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Oligo-Miocene syn-rift and Miocene post-rift sedimentary records: the tectono-stratigraphic development of the northern proximal margin of the Gulf of Aden

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The northern margin of the Gulf of Aden results from the Oligo-Miocene rifting (34Ma) leading to continental break-up and the oceanic spreading since the Burdigalian (17.6 Ma). We, here, investigate in detail the tectono-stratigraphy development of the Ashawq Graben belonging to the proximal part of northern margin (southern Oman, Dhofar). This graben exhibits sedimentary records of syn-rift and post-rift sequences, so-called Dhofar (Rupelian-Burdigalian) and Fars (middle Miocene-Pliocene) Groups respectively. Analyzing the deposit conditions and sequences geometries provide fundamental inputs for the whole margin understanding.

An accurate sedimentological and biostratigraphical analysis evidences two second-order sea level cycles corresponding to the syn-rift and the post-rift units separated by an erosive surface with paleo-karst cavities.

The first stage of the rifting expresses as a regional uplift which led to set up of an early Oligocene mix platform system (Ashawq Fm., Shizar Mb.) overlying the proximal platform (Aydim Fm.) and continental (Zalumah Fm.) system deposit of the late Eocene to earliest Oligocene time. Then, the rift extension process during early Oligocene leads to verticals movements along normal faults and increase of the accommodation rate in the Ashawq graben. Such increase of accommodation is fully compensated by an important carbonate production leading to the aggradation of a thick reefal carbonate platform (Ashawq Fm., Nakhlit Mb.).

An acceleration of the extension processes during late Oligocene time reaches an increase of the tectonic subsidence associated to the partial drowning and collapsing of the platform and to the set up of carbonate gravity-flow deposits in a deep basin (Mughsayl Fm.). In the most proximal realm, the sedimentation rate attempts to compensate the accommodation rate resulting in a differential aggradation of the reefal carbonate platform, sometimes in the form of patch reef.

At the early Miocene time, the progradation of a conglomeratic fan delta system testifies the decrease of the accommodation rate and a strong basinward system shift controlled by a general uplift of the margin. This surrection phase leading to a subaerial exposure is interpreted as the consequence of the continental breakup at the Burdigalian time (17.6 Ma) and the set up of Ocean-Continent Transition (OCT).

At the middle Miocene time, new subsidence phase is associated with a partial marine incursion and to the set up of proximal shallow marine carbonate deposits (Adawnib Fm.) and the lateral equivalent conglomeratic alluvial fan deposits (Nar Fm.). This post-rift unit records a progressive decrease of the tectonic activity, which may be related to the migration of the deformation towards the distal margin up to the oceanic spreading in the Gulf of Aden.

Late deformation phases (erosive paleo-surface at the top the post-rift conglomerates, preservation of uplifted paleo-beach deposits) may imply a large-scale geodynamic processes.