Spring 2017

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Recommended Citation

Miller, Mitchell P., "The Methane-Oxidizing Capability of Pumice Biocovers on Icelandic Landfills" (2017). *Independent Study Project (ISP) Collection*. 2592.
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The Methane-Oxidizing Capability of Pumice Biocovers on Icelandic Landfills

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SIT Study Abroad
Iceland and Greenland: Climate Change and the Arctic, Spring 2017

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Abstract

Pumice has been shown in laboratory biofilter experiments to improve the oxidation of methane (Pratt et al. 2012, Pratt, Tate, & Deslippe 2012). Pumice biocovers were tested on two Icelandic landfills, Kirkjuferjuhjáleiga and Álfsnes. Seven biocover plots were dug and filled with a 50:50 blend of pumice and native soil. CH_4 and CO_2 were measured using the static chamber method before and after biocover placement. After one week, the CH_4:CO_2 ratio was reduced on four of the seven plots, weakly indicating that pumice biocovers may be an effective way to better oxidize landfill methane.

Introduction

Methane is the third most abundant greenhouse gas and is 28 times more potent than CO_2, making it a major climatic force (Jain et al. 2000). It accounts for 18% of the total radiative forcing of the long-lived greenhouse gases (Forster et al. 2007). The concentration of atmospheric methane has increased dramatically from pre-industrial levels of 722 ppb to 1851 ppb in January 2017 (Dlugokencky). Such high methane levels have not occurred in at least 800,000 years, as evidenced by ice cores (IPCC 2013).

Methane is produced by methanogenic bacteria during the decomposition of organic material in anaerobic conditions, such as within landfills. As an example, the anaerobic digestion of glucose can be summarized by the chemical equation:

$$C_6H_{12}O_6 \rightarrow 3CO_2 + 3CH_4$$

Landfill emissions account for 11% of global methane emissions, or 799 million metric tons of CO_2 equivalent (Global Methane Initiative 2011). In Europe, landfills are the second largest anthropogenic source of methane at 22% (EEA 2008). Many large landfills have installed methane recovery systems, but most smaller landfills and landfills in developing countries release methane into the atmosphere through passive diffusion. A portion of this methane is oxidized to CO_2 in the topsoil by methanotrophs, aerobic bacteria that use the enzyme CH_4 monooxygenase to digest methane (Bogner, Meadows, & Czepiel 1997). This process is summarized by:

$$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O + \text{heat}$$

Aerobic methanotrophs require sufficient oxygen to metabolize methane. According to Czepiel et al., methanotrophs prefer O_2-mixing levels of 3% or higher (1996b). Soil with high pore volume enhances the ability of air to penetrate deep below the surface so oxygen levels are sufficient for bacterial activity. Methanotrophs also require proper soil moisture. At 5% w/w or less soil moisture, methane oxidation drops as the bacteria desiccate. At 30% w/w and greater, oxidation decreases because the diffusion of oxygen is inhibited by waterlogged soil (Boeckx & Van Cleemput 1996). Thus, landfill covers must be designed for proper soil aeration and drainage.

In 2003, Iceland implemented the EU Landfill Directive, which calls for gas to be collected at landfill sites and processed into fuel. If collection is not possible, the directive orders the gas to be flared. Iceland's largest landfill, Álfsnes, has installed a methane recovery systems, but most Icelandic landfills are too small for collection to be economically or practically feasible. It is therefore important to find methods of mitigating emissions. One such method suggested in a 2011 TAIEX mission report is employing methane-oxidizing landfill covers (Scharff, Hansen, & Gústafsson). I will investigate using biocovers, biologically-active landfill soil covers, to improve the oxidation of landfill methane. Pumice, an extremely porous and lightweight rock common in Iceland, has been shown to improve methane oxidation. Through my research, I will determine if pumice enhances methane oxidation as part of Icelandic landfill biocovers.

Literature Review

Three recent research projects have been conducted on Icelandic landfill methane. The first, conducted by Atli Geir Júlíusson, measured the total methane emissions from ten landfills that are exempt from gas collection, and found that only one, the Akureyri landfill, produced enough necessary for collection (2011). Instead of building expensive gas collection systems on these small landfills, Júlíusson recommended that methods of reducing emissions be investigated. In the second project, Alexandra Kjeld measured the oxidizing potential of existing soil at the Fíflholt landfill (2013). Kjeld found that the gravelly sand soil had oxidizing efficiencies of 59 to 77%, and the optimal depth for oxidation was 30 to 60 cm. The third project by Guðrún Meyvantsdóttir analyzed the spatial variability of methane emissions at the

Kirkjuferjuhjáleiga and Fíflholt landfills (2014). Meyvantsdóttir found that methane flux varied dramatically across each landfill, with negligible flux at over half of the measured locations and fluxes in excess of 500 g m^{-2} day^{-1} at others. She also found that methane emissions were much higher at Kirkjuferjuhjáleiga, possibly because the soil drains poorly, inhibiting the oxidation of methane. Meyvantsdóttir recommends that biocovers be explored as a more cost-efficient way to reduce methane emissions from landfills that are too small for gas recovery, and specifically mentions pumice soil as a promising option.

