

**A STUDY OF METHANE PROCESSES OF PRODUCTION AND RELEASE
FROM A NORTHERN WISCONSIN PEAT BOG**

BIOS 569 PRACTICUM IN AQUATIC BIOLOGY

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I. ABSTRACT

The purposes of this experiment were to determine the distribution of methane in the sediment of a peat bog in Northern Wisconsin, to investigate what effect flushing peat samples with atmospheric air versus pure nitrogen has on methanogenesis, and finally, to investigate the effect that additions (to peat) of acidic and nonacidic sulfate have on methanogenesis. The production, consumption and release of methane are all poorly quantified in peat bogs and have important global implications. Findings generated by this study will not only serve to increase the knowledge of methane production, consumption and release in bogs, but will also provide information which will be useful in the future study and management of other freshwater ecosystems.

The methane concentration beneath the bog surface showed a variety of gradients. Air flushed sediment samples showed a decrease in methane concentration over time and nitrogen flushed samples showed an increase in methane concentration over time. In vitro treatments of sulfuric acid and sodium sulfate decreased methane concentration.

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II. INTRODUCTION

Bogs are soils which are highly organic and water-logged. The saturation of bogs by water does not allow for the aeration of the soil. Instead, the water-logged condition promotes an anaerobic environment where methane production can be high. In the case of anaerobic metabolism, methane is produced, however, carbon dioxide is produced as a result of aerobic metabolism. The combination of carbon and oxygen results in the production of carbon dioxide; this process occurs in non-water-logged aerated soils. The rate of diffusion of oxygen through water is much slower than the rate of diffusion of oxygen through soil due to the fact that water is very dense, making diffusion difficult, while soil contains many empty air spaces through which oxygen can readily diffuse. Thus, in the saturated soil of bogs, water blocks oxygen from diffusing into the soil, creating the anaerobic environment which is necessary for the occurrence of methanogenesis.

The need for an increase in knowledge of the processes involved in the release of methane is due primarily to the fact that methane may play a major role in global warming. On a molecule per molecule basis, methane has a green house effect which is thirty seven times greater than that of carbon dioxide. Currently, the atmospheric concentration of methane is 1.41 ppm, that of carbon dioxide is 340 ppm, and both are increasing. There is a need for more detailed studies of methane production, consumption and release. At this time there are no accurate estimates for the contribution of methane from peat bogs to the global atmosphere.

Once the gradient of methane concentration was determined, all other studies on methane involved in the experiment were undertaken. In order to manipulate the sediment in vitro, the process around which most of the study revolved, facts about the methanogenesis activity and about the levels of methane at specific sediment depths had to be known so that in situ conditions could be properly replicated.

The study of in situ conditions is also an important factor in this study, as various sediment conditions determine whether or not methane is oxidized. Methane in

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sediment surrounded by nitrogen does not undergo oxidation because no oxygen is present. However, methane in sediment surrounded by air can be oxidized. Beneath the surface of a bog a gradient of gas is established such that the greatest concentration of oxygen is near the surface and the least concentration is at the greater depths where the sediment becomes anoxic. Therefore, it is more likely for methane to be found beneath the surface, in the anoxic zone, than near the surface where the oxygen concentration is high.

Acid rain is an important factor in this study, as acidified precipitation increases the concentration of sulfate, an ion which has a potentially large impact on the biogeochemical processes in water-logged soils. The supply of sulfate to a bog by acid rain has the potential of inhibiting methanogenesis. This process decreases the amount of methane which is released from the bog surface. When sulfate is present in the anoxic zone, where methane is produced, methanogenesis is inhibited because acetate, in the presence of oxygen, is broken down to carbon dioxide rather than to carbon dioxide and methane. Even if methanogenesis is not inhibited methane may be oxidized due to the presence of sulfate. When methane is oxidized a microbial consortium uses the sulfate as a terminal electron acceptor and enzymatically oxidizes the methane and thereby decreases the amount of methane released and increases the amount of carbon dioxide released.

This study examined methane processes of production, storage and release of methane from the surface of a bog. Particular emphasis was placed on: 1) the determination of the methane gradient established below the bog surface (especially its maximum and minimums), 2) the effects of methane in an environment surrounded by oxygen (air flush) versus surrounded by no oxygen (nitrogen flush), and 3) the effects of acidified precipitation. The production, consumption, diffusion and release of methane are all poorly quantified processes globally which have very important implications. This experiment was performed in a very specific type of freshwater system, a peat bog, which is an ecosystem with very few studies of this kind reported.

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III. PROJECT DESCRIPTION

A. TOPIC DETAILS

In order for methane gas to be produced, organic carbon must be present and the environment must be anoxic so that the anaerobic process of methanogenesis may occur. Once methane is produced in the anoxic zone, it may be released to the atmosphere only if it is able to diffuse upward through the transition zone (the zone containing oxygen). Methane must also escape oxidation by inorganic terminal electron acceptors. These acceptors include oxygen, nitrate and sulfate, all of which can occur in the upper region of the sediment, which extends for only a few centimeters below the surface.

There are two primary processes which can cause a decrease in the release of methane gas from a bog surface. The first is any process which inhibits methanogenesis. For example, if the sulfate supply is sufficient, sulfate reducers in the upper sediment zones can outcompete methanogens for acetate. The second cause of decreased methane release is the biological oxidation of methane, once it diffuses up into the oxygenated zone. Methane oxidation is dependent on oxygen availability, and therefore, changes in oxygenation of the transition zone can lead to temporal changes in methane release.

B. HYPOTHESES

The experimental design consists of the testing of three hypotheses. The first hypothesis is that the gradient of methane is low at and near the surface and then increases as the sediment becomes anoxic. Thus the gradient should proceed (shallow to deep) as follows: low to high. The second hypothesis is that methane is oxidized in the presence of oxygen but is not oxidized in an anoxic environment. The third hypothesis is that the presence or absence of sulfate in the bog sediment affects the rates of methanogenesis, methane oxidation and methane release. In the presence of sulfate, acetate is metabolized only to carbon dioxide, rather than to carbon dioxide and methane. Thus, sulfate should be

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capable of decreasing methane production through competitive inhibition. Even if methanogenesis does occur, sulfate also can be used by microbial consortia to oxidize methane. Therefore, the application of an acidified sulfate solution (which is meant to simulate acid rain) to the sediment is expected to decrease the rate of methane released from the surface via these two processes.

IV. MATERIALS AND METHODS

A. STUDY SITE

Peat for methanogenesis was collected at Donut Bog (Fig. 10), a sphagnum peat bog on the University of Notre Dame Environmental Research Center property in Northern Wisconsin. The bog is approximately 80 yards long and 50 yards wide. The locations used for sampling were on south, central and north sites of the bog. The highest elevation of the bog is in the central portion. The north end of the bog is slightly lower than the center and slightly higher than the south end. The south end of the bog has the lowest elevation and consequently the water table is closest to the surface in this area. The bog is entirely covered by sphagnum, much of the bog is covered by shrubs and some parts of the bog are spotted with trees (mostly dead).

B. GAS CHROMATOGRAPHY

A Hewlett Packard 5890 Series II gas chromatograph was used for the quantification of methane.

C. SAMPLING PROCEDURE

Samples for methanogenesis experiments were collected in three ways. The first method: interstitial dialysis sticks (Fig. 11). Methane dissolved in peatland interstitial water was collected with these sticks which were placed in the sphagnum and remained there for a period of one to three weeks. When pulled out of the bog mat, the gas and liquid contents of each chamber was immediately drawn from the chamber and into a 10ml

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vacutainer tube. To facilitate equilibration, the vacutainers were shaken vigorously. Gas samples from the headspaces were injected into the gas chromatograph within approximately six hours.

One possible source of error which occurred in this method arose from the fact that in the processes of both inserting and removing the popsicle sticks, the sediment was disturbed which may have caused artificially induced change of the methane gradients in the ground as well as in the sticks.

The second method of sample collection was accomplished via circular chambers (methane release chambers) which served the purpose of trapping the gas which diffused out from the surface of the bog. The gas collected under the chambers and gas samples were drawn from the chambers (which were plugged in the center with septa) into 7ml vacutainers. Depending on the particular experiment, the gas samples were drawn two to four times over a period of several hours. All gas samples were run through the gas chromatograph within a twenty four hour period.

A possible source of error of this experiment was that the sediment surrounding the chambers was disturbed when the chambers were laid down as well as when the samples are drawn, causing an alteration in the normal rates of diffusion of methane gas near the surface. Cinder block bricks were used to hold the chambers down as tightly as possible to the surface, however, some gas was able to diffuse out from the bottom sides of the chamber where it met the sediment surface, resulting in another source of error.

The third method of collecting samples was done through core sampling. A core sample was taken from the desired depth and then was immediately placed in a 125ml wide mouth glass jar. Within one hour of collection, samples were returned to the lab at ambient temperature. In the lab smaller sample portions were immediately placed into 15ml or 500ml jars. Each jar was either nitrogen or air flushed (after the sample was placed in it) and the jar was sealed. In some experiments sodium sulfate or sulfuric acid was then added to the jars. Within two hours after collection, injections of the samples into the gas chromatograph began. Depending on

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the particular experiment, the gas from each sample jar was injected one to four times over a period of several hours.

