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COMPARISON OF THE GLOBAL ONLAP CURVE AND SEA-LEVEL CHANGES WITH TIMING OF UNCONFORMABLE SEQUENCE BOUNDARIES FORMATION OF A PALEOCENE SUCCESSION, SIRTE BASIN, LIBYA

Ayman Nassar, Akram Zafir, Ahmad Abuharara, Muneer Abdalla
Department of Geology
Omar Al-Mukhtar University, Al Bayda PO. Box 919, Libya

Abstract— **The Paleocene sedimentary successions in the NW Sirte Basin in north central Libya have complex stratigraphic architecture and internal configuration. This stratigraphic architecture can provide information on timing of sea-level changes and associated onlaps. Therefore, this study uses the formation timing of the sequence boundaries separating between the stratigraphic sequences and correlate it with the global online curve and global sea-level changes. The number of sequences recognized in the Paleocene succession of the studied platform matches the number of third-order cycles, indicating that each sequence represents a single third-order cycle and was created as a consequence of one third-order cycle of sea-level fluctuation.**

Keywords— **3D seismic, Sea-level changes, Isolated carbonate platform, Sirte Basin.**

I. INTRODUCTION

The study area is located in north central Libya within the Sirte Basin, the most productive petroliferous basin in Africa (Fig. 1). The basin is considered to be a rift basin formed due to large scale extension and resulted rifting and subsidence. It covers an area of around 600,000 km^2. Thickness of the sedimentary strata of the basin ranges from ~ 6.5 km offshore in the northern Gulf of Sirte to less than 1 km in the south (Roohi, 1996; Guiraud and Bosworth, 1997; Hallett, 2002).

The S Field in NW Sirte Basin is the focus of this study. It contains isolated carbonate platforms that are several square kilometers in size. Those isolated platforms contain several stratigraphic sequences bounded by unconformities, which indicate sea-level oscillation. This study aims to correlate those sequences to global sea-level changes reconstructed by Haq et al., (1987), and reveal the control of sea-level changes on the platform sequences.

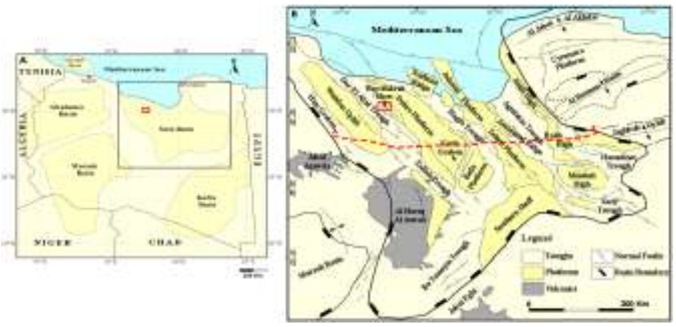

Fig. 1. (a) The major sedimentary basins in Libya (modified after Abdalla (2021a, 2021b). (b) A simplified map of the Sirte Basin in (modified after Mouzughi and Taleb, 1981; Abdalla and Yang, 2021, 2022). The study area is marked by the red square box.

II. DATA AND METHODOLOGY

Three-dimensional seismic data was used in this study. The seismic volume occupies an area of 113 km^2 and contains 1000 in lines and 500 cross lines. The maximum two-way travel time is 4 seconds. The volume was recorded with SEG normal polarity, where the increase in acoustic impedance is shown as positive amplitude (Fig. 2). The frequency has a range of 12-60 Hz with a main frequency of 22-35 Hz. Unconformable sequence boundaries that separate stratigraphic sequence were correlated to global sea-level changes in order to establish a relationship between the global sea-level changes and formation of the stratigraphic sequences (Fig. 3).

III. RESULTS AND DISCUSSIONS

A Comparison of the onlap curve from the platform with the global coastal onlap and correlation of the platform seismic sequences with the global eustatic sea-level fluctuations is shown in Fig. 4. Isolated carbonate platforms have no coastline; thus, they have no onlap (Eberli and Ginsburg, Notwithstanding, the platform was flooded multiple times.

