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GEOLOGY

The Major Cyclicity of Mesozoic Epicontinental Sedimentation and Geodynamic Events in the Adjacent Active Oceanic Region

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Mesozoic rocks of Sikhote Alin are well studied. However, they have been considered so far separately for the tectonically passive eastern margin of the Sino–Korean craton (hereafter, in the west) [2, 4] and for the active adjacent area of the Paleopacific, framing the craton from the east (hereafter, in the east) [5]. Sedimentation in the west was not correlated with Mesozoic geodynamic events in the east. This statement is substantiated in the present paper.

Figure 1 demonstrates the major structural elements of the Sea of Japan region, situated at the boundary between the Pacific Ocean and the Eurasian continent. Several types of the continental margin are distinguished in the Mesozoic geodynamic evolution of the region [5] (Fig. 2).

It was a passive margin in the pre-Jurassic time. Oceanic sedimentation proceeded in the east, whereas epicontinental marine shelf sedimentation, which started in the Paleozoic, went on in the west. Predominantly Lower and Middle Triassic (except for the Ladinian) marine sediments accumulated here at that time included transgressive [3] coarse-clastic rocks and sandstones (with coquina sandstone lenses) and regressive (mudstones and fucoid sandstones with concretions) formations. Mainly Upper Triassic Series are composed of alternating continental and marine shelf sediments.

In the east, the beginning of the Jurassic was marked by the onset of the closure of the Mongolian–Okhotsk paleocean and a partial collision of the North Asian (Siberian Craton) and South Asian (Bureya–Jiamusi–Khanka superterrane and Sino–Korean Craton) paleocontinents (Fig. 1). Therefore, northward drift of the South Asian paleocontinent became impossible. A zone of oblique subduction formed along the major part of its eastern margin, and a Jurassic accretionary prism began to form. The prism represented oceanic plateau rocks disintegrated into tectonic plates, with a partial subduction of younger plates beneath older ones. Synchronous suprasubduction volcanites developed in China, Korea, and southern Primorye. Thus, the passive margin regime was replaced by the Andean-type active margin environment. In the west, marine shelf sediments accumulated after a regional hiatus and transgression.

In the east, the Middle and Late Jurassic (excluding the Tithonian) episode was marked by subduction of a slightly disintegrated part of the oceanic plate. The accreted fragments of the plate are represented by siliceous–terrigenous successions differing only in the age of layers transitional from the lower siliceous part of the section to the terrigenous part (the successions gradually become younger eastward) [6]. In the west, marine shelf sediments continued to accumulate. Continental sediments accumulated in places only in the Middle Jurassic.

In the east, from the Tithonian to the Albian, the subduction regime gave way to a northward transform sliding of the oceanic plate, and thick turbidite and other rhythmic sequences of the Zhuravlevka–Amur terrane began to accumulate along the eastern margin of the Eurasian continent. From the Tithonian to Hauterivian, against a background of transform geodynamics and sedimentation in the southeastern part of the continent, the subduction regime retained in the areas oriented at an acute angle to the moving oceanic plate, resulting in the formation of the Late Jurassic–Early Cretaceous accretionary prism. In Sikhote Alin, the prism is represented by the Taukhe terrane, composed of the Berriasian–Hauterivian terrigenous rocks with fragments of Late Devonian–Jurassic guyots and sediments of the adjacent oceanic plate areas. Shelf sediments accumulated in the west.

In the east, the Kema island arc of the Moneron–Samarga volcanic island-arc system emerged on the oceanic plate east of the turbidite basin in the Hauterivian–Albian, and an accretionary prism (Kiselevka–Manoma terrane) of the same age formed beneath the island-arc system. Fragments of this prism are represented by oceanic siliceous–terrigenous sediments. The

