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PRESENT-DAY GROUND- AND ICE VEINS IN THE REGION OF THE MIDDLE LENA

Periglacial phenomena in Pleistocene permafrost are most commonly recorded in the form of various ground veins. These are regarded as either (1) pseudomorphoses i.e. as ice wedges which on having terminated their life time on thawing, were subsequently filled by material from the overlying sediments, or as (2) primary ground forms due to the infilling of frost fissures with mineral and organic material. Those workers who take the third point of view completely disbelieve the possibility of a cryogenic origin and believe that the formation of periglacial structures can be best explained by physical processes operating on sufficiently moistened grounds.

In central Yakutia both ground- and ice veins are still initiated in our times. Knowledge of the climatic, frozen ground and facial conditions of their formation, one can venture to explain the pecularities of the development of these veins, with a view to correct application of present-day observations to ancient Pleistocene periglacial phenomena.

The ground veins encountered in central Yakutia are of various, though predominantly cryogenic origin. With regard to the mechanism of their formation they have been divided into three groups.

1. Ground veins – "sag" veins – due to subsidence are associated with tiny frost-fissures and built of layers that were dissected and pushed downward along the fissure walls. Subsidence of the layers is due to changes in moisture content and resistance of the ground.

2. Veins with mineral infilling, originate as a result of mineral particles falling into the fissure or of material penetrating into the fissure-furrows that are seasonally formed in the thawing ground layer. Penetration of humus plays here a considerable role.

3. Ground veins resulting from a change of the infilling material (syngenetic pseudomorphoses). They are formed while the vein ice is melting out at a varying depth of seasonal thaw.

CROSS-SECTIONS AT MAIMAGA, ŠAMANSKIJ BEREG, TURIJ VZVOZ
(Left side of the Lena, below Yakutsk, at 130, 145, 170 km)

Figure 2 shows a cross cut through the inundational terrace near the village of Maimaga (fig. 1, route I, site 1). The downward part of the terrace shows comparatively low relief. The long, ridge-like forms are feebly outlined and the intervening depressions are overgrown with forests and shruby brushwoods. Fissures at the surface are but slightly marked and polygons are absent. The crest-ridges occurring on the upper inundational terrace are devoid of both trees and shrubs. Alone few small, shallow gullies that intersect those ridge-like forms are forested. Larger inter-ridge depressions are often swampy.

Concave and convex mesorelief forms constitute the basic facial-landscape units of the inundational terrace. These concave and convex forms differ from each other in composition of sediments, moisture and thickness of the active layer. They are characterized by three types of fissures: (1) tiny, not gaping fissures occur in dry places and are not associated with either ground- or ice veins; (2) narrow ones, formed on the gentle slopes of small

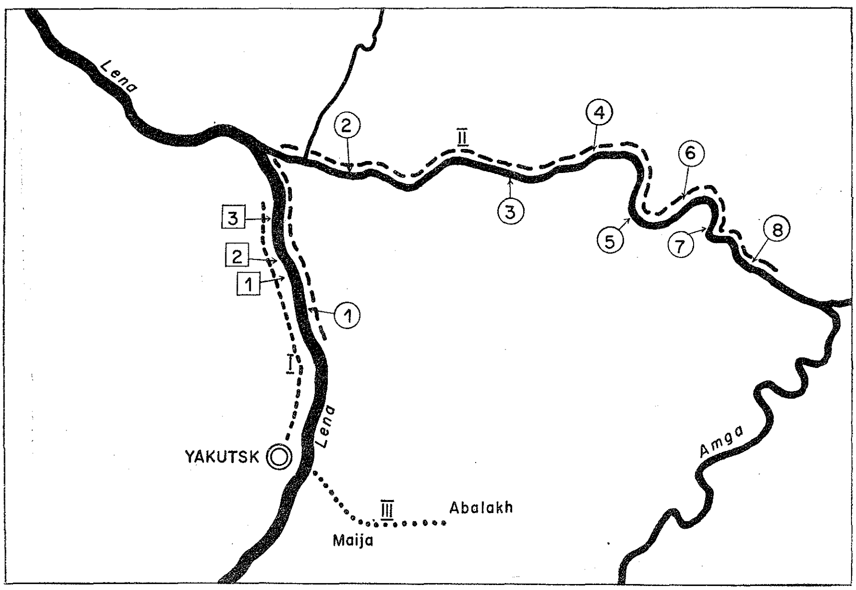

Fig. 1. Routes of excursions: I – middle course of the Lena; II – along the Aldan; III – in the Lena-Amga watershed

