Integration of lithofacies, biofacies, and stable isotope analysis of Middle Callovian Tuwaiq Formation: Implications for paleoenvironments and paleoclimate, Central Saudi Arabia.

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Several characteristics and properties of Jurassic carbonates have received great attention as they have economic significance and was attractive for several researchers. Micro-fauna was studied for various purposes such as biostratigraphy and paleo-environment. Stable isotope composition analysis of ancient successions of carbonates is one of the strongest and powerful tools for the purpose of reconstructing paleoclimate and paleo-environment. This study aims to refine the stratigraphic signatures on the Carbon and Oxygen isotope composition through picking different timeline surfaces during middle Jurassic Tuwaiq Limestone Formation and related sequences. Field observations were carried out and samples were collected. Several laboratory analyses were performed including thin section petrography, X-Ray Diffraction (XRD) and Scanning Electron Microscope (SEM). Powder samples were prepared to analyze isotopic composition.

Tuwaiq Mountains Formation consists of skeletal, oolitic, intraclasts, fossiliferous planar laminated limestones and trough crossbedded limestone in the most upper part of the studied section. The cherty and bioturbated limestone is predominated also as well as large reef bioherm within the thick massive beds. The studied section consists of several types of foraminiferal assemblage species including Trocholina elongata, Redmondoides lugeoni, Kurnubia palastiniensis, Cladocoropsis, and minor amounts of Lenticulina and Nautiloculina oolithica. Other non-foraminiferal species also exist including noncostate gastropods, brachiopods fragments, bivalve, echinoderm, and coral fragments. Based on previous studies and the results of fossil associations that are found in the studied section, the Tuwaiq Mountains Limestone Formation varies from fore-bank into lagoonal and intertidal sub-environments. Due to the absence of sponge spicules species, deep marine intra-shelf basin was excluded. Tuwaiq Mountain Limestone Formation is composed of shallowing upward outer lagoon (T1) graded upward into a back reef (T2) and reef (T3) Members. This is reflected in the vertical signatures of both Oxygen and Carbon isotopes. Both of them are enriched upward because of the change to more shallow marine lithofacies (low temperature and higher organic productivity). Two breakthroughs were observed in the upper part of Tuwaiq Formation where strong depletion for both Carbon and Oxygen isotopes is found, this is thought to be a result of a nearby continental source of negative lighter carbon and oxygen isotopes ($\delta^{13}C$ and $\delta^{18}O$). Chert nodules and stratified chert might have an impact on isotope curves and thought to be associated with the overlying intensive occurrences of sponge spicules.
that are rich in silica in the lower parts Hanifa Formation. The overall enrichment in Oxygen isotopes is probably associated with the predominant Callovian-Oxfordian polar glaciation.