

Early investigations of permafrost in Siberia by Baltic-German and German scientists



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In the 18th and 19th centuries several German and Baltic-German scientists investigated almost unknown territories of the Russian Empire. Many of them were invited by Russian emperors and some became academicians of the St. Petersburg Academy of Sciences. German naturalists like Georg Wilhelm Steller (1709-1746), Johann Georg Gmelin (1709-1755), Peter Simon Pallas (1741-1811), Karl Ernst von Baer (1792-1876), Ferdinand von Wrangell (1797-1870) and Alexander Theodor von Middendorff

(1815-1894) traveled through Siberia collecting information about the flora, fauna, geology, climate, ethnology, history and economy of the Far East of Russia. Their results were mostly published in journals of the Russian Geographical Society. Information about Russia became available in Europe through special journals edited by Germans such as P.S. Pallas [1], J.G. Georgi [2], Th. Fr. Ehrmann [3], A. Erman [4], K.E. v. Baer and G. v. Helmersen [5].

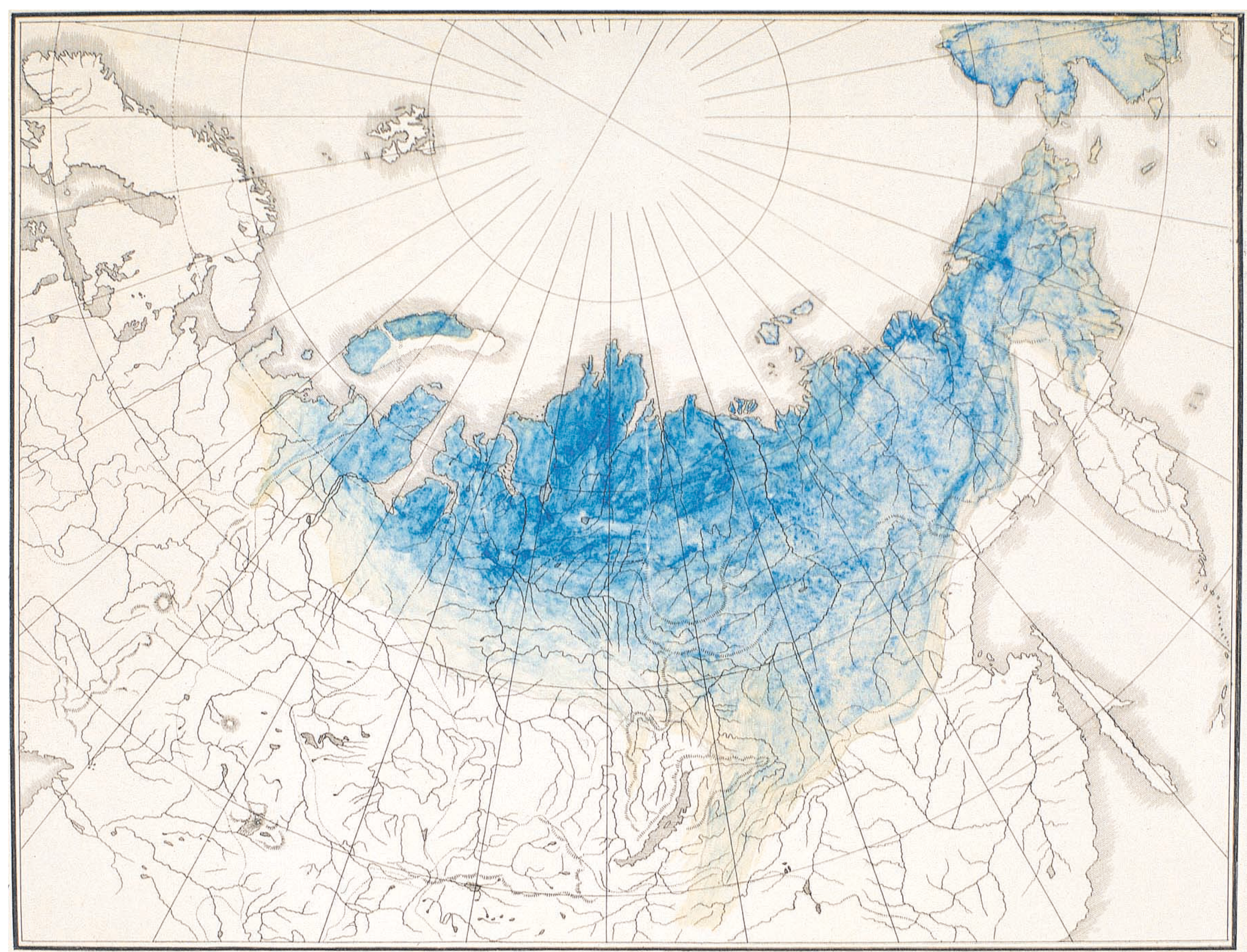
Karl Ernst von Baer

Karl Ernst von Baer (1792-1876) was a Baltic-German naturalist and member of the St. Petersburg Academy of Sciences. Between 1838 and 1843 he collected all data available on Siberian ever frozen ground. He wrote a special permafrost study including the first classification of permafrost and suggested to carry out regular observations in the Shergin shaft. Baer formulated instructions for

