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Palaeogeographic significance of the distribution of Albian (Cretaceous) ammonite faunas in the Pacific coast of North-East Russia

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With 4 figures and 1 table in the text

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Abstract: The geographic distribution of Albian ammonite faunas of the Pacific margin of North-East Russia is correlated with the main features of a miogeosynclinal trough and an accompanying island arc: intensive terrigenous-tuffaceous sedimentation, continuous volcanic activity and pulsate character of marine transgressions. North Pacific faunal provincialism increased from Early to Middle Albian, when the marine basins were much reduced. Beginning from the Late Albian, a major transgression covers large areas of the examined region, in consequence the ammonite provincialism disappeared towards the Cenomanian.

Zusammenfassung: Korreliert wird die Verbreitung der Alb-Ammoniten der Pazifik-Küste NE-Rußlands mit den Hauptstadien des miogeosynklinalen Korjak-Kamchatka-Troges und des begleitenden Inselbogens: mächtige vulkano-detritische Sedimentation, anhaltender Vulkanismus und transgressive Pulse. Die Ammonitenfaunen gehören der Nordpazifischen Provinz Nordamerikas an, zu der der Korjak-Kamchatka-Trog und Sachalin im Alb in Verbindung standen. Im Cenoman bricht diese Verbindung ab; statt dessen öffnet sich ein Seeweg nach Hokkaido, was eine Einwanderung von kosmopolitischen Arten nach sich zieht.

1. Introduction

Albian marine strata are widespread in North-East Russia along the eastern periphery of the continent. It is well known that the faunas, especially ammonites, of these strata are fundamentally different from the contemporary faunas of the Atlantic and Tethyan realms, and considered to represent a separate Pacific Realm. But, there are differences between the Albian faunas of the Pacific coast of North America and that of North-East Russia, as well as inside the Korjak-Kamchatka region (Fig. 1). POKHIALAYNEN (1985) proposed the existence of two isolated arcs of marine basins along the northern periphery of the Pacific Ocean to give a more comprehensive idea on the geographic differentiation of North Pacific ammonites.

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This short review gives a new interpretation of Albian facies and geological setting of the Pacific coast of Russia in order to explain the pattern of distribution of Albian ammonites. The main material was collected by the first author during field work between 1984–1988 in the Korjak-Kamchatka region. It is mostly deposited in the North-Eastern Interdisciplinary Scientific Research Institute Magadan (NEIM) and partly in the Geologisch-Paläontologisches Institut Tübingen (GPIT).

2. Reference sections and ammonite faunas

According to the actual understanding, North-East Russia comprises a mosaic of tectonic blocks cemented by fold zones. It is important for this discussion that the Korjak-Kamchatka region was a consolidated block from Early Mesozoic to Recent. The Albian strata are represented here by terrigenous-tuffaceous rocks which were deposited in the Mid-Cretaceous miogeosynclinal trough between the Okhotsk-Chukchi volcano-

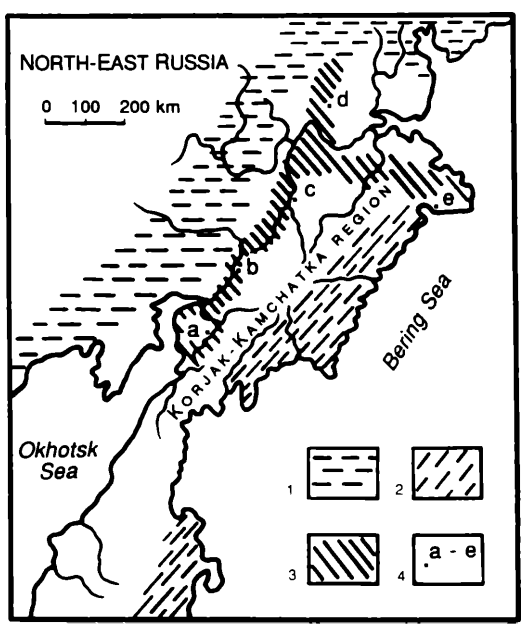


Fig. 1. Regional map of North-East Russia showing the distribution of Mid-Cretaceous structural-facies zones: 1 – Okhotsk-Chukchi volcano-plutonic belt, 2 – system of island arcs, 3 – miogeosynclinal trough, 4 – Albian localities: a – eastern coast of Penzhina Bay, b – Penzhina Valley, c – Main Valley, d – Pekul'nej Mountain Range, e – Ugol'naja Bay.