Two New Zealand studies tested the oxidizing capabilities of various types of landfill biofilters. Biofilters are specialized soil columns with a controlled flow of collected landfill methane. One study showed that pumice soil is capable of oxidizing 100% of a methane influx of 24 g CH_4 m^{-3} h^{-1} (Pratt et al. 2012). The other study showed that pumice soil, garden-waste compost, and a 50:50 pumice-compost blend were all capable of 94-99% oxidation at methane influxes of 14 and 28 g m^{-3} h^{-1} (Pratt, Tate, & Deslippe 2012). This is compared to an average steady-state methane oxidation of 4 to 6 g CH_4 m^{-3} h^{-1}, or 30-60% of total CH_4, in typical landfill cover soils (Scheutz, et al. 2009). Both studies lasted an entire year and demonstrated that there is longevity to the oxidizing power of pumice biofilters. Both studies were also largely done in laboratories. It has yet to be determined if pumice biocovers are equally effective in the field.

Many alternative materials have also been tested as biocovers/biofilters. Mature compost, polystyrene pellets, sewage sludge, wood chips, and perlite have all been shown to improve methane oxidation (Scheutz, et al. 2009). In 2003, crushed expanded clay was added to a German landfill and was capable of oxidizing 35 g CH_4 m^{-3} h^{-1} (Gebert et al.). Expanded clay has a very high pore volume of 82.6%, so it maintains high oxygen and moisture in the soil, much like pumice. Another benefit to expanded clay, which may also apply to pumice, is that clogging by extracellular polymeric substances (EPSs) was never observed. EPSs are secreted by bacteria and have reduced long-term oxidation rates in other biofilter studies by blocking the diffusion of oxygen (Scheutz & Kjeldson 2005). More recently, an Indian study explored the effect of adding rice husks to landfill soil on methane oxidation (Bajar et al. 2016). They found that soil with 6% husk mass was capable of oxidizing 76.83 μg CH_4 g^{-1} h^{-1}. The researchers believe that, in a similar way to pumice, the rice husks' texture sustains methanotrophs by aerating the soil and retaining moisture. In addition, the husks increase the amount of nitrogen in the soil, which is necessary nutrient to methanotrophs.

Methods

With the effectiveness of pumice soil supported by laboratory research, it was imperative to test them in the field. Over two weeks, I assessed the ability of a pumice biocover to reduce methane emissions from the Kirkjuferjuhjáleiga landfill, located at 63°56’N, 21°08’W in the south of Iceland and the Álfsnes landfill, located at 64°11’N, 21°45’W in the capital region (Figure 1).

Kirkjuferjuhjáleiga

I was granted permission to perform research at Kirkjuferjuhjáleiga from Sorpstöð Suðurlands, the solid waste company that operated the site from 1996 to 2009. Kirkjuferjuhjáleiga has a total area of 64 ha and is divided into 9 cells. During its operation, the landfill served 20,000 people and collected 21,900 tons of waste per year, most of which was food or industrial waste (Sorpstöð Suðurlands 2010). My study focused on cell 9 at the northern end of the landfill, which was in operation from January 2008 to December 2009. The waste in Cell 9 was therefore 7.5-9 years old. From the bedrock up, the cells consist of: a synthetic liner, a leachate pipe collection system, a 0.5 m drain layer, compacted waste of density 750-900 kg m^{-3},

Table 1. Coordinates of biocover plots.

Plot	Latitude	Longitude
1	63.94142	-21.13659
2	63.94129	-21.13638
3	63.94110	-21.13679
4	64.18903	-21.74493
5	64.18965	-21.74493
6	64.18980	-21.74467
7	64.18970	-21.74452

Figure 1. The location of Kirkjuferjuhjáleiga and Álfsnes in Iceland.

