

Soft-sediment deformation structures
and palaeoseismic phenomena
in the South-eastern Baltic Region

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Soft-sediment deformation structures in soil of discontinuous permafrost zone, Nadym region, West Siberia, Russia

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High contrast and the diverse range of the ecosystems development paths always characterize landscapes, developing in boundary, transitional conditions. Especially it is typical for forest-tundra ecosystems in the north of Western Siberia associated with presence of areas with permafrost and without and the different contribution of cryogenic processes to the landscape formation. The research area (Nadym region, West Siberia, Russia, 65°18'51.9" N 72°52'21.1" E) is characterized by extremely high contrast of geocryological conditions. On a small territory, forest ecosystems are developed, where permafrost are absent and ecosystems of hummocky peatlands with permafrost islands. Thus, we can simultaneously observe both active actual cryogenic phenomena (on hummocky peatlands) and traces of their action in the past (in forest ecosystems). The current state of the landscapes was influenced by several stages of climate warming and cooling that took place during the last 20000 years, accompanied by permafrost degradation and aggradation. These events are reflected and easily read in the soil profiles of the research area. They are mainly represented by cryoturbations of the relict seasonally thawed layer and pseudomorphs over thawed polygonal wedge ice. In soils of frozen peatlands, deformations are represented by a chaotic system of vertical cracks, sometimes with a vortex pattern in the mineral soils horizons and filled with peat material. The leading mechanism of their formation is associated with uneven frost heaving and modern winter frost cracking within the active layer. Deformations in soils of forest ecosystems can be divided into several types. It is a regular network of large (up to 2 m high) wedge-shaped structures (pseudomorphs) located every 5–10 m, having a typical paleocryogenic genesis. The formation of wedge-shaped structures is associated with the thawing of ice wedge network during the Holocene “climate optimum”. Local plots of a network of strongly deformed wedge-shaped structures usually confined to small depressions. Their deformations can be caused by cryogenic, biogenic, soil, eolian processes occurring in these areas in the past after thawing of permafrost. Another group of deformations is a large number of small (up to 0.5 m) irregular structures of vortex, annular, wedge-shaped, drop-shaped and other types of chaotic form. Their development is associated with the alternation of sediment freezing-thawing processes and with cryogenic convective deformation in the relict active layer and the present-day layer of seasonal freezing. Thus, a wide range of modern and relic cryogenic deformations reflecting the paleogeography of the area characterize the soils of the Nadym region. The origin of deformations is due to a combination of different mechanisms, mainly cryogenic processes of cracking and cryoturbating, convective deformations, as well as biogenic and aeolian processes superimposed on them and complicating their form.

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