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Gas-geochemical condition and ecological functions of urban soils in areas with gas generating grounds

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Rapid urbanization and expansion of city borders lead to development of new areas, often following with relief changes, covering of gully–ravine systems and river beds with technogenic grounds containing construction and municipal waste. Decomposition of organic matter in these grounds is a source of methane and carbon dioxide. Intensive generation and accumulation of CO_2 and CH_4 into grounds may cause a fire and explosion risk for constructed objects. Gases emission to the atmosphere changes the global balance of GHGs and negatively influences on human health.

The aim of this investigation is to study gas-geochemical condition and ecological functions of urban soils in areas with gas generating grounds.

Studied areas are the gully–ravine systems or river beds, covered with technogenic grounds during land development. Stratigraphic columns of these grounds are 5-17 meters of man-made loamy material with inclusion of construction waste. Gas generating layer with increased content of organic matter, reductive conditions and high methanogenic activity (up to 1.0 ng*g-1*h-1) is situated at the certain depth. Maximum CH_4 and CO_2 concentrations in this layer reach dangerous values (2-10% and 11%, respectively) in the current standards.

In case of disturbance of ground layer (e.g. well-drilling) methane is rapidly transferred by convective flux to atmosphere. The rate of CH_4 emission reaches 100 mg*m-2*h-1 resulting in its atmospheric concentration growth by an order of magnitude compared with background.

In normal occurrence of grounds methane gradually diffuses into the upper layers by pore space, consuming on different processes (e.g. formation of organic matter, nitrogen compounds or specific particles of magnetite), and emits to atmosphere. CH_4 emission rate varies from 1 to 40 mg*m-2*h-1 increasing with depth of grounds. Carbon dioxide emission is about 100 mg*m-2*h-1.

During soil formation on gas generating grounds bacterial oxidation of methane, one of the most important ecological functions of such soils, is initiated. Due to high rate of this process (25-30 ng*g-1*h-1) accumulation of methane in the profile does not observed, its content in soil averages 2-5 ppm. Methane emission from soils is low (0.01-0.03 mg*m-2*h-1) or there is a weak consumption of atmospheric CH_4, whereby its concentration in the air corresponds to the average content of this gas.

Active methane oxidation and decomposition of organic matter under aerobic conditions result to intensive formation of carbon dioxide and, thus, increase its emission (600 mg*m-2*h-1), concentration in soils (0.2-0.9%) and in atmosphere (up to 0.5%). Fixed concentration of CO_2 in the air is dangerous for human health.

Thus, presence of gas generating grounds with high content of organic matter leads to methane formation, causing its intensive emission to atmosphere. At upper layers of soils and grounds bacterial oxidation of methane occurs and results in complete CH_4 utilization. During this process significant amounts of carbon dioxide are released and accumulated in the atmosphere up to concentration dangerous for people. Carbon dioxide emission increases current level of this gas in the urban atmosphere.