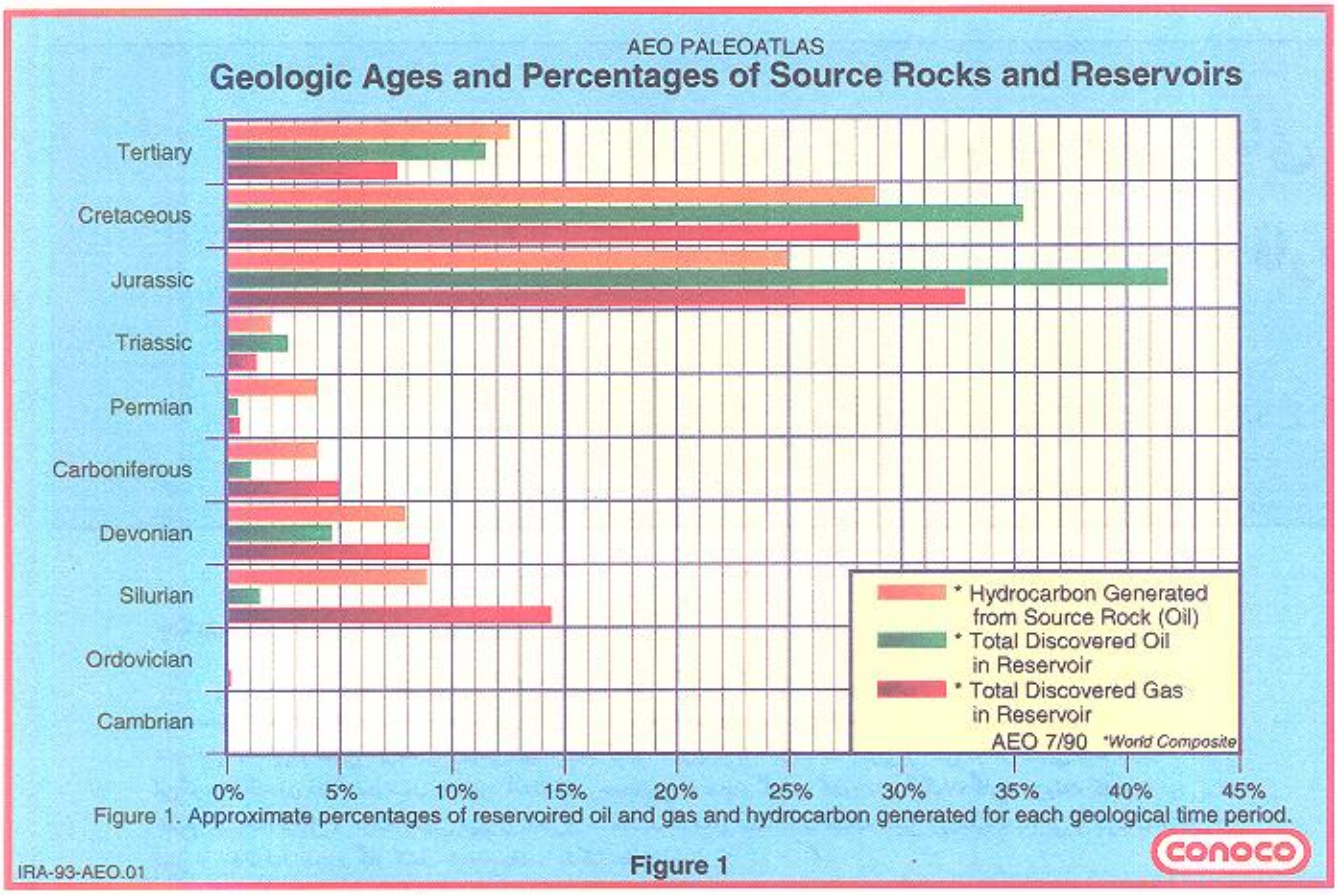

Figure 1

lithologies and continents during Turonian- Cenomanian time (89 Mybp). This map, and the companion Middle Eastern closeup (Fig. 4B) display the principles behind this study- that is, during certain intervals of time, organics were deposited and preserved in all ocean basins in response to climate, latitude, wind direction, upwelling, and other mechanisms. Little- known rich organic areas occur even in the South Atlantic, yielding commercial oil production from each of the two locations where the Turonian lies in the oil window (the Ogooue Delta in Gabon and the Zaire deep-sea fan in Zaire and Angola, where an aggregate 4.5 BBOR have been discovered to date). In the Caribbean area, the Venezuelan and Andean basins contain nearly 300 BBOR (both heavy and light) generated from Turonian source rocks. Other petroliferous basins with oils of this age include the Mexican Gulf Coast, several European basins, the Middle East (Sarvak/Shilaif/Ahmadi/Khatiyah anoxic facies), northwestern Siberia, and North Africa.

Amorphous/marine kerogens were abundant in the lower latitude zones, while simultaneously, woody/continental kerogens became more prominent in the higher latitudes. For example, Cretaceous forests in the paleo- tundra of western Siberia generated a high quality Type III kerogen which is a principal contributor to the vast gas deposits in the northern West Siberian basin and adjacent Kara Sea.

The principles learned from studying this Turonian time slice can be applied equally well to the Albian Khazdumi and its equivalents in the Middle Cretaceous seaways of North America, Siberia, South Atlantic, interior Australia, and China. Likewise, one could study the Upper Jurassic source rocks of Lurestan and Iraq; the Central North Sea Kimmeridgian; Gulf of Mexico Smackover; Northwest Shelf of Australia Upper Dingo; and the Wet Siberian Basin Bazhenov.

