TECTONIC EVOLUTION OF THE EASTERN MARGIN OF EURASIA IN LATE MESOZOIC AND CENOZOIC

SOROKIN A.P. AND ARTYOMENKO T.V.

Amur Scientific Center, Far Eastern Branch of Russian Academy of Sciences

1.The south of Far East comprises the largest mountain-folded and platform structures in the eastern margin of Eurasia. A formation of this region is associated, on the one hand, with the Late Mesozoic stage of collision between the Siberian craton and the Amur composite mass, and, on the other hand, with the increment of accretionary prisms from the east mainly in the Cenozoic. These events were accompanied by the formation of orogenic and depression systems, volcano-plutonic belts and continental sedimentation regions characteristic of various types and intensity of tectonic movements.

In the course of the long-term geological history of the study region three developmental stages may be singled out: rift-like (the Late Jurassic-Early Cretaceous), platform (the Late Cretaceous) and neotectonic of riftogenic nature (the Paleogene-Anthropogen). The boundaries between these stages are distinctly fixed by geological limits of planetary range.

2. The riftogenic stage is associated with the formation of grabens of NE and NS trending and the lower stage of the Zeya-Bureya and Songliao basins presented by volcano-plutonic and sedimentary deposits. The volcano-plutonic deposits form large distribution areas: Greater Khingan, Lesser Khingan, Umlekan-Ogodzha etc, and sedimentary deposits fill the subsided parts of these basins.

In the Zeya-Bureya basin the grabens (Priamursky, Zeya-Zelemdzha, Yekaterinoslavka, Arkhara) are filled with the Upper Jurssic and Lower Cretaceous terrigenous and volcanic deposits with thickness up to 2500 m. It should be noted that the primal stage of riftogenic development of the basin took place in the Early Cretaceous. The rocks formed at that time are presented by a complex of effusive rocks of basic, middle and acid compositions and also of terrigenous occurrences. Along the subsided zones developed in the territory of Russia , within China there are small basins such as Sun'u, Dzhanhe, Fuzhao, Jiayin.

In the Late Mesozoic the above mentioned events were going on under the conditions of regional morphostructural tilting of the surface in the direction from the north to the south as the result of collision of the Siberian craton and the Amur mass. Just at that time, exactly, in the Early Cretaceous there formed a single river net of the Zeya-Bureya basin which was quite similar to the modern one regarding a pattern and direction of the surface water discharge from the north to the south. The Early Cretaceous valley of the Amur river may be traced by coeval sediments of alluvial complex with initial tilting of strata toward south-east from the upper riches of the river up to the southern border of the basin. A fragmentary character of these sediments' distribution may be explained by the presence of antecedent sections of the paleo-Amur, that, in general, is typical for the far Eastern rivers. The

paleovalley of the Zeya river is also distinctly expressed, being confined to the Zeya-Selemdzha subsided zone. The surface water discharged through the Unyu and Dzhanhe intermontane depressions into the Songliao basin.

3. The posterior, the platform stage, embraces the Late Cretaceous period. Almost complete chronicle of its geological history is presented within the Zeya-Bureya, Songliao basins and their surroundings. The developmental history of the Zeya-Bureya basin during this period is connected with the formation of overrift depressions and intrarift uplifts. At that time the sedimentation took place within hollows that occurred above rift valleys under the conditions of contrast configurations of lacustrine-alluvial plains"conjugation with the Lesser Khingan, Turan, Bureya mountain-folded structures. At the same time there formed a plate complex of the Zeya-Bureya young complex composed of the Cenomanian (?)-Campanian and Maastrichtian deposits.

The rocks of the age under study unconformably overlap the Lower Cretaceous volcano-sedimentary deposits of riftogenic complex as well as the rocks of the Premesozoic basement. Their analogues at the coast of the Amur river within China are the Yunanzun, Nenjian and Yuilianjy formations.They are composed of alternating sequences of slightly coherent sandstone, siltstone, argillite-like clays with bands of pelitomorphic limestone, gritstone and conglomerates with thickness over 1000 m. The general peculiarity of geotectonic regime of the platform stage is a considerable reduction of contrast configuration and decrease in downwarping rate of the Zeya-Bureya plain that brought about the accumulation of more fine-grained sediments within it. Fluvial-floodplain facies, as part of the above sediments' compositions, have been formed in the regions of maximum downwarping. In the Priamurskaya depression zone fluvial –floodplain complex, fixing the paleo-Amur valley composes the extended lenses gently tilted from the north-west to the south-east. The pattern of the Late Cretaceous hydronet is also distinctly expressed in the Zeya-Selemdzha and Yekaterinoslavka zones. Within the first one, judging by the foot of fluvial-floodplain sediments, the paleo-Zeya river valley located at the eastern margin of the depression, while within the second zone the paleo-Zavitaya river was draining its central part. Given data are the evidence that in the Late Cretacous the river net of the Zeya-Bureya basin practically remained within channel hollows embedded in the Early Cretaceous with the surface water discharge from the north to the south and into the Songliao basin.

4. Large-scale structural reconstructions of the western margin of Eurasia are associated with the final, neotectonic stage (the Paleogene-Anthropogen).There occurred the Tanlu-Okhotask riftogenic system with the formation of the sedimentary basins (Sanjian, Mid Amur, Konino-Khurmulinsky, Lower Amur,etc.) as well as basaltic nappes. The most important event of this period was the formation of the large Mohe-Jiamusy-Khanka arched belt. As a result, in addition to existing morphostructural tilting of the surface from the north to the south, there occurred a new one of reverse trending. The channel of the paleo-Amur at the southern margin of the Zeya-Bureya basin has changed its direction from NS to WE and then, in the Late Miocene, it cut through the Mohe-Jiamusy mountain structures. Then there began the surface water discharge into the Mid Amur basin. So, there occurred a new paleogeographic situation with a single Amur-Zeya river basin.

