

Tectonic and Climatic Controls of Post Glacial Terminal Fluvial Systems, Permian Unayzah Reservoir, Saudi Arabia

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ABSTRACT

Post Glacial Permian sandstones of the Unayzah reservoir host substantial oil and gas reserves in Saudi Arabia. They are informally known as Unayzah 'A' and Basal Khuff Clastics. Facies analysis of these deposits revealed the presence of playa, sabkha, flood plain, ephemeral stream and sheet flood, and aeolian facies. In addition, diverse palaeosols, reflecting arid and semiarid climates, exist throughout the reservoir. An eastward progradational terminal fan-bajada system is recognized. The system was repeatedly reworked by easterly winds that developed widespread aeolian dune and sand sheet deposits. Rapid marine transgression also recycled the topmost part of the terminal fluvial system and deposited thin restricted marine facies at the top of the reservoir.

Evolution of the terminal fluvial system is marked by the development of three major tectono-stratigraphic sequences that are bounded by unconformities and correlative conformities. Deposition of the lower sequence was marked by a relative tectonic quiescence, uniform subsidence, overfilled basin conditions, and consistent aggradation and progradation of a transverse terminal fluvial system into extensive playa lakes in the east.

The middle sequence experienced faulting, uplift of proximal areas and development of extensive sequence boundaries in the west, subsidence and formation of correlative conformities in the east, widespread development of local playa lakes, sediment bypass and forced progradation of the terminal fluvial system.

The upper sequence recorded intense faulting and structural inversions, under-filled basin conditions, overall retrogradation of fluvial systems and consequent marine transgression. Minor axial fluvial systems, in addition to the main transverse one, were developed during this period. Widespread palaeosols with distinct catenas were also formed. They reflect, respectively, seasonally wet climates and contemporaneous structural topography. The wet climate combined with active tectonics resulted in more competent flows, development of structurally-controlled arroyos and enhanced primary coarse sediment supply.

The Unayzah sequences record a gradual upward change from predominantly fluvial to widespread aeolian and then back to prevailing fluvial systems. This

trend reflects transitions from semiarid to arid to semiarid climates. It is inferred that these low order climatic shifts coincided with the northward drift of NE Gondwana into the trade wind and lower latitude climatic belts in addition to progressive transition towards greenhouse conditions.

High frequency wet-dry-wet cycles are superimposed on the low order climatic shifts. They reflect autogenic processes, local subsidence events and climatic fluctuations. The latter are related to orbital perturbations. Progradation of individual terminal fan lobes was cyclically punctuated by periods of pedogenesis and wind reworking. Coincidence of arid periods of the medial low and high order cycles developed an extensive dry aeolian system that corresponds to the most arid climate. During this peak aridity period, thick and dry aeolian dunes preferentially accumulated in syn-depositional structural lows with faults facing easterly winds.

This study demonstrates that tectonics controlled the large scale stratigraphic architecture of the Unayzah terminal fluvial and associated aeolian systems. It also forced the localization of the main facies belts. In contrast, climate controlled temporal facies changes and greatly affected sediment supply and its calibre.