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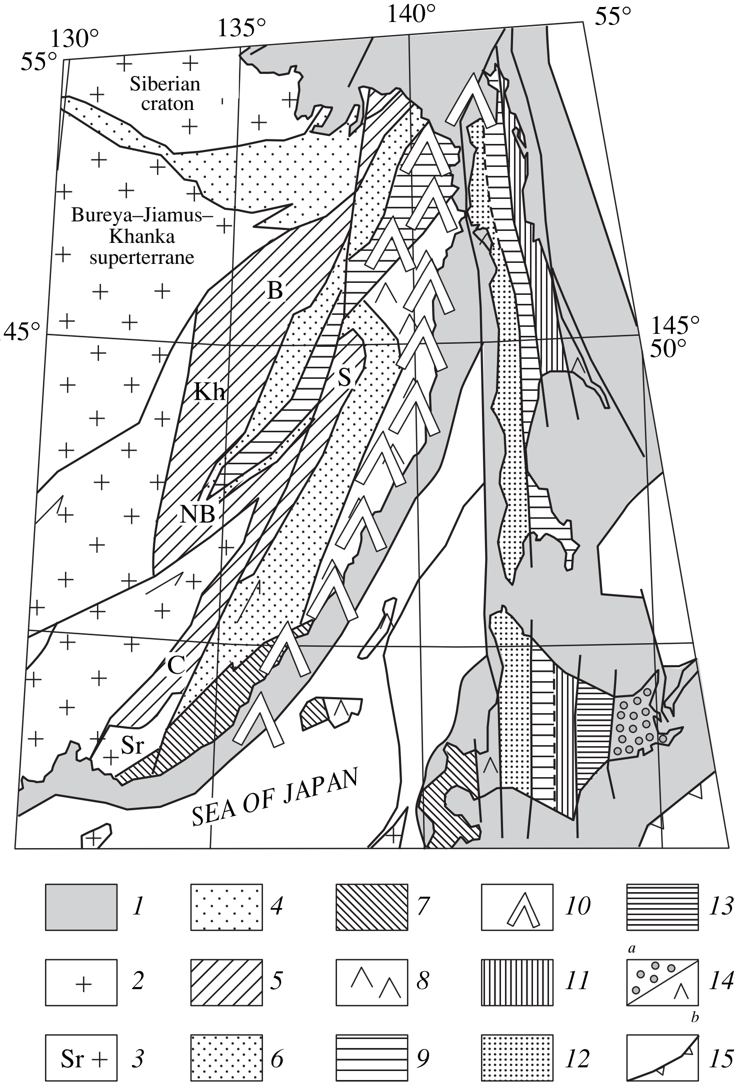

Fig. 1. Major structural elements of the Sea of Japan region. (*1*) Recent continental marine and island shelf; (*2, 3*) ancient crystalline massifs on the continent: (*2*) Bureya–Jiamusi–Khanka superterrane and the Sino–Korean and Siberian cratons, (*3*) Sergeevka terrane; (*4*) Jurassic turbidite basin (Ul'ban and Un'ya–Bom terranes); (*5*) Jurassic accretionary prism including terranes: (B) Badzal, (NB) Nadan'khada–Bikin, (S) Samarka, (Kh) Khabarovsk; (*6*) Early Cretaceous turbidite basin (Zhuravlevka–Amur terrane); (*7*) Tithonian–Hauterivian accretionary prism (Taukhe and Oshima terranes); (*8*) Hauterivian–Albian volcanic island arc (Kema, Kamyshov, Schmidt, Moneron, and Rebun–Kabato terranes); (*9*) Hauterivian–Albian accretionary prism (Kiselevka–Manoma, Goniva–Amon, and West Hidaka terranes); (*10*) Late Cretaceous volcanic arc (East Sikhote Alin volcanic belt); (*11*) Late Cretaceous accretionary prism (Nabil and East Hidaka terranes); (*12*) Late Cretaceous foredeep (West Sakhalin and Sorachi–Ezo terranes); (*13, 14*) subduction–accretion complexes of the paleo-Okhotsk subduction zone: (*13*) Late Cretaceous accretionary prism (Tokoro terrane), (*14a*) Late Cretaceous foredeep (Nemuro terrane), (*14b*) Late Cretaceous volcanic island arc (Terpeniya terrane); (*15*) Recent subduction zone.

siliceous part of the oceanic sediments comprises alkaline lava and limestone. In the west, this period was marked by the accumulation of continental sediments (in pull-apart basins formed during strike-slip faulting [1]) and marine shelf sediments (products of transgressions from the south and east).