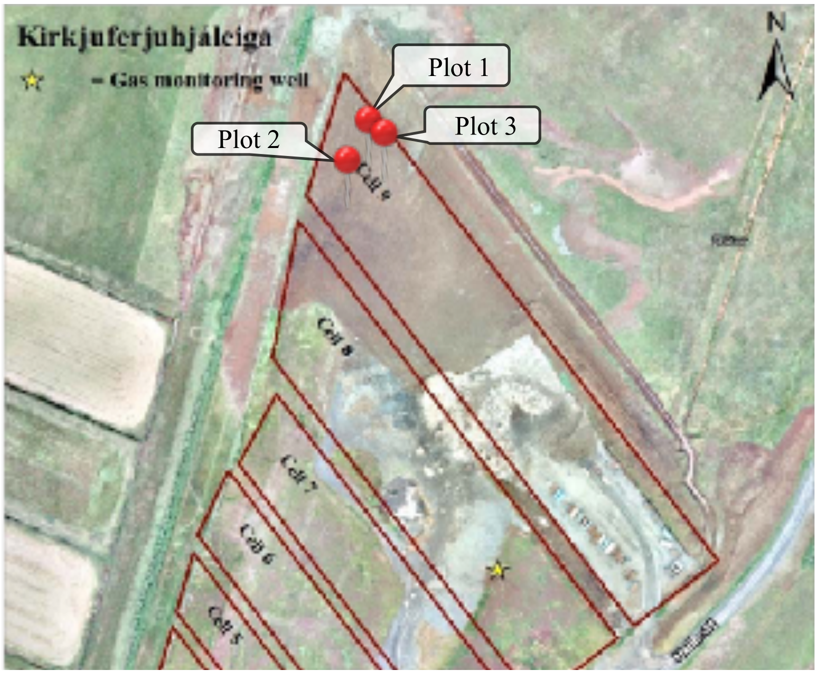


Figure 2. The locations of Plots 1-3 at Kirkjuferjuhjáleiga.

20 cm of gravel and sand, and 80 cm of local soil (Meyvantsdóttir 2014). The landfill surface varies from grass to bare soil to pools of water. The soil type at Kirkjuferjuhjáleiga is histic andosol (Arnalds et al. 2009). Histic andosols have a 12-20% carbon content and high water holding capacity (Arnalds & Gretarsson 2004).

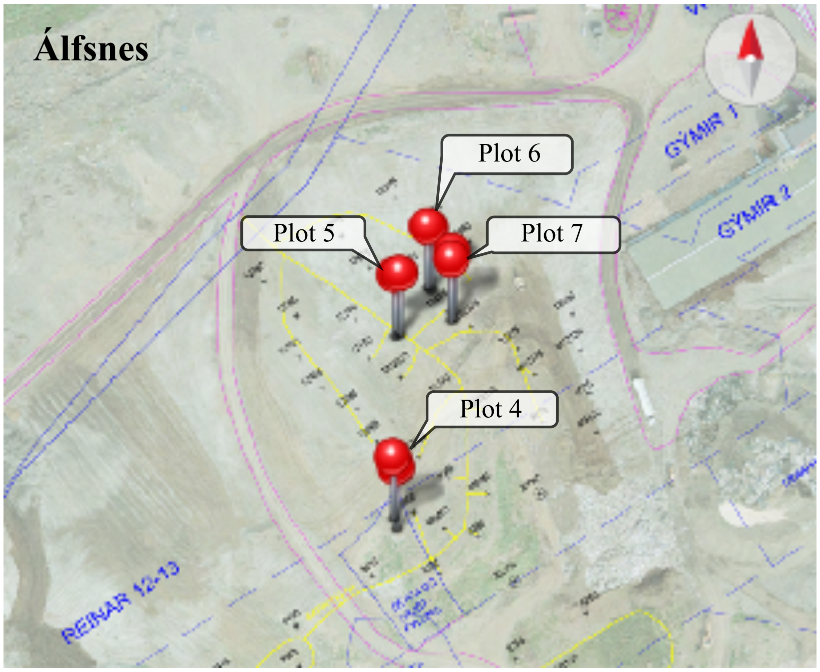


Figure 3. Locations of Plots 4-7 at Álfsnes.

Álfsnes

SORPA, another Icelandic waste company, permitted me to perform research on Álfsnes, the landfill actively serving the greater Reykjavík area. Álfsnes, Iceland's largest landfill, has been in operation since 1997, receiving 100,000 tons per year from 230,000 residents (Kjeld 2013). Álfsnes is the only Icelandic landfill with a gas collection system, with over 100 boreholes collecting landfill gas. The gas consists of 57% CH_4, 41% CO_2, and 2% others. The company Metan collects and purifies the biogas, which is used to power Reykjavík's garbage trucks, two Strætó buses, and personal vehicles (Metan 2017). Of the landfill's 13 cells, I focused on Cells 9 and 12-13 at the northern end of the landfill, which contain 1-3 year old waste. Cells are filled with 10 m of baled waste and covered with 2-5 m of local soil. The landfill surface was mostly bare soil, with patches of young grass. The soil type at Álfsnes is a complex of histic andosol, gleyic andosol, and brown andosol (Arnalds et al., 2009). This complex has <20% carbon content and moderate water holding capacity (Arnalds & Gretarsson 2004).

Static chamber fluxmeter

For my study, I employed the static chamber method, the most common way to make small-scale landfill gas emission measurements. This method involves placing a small hollow

Figure 4. The West Systems 2012 static chamber fluxmeter. Gas collects in the circular chamber and is pumped through CH_4 and CO_2 IR detectors. Gas concentration data is transmitted wirelessly to a handheld computer.

