УДК: 551.791(571.651):621.039.86

AEOLIAN SEDIMENTS IN THE ULAKHAN-SULAR OUTCROP IN THE ADYCHA RIVER VALLEY, YANA PLATEAU, YAKUTIA

A. V. Lozhkin[1], P. M. Anderson[2]

[1] North-East Interdisciplinary Research Institute n. a. N. A. Shilo, FEB RAS, Magadan, Russia
[2] University of Washington, Department of Earth and Space Sciences and Quaternary Research Center, Seattle, WA, USA
E-mail: lozhkin@neisri.ru, pata@uw.edu

Radiocarbon dating indicates that the sediments exposed in the Ulakhan-Sular outcrop in the Adycha River valley accumulated continuously during the period corresponding to marine isotope stage 2. The study of the Ulakhan-Sular site provided the first data about the accumulation of aeolian sediments on the Yana Plateau. The aeolian formations are represented by unstratified silty sands with interlayers of organic matter, which included shrub branches and tree stumps. The aeolian sands exposed in the outcrop were formed over the past 1,600 years. Earlier accumulations of aeolian sediments were not preserved as the result of erosion of the outcrop, including ice wedge melting.

***Keywords*: Ulakhan-Sular suite, sandy sediments, buried soil, peat, radiocarbon dating.**

DOI: 10.34078/1814-0998-2024-4-12-15

INTRODUCTION

The first data on aeolian sediments from the Yana Plateau were obtained during the study of a 65-m terrace in the Adycha River valley (Fig. 1).

The Yana Plateau with predominant peaks of about 500–800 m in height is bordered to the west and south by spurs of the Verkhoyansk Range and to the east by spurs of the Chersky chain. In the north, the Plateau gives way to the vast Primorskaya Lowland, the border of which is formed by the coast of the Laptev and the East Siberian Seas. Within the Plateau, the Yana River and its right tributary, the Adycha River, originate in the region of the Arctic Circle between 132° and 136° E.

In its lower reaches, the Adycha River crosses the Tuostakh Depression, which has been infilled with sediments. The formation of the depression dates to the Neogene and Quaternary periods. The absolute elevation of the depression's surface increases from north to south from 300 to 700 m. The bed of the Adycha River at its confluence with the Yana River has an elevation of 104 m. The sediments of the depression were exposed along the right bank of the Adycha River 60 km from its mouth in the area with coordinates 67° 49′ N, 135° 40′ E. This outcrop, called Ulakhan-Sular (Kaplina et al., 1983; Minyuk, 2004), is composed primarily of sandy strata and can be traced along the bed of the Adycha River for 2.4 km. The Ulakhan-Sular outcrop is a key reference section for addressing issues of stratigraphy and paleogeography of the Quaternary period in the cold pole region of the Northern Hemisphere.

RADIOCARBON DATING OF SEDIMENTS OF THE ULAKHAN-SULAR OUTCROP

Faunal materials indicate that the bulk of the sediments in the Ulakhan-Sular outcrop, identified as the Ulakhan-Sular suite, are Middle Pleistocene in age. The uppermost layers at the site are presumably dated to the Late Pleistocene, but this assumption "requires additional substantiation" (Kaplina et al., 1983. P. 121).

The upper layers of the Ulakhan-Sular suite are represented by fine-grained sands with layers of peat, which contain remains of grass and branches of shrubs between 515 and 1,760 cm (note: all measurements reflect the distance below the outcrop's surface). Seven dates were obtained, most of which are near the limit of the radiocarbon method (Table 1).

Between 550 and 1,450 cm, an ice wedge was observed in the sands, with a width of 190 cm at the top and a vertical length of 680 cm. The cores of the ice wedge polygons are composed of sand, peat, and sandy loam with plant remains.