plutonic belt and a system of island arcs (Fig. 1). Our study focusses on the five key-sections (Figs. 1, 2) which are reflecting different structural facies settings. Lithologically similar rocks were studied in the Naiba key-section of southern Sakhalin.

2.1 General distribution of Albian strata

Along the axial part of the miogeosynclinal trough (Penzhina-Main area), the Albian strata are mainly formed by terrigenous rocks with variegated facies and discontinuous bedding (VERESHCHAGIN 1977, GRIGORJEV et al. 1983, TEREKHOVA & DUNDO 1987).

A nearly complete marine sequence ranging from Berriasian to Maastrichtian with a short erosional hiatus between Middle and Upper Albian is exposed at the eastern coast of Penzhina Bay along the Ajnyn River (Fig. 1a). The Albian strata (Fig. 2A) overlay Aptian marine rocks in part conformably, in part unconformably; typical features are the wide distribution of a Middle Albian turbidite facies and an Upper Albian thick-bedded conglomerate facies. The pebbles of the conglomerate consist mainly of sedimentary and subordinate of intrusive rocks. Here, the main ammonite-bearing stratigraphic interval is of lowermost Middle Albian age. North of the Ajnyn Valley, the Albian strata are

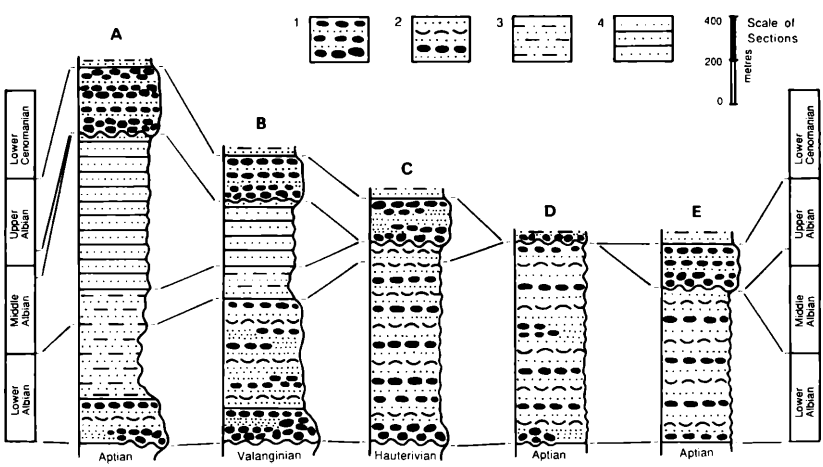


Fig. 2. Correlation of Albian strata of the Korjak-Kamchatka basin. A–E – generalized key-sections: A – Ajnyn Valley, B – Penzhina Valley, C – Main Valley, D – eastern slope of Pekul'nej Range, E – Ugol'naja Bay. 1–4 – lithofacies: 1 – thick-bedded conglomerates, 2 – interbedded sandstones, conglomerates and tuffites, 3 – interbedded sandstones and siltstones, 4 – turbidites.

characterized by an increasing amount of intraformational conglomerates and interfoliated thin coal layers.