(figures in squares indicate the stations on the route of excursion I, figures in circles – those on the route of excursion II)

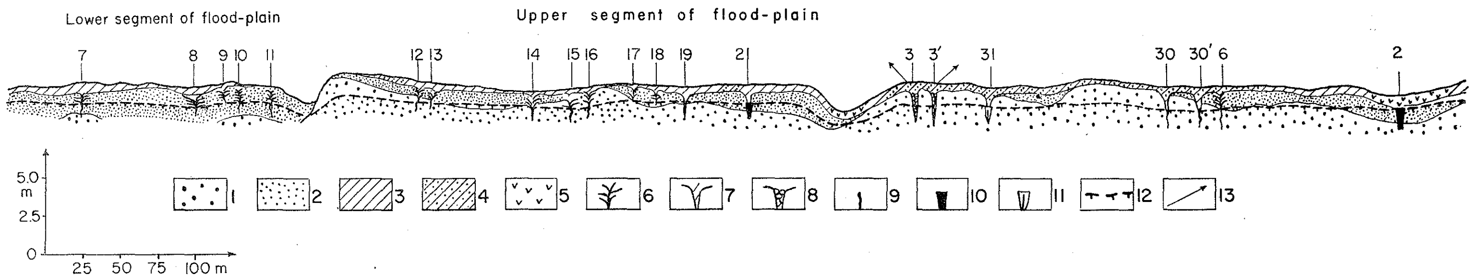

Fig. 2. Cross-section through the inundational terrace of the Lena, near the village of Maimaga

1. fluvial sands; 2. sands with lenses of silt and vegetal detritus (near-bed shallow facies); 3. loess-like silts including humus; 4. fine sands; 5. silts with peat; ground veins; 6. "sag" veins – due to subsidence, 7. due to infilling, 8. composite; 9. intercalation of ice; 10. ice veins; 11. ground veins with altered infilling; 12. limit of the active layer; 13. direction of veins

valleys, in the cross-cut they resemble ground veins and are set 10–15 m apart; (3) fissure-furrows, 0.8 m in width running across the near-bed ridges and disappear at the bottom of inter-ridge depressions. Below these fissure-furrows occur ground veins and in swampy places – ice veins.

The same landscape-facial categories – swamps and periodical drying out of the furrows, forests or absence of vegetation in the near-bed ridges – appear likewise in other places of the inundational terrace of the Lena in the regions of the Šamanskij Bereg and the Turij Vzvoz (fig. 1, route I, sites 2, 3).

In the Maimaga section, present-day alluvial sediments are visibly extending over a distance of 4 km. They are underlain by fine fluvial sands. Of importance in this exposure are the deposits of near-bed shoals, consisting of dusty sands interbedded with silts and vegetal detritus, marked by thin bands (fig. 2: 2). They are mantled by a thin layer of silt whose upper part underwent pedological processes. Such a construction of the inundational terrace occurs for instance, in Šamanskij Bereg and in Turij Vzvoz. Cryogenic phenomena manifest themselves everywhere in the form of ground- and ice veins. Ground veins of a "sag" type occur mainly in silty sands of near-bed shoals. In the upper silts they in general disappear.

Ground veins due to subsidence ("sag" veins) are genetically associated with narrow frost fissures, 1–3 cm in width, which can be laid bare on raking the snow from the surface of sandy slime (Pl. 1). Veins of that type are often wholly set in the active layer (fig. 3, vein 7). In permafrost such veins exhibit downward extensions in the form of thin ice veins, at the contact with which the layers are undisturbed. While such veins are thawing in coarse sands, subsidence ("sag") veins come into being.