One possible error source was the lack of equilibration of the jars in an anaerobic chamber and the subsequent sealing of the jars with rubber stoppers before use in the field. Consequently, oxidation of the methane in the sample by atmospheric oxygen was not completely prevented. Also, the sediment was jarred as the core sampler was inserted into the sediment and as the samples were removed.

D. NUTRIENT ADDITIONS

Sulfate was added to samples in vitro as sulfuric acid and as sodium sulfate.

V. RESULTS

In the first of the two interstitial dialysis stick experiments, six sticks were placed in three different bog locations, south, central and north. The first chamber of S1 (Fig. 1 & Tbl. 2) was at a depth of 10cm and showed a methane concentration of 1.28 mmol/L, while the last chamber, at 43cm, showed 0.0412 mmol/L. The maximum methane concentration of 1.65 mmol/L was found at 19cm and the minimum amount of 0.0412 mmol/L at 43cm. The first chamber of S2 (Fig. 1 & Tbl. 1) was at a depth of 20cm and held 1.04 mmol/L methane, while the last chamber held 1.47 mmol/L at 53cm. The maximum amount of methane was 1.64 mmol/L at 47cm and the minimum amount was 1.04 mmol/L at 20cm. The air/water interface was at a depth of 10cm in the south end of the bog. The trends of the methane concentration gradients in the two sticks were markedly different. The gradient of methane concentration in S1 proceeded from high to low, whereas the S2 gradient proceeded from low to high.

The first chamber of C1 (Fig. 2 & Tbl. 2) was at a depth of 15cm and it showed a methane concentration of 1.16 mmol/L, while the last chamber, at 48cm, showed the methane concentration to be 0.0441 mmol/L. The maximum amount of methane, 1.56 mmol/L, was found at 33cm and the minimum amount, 0.0439 mmol/L, at 45cm. The first

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chamber of C2 (Fig. 2 & Tbl. 2) was at a depth of 10cm and showed the methane concentration to be 0.86 mmol/L, while the amount of methane in the last chamber was 1.52 mmol/L at 43cm. The maximum amount of methane, 1.59 mmol/L, was found at 37cm and the minimum, 0.862 mmol/L, at 10cm. The air/water interface was at 30cm in the central part of the bog. The trends seen in the methane concentration gradients in the two sticks was markedly different. The gradient of methane concentration in C1 proceeded from high to low, whereas the C2 gradient proceeded from low to high.

The first chamber of N1 (Fig. 3 & Tbl. 3) was at a depth of 15cm and held 1.22 mmol/L methane, while the last chamber, at 48cm, held 0.0412 mmol/L. The methane concentration reached its maximum, 1.66 mmol/L, at 24cm and its minimum, 0.0263 mmol/L, at 45cm. The first chamber of N2 (Fig. 3 & Tbl. 3) was 30cm deep and contained 0.0633 mmol/L methane, while the last chamber contained 1.47 mmol/L at a depth of 63cm. The maximum methane concentration was 1.49 mmol/L at 60cm and the minimum was 0.0633 mmol/L at 30cm. The air/water interface was at a depth of 20cm in the north end of the bog. The trends seen in the methane concentration gradients in each stick was markedly different. The gradient of methane concentration in N1 proceeded from high to low, whereas the N2 gradient proceeded from low to high.

In the second interstitial dialysis stick experiment, 3 sticks (Fig. 4 & Tbl. 4), S1, S2 & S3, were placed in the south end of the bog for two weeks. The first chamber of each stick was at a depth of 5cm, the air/water interface was at a depth of 5cm, and the last chamber of each was at a depth of 38cm. In S1, the maximum amount of methane, 1.18 mmol/L, was at 17cm and the minimum of 0.04 mmol/L at 38cm. In S2, the maximum amount of methane, 1.44 mmol/L, was at 5cm and the minimum, 0.59 mmol/L, at 38cm. In S3, the maximum amount of methane, 2.28 mmol/L, was at 14cm and the minimum, 0.049 mmol/L, at 38cm. S1, S2 & S3 all showed a methane concentration gradient which proceeded from high to low.

In the first of two methane release chamber experiments (Fig. 5 & Tbl. 5), 6 methane release chambers, each with a volume of 8.052L, were placed over

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the bog surface, 2 at each location, south, central and north. There were 3 samples drawn at each sampling time from each chamber. Samples were drawn from the chambers every hour for four hours. Methane content in the chambers at the south site increased gradually from an average of 5.29ml at t1 (10 p.m.) to an average of 11.27ml at t4 (1 a.m.). Chambers at the central site showed a similar trend, beginning with an average of 5.28ml methane at t1 and ending with an average of 8.31ml methane at t4. Chambers at the north site showed a similar trend initially, increasing from an average of 4.41ml methane at t1 to an average of 5.28ml methane at t3. However, by t4, the average amount of methane in the north site chambers reached 19.86ml.

In the second methane release chamber experiment (Fig. 6 & Tbl. 6), 4 chambers were placed over the bog surface, 2 in south and 2 in central. Three samples were drawn from each chamber at each sampling time. Samples were drawn at t0 (immediately after the chambers were laid down) and at t1 (24 hours after the chambers were laid down). The chambers at the south site initially contained an average of 4.10ml methane and 24 hours later contained an average of 3.64ml methane, showing a decrease in methane trapped with time. Conversely, the chambers at the central site initially contained an average of 4.06ml methane and 24 hours later contained an average of 4.28ml methane, showing an increase in methane trapped with time.

In the first of three in vitro experiments (Fig. 7 & Tbl. 7), samples of bog sediment were taken from three depths: 0-20cm, 30-40cm and 50-60cm. Jars containing the samples were flushed with nitrogen and sodium sulfate or sulfuric acid was added to each jar to determine the effect of acidic versus nonacidic sulfate on methane production and consumption. After an incubation period of 2 hours and 45 minutes to 3 hours and 30 minutes for each vial, no methane was found in the samples from 0-20cm. At 30-40cm, 100 nmol methane/g/h was found in the sulfuric acid and sodium sulfate treated samples. At 50-60cm, 150 nmol methane/g/h was found in the sodium sulfate treated sample and 200 nmol methane/g/h was found in the sulfuric acid treated sample. No methane was found at 0-20cm and no difference in methane

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concentration was shown at 30-40cm. The methane concentration was greater in the sulfuric acid treated samples than in the sodium sulfate treated samples at 50-60cm, indicating that sodium sulfate was a stronger inhibitor of methanogenesis than sulfuric acid at that depth.

In the second in vitro experiment (Fig. 8 & Tbl. 8), samples were taken from 20-30cm, 40-50cm and 60-70cm. The jars were flushed either with air or nitrogen to determine the effect of an anoxic versus an oxygenated environment on methane production and consumption. After an incubation time of approximately 30 minutes to 1 hour and 25 minutes for each vial, gas samples were drawn from the sediment sample vials. The maximum amount of methane, an average of 251 nmol/g/h, was found in the nitrogen flushed samples from a depth of 20-30cm. The minimum amount of methane, an average of 8 nmol/g/h, was found in the nitrogen flushed vials from a depth of 60-70cm. The maximum amount of methane in the air flushed vials, 78 nmol/g/h, was found at a depth of 20-30cm and the minimum amount of methane in the air flushed vials, 43 nmol/g/h, was found at a depth of 60-70cm. The methane concentration was higher in nitrogen flushed samples than in air flushed samples at 20-30cm and 40-50cm. However, the methane concentration was lower in nitrogen flushed samples at 60-70cm. The highest level of methane was found at 20-30cm. Samples in anoxic surroundings showed the highest methane concentrations. Anoxic and oxygenated samples showed that methane concentration decreased with increased depth, dropping drastically between 40-50cm and 60-70cm.

In the third in vitro experiment (Fig. 9 & Tbl. 9), samples were taken from two depths: 0-10cm and 20-30cm. The samples from 0-10cm were either air flushed or air and methane flushed. The samples from 20-30cm were flushed with nitrogen. Gas samples were taken from the sediment sample vials at t1 (51 minutes to 1 hour & 31 minutes), t2 (2 hours & 25 minutes to 3 hours & 7 minutes) and t3 (4 hours & 39 minutes to 5 hours). The amount of methane found in the air flushed samples was essentially zero at each sampling time. The air and methane flushed samples showed higher amounts of methane than did the nitrogen flushed samples. The maximum

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amount of methane, an average of 301.67 nmol/g/h, was found in the air and methane flushed samples at t1. Samples flushed with air and methane showed a decreased level of methane concentration with time, as did samples flushed with nitrogen. However, the air and methane flushed samples maintained higher levels of methane at each sampling time. Air flushed samples from 0-10cm and nitrogen flushed samples from 20-30cm simulated actual in situ conditions.

