15th International Congress of the Geological Society of Greece
Athens, 22-24 May, 2019 | Harokopio University of Athens, Greece
Bulletin of the Geological Society of Greece, Sp. Pub. 7 Ext. Abs. GSG2019-332

Seismic Stratigraphy of North Aegean Trough: Indicative Evidence of Messinian Evaporites, Preliminary Results

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Introduction

The North Aegean Trough (NAT), is a ENE – WSW trending structural deep, that forms along the westward propagation of the North Anatolian Fault (NAF) (Le Pichon et al., 1984). Structural and basin analysis of NAT addressed mainly the tectonic fragmentation that led to the development of sub – basins forming in the Uppermost Miocene (Lalechos and Savoyat, 1979; Mascle and Martin, 1990). Moreover, the discovery of the Prinos and Espilon hydrocarbon fields to the NE of NAT in the 70s, led to an increased interest of the Upper Cenozoic evolution of the broader region. (Laigle *et al.*, 2000; Beniest *et al.*, 2016; Ferentinos *et al.*, 2018).

Objectives

This study, focused on the western and central NAT, is derived exclusively from deep penetrating seismic reflection data. By processing and interpreting the digitally available data – set we proceed to the qualitative identification of the stratigraphic top, of the Upper Miocene (Messinian) and describe the seismic stratigraphy of the identified depositional units. A refined understanding of the sedimentary column, for the various depocenters in the area under investigation, will enhance the geological perception of the region and will update the knowledge on the structural mechanisms that formed the basins.

Methods

The available data set consists, by several two-dimensional (2D) seismic profiles (multichannel, PSDM). They were acquired as part of the SEISGRECE campaign (Vigner, 2002). The acquisition parameters consist of a 16-fold coverage with a source of 16 generator – injector air guns with a total volume of 31L, operated in single bubble mode along a multi-channel streamer (96 channels, 2.4 km long streamer). We focus on an area of 600 km^2 defined as Central NAT (Fig.1). Characteristics such as: (a) the reflection continuity, (b) the geometry and architecture, (c) the frequency and (d) the amplitude of the reflectors are used in order to enhance the seismic stratigraphy of the region.