the expedition to North and East Siberia by A. Th. von Middendorff. The main task was to investigate permafrost thickness, temperature and distribution [15]. Baer drew the first permafrost map of Siberia (below). Unfortunately his study and the map were not published before 2000 [16]. He also suggested investigations of air and soil temperatures in British North America [17][18].



Karl Ernst von Baer in 1840



Baer's map of permafrost distribution in Siberia drawn in 1843 [17]

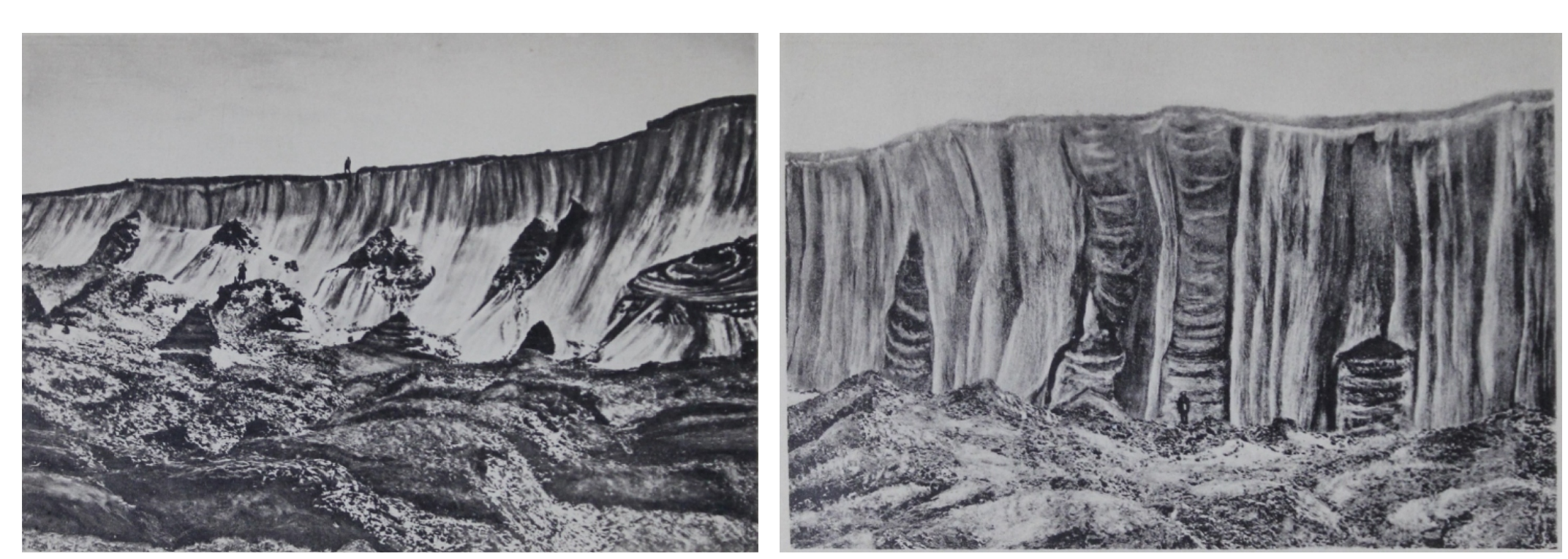
Genesis of ground ice

Scientific world was deeply impressed by the first photographs of huge ground ice wedges published by Baron Eduard von Toll in 1897. He speculated that these formations were relicts of glaciers and introduced terms like

“fossil ice” and “ice rock” (Steineis) in geocryology [22]. Alexander von Bunge did not agree with him. In 1902, Bunge was the first one to publish a hypothesis of the genesis of ground ice by thermal contraction [23].