Towards the Penzhina area, Albian strata progressively cover older rocks, and exhibit greater thicknesses of the basal and intraformational conglomerates. On the left side of Penzhina Valley, along the Niklekujul River (Fig. 1b), the Albian strata (Fig. 2B) are represented by deposits with variegated facies, in which an interbedded sandstone-conglomerate-tuffite lithofacies is dominant. The components of the conglomerates are mainly effusive rocks. There is a short but distinct erosional hiatus between the Middle and the Upper Albian. In this case, the main ammonite-bearing interval is of Upper Albian age.

Towards the Main Valley, the sequence again becomes more complete at the base of the Albian, while the erosional hiatus between Middle and Upper Albian is more pronounced. North of the upper Main Valley, however, the continental-paralic Krivorechenskaja Formation (Cenomanian – Lower Turonian) directly overlays Barremian rocks. In the Main Valley (Fig. 1c), the Albian sequence (Fig. 2C) consists of two series of strata starting with thick-bedded conglomerates with pebbles yielding fossiliferous concretions from older strata (up to the Paleozoic). The upper part of the sequence consists of interbedded sandstones, conglomerates and tuffites which are covered by basal conglomerates of a second analogous series. In this case, ammonite-bearing layers are of Lower and lowermost Middle Albian age. East of Main Valley, undoubted Upper Albian strata contain the ammonites *Pseudhelicoceras* and *Marshallites* and cover unfossiliferous rocks, probably of Aptian age.

At the eastern slope of the Pekul'nej Mountain Range (Fig. 1d), the Albian is poorly fossiliferous, the rocks consist of a sandstone-conglomerate-tuffite lithofacies and are of Lower Albian age (Fig. 2D). These strata overlay either conformably or unconformably Aptian sandstone-siltstone deposits, whereas at the western slope, a pronounced depositional hiatus from Valanginian to Coniacian is observed. Northeast of the Pekul'nej Mountain Range, the Albian stage is represented by continental deposits.

In the northeastern part of the Korjak-Kamchatka region, near Ugol'naja Bay (Fig. 1e), the Albian section exhibits some facies similarity with the Pekul'nej Range section, and is characterized by a continuous stratigraphic sequence from Aptian through Lower Albian followed by a distinct depositional hiatus between the Lower and Upper Albian (Fig. 2E).

2.2 Stratigraphic and geographic differentiation of ammonite faunas

The sequence of Albian ammonite faunas (Table 1) repeats in general the developmental features of the North Pacific ammonites as described by MATSUMOTO (1959, 1960), IMLAY (1960, 1961), JONES (1967), JELETZKY (1971) and MCLEARN (1972). In detail, the geographic differentiation of Albian facies and ammonite faunas (Fig. 3) give an interesting insight for the interpretation of the geological history of the Korjak-Kamchatka region.

The distribution of Lower Albian ammonites along the NE-running trough axis (Fig. 3A) is more or less uniform. The ammonite association is very similar to those of Alaska (IMLAY 1960, 1961; MATSUMOTO 1959; JONES 1967) and British Columbia (MCLEARN 1972). This sedimentary trough was open towards the Okhotsk Sea and the Bering Sea.

During the Middle Albian, the sedimentary basin was much reduced (Fig. 3B). In the western part, the Middle Albian is characterized by a deep-water turbidite facies in which fossils are very rare. In the eastern part of the basin, few ammonites are recognized, i.e. *Grantziceras affine*

Table 1. Stratigraphic distribution of Albian ammonite faunas at the Pacific coast of North-East Russia.