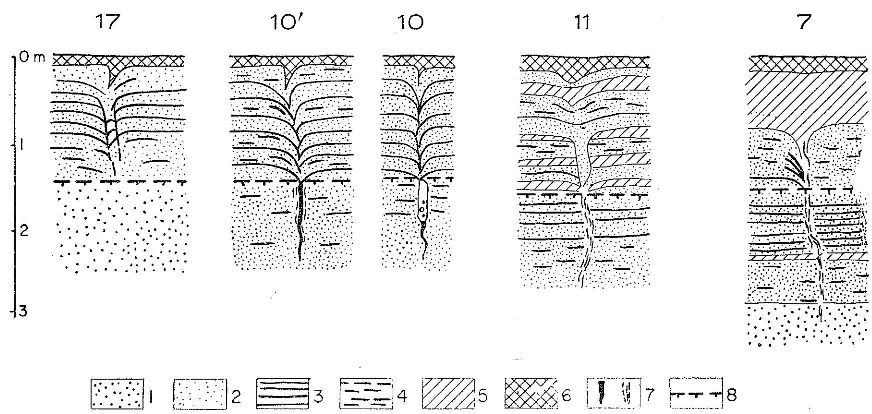

Fig. 3. Ground veins of subsidence ("sag") in the Maimaga section

1. well-washed sand; 2. silty sand (facies of near-bed shallows); 3. interlayers of silt and vegetal detritus; 4. lenses of vegetal detritus; 5. loess-like silts; 6. silts with humus; 7. ice and ice-ground extension of veins; 8. permafrost table

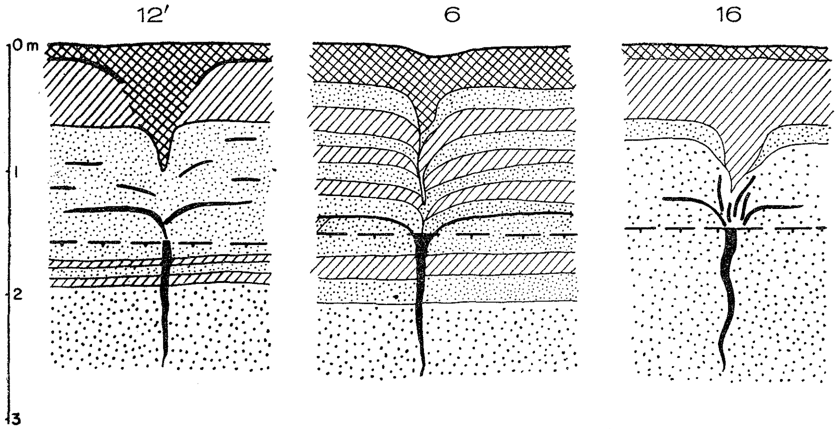

Fig. 4. Ground veins due to infilling and subsidence in the Maimaga section
(explanation like in fig. 3)

Ground veins of an infilling type occur in the active layer on the ridges of the inundational terraces and in the furrows and depressions that diversify the ridge surface. They are not characteristic of the lower segments of the terrace. Veins 6, 12, 16 (fig. 4) are rudimentary forms. Their formation and development are due to accumulation of silts and humus in shallow fissure--furrows. Veins 14, 21, 30 (fig. 5) are formed above ice wedges and consist of loose, loess-like vertically striated silts. From above, humus penetrates into the silty material and acquires a wedge-like form.

