METHANE OXIDATION IN AN ORGANIC LANDFILL COVER SOIL INCUBATED AT DIFFERENT TEMPERATURES

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Introduction

Methane oxidation is an important biological process regulating emissions of methane from landfills. This process seems to be performed only by methanotrophic bacteria, which are strictly aerobic, i.e. they consume methane only in the presence of oxygen. The knowledge about the extent of this process has taken several steps forward with the development of carbon isotope analysis for utilization in field studies. The method (as described by Liptay et al 1998) assumes that methanotrophs prefer methane containing the common isotope ^{12}C and discriminate methane containing ^{13}C. Thus, methane oxidation can be estimated through comparison of the content of ^{13}C in emitted methane with ^{13}C in methane in the anaerobic phase. In order to estimate the ratio between oxidized and emitted methane, knowledge is also required about how large the discrimination is, i.e. the fractionation factor α_{ox} must be determined. This is done by laboratory incubations of soils, where field conditions should be imitated as far as possible, e.g. original moisture and temperature should be kept in the soil samples. Since α_{ox} has been found to vary with soil type and temperatures, an experiment was set up in order to investigate parameters that could be expected to be influential for α_{ox}.

Material and methods

Soil samples were taken from the cover of the largest landfill for municipal solid waste in Sweden, i.e. at Filborna in Helsingborg. The samples were taken from the most active of several subsites, where the waste had been covered for one year with a 0.6 m thick compost material, derived from a mixture of wood chips and sewage sludge. When samples were taken (28 Nov. 2001), the soil was moisty (between 56 and 75% water of wet weight). The loss on ignition (550°C) was between 29 and 44% of dry weight, and pH(water) was 5.81-6.37 in the topsoil. Soil samples were taken from two areas 5 m apart, at 10 cm intervals down to 0.40 m (area 1) and 0.50 m (area 2). Further sampling was obstructed by water pouring in. The soils were stored at +3°C. In the laboratory, the nine soil samples were separately sieved (4 mm). For incubations, 4 x 100 g fresh weight of each of the nine soil samples were transferred to 1L flasks with gastight screwcaps. These were incubated at 5, 10, 15 and 20°C, respectively. After one hour, 50 mL extra ambient air and 60 mL methane were added (time zero). Samples for immediate methane analysis (flame ionization detector) and for later $\delta^{13}C$-CH_4-analysis (stored in Labco exetainers) were then withdrawn with time-intervals ranging from 2 hours in the beginning and then less frequent for up to 2 months. (For more details cf. Börjesson et al. 2001). $\delta^{13}C$-CH_4 was analyzed at Dept. of Forest

Ecology, SLU, Umeå, Sweden) according to methods described by Ohlsson and Wallmark (1999).

Results

Methane consumption varied between temperatures, with initial consumption rates in the range 0-2.0 µL CH_4 per g dw soil and hour at 5°C, and in the range 5.6-34.3 µL CH_4 per g dw soil and hour at 20°C, with the highest consumption rates found in the top soil (0-10 cm) at all temperatures. Alpha values (α_{ox}) were in a range from 1.0139 to 1.0319, and means for α_{ox} were 1.0194±0.0049 at 5°C (n=8), 1.0202±0.0053 at 10°C (n=9), 1.0188±0.0031 at 15°C (n=9), and 1.0176±0.0030 at 20°C (n=9), with no significant differences between temperatures (Tukey-Kramer HSD-test at α=0.10; analysis of variance showed prob>F=0.60). Attempts to find correlations between α_{ox} and other parameters (consumption rates, moisture, organic matter, carbon utilization) were not successful. PLFA(phospholipid fatty acid)-analyses will be conducted and presented at the symposium.

Discussion

The results further emphazises that α_{ox} is highly individual for each cover soil. The α_{ox}– values reported here, around 1.019, are somewhere in between what has been reported for other landfill covers (cf. Chanton et al. 1999). Other reports have shown that α_{ox} (the degree of C-13 discrimination) is reversely proportional to temperature (cf. Chanton and Liptay 2000). In the experiment presented here, this type of correlation could only be seen as a week tendency, which was not statistically significant. A comparison between the obtained α_{ox} values and results from PLFA-analyses could bring more light to the reasons behind this phenomenon, which is likely to be dependent on different methanotrophs being active at different temperatures. It will also be important to compare the results from this organic soil with mineral soils and soils from other landfills.

References

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