UPPER ALBIAN	*Hypophylloceras californicum* (ANDERSON), *Pseudhelicoceras carlottense* (WHITEAVES), *Desmoceras (Pseudouhligella) dawsoni* (WHITEAVES), *Marshallites cumshewaensis* (WHITEAVES), *M. columbianus* MCLEARN, *Neogastroplites americanus* (REESIDE & WEYMOUTH), *Rapidoplacenticeras sutherlandbrowni* (MCLEARN)
MIDDLE ALBIAN	*Grantziceras affine* (WHITEAVES), *G. glabrum* (WHITEAVES), *Grycia pereziana* (WHITEAVES), *Gr. dubia* (MIKHAILOVA & TEREKHOVA)
LOWER ALBIAN	*Subarcthoplites talkeetnanus* (IMLAY), *S. belli* (MCLEARN), *Parasilesites bullatus* IMLAY, *P. laperousianus* (WHITEAVES), *P. irregularis* IMLAY, *P. orientalis* (MIKHAILOVA & TEREKHOVA), *Grycia dubia* (MIKHAILOVA & TEREKHOVA), *Grantziceras affine* (WHITEAVES), *G. glabrum* (WHITEAVES), *Freboldiceras singulare* IMLAY, *Anagaudryceras aurarium* (ANDERSON), *Leconteites deansi* (WHITEAVES), *Kennicottia bifurcata* IMLAY, *Moffitites robustus* IMLAY, *Kossmatella cappsi* IMLAY

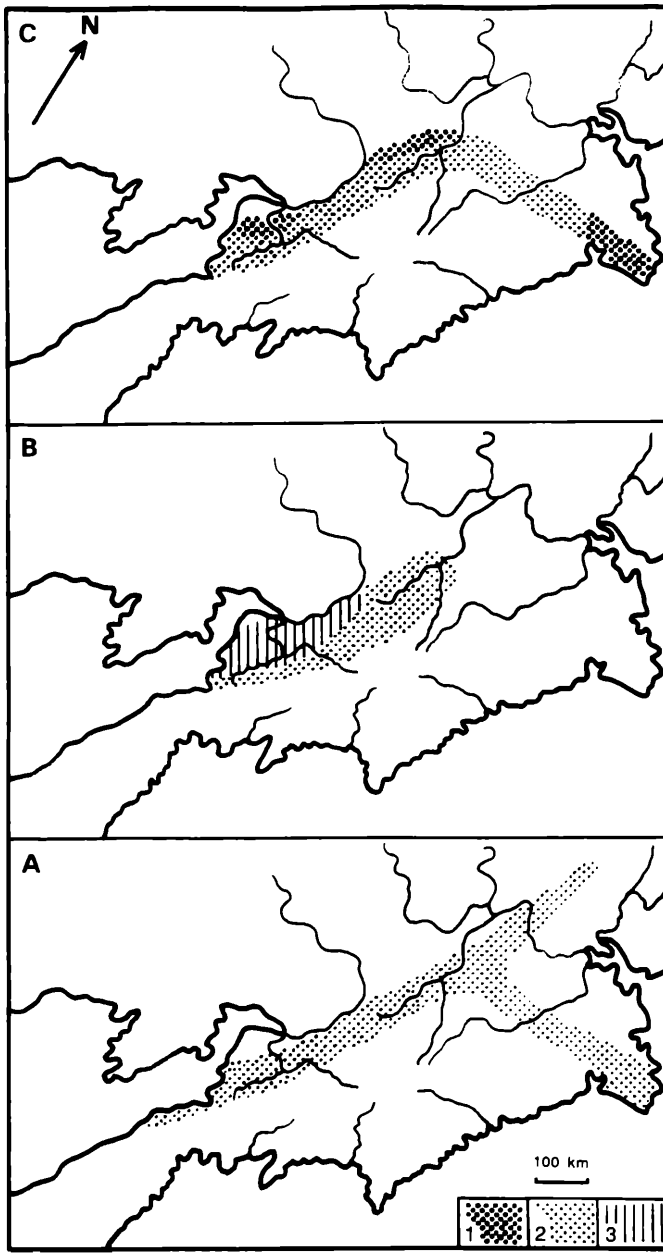


Fig. 3. Evolution of the Korjak-Kamchatka marine basin during Early (A), Middle (B) and Late (C) Albian. 1–3 – lithofacies: 1 – paralic, 2 – moderately deep-water terrigenous-tuffaceous, 3 – deep-water turbidites.