VII. DISCUSSION

In the first interstitial dialysis stick experiment, the maximum methane concentration beneath the surface was found between the depths of 37-60cm, from the south, central and north sites of the bog. However, the second interstitial dialysis experiment, for which only the south site of the bog was used, showed the maximum amount of methane beneath the surface to be between the depths of 5-17cm. The second experiment was performed after and during an extensive period of rain. The water table was therefore higher over the entire bog. In saturated soil, water blocks oxygen from diffusing into the soil, creating an anaerobic environment. Thus, in the second experiment the anoxic zone encompassed more shallow depths than in the first experiment and consequently methanogenesis occurred at more shallow depths.

In the first methane release chamber experiment, on the average, 2ml of methane were released per hour from the south site bog surface and 1ml of methane per hour was released from the central site bog surface and 5ml of methane were released per hour from the north site bog surface. Further studies are needed to determine the cause of the high concentration of methane released from the north site. The south site released more methane than the central site for the following reasons. The south site was at a lower elevation and its surface was closer to the water table. Methanogenesis occurred at depths which were closer to the surface in south site and more methane was released possibly because the methane which diffused upward traveled through little or no oxygenated soil due to the saturation of the bog mat with water. More methane therefore escaped oxidation and was

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released from the surface in the south site compared to the central site.

The second methane release chamber experiment showed that methane concentration in gas trapping chambers decreased from 4.10ml to 3.64ml in the south site and increased from 4.06ml to 4.28ml in the central site over a 24 hour period. These variations suggest that slightly more methane was released from the central site than the south site in a one day period.

The first in vitro experiment showed that sodium sulfate is a slightly stonger inhibitor of methanogenesis than is sulfuric acid. This experiment showed that acidified precipitation is an effective means of inhibiting methanogenesis and/or of oxidizing methane.

The second in vitro experiment showed that samples in anoxic surroundings contained the highest concentrations of methane and that methane concentration in the sediment decreased with increased depth.

In the third in vitro experiment, in situ conditions were replicated by air flushing the samples from 0-10cm and by nitrogen flushing the samples from 20-30cm, as these conditions (oxygenated and anoxic, repectively) were observed in bog sediment at these depths. The results suggested that these postulations of the in situ conditions were correct, as the shallow depth sediment showed no methane and the deeper sediment contained methane in the sample vials. Sediment samples from 0-10cm which were flushed with air and methane showed the highest levels of methane concentration. All samples which contained methane (air + methane flushed and nitrogen flushed) showed decreased concentrations of methane with time, indicationg that methane oxidation and/or inhibition of methanogenesis occured over time.

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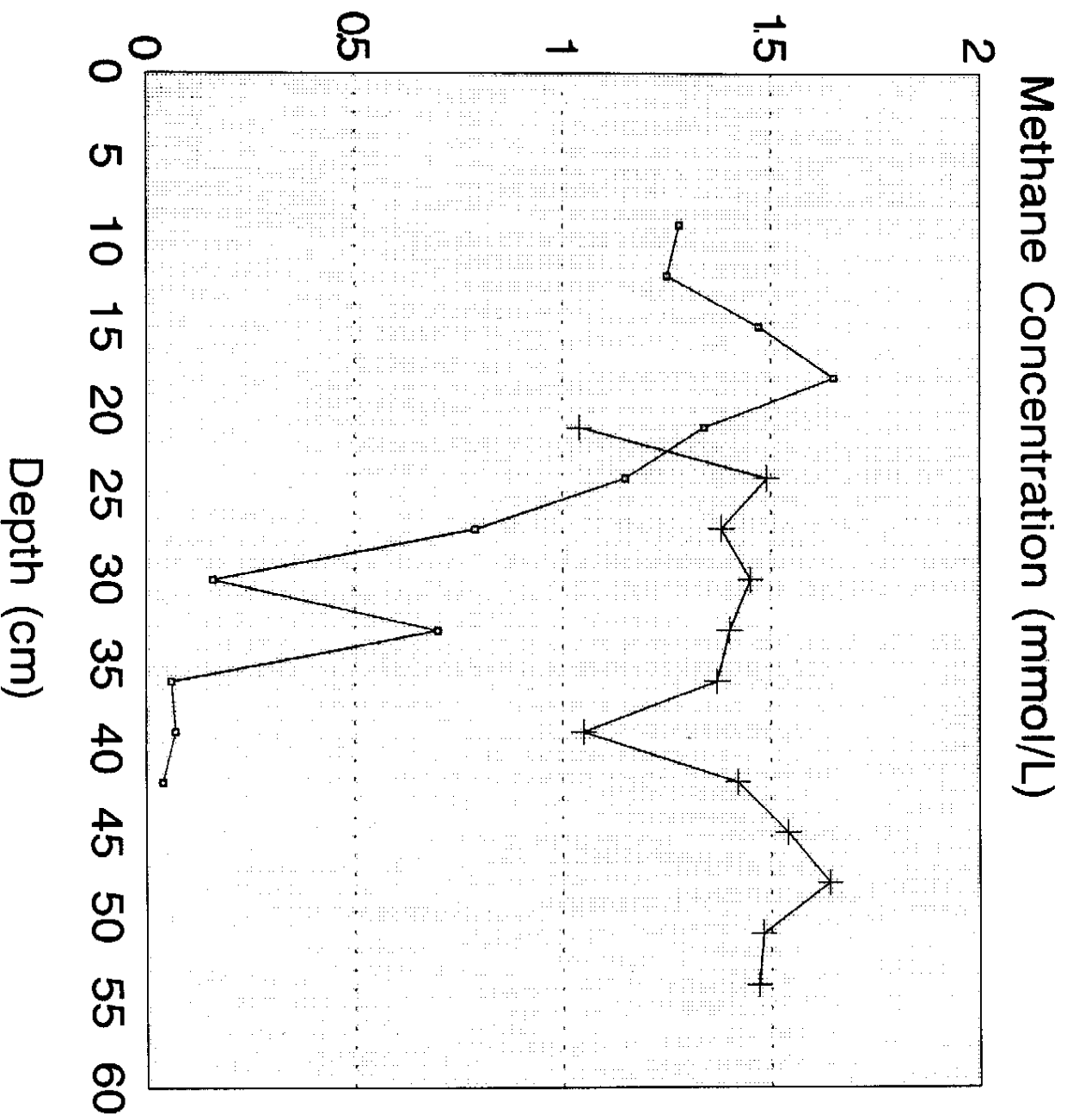
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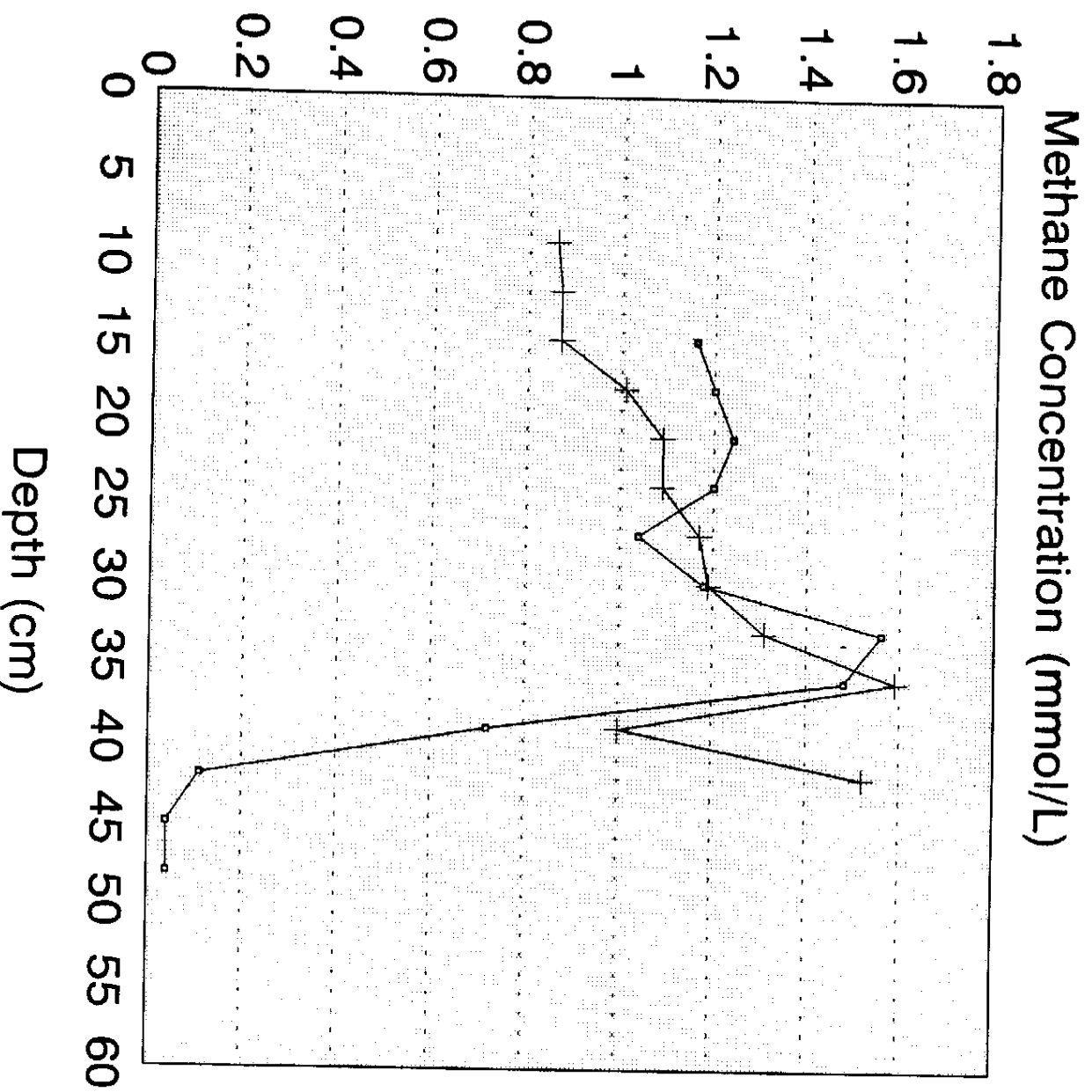
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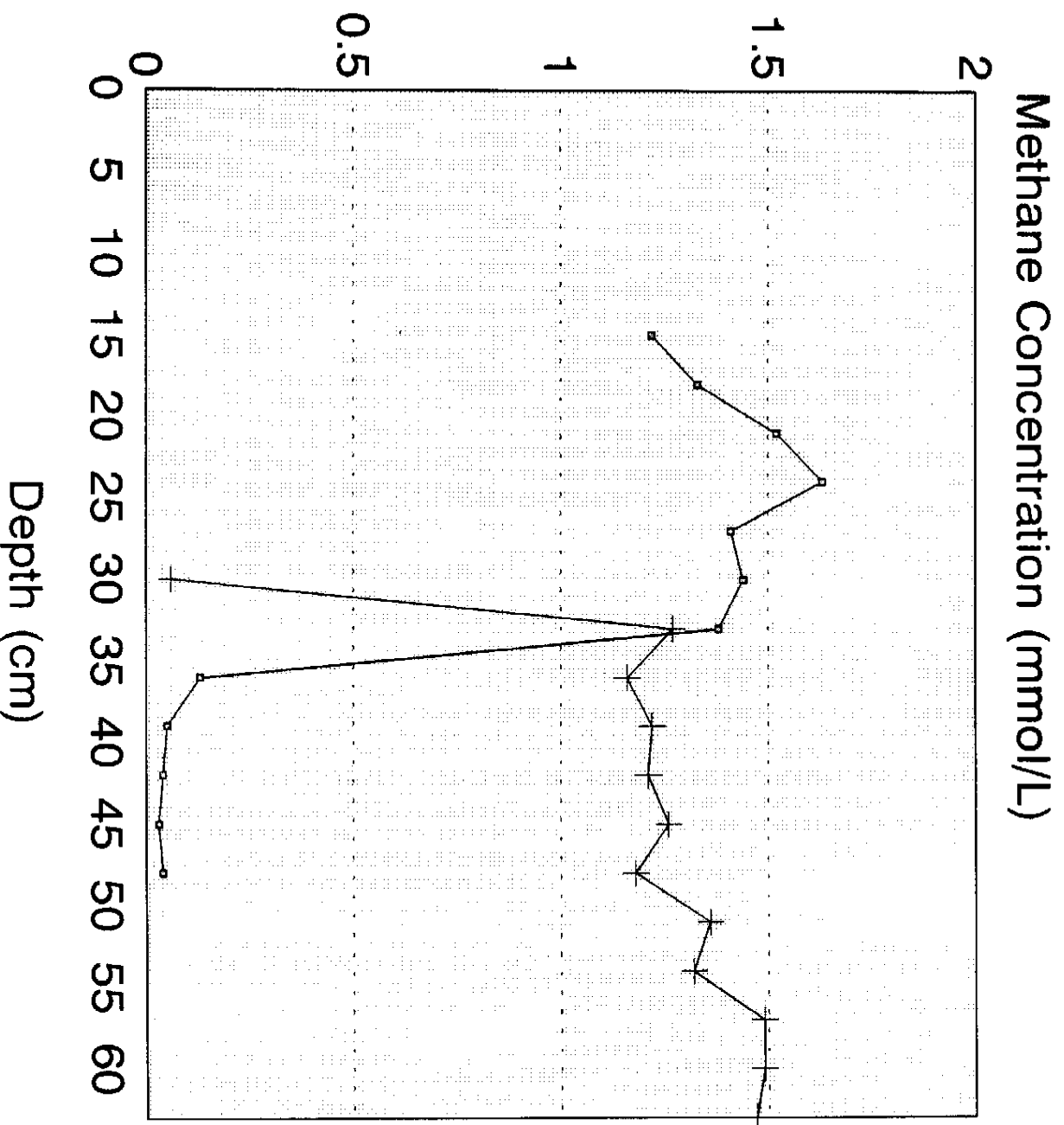
South Site Sticks
 -□- S1
 + S2

