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Treatability Study of the Graces Quarters Contaminated Aquifer Using Vitamin B12-Catalyzed Reductive Dechlorination Part I: Microcosms

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Treatability study of the Graces Quarters Contaminated Aquifer using Vitamin B12-Catalyzed Reductive Dechlorination Part 1: Microcosms

Final Report

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MANAGEMENT PERSPECTIVE

Title: **Treatability Study of the Graces Quarters Contaminated Aquifer using Vitamin B12-Catalyzed Reductive Dechlorination. Part 1: Microcosms.**

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EC Priority/Issue: This work is being conducted under the "Clean Environment" issue. The paper presents the results of a contract obtained from the U.S. Department of Energy through Dames and Moore Inc. to conduct a treatability study for groundwater at from Graces Quarters, Aberdeen Proving Ground, a U.S. Military research facility in Maryland. This contract was obtained to test the vitamin B12 technology for the remediation chlorinated compounds, for which a patent was received last year.

Current Status: The microcosms study is complete. It was followed by a column test which is a separate report.

Next Steps: This work was conducted as part of a larger feasibility study to evaluate all existing technologies at the site. The results were very positive and the technology has been selected for a pilot scale study to be conducted at the site. The project, which is in the planning stage, will be conducted by Dames and Moore, with our technical advice.

ABSTRACT

The use of vitamin B12 reduced by titanium (III) citrate for the reductive dechlorination of chlorinated aliphatic hydrocarbons has been the subject of numerous microcosm studies, many suggesting possible *in situ* field applications. However, most of the work has been conducted in the aqueous phase with carbon tetrachloride or tetrachoroethene. This paper describes a laboratory treatability study consisting of eight treatment conditions conducted with aquifer material and contaminated site groundwater from Graces Quarters, Aberdeen Proving Ground, MD. The purpose of the study was to look at the effect of combining the use of vitamin B12 and titanium citrate with various carbon sources to evaluate the combination of chemical and biological treatments. The site groundwater is contaminated with a mixture of 1,1,2,2-tetrachloroethane, carbon tetrachloride, chloroform, tetrachloroethene, and trichloroethene.

The eight treatment conditions evaluated were: (1) vitamin B12 (10 mg/L), titanium citrate, and glucose; (2) titanium citrate and glucose; (3) titanium citrate and yeast extract; (4) γ-irradiated sterile control with vitamin B12 (10 mg/l), titanium citrate, and glucose; (5) glucose only; (6) vitamin B12 (10 mg/l), titanium citrate and glucose, with yeast extract added after 2 days; (7) an alternate chelating agent and vitamin B12; and (8) vitamin B12, titanium citrate, and yeast extract.

Each treatment combination was conducted using site aquifer material and highly contaminated groundwater (2000 - 4000 μg/L) or less contaminated groundwater (<1,000 μg/L). Each was run in triplicate, for a total of six active microcosms per treatment condition. In addition, two microcosms consisting of aquifer material and highly or less-contaminated groundwater (with nothing else added) were used as controls for each microcosm condition. In addition to monitoring for the chlorinated hydrocarbons, the microcosms were monitored for titanium, methane, ethane, ethene, acetylene, glucose, citrate, lactate, acetate, and propionate.

This series of experiments showed that the vitamin B12/titanium citrate reaction was effective in treating all the compounds initally present in the site groundwater. When vitamin B12 was present, chlorinated alkanes were fully degraded within 5 minutes, whereas the half-life for tetrachloroethene was 33 minutes. The final products of the 1,1,2,2-tetrachloroethane degradation were *cis*- and *trans*-DCE, which remained above their maximum acceptable concentration after 28 days. Some vinyl chloride was formed, but did not persist. First order reaction rate constants were not dependant upon contaminant concentration. The addition of titanium citrate alone, without vitamin B12, did degrade the chlorinated methanes and ethanes (but not the ethenes), but at a much reduced rate. The γ-irradiated control showed that most of the dechlorination observed was abiotic; however, vinyl chloride degraded more rapidly in the non-sterilized microcosms. In the treatment containing glucose only, carbon tetrachloride was dechlorinated to chloroform, but no other reaction was observed. This means that the addition of a carbon source alone would not be sufficient to induce bacterial populations capable of degrading all the contaminants. The degradation of glucose under these anerobic conditions produced large amounts of CO_2, which contributed to the removal of some of the chlorinated products.

List of abbreviations

B12	Vitamin B12
DCE	dichloroethene
DCM	dichloromethane
DUP	duplicate
ECD	electron capture detector
FID	flame ionization detector
GC/MS	gas chromatography/mass spectrometry
L	liter
MDL	method detection limit
mM	millimolar
PERC	perchloroethylene or tetrachloroethene
ppm	parts-per-million
PQL	practical quantitation limit
TCD	thermal conductivity detector
TCE	trichloroethene
TeCA	1,1,2,2-tetrachloroethane
µg	microgram
VC	vinyl chloride
VFA	volatile fatty acid

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I. Introduction

This report summarizes the results that were obtained by conducting a series of microcosms for the treatment of groundwater from the Graces Quarter area at Aberdeen Proving Grounds. The use of vitamin B12 as part of an integrated chemical/biological treatment train was being envisaged because of the suitability of the contaminants at the site for the vitamin B12- catalyzed reaction.