Veins 3^1 and 3 (fig. 6, Pl. 2) provide examples of infilled fissure-like structures which still retain water. The infilling sediments include leaves, bits of

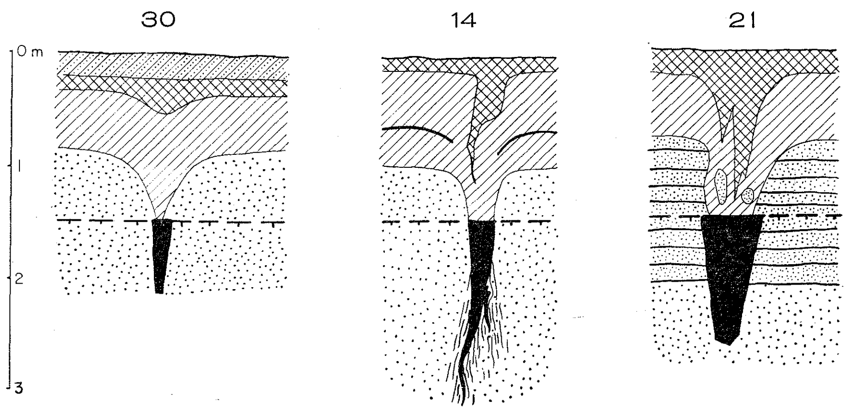

Fig. 5. Ground veins of infilling and ice veins in the Maimaga section
(explanation like in fig. 3)

branches but predominantly distinct laminae of clay and vegetal detritus. They form small concavities into which wedges of silts containing humus are thrust from above. The present writer believes that disturbance of the stratified sediments took place at the time of their accumulation but is still in progress to-day. Penetration with water infiltrating into the fissure of mineral particles and humus is responsible for the fact that during upfreezing of the active layer (from both below and above) the stratified sediments together with the surrounding formations were affected by deformation, squeezing and upturning.

Squashed and upturned layers provide evidence of spontaneous development of ground veins within the active layer. Underlying ice interlayers and veins do not undergo any disturbances. Their thawing out as a result of growing thickness of the active layer (e.g. with alteration of the vegetal cover) contributes solely to an increase in the length of ground veins (fig. 6, vein 3) but does not affect the basic mechanism of vein formation i.e. the infilling of fissures. In the writer's opinion, the downward extension of veins causes – as already noted by A. I. Popov (1960) – these widespread periglacial structures to occur in the form of two superimposed levels. Ground veins of secondary infilling (syngenetic pseudomorphoses) do not occur as independant structures in present-day alluvium. In the Maimaga section, however, (fig. 3, vein 10) as well as in the deposits forming the bečevnik voids left by thawed vein ice at deeper levels are found to be either totally infilled

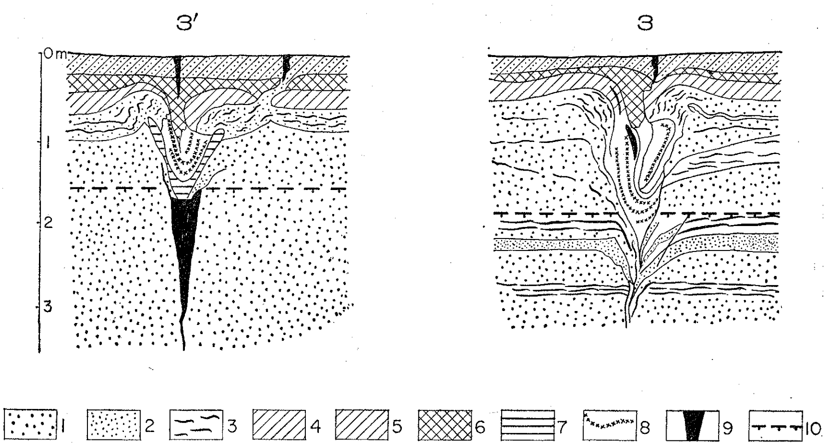

Fig. 6. Composite ground veins of infilling in the Maimaga section

1. well-washed sand; 2. silty sand; 3. interlayers and lenses of silts and vegetal detritus; 4. sand; 5. loess-like silts; 6. silts with humus (soil); 7. dark, plastic clays; 8. clay with bits of tree-branches and intercalations of vegetal detritus; 9. ice vein; 10. permafrost table

or only partly filled. Investigation has shown that in stratified sands and still more so in silts these either voids remain preserved or exihibit veins consisting of loose material. These structures have straight walls. Present-day, epigenetic pseudomorphoses ought – as it seems – to display the same features.