Fig. 1. Comparison of methane concentration in chambers of interstitial dialysis sticks: S1 & S2. (Concentration measured in units of millimoles of methane per liter of sample.)



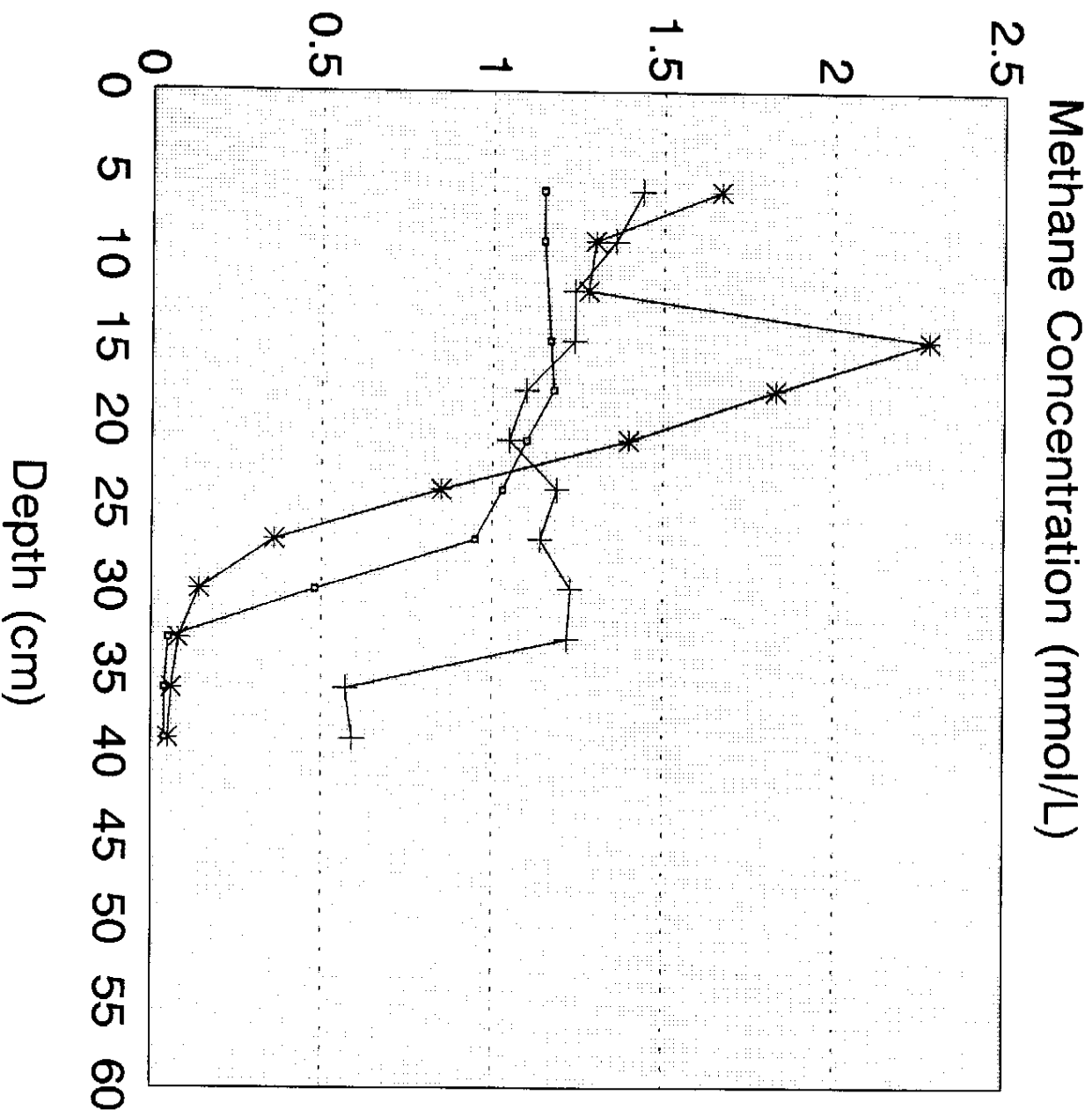
Central Site Sticks
 ○ C1
 + C2

Fig. 2. Comparison of methane concentration in chambers of interstitial dialysis sticks: C1 & C2. C1 concentration measured in units of millimole of methane per liter of sample.



