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Geological Structure, Geodynamic Evolution and Hydrocarbon Potential of NE Black Sea Region

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SUMMARY

Here we present the synthesis of available geological and geophysical data in order to discuss the present-day structure, geological history and hydrocarbon potential of northeastern Black Sea region, including Shatsky Ridge, Tuapse Basin, Western and Eastern Black Sea basins. Regional geology and Mesozoic - Cenozoic geodynamic evolution are considered.

Here we present the synthesis of available geological and geophysical data in order to discuss the present-day structure, geological history and hydrocarbon potential of northeastern Black Sea region, including Shatsky Ridge and Tuapse Basin (fig. 1). It is well-known, that Shatsky Ridge is one of the main buried hydrocarbon potential structures of the Black Sea basin. According to interpretation of seismic data (Finetti et al., 1988), the Shatsky Ridge is overthrusted on the Eastern Black Sea basin. The timing of this event supposed to be the end of Paleocene – beginning of Oligocene. According to another point of view (Robinson et al., 1996), southwestern flank of the ridge is complicated by series of listric normal faults and, thus, represents passive margin (with no evidence of inversion) formed as the result of Paleocene (?) rifting. Tuapse depression is the typical foredeep basin, located to the south-east from the front of Greater Caucasian orogen. Prior to the Mid-Miocene time the Shatsky Ridge represented the border between Eastern Black Sea and Greater Caucasus basins, whereas Andrusov Ridge - between Western and Eastern Black Sea basins (Kazmin and Lobkovsky, 2003) (fig. 1).

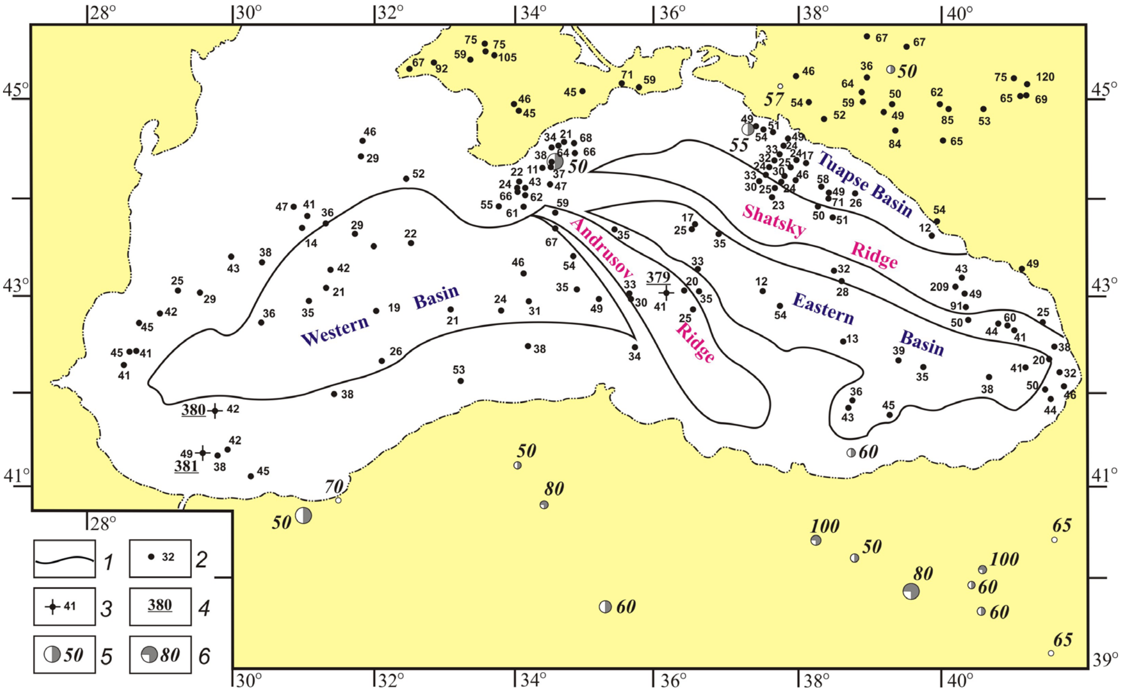

Fig. 1. Main geological structures, heat flow and mantle seismicity of Black Sea region (Verzhbitsky, 2003).

