flanks of channel-margin bars; passing upward into argillaceous sands of flood-plain origin. The channels which produced this sequence were up to 45 m deep and many hundreds of meters wide. Where they eroded and reworked the preexisting sedimentary pile, apparently along discrete meander-belt trends, they left behind a sand-dominated sequence that today constitutes some of the thickest and richest oil pay zones in the entire deposit.

MURRIS, ROELOF J., Shell Internationale Petroleum Maatschappij B.V., The Hague, Netherlands

Middle East—Stratigraphic Evolution and Oil Habitat

The post-Hercynian sequence of the Middle East is dominated by carbonate sedimentation on a stable platform flanked on the northeast by the Tethys ocean. Two principal types of depositional systems alternated in time: (1) ramp-type mixed carbonate-clastic units and (2) differentiated carbonate shelves. The first type was deposited during regressive conditions, when clastics were brought into the basin and resulted in "layer-cake" formations. The second type was formed during transgressive periods and is dominated by carbonate cycles separated by lithoclines, time-transgressive submarine lithified surfaces. Differentiation is marked, with starved euxinic basins separated by high-energy margins from carbonate-evaporite platforms.

The tectonic development of the Middle East can be divided into several stages. The first stage, which ended with the Turonian, was characterized by very stable platform conditions. Three types of positive elements were dominant: (1) broad regional paleohighs; (2) horsts and tilted fault blocks trending NNE-SSW; and (3) salt domes. All three influenced deposition through synsedimentary growth. The subsequent stage, from Turonian to Maestrichtian, was one of orogenic activity, with the formation of a foredeep along the Tethys margin and subsequent ophiolite-radiolarite nappe emplacement. From the Late Cretaceous to the Miocene, the platform regained its stability, only to lose it again at the close of the Tertiary, when the last Alpine orogenic phase affected the region, creating the Zagros anticlinal traps.

Source rocks were formed in the starved basins during the transgressive periods. Marginal mounds, rudist banks, oolite bars and sheets, and regressive sandstones form the main reservoirs. Supratidal evaporites and regressive shales are the regional seals. The spatial arrangement of these elements and the development of source maturity through time explain the observed distribution of the oil and gas fields.

The Middle Jurassic to Albian sequence in the central part of the Gulf, around the Qatar Peninsula, provides a well-studied example of the control on oil distribution by the distribution in space and time of mature source beds, effective regional seals, and reservoirs. Oil, tar, and extract typing as well as maturation studies show that the Upper Jurassic Hanifa bituminous limestone is the source for the oil and tar in the Jurassic as well as the Lower Cretaceous reservoirs, the latter reservoirs being only charged where the intervening regional Hith seal is either absent through nondeposition or is breached through faulting. Growth structures draining mature Hanifa kitchens contain sizable accumulations, whereas the Jurassic and Cretaceous reservoirs of the large Qatar dome contain only minor amounts of oil, which can be ascribed to insufficient source maturity and too late closure.

Geochemical and geologic evidence indicates that the tar mats present at the base of many oil accumulations are not the result of biodegradation or early, immature expulsion from the source, but probably the product of gas deasphalting of reservoired oil.

SALVADOR, AMOS, Univ. Texas at Austin, Austin, TX

Late Triassic-Jurassic Paleogeography and Origin of Gulf of Mexico

A step-by-step reconstruction of the paleogeography of the Gulf of Mexico and surrounding areas suggests that the basic structural and stratigraphic framework of the region was established by events during the Late Triassic and the Jurassic. Cretaceous and Tertiary events only accentuated and modified this framework. During the Late Triassic and Early Jurassic, continental conditions prevailed over most of the southern part of the North American plate. Marine deposition was restricted to parts of western and central Mexico that were covered by embayments of the Pacific Ocean. As the supercontinent of Pangea began to crack and break up in the Late Triassic and as the North American plate started to separate from the South American and African plates, tensional grabens began to form. They were filled with red beds and volcanic rocks.

It was not until late in the Middle Jurassic (Callovian) that Pacific marine waters began to reach the Gulf of Mexico area across central Mexico. These marine waters flooded intermittently the preexisting grabens and, between floods, evaporated to produce extensive salt deposits (Louann Salt). The salt varied markedly in thickness according to the rate of subsidence in the grabens. Little or no salt was formed in the intervening high areas. During the Late Jurassic, marine waters from the Pacific progressively covered an increasingly large part of the Gulf of Mexico and surrounding areas as a result of continued subsidence, sea-level rise, or both. Connection with the Atlantic, however, was not established until late Kimmeridgian or Tithonian time.

On the basis of these paleogeographic data, it is possible to speculate that in the Late Triassic and Early Jurassic the Yucatan continental block was located roughly 300 km north-northwest of its present position, and that it was a part of the large North American plate. As the North American plate began to drift northwestward, the Yucatan block seems to have been "left behind." The separation of the Yucatan block from the main North American plate probably started in the Late Triassic, continued slowly and sporadically during the Early and Middle Jurassic, and quickened after the formation of the extensive Callovian salt deposits. By the close of the Oxfordian the Yucatan block had reached essentially its present position, and the Gulf of Mexico had been born.

AAPG RESEARCH CONFERENCE

Temperature Environment of Oil and Gas

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WM. H. ROBERTS, III, and P. H. JONES, Conveners

Abstracts

AMBS, LORAN D., ARCO Oil and Gas Co., Dallas, TX

Shallow Geothermal Survey of Durkee Oil Field and Woodgate Fault, Harris County, Texas

This study was conducted northwest of Houston, Texas, in two areas of intensive investigation: Durkee oil field and a nearby segment of Woodgate fault. Temperature measurements made with thermistors at a depth of 2 m revealed temperature anomalies caused by sources at depth and in the near surface.