

## Exploration Country Focus: Ukraine\*

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### Introduction

The following brief country overview of Ukraine highlights some exploration aspects in this country in the context of the AAPG Europe Annual Meeting in Kiev, October 17-19, 2010. Ukraine has a long-standing history in oil exploration as some of the early oil discoveries along the Carpathians occurred in the 19th century. The very diverse and spectacular geology of Ukraine translates to distinct petroleum provinces across the country ([Figure 1](#)). The most important regions, such as the Carpathian folded belt and its foreland, the Dnieper-Donetsk Basin, the Black Sea shelf and deepwater regions will be shortly described below in the context of the traditional, emerging and untested play types.

### Carpathians

The Ukrainian segment of the Carpathian folded belt and its foreland basin is located in the westernmost part of the country, next to Poland, Slovakia, Hungary and Romania ([Figure 1](#)).

The regional transect ([Figure 2](#)) taken from Oszczypko et al. (2005) illustrates well the structural complexity of this petroleum province. Most of the production comes from the folded belt itself with the structural traps in various nappe and imbricate units. Note that most of the fields were found based on surface geology, prior to acquisition of any seismic reflection data.

Some of the fields are situated in the autochthonous platform sequence of the foreland. In this particular petroleum basin the main challenge is to find more traps associated with the well established play types using modern structural geology (e.g., cross-section balancing) and acquiring better seismic to image the deeper parts of the foldbelts. Besides modern long-offset seismic-reflection data, sub-regional- to regional-scale potential field data could help to position deep to ultradeep wells testing the platform sequences underneath the Carpathians.

## **Dnieper-Donetsk Basin**

The Dnieper-Donetsk basin, to date the most important hydrocarbon province of the Ukraine, is an elongated Late Devonian rift basin located in the northeastern part of the country ([Figure 1](#)). The basin is large, measuring around 500 by 100 km, and very deep, with a total sedimentary column locally thicker than 15 km. The Precambrian basement of the Ukrainian shield borders the basin to the southwest, whereas to the northeast it is the Voronezh regional basement high covered by a thin veneer of Paleozoic sedimentary rocks. The Dnieper-Donetsk basin shows a gradual transition to the southeast to the Donbas folded belt, which is a structurally inverted and much more deformed continuation of the same rift (aulacogen) system.

Most of the hydrocarbon accumulations were found within the Carboniferous to Early Permian post-rift series ([Figure 3](#)). Source rock intervals occur in the Devonian syn-rift and Carboniferous post-rift series. These units reached the maturation window by the end of the Paleozoic (Ulmishek, 2001), and the subsequent inversional episodes are thought to be responsible for the re-migration of hydrocarbons resulting in fairly complex charge/trap-timing scenarios.

Most of the traps are the related to salt tectonics ([Figure 3](#)); however, the full spectrum of salt-related play types remains to be further explored, mostly due to the quality of the typically available vintage seismic-reflection data. Therefore, better imaging and understanding of the deep structure by acquiring modern 2D/3D seismic data could result in a revival of this classical Ukrainian petroleum province.

## **Black Sea, Shelf, and Deepwater**

The Ukrainian part of the Black Sea shelf has two major parts, the Gulf of Odessa and the Sea of Azov ([Figure 1](#)). In between, the shelf is quite narrow on the southern margin of Crimea and the Kerch Peninsula ([Figure 4](#)). In the Gulf of Odessa about 90 wells were drilled during the last four decades (Khriachtchevskaia et al., 2009). Note that this is quite a small number, considering the area ([Figure 1](#)). Eight gas/gas-condensate fields were discovered within the Odessa shelf to date, totaling about 2 TCF of gas. So far, exploration activity targeted mostly inverted structural traps that were formed due to compressional tectonic events during the late Eocene and middle Miocene ([Figure 5](#)). The main productive horizons are located in Upper Cretaceous (Maastrichtian), Paleocene, Eocene, Oligocene and lower Miocene sequences. Oligocene to lower Miocene Maykop shales and Aptian-Albian mudstones are thought to be the effective source rocks in the area. However, deeper stratigraphic levels might have also contributed to the gas charge documented so far. The next steps for exploration on the Odessa shelf are fairly straightforward as there are some sixty undrilled structures known in the area (Khriachtchevskaia et al., 2009). Therefore the existing play types are far from being exhausted. Until just recently, there were no 3D seismic surveys acquired in the entire area; therefore, stratigraphic traps within the Paleocene-Eocene units could not be addressed properly. Similarly, deeper structural levels within the Mesozoic remain completely unexplored, despite the significant resource potential.

The offshore foldbelt (informally called Sudak folded belt) is situated just south of the Crimea and the Kerch peninsula, and it extends into the deepwater bounding the Sorokin foredeep basin from the north ([Figure 6](#)). A few prominent syn-rift structures (e.g., Tetyaev High) in the broader Ukrainian deepwater area provide multiple untested play types ([Figure 6](#)), with very significant exploration potential.

