overlying the trap are the factors necessary for the formation of a giant oil field. The five essential bodies—source bed, carrier bed, reservoir, trap, and cap rock—provided favorable geologic conditions that contributed to the formation of Daqing oil field.

2. Within the spatial assemblage, the favorable coordination among the geochemical conditions for the generation, expulsion, migration, and accumulation of oil and gas, and the stage of structure growth is obviously the key to the formation of a giant nonmarine oil field.

The vertical and lateral variations of properties of the crude oil in the main reservoir are discussed in detail. It has been determined that no differential accumulation ever occurred. Thus, it is possible for the huge space to receive great amounts of oil continuously and to form such a giant oilfield.

The formation processes of Daqing oil field provided an ideal model for the formation of a giant nonmarine oil field. The theoretical and practical investigation of this model and the analysis of the geologic and geochemical conditions for the formation of this kind of field, are of significance for understanding the formation regularities of giant nonmarine oil fields and are important for guiding exploration for oil and gas.

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Relationship of Vitrinite Reflectance to Heat-Flow History of North Sea

Vitrinite reflectance has been modeled for North Sea wells assuming that reflectance changes as a result of first-order chemical reactions. The Arrhenius equation is used to relate changes in the first-order rate constant to temperature, and is modified by including a term that allows the rate of a chemical reaction to exponentiate for every T_D increase in temperature above a "threshold" temperature of T_c. The approach treats time and temperature as knowns, deduced from thermal modeling and burial history, and tries to minimize the difference between calculated and measured reflectances by stepping through various values for the activation energy, E_a, scaling temperature, T_D, threshold temperature, T_c, and time varying heat flow, Q(t), using a nonlinear least-squares technique.

As a consequence of the modeling, we conclude that vitrinite reflectance can be modeled using an activation energy, threshold temperature, and scaling temperature of about 0.05 kcal/mole, 295°K, and 200°K, respectively. The model allows the prediction of depths and timing for oil generation in areas where the temperature history is known. Conversely, and significantly, an inverse approach can be taken whereby paleo-heat flow can be deduced from reflectance measurements. Applying this inverse approach in the North Sea has allowed us to determine its spatially varying heat flux over the last 100 m.y. or so, and also permits us to predict vitrinite reflectance with depth ahead of drilling operations.

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Geologic Framework, Evolutionary History, and Distribution of Hydrocarbon in Jizhong Depression

North China basin is a large Mesozoic to Cenozoic sedimentary basin in eastern China. A result of strong block-faulting activities, the inner part of the basin reveals the characteristics of multiple uplifts and depressions. Each depression is generally an independent exploration unit.

The practice of exploration in recent years has proved the following: taking each depression as an individual unit, the basic geologic framework and evolutionary history are quickly determined. This is very important in order to achieve the best effects in petroleum exploration.

Jizhong depression is located at the western part of the North China basin. This area is about 25,000 km^2 (9,650 mi^2). Extensive seismic surveys and several hundred exploration wells have been completed during the past few years, resulting in the discovery of Renqiu and other oil fields. Taking the Jizhong depression as an example, the writer has considered the four following problems.

1. *Pre-Tertiary fault blocks and their distributional form.*—There are 11 primary fault blocks in the Jizhong depression. They are all the result of Himalayan movement, but they are obviously subjected to the effects of the structure lines of Yenshan stage.

2. *Some characteristics of block-faulting activities.*—At present, most geologists think that the eastern part of the Eurasian plate, where the Jizhong depression lies, is subject to the effect of subduction of the Pacific plate, which was first compressed and uplifted in Late Jurassic and Early Cretaceous times and then fractured and sagged in Late Cretaceous and early Tertiary. The writer, considers Tertiary block-faulting activities with characteristics of pulsation, through analysis of fault-block development of the Jizhong depression. This analysis follows the generation, development, and extinction of the faults in the depression. The result is that pre-Tertiary blocks are known to have experienced many processes of disruption and union. Because the active period of each fault is at a different time, the main periods of disruption and union in the different parts of the depression are also varied.

3. *Block-faulting in relation to the controlling of Tertiary sediments and structures.*—Block-faulting activities controlled the differences in source area and depositional center, giving rise to regional climatic differences and leaving clear and definitive time marks in the sedimentary bodies. In the Jizhong depression, each stage has its own special sedimentary formations. By analysis of the main faults and main structures, we may make a conclusion which is somewhat different from that previously accepted--that the block-faulting activities in this area may have formed either tensile structure or compressive and compressive-shear structures. Both of these structures contain petroleum.

