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. GSG2019-226

Seismic Character as a Tool to Identify Different Geotectonic Zones in the Frontier Area Offshore South of Crete, Greece

K. Oikonomopoulos[1], G. Makrodimitras[1], N. Papadimitriou[1], Y. Bassias[1]

(1) Hellenic Hydrocarbon Resources Management SA (HHRM SA), Dim. Margari 18, Athens, Greece, k.oikonomopoulos@greekhydrocarbons.gr

Abstract

Although the geotectonic zones in western Greece are clearly thrusted on top of each other from east to west, in Crete these nappes are piled up cropping out thanks to tectonic windows. In western Greece, the Ionian islands provide a lot of information with regards to the most external parts of the Hellenides Thrust-and-Fold Belt (TFB). In addition, several wells and a dense seismic grid confirm the geological knowledge of the area and mitigate the uncertainty about the petroleum system there. In contrast, the area south of Crete includes only four (4) very small islands providing scattered information of the geological setting in the Cretan margin, along with a sparse seismic grid and the lack of wells.

Despite more than forty (40) years of geological and geophysical work in the region, the geodynamic and tectonic processes have been debatable and controversial. An initial attempt to distinguish and outline the geotectonic zones present in the area south of the island of Crete has been done based on the integration of seismic data and onshore geology. However, because of the above-mentioned limitations the attempt remains speculative.

The use of the seismic data allowed for a more accurate mapping of the three (3) distinct geological areas south of Crete; Cretan margin, Backstop and Mediterranean Ridge. The Cretan margin includes stacked nappes similar to those onshore Crete, the Backstop includes probably the most external Hellenides, while the Mediterranean Ridge cannot be assigned to any of the known Hellenides.

Introduction

Following the convergence between the African and Eurasian plate, which initiated in the Late Jurassic, successive orogenic belts were produced. The orogenic systems of the Hellenides which are a segment of the Alpine Orogenic Belt developed along the European active margin. In particular, on the island of Crete a stack of five (5) tectonic units are related to the Hellenides. There are two (2) sets of nappes according to their position and metamorphism which are separated by a low-angle detachment fault. These two (2) sets are: the lower metamorphic set of nappes, consisting of clastic Phyllites-Quartzites together with the carbonate para-autochthonous Plattenkalk unit and the upper non-metamorphic set consisting of Tripolitza, Pindos and the uppermost nappes.

Previous studies have shown that the Cretan margin is bound to the north by the Cretan coastline and by Ptolemy trough to the southwest and the Pliny trough to the southeast, while the Backstop extends from the Pliny trough to the overthrusted Mediterranean Ridge (Huguen et al., 2001).

Results

This study used seismic data, acquired by Petroleum Geo-Services (PGS) in 2012 and the reprocessed legacy data integrated with the onshore geology of Crete (Fig. 1). Comparison of the seismic characters from Crete and western Greece led to the following results as is shown in Fig. 2 and Table 1:

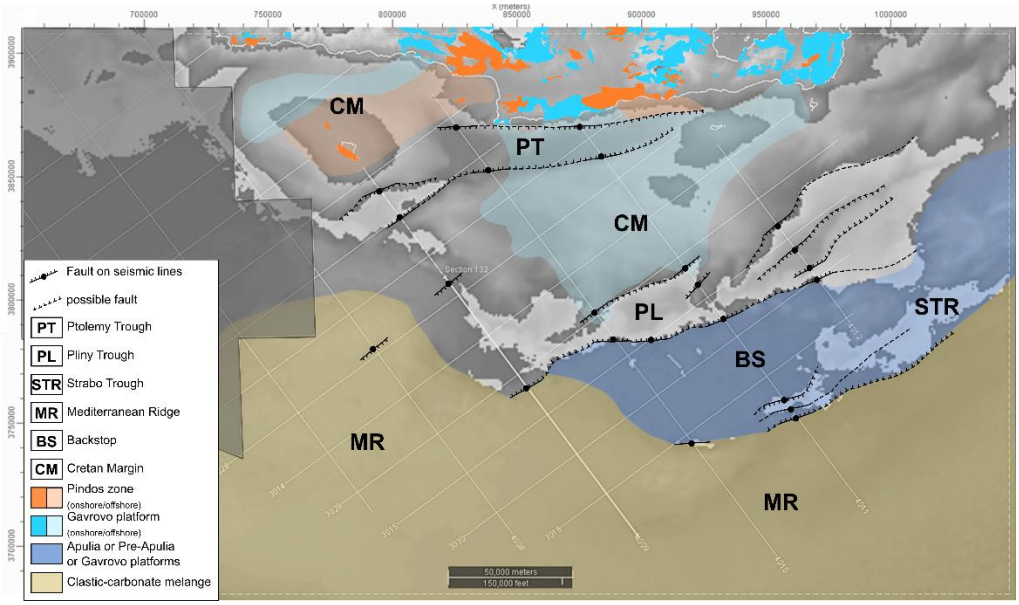

Figure 1: Geotectonic zones and geomorphological elements south of Crete.

