First insights about Pliocene-Quaternary sedimentation in Neretva River palaeodelta

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ABSTRACT

The Neretva River is the longest river flow at the eastern coast of the Adriatic Sea. That entire coast is characterised very low material transport, in comparison with the west, and especially north-west coast. The Neretva River (palaeo) delta is selected as example for analysis of seismic interpretation of possible Pliocene and Quaternary sediments, deposited in geomorphologically highly tectonized areas. The extension of (palaeo) delta is interpreted in the Neretva Channel, and of (palaeo) prodelta in the part of the Korčula Channel.

INTRODUCTION

Sandy, silty and clayey clastic of Pliocene and Quaternary are proven along entire Adriatic Sea basin, however their thickness and composition is not homogeneous. They prevail in several Pliocene and Quaternary depressions, i.e. in Venetto, Po, Middle Adriatic, March-Abruzzi, Bradano and Adriatic-Ionian Depressions (e.g. Velić and Malvić, 2011; Prelogović and Kranjec, 1983). Their origin is connected with delta and prodelta of surrounding inland rivers and pelagic basin sedimentation. The most terrigenous clastics had been transported in the largest palaeodeltas located on the north-western Adriatic coast, i.e. in palaeodelta of the Po, Adige and Piave rivers, i.e. in the Po and Venetto Depressions. The several smaller deltas are developed on the Italian coast, spreading in the Marche-Abruzzi and Bradano Depressions. Generally, all Pliocene and Quaternary sediments (consolidated and unconsolidated) of such origin are characterised by high porosity and permeability values, and somewhere encompass commercial gas reserves. Such deltas at least existed in the last several million years, both at the western and eastern coasts of the palaeo Adriatic Sea, highly influenced with palaeotopology. However, at the eastern (mostly Croatian) coast are not established any Pliocene-Quaternary depression, like on the western coast, which would be filled with river transported clastics, although there existed several smaller rivers. Here are analysed depth and thickness of sediments visible on seismic sections from one of the largest such rivers – the Neretva River.

PALAEOGEOGRAPHY AT THE EASTERN (CROATIAN) ADRIATIC COAST

The main feature of the eastern Adriatic coast is extremely geomorphological diversification, especially in comparison with western coast. It is mostly results of subduction and disintegration (Vlahović et al., 2005) of Adriatic Carbonate Platform (AdCP) in Palaeogene what continued in folding and faulting of Dinarides (as part of AdCP). Many regional fault zones and mountain ranges, especially of dominant Dinaric fault strike (NW-SE), had been formed. Ad result, the main drainage divide between Mediterranean and Black Sea basins is just near the eastern coast of the Adriatic Sea (**Figure 1**. It is why there had not been developed long and ramified river flows like the Po River that could accumulate and transport large quantities of terrigenous clastics and deposit it with delta and prodelta mechanisms.

The larger river flows at the eastern coast of the Adriatic Sea are (from the north to the south) Soča, Raša, Zrmanja, Krka, Cetina, Neretva and Bojana Rivers. The most remarkable river is the Neretva River with the length 225 km and delta area approx. 170 km^2, which also can be considered as estuary, due to large influence of tide. However, areal extension of delta is determined with inland relief, i.e. location of the Pelješac Peninsula and Hvar, Šćedro and Brač Islands (**Figure 2)**.

It means that river material could be deposited only in narrow channels among coast, the Pelješac Peninsula and islands. These inland geomorphological units existed in similar positions during Pliocene and Quaternary, and even in Quaternary glacial periods had been part of land.

SEISMIC SECTIONS OF THE NERETVA DELTA

Pliocene and Quaternary sediments along the eastern coast of the Adriatic Sea have a different portion of hemipelagic deposits compared with such sediments along the western coast, due to smaller transport energy. It depends on palaeostructural evolution, which can be very well estimated from contemporary structural relations, due to analysis of relatively young structures and sediments. So, here is first try of structural analysis of (probably) Pl-Q sequence (but for sure Cenozoic sequence), based on 3 seismic sections selected from the set of 10 available in the wider area of the Neretva Delta (*from the archive of INA-Industry of Oil Plc.*).