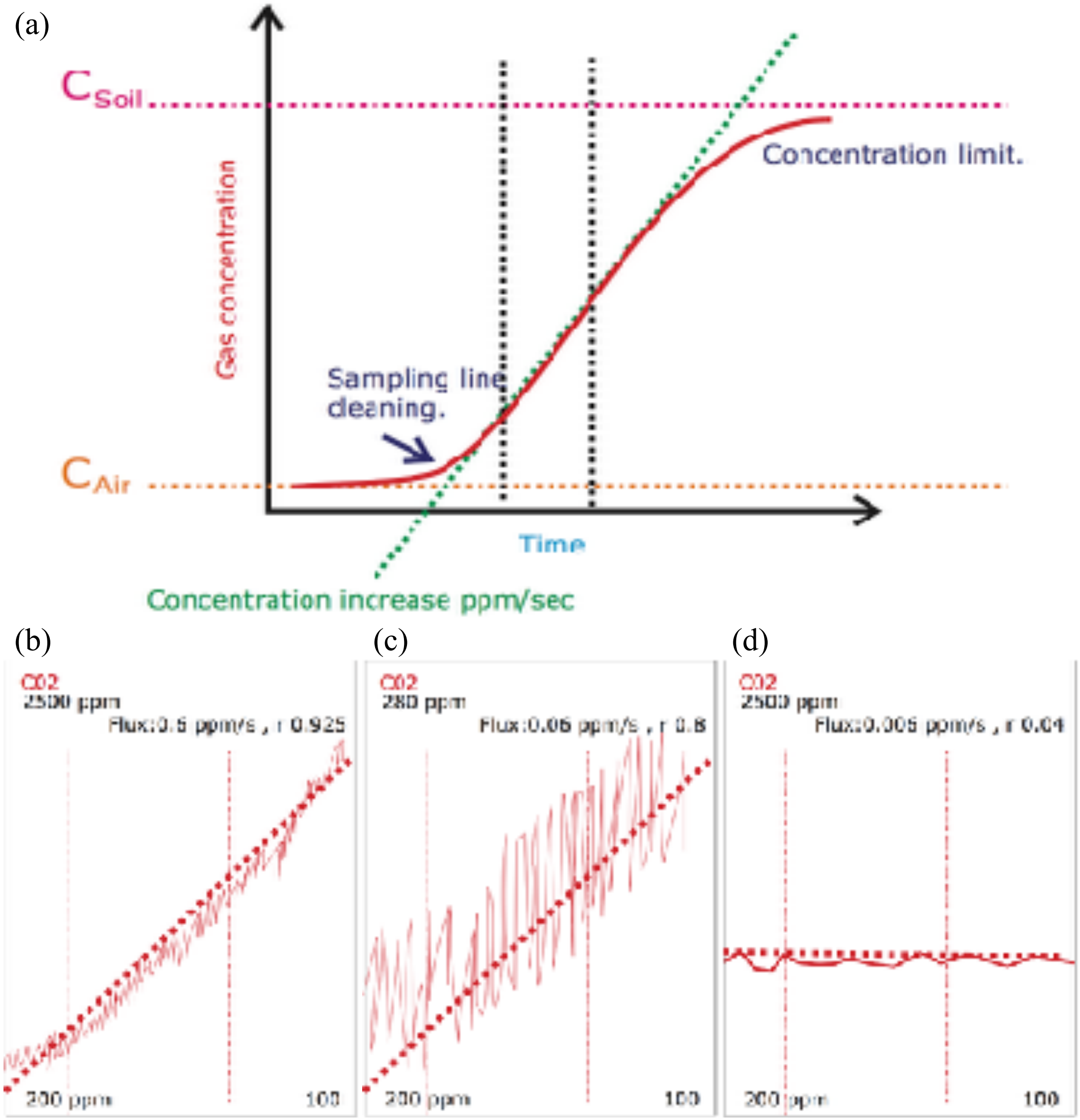


Figure 5. a) The characteristic parts of a flux curve. b) Curve with low flux. Noise is small compared to the flux. c) Curve with very low flux. Noise is large compared to the flux. d) Curve with zero flux (West Systems 2012).

chamber on Earth's surface and monitoring the concentration of gases as they fill the chamber. (Bogner & Scott 1995). The West Systems static-chamber fluxmeter used in my study was provided by Iceland GeoSurvey (ÍSOR), an environmental engineering company based in Reykjavík. This fluxmeter, shown in Figure 4, has a circular chamber with diameter 20 cm, height 9.7 cm, volume 2.76 L, and covering area 0.0314 m^2. The air inside the chamber is pumped through two infrared detectors that simultaneously measure the concentration of CO_2 and CH_4. The detectors are wirelessly connected to an Acer n300 handheld computer that uses