Aggradation occurred on the platform interior and margins, and progradation occurred on the slopes, indicating changes in sea-level.

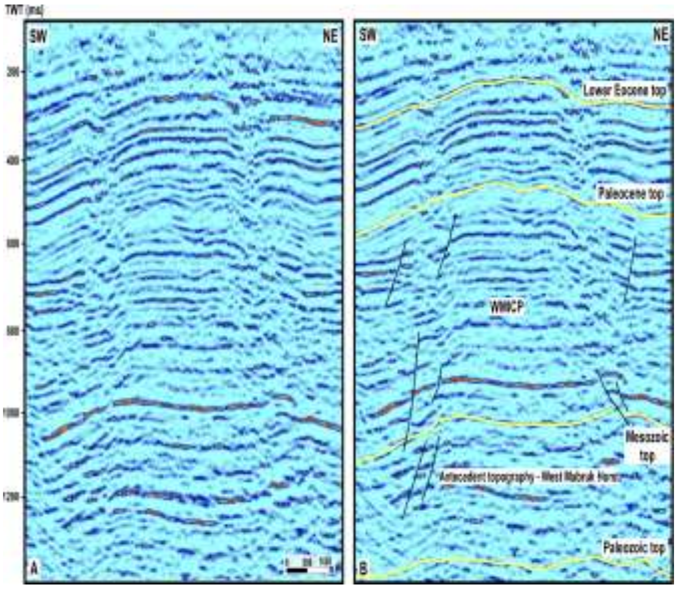

Fig. 2. (a) Raw seismic line 4600. (b) Same line showing the main strati graphic boundaries.

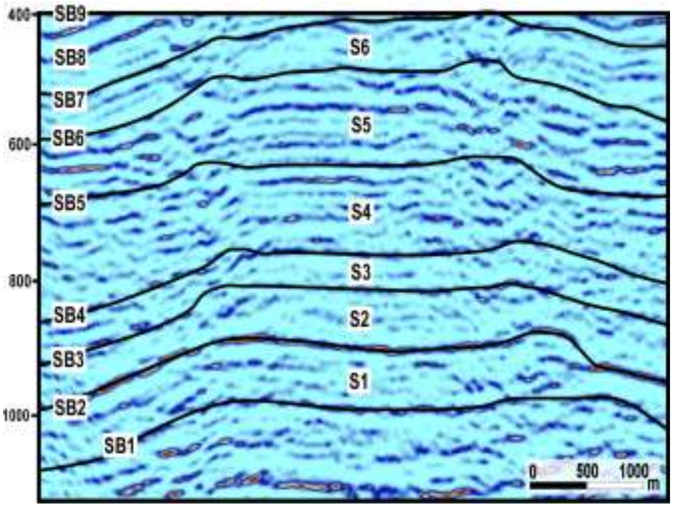

Fig. 3. (a) Interpreted seismic line showing the sequence boundaries and strati graphic sequences.

The five seismic sequences of the platform developed from early to late Paleocene in accordance with the comparison between the sequence boundaries identified on seismic profiles and dating from the chrono-stratigraphy created by Mabruk Oil Operations Company (2002). This time conforms with the lower part of the super cycle set TEJAS A (TA), which contains two second-order super cycles (TA1 and lower part of TA2). TA1 super cycle comprises four third-order cycles (1.1, 1.2, 1.3, and 1.4), and the lower part of TA2 contains one third-order cycle (2.1; Haq et al., 1987). The five Paleocene sequences of the platform are bounded by six sequence boundaries. Those seismic sequences are the time equivalent with the supercycles TA1 and the older third-order cycle of supercycle TA2. Moreover, if the interpretation is correct, the five seismic sequences of the Paleocene coincide with the five third-order cycles: 1.1, 1.2, 1.3, and 1.4 of the super cycle TA1 and 2.1 of the supercycle TA2. Sequence 6, which overlies the platform and contains anhydrite interbedded with dolomite, correlates with the middle part of supercycle TA2, which contain three third- order cycles (2.2, 2.3, and 2.4). Therefore, we speculate that seismic stratigraphic sequence 6 may comprise more than a single third-order cycle.