Seismic interpretation in the analyzed area (about 1500 km^2) had been uncertain due to lack of well information, and consequently spatially available marker horizons. It means that only the most certain seismic reflection was easily followed regionally. It was border between Mesozoic and Cenozoic. The single available well, with marker horizons, was approx. 90 km on the west from the Neretva Delta (**Figure 2**).

Moreover, the primary goal of seismic acquisitions in the eastern coast of the Adriatic Sea, until to discoveries of the Northern Adriatic gas field, had been Mesozoic and older rocks, where had been expected hydrocarbon traps. It means that vertical resolution had not been focused on Cenozoic sediments, which are locally very thin, and any correlation of regional markers in this area includes a lot of assumptions, especially for interpretation of possible “bright spot” or “pull-down” effect.

The longest seismic section A-A' (**Figure 3**), interpreted in time scale, indicated that thickness of entire Cenozoic sequence in small, especially in intra-island channels. Moreover, the Cenozoic structures are folded only in older part as results forms heritage from palaeorelief.

Section (A-A') follows transversal direction of sediments, probably in the first 15-20 km mostly deposited in the Neretva River palaeodelta. There are also numerous reverse faults in Mesozoic rocks that shaped basement. Furthermore, palaeo delta and prodelta cannot be distinguished from available dataset, but if Cenozoic sediments are assumed to belong the Neretva deposits, they were probably part of prodelta that extended parallel with top of the Pelješac Peninsula and the Hvar Island. There is easily recognized increasing of thickness (**Figure 3**) toward the west, i.e. the small Šćedro Island.

The next seismic section B-B' (**Figure 4**) is located approximately perpendicular (**Figure 2**) at the contemporary delta of the Neretva River. It is easy to recognize the thickest part (syncline) almost in the middle of the Pelješac Channel.

The last one section C-C' (**Figure 5**) is located inside (transversal) in the Pelješac Channel (**Figure 2**) and excellent reveal the thickness increasing toward the Hvar Island. If the eastern part of Cenozoic sediments on the **Figure 3** is considered as prodelta, then these on the **Figure 5** belonged to delta environment. Here, at **Figure 5**, is clearly visible the direction of detritus transport, which had been followed in entire Cenozoic sequence. The maximal vertical depth of those clastics is about 150 ms, what is approximately 130 m.

Figure 1: *Drainage divides in Europe (from http://hr.wikipedia.org/wiki/Datoteka:Europ%C3%A4isches_Wasserscheiden.png)*

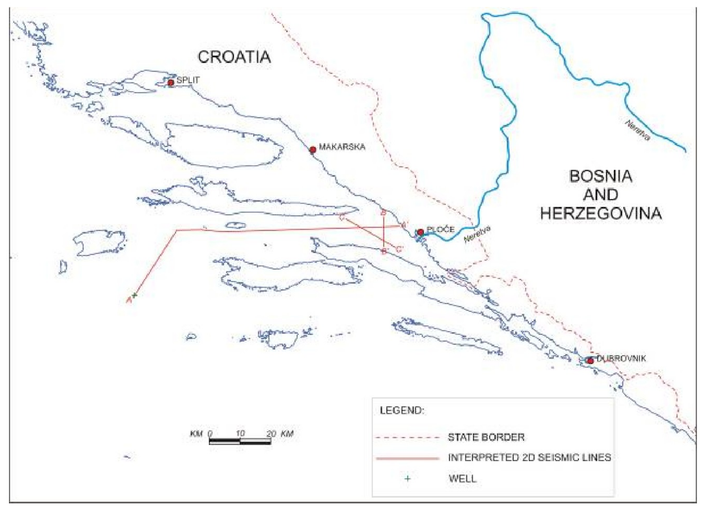

Figure 2: *The location of delta of the Neretva River and analysed 2D seismic lines*

