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Diffusion O_2 in soil as a controlling factor of CO_2 and CH_4 emission from thawing permafrost.

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Northern Siberian plains are covered with a thick layer of frozen Pleistocene loess, termed yedoma. These soils have a high (1-4%) concentration of labile carbon and represents a carbon stock of $\sim$500 Gt. Thawing of yedoma under aerobic conditions leads to emission of CO_2 and under anaerobic conditions to CH_4 emissions. Global climate warming is projected to cause extensive thawing of permafrost. However, the nature of emissions from thawing permafrost depends on patterns of ventilation of thawed yedoma sediments. Toward this end, field and lab experiments of gas diffusion were conducted in thawed yedoma sediments of the Kolyma River lowland. They showed that CO_2 production after permafrost thaw, even in well-drained conditions, existed only in the surface layers of thawed loess, namely to the depth of 1.5 m in the presence of high labile organic carbon content and to the depth of 3-m in the presence of low labile organic carbon content. Thus, in spite of a high content of labile carbon, the CO_2 fluxes from thawing permafrost did not exceed several grams of carbon per square meter per day. Oxygen can only penetrate deeper than this after labile organic matter has been consumed in the surface layers. Therefore, deeper layers of thawed yedoma exist in anaerobic conditions. After the appearance of anaerobic bacteria, deep sediment layers are capable of producing methane with the same intensity as thaw lake sediments in the places of intense thermoerosion of yedoma. Therefore methane emissions from thawing yedoma may be more important than emissions of CO_2.