



## Global climate warming: permafrost degradation and expected consequences

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At present, the degradation of permafrost caused by climate warming raises serious concerns of scientists and the public around the world. As a result of degradation of permafrost containing a huge amount of organic material and the decomposition of this organic material, the greenhouse effect can increase significantly. Some scientists estimate that the amount of carbon in the permafrost is more than two times than there is in atmospheric carbon dioxide (Schuur E. A. G. et al., 2015). Besides, a large amount of greenhouse gasses, mostly methane, is already contained in watery glacier bottoms, where these gasses build up through anaerobic organic decomposition (Burns R., 2018). Therefore, there are concerns that permafrost thaw and glacier retreat as the Earth warms will lead to new greenhouse gasses being released into the atmosphere, thus further accelerating the global warming process.

Our research devoted to this problem was carried out at the archaeological Upper Paleolithic site Divnogorie 9 (50.9649° N, 39.3031° E) in the National Park "Divnogorie". Our study area occupies the southern part of the Middle Russian Upland (the East European Plain). It has experienced several Quaternary glaciations: the Don, Dnepr, Moscow, and Valdai Glaciations. The facts of the presence of permafrost and its degradation during the late Pleistocene and Holocene are established here as well. The site is located at the right bank of the Tikhaya Sosna River, a right tributary of the Don River. The Don River basin is a world known area because of high concentration of the Upper Paleolithic archaeological sites here - Kostenki-Borshevo district (51°23'40" N, 39°30'31"E) which contains 26 open-air mammoth remnant sites (38-18 ka BP).

Divnogorie 9 is an unique site in Europe which is well-known for numerous findings of fossilized equestrian remains of wild horses - more than eight thousands samples. Our most detailed study of the Quaternary deposits was carried out at a 18-m thick section. Bones are concentrated in seven layers (levels). This section exposes several paleosol layers, as well. Estimates of the radiocarbon age of the fossils and paleosol layers here yielded 14-12 ka BP. We studied the organic carbon from paleo-soils of Divnogorie 9. The abundant presence of such large grazers as horses and especially mammoths during the Late Pleistocene supports the widespread existence of high productivity grasslands and organic-rich soils.

However, the results of our analysis do not show a significant amount of organic carbon in these paleo-soils at the present. It may possibly be an indication that the originally carbon rich permafrost and subglacial deposits lost their carbon upon permafrost thaw and glacial retreat during the transition from the last glaciation to the Holocene. This ancient carbon was massively released into the atmosphere and to the aquatic systems during that time. At the same time, there

were not widespread catastrophic consequences to the Earth's environment except possibly for the extinction of mammoths and other large fauna in the arctic and subarctic. These results provide some cautious optimism about the severity in current amount of changes and consequences thereof.