Three main stages of the Cretaceous - Neogene tectonic evolution of Odessa Shelf and Azov Sea (northern part of the Black Sea) were revealed from the analysis of reinterpreted regional seismic profiling (more than 20000 km) and 1-D modelling of 49 wells, the correlation of which was recently revised.

The first stage began in the Early Cretaceous and continued until the Santonian in the Late Cretaceous (~128-83 My). During this time the extensional opening of the NE – SW oriented Karkinit-Gubkin rift took place at the boundary between the East-European and Scythian. The Karkinit-Gubkin rift was prolonged to Azov Sea to the east and involved the present-day Gubkin Swell to the west. Horsts, grabens and half grabens formed on its flanks. The axis of the rift was located along the Sulina-Tarhankut Fault and had tectonic subsidence rates 30-50 m/Myr in the Senomanian-Santonian. The Early Cretaceous fault system probably inherited a Permian-Triasic fault system, as the wide development of Permian-Triasic rifting is well known within the adjacent Predobrodjea Depression and Northern Dobrogea. The 1-D modelling allows the clear recognition of the rifting stage only since Albian times, when the peak of extensional processes occurred (Fig. 1). Syn-rift Lower Cretaceous deposits are found only in the dipping parts of half grabens, while their uplifted parts were exposed above sea level and eroded. Volcanic activity accompanied the rifting stage. Later, at the beginning of the Late Cretaceous, tectonic activity became weaker and limestones were deposited, although extensional processes continued throughout the Odessa shelf as before, with calculated extension factors of 1.08-1.13. Extension affected only the western part of Azov Sea where it ceased earlier (by 97 My) than within Odessa shelf (by 83 My).

The same extensional regime also dominated in the adjacent area. To the south-west along the Romanian offshore a NW-SE oriented rift – the proto-Histria depression – developed. It was formed during the Jurassic until the Albian. The Almin Depression of southwestern Crimea is also characterized by relatively rapid Valanginian – Early Aptian subsidence. The Indolo-Kuban Depression subsided rapidly during the Early Cretaceous and particularly during Aptian – Albian times and was accompanied by basaltic and andesitic volcanism.

The second tectonic stage is characterized by a reduction of tectonic activity and the onset of post-rift thermal subsidence. It lasted from the Campanian, Late Cretaceous, to the end of the Middle Eocene (83-38,6 My). Rift development stopped. The Karkinit-Gubkin unit developed as single basinal depression. Tectonic subsidence rates were 5-10 m/Myr. Deposition of a thick sequence (up to 2000 m) of limestones and marls occurred. The same regime is noted within Romanian shelf.
The third stage corresponds to a period of inversion tectonics. Multiple phases of compression are in evidence during this stage, in particular at the end of the Middle Eocene, Late Eocene, Early Miocene and Middle Miocene (~38.6 Ma, ~35.4 Ma, ~16.3 Ma, ~10.4 Ma). These inversion events resulted in the uplift of the former basin or parts of it. The second compression event, at the end of the Late Eocene, led to the uplift of the southern part of the Odessa shelf (Kalamit Swell and Krayova Step) and Azov Sea (Azov Uplift), which was affected by widespread erosional processes. A considerable part of the sedimentary sequence up to the upper part of the Late Cretaceous was eroded. The next compressional event, at the end of the Early Miocene, led to the uplift and widespread erosion of the western part of the Odessa shelf. The rate of tectonic subsidence was 10-30 m/My at the Late Eocene and decreased to 5-10 m/Myr later.

The former listric faults became reverse faults as result of north directed compressional forces. These reactivated faults formed different types of inversion structures within the Odessa shelf. Similar inversion structures occur within the Romanian offshore. Within the Azov Sea, rapid subsidence of its southern part is observed during Oligocene – Early Miocene and of its south-eastern part during Middle Miocene – Quaternary times. This is connected with the development of the Indolo-Kuban (Greater Caucasus) Foreland Basin.

Multiple phases of compression are also determined from the Late Eocene until the Quaternary within the whole Caucasus – Pontides – Black Sea region and were connected with the collision of the Arabian continent with Eurasia.