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Research paper

The Black Sea basins structure and history: New model based on new deep penetration regional seismic data. Part 1: Basins structure and fill

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ABSTRACT

This work is based upon results of interpretation of about 8872 km-long regional seismic lines acquired in 2011 within the international project *Geology Without Limits* in the Black Sea. The seismic lines cover nearly the entire Black Sea Basins, including Russia, Turkey, Ukraine, Romania and Bulgaria sectors. A new map of acoustic basement relief and a new tectonic structure scheme are constructed for the Black Sea Basins. The basement of the Black Sea includes areas with oceanic crust and areas with highly rifted continental crust. A chain of buried seamounts, which were interpreted as submarine volcanoes of Late Cretaceous (Santonian to Campanian) age, has been identified to the north of the Turkish coast. On the Shatsky Ridge, probable volcanoes of Albian age have also been recognized. Synorogenic turbidite sequences of Paleocene, Eocene and Oligocene ages have been mapped. In the Cenozoic, numerous compressional and transpressional structures were formed in different parts of the Black Sea Basin. During the Pleistocene–Quaternary, turbidites, mass-transport deposits and leveed channels were formed in the distal part of the Danube Delta.

1. Introduction

The geological structure of the Black Sea has been under investigation since the publications of regional seismic lines for the entire area in the 1980's (Tugolesov et al., 1985; Finetti et al., 1988; Belousov et al., 1988, 1989). More recent seismic lines were shot in parts of the Black Sea and were published by Robinson et al. (1996), Dinu et al. (2005), Afanasenkov et al. (2007), Shillington et al. (2008), Rangin et al. (2002), Khriachtchevskaia et al. (2009, 2010), Munteanu et al. (2011), Menlikli et al. (2009), Stovba et al. (2009), Tari et al. (2009), Stuart et al. (2011), Nikishin et al. (2010, 2012), Mityukov et al. (2012), Almendinger et al. (2011), Georgiev (2012), TPAO/BP Eastern Black Sea Project Study Group (1997), Gozhik et al. (2010), Graham et al. (2013). In recent years, various petroleum companies have acquired a very large amount of 2D and 3D seismic data for individual blocks, though results of these operations are not published.

Presence of oceanic crust has been proposed for the deep-water part of the Black Sea (Neprochnov et al., 1970). Data on structure of the crust in the Black Sea were summarized by Starostenko et al. (2004). Recent research dealing with the crustal structure in the Eastern Black Sea Region is presented in Scott et al. (2009) and Shillington et al. (2008, 2009).

Formation history and dynamics of the Black Sea basins were discussed in many publications. Starting from several classical works (Letouzey et al., 1977; Zonenshain and Le Pichon, 1986; Görür, 1988; Finetti et al., 1988), it is considered that the Western Black Sea Basin and the Eastern Black Sea Basin were formed as back-arc basins behind the Pontide volcanic arc. This problem was considered by a number of researchers (Okay et al., 1994, 2013; Robinson et al., 1996; Nikishin et al., 2003, 2012; Saintot et al., 2006; Afanasenkov et al., 2007; Shillington et al., 2008, 2009; Stephenson and Schellart, 2010; Meijers et al., 2010; Munteanu et al., 2011). The unresolved issues are the time of formation of back-arc basins and whether the Western Black Sea and the Eastern Black Sea basins were formed synchronously or at different times.

Based on published data and on our recent research presented in this paper, we have compiled a new scheme explaining the tectonic structure of the Black Sea Region (Fig. 1). The major

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elements of the Black Sea Basin are the two basins – the Western Black Sea Basin and the Eastern Black Sea Basin, each one with oceanic or strongly thinned continental crust. These basins are separated by the Andrusov and Arkhangelsky ridges with continental crust. Other structural elements include the Shatsky Ridge with continental crust and the Tuapse, Sorokin and Gurian foredeep basins. The largest shelf area is the Odessa Shelf. Many other structures are also identified (Fig. 1) and will be discussed in this paper.

This work is based upon results of interpretation of the new regional seismic lines acquired in 2011 within the international project *Geology Without Limits* in whose realization specialists from Russia, Turkey, Ukraine, Romania and Bulgaria took part (Fig. 2). Total length of the acquired seismic lines reaches up to 8890.5 km. The processing of these seismic data is still underway. In this paper we will only delineate our key findings with respect to structure and formation history of the Black Sea region based on the early processing results of the new seismic data.