West System's FluxManager software to plot the gas concentration in ppm over time. The software calculates the slope and R^2 value of the regression line. See Figure 5 for examples of characteristic flux curves. The slope of the regression line (in ppm sec^{-1}) can be converted to g m^{-2} day^{-1} using the equation (West Systems 2012):

$$F = \frac{b}{10^6 A} \cdot \frac{PVM}{RT_k} \cdot 86400$$

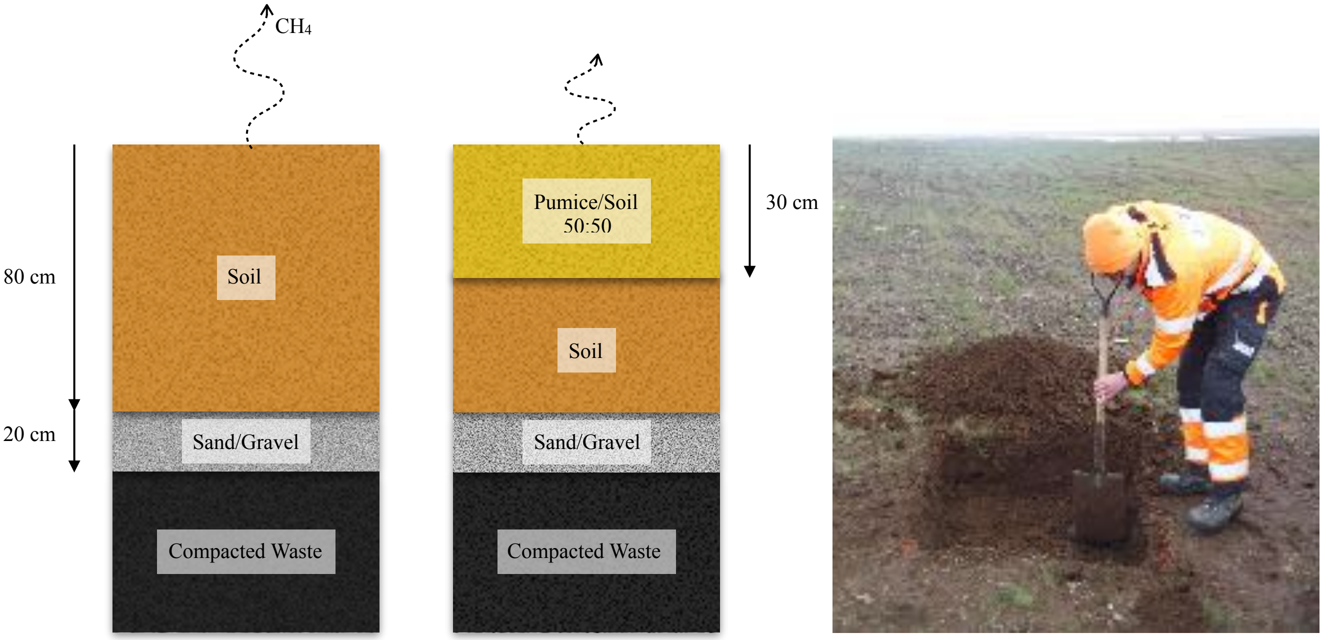
Where:

- F is the flux in g m^{-2} day^{-1}
- b is the rate of concentration change of gas (slope of regression line), expressed in ppm s^{-1}
- A is the chamber inlet area in square meters, $3.140*10^{-2}$ m^2
- P is the barometric pressure expressed in mbar (hPa)
- V is the chamber net volume, $2.756*10^{-3}$ m^3
- M is the molar mass of the target gas (16.04 g $mole^{-1}$ for CH_4 and 44.01 g $mole^{-1}$ for CO_2)
- R is the gas constant 0.0831451 hPa m^3 K^{-1} mol^{-1}
- T_k is the air temperature in Kelvin
- 86400 is the number of seconds in one day

Pumice biocovers

Pumice was purchased from Jarðefnaiðnaður (JEI), a firm in Þorlákshöfn, Iceland, specializing in the mining and processing of pumice from the Hekla volcano in the south of Iceland. The pumice has a 1-4 mm grain size and 75-85% pore volume. Around two-thirds of the pores are open and one-third are closed. The estimated loose dry bulk density is 350 kg m^{-3} and the pH is 6.5-7.0 (Jarðefnaiðnaður).

On May 16th, 2017, I made initial methane and carbon dioxide flux measurements at Kirkjuferjuhjáleiga. After locating sites with substantial gas emissions, I dug three 1 m x 1 m x 30 cm holes. I then filled these holes with a 50:50 blend of pumice and the native topsoil, as shown in the schematic diagram in Figure 6. This blend was meant to mimic the landfill cover samples from the New Zealand studies, which contained a mixture of organic material, sand, silt, and pumice. It was also important to add native soil to the pumice to expedite the colonization of



(a) (b) (c)

Figure 6. Schematic diagram of the pumice biocover at Kirkjuferjuhjáleiga. (a) An unaltered control site. (b) Biocover site. (c) Digging a biocover plot at Kirkjuferjuhjáleiga.

methanotrophic bacteria and provide a nutrient-rich habitat. On May 17th, three control plots were constructed adjacent to the experimental plots by digging holes of the same dimensions and then refilling with native soil. On May 18th, four biocover plots and four control plots were constructed in the same manner at Álfsnes.

