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Radiolarians from Cretaceous Deposits of the Maini–Kakyine Ridge, Koryak Highland

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Cretaceous–Paleogene deposits represented by thick volcano-sedimentary sequences are widespread in the Maini–Kakyine Ridge area (figure). The problem of the stratigraphic subdivision of these deposits has long been discussed, because their paleontological characteristics were poorly known. Comprehensive study and detailed sampling for foraminifers were carried out in 1963–1964 to solve this problem (Tarasenko *et al.*, 1970). As a result a series of formations has been distinguished: the Khakina Formation of Maastrichtian age with *Inoceramus shikotanensis*, the Inetyvayam Formation of Danian–Paleocene age with *Rzhehakina epigona*, the Ivtygyn Formation of Danian–Paleocene age with *Rzhehakina epigona*, the Inochvivayam Formation of Paleocene age with *Globigerina nana* and *Acarinina primitiva*, and the Ilpin Formation of Eocene–Oligocene age. Radiolarians were originally identified from deposits of the Inetyvayam Formation and studied in thin sections by Zhamoida. The age was determined in the wide Cretaceous–Paleogene range (Zhamoida *et al.*, 1963).

At present, a procedure of separation of radiolarians from different rocks, including siliceous, by means of dissolving them in a dilute solution of hydrofluoric acid (HF) has been developed that allows an isolation of whole shells of radiolarians from such sequences.

In 1986, researchers from the Geological Institute, Russian Academy of Sciences, studied and sampled radiolarians (samples by K.G.Kazakov) from a section exposed along the Inochvivayam River, a left upper tributary of the Vyvenka River, which is represented from the base upward as follows.

The Khakina Formation:

Dark gray and brownish-gray basaltic agglomerate lavas, the thickness is 50 m. Sixty meters of the section are unexposed.

The Inetyvayam Formation:

(1) Medium to small-pebbled, sometimes bouldery conglomerates, 30 m thick. Ten meters of the section are unexposed.

(2) Sandy, small-detrital, claret siltstones, 28 m thick.

(3) Rhythmically interbedding dark gray laminated cherts, thin interlayers (0.1–0.15 m) of silicified tuffs, and highly siliceous, tuffaceous greenish-gray siltstones that grade into massive siliceous siltstones. A radiolarian assemblage of *Clathrocyclas hyronia* Foreman, *Stichomitra livermorensis* (Campbell et Clark), *Lithostrobos zhamoidai* Kasinzova, *Xitus asymbatos* (Foreman), *Phacodiscus* (?) sp., and *Hexacromyrum* sp. of the late Campanian–Maastrichtian age is revealed at the base of the bed. The thickness is 50 m.

(4) Medium-grained, volcanogenic–terrigenous, dark-gray sandstones alternating with dark gray, tuffaceous siltstones. The thickness is 35 m.

(5) Massive, fine-grained, volcanogenic–terrigenous sandstones, 12 m thick.

(6) Gray, tuffaceous, sandy siltstones with individual thin interlayers of fine-grained, volcanogenic–terrigenous sandstones. The thickness is 12 m.

(7) Dark gray to black, fine-grained siltstones with interlayers of medium-grained, sandy, volcanogenic–terrigenous deposits. The thickness is 4 m.

(8) Rhythmic flyschoid interbedding of dark gray, medium-grained, volcanogenic–terrigenous, and tuffaceous sandstones. The thickness is 6 m.

The Inochvivayam Formation:

(1) Brown, tuffaceous, siliceous silts with oval carbonate concretions. The thickness is 15 m.

(2) Rhythmic flyschoid interbedding of gray volcanogenic–terrigenous medium-grained sandstones with sandy, brown to grayish-brown siltstones and gray siltstones. The thickness is 85 m.

(3) Rhythmic flyschoid interbedding of gray volcanogenic–terrigenous medium-grained sandstones with dark gray massive siltstones. The thickness is 20 m.

(4) Gray sandy siltstones, 8 m thick.

(5) Dark gray fine-detrital mudstones with carbonate concretions. The thickness is 70 m.

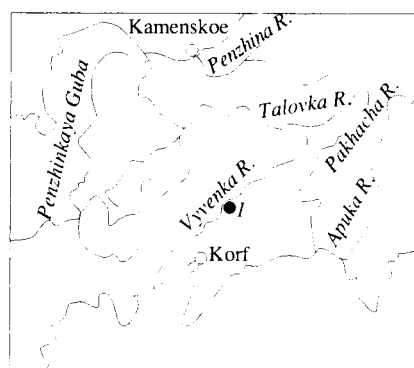
Forms of suborders Sphaeroidea, Discoidea and Larcoidea of Cenozoic appearance, undeterminable with more precision because of poor preservation, are

extracted from deposits of the Inochvuyayam Formation. The Nassellaria species are missing.