Hence, the Tithonian–Albian geodynamic environment in the east of Eurasia was characterized by the combination of a transform (strike-slip fault) margin and active margins of the Andean and Sea of Japan types.

In the east, at the beginning of the Cenomanian, the configuration of the South Asian continent and the direction of the oceanic plate motion changed due to sinistral displacements of the eastern edge of the continent along the submeridional Tan-Lu fault system. Consequently, a new subduction zone appeared and conditions of the Andean-type active margin recommenced. In the west, continental sediments accumulated at that time.

In the east, the Late Cretaceous–Paleocene was marked by the formation of the following lateral series:

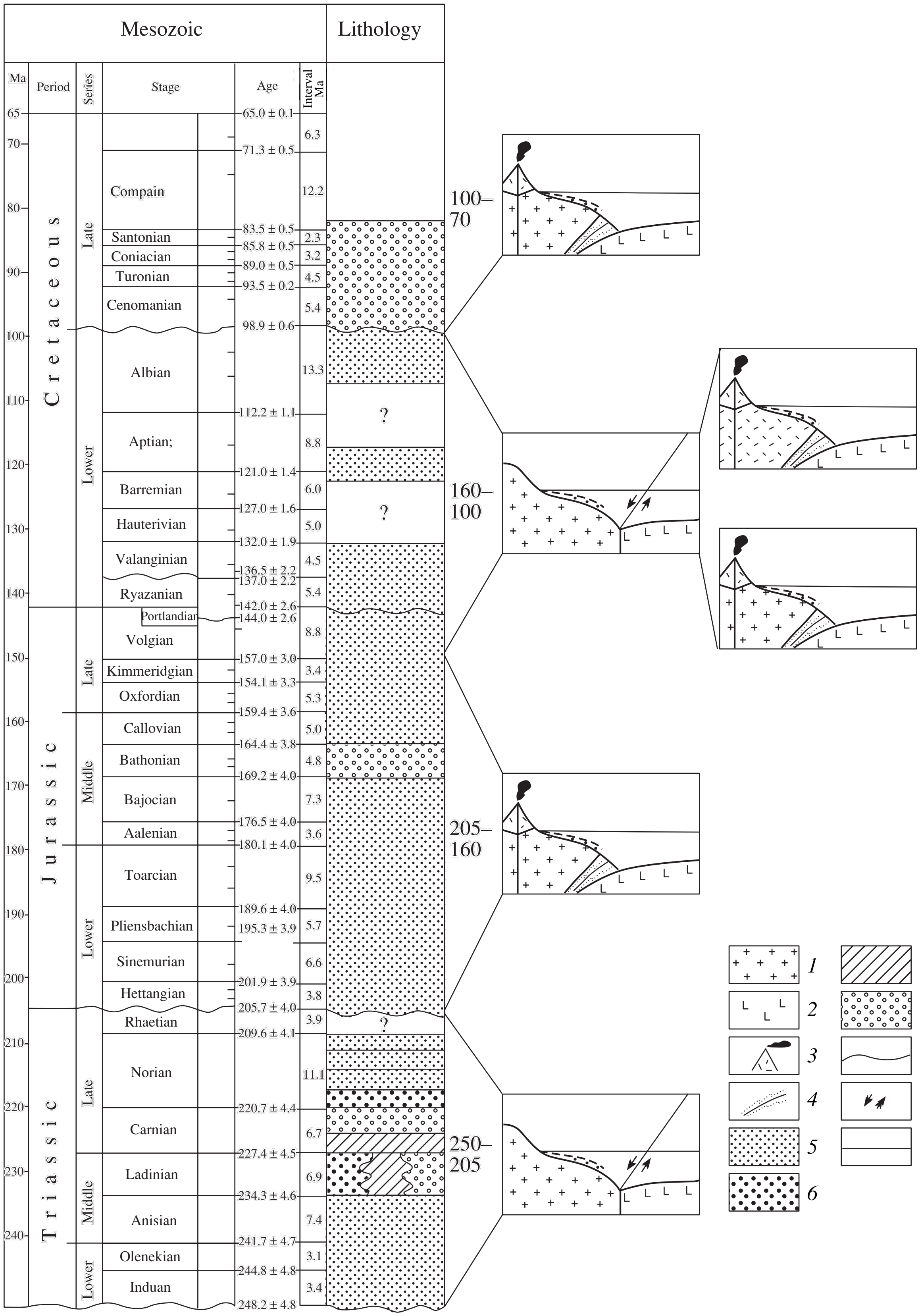

Fig. 2. Mesozoic epicontinental sedimentation and geodynamic settings at the eastern margin of Asia. (*1, 2*) Lithospheric plates: (*1*) continental, (*2*) oceanic; (*3*) volcanic arcs; (*4*) accretionary prisms; (*5–8*) sediments: (*5*) littoral; (*6*) sublittoral, (*7*) lagoonal, (*8*) continental; (*9*) unconformities; (*10*) strike-slip faults; (*11*) other faults.

epicontinental volcanic arc (East Sikhote Alin volcanic belt), forearc basin (West Sakhalin and Sorachi–Ezo terranes) and accretionary prism (Nabil and East Hidaka terranes). The Simanto prism emerged in the southern area. Continental sedimentation went on in the west.

As a result of these events, Mesozoic folded terranes located east of the Sino–Korean Craton can be divided into the following fragments distinguishable in the east (Fig. 1): Early–Late Jurassic (Hettangian–Tithonian) accretionary prism (Samarka, Nadan'khada–Bikin, Khabarovsk, and Badzal terranes); Late Jurassic–Early Cretaceous (Tithonian–Hauterivian) accretionary prism (Taukhe terrane); Early–Middle Cretaceous (Hauterivian–Albian) accretionary prism (Kiselevka–Manoma terrane); Early Cretaceous turbidite basin of the transform-fault margin (Zhuravlevka–Amur terrane); Early–Middle Cretaceous (Hauterivian–Albian) Kema volcanic arc (Kema terrane); and Late Cretaceous–Paleocene East Sikhote Alin volcanic belt.

CONCLUSIONS

In the west, where the Paleozoic epicontinental sedimentation continued, the history of Mesozoic sedimentation on the marine shelf (sublittoral and littoral zones) and continental settings can be divided into four major cycles. The cycles correspond in the formation time to different geodynamic settings on the eastern margin of paleo-Asia (Fig. 2).

