

Early Cretaceous radiolarians of the Amur River lower stream area (Russia Far East) and their tectonic significance

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Abstract: The results of lithological-biostratigraphic study of volcanogenic–chert rocks developed on the left side of the Machtovaya River, a right tributary of the Amur River, are given. The composition, structure, and age of these strata and the rocks constituting the Kiselevka–Manoma accretionary complex are different, which indicates their different tectonic origins.

Key words: radiolarian; biostratigraphy; volcanogenic-chert rocks

In the area of lower stream of the Amur River (Russia Far East) the tectonic slices of volcanogenic-chert formations sporadically occur among the Albian-Cenomanian terrigenous deposits of the so-called Zhouravlevka-Amur terrane (turbidite basin of transform margin). The slices are about 20 m thick and extend for several tens of kilometers. The age as well as structural position of these formations is not established. In this connection, we carried out the lithological and biostratigraphic researches within one of such slices on the left side of the Machtovaya River (a right tributary of the Amur River).

The results of our study have shown that rocks inside the slice are intensively deformed and broken up by the numerous faults on separate blocks. The lowermost part of the slice is composed of massive and amygdaloidal tholeiitic basalts quite often containing cherts xenoliths. There are also rocks being a mixture of cherty sediment and basaltic lava fragments. The basalts are overlain by the massive and brecciated dark red and red-brown radiolarian cherts composed of fine-chalcedony aggregates with abundant powdery particles of hematite. Radiolarian skeletons are well preserved there and make up 40–60% of the rock volume. Structurally above there occur dark grey radiolarian clayey cherts. These cherts consist of clayey and quartz-chalcedony aggregates saturated with abundant coalified particles and Fe hydroxides, the silt-sized fragments of plagioclase (10–15%) and mica flakes. Radiolarian skeletons are perfectly preserved, and their content of the rock volume ranges from 20 to 60%.

Besides that, the rare separate blocks of olive-gray siliceous-tuffaceous mudstones are also

observed. They are more enriched in clayey material compared with the clayey cherts. These siliceous-tuffaceous mudstones contain angular grains of quartz and plagioclase as detrital components, abundant fork-shaped fragments of quartz with a ferruginous film as a pyroclastic material and fragments of altered volcanic glass cemented by a mixture of quartz and clay minerals with Fe hydroxides. Radiolarian skeletons are rare.

The volcanogenic-chert rocks are in fault contact with a terrigenous sequence consisting of members of the alternating sandstones and siltstones, beds of massive sandstones and dark gray siltstones containing remnants of Albian-Cenomanian macrofauna.

The age of the cherts and clayey cherts is established by us based on radiolarian fossils, which were extracted using a weak solution of hydrofluoric acid, then picked from the residue, and photographed under a scanning electron microscope. According to the study on microfauna, two consecutive radiolarian assemblages are established in the dark red cherts. The first assemblage is dated as late Late Tithonian on the basis of a joint presence of such species as *Wrangellium puga* (Schaaf), *Wrangellium depressum* (Baumgartner), and *Pseudodictyomitra carpatica* (Lozyniak), evolution of which began in the late Late Tithonian, and *Eucyrtidiellum pyramis* (Aita), *Archaeodictyomitra minoensis* (Mizutani), and *Zhamoidellum ovum* Dumitrica, last occurrence of which is also recorded in the late Late Tithonian (Baumgartner et al., 1995; Dumitrica et al., 1997). The age of the second radiolarian assemblage is accepted as late Late Tithonian–early Valanginian based on co-occurrence of *Xitus gifuensis* Mizutani, the upper

age limit of which is restricted by early Valanginian, and *Wrangellium depressum* (Baumgartner), the first appearance of which is recorded in the late Late Tithonian (Baumgarther et al., 1995; Dumitrica et al., 1997).

It should be noted that the genus *Wrangellium* was renamed by Paulian Dumitrica with co-authors in the genus *Svinitzium* (Dumitrica et al., 1997). In this connection, radiolarians of the similar morphology are identified in some publications as *Svinitzium depressum* and *Svinitzium puga*, however stratigraphic ranges of these species remain unchanged. A similar situation is also characteristic for representatives of the genus *Parvicingula*, which received the new name *Tethysetta* (Dumitrica et al., 1997), and for the genus *Sethocapsa* renamed by Luis O'Dogherty in the genus *Hiscocapsa* (O'Dogherty, 1994), as well for the species *Pseudodictyomitra nuda* Shaaf, which is now called *Loopus doliolum* (Dumitrica et al., 1997). In this paper, we use old (more traditional) generic and species names of the above-listed radiolarian taxa, especially as their stratigraphic ranges have not changed.