1 – the boundaries of main geological structures; 2 – heat flow measurements stations (mWt/m^3); 3 – the same, in deep-drilled wells; 4 – numbers of deep-drilled wells; 5,6 – depths of mantle earthquakes hypocenters: 5 – 50-75 km, 6 – 75-100 km.

It is believed, that all the mentioned above ancient depressions represent the Mesozoic-Early Cenozoic back-arc basins of Tethys paleoocean (Adamia et al., 1977; etc). The opening of Greater Caucasian basin started in Early Jurassic time. The timing of the Western and Eastern Black Sea basins opening is still a matter of discussion. Several attempts to determine the age of opening on the basis of heat flow analysis (fig. 1) led to the controversial results. Golmshtok et al. (1992) have calculated the Hauterivian/Barremian-Cenomanian (~130-95 Ma) age for Western and Albian (~110 Ma) for Eastern basin. The later modeling results by (Verzhbitsky et al., 2003) pointed to the Maastrichtian-Danian/Selandian (~70-60 Ma) probable age for both of the basins (fig. 2).

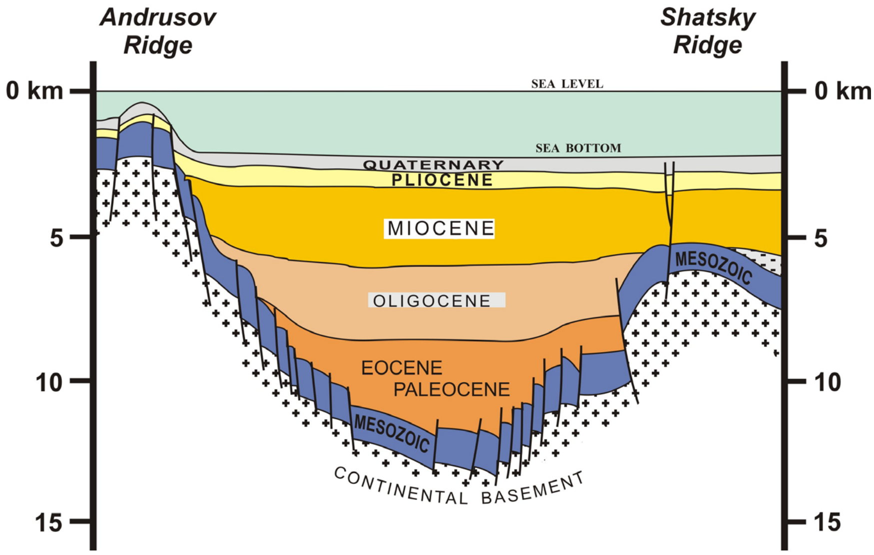

Fig. 2. Interpreted seismic section across (from SW to NE) Andrusov Ridge, Eastern Black Sea Basin and Shatsky Ridge. After (Finetti et al., 1988) from (Verzhbitsky et al., 2003).

An analysis of magnetic field of the Eastern Black Sea basins led to suggestion, that narrow zone of Late Maastrichtian-Paleocene oceanic crust adjoins Shatsky ridge (Shreider et al., 1997). The later research of Eastern basin magnetic field pointed to its opening during Campanian-Maastrichtian, ~ 74-70 Ma (Shreider, 2005). Recent calculations for the Western basin led to the similar results - Campanian-Maastrichtian, ~ 71.5-69 Ma (Kaz'min et al., 2007). On the basis of available onshore and offshore geological data compilation and analysis, Kazmin et al. (2007) pointed to the Paleocene-Eocene time of main phase of Eastern Black Sea Basin opening, although the basin formation initiation might took place much earlier, during Albian-Cenomanian time. From the other hand, the rifting/spreading processes in the Western Basin may correspond to Aptian-Cenomanian time span and were completed in Turonian (Kazmin et al. 2007).

