FACIES AND SEQUENCE STRATIGRAPHY STUDY OF THE HANIFA FORMATION, KHURAIS FIELD, SAUDI ARABIA

Yusuf H. Mousa B.S.

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Abstract

Plans are being implemented to increase the hydrocarbon productivity of the Khurais field, Saudi Arabia. This increase in production will come from the Hanifa Formation (age: late Callovian to early Oxfordian). Currently, the Khurais field lacks a detailed description of the lithofacies for the Hanifa Formation. Such a lithofacies scheme, however, is essential (together with biostratigraphy) to generate a general sequence stratigraphic framework for the Khurais field.

The Khurais oil field of eastern Saudi Arabia was first discovered in 1957 by means of gravity and magnetic surveys and produces from three major stratigraphic intervals (Arab, Hanifa, and Fadhili Formations). The Hanifa reservoir has a net thickness of about 91.5 meters (300 feet). The limits of the Khurais field are approximately 75 kilometers in length and from 4 to 15 kilometers in width with a total productive area of approximately 487 km^2 (188 mi^2). Drill stem tests (DST), which are tests conducted for the productivity of an oil or gas well, established a 33-degree API (American Petroleum Institute) for the oil quality.

A facies scheme for the Hanifa Formation in the Khurais field was developed by integrating data obtained from core description, core plugs, and thin section analysis. This resulted in twelve separate lithofacies, which can be summarized as follows: (1) Stromatoporoid/Coral Boundstone/Rudstone with Mud Matrix, (2) Stromatoporoid/Coral Boundstone/Rudstone without Mud Matrix,

(3) Laminated Lime Mudstone, (4) Organic-Rich Laminated Lime Mudstone, (5) Mud Lean Wackestone, (6) Skeletal Wackestone, (7) Pelletal Packstone, (8) Burrowed Skeletal/Intraclast Grainstone, (9) Cross-Bedded Skeletal/Intraclast Grainstone, (10) Massive Skeletal/Intraclast Grainstone, (11) Skeletal/Peloidal/Intraclast Packstone-Rudstone, and finally (12) Skeletal/Peloidal/Intraclast Grainstone-Rudstone.

Stratigraphic analysis indicates that the sediment comprising the Hanifa Formation accumulated on the slope of a wide carbonate ramp dipping to the east. The different environments include inner ramp, mid ramp, outer ramp, and basin. Two cross sections taken along the Khurais field, the first in a north-south direction along the field's elongation, the second in an east to west direction along the regional dip, indicate that the Khurais field straddles the edge of the Arabian basin.

Sequence stratigraphic analysis reveals two transgressive-regressive sequences (3^{rd} order) and each sequence is composed of several higher order cycles (4^{th} and 5^{th}). These sequences comprise, as key stratigraphic surfaces, (1) a maximum flooding surface (MFS), which separates the Hanifa Formation from the overlaying Jubaila Formation, (2) two sequence boundaries: the first is a subaerial exposure surface separating the highstand system tract (HST) from the lowstand system tract (TST), while the second is thought to be a drowning surface. The lithofacies deposited within the HST as prograding grainstones form the best reservoir zones with high porosity and good permeability. Lithofacies deposited within the TST show relatively good porosity with moderate to low permeability.