The Eocene Carbonate Platform-to-Basin Transition of Eastern Oman: Insights from a Seismic-Scale, Drone-Based Photogrammetric Outcrop Model

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Abstract

The limited access to large-scale cliffs outcrops remains a challenge when assessing the architecture of sedimentary systems using "conventional" field geology. The democratization of drone technologies, together with the improvement of photogrammetry processing and interpretation software, allow to determine the architecture of sedimentary systems more accurately along outcrops up to seismic scale.

The hereby study focuses on the platform-to-basin transition of a Paleocene-Eocene, benthic foraminifera dominated carbonate system (Umm Er Radhuma or Jafnayn Formation), where we combined a 3 km x 5 km, 7 km linear and ca. 900 m height drone-based photogrammetric model with existing ground field data to further constrain the stratigraphic architecture and internal geometries of this spectacular seismic scale outcrop. The photogrammetric dataset covers 3 successive wadis (Wad, Sifaq, Adah) which allow the analysis of the carbonate succession along dip and strike sections.

Two cycles with large-scale platform collapses are captured (Thanetian and Ypresian Sequences 3a & 3b, equivalent to Jafnayn 1&2 – Abat Formations), interpreted as a resultant of major transgressive phases leading to the aggradation of the edge of the platform and a correlative accentuation of the depositional profile at the platform-basin transition. Typical features described are erosive surfaces along the depositional profile with underlying truncations and overlying onlaps terminations. Associated chaotic debrites, turbitides (i.e., Wad turbidites) and hemipelagites are also recognized and mapped. This phase of relative tectonic quiescence is then interrupted during the Cuisian (Upper Ypresian) by tectonic movements that are recorded in different ways regionally. In the studied area, this event coincides with forced progradation geometries (Sequence 4, Jafnayn 3 Formation), reflecting a fall of relative sea level. This progradation and the subsequent aggradation of platform deposits on this unstable edge were accompanied by a strong intensification of carbonate gravity sedimentation, leading to the accumulation of a thick turbiditic series basinward (Sequence 4, Fitah Formation).

The continuous large-scale photogrammetric data used in this study not only further constrains the stratigraphic architecture of this carbonate system, but also highlights key features not observable with "conventional" field geology approach. It provides critical insights to reduce geometrical uncertainties for equivalent systems in subsurface. Such large-scale digital model constitutes a game changer in the studies of seismic scale sedimentary system on outcrops, allowing to accurately quantify and extract parameters required both in exploration and reservoir modeling workflows.