Baron Eduard von Toll in 1889



Ice wedges at the coast of Bolshoy Lyakhovskiy Island

Photos: Eduard von Toll [22]

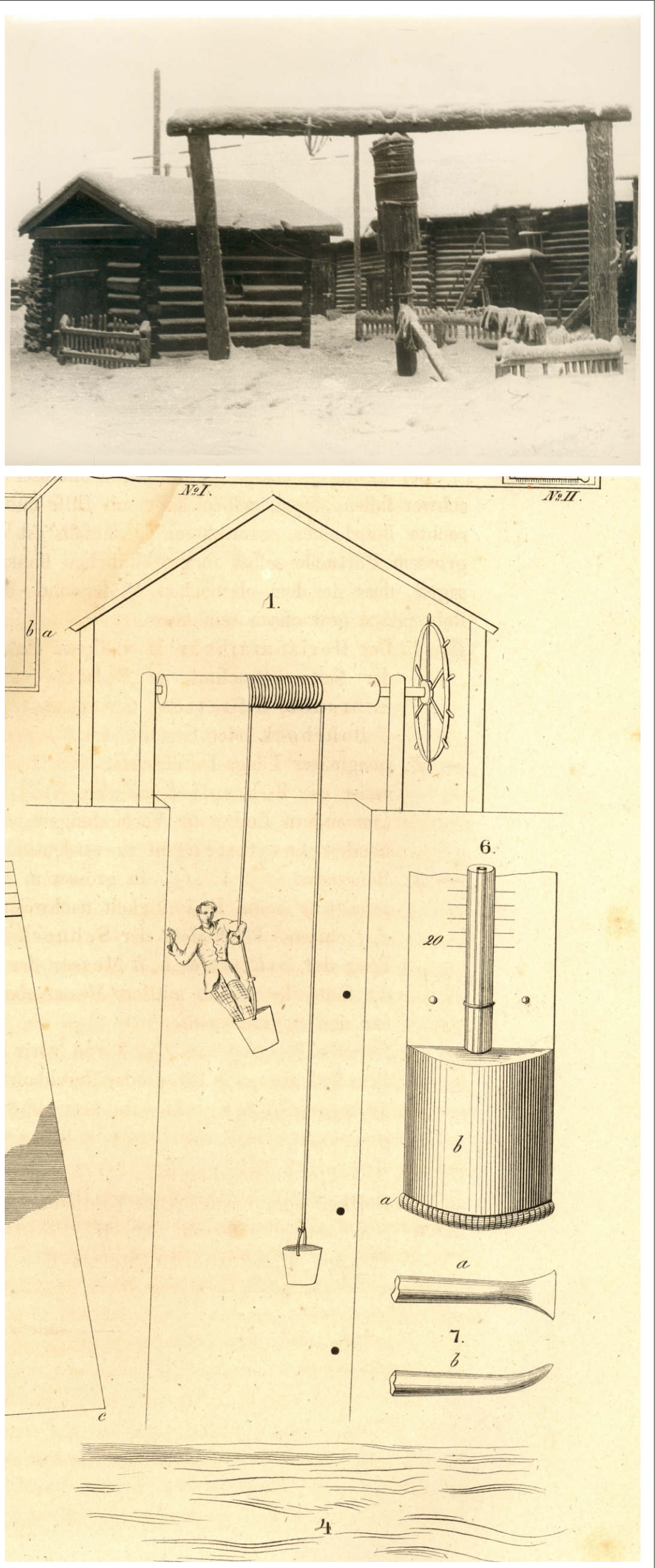
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First soil temperature studies in Yakutsk

The western world was first informed of the permanent frozen ground in Siberia by J.G. Gmelin who had reported about such a phenomenon in Yakutsk, but Leopold von Buch (1774-1853) was doubtful and considered impossible that plants were growing in this region on the permanently frozen soil [6] [7]. On the initiative of the merchant of the Russian-American Company, Fedor Shergin, a shaft was dug in Yakutsk to get drinking water. To Shergin's surprise, they did not reach water. Ferdinand von Wrangell, new Governor of the Russian America, insisted in 1829 on continuation of digging at the expense of the Company in order to study the frozen ground underneath Yakutsk. Between 1828 and 1837, they reached the depth of about 116.5 m, but the soil was continuously frozen [8]. The shaft appeared to be of great importance for further geocryological studies. First measurements of the frozen soil temperature were carried out

therein in April 1829 by the German physicist Adolph Erman (1806-1877). Down to the bottom of the shaft (about 15 m deep at that time) he recorded continuously -7.5° C in deeper parts, which corresponded well to the mean annual temperature in Yakutsk of -7.4° C. This result can be regarded as the first record of the depth of permafrost of "Zero Annual Amplitude". Erman expected liquid water at the depth of about 190 m [9] [10]. Shergin's measurements published in 1838 indicated temperatures of ~-0.6° C at the bottom of the shaft [8]. Several scientists were doubtful about Shergin's data [10] [11]. Regular measurements in the Shergin shaft (1844-1846) were carried out by A. Th. von Middendorff. He reported on a bottom temperature -3.0° C [12] and published his detailed geothermal observations, including data on the thermal conductivity of soils – a result of geothermal measurements in the Shergin shaft [13].