North Site Sticks
 ○ N1
 + N2

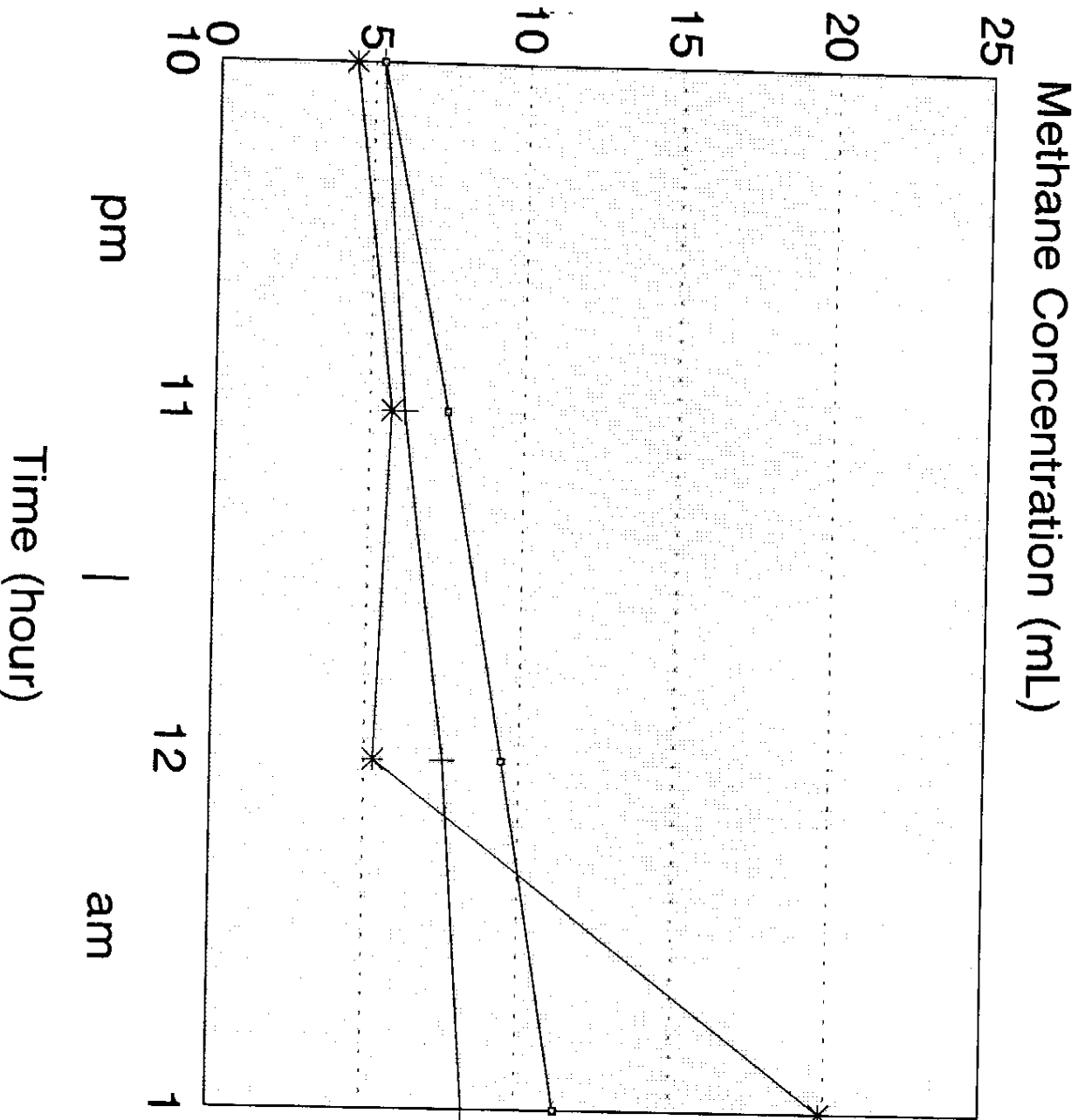
Fig. 3. Comparison of methane concentration in chambers of interstitial dialysis sticks: N1 & N2. Concentration measured in units of millimoles of methane per liter of sample.



South Site Sticks

—□— S1
 —+— S2
 —*— S3

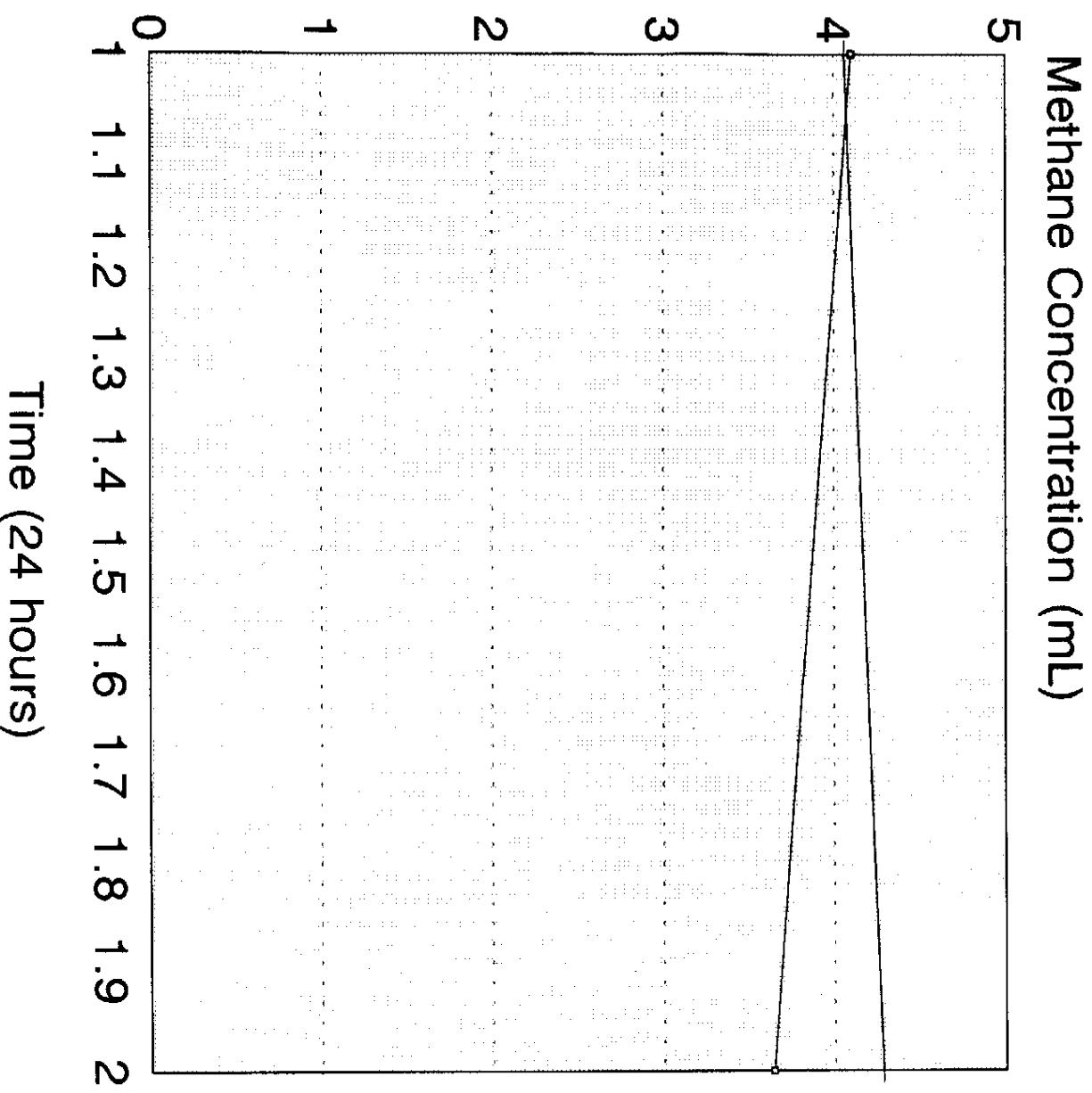
Fig. 4. Comparison of methane conc. in chambers of interstitial dialysis sticks: S1, S2 & S3. Methane concentration measured in units of millimoles of methane per liter of sample.



Site Chambers

- South
- + Central
- * North

Fig. 5. Comparison of methane concentration in methane release chambers: S, C & N. C ncentration measured in units of milliliters of methane per 8.052L chamber.



South & Central Site Chambers
 —○— South
 —+— Central

Fig. 6. Comparison of methane concentration in methane release chambers: S & C. Concentration measured in units of milliliters of methane per 8.052L chamber.