## **Unconventional Resources, Basin-Centered Gas, and Shale-Gas Potential**

Besides the conventional exploration play types highlighted above, Ukraine appears to have significant unconventional resource potential as well. In particular, the Dnieper-Donetsk basin may have a very large basin-centered gas accumulation, based on the presence of overpressure and reported gas shows within the Carboniferous (Dyman et al., 2000). As to the shale-gas potential in general, Ukraine has, for example, a very similar, if not identical, Silurian-Lower Devonian black shale succession to that of Poland. The target areas are located near the Polish border in the foreland of the Carpathians and between Moldova and the Black Sea coast ([Figure 1](#)).

### **Conclusions**

Ukraine has a lot to offer to a determined explorationist. Despite many years of dedicated and solid exploration efforts by our Ukrainian colleagues, there are still areas/basins which remain underexplored. This is primarily due to the lack of proper technology and funding during Soviet times. As the most important example, the entire Ukrainian sector of the deepwater Black Sea is practically unexplored. In the process of trying to become a largely energy-independent country by finding and producing significant hydrocarbon resources/reserves, the next decade will be critical for Ukraine.

### **Acknowledgements**

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Figure 1. Simplified subdivision of the major Ukrainian geologic provinces. Approximate locations of Figures 2-6 are shown by black lines.



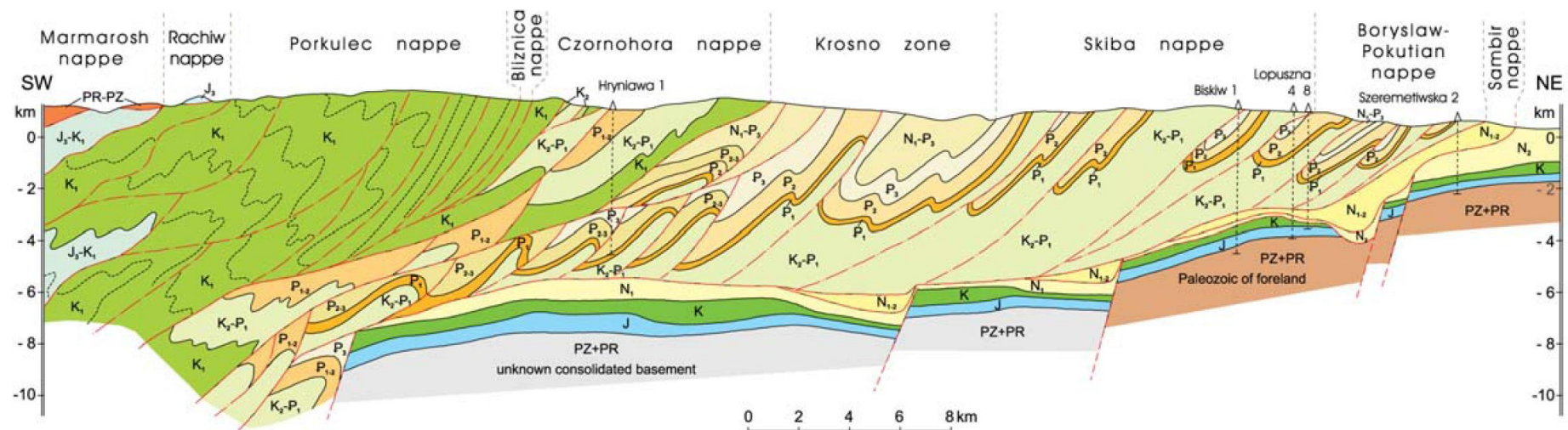


Figure 2. Typical cross-section across Ukrainian Carpathians, adapted from Oszczytko et al. (2005). For approximate location see [Figure 1](#).