In this project, combinations of chemical and biological treatments were conducted in microcosms containing contaminated water from two areas at the site, representing high (Q14) and low (Q52) concentrations of contaminants, in the presence of aquifer material from a single source at the site.

The experimental design was developed in collaboration with the supervising group. The purpose of the different treatments was to establish the rate of reaction of the different contaminants with titanium citrate with and without vitamin B12 and in combination with carbon sources to determine the possibility of natural attenuation after the chemical treatment.

In the vitamin B12/titanium citrate process, vitamin B12 is a catalyst, meaning that it enhances the reaction, but is not consumed by it. The titanium (III) citrate, on the other hand, provides the electrons for the reduction of the chlorinated compounds. It is therefore consumed and must be replenished. We have developed an alternative technique for field use based on titanium metal (Lesage et al., 1997). This method was used throughout the experiment.

The principal contaminants in the site water are: 1,1,2,2-tetrachloroethane (TeCA), carbon tetrachloride, chloroform, tetrachloroethene (PERC) and trichloroethene (TCE). The vitamin B12 reaction produces sequential reductive dechlorination of all of these compounds. A schematic diagram of the degradation pathways is shown on Figure 1.

Reductive dechlorination may be caused by titanium citrate alone or be catalysed by vitamin B12. The ease of dechlorination is governed by the oxidation state of the carbon. Therefore carbon tetrachloride is the most reactive, followed by chloroform and TeCA. All of these compounds can be dechlorinated by reduced titanium only, but the rate of reaction is enhanced by the presence of B12. The ethenes are much less reactive and require the presence of vitamin B12. The rate of reaction also decreases with the degree of chlorination. Because the reaction medium is buffered to pH 8, some base-catalyzed elimination of HCl may occur with the chloroethanes.

This unique combination of contaminants makes the site an ideal candidate for remediation using an integrated chemical/biological approach based on the use of vitamin B12. In the proposed scenario, the vitamin B12/titanium citrate would be injected in the zones of high contamination to reduce the concentration of the chlorinated solvents to a level that could be tolerated by bacteria. A carbon source is included in the treatment such that bacteria will be able to proliferate down gradient. The vitamin B12 treatment has been shown to be non-toxic and compatible with the growth of anaerobic bacteria (Lesage et al., 1996). This integrated approach is expected to reduce the cost of treating a plume.

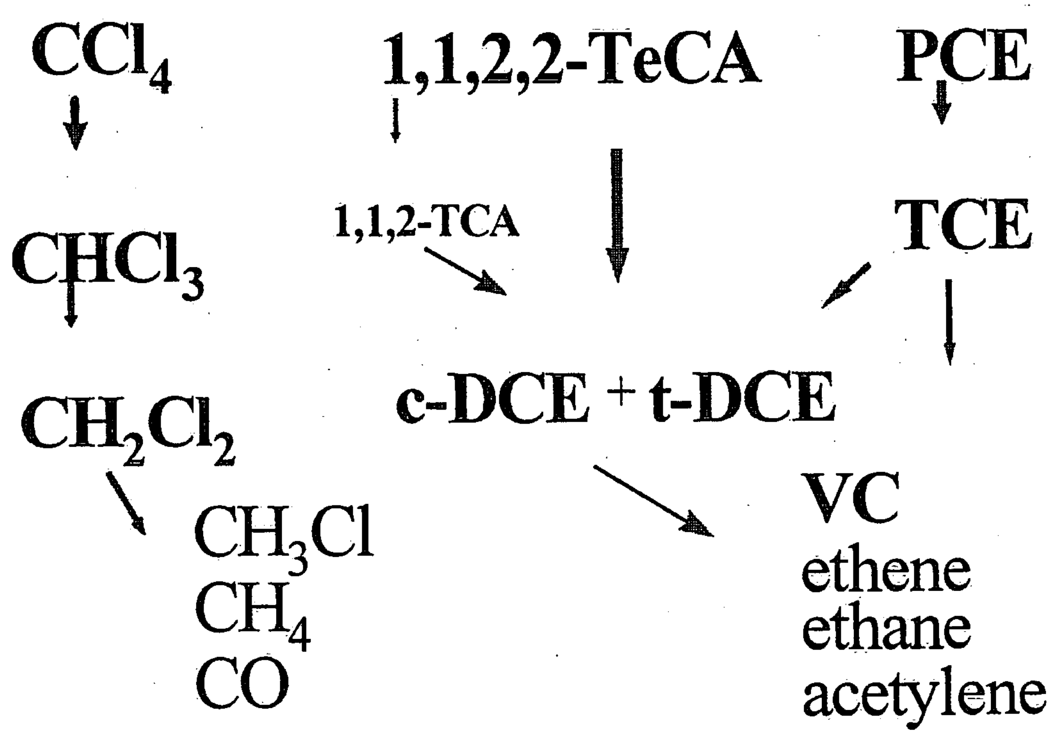


Figure 1: Reactions pathways for the reaction of the site contaminants with vitamin B12 and titanium citrate.