(WHITEAVES), *G. glabrum* (WHITEAVES), *Grycia dubia* (MIKHAILOVA & TEREKHOVA) and *Grycia pereziana* (WHITEAVES), persisting from the Lower into the Middle Albian. Probably, this basin was connected with the Okhotsk Sea, only.

In the Upper Albian (Fig. 3C), the spatial distribution of marine basins was similar to the Lower Albian, except for the northern part (area of Pekulnej Mountain Range). The spatial differentiation and distribution of facies and ammonite faunas within the examined basin is, however, distinct. The genera *Neogastroplites* and *Marshallites* are common for the western part of the trough, whereas *Hypophylloceras, Rapidoplacenticeras, Desmoceras* and *Pseudhelicoceras* are dominant taxa of the central part, and *Marshallites* and *Pseudhelicoceras* of the eastern part.

In general, the geographic distribution of Albian faunas may be characterized by numerous associations in the moderately deep-water western and central parts and by the rarity of ammonites in the shallower eastern part of the trough.

The analysis of facies and ammonite faunas indicates that the Albian Korjak-Kamchatka miogeosynclinal trough was connected with the Sakhalin basin. On the other hand, the Matanuska depression of Alaska (BURK 1965) is analogous in development and a continuation of the examinded trough. Most likely, this sequence of basins had the same orientation from W-SW to E-NE. Later, it was faulted as a result of spreading of the Japan Sea and the southern part of the Okhotsk Sea (HILDE & WAGEMAN 1973; GNIBIDENKO 1983; TUEZOV et al. 1984).

3. Discussion on the distribution of Albian facies and ammonite faunas

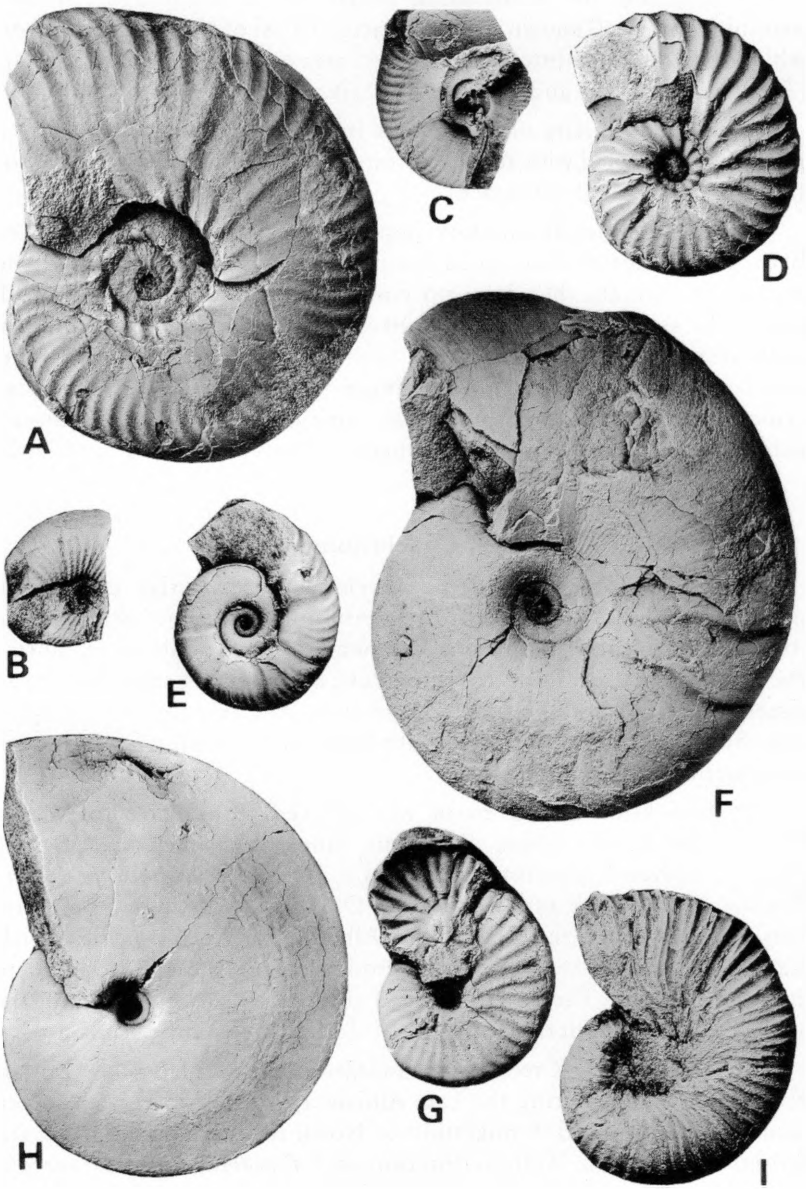
During the Early Albian (Fig. 3A), the miogeosynclinal trough developed as a deep depression between cordillera and raised island arcs. The composition of terrigenous rocks, especially of conglomerates, indicates that a supposed source of sediments for the southwestern and northern parts of the trough might have been old basement of the originated Okhotsk-Chukchi volcano-plutonic belt, whereas the source for the central and eastern parts of the trough probably were the "green tuffs" formations of young island arcs. In between, migrations of the ammonite fauna took place from Alaska through Korjak-Kamchatka up to the southern Sikhote-Alin' and the Sakhalin basins, in decreasing quantities. This sequence of miogeosyncline basins became shallower towards the southern Sakhalin basin. Differences in ammonite faunas indicate that during Early Albian time, the Sakhalin and Hokkaido basins were unconnected. Typical North American invaders in the Korjak-Kamchatka basin

