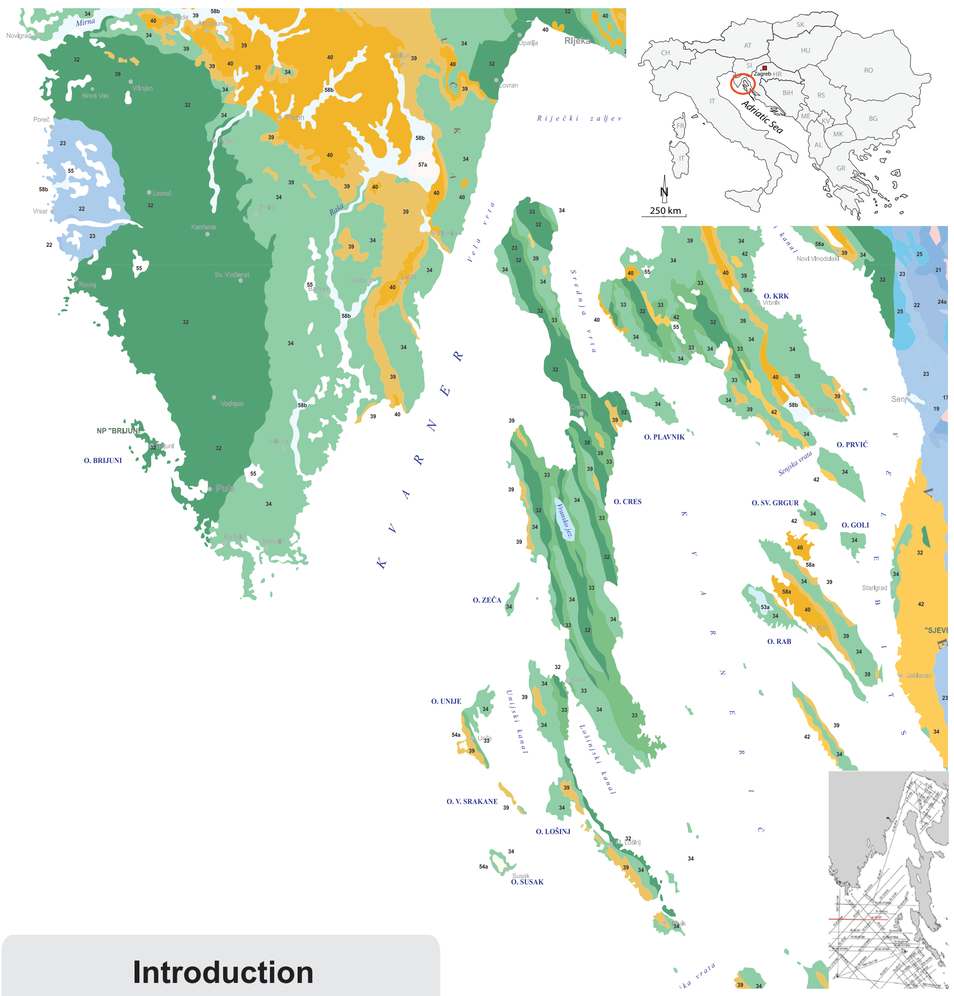
GEOLOGICAL AND SEISMIC FEATURES OF THE NORTHERN PART OF CROATIAN OFFSHORE AND KVARNER AREA

M. Špelić[1], Anna Del Ben[2]

[1]Croatian Geological Survey (Zagreb, Croatia), [2]University of Trieste, DMG (Trieste, Italy)



Introduction

This study presents an overview of structural and stratigraphic relationships of the northern part of Croatian offshore and Kvarner area. The availability of a large 2D seismic dataset covering the area, integrated by three boreholes and one sonic log allowed a good correlation between sedimentary units and seismic facies highlighted on the profiles.

Despite intensive geological and geophysical exploration during the past few decades, there is a lack of published work on seismic facies analysis and structural framework in this area. The present geological understanding in the part of a wider Dinaric and Adriatic area is mostly related to the studies conducted on the onshore (GKSFRJ, 1970; Vlahović et al., 2005; GKHR, 2009; Korbar, 2009 and references therein), or by integration of offshore seismic and well data (Đurasek et al., 1981; Prelogović, 1995; Grandić et al., 1999, 2001; Del Ben, 2002). However, majority of publication deals with southern Croatian (Prtoljan et al., 2007; Wrigley et al., 2012) and other with Italian part of Adriatic offshore area (Finetti, 2005; Busetti et al., 2010; Cazzini et al., 2015). Therefore, this study aims to give a geological meaning to main reflectors and compare them with onshore units by integration of interpreted structural framework. This was achieved by synthetic seismogram generation, while some seismic attributes were used to improve fault detection and better recognition of some deep reflectors, particularly the Top Triassic clastites/base Carbonates.

