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IMPLICATIONS OF THE BASEMENT EVOLUTION AND LITHOSPHERIC STRUCTURE ON THE SEDIMENTARY BASINS OF THE UNITED ARAB EMIRATES

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ABSTRACT

The over 15-kilometer-thick sedimentary basins in the United Arab Emirates have evolved through complex tectonic history. These basins disclose a unique plate geodynamic setting of continental lithosphere stretching, passive margin formation, and subsequent down-flexing in obduction and subduction settings, respectively. The basement underlying these sedimentary basins has not been sampled by deepest exploration wells nor imaged by seismic surveys. Thus, the tectonic evolution of the area remains puzzling due to the deep burial cover and the lack of resolving data. In this study, we integrate the interpretation of 372 2D seismic reflection profiles and 3D volume extracts with biostratigraphic and lithostratigraphic data from 510 wells to decipher the basement's evolution and the lithosphere's structure. Seismic stratigraphy suggests the presence of seven seismic sequences bounded by plate-wide unconformities plausibly associated with the tectonic evolution of the Arabian Plate. These seismic sequences are associated with three dominant tectonostratigraphic mega sequences: a pre-Permian sequence, a Permian-Turonian rifted margin sequence, and a Coniacian-Pleistocene active margin sequence. Our tectonic subsidence analysis inferred two episodes of rifting: the oldest rift was initiated at 272 Ma and lasted for ca. 20 Myr and the final rifting event occurred at 160 Ma and lasted for ca. 25 Myr. The first rifting stage is linked to the initial Tethys opening, while the second phase is associated with the final Gondwanaland fragmentation. Additionally, we mapped a NE-SW oriented intracratonic basin in the central UAE during the final, Late Jurassic rifting event that is potentially influenced by pre-existing structures. Nevertheless, the structural manifestations of the interpreted rifts are severely obscured by the Ophiolite obduction in the Late Cretaceous and the intra-plate collision in the Miocene resulting in the absence or highly-negatively inverted faults due to the crustal shortening. A uniform depth extension model implies that the lithosphere was thinned to ca. 85% during the initial rifting and by <2% during the final rifting based on modeled stretching factors of 1.13 to 1.27 and 1.11 to 1.17, respectively. Spatial modeling of the stretching factors yielded critical insight into the lithospheric necking that occurred in the area with new estimates that are ~40% lower compared to the previous attempt and consistent with recent estimates of Moho depths derived from seismological and potential data.
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