2. Results

2.1. Interpretation of 2D seismic lines

The seismic survey was conducted from the research vessel «Mezen». The study area within the Program included Exclusive Economic Zones of the Black Sea Countries: Russia, Ukraine,

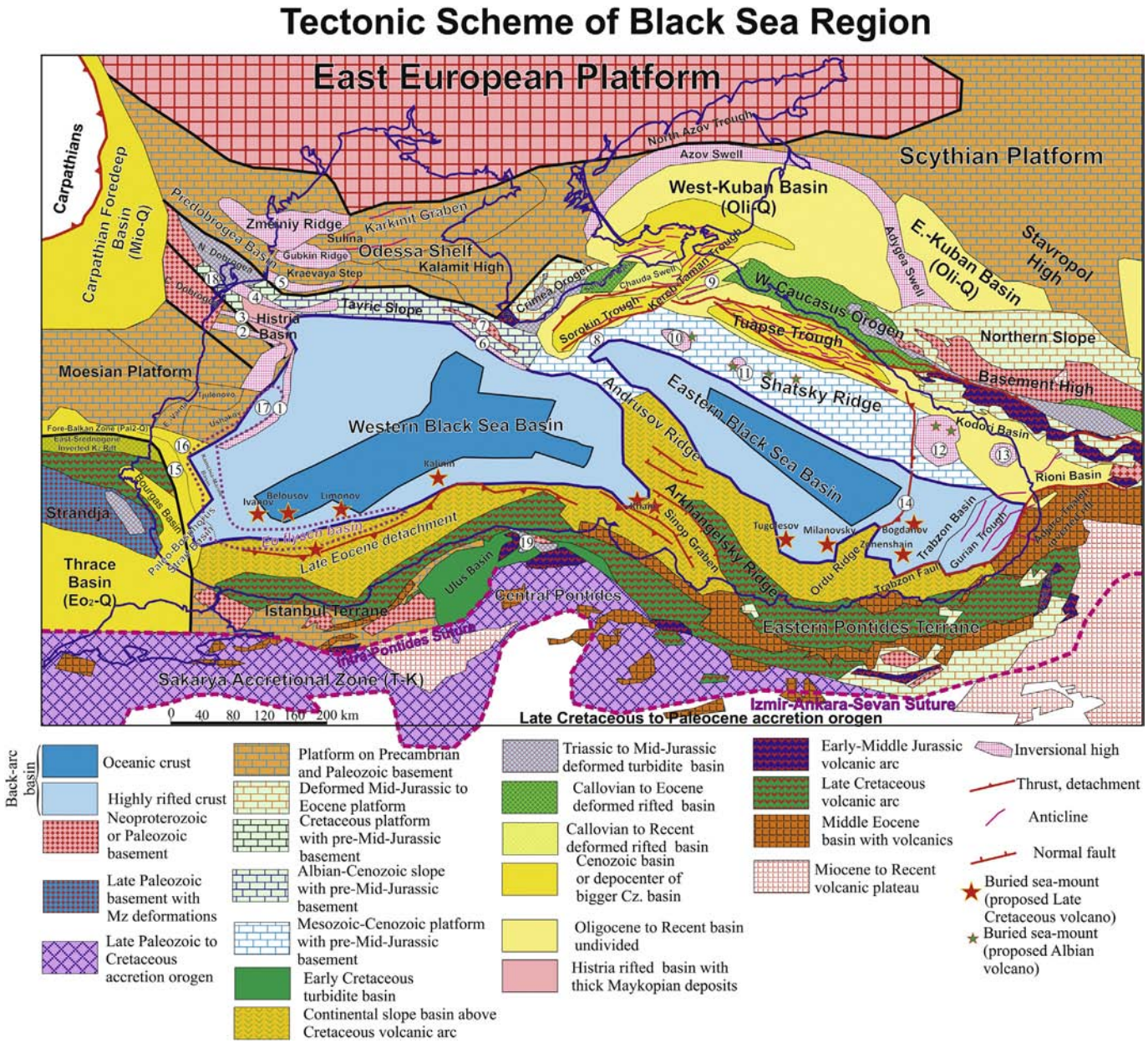

Figure 1. Tectonic map of the Black Sea region. The map is compiled by using both new data presented in this paper and published data (Tugolesov et al., 1985; Okay et al., 1994, 2013; Robinson et al., 1996; Afanasenkov et al., 2007; Khriachtchevskaia et al., 2010; Munteanu et al., 2011; Nikishin et al., 2012; Georgiev, 2012). Eo – Eocene, T-K – Triassic to Cretaceous. 1 – Polshkov Ridge, 2 – Tindala-Midia Ridge, 3 – Tomis Ridge, 4 – Lebada Ridge, 5 – Sf. Georg Ridge, 6 – Sevastopol Swell, 7 – Lomonosov Massif, 8 –Tetyaev Ridge, 9 – Anapa Swell, 10 – North Black Sea High, 11 – South-Doobskaya High, 12 – Gudauta High, 13 – Ochamchira High, 14 – Ordu–Pitsunda Flexure, 15 – Rezovo-Limankoy Folds, 16 – Kamchia Basin, 17 – East-Moesian Trough, 18 – Babadag Bassin, 19 – Küre Basin.