



The possible consequences of increasing greenhouse gases released as a result of climate warming

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It is well known that an enormous amount of organic material is sequestered in permafrost and the overlying active layer. Some estimates say the amount of carbon in the permafrost is more than two times than there is in atmospheric carbon dioxide (Romanovsky V.E. et al., 2018). The presence of a significant amount of organic matter, microbes, and water and low oxygen concentrations under impermeable caps of ice and glacier beds creates very good conditions for greenhouse gas production (Burns R. et al., 2018). These facts raise concerns associated with an increased release of greenhouse gases caused by modern climate warming.

Our study area occupies the southern part of the Middle Russian Upland (the East European Plain). It has experienced several Quaternary glaciations. The results of our comprehensive geological and geomorphological exploration and analysis of the area have clearly shown that this upland was formed under the influence of the Don, Dnepr, Moscow, and Valdai Glaciations (Romanovskaya M.A. et al., 2017, 2018). The facts of the presence of permafrost and its degradation during the late Pleistocene and Holocene are established here as well. The area is located within of the equilibrium permafrost zone as it is shown on the map of the Last Permafrost Maximum (LPM) (Vandenberghe J. et al, 2014).

Our finest and most detailed study of a cross-section of the Quaternary deposits was carried out at the multilevel archaeological site Divnogorie-9 (50°36'49" N, 39°30'31"E), known for the discovery of an enormous amount of fossilized horse bones. This section exposed several brownish paleosol layers. Radiocarbon dating of the fossils and paleosol layers found at the site led to estimates of 14-12 ka BP (Lavrushin et al., 2010). At 30 km from the Divnogorie site, another world famous archeological site of mammoth remnants - the Borshchevo-Kostenki site is located (51°23'40" N, 39°30'31"E, 38-18 ka BP).

The development of such a large population of grazers at the study area in the late Pleistocene and Holocene tells us about the presence of rich grassy vegetation and rich organic soils here at that time. Our measurements of the present-day concentrations of organic carbon in the paleosol layers have shown very small amounts of the organic carbon, comparable to the sensitivity of the measurements method. This data allows us to make an optimistic conclusion that climate warming caused by the decomposition of organic material in thawing permafrost and under disappearing ice sheets had already had a place in Quaternary history in this area and has not led to particularly devastating global consequences. However, on a regional scale, the related changes had a disastrous effect on the local flora and fauna.