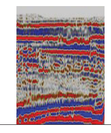
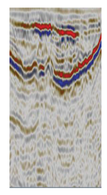
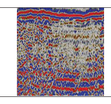
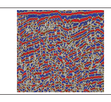
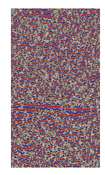
Geological map legend

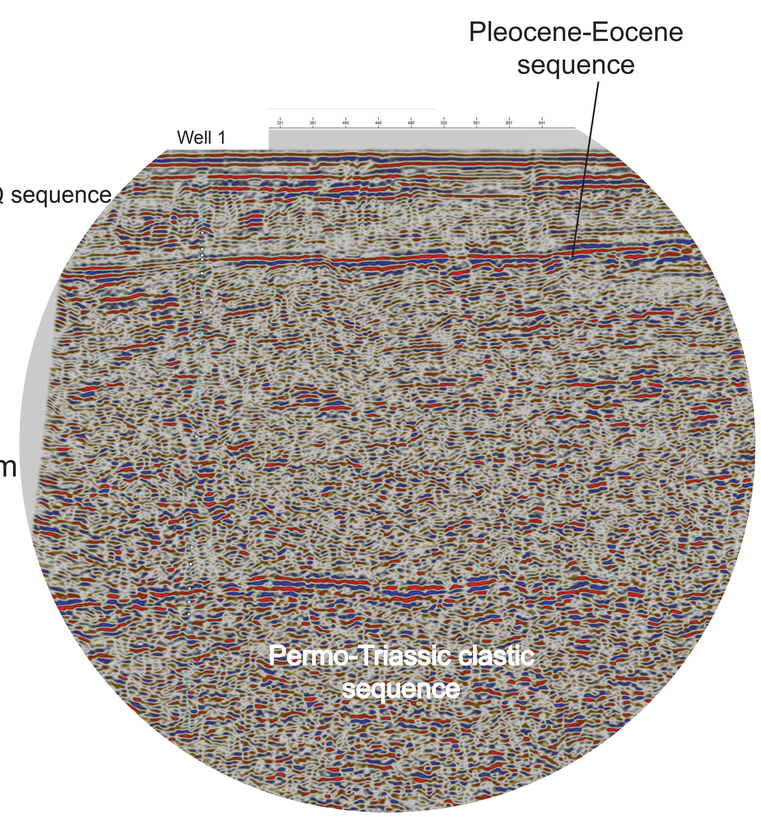
58 b	$dprQ_2$ aQ_2	38	Pc, E
57 b	jQ_2 bQ_2	35	K_1
56	pQ_2	34	K_2^{1-6}
55	tsQ_2	33	K_1^6, K
54 b	lQ_1 $jblQ_1$	32	K_1
53 b	aQ_1 fgQ_1	28	J_3^3, K_1^1
52	Pl,Q	25	$J_3^{2,3}$
51	M_3 - M_5	24 a b	J_3^{1-3}
42	Pg, Ng	23	J_3^1
41	E,Ol	22	J_2
40	$E_{2,3}$	21	J_1
39	?Pc, $E_{1,2}$		