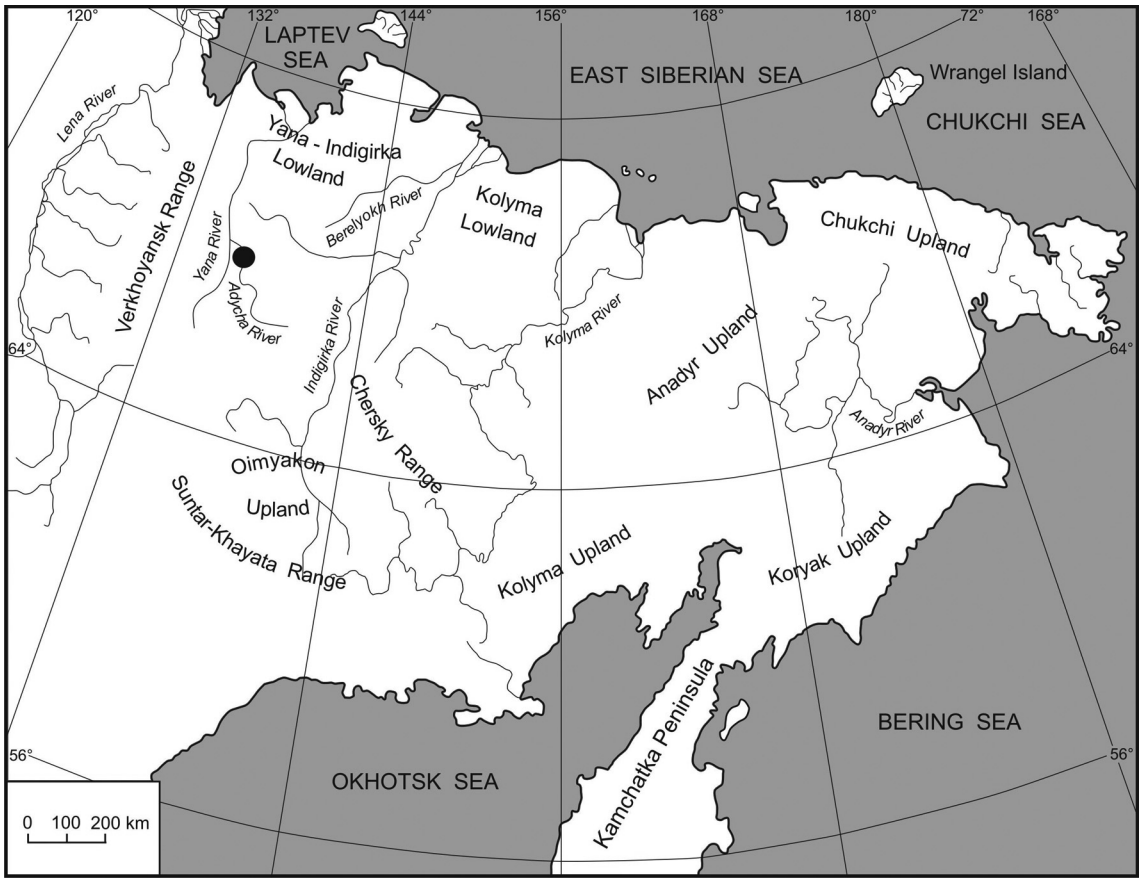

Рис. 1. Географическое положение обнажения Улахан-Сулар в долине реки Адыча.
Fig. 1. Ulakhan-Sular outcrop location in the Adycha River valley.

Таблица 1. **Радиоуглеродные датировки в обнажении Улахан-Сулар**
Table 1. **Radiocarbon dates in the Ulakhan-Sular outcrop**

Sample depth, cm	^{14}C age	Median cal age; 2 sigma range	Sample number	Material dated
Sediments of the Ulakhan-Sular outcrop				
515	24,800 ± 1,300	29,020 26,380–31,330	MAG-785	Accumulations of gopher excrement
1,200	≥ 45,000	47,300	MAG-798	Tree trunk
1,250	≥ 43,000	45,500	MGU-570	Wood in peat
1,360	≥ 39,000	42,600	MAG-796	Wood in peat
1,440	40,800 ± 1,100	43,850 42,500–45,370	MAG-793	Peat
1,440	40,900 ± 900	43,880 42,685–45,140	MAG-795	Larch trunk
1,760	≥ 45,000	47,300	MAG-794	Peat
Aeolian sediments				
10–25	45 ± 25	modern	MAG-788	Layer of buried soil
50	660 ± 50	620 550–675	MAG-790	Tree trunk
75	680 ± 50	635 550–685	MAG-789	Tree trunk
145	920 ±50	830 730–920	MAG-787	Tree stump roots in buried soil
150	1,600 ± 100	1,485 1,310–1,640	MAG-786	Buried soil with branches of shrubs

At a depth of 550 cm, the sands are covered by a layer of silt, the thickness of which reaches 400 cm. The silt is characterized by a horizontal, irregular or wavy stratification, emphasized by the presence of grass roots. The sand and silt with their characteristic stratification represent a floodplain facies of alluvium.

