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Giant intertidal hardground polygons of the southern Arabian Gulf

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This study presents a model for the formation of very large-scale intertidal hardground polygons identified along the southern shore of the Arabian Gulf. These large scale sedimentological features have diameters in excess of 150 m and, although easily visible on aerial and satellite imagery, are difficult to distinguish on the ground. Initial identification was made on the coastline of Abu Dhabi but subsequent investigations have revealed these giant polygons to be common features along much of the southern shoreline of the Arabian Gulf.

A quantitative analysis of the polygons was undertaken with integrated field, petrographic and geochemical analysis techniques employed to establish a model for their initial formation and subsequent development. Within this framework we also consider the preservation potential of these features and the limitations for their identification in ancient sedimentological sequences.

This study has found that polygon formation takes place through displacive carbonate cementation of carbonate sand below a thin (3 to 5 cm) cover of unconsolidated carbonate sediment. Geochemical analysis of the carbonate cements reveals an oxygen isotopic composition that is consistent with precipitation from evaporated seawater. The uppermost portion of the cemented zone is a relatively poorly consolidated layer that grades downward into an 8 to 14 cm thick, well-cemented bioclastic grainstone. Ongoing cement precipitation results in the outward expansion of polygons, this, in turn, results in uplift, fracturing, and overthrusting at polygon borders.

Three distinct categories of polygon border are identified in this study – tepee, gap and overlap borders. Tepee and gap borders were found to be rare in these settings, accounting for less than 3% of all border area. Tepees were found to be transient features in the relatively high-energy setting of the intertidal zone, being destroyed during high-energy events, such as storms, or collapsing due to a lack of sediment accumulation that would support them in lower energy settings. Overlap borders are, by far, the dominant and most stable margin type. These observations have clear implications for the use of tepees in the interpretation of ancient polygons and their associated environments. Ancient intertidal hardground polygon boundaries will be dominated by overlapping borders that, while potentially recognisable in outcrop, will be very difficult to establish in core.