A quite different radiolarian assemblage was extracted from the dark gray clayey cherts. It is worth noting that 85% of this assemblage is composed of multicyrtoid radiolarians that are unknown for the Cretaceous marine sediments of the Tethys and continental frame of the Pacific Ocean and have not been yet described in the literature. However the remaining 15% are represented by the identified radiolarians such as *Stichomitra mediocris* (Tan), *Pseudoaulophacus sculptus* (Squinabol), *Dictyomitra montisserei* (Squinabol), *Dactyliosphaera acutispina* (Squinabol), *Crucella (?) inflexa* (Rust), *Dactyliosphaera maxima* (Pessadno), and *Dactylidiscus longispinus* (Squinabol). The age of this assemblage is determined as Middle-Late Albian judging by co-occurrence of the species *Stichomitra mediocris*, evolution of which was ended in Late Albian, and *Orbiculiforma cf. cachensis*, first appearance of which is recorded in the Middle-Albian (Baumgarther et al., 1995; Dumitrica et al., 1997; O'Dogherty, 1994; Schaaf, 1981).

Thus, based on the results of biostratigraphic data, the volcanogenic-chert formations of the Machtovaya River area are ranged in age from Late Tithonian to Late Albian.

It is important to notice that in Lower Priamurye, volcanogenic-chert formations of the Jurassic-Early Cretaceous age have been known until the present time only in the Kiselevka-Manoma terrane of the Early Cretaceous accretionary prism (Zyabrev, 1994; Zyabrev et al., 2005; Natal'in and Zyabrev, 1989). This terrane is made up of Jurassic (from Hettangian) and Early Cretaceous (up to Albian) cherts, cherty-clayey rocks, and basic volcanites. The lower

part of the terrane is composed of pelagic cherts (from Hettangian up to Barremian) that contain the layers of high-titanium alkaline basalts associated with limestones, and beds of volcanogenic-clastic and chert-clastic rocks. Hemipelagic cherty-clayey sediments are confined to a period from Barremian-Aptian to lower Albian. As for upper part of the stratigraphic succession of this terrane, it is composed of terrigenous sediments of the near-island arc sedimentation zone and are represented by the Albian greywackes and chaotic formations (subduction mélange) (Markevich et al., 1997a; Markevich et al., 1997b).

A comparative study of the volcanogenic-chert rocks of the Machtovaya River area and Kiselevka-Manoma accretionary complex reveals their differences in composition, stratigraphic succession and age. Volcanogenic-chert formations of the Kiselevka-Manoma terrane are ranged in age from Hettangian to Early Albian. Volcanic rocks are represented by the high-titanium alkaline basalts with frequent Jurassic limestone xenoliths. Basalts make up a series of thick layers (up to 30 m) within the chert sequence. In the area of Machtovaya River the volcanogenic-chert rocks are Late Tithonian to Late Albian in age. Volcanic rocks are represented by tholeiitic basalts and compose the chert sequence basis.

The Kiselevka-Manoma terrane volcanogenic-chert formations are overlain by the Albian relatively deep-sea water terrigenous rocks that most likely are greywackes, from a composition of their main rock-forming component. They consist of fragments of rocks (basic and intermediate volcanites and cherts) and mineral fragments (basic and intermediate plagioclase and quartz). Heavy minerals are represented by chromite, hornblende, clinopyroxene, orthopyroxene, magnetite, and ilmenite. Volcanogenic-chert formations in the Machtovaya River area associate with shallow-water (containing remnants of macrofauna) arkosic terrigenous rocks of Albian-Cenomanian age. Detrital material of these rocks is represented by fragments of quartz, acid plagioclase, potash feldspar, siltstones, granite, quartzite, mica slate, and rhyolite. Heavy minerals are zircon, rutile, garnet, and tourmaline.

All these data show that geological nature and tectonic history of the Machtovaya River area and the Kiselevka-Manoma terrane are different. Analysis of data on structure, composition, age and regional tectonic position of these formations in the modern Sikhote-Alin structure allows us to assume that the volcanogenic-chert rocks of the Machtovaya River area represent a fragment of the paleoceanic (Izanagi) plate adjoining the eastern margin of the Paleo-Asian continent in the first half of Early Cretaceous, that then became an isolated continental-margin sea basin in the second half of Early Cretaceous (see Fig. 1).

