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

M. Špelić[1], A. Del Ben[2]
[1] *Croatian Geological Survey, Zagreb, Croatia*
[2] *University of Trieste, Department of Mathematics and Earth Sciences, Trieste, Italy*

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.

As result, 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.

Recognition and interpretation of the seismic facies led to reconstruction of the spatial distribution of the different sedimentary units and structures with aim to correlate them with those mapped onshore.

The Messinain canyons seem to be developed above the main fault zones evidenced along the seismic profiles. Accordingly, this can be the potential zone of Kvarner fault (Salopek, 1954; Juračić, 1999; Grandić *et al*., 2010; Korbar, 2009; Placer *et al*., 2010; Soto *et al*., 2017), which is previously not well mapped. One of the most important structures recognized on the dataset is the frontal Dinarides thrust: to the western offshore area, several transpressional faults are occurring, which can be described as part of a regional flower structure system, probably reactivated also in recent times.

The exact structural style, geometry and their relationship definition is in progress, due to the huge amount of data. 3D modeling tools and balanced sections are currently producing new results to better define the recent tectonics of the area.

Acknowledgements. This work is part of GEOSEKVA project (IP-06-2016-1854) funded by Croatian Science Foundation (HRZZ). The whole research is conducted using academic license of Petrel software, provided by Schlumberger Company. Authors are grateful to Croatian Hydrocarbon Agency (AZU) for 2D seismic and well data usage permission as well.

References

Aljinović, B., Prelogović, E., Skoko, D.; 1987: *Novi podaci o dubinskoj geološkoj građi i seizmotektonski aktivnim zonama u Jugoslaviji* (*New data on deep geological structure and seismotectonic active zone in region of Yugoslavia*). Geološki Vjesnik, 40, 255-263.

Busetti, M., Volpi, V., Barison, E., Giustiniani, M., Marchi, M., Ramella, R., Wardell, N., Zanolla, C.; 2010: *Meso-Cenozoic seismic stratigraphy and the tectonic setting of the Gulf of Trieste* (*northern Adriatic*). Geology of the Adriatic area, GeoActa, Special Publication, 3, 1-14.

Cazzini, F., Zotto, O., Fantoni, R., Ghielmi, M., Ronchi, P., Scotti P.; 2015: *Oil and gas in the Adriatic foreland, Italy*. Journal of Petroleum Geology, 38 (3), 255-279. DOI 10.1111/jpg.12610.

Del Ben, A.; 2002: *Interpretation of CROP M-16 Seismic Section in the the Central Adriatic Sea*. Mem. Soc. Geol. It, 57, 327-333.

Juračić, M., Benac, Č., Crmarić, R.; 1999: *Seabed and Surface Sediment Map of the Kvarner Region, Adriatic Sea, Croatia (Lithological Map, 1:500,000)*. Geologia Croatica, 52/2, 131-140, DOI 10.4154/GC.1999.11.

Finetti, I.; 2005: *CROP PROJECT: Deep Seismic Exploration of the Central Mediterranean and Italy*. Elsevier, Volume 1, 794.

GKSFRJ; 1970: *Geološka karta SFR Jugoslavije* (*Geological Map of the SFR Yugoslavia*) *scale 1:500.000*. Savezni geološki Zavod, Beograd (Federal geological Institute, Belgrade), 1 sheet.

GKHR; 2009: *Geološka karta Republike Hrvatske* (*Geological Map of the Republic of Croatia*) *scale 1:300.000*. Hrvatski geološki institut (Croatian Geological Survey), 1 sheet. <www.hgi-cgs.hr/ogk300/ogk300.html>.

Grandić, S., Boromisa-Balaš, E., Šušterčić, M., Kolbah, S.; 1999: *Hydrocarbon possibilities in the Eastern Adriatic Slope zone of Croatian offshore area*. Nafta, 50/2, 51-73.

Grandić, S., Biancone, M., Samaržija, J.; 2001: *Geophysical and stratigraphic evidence of the Triassic rift structuration in the Adriatic offshore area*. Nafta, 52/12, 383-396.

Grandić, S., Kratković, I., Rusan, I.; 2010: *Hydrocarbon potential assessment of the slope deposits along the SW Dinarides carbonate platform edge*. Nafta, 61 (7-8), 325-338.

Đurasek, N., Frank, G., Jenko, K., Kužina, A., Tončić-Gregl, R.; 1981: *Prilog poznavanju naftno-geoloških odnosa u sjeverozapadnom dijelu jadranskog podmorja*. (*Contribution to the understanding of oil-geological relations in NW Adriatic area*). In: Šolc, A. (Ed.), Kompleksna naftno-geološka problematika podmorja i priobalnih dijelova Jadranskog mora, (Complex Oil-geological Aspects for Offshore and Coastal Adriatic Areas), Split, Zbornik radova (Proceedings), I, 201-213.

Korbar, T.; 2009: *Orogenic evolution of the External Dinarides in the NE Adriatic region: a model constrained by tectonostratigraphy of Upper Cretaceous to Paleogene carbonates*. Earth-Science Reviews, 96, 296-312, DOI 10.1016/j.earscirev.2009.07.004.

Placer, L., Vrabec, M., Celarc, B.; 2010: *The bases for understanding of the NW Dinarides and Istria Peninsula tectonics*. Geologija, 53/1, 55-86, DOI 10.5474/geologija.2010.005.

Prelogović, E., Kuk, V., Jamičić, D., Aljinović, B., Marić, K.; 1995: *Seizmotektonska aktivnost Kvarnerskog područja*. In: Vlahović, I., Velić, I.,Šparica, M. (Eds.) Proceedings of the First Croatian Geological Congress, Opatija, vol. 2, Croatian geological society and Institute of geology, 487- 49.

Prtoljan B., Jamičić, D., Cvetko-Tešković, B., Kratković, I., Markulin, Ž.; 2007: *The influence of Late Cretaceous synsedimentary deformation on the Cenozoic structuration of the middle Adriatic, Croatia*. Geodinamica Acta, 20/5, 287-300, DOI 10.3166/ga.20.287-300.

Salopek, M.; 1954: *Prilozi poznavanju geološke građe Labinskog i Pićanskog basena Istre*. JAZU, 60.

Soto, I. J., Flinch, J., Tari, G.; 2017: *Permo-Triassic Salt Provinces of Europe, North Africa and the Atlantic Margins 1st Edition, Tectonics and Hydrocarbon Potential*. Elsevier, 632, DOI 10.1016/C2015-0-05796-3.

Vlahović I., Tišljar, J., Velić, I., Matičec D.; 2005: *Evolution of Adriatic Carbonate Platform: paleogeography, main events and depositional dynamics*. Paleogeography, Paleoclimatology, Paleoecology, 220/3-4, 333-360, DOI 10.1016/j.palaeo.2005.01.011.

Wrigley, R., Marszalek A., Rodriguez, K., Hodgson, N.; 2014: *Offshore Croatia – Hunting 'Big Oil' in the centre of Europe*. First Break, 32, 61-68.