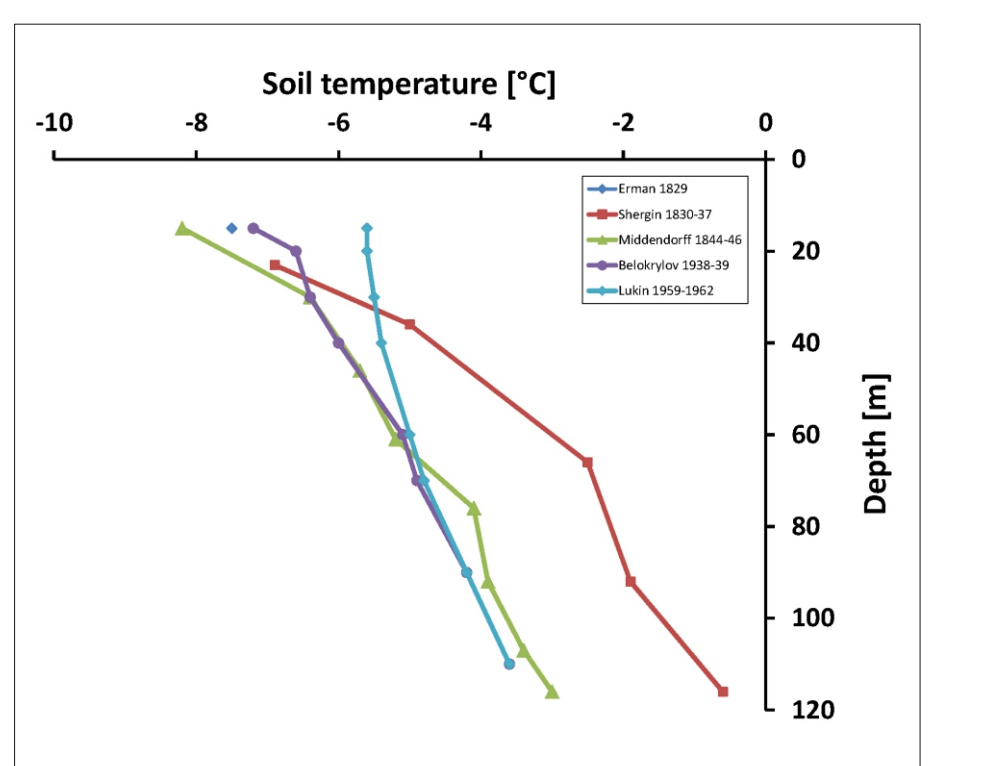


Shergin's shaft in Yakutsk

- 1 - Longitudinal section of the 116.5 m deep shaft. Black dots symbolizing measuring cavities.
 - 4 - Sandstone found in the bottom part.
 - 6 - Thermometer in a copper shell (b) filled with tallow - used by Middendorff.
 - 7 - Tool for preparation of measuring cavities in the shaft's wall
- Photo: Senkin
 Scheme: A. Th. v. Middendorff [13]

Profiles of soil temperature in Shergin's shaft

First measurements were carried out by Adolph Erman in 1829 (upper 15 m) and by A. Th. von Middendorff (1844-46) over the whole shaft's depth. They have been repeated - amongst others - by Belokrylov (1938-39) and Lukin (1959-63)
 Data after Solov'ev [14]



Hunting for Mammoth carcasses

The Russian empire participated in the 1st International Polar Year of 1882-1883 with two Arctic stations, one on Novaya Zemlya and the other on Sagastyr Island in the north of the Lena delta. Regular soil temperature measurements in three different depths were included in the meteorological program of both stations. On Sagastyr, these observations were carried out by the astronomer and geophysicist Adolph Eigner (1854- ?) [19], while Alexander von Bunge (1851-1930) served as a medical doctor. Both were Baltic-Germans. The head of the station was Lieutenant Nikolay D. Jürgens (1847-1898). Bunge was especially interested in mammoth carcasses and visited Bykovskiy peninsula where the first find was recorded in 1799. In 1883, he

learned that close to the Sagastyr station there was a place, well known to indigenous people, where a mammoth was found. He prolonged the trip for another year and found the carcass [20]. In 1885-1886, an expedition organized by the St. Petersburg Academy of Sciences under his command studied New Siberian Islands where mammoth ivory was frequently found [21]. Eduard von Toll (1858-1902) acted as the zoologist and geologist of the expedition. It was the first natural scientific expedition to the archipelago in which inter alia numerous remains of Pleistocene mammals were found referring to a relatively warm climate in late Pleistocene. The expedition members were impressed by huge ground ice complexes they found.



Alexander von Bunge ca. 1895