On May 22nd, I returned to each landfill to remeasure methane and carbon dioxide flux at each experimental site. I calculated the CH_4:CO_2 ratios at each site and the percent change of CO_2:CH_4 over the course of the week. Finally, I subtracted the percent change of the control plots from the percent change of the experimental plots to find the percent change attributable to the biocover. This is a rough indication of the effectiveness of the pumice biocover at oxidizing methane.

Ethical Review

As a natural science project involving no human subjects, any ethical issues were minimal. Of course, I operated the loaned fluxmeter with utmost care and respected the landfill facility that I was granted access to. I also was careful to remain unbiased when analyzing the data.

Results

Every experimental and control plot except for Plot 7 showed a reduction in CH_4 and CO_2 flux. Plot 3's methane flux changed from positive to negative over the week, meaning that atmospheric methane was being taken up and metabolized by soil bacteria. The percent change in CO_2:CH_4 several days after placement varied widely among the plots (Figure 7). Four of the seven (57%) plots had a reduction in CH_4:CO_2 relative to controls, indicating that they were successful at oxidizing methane (Table 2). Of these plots, two were at Kirkjuferjuhjáleiga and two were at Álfsnes. Plots 2, 3, and 6 had a substantial reduction, while Plot 7 was only marginally successful at -0.9%. After a week, Plot 1 had ~0.5 ppm s^{-1} methane flux, while the control had neglibible methane flux. This produced an infinite percent change attributable to the biocover, meaning the biocover was unsuccessful at oxidizing methane. Plots four and five had

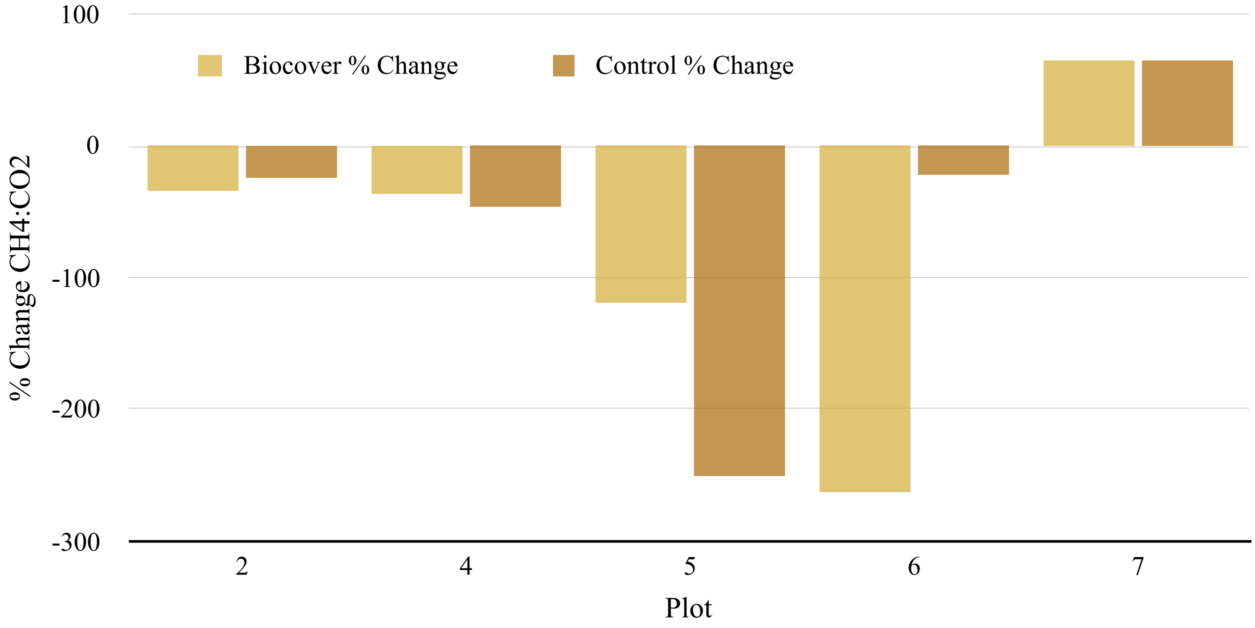


Figure 7. Percent change in CH_4:CO_2 ratios for selected plots. Plots 1 and 3 were omitted because they featured negligible or negative methane flux.

positive percent changes attributable to the biocover, meaning they were also unsuccessful. See appendix for complete data.

Table 2. Success of pumice biocovers.

Plot	% Change in CH_4:CO_2 relative to control	Successful at oxidizing CH_4?
1	infinite	No
2	-10.6	Yes
3	-174.2	Yes
4	8.8	No
5	130.5	No
6	-241.0	Yes
7	-0.9	Yes

Discussion

My results are weakly suggestive that the pumice biocovers improve methane oxidation on landfills. Landfills are dynamic and unpredictable systems, so there was extremely high spatial and temporal variability in the CO_2 and CH_4 emissions. Waste composition, atmospheric pressure, temperature, wind, soil moisture, and soil desiccation all cause irregularity in landfill gas emissions.