II. Methods

The experimental methods are described in details in the Work Plan and will only be summarized here.

The microcosms were conducted in sealed 160 mL serum bottles containing 100 g of aquifer material from the site and 100 mL of site water. The bottles were incubated inverted at room temperature. Each treatment was carried out in triplicate with Q52 (low) and Q14 (high) site water, except for M7 and M8 where only low site water was used. In addition, because the site water samples had not been composited and there was potential for variability between bottles, two references containing water from the same bottles as the treatment, but no reagents, were setup as on-going controls.

The eight treatments used, their purpose and the monitoring schedule are listed in Table 1.

All the microcosms were monitored using an SRI GC equipped with dual columns leading to an electron capture detector (ECD) and a TCD/FID in series. This instrument was used to monitor the headspace of the microcosms for all the chlorinated volatile compounds and their known degradation products, except CO. Small liquid samples were withdrawn to analyze for citrate and the volatile fatty acids that are known biological degradation products of glucose and citrate. Glucose itself was tested using an Encore™ glucometer .

Table 1: Experimental design- Microcosms.

Treatment (Each at 2 substrate concentrations)	*Purpose*	*Chemical Analyses and Schedule*
1.vitamin B12 (10 mg/L) with titanium citrate and glucose	optimal treatment	**Days**: 0, 1, 3, 7, 15, 30
2. titanium citrate and glucose	control for reducing conditions	**Days**: 0, 1, 7, 19, 29
3. titanium citrate and yeast extract	to promote methanogens	**Days**: 0, 1, 4, 16, 28
4. γ-irradiated with vitamin B12, titanium citrate and glucose	abiotic control	**Days**: 0, 1, 3, 7, 16, 28
5. glucose	Biologically active control	**Days**: 0, 5, 14, 27, 48
6. vitamin B12 (10 mg/L) with titanium citrate and glucose. Yeast extract after 2 days.	to establish a methanogenic population after TeCA has been reduced by B12	**Days**: 0, 1, 2, 6, 14, 29
7. Alternate chelator with vitamin B12	- hopefully not as easily biodegraded as citrate	**Days**: 0, 1, 3, 7, 15, 28
8. vitamin B12 (10 mg/L) with titanium citrate and yeast extract	similar to 3, but with vitamin B12 - again to promote methanogens	**Days**: 0, 1, 3, 7, 15, 28

III. Results

1. Preliminary experiments

Before beginning the actual experiments, it was necessary to establish the amount of titanium necessary for the reduction of the aquifer solids. Based on experience elsewhere, three rinses with a concentrated titanium citrate solution had been sufficient. Also, no data existed on the effect of titanium citrate alone on carbon tetrachloride and TeCA. It was therefore necessary to establish the effect of the treatment on site water alone.

It was found that only measuring the Eh was not sufficient to evaluate the long term viability of the treatment. Instead, the amount of iron (as Fe^{+2}) was found to be a more useful indicator of the redox status of the aquifer material. The measurement was done using colorimetric test strips. The aquifer material was judged as being sufficiently reduced when the supernatant contained less than 50 ppm Fe. This required six rinses with 30 mM Titanium (III) citrate on average. Based on the very high reducible Fe content of the aquifer material, a full scale system where all the aquifer material would have to be reduced would be cost prohibitive. Nonetheless, the experiments were still carried out with the planned amounts of solids, because combined chemical/biological treatment scenarios were to be evaluated.

2. Microcosm 1 (titanium citrate, 10 mg/L vitamin B12 and glucose)

The purpose of microcosm 1 was to see the effect on the site water of the vitamin B12/titanium citrate using conditions that had been found optimal for the degradation of PERC. The results obtained are to be used in the design of the column experiments. The results are summarized in graph in Figure 2, and the complete results are shown in Appendix A. Within one day, all the tetrachloroethane (TeCA), carbon tetrachloride and tetrachloroethylene (PERC), were below detection limit. Some chloroform, dichloromethane and chloromethane were apparent on day 0, but had disappeared by day 1. Trichloroethylene also decreased significantly by day 1 and was below detection limit by day 3. The products of transformation appearing within the first 3 days, *cis* and *trans*-DCE, vinyl chloride (VC), ethane and ethene can account for all the TeCA and PERC and TCE transformed within experimental error (400 from 450 nmoles for the low site water). For the high site water, approximately 1000 nmoles of product were obtained from 1400 nmoles (sum of TeCA, PCE and TCE). No significant amounts of 1,1,2-trichloroethane and chloroethane were found.

The half-lives for TeCA and carbon tetrachloride cannot be calculated because more than 90% was degraded at the first measurement. It is therefore estimated to be less than 5 minutes, the time usually taken for mixing and equilibration after the addition of vitamin B12. The half-lives for PERC was calculated using first order kinetics to be 33 min for the low and 57 min for the high level water. For TCE it was 5.6 hours and 6.2 hours for the low and high water respectively. This implies that in an *in-situ* well application most of the initial reaction would occurs in the well, before recirculation into the surrounding aquifer.