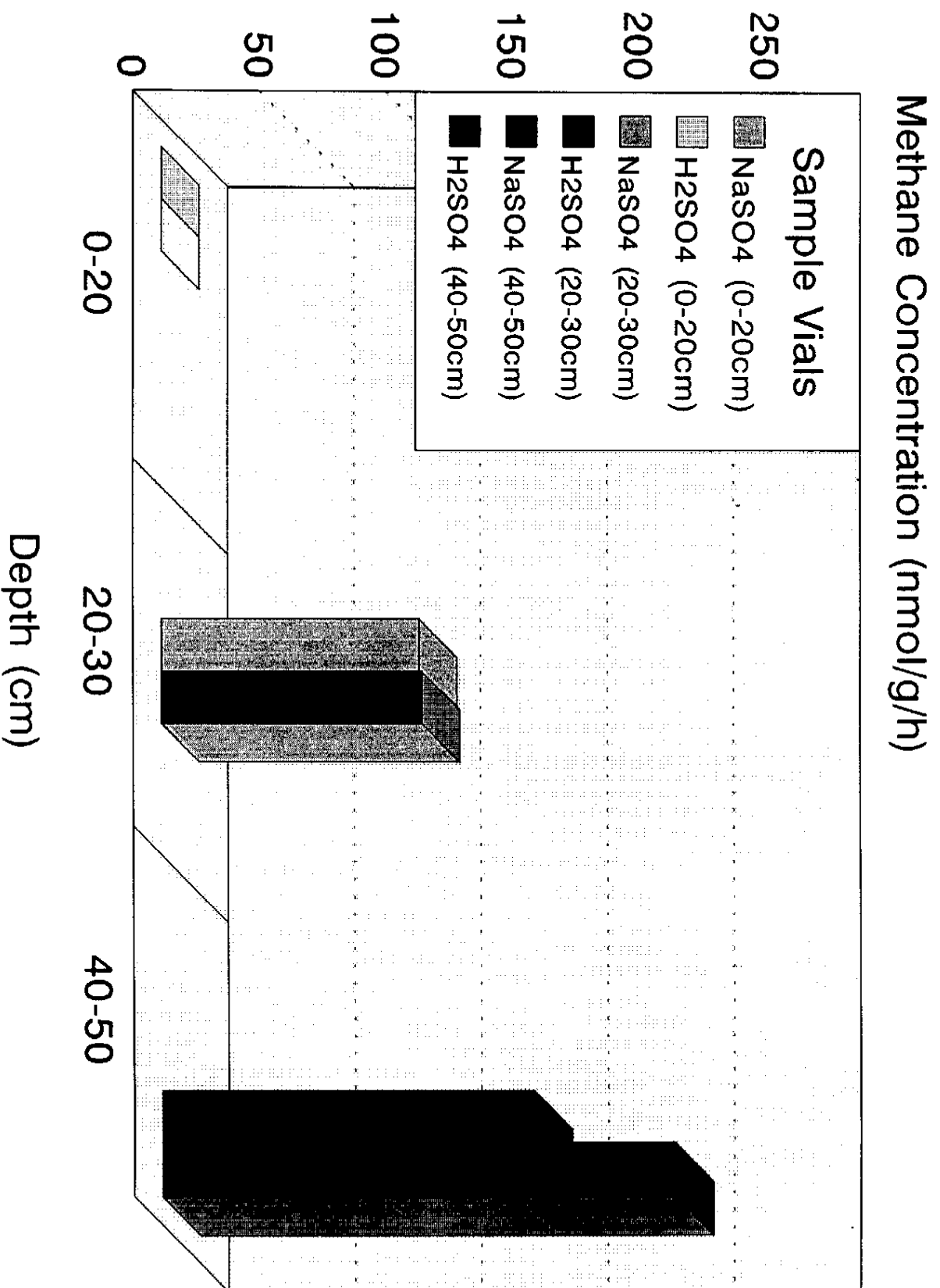


Fig. 7. In vitro vial experiment showing methane concentration of samples from 3 depths. All samples were flushed with N₂ and then were treated with NaSO₄ or H₂SO₄.

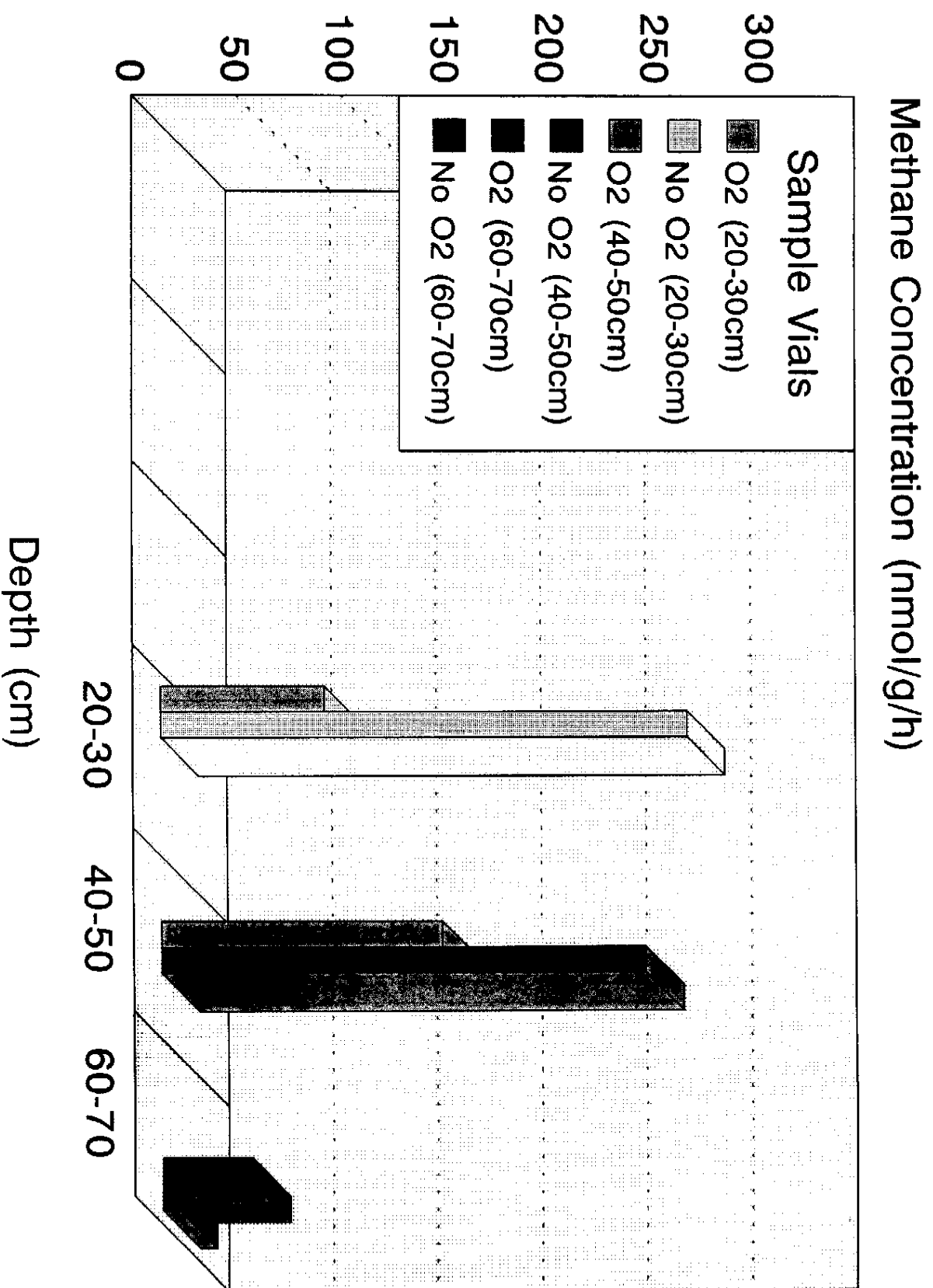


Fig. 8. In vitro vial experiment showing methane concentration of samples from 3 depths. Each sample vial was flushed with oxygen or with nitrogen.