Because Kirkjuferjuhjáleiga is an older landfill, gas emissions were generally lower and more isolated. Of nearly twenty sites initially tested, only six had detectable methane fluxes. The waste at Álfsnes is much younger, so methane emissions were more widespread and substantial. Landfill gas at Álfsnes was evident not only using the fluxmeter but also by the prominent smell of H_2S gas.

Warmer temperature improves the activity of methanotrophs in the soil, reducing CH_4 emissions and raising CO_2 (Rachor et al. 2013). The air temperature was 3°C warmer at Kirkjuferjuhjáleiga and 8°C warmer at Álfsnes during the second week of measurements. This may explain why the CH_4 flux declined at most plots, but does not account for why CO_2 did as well.

Lower atmospheric pressure permits more gas to diffuse up and out of landfill covers (Börjesson & Svensson 1997). This effect was evident on Kirkjuferjuhjáleiga, as there was a substantial decrease in flux at nearly every plot after the atmospheric pressure increased from 996 to 1006 hPa. However, there was an opposite correlation on Álfsnes, as most plots had a decrease in flux after the pressure fell from 1014 to 1006 hPa.

Wind can also impact flux by causing brief fluctuations in pressure. Most of my measurements were performed in windy (>10 m/s) conditions. Pressure fluctuations from wind produced noise on the flux curves and reduced the R^2 value of some regression lines. This interference was lessened by packing loose soil around the edges of the fluxmeter chamber.

As discussed previously, soil that is very wet or very dry can reduce the oxidation of methane. From appearance, the soil at both landfills was less moist a week after placement. This may explain why most plots initially had higher methane fluxes. The wet soil before biocover placement prevented oxygen from permeating deep into the soil, reducing the activity of methanotrophic bacteria.

Soil dessiccation, or cracking, can increase flux by providing an easier route of escape for landfill gas. Most of the high-flux sites that were chosen for the biocover featured dessiccated soil. These cracks were eradicated by constructing the biocovers, which may be an explanation for the reduction in fluxes in all plots except Plot 7.

The reduction in the CH_4:CO_2 ratio seen in four of the plots may be a short-term result of digging the plots. The soil in most plots was dense and compacted, which likely prevented oxygen from permeating deep into the surface. Digging incorporates oxygen into the soil, and introduces more pores for air to diffuse into the earth. This temporarily enhances the activity of aerobic methanotrophs. As the soil recompacts, the properties of the pumice soils will become more apparent.

According to a study by Stern et al. on a Florida landfill, glass-and-mulch biocover cells did not become more efficient at oxidizing methane than control cells until three months after biocover placement (2007). The researchers theorized this is the length of time it took to establish a sufficiently large population of methanotrophs within the biocover. My research proposal was to place the pumice biocovers in late March to allow the bacteria time to colonize, but due to a series of plane delays and equipment difficulties, I was not able to begin until May 16th. This only allowed me to collect one week of data, which was too short to see any conclusive improvements in methane oxidation. Salóme, Gianni, and Rossana, three Master's students under Jamie's direction, have offered to continue the study into July, and SIT students in Fall 2017 and Spring 2017 may take the baton to make long-term measurements.

Conclusion

CH_4 and CO_2 fluxes mostly decreased one week after biocover placement, with some CH_4 fluxes becoming negative, showing a high degree of oxidation. After correcting for meteorological variance using control data, four of the seven plots had a reduction in the CH_4:CO_2 ratio, weakly indicating that pumice soil may be an effective way of improving methane oxidation.

Besides long-term flux readings, additional tests may indicate other qualities of pumice biocovers. One such test is analyzing landfill gas composition at various soil depths, using the method in Alexandra Kjeld's thesis. This would indicate the depth of maximum methane oxidation and allow waste companies to cover future landfills with only as much pumice soil as necessary. Also critical parts of any soil study is an analysis of grain size, pH, and organic content. These soil characteristics impact landfill gas reactions and dynamics, and are important for experiment replication. Finally, similar pumice biocovers could be installed and monitored on other Icelandic landfills. Iceland's climate and soil varies dramatically, so pumice biocovers may behave differently on landfills in other parts of the country.

Continued work on this project will reveal whether pumice biocovers are truly capable of improving methane oxidation. JEI's pumice manufacturing process involves washing crude pumice to remove impurities. The remaining impure pumice is buried deep in landfills. If pumice biocovers are proven to be successful, JEI's impure pumice could be added to landfill cover soil by SORPA, Sorpstöð Suðurlands, and other Icelandic waste companies. This would allow the waste companies to reduce their environmental impact at minimal expense, and would give purpose to JEI's undesirable pumice.

Acknowledgements

I extend gratitude to:

- Jamie McQuilken, my advisor.
- SORPA, for allowing me to conduct my research at Álfsnes and funding Jamie's time helping with my project.
- Sorpstöð Suðurlands, for allowing me to conduct my research at Kirkjuferjuhjáleiga.
- Salóme Bechtler, Ryan Opila, Gianni Cordaro, Rosanna Gloriosi, and Kalle Fox for assisting with the biocover placement and flux measurements.
- Jennifer Smith, my academic director.