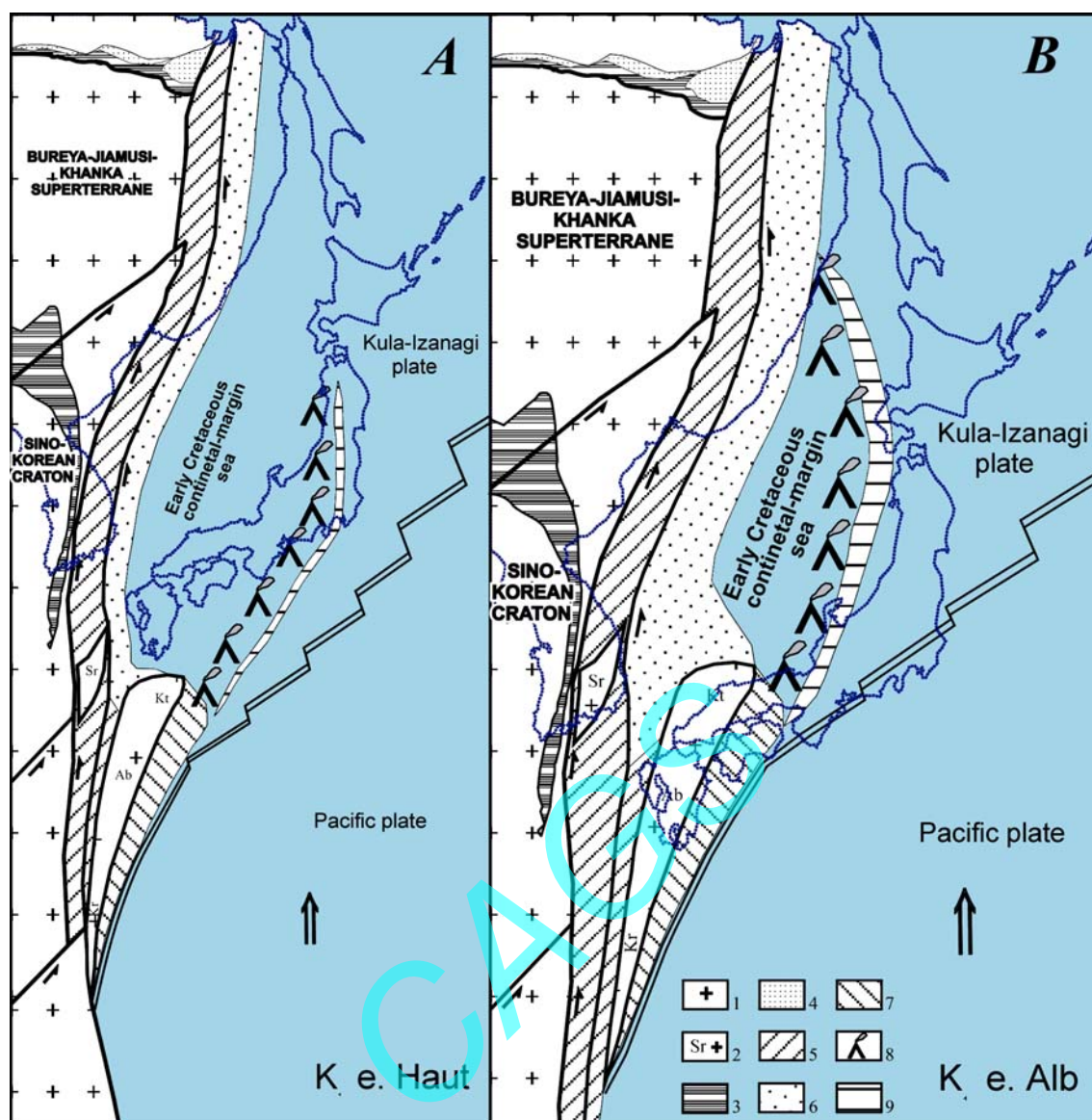


Fig. 1 Paleoreconstructions of the Paleo-Asian continent eastern margin in Early Hauterivian (A) and Early Albian (B) (After Kemkin, 2006 with additions).

1. Early Paleozoic continental blocks: Bureya- Jiamusi-Khanka superterrane and Sino-Korean craton; 2. Fragments of an Early Paleozoic continental margin: Sergeevka terrane (Sr), Southern Kitakami (Kt), Abukuma (Ab), and Kurosegawa (Kr) terranes; 3. Permian-Triassic accretionary prisms; 4. Jurassic turbidite basin (Ulban and Un'ya-Bom terranes); 5. Jurassic accretionary prism (Samarka, Nadezhda-Bikin, Khabarovsk, Badzhal, Tamba, Mino, Ashio, Rioke, Sambagawa, and Northern Chichibu terranes); 6. Early Cretaceous turbidite basin (Zhuravlevka-Amur terrane); 7. Tithonian-Hauterivian accretionary prism (Taukha, Oshima, Northern Kitakami, and Southern Chichibu terranes); 8. Hauterivian-Albian island arc (Kema, Kamyshevka, Shmidt, Moneron, and Rebun-Kabato terranes); 9. Hauterivian-Albian accretionary prism (Kiselevka-Manoma, Aniva-Gomon, and Western Hidaka terranes).

The existence of this basin and its relative isolation is indirectly confirmed by the specific Middle-Late Albian radiolarian assemblage with a significant amount of species unknown for the Cretaceous marine sediments of the Tethys and continental frame of the Pacific Ocean. The origin of this sea basin was caused by forming in Hauterivian and further growth in Hauterivian-Albian the Kema-Rebun-Kabato island arc, and accretion of it to the eastern margin of the Paleo-Asian continent at the end of Albian.

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