Arabia/Eurasia collision-related inversion of Greater Caucasus basin began in the Late Eocene. It caused the overthrusting of Shatsky Ridge northeastern margin by the Greater Caucasian fold belt and related formation of Tuapse foredeep basin (fig. 3).

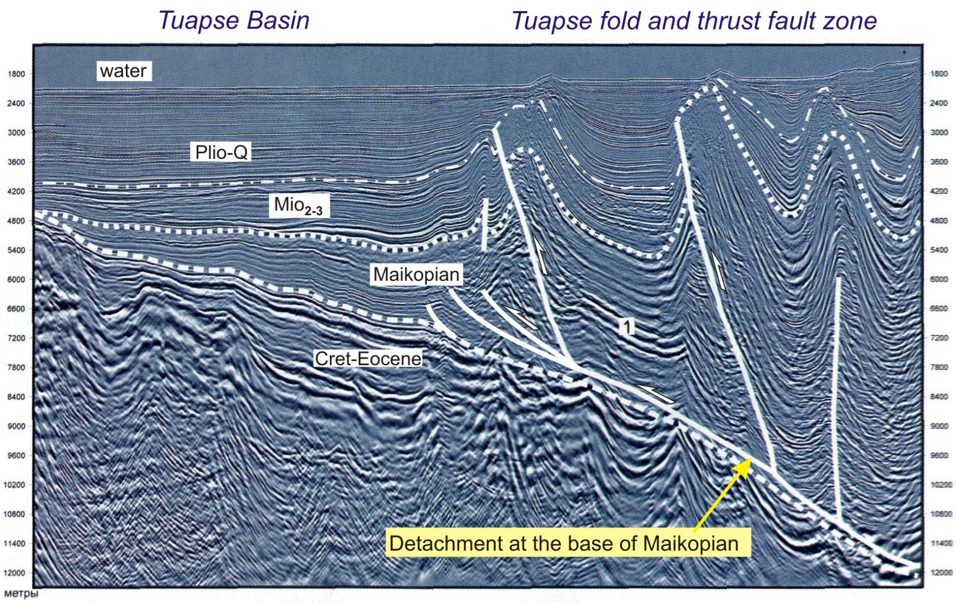

Fig. 3. The interpreted seismic section of WBS-02-40 profile, illustrating the structural style of Tuapse Basin. Slightly modified after (Afanasenkov et al., 2007).

During the Oligocene-Early Miocene time it had being filled by argillaceous sediments of Maikopian formation (Caucasian “Lower molasse” by V.E.Khain). Most of the researches agreed, that subsequent Mid-Late Miocene general compression led to the final inversion and formation of Greater Caucasian orogen. The still active deformation of Tuapse basin sediments is related to the Shatsky Ridge underthrusting or pseudosubduction (Khain, 2003) in the north-northeastern direction beneath the Caucasus orogen. The main detachments appears to be at the base of Oligocene-top Eocene and, probably, at the lower levels also (Kazmin and Lobkovsky, 2003; Afanasenkov et al., 2007; etc) (fig. 3). Recent rapid subsidence of the Black Sea region during Neogene-Quaternary were considered and modeled by (Nikishin et al., 2003).

On the basis of seismological and structural data, the independent Eastern Black Sea microplate were defined by V.G.Kazmin (Kazmin and Lobkovsky, 2003; Kazmin et al., 2004), which plays the key role in the present-day regional geodynamics. The microplate is bounded by seismic belts, while its interior part is seismically inactive(fig. 4). Relative to the Eurasian, the microplate is moving towards the north-west and clockwise rotating. Eastern Black Sea basin, Andrusov and Shatsky Ridges belong to the interior part of Eastern Black Sea microplate, whereas the frontal thrusts of Greater Caucasus, Southern Crimea, Sorokin and Tuapse Basins represents its northern compressional / transpressional boundary (Kazmin and Lobkovsky, 2003; Kazmin et al., 2004).