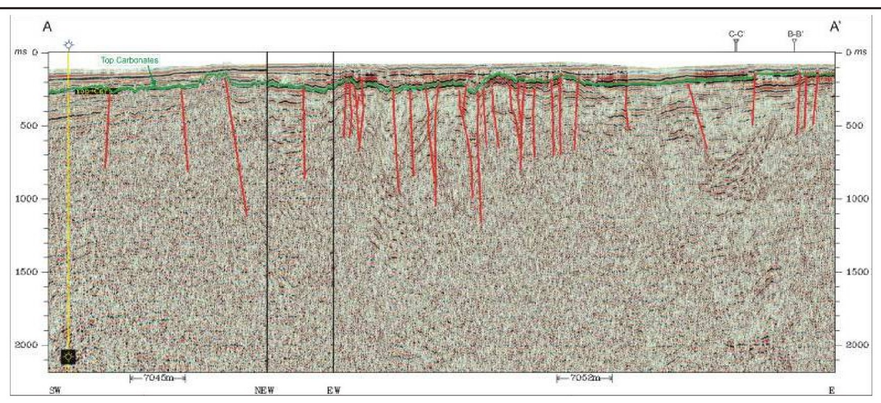

Figure 3: *Interpreted seismic section A-A’ (time domain)*

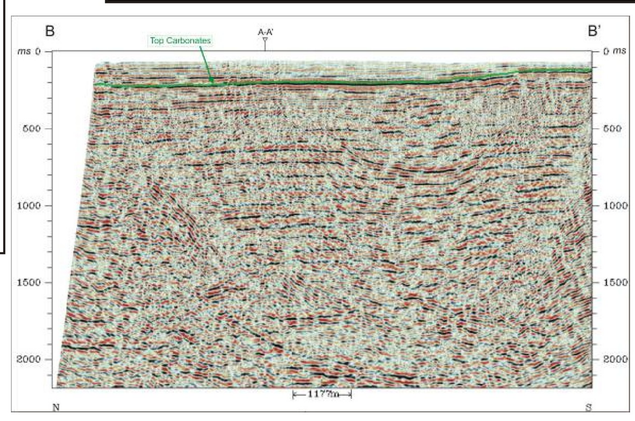

Figure 4: *Interpreted seismic section B-B’ (time domain)*

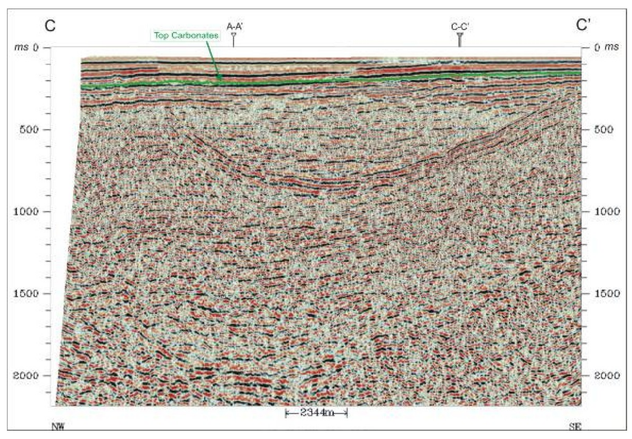

Figure 5: *Interpreted seismic section C-C’ (time domain)*

CONCLUSIONS

This is the first seismic analysis of Cenozoic clastic in the area of the Neretva River delta. The contemporary borders of the Adriatic Sea started to form after Messinian salinity crisis. It is why authors assumed that contemporary rivers mostly also existed in the last 5-6 Ma, i.e. in the Pliocene and Quaternary periods. Indirectly, authors supposed that analysed Cenozoic sediments belong to Pliocene and Quaternary periods.

Moreover, the delta and prodelta progradation can be easily followed on presented seismic sections (**Figures 3, 4, 5**), especially at **Figure 5** even to the Mesozoic basement, what is the second indirect prove that entire Cenozoic sequence is of Pliocene and Quaternary age, when is assumed activity of the palaeo Neretva River mouth. Also, the analogy with Pliocene and Quaternary sedimentation in the Po Depression is used.

However, the possible lateral extension of analysed delta and prodelta sediments had been highly restricted with geomorphological units exposed inland in the past. It means that the thickness of clastics is significantly lower than in e.g. the Po or Venetto Depressions. Consequently, the formed anticlines have the very small potential structural closure, smaller than in the northern Adriatic in the sediments of the same age.

To explore hydrocarbon potential of described sediments, it would be useful to perform additional seismic exploration and drill at least one well southern from the Hvar and Korčula Islands. Such results could probably show extension and thickness of possible prodelta sediments deposited in the glacial periods, in areas where the Mesozoic basement had been deeper.

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