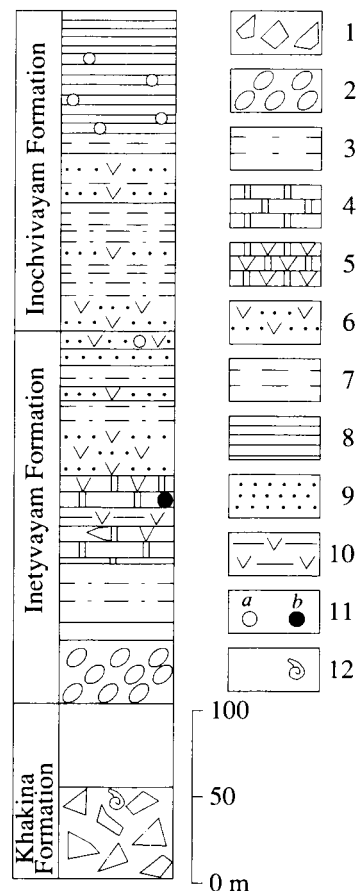
Volcanogenic and siliceous deposits are characteristic of the Upper Cretaceous sequences in the Koryak Highland. Their dating is problematic, as macro- and microfauna with a calcareous shell are, as a rule, missing from such deposits.

Deposits of the Inetyvayam Formation are not an exception in this respect. The lower part of the formation is represented by bouldery conglomerates with gritstone interlayers, the red-brown silts overlying them. The middle and upper parts of the formation are made up mainly of siliceous rocks. When desintegrating the samples, it was found that only several of them taken from the middle part of the Inetyvayam Formation appeared to have fauna. The radiolarian assemblage from siliceous rocks is represented by *Orbiculiforma renillaeformis* (Campbell et Clark), *Clathrocyclus hyronia* Foreman, *C. dicerus* Foreman, *C. gravis* Vishnevskaya, *Lithostrobos zharnoidai* Kasinzova, *Xitus asymbatos* (Foreman), *Phacodiscus* (?) sp., *Hexacromyrum* cf. sp., and by species of the Hagiastriidae family. The assemblage is not diverse; representatives of the genus *Clathrocyclus* are dominant. All other species are subordinate. This is conditioned, on the one hand, by a selective preservation of shells, when fine skeletons might not be preserved (the selected forms bear evidence of lithification often being squeezed and crushed); on the other, it is not improbable that the assemblage was formed under neritic conditions as the prevalence of one or two species is very typical of neritic radiolarian assemblages (Kruglikova, 1974; Vitukhin, 1993).

The presence of *Orbiculiforma renillaeformis*, *Clathrocyclus hyronia*, and *Stichomitra livermorensis* in the assemblage allows its stratigraphic range to be limited by the late Campanian–Maastrichtian interval. The assemblage is correlative with coeval boreal assemblages of eastern Kamchatka (Zinkevich *et al.*, 1988), western Kamchatka (Zinkevich *et al.*, 1991), and Shikotan Island (Bragina, 1994) because of the presence of common species, especially *Clathrocyclus hyronia* and *Stichomitra livermorensis*. G.Yu. Averina found radiolarians in the same region in deposits of the Inetyvayam Formation (Chekhovich *et al.*, 1990). In Averina's opinion, the identified *Dictyopora* sp. suggests the late Campanian–Paleocene age of the assemblage. As no images of these forms were published, such a suggestion is hard to judge. Besides, Vishnevskaya described a more diverse assemblage from the same formation, whose deposits in the Inetyvayam River mouth area overlies sediments with *Inoceramus shikotanensis* and are overlain by beds with *Rzhehakiina* (Bogdanov *et al.*, 1987). This sequence is similar to that described in this work. By the position in the section, Vishnevskaya assigns the assemblage to the Cretaceous–Paleogene. Unfortunately, no reliable data are available as yet on the Danian radiolarians from north-



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The Upper Cretaceous–Lower Paleogene section of the Maini–Kakyine Ridge deposits (the inset shows the section locality on the map):

- 1, agglomerates; 2, conglomerates; 3, sandy siltstones;
- 4, cherts; 5, tuffite cherts; 6, siliceous siltstones; 7, siltstones; 8, mudstones; 9, sandstones; 10, tuffite siltstones;
- 11, (a) carbonate concretions, (b) level of radiolarian fauna;
- 12, *Inoceramus* Beds.

eastern Asia. According to Hollis (1993), some species of the studied assemblage are found in Paleocene deposits. However, the assemblage discussed comprises no typical Cenozoic species, and this allows the enclosing deposits to be dated to the end of the Late Cretaceous (late Campanian–Maastrichtian).