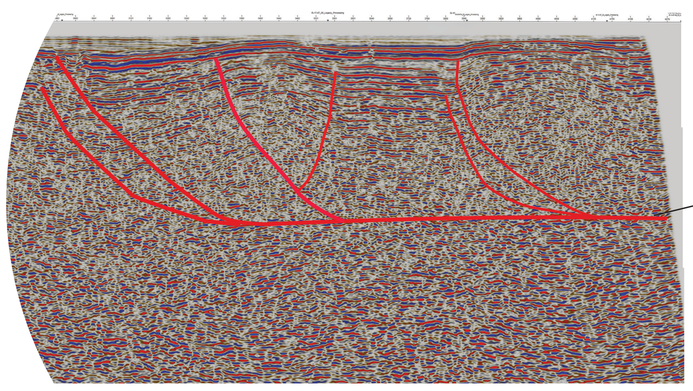
Discussion

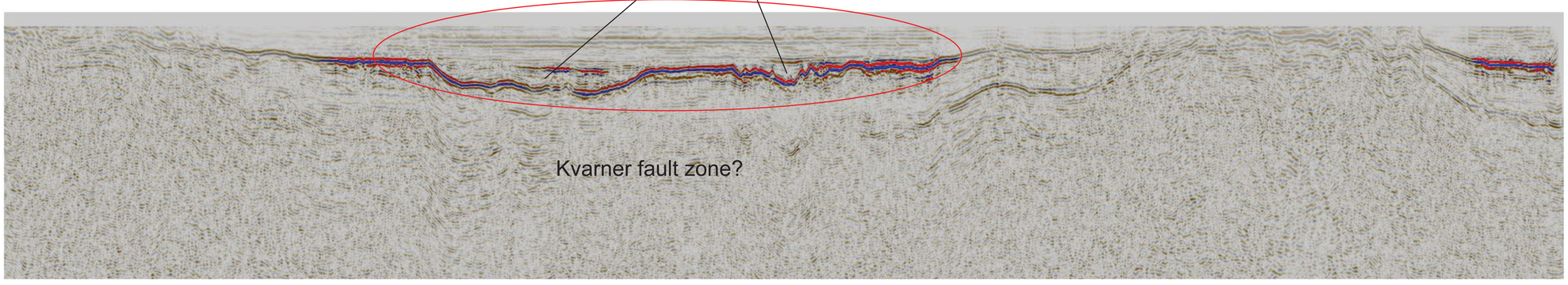
Interpreted seismic lines provide information about mapped seismic facies distribution. Whole sequence can be generally separated into some main sequences that are not always seismically well defined. From the bottom to the top, the first is the Permo-Triassic clastic sequence, characterized by deep low frequency reflectors below the Base Carbonates horizon. It is overlain by a thick sequence of Jurassic-Paleogene carbonates, with a changeable, mainly opaque seismic facies. This sequence is often tectonically and erosional disturbed, due to several episodes of intense erosion followed by karstification. Above this, the Eocene clastic sequence is often at the limit of the seismic resolution, with the Flysch unit only locally present, characterized by medium/high amplitude reflectors gradually disappearing toward west. The upper sequence is represented by Neogene and Quaternary siliclastic deposits, generally showing medium/high amplitude reflectors. The Messinian age processes can be recognized inside this sequence, with alternate process of sedimentation in some parts of the area, and simultaneous erosion in other parts. Erosional processes related to Messinian age are evident as large canyons especially present on the line from Susak Island to the Istria shoreline, while a regional erosional truncation characterizes the westward deepening outermost sector.

Seismic facies description

Lithological Unit	Age	Reflection geometry	Amplitude	Seismic facies example
Upper PQ	(Upper ? Pliocene-Quaternary)	Parallel, often discontinuous	Medium/ high amplitude	
Lower PQ	(Lower ? Pliocene)	Parallel, often discontinuous	Low amplitude	
PQ resedimented flysch	LowerPliocene, immediately after MES	Discontinuous, it onlaps the folded top of the flysch	Medium/low amplitude	
Flysch	Eocene	Continuous in the upper part, sometimes more discontinuous in the lower part, where more deformed	Medium/low amplitude	
Transitional beds	Eocene	No seismic resolution		
Foraminiferal limestone	Early to Middle or Late Eocene	Parallel discontinuous	Low amplitude, low frequency	
Liburnia Fm / Kozina unit/ transitional bed	Paleocene	No seismic resolution		
Upper Carbonate Platform	Cretaceous …..	Locally continuous, parallel and tilted reflectors with erosional truncation	Medium/high? amplitude	
Middle/Lower Carbonate Platform	Jurassic/ Upper Triassic	discontinuous	Low amplitude, low frequency, semi-opaque facies	
Clastic sequence	Permian-Lower Triassic	Continuous at the top package, discontinuous below	High amplitude, low frequency at the top package	







Conclusion

The wide available seismic reflection dataset has offered a good opportunity to depict the seismic-stratigraphy of the Kvarnar offshore. Recognition and interpretation of some peculiar seismic facies led to reconstruct the spatial distribution of the different sedimentary units. Their correlation with those mapped in the Istrian and northern Dalmatian onshore shall allow to depict the structural style and the origin of the tectonic activity recorded in the area. The Messinain canyons seem to be developed above the fault zones evidenced along the seismic profiles. Accordingly, the main potential fault system can be the Kvarner fault, already discussed in literature (Salopek, 1954; Juračić, 1999; Grandić et al., 2010; Korbar, 2009; Placer et al., 2010; Soto et al., 2017), and previously not well mapped offsohre. The frontal Dinarides thrusts have been recognized on the dataset, which seems to be affected by several flower structures in the western offshore area. They can be interpreted as part of a regional transpressional system, likely reactivated in recent times. The interpretation of units spatial distribution and of the regional structural style are in progress, due to the huge amount of data. 3D modeling tools and balanced sections are currently producing new results that will led new important information to define the recent tectonics of the studied area.

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