thawed to the depth of 7 m. Pseudomorphosis, postcryogenic texture is composed with the thawing of the syncryogenic thick with ice wedges. Involutions in sands were probably connected with epigenetic frozen penetration of a closed system.

In the outcrop of the erosive – thermokarst hollow there are involved the frozen alluvial thin sands; taberal complex – sandy loams with mashed stratification, ocher stains and involution; ice deposits of flow lake and early Holocene peat with polygonal ice wedges. Involutions in the taberal complex are educated with the thawing of deposits under the water reservoir in the end of Sartan.

In interalass in the layer of hole under the soil there are the stratified silty sands and sandy loam with 2 horizone of cryoturbations opened. Repeated injection of sandy loams, sands taken from the different depths into the surface frost boils occurred with freezing of pinched thawed rocks in early Holocene. Deformations of cryoturbation of the active layer are connected with the creep of thawed ground onto the slopes. The absence of injections under the frost boils in the lower part of the slope between spurs indicates the displacement of the soil mass.

In khasyreys on the surface of polygon peatland frost boils and injections are connected with the increase of peat thawing depth. Constant seasonal thawing layer is constructed by the dense unfolded heaving peat. In recent years during the summer the intermediate layer and upper part permafrost undecomposed of peat is thewed. The frost boils are formed in warm seasons excluding processes of freezing and fixate uneven lowering of the permafrost roof.

Cryoturbations, pseudomorphs, postcryogenic textures and involutions in the outcrops of the perennial frozen sediments fixate the evolution of cryolithozone connected with the long period fluctuation climate changes in late Neopleistocene and early Holocene. Dynamics of the upper cryolithozone part appears in cryoturbations of thawed layer and its deformation due to the seasonal thawing depth changes on the interalass and khasyreys, related with short period climate fluctuation in Holocene.

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Assessing hydrological connectivity in permafrost catchments using natural tracers

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Hydrological connectivity refers, in a narrow sense, to water transfer intensity within or between different compartments in river catchments, and can be quantified as such. This approach was found particularly useful in developing a concept of runoff contributing areas and, further, hydrological response units. Hydrological connectivity is variable through time, whence some links may be temporarily down but reactivated later as water seasons change. It can be defined in terms of saturation properties, hydraulic head variations and topography. Natural tracers are used in describing catchment hydrology when tracer concentrations vary significantly between compartments. Such variations may reflect differences in water origin, i.e. precipitation vs groundwater; water transfer processes, i.e. surface vs subsurface runoff through topsoil or topsoil; or water source, in geographical sense.

In permafrost hydrology, hydrological connectivity is heavily influenced by the presence of cryogenic aquitards, of which the active layer bottom is by far the most important. In the deep subsurface, the water routing is confined to intra-permafrost and sub-lacustrine taliks. Besides, permafrost soils and catchments host significant transient water volumes, redistributing runoff within and between seasons, years and millenia.

Rare earth elements (REEs) and their ratios were used to trace runoff origin in the Northern Yenisey region rivers, in the extremely dry year (2013) under summer low-flow conditions. In particular, light (Nd) to heavy (Yb) REEs ratio was used, as described in literature. In a medium, ca. 323 km^2, peatland-dominated catchment, most runoff developed as slow subsurface on slopes with mineral soils, while in smaller catchments underlain by sandy and silty soils, water was mostly transferred via topsoil compartment as fast subsurface runoff. The observed runoff distribution is related to permafrost spatial distribution within the Yenisey River terraces, where a double-layer permafrost is found in the 'plateau zone' of the third terrace, while only seasonally frozen layer develops on the younger terrace surfaces, underlain by sands and silts. In a more regional sense, REE concentrations can be used to infer water origin from different parts of the catchment, i.e. from leaching through fissured carbonates or from icing meltdown.

Stable water isotopes, measured in an intermittent creek in the Bol'shaya Zemlya Tundra region in the vicinity of Vorkuta, Komi Republic, were used to trace water origin in a system of watertracks. These features are abundant in the region, resembling minor rivers in their lower reaches. An ERT survey, performed by O.I. Komarov (MSU), confirmed an existence of open taliks under watertracks, and stable water isotope data suggest subpermafrost groundwater discharge through these taliks.

Natural tracers can decrypt hydrological connectivity patterns in permafrost, and showcase both its spatial and temporal variability. Temporal variations in active layer depth and non-frozen zone thickness, connectivity via taliks and double-layer permafrost, water retention in ground ice and icings, as well as spatial distribution of frozen ground in discontinuous permafrost, can be tracked via changes they apport to tracer concentrations and ratios. The development of permafrost-specific hydrochemical indices of these processes is an open task far from being accomplished.

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Investigation of water tracks hydrology in the north-west of Yakutia

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Water tracks (or dells) are widespread hillslope flowpaths in permafrost areas. They are shaped as hollows with gentle slopes and are 1-30 m width and several hundred meters length. Devoid of pronounced talveg, they stretch from the top of uplands down to the valley bottoms, forming a dense network on gentle and medium slopes. Depending on the slope topography, they develop parallel to each other, branch downwards or form dendritic system. There is still no consensus on genesis of water tracks. They are considered a rudimentary channel network that is not fully developed due to the erosional resistance of permafrost [McNamara, 1997], a result of thermokarst processes on ice wedges, or a consequence of uneven movement of slope material [Katasonova, 1959]. Water tracks are known as preferential suprapermafrost flowpaths, providing an area for fast runoff generation [McNamara et al., 1997].

We investigated the mechanisms and pathways by which water travels through the small basin of Krestyakh River located in continuous permafrost near the Lena Delta. The slopes of the basin are composed of ice rich silt (up to 300% of dry weight). The Paleozoic rocks (aleurolites) are exposed in the upper part of the ridges and in the incised channel of the creek, where gravelly material appears in the sediments. The active layer of an average thickness of 20–25 cm