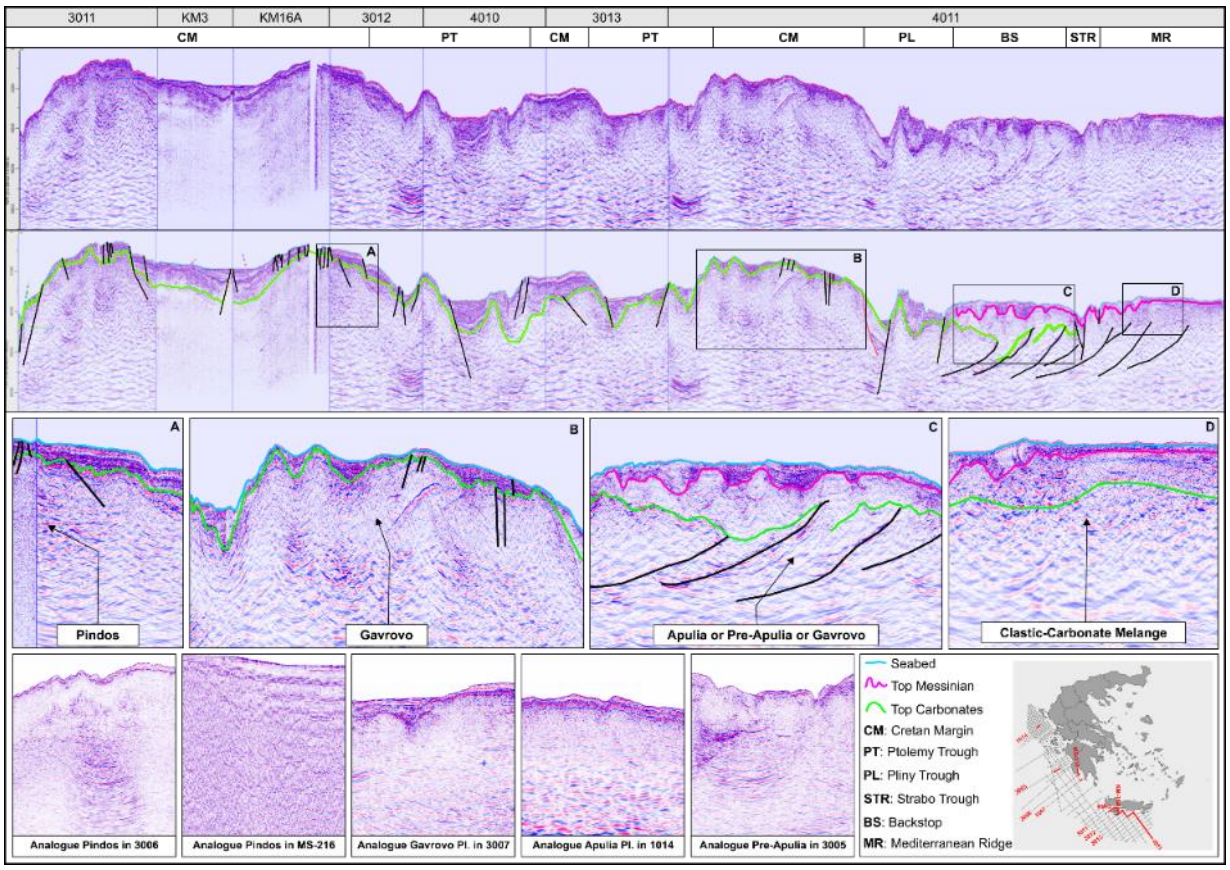

Figure 2: Seismic character of the geotectonic zones south of Crete compared to data from offshore western Greece.

Table 1. Seismic character identified in the distinct geological areas south of Crete.

South of Crete geological units		Cretan Margin		Backstop	Mediterranean Ridge
		West	East		
Pleistocene	Amplitude	High	High	High	High
	Frequency	High	High	High	High
	Continuity	Continuous	Continuous	Continuous	Continuous to discontinuous
Messinian-Pliocene	Amplitude	High	High	Low	Low to High
	Frequency	High	High	Low	Low to High
	Continuity	Continuous	Continuous	Transparent	Chaotic
Pre-Messinian	Amplitude	High	High	N/A	**
	Frequency	High	High	N/A	**
	Continuity	Continuous to discontinuous	Continuous to discontinuous	N/A	**
Carbonate*	Amplitude	Low	High	Locally High	Low
	Frequency	Low	Continuous to discontinuous	Low	Low
	Continuity	Transparent discontinuous	Transparent continuous to discontinuous	Chaotic to transparent	Chaotic

**The Mediterranean Ridge cannot be assigned to any known Hellenides zone. Mud volcanoes studies indicate a clastic/carbonate melange (Akhmanov et al., 2003) and perhaps Cretaceous to Pleistocene sediments according to Chaumillon et al. (1996).*

***Pre-Messinian series cannot be found in available seismic data, however it has been described by Akhmanov et al. (2003).*

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