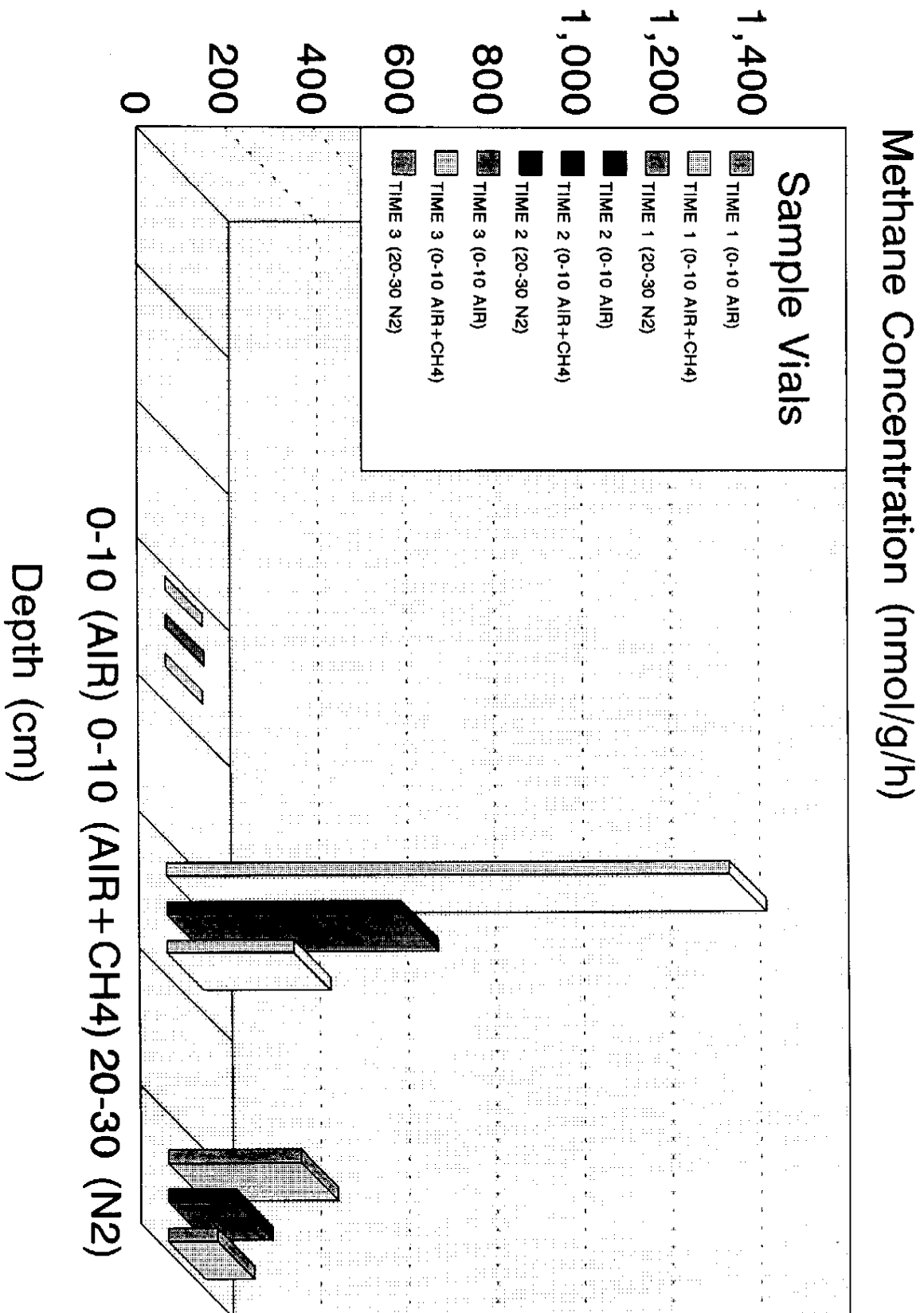
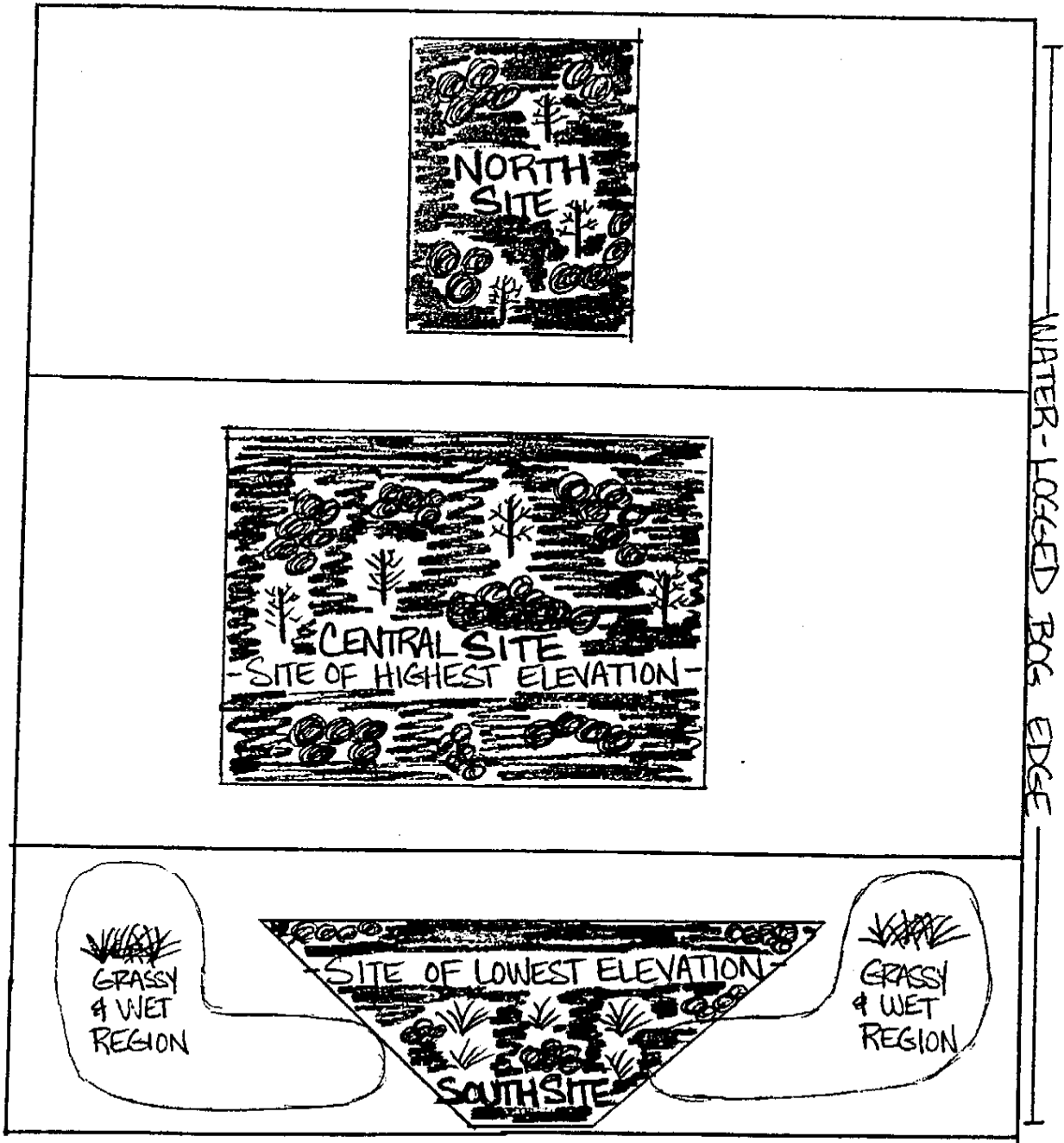


Fig. 9. In vitro vial experiment showing methane concentration of samples from 2 depths. Samples from 0-10cm were contained in vials flushed with air or air & methane. Samples from 20-30cm were contained in vials flushed with nitrogen.

FOREST



FOREST

WATER-LOGGED BOG EDGE

FOREST

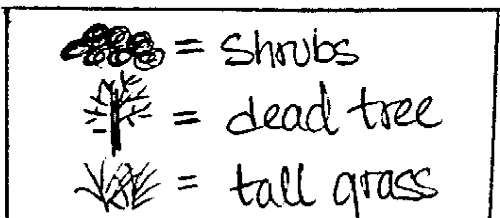


Fig. 10. Sampling Sites: South, Central and North, at Dorlot Bog in Land O' Lakes, Wisconsin. Samples were taken from shaded regions. Lowest elevation was in South Site, highest in Central Site. The variation in elevation over the entire bog, however, is slight.