The northern Tethys is an obvious place to seek a mirror image of the Arabian Platform for the Upper Jurassic, Middle Cretaceous, or Upper Cretaceous (Turonian). In Figure 5 the ancient Tethys region is displayed in its present- day configuration. The petroliferous Jurassic and Cretaceous hydrocarbon generative basins are shown in various shades of green.

Those regions not resting on very firm, thick continental crust have been effectively destroyed by the most recent collisions

سنگ‌های منشأ نفت خاورمیانه و هم‌ارزهای آن در دیگر قاره‌ها

نوشته: دی. سی. فولی * و ان. ای. فورمن *

چکیده

سنگ‌های منشأ نفت خاورمیانه در آبراهه‌های دریایی نهشته گردیده که یک سیستم جهانی سنگ منشأ نفت را تشکیل داده‌اند. برای نمونه سنگ منشأ نفت حوضه رسوبی زاگرس که به نام احمدی- خطیه (سازند سروک) معروف است، در زمان تورونین- سنومانین در یکی از همین آبراهه‌های ارتباطی نهشته شده که از خاورمیانه تا آتلانتیک جنوبی و حتی نواحی قطبی ادامه داشته است. این گونه سنگ‌های منشأ نفت سبب به وجود آمدن مقادیر معتنابهی از نفت و گاز در کشورهای آنگولا، گابن، ونزوئلا، کلمبیا، تونس، خلیج مکزیک، برزیل و حوضه رسوبی سیبری باختری شده‌اند. سنگ‌های منشأ نفت مشابه باسن ژوراسیک بالایی و کرتاسه میانی بیش از ۵۰ درصد نفت و گاز کشف شده جهان را تشکیل داده‌اند.

امور اکتشاف پیشرو شرکت کونوکو سعی بر آن دارد نقاطی از جهان را که از نفت و گاز غنی هستند و تا کنون اکتشاف نشده‌اند، شناسایی نماید. به همین جهت و به دلیل اهمیت پژوهش‌های زمین‌شناسی منطقه‌ای در امر اکتشاف، امور اکتشاف شرکت کونوکو موفق به ابداع یک سیستم کامپیوتری شده که تهیه نقشه‌های زمین‌شناسی این آبراهه‌های ارتباطی نفت‌زای کلیه دوره‌های زمین‌شناسی را آسان نموده است.