A sample of brown peat from a lens-shaped sandy loam layer within the sands (depth 1,760 cm), was radiocarbon dated to ≥ 45,000 years ago (MAG-794). At 1,440 cm, a 30-cm-thick layer of peat with uneven boundaries was traced in the sand layer. This peat included an abundance of roots, large branches of shrubs, and horizontally oriented tree trunks of 7 cm thickness. A sample of this dark brown, long-fibered peat was dated to 40,800 ± 1,100 years ago (MAG-793). At the same depth, a date of 40,900 ± 900 years ago (MAG-795) was obtained from a larch trunk found at the upper boundary of the peat layer. Wood from a peat layer, which occurred in medium-grained sands (depth 1,360 cm) was dated to ≥ 39,000 BP (MAG-796). A small tree trunk found in a peat layer (depth 1,250 cm) was dated to ≥ 45,000 BP (MAG-798). A similar date, ≥ 43,000 BP (MGU-570), was established for wood from a peat layer at a depth of about 1,200 cm.

Analysis of radiocarbon samples of organic remains from the sand deposits between 1,200 and 1,760 cm indicates that the MAG-793 and MAG-795 dates, which are at the lower threshold of the radiocarbon method, may be problematic. Because the other samples between 1,200 and 1,760 cm yielded "greater than" dates, it is reasonable that the dates at 1,440 cm are also infinite. At the same time, the 1,440 cm dates are consistent with the occurrence of Late Pleistocene sand layers with ice wedges, which are characteristic of the region (Kaplina et al., 1983).

Radiocarbon dating of ground squirrel excrement (depth 515 cm), which had accumulated at the contact of siltstone and fine-grained sands yielded a date of 24,800 ± 1,300 years BP (MAG-785), corresponding to marine isotope stage 2, which characterizes the last Late Pleistocene glacial stage.

These reconstructions are consistent with palynological data (Kaplina et al., 1983), which showed a very high component of *Selaginella rupestris* (L.) Spring spores in the spectra. *Selaginella rupestris* is typical of dry tundra communities and in disturbed areas with coarse substrates. Although present in areas with shrub *Betula*, *Alnus* and *Pinus pumila,* it is not common. The vegetation of the Yana and Adycha River basins probably was not characterized by larch forest-tundra (e. g., *Larix* pollen was not found in the spectra). Rather, open tundra areas with Caryophyllaceae, Asteraceae, *Artemisia*, Cyperaceae, and Poaceae were relatively widespread.

RADIOCARBON DATING OF AEOLIAN SEDIMENTS IN THE ULAKHAN-SULAR OUTCROP

The uppermost sediment layers in the Ulakhan-Sular outcrop, which are approximately 150 cm thick, consist of fine-grained sand that sometimes has a silty component. This deposit has been defined as a floodplain alluvial facies (Kaplina et al., 1983). No direct evidence was found of wind processes exerting an erosive effect on the sediments at the Ulakhan-Sular site. However, given the composition and relative exposure of the outcrop, it is reasonable to postulate that the wind loosened sand grains from the outcrop and subsequently lifted and spread them over the flat, wooded (sparse *Larix cajanderi* (*Larix gmelinii* var. gmelinii) forest) surface of the outcrop. Today sand covers this surface for more than a hundred meters from the edge of the cliff, where dunes up to 1–1.5 m in height have formed.

The aeolian formations represented by gray unstratified, fine-grained sands include organic layers, branches and roots of shrubs, and tree stumps. A series of radiocarbon dates indicate that these deposits formed in the Late Holocene (Table 1). At a depth of 150 cm, a 7-cm-thick, black-brown buried soil can be traced in the sands. This paleosol contains charred roots and small branches of shrubs and was dated to 1,600 ± 100 years ago (MAG-786). At a depth of 145 cm, in a 5 to 10 cm thick layer of buried soil, a 50-cm-high tree stump with preserved roots was discovered. Dating of the wood showed an age of 920 ± 50 years ago (MAG-787). A date of 680 ± 50 years ago (MAG-789) was obtained from a tree trunk (5 cm in diameter), discovered at a depth of 75 cm. A close dating of 660 ± 50 years ago (MAG-790), was obtained for a tree trunk (7 cm in diameter) lying horizontally at a depth of 50 cm. At the surface of the aeolian sands, a 15-cm-thick layer of buried soil was dated to 45 ± 25 years ago (MAG-788).