The *first (Triassic) transgressive–regressive cycle* started after a regional hiatus with accumulation of the Indian marine sediments (coarse-clastic formation and formation of sandstones with coquina sandstone lenses) and continued until the Middle Triassic, which marked the onset of a regression episode of the cycle. The lower section of the regression cycle is represented by the upper portion of mudstones with carbonate concretions, whereas the overlying section is composed of fine-grained sandstones with concretions [3].

The Olenekian and Anisian stages of the Triassic System are represented by marine sediments; the Ladinian Stage, by littoral, lagoonal, and continental sediments; the Carnian Stage, by lagoonal and continental sediments; and the Norian Stage, by littoral and lagoonal sediments. Hence, units described above make up *a complete transgression–regression sedimentation cycle accumulated under conditions of the passive continental margin.*

The *second (Jurassic) transgression cycle* spans the whole period until the earliest Tithonian. Terrigenous sediments of this cycle overlie sediments of the first cycle with a regional hiatus and structural unconformity. The second cycle is represented by sediments of the littoral and sublittoral zones of different depths. Only the Bathonian section is represented by continental and volcanosedimentary rocks. The second cycle corresponds to *the environment of the Andean-type active continental margin.* Sedimentation of this cycle is related to the submeridional sinistral strike-slip faults at the boundary between the continental and oceanic lithospheric plates. Termination of this in the Berriasian is mainly marked by continental sediments and, to a lesser extent, by coaliferous littoral sediments. Continental sediments, including volcanosedimentary and volcanic varieties, accumulated in intracontinental basins, which emerged along the Tan-Lu system during the strike-slip faulting.

The *third (Early Cretaceous) cycle* corresponds to a transform-fault margin and active continental margins of the Andean and Sea of Japan types in the south and north, respectively.

The *fourth (Late Cretaceous–Paleogene)* orogenic cycle corresponds to the Andean-type active continental margin. In the east, this episode is recorded by the formation of the East Sikhote Alin orogenic volcanic belt and its forearc basin.

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