After seven days, the gas pressure increased significantly within the microcosms because of the formation of CO_2, a product of glucose biodegradation. It was necessary to vent the microcosms to take accurate headspace measurements. The amount of gas removed was recorded and used in the calculations. The graphs show the results in total number of moles per bottle. The results were calculated using the ideal gas law and the measured volume. Because the amount of gas removed was often as large as the volume of headspace remaining, this caused a depletion of the gases, most of which could not be detected after 15 days. This also had an effect on the remaining chlorinated compounds.

A predicted value could be calculated based on the volume of gas removed and the Ostwald coefficient. Most of the reduction in contaminant concentration could be accounted for by these calculation. Confirmation of this was expected from the sterile control (see Microcosm 4 below).

Summary M1a

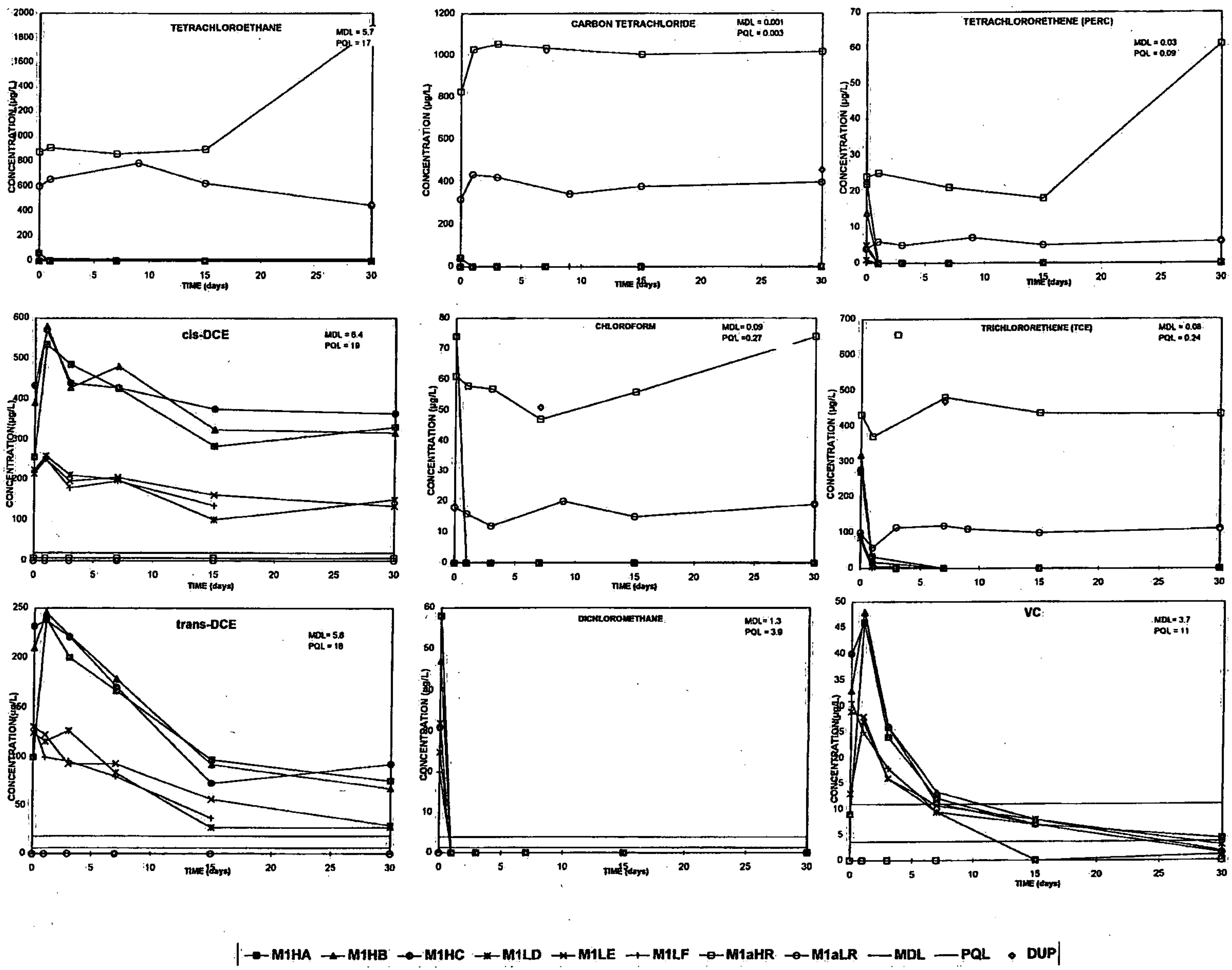


Figure 2

Summary M1a

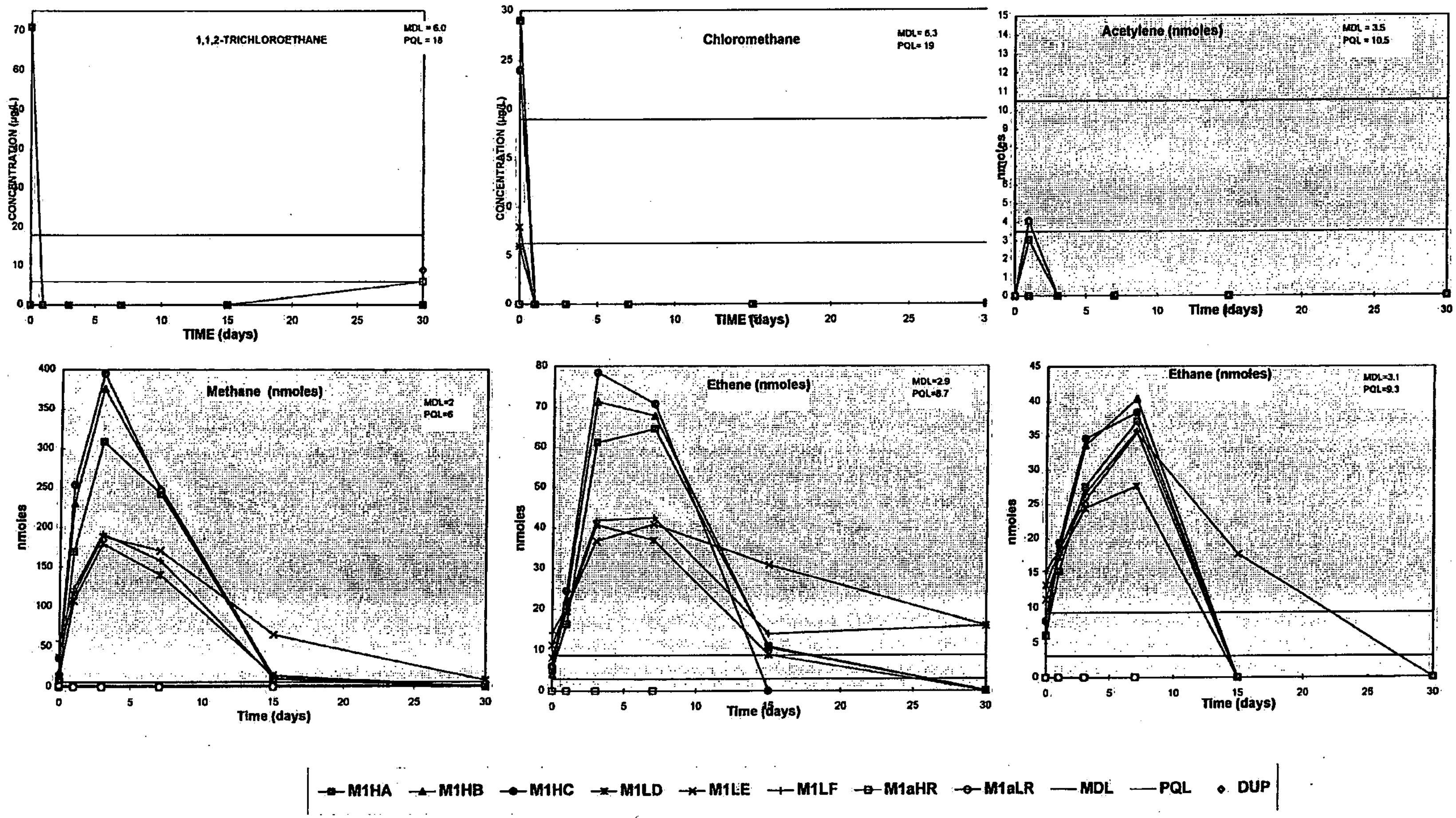


Figure 2

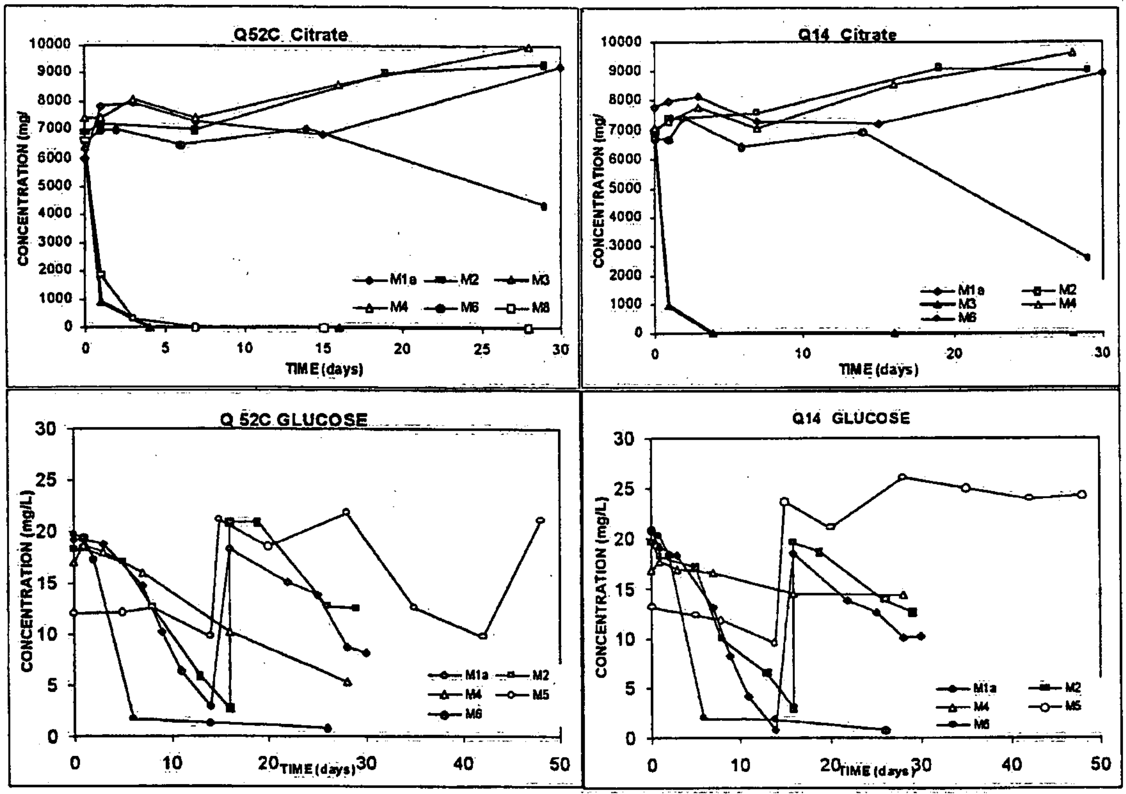


Figure 3. Average glucose and citrate concentrations for the Q52 and Q14 microcosms