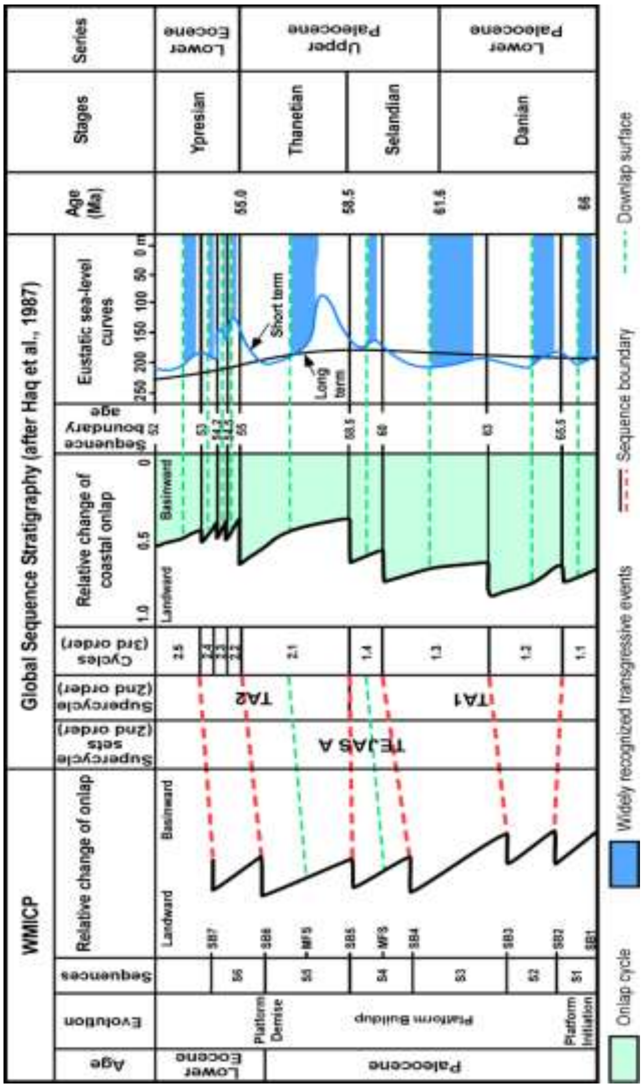

Fig. 4 Comparison of the platform on lap curve with the global coastal on lap chart and correlation of the platform sequences with eustatic sea-level fluctuations of Haq et al., (1987).

Correlation of the platform sequences with the global eustatic sea-level chart exhibits a close match between the development of the platform sequences and sea-level changes. For example, the five sequences recognized in the platform from the early Paleocene to late Paleocene-early Eocene boundary correlate with the five short-term changes in sea-level shown in the global eustatic sea-level chart. Thus, we interpret that each short-term change in sea-level creates one sequence. However, Haq et al., (1987) identified three short-term sea-level fluctuations in the lower Eocene interval where seismic sequence 6 developed. Thus, we speculate that sequence 6 of the lower Eocene may have resulted from more than one eustatic sea-level fluctuation.

IV. CONCLUSIONS

A correlation of the global coastal onlap curve and global sea-level changes with the timing of sequence boundaries formation in a detached isolated platform within the tectonically complex Sirte Basin was established. The study found that the number of stratigraphic sequences recognized in the Paleocene sedimentary succession of the platform matches the number of third-order cycles, suggesting that each sequence represents a single third-order cycle and was created because of one third-order cycle of sea-level fluctuation.

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