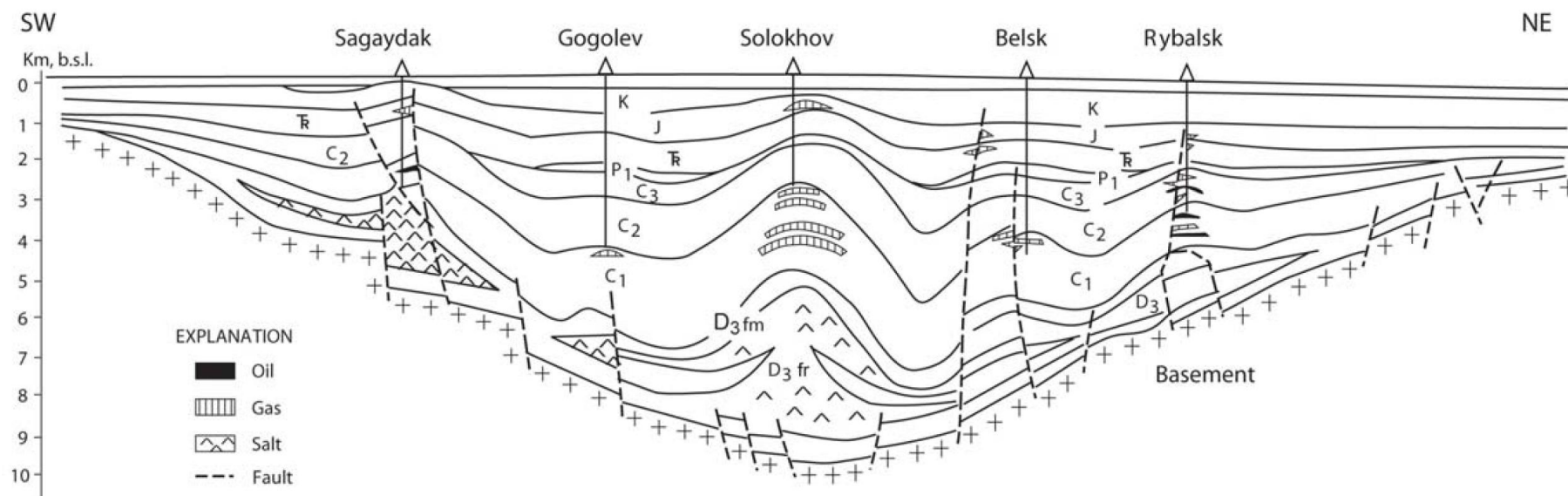


Figure 3. Cross-section of the Dnieper-Donetsk basin, adapted from Ulmishek (2001). For location see [Figure 1](#). D3fr and D3fm are Frasnian and Famennian stages, respectively, of the Upper Devonian; C1, C2, and C3 are Lower, Middle and Upper Carboniferous, respectively; P1, Lower Permian; Tr, Triassic; J, Jurassic, K, Cretaceous. Approximate length of the section is 160 km.



Figure 4. Bathymetry of the Black Sea. Image taken from the public website of GeoLogic Data systems:  
<http://www.geologicdata.com/products.html>.



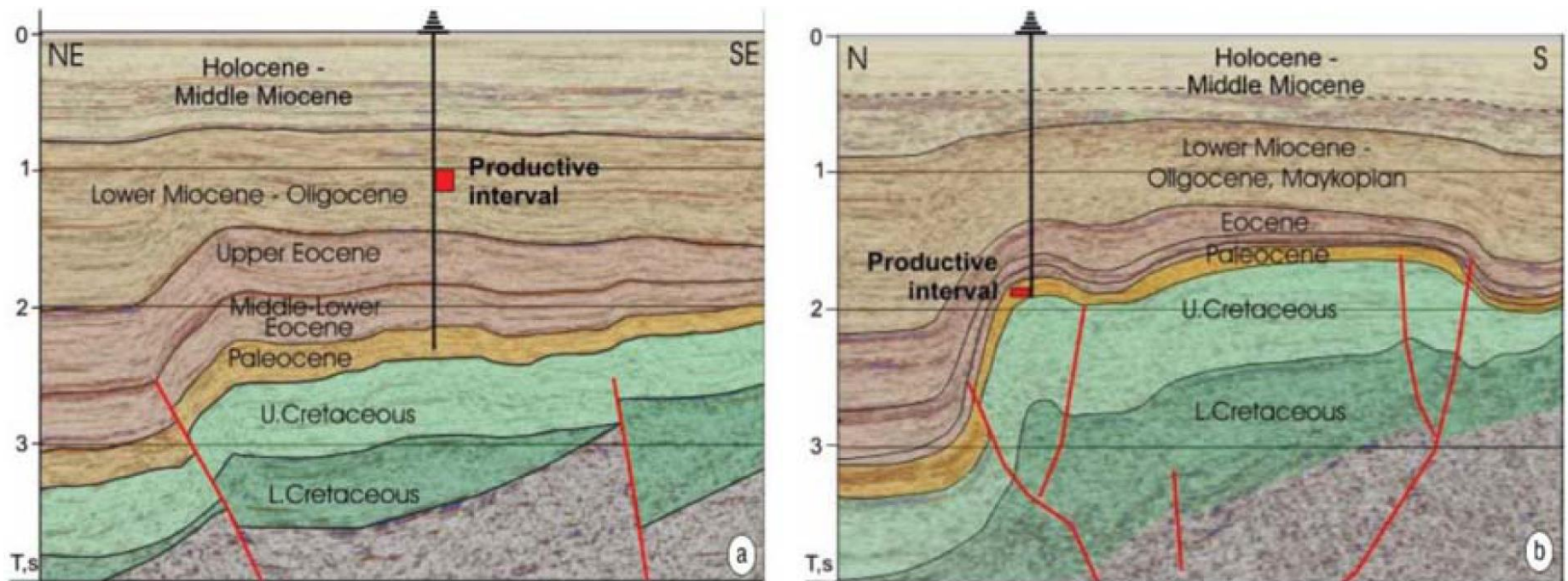


Figure 5. Seismic expression of typical inverted structures of the Odessa shelf: a) Krymskaya and b) Shtormovaya. For an approximate location see [Figure 1](#), adapted from Khriachtchevskaia et al. (2009).