The biological activity in the microcosms was monitored by analyzing for glucose, citrate (Figure 3) and the volatile fatty acids (Figure 4). Formate and acetate were produced immediately, however glucose levels did not decrease significantly until day 7. These products probably arise from the other sugars present in the commercial glucose used. Invertose is actually a high fructose corn syrup that contains glucose, fructose, and other higher saccharides, which are not measurable by the glucose meter. Lactate appeared after the supplementation at day 15, when glucose became seriously depleted (from 20 to <1 mM). Microcosm M1aLF exploded due to a hairline crack in the neck of the vial and pressure build up sometime between days 18 and 21, however some of the supernatant was saved and transferred to a 60-mL serum vial for continuous monitoring. Lactate, a common glucose metabolite, was measurable by day 19 and, along with formate and acetate, continued to increase over the 30 day monitoring period. Small amounts of propionate and butyrate, generally less than PQL, were measurable by the end of the analyses. The production of acid metabolites was accompanied by a drop in pH from 8.0 to a final pH of 5.5 on day 30. Because the methane concentrations were low and could be accounted for by the abiotic degradation of carbon tetrachloride during the first two days, it was concluded that no methanogenic bacteria were present A picture of the microcosms (Figure 5) at the beginning and after 28 days of incubation show the color changes that accompany the redox status of the microcosms.

At the end of the experiment, a GC/MS analysis was conducted to confirm the absence of TeCA and the quantity of VC left. The TeCA was below 1 μg/L whereas the concentration of vinyl chloride varied from 1.1 to 4.3 μg/L (full results in Appendix A). The GC/MS analysis also revealed the presence of several metabolites of glucose (heterofermentative pathways): acetaldehyde, ethanol, acetone, butanol and three esters of butanoic acid (ethyl, propyl and butyl). These peaks were probably the cause of the large unknown peaks seen in the FID. There was also some butene, a compound that has been observed as a product of the B12 reduction of PERC and TCE.

In summary then, the vitamin B12 with titanium citrate converted carbon tetrachloride completely to non-chlorinated products. TeCA, PERC and TCE were mostly converted to *cis* and *trans*-DCE, with some VC, ethene and ethane.