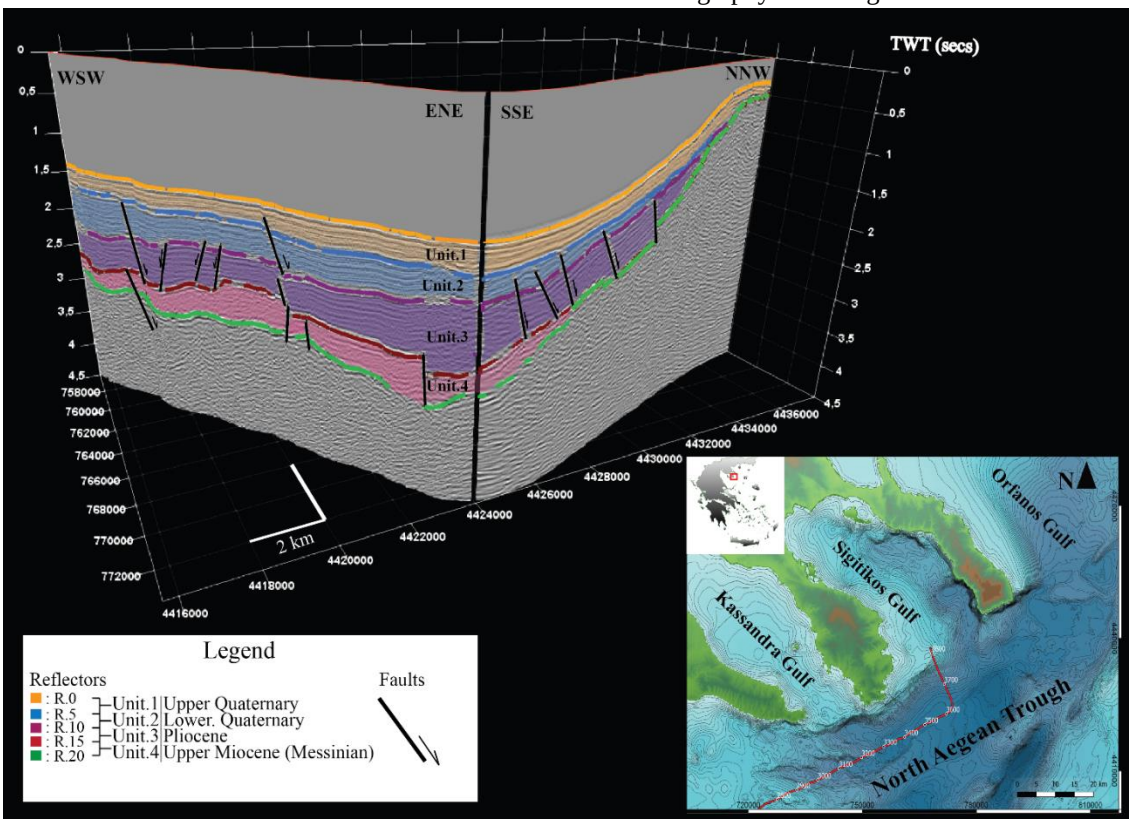

Figure. 1 Visual representation of the interpreted area (3D perspective).

Results

The utilised seismic reflection system, achieved an acquisition penetration down to approximately 17 secs (Vigner, 2002). Due to the fact that the resolution diminishes below the upper 6 seconds and because we were interested in Upper

Cenozoic seismic stratigraphy, the seismic profiles were processed vertically so that the upper 4 secs (TWT) were distinguished, allowing a more detailed insight in the upper sedimentary column. In the under-evaluation area (Central NAT), four major seismic stratigraphic units have been recognized (Fig.1) and characterized by different seismic signatures, separated by three major unconformities, as distinguished in other parts of the Aegean. The uppermost unit (Unit. 1) is characterized, by densely spaced, parallel reflectors, with relative high amplitude and continuity. The thickness of the unit, ranges from 150 ms along slope, increasing to 250 ms at the center of the basin. The underlying, second unit (Unit.2), demonstrates a similar seismic response with a set of rather well stratified reflector packages up to 500 ms, that rest unconformably over the underlying units. The third unit (Unit.3) interpreted below is bounded by a pronounced unconformity better expressed along slopes. A chaotic seismic response and intense faulting characterize this unit. It is predominantly differentiated by lower frequencies and its thickness varies from 150 to more than 650 ms basin-ward. Finally, the lower fourth unit (Unit. 4), is clearly distinguished due to, (a) an increase in seismic amplitude, (b) a characteristic internal signal blanking and (c) the presence of distinctive up – doming structures. The average thickness of this unit is around 300ms.

Conclusions

The mapped uppermost three seismic units in Central NAT are attributed to the Plio-Quaternary sediment fill of the basin. They are separated by two major unconformities that overlap the slopes of the basin. On the basis of the regional stratigraphy we attribute the three units to Upper Quaternary, Lower Quaternary and Pliocene respectively (Fig.01). The fourth unit represents the Upper Miocene (Messinian). In our proposed interpretation we highlight this distinct Unit 4 seismic reflector package, that overlaps unconformably over the basement and displays the acoustic characteristics of an evaporitic sequence (prominent acoustically turbulent-transparent unit). Available literature for the broad area of North Aegean Trough reports sceptical about the presence of Messinian evaporites in the western and central regions. Here we recognize a unit that displays clear reflection characteristics of an evaporitic sequence. Even though our study relies solely on the interpretation of seismic profiles, the proposed scenario is further supported by the identification through refraction tomography of an interval, of high velocity (4.1 km/s) between the unconsolidated sediment cover and the Alpine basement at the vicinity of the area (Le Pichon *et al.*, 1984). This, correlates also, with the calculated PSDM velocities of 4.43 km/s by Vigner (2002) that are compatible with an evaporitic sequence. Moreover doming-like structures, visible in low penetration medium resolution records (Ferentinos, 1990; Rodriguez *et al.*, 2018), clearly emanate from our clearly distinguished Unit 4. In the broader area of NAT there are some references hinting the presence of Messinian evaporates (Ferentinos, 1990; Mascle and Martin, 1990; Lalechos, 2000; Koukouvelas and Aydin, 2002; Sakellariou and Tsampouraki-Kraounaki, 2019).

Acknowledgements

We thank Professor Hirn from the Institut de Physique du Globe de Paris, for making available the multichannel seismic profiles.

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