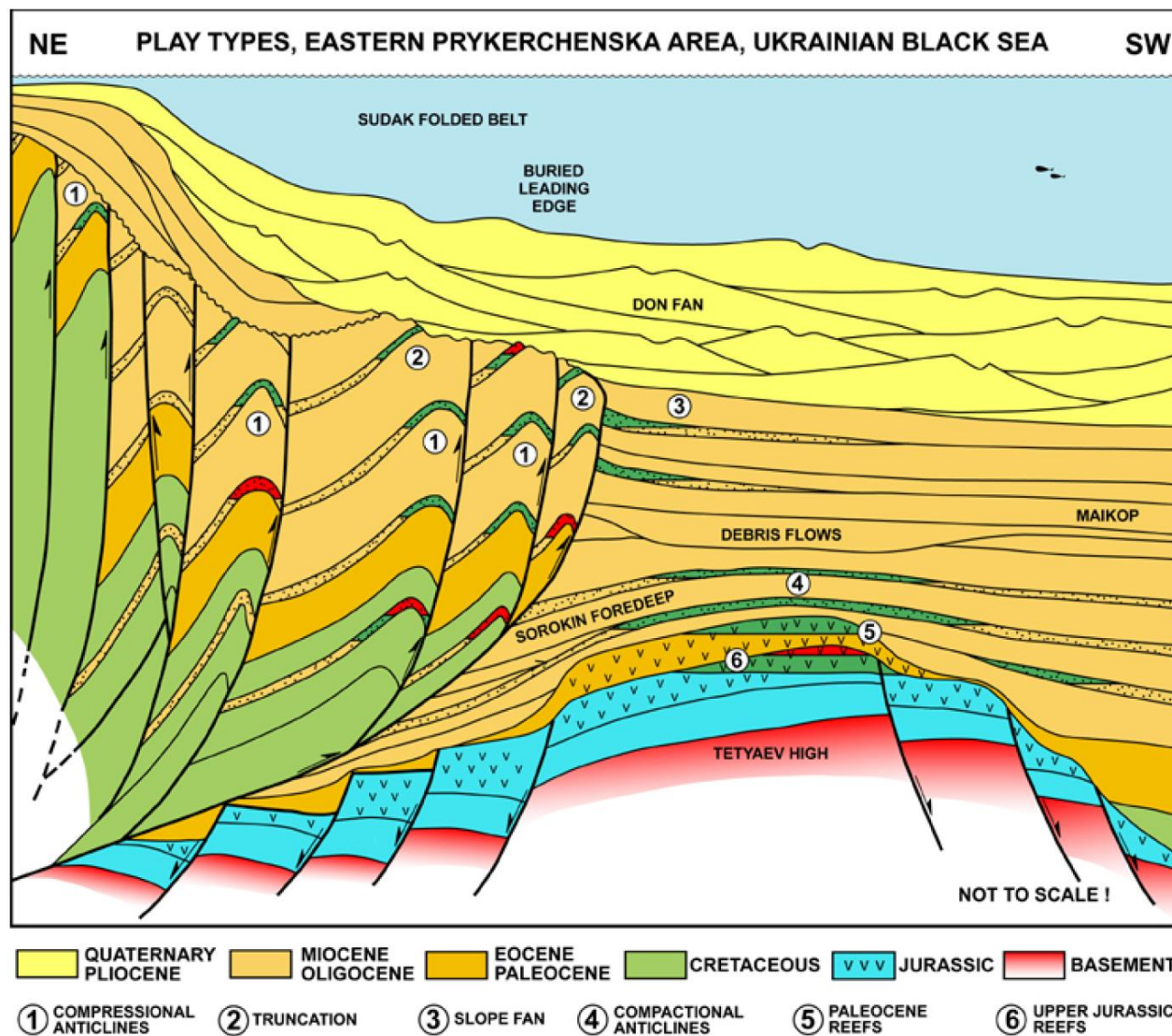


Figure 6. Deepwater play types in the area south of Crimea and the Kerch peninsula, for an approximate location see [Figure 1](#). Image taken in 2008 from the public web-site of Vanco Energy Company: <http://www.vancoenergy.com/>.