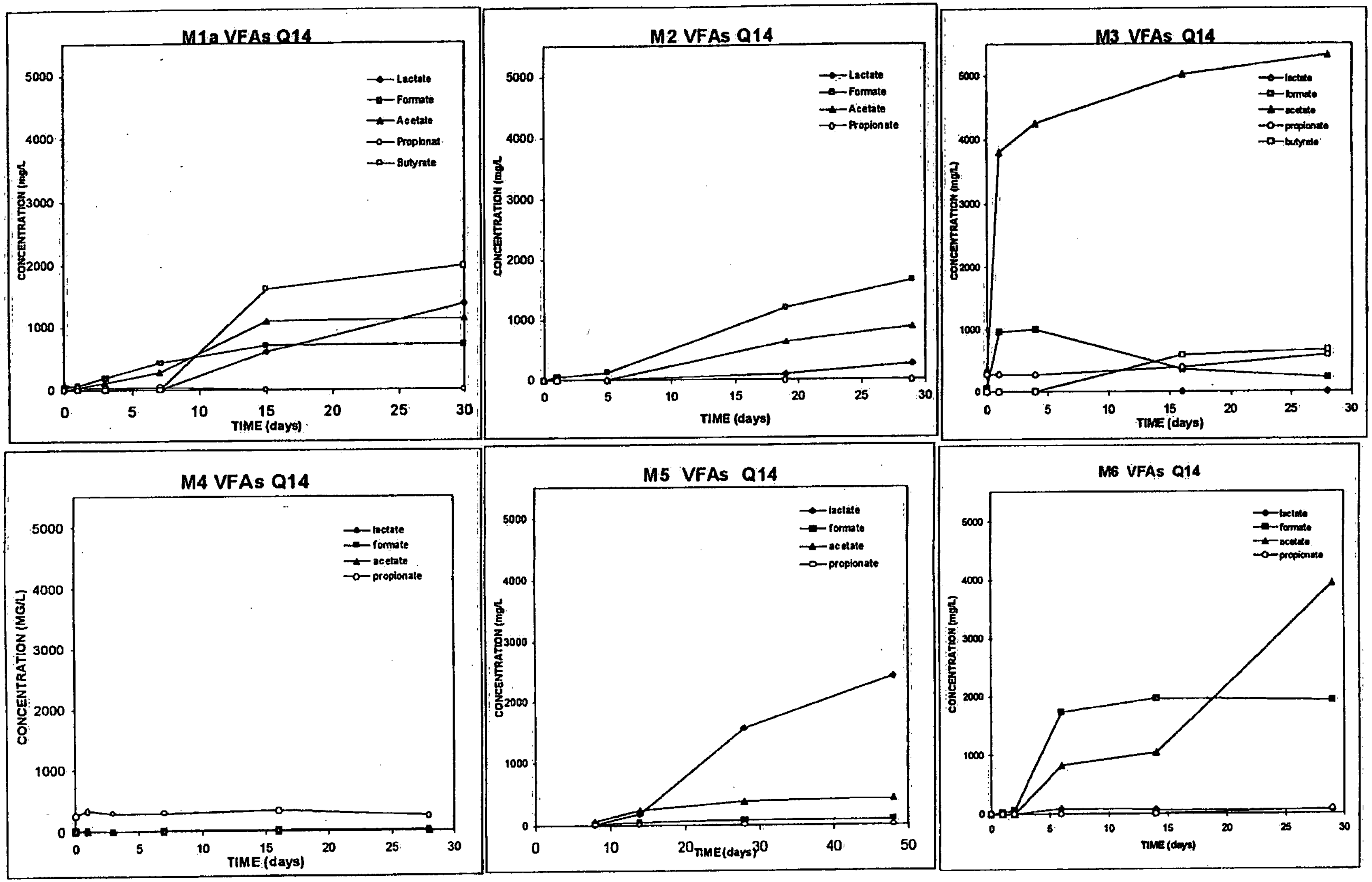


Figure 4. Volatile fatty acids (averages, full data sets in Appendix 1)

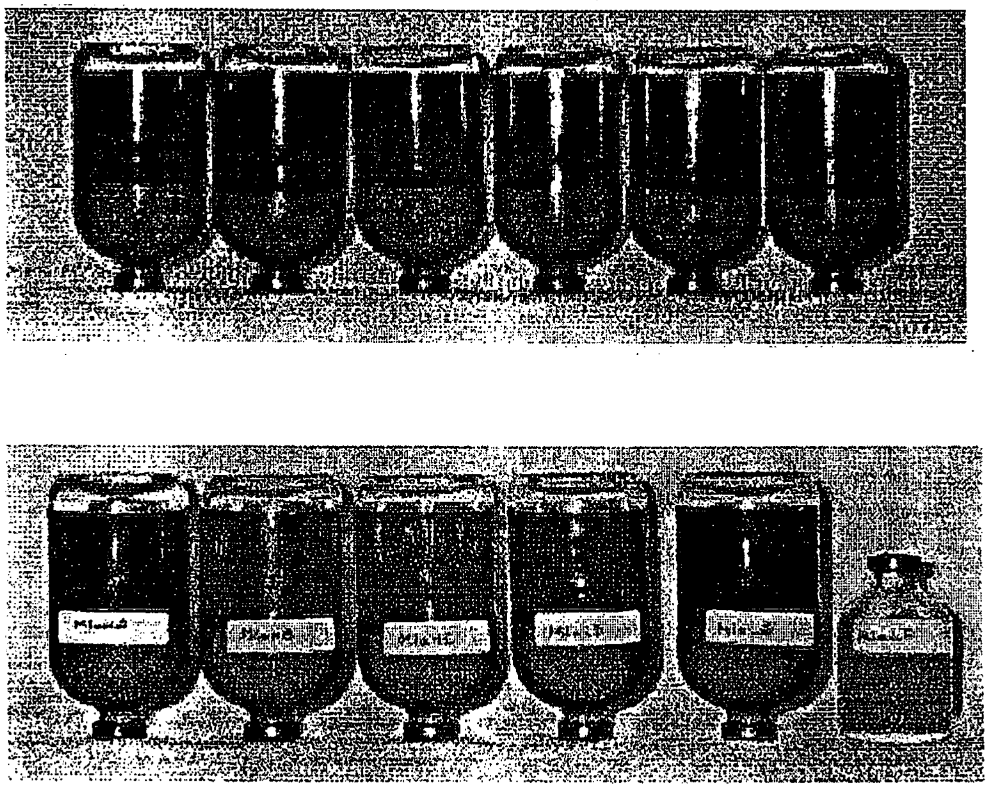


Figure 5. Microcosms 1a. Beginning and after 28 days. The small bottle is the supernatant of F that exploded.