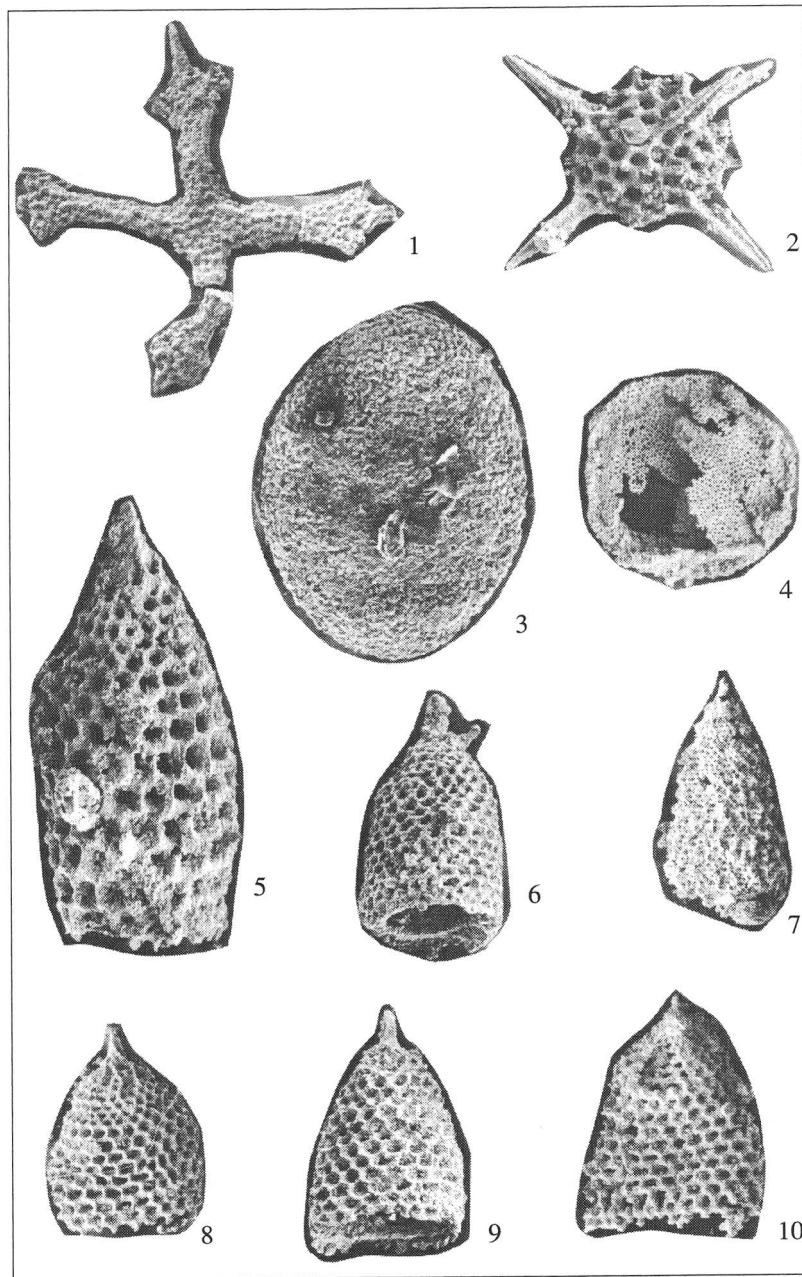


Plate. Radiolarian assemblage from the Inetyvay Formation: (1) Hagiastriidae gen. et sp. indet., $\times 200$; (2) *Stylosphaera* sp., $\times 500$; (3) *Orbiculiforma renillaeformis* (Campbell et Clark), $\times 200$; (4) Gen. et sp. indet., $\times 200$; (5) *Lithostrobos zharnoidai* Kasinzova, $\times 500$; (6) *Clathrocyclus* cf. *dicerus* Foreman, $\times 200$; (7) *Xitus asymbatos* (Foreman), $\times 200$; (8) *Clathrocyclus gravis* Vishnevskaya, $\times 200$; (9) *Clathrocyclus hyronia* Foreman, $\times 200$; (10) *Clathrocyclus* sp., $\times 200$.

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