Ice veins are formed at the bottom of small, swampy valleys (dells) which are devoid of arborescent vegetation. In the Maimaga section ice vein 2 (fig. 2) has 0.8 m in width and its beginning is in the peat layer which has here a thickness of 1–1.5 m. The downward part of this vein thrusts into fine grained and dusty sands containing a large amount of vegetal remnants. In the Šamanskij Bereg section (fig. 7, A) the ice vein is correlated with a conspicuous furrow-fissure (channel) 15–20 cm in depth. The thickness of the active layer is here of 0.5 m and the silts in which the vein occurs contain peatified vegetal remnants.

Some experts (V. V. Baulin, J. Büdel, T. L. Péwé and others) hold that the ground veins of the Maimaga section are pseudomorphoses. They believe that until quite lately the climatic conditions of the Yakutsk region were more rigorous than they are to-day, ice veins occurred just below the former ground surface, but on having later thawed out they were filled with mineral material instead of ice.

This opinion cannot stand up under criticism. To begin with, during the Upper Holocene (4–5 thousand years) at the time of formation of the afore mentioned segments of the inundational terrace, there was, in central Yakutia – as far as can be derived from the data available – no appreciable change of climate. Further, the sandy deposits in which the ground veins

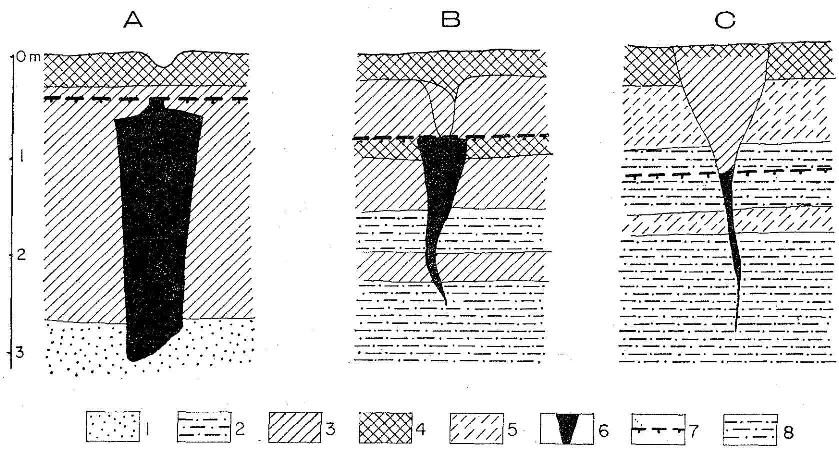

Fig. 7. Ice- and ground veins in the sections at Šamanskij Bereg (A, B) and at Turij Vzvoz (C)
(explanation like in fig. 3 and 6)

occur are never thawing any deeper even under the most severe conditions (e.g. such as those prevailing in the islands of New Syberia) than to a depth of barely 1 m. The dimensions of ground veins (1–2.5 m in lenght) correspond with the depth of thaw and afford irrefutable evidence of the fact that these structures originated spontaneously in the active layer, independantly of vein ice.

In central Yakutia ice- and ground veins are still being formed to-day, according to the prevailing landscape facial conditions. There are also some transitional forms such as veins whose upper part is ground vein, while its lower part consists of ice. In the light of investigatory results those structures can by no means be regarded as pseudomorphoses (Katasonova, 1963; Romanovskij, Boyarskij, 1966). Ground veins originate spontaneously in the active layer. The following evidence testifies to that effect: (1) some veins occur wholly in the active layer of permafrost, (2) shifting of ground veins in the horizontal plane in relation to the ice veins occurring below, (3) squeezing and upthrust of the component ground-vein sediments.

Ground veins being geologic forms ought to be contrasted with ice veins. There can be no doubt as to their formation in different deposits and facies. They reflect other regularities in zonal changes than do ice veins. The question is discussed in detail in the writer's paper included in the same volume[1].