were *Leconteites deansi* (WHITEAVES) (Fig. 4A), *Kennicottia bifurcata* IMLAY (Fig. 4B), *Hulenites* sp. (Fig. 4C), *Subarcthoplites talkeetnanus* (IMLAY) (Fig. 4D), *Parasilesites bullatus* IMLAY (Fig. 4E) and *Grantziceras affine* (WHITEAVES) (Fig. 4F).

During the Middle Albian (Fig. 3B), a general deepening of the reduced miogeosynclinal basins took place from Korjak-Kamchatka to southern Sakhalin. The accumulation of turbidite facies (upper part of the Kedrovskaja Formation of Korjak-Kamchatka, upper part of the Ukturskaja Formation of Sikhote-Alin' and Aiskaja Formation of Sakhalin) was preceding the basin inversion and foreshadowing the beginning of the molassoid depositional stage. The eastern part of the trough was probably uplifted beginning from the Middle up to the Late Albian. The absence of Middle Albian facies and ammonite faunas in the eastern part of the examined region indicates that the separation of the Korjak-Kamchatka basin most likely took place at the Early to Middle Albian boundary.

Beginning with the Late Albian (Fig. 3C), a new marine transgression involved wide areas of the Korjak-Kamchatka region. During this time, in the westernmost and northern parts of the trough – towards the continent – shallow-water and paralic facies developed (the basal parts of the Ginterovskaja and Mametchinskaja formations of Korjak-Kamchatka and the lower part of the Luzhninskaja Formation of Sikhote-Alin'). Towards the ocean, the southern part of the trough was developing deep-water deposits with distinct input of island arc sedimentation (the basal part of the Takynkujulskaja Formation of Korjak-Kamchatka and the lower part of the Naibinskaja Formation of Sakhalin). This differentiation is reflected by the Upper Albian ammonite biogeography: the sculptured *Neogastroplites americanus* (REESIDE & WEYMOUTH) (Fig. 4G) and torticone *Pseudhelicoceras carlottense* (WHITEAVES) are characteristic for the northern shallow-waters, whereas the platycone *Rapidoplacenticeras sutherlandbrowni* (MCLEARN) (Fig. 4H) and *Hypophylloceras californicum* (ANDERSON), as well as the smooth *Desmoceras* (*Pseudouhligella*) *dawsoni*