The neotectonic stage was the most fully studied within the Zeya-Bureya basin. Here it is subdivided into several stages: The Paleogene, Miocene, Pliocene, Eopliocene, Pleistocene-Holocene which differ from each other in the orientation and intensity of tectonic movements. The Paleogene is characterized by shrinking of sedimentation area in the Zeya-Bureya basin caused by tectonic movements not only along the external surrounding of the depression, including its southern part, but also in the area of inner uplifts. However, as early as in the Middle Miocene there occurred an intense expansion of the stable downwarping zones and accumulation of the Zeya-Bureya basin took place. At that time in the central part of the Zeya-Bureya plain a vast lacustrine-alluvial plain was formed within which a complex of sandy-argillaceous coal-bearing deposits occurred. In the Late Miocene the vast areas of the external surroundings of the Zeya-Bureya basin were also involved in the process of subsidence. In paleogeographical environments that were similar to the Early-Middle Miocene ones, the formation of primarily sandy deposits took place. They accumulated within wide-spread hydronet that belonged to the paleo-Amur and paleo-Zeya rivers. According to the hydronet pattern and the other features, the existence in the Neogene of water discharge from the study basin into the Mid Amur one through the Mohe-Jiamusy antecedent section was proved.

In the Pleistocene-Holocene time a general subsidence of the Zeya-Bureya plain was replaced by the uplifting. There occurred the incision of rivers and the formation in the valleys of five levels of supra flood plain terraces with regular or low alluvial thickness. The uplifting amplitude of the territory is 100-150 m.

The Cenozoic basins located to the east of the Zeya-Bureya basin are incorporated in the Tanlu-Okhotsk and Pribrezhnaya riftogenic systems of the East Asian transcontinental graben belt and their formation is directly related to neotectonic movements at the eastern margin of Eurasia. Within the belt the Mid Amur basin and the systems of Konino-Khurmulinsky and Lower Amur small basins are distinguished.

The formation of the Mid Amur basin underwent two neotectonic stages: The Paleocene-Miocene and Pliocene-Anthropogen. During the first stage there was accumulation of sediments within closed graben-like intermontane small basins (the Birofeld, Oboro-Ussuriysky, Mukhen, Khabarovsk, Sel'gonsky). In the lower parts of these structures' cover (the Paleocene-Early Miocene) rudaceous poorly grained sediments are distributed. At higher levels they are replaced by fine-grained terrigenous rocks with a total thickness more than 500 m. In the upper parts (the Late Oligocene and Miocene) the argillo-aleurite sediments and boulder-pebbled deposits are developed (up to 1000 m.).

Thus, by the end of the Late Miocene the Mid Amur basin was a complex polyfacies system. Its further development is related to the increase of tectonic activity that brought about structural reconstruction at the turn of the Miocene-Pliocene expressed in expansion of the accumulation area. Just at that time there was a breakthrough of the surface waters from the Zeya-Bureya basin into the Mid Amur one and the formation of the Amur river valley similar to the modern valley began. In the Pliocene-Anthropogene this process was going on under the conditions of the area's subsidece in which not only the grabens but also intergraben spaces were involved. At the same time there occurred a reanimation of systems

of deep disjunctive structures along the surroundings of depression zones within which the eruption of alkaline and olivine basalts took place.

The Konino-Khurmulinskaya system of small basins is presented by a group of grabens of NS and NE trending with thickness up to 750 m. The Paleogene-Neogene deposits here are mainly composed of aleurite-argillaceous sediments with lenses and partings of sand, sandstone and ,rarely, coal. The deposits of the Pliocene age are not distributed everywhere. They extremely differ by coarse composition, being associated with basalt nappes. The Pleistocene and Holocene deposits are mainly developed in the axial part of the study zone.

The Lower Amur system of small basins is presented by the Orelsky, Chlyasky, Magosky, Udylsky and Limuriysky grabens with thickness of deposits up to 1500 m. In the lower part of the section the Cenozoic deposits filling those grabens are composed of sandy-argillaceous sediments containing the bands of brown coal. At higher levels of the section they are replaced by rubbly-pebbled sediments, and, then, by sands and clays.

CONCLUSIONS

The Mesozoic-Cenozoic history of geological development is associated with three stages: rift-like (the Late Jurassic-Early Cretaceous), platform (the Late Cretaceous) and neotectonic of riftogenic nature (the Paleogene-Anthropogen). The boundaries between these stages are distinctly fixed by geological limits of planetary range.

Rift-like stage (the Late Jurassic-Early Cretaceous) is a stage of high geodynamic activity of the region. During this stage the eastern margin of Eurasia was formed due to the collision between the Siberian craton and the Amur composite mass and to the growth of accretionary prisms from the east.

Platform stage (the Late Cretaceous) marks a transition to the stable development of the area. During this stage there formed the Zeya-Bureya plain-platform region. Besides, this stage is characterized by planation of mountain-folded structures and by decrease of contrast of vertical movements.

Neotectonic stage (the Paleogene-Anthropogen) is characterized by activation of geodynamic mode, formation of new rift-like structures at the continental margin (Sanjian-Mid Amur, Lower Amur etc.) as well as of large Mohe-Jiamusy-Khanka arched belt. The formation of the latter one was caused by the tilting of morphostructural surface from the south to the north which led to alteration of orientation of the paleo-Amur river valley and breakthrough of the surface waters from the Zeya-Bureya basin into the Mid Amur one. In such a way there occurred the Amur river valley similar to the modern one.