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Appendix

Table 3. Fluxmeter measurement data.

Plot	Landfill	Day	Air temp (℃)	Air temp (K)	Wind speed (m s^{-1})	Atmospheric pressure (hPa)	CH_4 flux (ppm s^{-1})	R^2	CH_4 flux (g m^{-2} day^{-1})	CO_2 flux (ppm s^{-1})	R^2	CO_2 flux (g m^{-2} day^{-1})	CH_4:CO_2
1	**K**	**16/5/17**	8.0	281.15	5	996	15.998	0.994	82.912	2.958	0.997	42.06	5.408
2	**K**	**16/5/17**	8.5	281.65	5	996	2.105	0.970	10.890	1.221	0.997	17.332	1.724
3	**K**	**16/5/17**	9.2	282.35	6	997	0.281	0.457	1.452	0.478	0.997	6.775	0.588
1	**K**	**17/5/17**	8.8	281.95	10	1001	12.400	0.961	64.404	11.598	0.999	165.3	1.069
1C	**K**	**17/5/17**	8.6	281.75	10	1001	1.066	0.949	5.541	0.324	0.998	4.621	3.290
2	**K**	**17/5/17**	8.8	281.95	10	1001	10.863	0.996	56.421	12.817	0.998	182.7	0.848
2C	**K**	**17/5/17**	8.3	281.45	11	1002	5.576	0.994	29.042	3.471	0.999	49.602	1.606
3	**K**	**17/5/17**	8.7	281.85	10	1001	0.271	0.473	1.408	0.239	0.993	3.407	1.134
3C	**K**	**17/5/17**	8.2	281.35	11	1002	0.668	0.860	3.480	0.271	0.997	3.874	2.465
4	**Á**	**18/5/17**	4.3	277.45	15	1014	1603	0.909	8571	753.5	0.996	17475	2.127
4C	**Á**	**18/5/17**	4.3	277.45	16	1014	1683	0.973	8998	501.5	0.994	7357	3.356
5	**Á**	**18/5/17**	4.5	277.65	20	1014	5.233	0.997	27.959	3.313	0.998	48.567	1.580
5C	**Á**	**18/5/17**	4.5	277.65	21	1014	3.548	0.990	18.956	2.056	0.996	30.140	1.726
6	**Á**	**18/5/17**	4.6	277.75	21	1014	16.757	0.989	89.498	10.611	0.997	155.5	1.579
6C	**Á**	**18/5/17**	4.7	277.85	21	1014	10.085	0.992	53.844	13.566	0.995	198.7	0.743
7	**Á**	**18/5/17**	6.6	279.75	15	1014	1.627	0.855	8.628	2.971	0.991	43.226	0.548
7C	**Á**	**18/5/17**	6.7	279.85	15	1014	0.478	0.806	2.534	1.890	0.998	27.489	0.253
1	**K**	**22/5/17**	12.2	285.35	10	1006	0.535	0.802	2.759	0.632	0.995	8.944	0.847
1C	**K**	**22/5/17**	12.2	285.35	10	1006	negligible	-	-	0.613	0.998	8.675	0.000
2	**K**	**22/5/17**	12.1	285.25	9	1006	1.177	0.960	6.073	1.031	0.999	14.595	1.142
2C	**K**	**22/5/17**	12.1	285.25	9	1006	5.911	0.981	30.498	4.790	0.999	67.809	1.234
3	**K**	**22/5/17**	12.2	285.35	10	1006	-0.798	0.913	-4.116	0.365	0.998	5.165	-2.186
3C	**K**	**22/5/17**	12.2	285.35	10	1006	-0.266	0.802	-1.372	0.217	0.980	3.071	-1.226
4	**Á**	**22/5/17**	13.5	286.65	10	1006.5	92.003	0.998	472.601	58.995	0.999	831.5	1.560
4C	**Á**	**22/5/17**	13.4	286.55	10	1006.5	247.822	0.981	1273	107.2	0.993	1511	2.312
5	**Á**	**22/5/17**	13.3	286.45	11	1006.5	0.956	0.974	4.914	1.331	0.998	18.772	0.718
5C	**Á**	**22/5/17**	13.2	286.35	11	1006.5	1.211	0.980	6.227	2.459	0.999	34.694	0.492
6	**Á**	**22/5/17**	12.9	286.05	11	1006.5	1.288	0.926	6.630	2.960	0.999	41.806	0.435
6C	**Á**	**22/5/17**	12.8	285.95	11	1006.5	0.999	0.866	5.144	1.638	0.967	23.143	0.610
7	**Á**	**22/5/17**	13.1	286.25	11	1006.5	32.650	0.998	167.951	20.806	0.998	293.65	1.569
7C	**Á**	**22/5/17**	13.0	286.2	11	1006.5	16.144	0.997	83.073	21.732	0.999	306.83	0.743

Key: C = control, K = Kirkjuferjuhjáleiga, Á = Álfsnes