Fig. 4. Typical North American invaders into the Albian Korjak-Kamchatka basin. A: *Leconteites deansi* (WHITEAVES). NEIM 22s/7-1. Lowermost Albian, Ajnyn Valley. B: *Kennicottia bifurcata* IMLAY. GPIT 1734/1. Lowermost Albian, Main Valley. C: *Hulenites* sp. NEIM 22s/7-2. Lowermost Albian, Ajnyn Valley. D: *Subarcthoplites talkeetnanus* (IMLAY). NEIM 22s/7-3. Uppermost Lower Albian, Main Valley. E: *Parasilesites bullatus* IMLAY. NEIM 22s/7-4. Uppermost Lower Albian, Ajnyn Valley. F: *Grantziceras affine* (WHITEAVES). GPIT 1734/2. Lower Albian, Ajnyn Valley. G: *Neogastroplites americanus* (REESIDE & WEYMOUTH). NEIM 22s/9-1. Upper Albian, Penzhina Valley. H: *Rapidoplacenticeras sutherlandbrowni* (MCLEARN). NEIM 22s/11-3. Upper Albian, Ajnyn Valley. I: *Marshallites cumshewaensis* (WHITEAVES). NEIM 22s/11-4. Upper Albian, Ajnyn Valley.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(Whiteaves) characterize the southern deep-waters. *Marshallites cumshewaensis* (Whiteaves) (Fig. 4I) and *M. columbianus* McLearn, however, are found to be common in the whole Korjak-Kamchatka trough. All these ammonites are well known from the Pacific Coast of North America from which they migrated into the examined area and further up to Sakhalin (*Rapidoplacenticeras*) and Sikhote-Alin' (*Neogastroplites*).

The general scarcity of ammonites in the examined basin was most probably connected with strong tectonic and volcanic activities, not too favorable for faunal settlement.

While the faunal distribution implies a periodic marine connection between the Korjak-Kamchatka basin and the North American basins during the Albian, there was no continuation of the seaway towards Hokkaido as for. The great differences of Albian ammonite faunas of both areas reflect the fact that the Sakhalin and Hokkaido basins were not connected before the Cenomanian. With the Early Cenomanian typical Japanese and cosmopolitan ammonites started to migrate through Sakhalin and Korjak-Kamchatka up to Queen Charlotte Islands.

4. Conclusions

The Korjak-Kamchatka region developed at an active continental margin and is characterized by continuous volcanic activity and intensive terrigenous-tuffaceous sedimentation at an island arc during the Mid-Cretaceous. These environments, a connecting seaway to North America and pulses of marine transgressions determined the geographic distribution of the Albian ammonite fauna in the northwestern part of the Pacific Ocean.

The Korjak-Kamchatka basin was reduced from Early to Middle Albian. The Lower Albian ammonite fauna is characterized by the presence of North American invaders, i.e. *Leconteites, Kennicottia, Subarcthoplites, Grantziceras* and *Parasilesites*. Only a few of these ammonites persisted from Early into the Middle Albian. A large area of the Korjak-Kamchatka basin was uplifted and eroded during the late Middle and early Late Albian. The eastern part of the trough was uplifted and the seaway to North America was faulted during the Middle Albian.

The global Mid-Cretaceous transgression invaded the Korjak-Kamchatka region during the Late Albian. This time again is characterized by a pronounced immigration of North American ammonites, i.e. *Neogastroplites* from Western Interior, and *Pseudhelicoceras, Desmoceras* (*Pseudouhligella*), *Marshallites* and *Rapidoplacenticeras* from the Canadian insular belt. The immigration took place through Alaska into the Korjak-Kamchatka trough and further up to Sikhote-Alin' and Sakhalin.

