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Abstract—The Persian Gulf Basin is the richest region of the World in terms of hydrocarbon resources. According to different estimates, the basin contains 55–68% of recoverable oil reserves and more than 40% of gas reserves. The basin is located at the junction of the Arabian Shield and Iranian continental block that belong to two different (Arabian and Eurasian) lithospheric plates. Collision of these plates at the Mesozoic/Cenozoic boundary produced the Zagros Fold Belt and the large Mesopotamian Foredeep, which is a member of the Persian Gulf Basin. During the most part of the Phanerozoic, this basin belonged to an ancient passive margin of Gondwana, which was opened toward the Paleotethys Ocean in the Paleozoic and toward the Neotethys in the Mesozoic. Stable subsidence and the unique landscape–climatic conditions favored the accumulation of a very thick sedimentary lens of carbonate rocks and evaporites (up to 12–13 km and more). Carbonate rocks with excellent reservoir properties are widespread, while the evaporites play the role of regional fluid seals. Organic-rich rocks, which can generate liquid and gaseous hydrocarbons (HC), are present at different levels in the rock sequence.

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PRINCIPAL STRUCTURAL ELEMENTS AND STAGES OF GEOLOGICAL EVOLUTION OF THE REGION

The Persian Gulf Basin is situated in the Arabian Peninsula between the Arabian Shield in the west, Taurus Mountains in the north, and Zagros Orogen in the east and northeast. In addition to the plains of Arabia, this basin also includes water areas of the Persian and Oman gulf. At the end of the Paleozoic, this basin witnessed the origin of several structural elements, including the following three large troughs: Gotnia Trough in the north (Iraq and Syria), Arabian Trough in the central part of the basin (Saudi Arabia, northern branch of the Persian Gulf and Bahrain), and Rub-Al-Khali in the United Arab Emirate (U.A.E.). The second and third troughs were separated by the Qatar Arch and its extension in the form of the Fars Block (Iran), while the Arabian and Gotnia troughs were separated by a group of small horst-type elevations, e.g., the Kuwait and Rimthan arches. Small grabens and semigrabens situated between them were elongated in the meridional direction in accordance with a deep fault system (Fig. 1) that was inherited from the time of consolidation of the Arabian–Nubian Shield approximately 1000 Ma ago. The large Ghawar High, which appeared in the Paleozoic in the eastern Arabian Basin, is bounded by a deep fault system of the same trend (Edgell, 1992).

The most ancient (900 Ma) magmatic complexes of the study region are represented by diorites, quartz diorites, and trondhjemites in plutons related to a volcanic arc that existed here 920–680 Ma ago. Magmatism of that time was related to the Hidjaz tectonic cycle that was also manifested in Africa. This tectonic process was terminated by amalgamation of the Arabian Block with Gondwana.

Basement rocks in the majority of regions of the Arabian Plate are overlain by different age sandstones, which overlie salts and limestones in some areas. The age of these salts known as the Hormuz Salt is defined by different authors as Late Precambrian or Early Cambrian (Sharland et al., 2001). During the most part of the Paleozoic, the Persian Gulf Basin was a zone of stable subsidence. The Paleotethys Ocean was situated to the north of the Central Iranian Massif. In the Paleozoic, together with the Arabian–Nubian Shield, the Central Iranian Massif belonged to Gondwana as a member of the passive margin of this continent.

At the end of the Ordovician, Gondwana was subjected to glaciation. Fast retreat of glaciers at the initial Llandoveryan led to a drastic rise of the World Ocean level and marine transgression on continental margins, resulting in the formation of graptolite shales enriched in OM (C_{org} 4–12%) and radioactive components. Due to high radioactive background, the basal Silurian layers are well traced by gamma well logging. In Saudi Arabia, they are known as “hot shales” or Kusaiba Formation (Luning et al., 2000).

Uplift of a significant part of Arabia in the Carboniferous due to the Hercynian tectogenesis is reflected in
the large hiatus and unconformity recorded in the majority of Paleozoic sequences of this region. This event is known as the Main Hercynian unconformity. At the Zagros foothills, Devonian and Carboniferous rocks are absent at all as a result of the erosion of as much as 1000 m of rocks. In the central part of the Fars Platform, the Permian sequence with basal conglomerates overlies Ordovician clays with angular unconformity (10°). The new phase of glaciation of Gondwana at the Carboniferous/Permian boundary was successively followed by fast thawing of glaciers and peneplanation of relief. At the Paleozoic/Mesozoic boundary, the Persian Gulf Basin represented a relict of the ancient passive margin. At the same time, the surface of the Arabian Plate gently dipped in northeastern and eastern directions.

The new ocean (Neotethys) was opened in the Middle Triassic simultaneously with the Gondwana breakup into the western and eastern parts (Ziegler, 2001). These events are known as the Triassic phase of extension. The related movements along deep faults renovated the relief and enhanced the supply of terrigenous material. The end of the Triassic was marked by a new phase of intense extension in the Neotethys, which was accompanied by subsidence of the northeastern margin of the Arabian Plate (Stampfli et al., 1991). In contrast, large domains in southern areas were drained. Judging from the absence of Rhaetian and Hettangian rocks in many sections, the hiatus was quite prolonged. A large area of the Gotnia Trough was also involved in the tectonic reactivation, and the subsidence trend was only retained in its eastern half, which became isolated as the Zagros Basin.

In Jurassic and Cretaceous, vast epicontinental seas, which largely accumulated carbonate sediments, were located in the northern and eastern peripheral parts of the Arabian Plate. The Turonian marked the onset of processes leading to the closure of the Tethys Ocean at