4. *The types of oil and/or gas pools.*—Based on the analysis of the geoframework and evolution of the depression, there should be three main types of oil or gas pools: (a) Tertiary oil (gas) stored in Tertiary reservoirs; (b) Tertiary oil (gas) stored in older reservoirs (i.e., buried-hill oil or gas pools); and (c) sub-Sinian and early Paleozoic oil or gas stored in reservoirs of the same age.

In the future, the exploration of the buried-hill gas or oil pools will continue. This should expedite the exploration for the other two types of oil or gas pools. In addition, we should pay much attention to exploration for Tertiary stratigraphic-lithologic oil or gas pools.

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Hydrocarbon Potential of Newark Rift System, Eastern North America

Rift basins contain only 5% of the earth's sedimentary volume yet yield 10% of the world's hydrocarbon production. They consist of graben, half-graben, tilted fault blocks, and synclinal downwarps and are commonly preserved along continental margins. The Newark rift system represents the sediments preserved

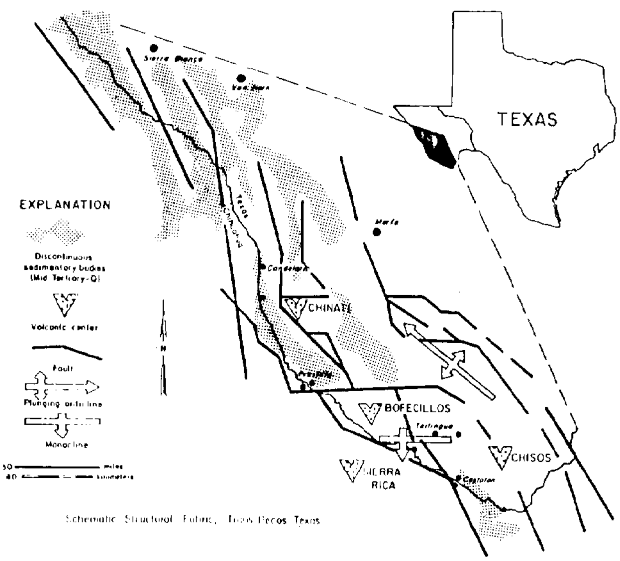
along the eastern seaboard which were deposited during the Triassic-Jurassic rifting of Pangea.

Continental rifting creates a linear series of tectonic depressions which form rift valleys. Commonly, these valleys are ponded, yielding long, narrow, deep lakes. The best modern example of this geologic setting is the East Africa rift system. Lake Tanganyika is 300 mi (483 km) long, 40 mi (64 km) wide and as deep as 4,000 ft (1,220 m). A fluviolacustrine depositional system is developed here where deltaic, littoral, shallow lake, and deep lake facies are well defined. Drastically fluctuating lake levels cause cyclic onlap and offlap resulting in a finely bedded stratigraphic section. The interfingering of these facies conveniently create a favorable source (deep lake) and reservoir (littoral, deltaic) relationship.

The lakes in rift valleys support prolific biologic ecosystems. The equatorial lakes are thermally stratified inducing anoxic conditions which preserve the organic material raining down from the surface. East African lake-bottom sediments often exceed 10% TOC. Some organic rift lake shales from the Cabinda basin contain more than 20% TOC. The Green River formation lake shales contain as much as 40% TOC. The Newark shales contain between 2 and 35% TOC and are up to 4,000 ft (1,220 m) thick. The shales from these basins often qualify as oil shales. The quantities cited are well above the general requirements for legitimate hydrocarbon source rocks.

There are other rift systems, analogous to the Newark rift system, that produce significant quantities of hydrocarbons. The Cabinda, Angola, and the Reconcavo (Brazil) basins of the southern hemisphere combined produce nearly 200,000 BOPD and have total recoverable reserves in excess of 2 billion bbl. There is notable production from rift basins in Australia, the southern North Sea, the Rhine graben, and China. Reservoir rocks are fluviolacustrine, deltaic, and alluvial siliciclastics, fractured shales, freshwater carbonates, intrusives, and turbidites. Attractive reservoir sandstones with up to 25% porosity are documented in the Newark basins.

The Newark rift system remains essentially unexplored. The archaic theory that "oil does not occur in continental settings" has stifled exploration. There have been encouraging signs. Oil has been recovered from the Richmond basin, a major discovery was made in the Triassic rift sediments of western Morocco in 1981, and significant oil and gas shows were found in the buried Georgia rift basin. Obviously the Newark rift system needs to be reevaluated. The current state of knowledge indicates that all of the necessary criteria of oil and gas generation and accumulation have been met. These basins warrant a thorough investigation.



(Figure for Stevens abstract, page 592).