بررسی نقاط شناخته شده نفت‌خیز دوره‌های مختلف زمین‌شناسی دنیا، این امکان را می‌دهد که به اهمیت نواحی غنی از نفت و گاز کشف نشده حوضه تتیس پی ببریم.

این نوشتار چگونگی به‌کارگیری این روش را برای شناسایی گستره‌های جدید غنی از نفت و گاز در حوضه‌های رسوبی تتیس کشورهای ایران، افغانستان و جمهوری‌های آسیای مرکزی به طور مشروح بیان می‌کند.

continental slope, which encourages organic preservation and effectively enriches the total organic carbon content of the zone containing continental slope muds. Figure 3A shows that the modern- day Indian Ocean, bounded on three sides by continents, is a partly restricted ocean basin featuring such an oxygen minimum zone. This oxygen minimum zone has reduced the marine oxygen content beyond that due to simple ocean basin restriction, allowing up to 11% organic carbon to be preserved along the continental edge of the Indian Ocean.

This Indian Ocean model is arguably a modern- day Tethys analog; however, applying this concept to hydrocarbon exploration requires that we reposition the continents as they were during Tethyan time. Only by so doing can we pinpoint the shorelines, deposystems and tectonic elements which determined source rock and reservoir depositional trends. With these concepts, we studied the possible extension of petroliferous Tethyan zones into central Iran and neighboring areas of Afghanistan and the CIS.

Global Turonian/Cenomanian Depositional Environments

Figure 4A shows the world's environments of deposition,

Middle East Source Rock Equivalents On Other Continents

By: D. C. Foley * and N. E. Foreman *

Abstract

Middle Eastern source rocks were deposited in interconnected coastal seaways that formed a global system of source rock provinces. For example, in the Turonian- Cenomanian the Zagros Basin's Ahmadi/Khatiyah source rock was deposited in a seaway that extended from the Middle East to the South Atlantic and even to the north polar regions. Source rocks deposited in this seaway have generated significant petroleium in Angola, Gabon, Venezuela, Colombia, Tunisia, the Gulf of Mexico, Brazil and the West Siberian Basin, among other areas. Upper Jurassic organic-rich beds were deposited in similar global seaways. Upper Jurassic and Middle Cretaceous source rocks such as these have generated more than 50% of the world's discovered petroleum reserves.

Conoco's Advance Exploration Organization focuses its efforts on identifying highly prospective, underexplored areas. Since regional geoscience research is required to support this work, we have created a computer system that facilitates mapping of global seaways for all of the world's major source- rock- rich time periods. Viewing the whole globe for any time in the geologic past allows us to project extensions of highly petroliferous geology, such as that of the ancient Tethyan realm, into underexplored areas. This study details usage of this methodology to identify high- potential new plays in the Tethyan basins of the southern republics of the Soviet Commonwealth, Iran, and Afghanistan.

Introduction

Conoco has in recent years combined the disciplines of plate tectonics, geochemistry, and sedimentology of organic facies to help select the richest underexplored basins remaining on the globe. The project, called PaleoAtlas, has produced 14 global maps, each representing a major source rock period. Each map displays the continental plates, coastal seaways, shallow water epicontinental seas, deltas, and other pertinent geologic data as they were situated then.

Explorationists first noticed that hydrocarbon source rocks concentrate in discrete time periods about 25 years ago (Fg.1). Since then, exploration in nearly all accessible basins has confirmed the preeminence of very "oily" time periods. Figure 2 focuses upon those Jurassic and Cretaceous oil-generating times (4 of the 14 oily time periods) which have yielded over half of th world's discovered hydrocarbons.

Even though each of the 14 time periods is predisposed by climate, sea level, ocean circulation, etc., toward organic productivity/ preservation, there are ocean basins within each time period that are richer than others. Figure 3B displays a likely geochemical explanation for particularly organic- rich ocean basins proposed by Demaison and Moore in 1980. They identified an oxygen- deficient layer within the ocean basins that onlaps the