This faunal influence and North Pacific provincialism disappeared with the Early Cenomanian, when Japanese species accompanied by cosmopolitan taxa (*Hypoturrilites gravesianus* (D'ORBIGNY), *Mariella* (*M.*) *cenomanensis* (SCHLÜTER), *Turrilites* (*T.*) *pseudocostatus* COLLIGNON, *T* (*T.*) *costatus* LAMARCK and *Acanthoceras sussexiense* (MANTELL)) became common species in the North Pacific Realm.

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References

BURK, C. A. (1965): Geology of the Alaska Peninsula – Island arc and continental margin. – Geol. Soc. Amer. Mem., **99**: 250 p.

GNIBIDENKO, G. S. (1983): Tectonic of the northeastern part of the Pacific Ocean. – 117 p.; Moscow (Nauka). [In Russ.]

GRIGORJEV, V. N.; KAZIMIROV, A. D. & POKHIALAYNEN, V. P. (1983): Upper Albian-Turonian deposits of the eastern part of the Korjak upland. – Izv. Akad. Nauk SSSR, Ser. Geol., **1983** (1): 47–57. [In Russ.]

HILDE, T. W. C. & WAGEMAN, J. W. (1973): Structure and origin of the Japan Sea. [In:] COLEMAN, P. J. (Ed.): The Western Pacific: 415–435; Nedlands: Univ. West. Austral. Press.

IMLAY, R. W. (1960): Early Cretaceous (Albian) ammonites from the Chitina Valley and Talkeetna Mountains, Alaska. – U.S. Geol. Surv. Prof. Pap., **354-D**: 87–114.

– (1961): Characteristic Lower Cretaceous megafossils from Northern Alaska. – Ibidem, **335**: 74 p.

IVANOV, V. V. (1985): Sedimentary basins of North-East Asia. – 208 p.; Moscow (Nauka). [In Russ.]

JELETZKY, J. A. (1971): Marine Cretaceous biotic provinces and paleogeography of Western and Arctic Canada. – Geol. Surv. Canada Pap., **70–22**: 92 p.

JONES, D. L. (1967): Cretaceous Ammonites from the Lower Part of the Matanuska Formation, Southern Alaska. – U.S. Geol. Surv. Prof. Pap., **547**: 47 p.

MATSUMOTO, T. (1959): Cretaceous Ammonites from the Upper Chitina Valley, Alaska. – Mem. Fac. Sci. Kyushu Univ. (D), **8** (3): 49–90.

– (1960): Upper Cretaceous Ammonites of California. Pt. 3. – Ibidem, (D). Spec. vol. **2**: 204 p.

MCLEARN, F. H. (1972): Ammonites of the Lower Cretaceous Sandstone Member of the Haida Formation, Skidegate Inlet, Queen Charlotte Islands, Western British Columbia. – Geol. Surv. Canada. Bull., **188**: 78 p.

POKHIALAYNEN, V. P. (1985): Albian/Cenomanian Mollusks of Mowry basin and his analogies at the North Pacific Ocean. –. tikhookeanskaja Geologija, **1985** (5): 15–22. [In Russ.]

TEREKHOVA, G. P. & DUNDO, O. P. (1987): Regional stratigraphy of Anadyr'-Kamchatka region. [In:] SOKOLOV, B. S. (Ed.): Stratigraphy of the USSR. Cretaceous System. Pt. 2: 137–153; Moscow (Nedra). [In Russ.]

Tuezov, I. K.; Kharakhinov, V. V. & Tereshchenkov, A. A. (1984): Sedimentary layer of Okhotsk and Bering Seas. [In:] Abstr. 27 session Internat. Geol. Congr., 3: 435–436; Moscow (Nauka). [In Russ.]

Vereshchagin, V. N. (1977): Cretaceous system of Far East. – 208 p.; Leningrad (Nedra). [In Russ.]

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