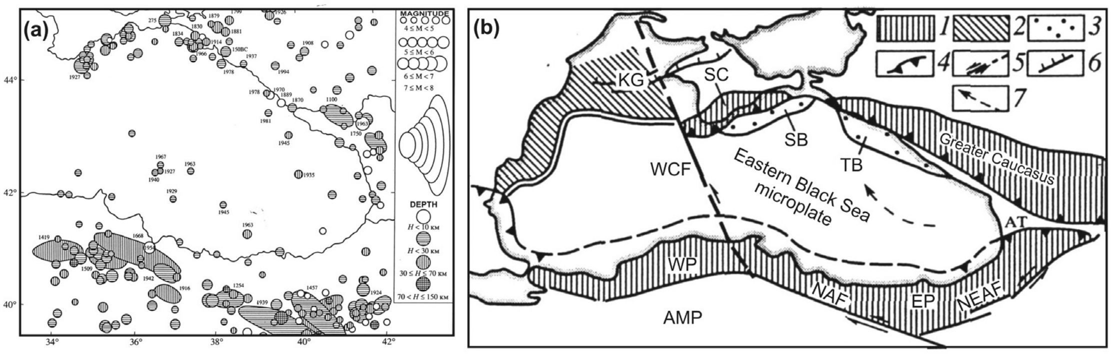

Fig. 4. Seismicity (a) and present-day geodynamics (b) of the Eastern Black Sea region. Compiled after (Kazmin and Lobkovsky, 2003; Kazmin et al., 2004). The epicentral areas are shown for (a).

1 – fold belts; 2 – passive margin; 3 – foredeep basin; main thrust front; 5 – strike-slip fault; 6 – normal fault; 6 – sense of Eastern Black Sea microplate rotation.

AMP – Anatolian microplate; AT – Adjaro-Trialetian thrust; EP – Eastern Pontides; WCF – Western Crimea Fault; WP – Western Pontides; KG – Karkinit graben; SB – Sorokin Basin; NAF – Northern Anatolian fault; NEAF – Northeast Anatolian fault; TB – Tuapse Basin; SC – South Crimea terrane.

The oil and gas fields of adjoining to Northeastern Black Sea onshore regions are known for Upper Cretaceous, Upper Miocene (oil) and Upper Jurassic (condensate) sediments; oil and gas shows and small accumulations are known for Jurassic, Cretaceous and Paleogene-Neogene sediments along the Northeastern coast of Black Sea (e.g. Afanasenkov et al., 2007). Tuapse basin and Shatsky Ridge proposed oil source rocks may correspond to Lower-Middle Jurassic and Aptian-Albian argillites, black shales in Upper Cenomanian, and also Upper Miocene and Maikopian sedimentary successions, whereas upper part of Upper Jurassic carbonates, Mid-Eocene limestones, Maikopian and Neogene turbidite fan deposits, and Miocene paleochannels may represent potential reservoirs for hydrocarbons (Afanasenkov et al., 2007). It is interesting to note also, that geochemical investigations of the bottom sediments on the Shatsky Ridge area have revealed the maximum methane concentration above Doobskaya and Maria potential structures (Egorov, 2003). This result may point to the existence of regional channels of hydrocarbon gases migration, probably associated with fault zones (Egorov, 2003). Proposed gas chimneys and bright spot seismic anomalies over the Shatsky Ridge support this idea. The independent geothermal modeling results (Galushkin et al., 2007) also argue for the significant regional hydrocarbon potential of Mesozoic and Cenozoic offshore sedimentary successions.

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