MESSINIAN CRISIS: SEISMIC STRATIGRAPHIC VIEW FROM THE EGYPTIAN CLASTIC COASTAL PLAIN

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Abstract

A new interpretation of 1100 km of 2D seismic with 18 boreholes constrains the sequence stratigraphy of the Messinian Coastal Plain of the Nile Delta. Detailed seismic facies analysis coupled with depositional log motifs allows the identification of downstepping fluvial terraces within incised valleys. These fluvial terraces represent the preservation of Regressive Systems Tracts (RST) of [1] which record the fall of relative fluvial base level (sea level). Construction of a relative sea level curve (Tab. 1) from these observations shows that prior to closure, the global and Mediterranean relative sea level curves were coincident, but with Messinian isolation, the relative sea level curves are antithetic.

Keywords: Messinian, Sea level, Seismics, Stratigraphy, Nile Delta

The Egyptian Late Miocene stratigraphy directly record the fluvial channel cut and fill stages which bracket the Messinian crisis. Figure 1 illustrates in one reflection seismic line three channels with a downcut valley which record these stages. During the early Messinian, owing to a global sea level fall, the Qawasim sequence records the Nile delta progradation and channel downcutting on the coastal plain with deposition of fluvial RST M1 terraces. At its lowest level, Lowstand Systems Tract (LST) M2 channel lags occur. With a subsequent global sea level rise, as the Mediterranean is still connected, the Nile delta retrogrades with subsequent channel flooding with transgressive systems tract (TST) M3 shales culminating with a Highstand Systems Tract (HST) M4 shale. At around 5.95 Ma, the global and Egyptian sea level curves begin to diverge and at 5.59 the Egyptian Sea Level begins to fall which is recorded by the Late Messinian Abu Madi Sequence (Tab. 1).

Tab. 1. Global sea level change [2] and interpreted Nile Delta sea level change of the Messinian age in Egypt. The ages of the onset, opening and closing of the Mediterranean Sea are from [3]. Stratigraphic ages are from A: [1], B: [4], and C: [3].

As the Mediterranean Sea continues to lower Nile fluvial base levels, channels downcut with Abu Madi M5 terraces ending with M6 channel lags. Suddenly at about 5.33 Ma, the Egyptian sea level curve begins a rapid rise with the Nile Delta rapidly retrograding and the deposition of M7 transgressive prodelta shales which culminate with M8 widespread marine shale deposition accompanying the reconnection of the Mediterranean with the global ocean. These TST events ending with widespread HST shales provide excellent seals for hydrocarbon entrapment in the preserved fluvial terraces as evidenced by commercial gas production within. The construction of an Egyptian Messinian sea level curve which brackets the Messinian Crisis provides potential utility for correlation to other Mediterranean depositional systems if similar high resolution sequence defined relative sea level curves are constructed (e.g. correlations by [5]). However, much work remains to be done in specifying the absolute ages of relative sea level excursions for better temporal constraint upon future correlations documenting this extraordinary event in the Earth’s history.

References