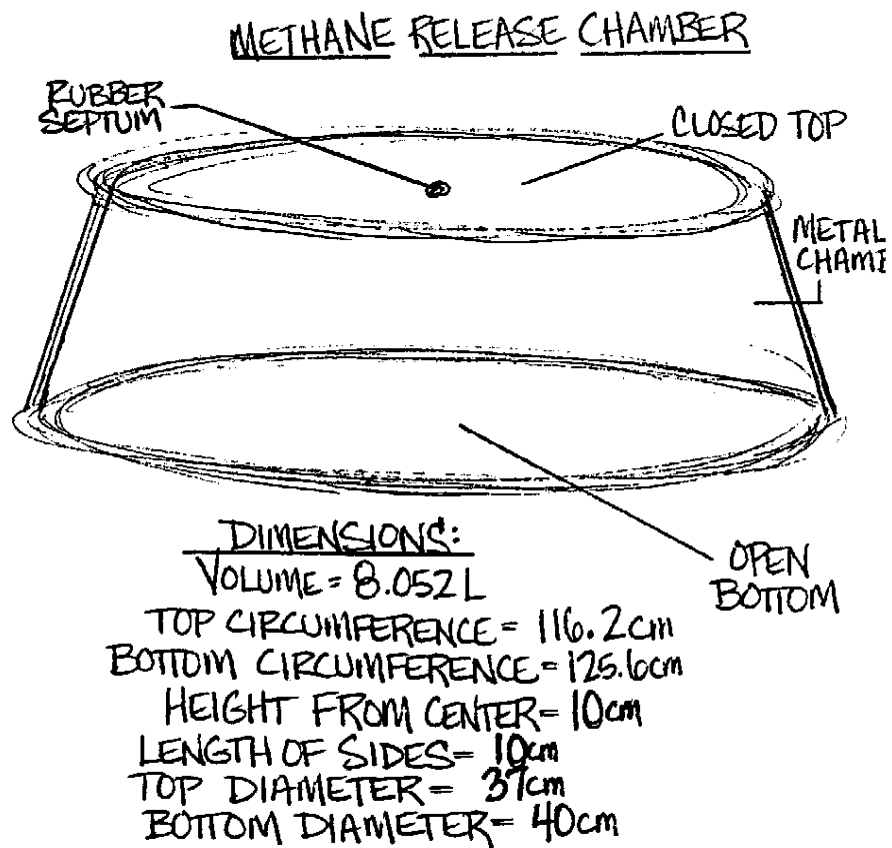
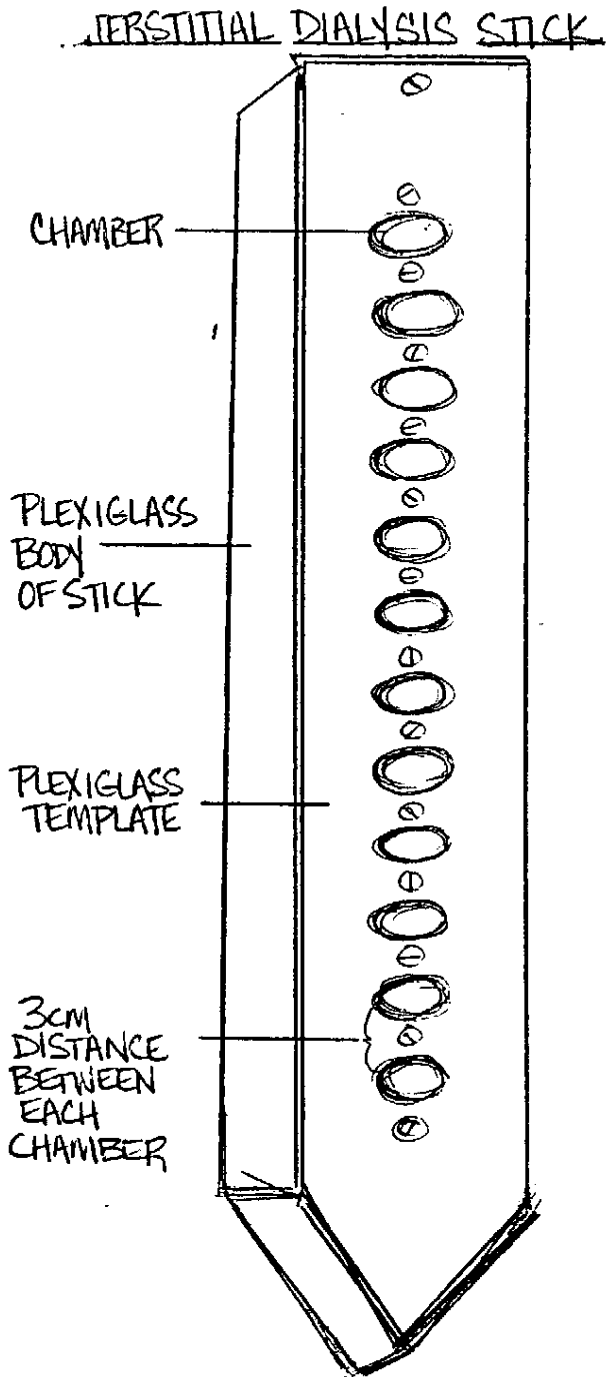


Fig. 11. Experimental Equipment used to measure methane concentration. Interstitial dialysis sticks were used to measure the gradient of the methane concentration beneath the bog surface. Methane release chambers were used to measure the amount of methane released from the surface of the bog.

TABLE 1 - METHANE CONCENTRATION

 INTERSTITIAL DIALYSIS STICKS: S1 & S2

COLUMNS S1 & S2 LIST METHANE CONCENTRATION (MMOL/L) AT EACH DEPTH

CHAMBER NUMBER	DEPTH (CM)	S1	DEPTH (CM)	S2
1	10	1.28	20	1.04
2	13	1.25	23	1.49
3	16	1.47	26	1.38
4	19	1.65	29	1.45
5	22	1.34	32	1.36
6	25	1.15	35	1.37
7	28	0.79	38	1.05
8	31	0.16	41	1.42
9	34	0.70	44	1.54
10	37	0.06	47	1.64
11	40	0.07	50	1.48
12	43	0.04	53	1.47

TABLE 2 - METHANE CONCENTRATION

 INTERSTITIAL DIALYSIS STICKS: C1 & C2

COLUMNS C1 & C2 LIST METHANE CONCENTRATION (MMOL/L) AT EACH DEPTH

CHAMBER NUMBER	DEPTH (CM)	C1	DEPTH (CM)	C2
1	15	1.16	10	0.86
2	18	1.20	13	0.87
3	21	1.24	16	0.87
4	24	1.20	19	1.01
5	27	1.04	22	1.09
6	30	1.18	25	1.09
7	33	1.56	28	1.17
8	36	1.48	31	1.19
9	39	0.72	34	1.31
10	42	0.11	37	1.59
11	45	0.04	40	0.98
12	48	0.04	43	1.52

TABLE 3 - METHANE CONCENTRATION

 INTERSTITIAL DIALYSIS STICKS: N1 & N2

COLUMNS N1 & N2 LIST METHANE CONCENTRATION (MMOL/L) AT EACH DEPTH

CHAMBER NUMBER	DEPTH (CM)	N1	DEPTH (CM)	N2
1	15	1.22	30	0.06
2	18	1.33	33	1.27
3	21	1.52	36	1.16
4	24	1.63	39	1.22
5	27	1.41	42	1.21
6	30	1.44	45	1.26
7	33	1.38	48	1.18
8	36	0.13	51	1.36
9	39	0.05	54	1.32
10	42	0.04	57	1.49
11	45	0.03	60	1.49
12	48	0.04	63	1.47

TABLE 4 - METHANE CONCENTRATION

 INTERSTITIAL DIALYSIS STICKS: S1, S2 & S3

COLUMNS S1, S2 & S3 LIST METHANE CONC. (MMOL/L) AT EACH DEPTH

CHAMBER NUMBER	DEPTH (CM)	S1	S2	S3
1	5	1.15	1.44	1.67
2	8	1.15	1.36	1.30
3	11		1.24	1.28
4	14	1.17	1.24	2.28
5	17	1.18	1.10	1.83
6	20	1.10	1.05	1.40
7	23	1.03	1.19	0.85
8	26	0.95	1.14	0.36
9	29	0.48	1.23	0.14
10	32	0.05	1.22	0.08
11	35	0.04	0.57	0.06
12	38	0.04	0.59	0.05

TABLE 5 - METHANE RELEASE FROM BOG SURFACE

METHANE RELEASE CHAMBERS: S, C & N

COLUMNS S, C & N LIST METHANE CONCENTRATION (ML) IN CHAMBER

TIME	S	C	N
1	5.29	5.28	4.41
2	7.53	6.12	5.71
3	9.44	7.53	5.28
4	11.27	8.31	19.86

METHANE (ML) RELEASED PER HOUR

TIME	S	C	N
HOUR 1	2.25	0.84	1.30
HOUR 2	1.91	1.40	-0.43
HOUR 3	1.82	0.78	14.58

TABLE 7 - METHANE CONCENTRATION

IN VITRO EXPERIMENT

COLUMNS N2 + NASO4 & N2 + H2SO4 LIST METHANE CONCENTRATION (NMOL/G/H)

DEPTH (CM)	N2 + NASO4	N2 + H2SO4
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0-20	0	0
30-40	102	103
50-60	147	203

TABLE 8 - METHANE CONCENTRATION

IN VITRO EXPERIMENT

COLUMNS AIR & NITROGEN LIST METHANE CONCENTRATION (NMOL/G/H)

DEPTH (CM)	AIR	NITROGEN
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20-30	78	251
40-50	134	231
60-70	43	8

TABLE 9 - METHANE CONCENTRATION

 IN VITRO EXPERIMENT

COLUMNS TIME 1, TIME 2 & TI METHANE CONCENTRATION (NMOL/G/H)

DEPTH(CM)	FLUSH	TIME 1	TIME 2	TIME 3
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0-10	AIR	0.00	4.00	0.00
0-10	AIR + CH4	1276.67	532.33	287.00
20-30	NITROGEN	301.67	152.67	111.67