CONCLUSION

As shown by radiocarbon dating, the accumulation of sediments in the Tuostakh Depression spans a period comparable to marine isotope stage 2. This accumulation probably continued until the onset of the sharp and rapid climate warming that occurred at the Pleistocene-Holocene boundary. As a consequence of fluvial processes that became active at the beginning of the Holocene, the Ulakhan-Sular outcrop was exposed in the Adycha River valley.

When the Ulakhan-Sular outcrop was formed, sand particles from the outcrop became wind born, as occurs today, and covered the *Larix cajanderi* forest which grew on the surface of the site. The aeolian sands now exposed in the outcrop accumulated over the last 1,600 years. The earlier buildup of aeolian

sediments has not been preserved, apparently as a result of erosional processes, which included the melting of ice wedges.

Aeolian processes like those currently occurring in the Ulakhan-Sular outcrop can be observed in other physical-geographical regions of Beringia. For example, aeolian sands have been noted near Magadan on the western shore of the Gertner Bay. In this area, a layer of conglomerates, traced along the coast in the form of a 30-m-high cliff, can be attributed to the Nagaev layer associated with a Miocene river valley, which is confined to the latitudinally oriented Kava-Tauysk-Yama depression on the northern shore of the Sea of Okhotsk (Baranova, Biske, 1964). The conglomerates are covered by a 3-m-thick layer of fine-grained aeolian sands, whose distribution far from the edge of the outcrop's face has been obscured by human activity.

REFERENCES

Baranova, Yu. P., Biske, S. F., 1964. North-East of the USSR. Moscow, Nauka [In Russian].

Kaplina, T. N., Kartashova, G. G., Nikitin, V. P., Shilova, G. N., 1983. New Data on the Sandy Layer of the Tuostakh Depression, *Bulletin of the Commission for the Study of the Quaternary Period*. 52, 107–122 [In Russian].

Minyuk, P. S., 2004. Magnetostratigraphy of the Cenozoic of North-East Russia. Magadan, NEISRI FEB RAS [In Russian].

Received 03.10.2024.
Received after revision 18.10.2024.

ЭОЛОВЫЕ ОСАДКИ В ОБНАЖЕНИИ УЛАХАН-СУЛАР В ДОЛИНЕ р. АДЫЧА, ЯНСКОЕ ПЛОСКОГОРЬЕ, ЯКУТИЯ

Ложкин А. В.[1], Андерсон П. М.[2]

[1] ФГБУН Северо-Восточный комплексный научно-исследовательский институт им. Н. А. Шило ДВО РАН, г. Магадан
[2] Вашингтонский университет, кафедра наук о Земле и космосе, Центр четвертичных исследований, г. Сиэтл, США

Радиоуглеродные датировки показали, что формирование осадков, вскрытых в долине реки Адыча в обнажении Улахан-Сулар, продолжалось в период, сопоставляемый с морской изотопной стадией 2. При исследовании обнажения Улахан-Сулар получены также первые данные об эоловых осадках Янского плоскогорья. Эоловые образования представлены неслоистыми пылеватыми песками с прослоями органики, ветвей кустарников и пней деревьев. Вскрытые в обнажении эоловые пески формировались последние 1 600 лет. Более ранние накопления эоловых осадков не сохранились в результате эрозионного разрушения обнажения, включая таяние жил повторно-жильных льдов.

***Ключевые слова*: Улахан-Суларская свита, песчаные осадки, погребенная почва, торф, радиоуглеродные датировки.**

ЛИТЕРАТУРА

Баранова Ю. П., Бискэ С. Ф. Северо-Восток СССР. Москва: Наука, 1964. 290 с.

Каплина Т. Н., Карташова Г. Г., Никитин В. П., Шилова Г. Н. Новые данные о песчаной толще Туостахской впадины // Бюллетень комиссии по изучению четвертичного периода. 1983. № 52. С. 107–122.

Минюк П. С. Магнитостратиграфия кайнозоя Северо-Востока России. Магадан: СВКНИИ ДВО РАН, 2004. 198 с.