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A Multi-Scale Facies Analysis and Diagenetic Patterns of Early Devonian Microbial Carbonate, Qasr Member, Jauf Formation

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In Northwestern Saudi Arabia, Al-Jauf area provides well-exposed outcrops of Early Devonian microbial carbonate in the Dumat Al-Jandal and Wadi Murayr areas. The Qasr Member of Jauf Formation is the first major carbonate unit of the Paleozoic succession in Saudi Arabia that mainly consists of stromatolite and coralline sponge (stromatoporoid) reef. Petrographic and stratigraphic examination, together with geochemical analyses, were designed to characterize the facies distribution and interpret their depositional and diagenetic processes. Multiscale facies analysis from macroscopic to microscopic scales shows a large facies heterogeneity, with a total of 11 facies being identified. Based on the facies analysis and faunal assemblages, the Qasr Member was deposited in the warm-shallow water carbonate rimmed platform and range between a tidal flat, platform interior, barrier reef/shoal to upper slope. Major part of the carbonate successions were deposited in the tidal flat environment. The presence of stromatolite may suggest warm-very shallow water with elevated salinity condition due to the restriction from open marine water. The main diagenetic alterations observed from the studied samples are carbonate cementation and dolomitization. Integration of petrography and cathodoluminescence studies shows four distinct cement generations that include 1) isophachous blocky cements, 2) poikilotopic calcite cements, 3) drusy cements, 4) fine-to-medium equant cements. Three distinct types of dolomite texture are recognized from petrographic study and include: planar-e dolomite (euhedral, most dominant), planar-s dolomite (subhedral) and matrix selective dolomite (anhedral).