Translated by T. Dmochowska

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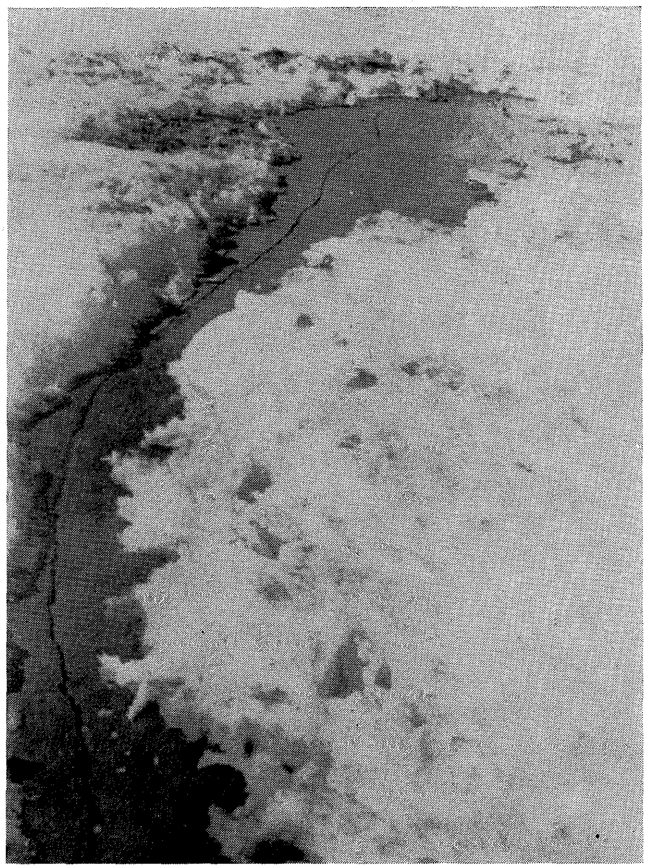
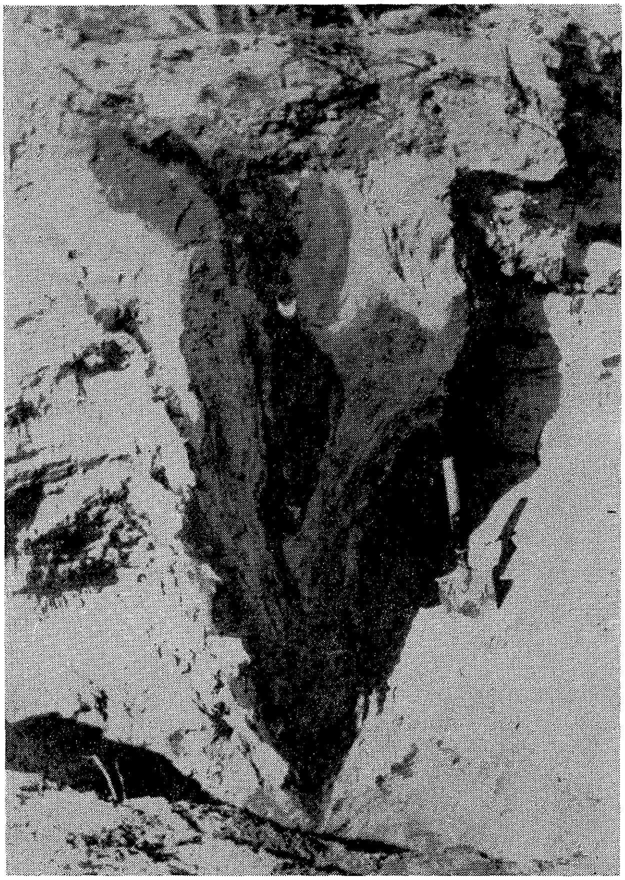
[1] E. G. Katasonov, page 71.



Pl. 1. Frost fissure in the sandy sediments of near-bed shallows. Right bank of the Lena near Yakutsk



Pl. 2. Ground vein due to infilling. Section at Maimaga (see fig. 6)

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