3. *Microcosm 2 (titanium citrate and glucose)*

The purpose of microcosm 2 was to measure the effect of the reducing solution alone, without vitamin B12 being present. Glucose was added to prevent citrate utilization by bacteria.

A summary of the results is shown on Figure 6. Carbon tetrachloride was degraded within one day to chloroform which in turn was dechlorinated to DCM. However, in the absence of B12, DCM persisted for the 28 days of the study. TeCA was also degraded with the concurrent formation of *cis*- and *trans*-DCE, but at a much lower rate than in the

Summary Microcosm 2

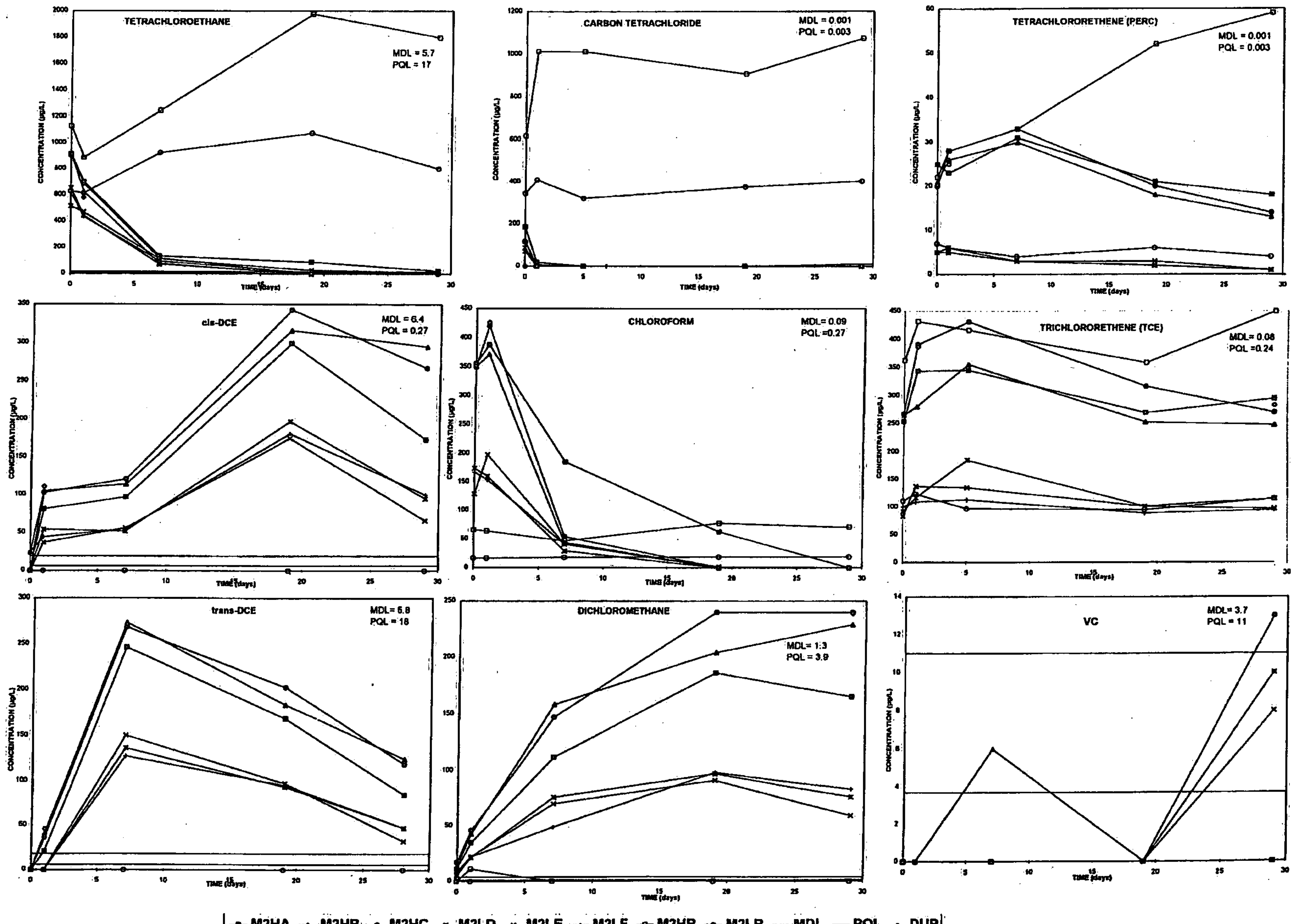


Figure 6

Summary Microcosm 2

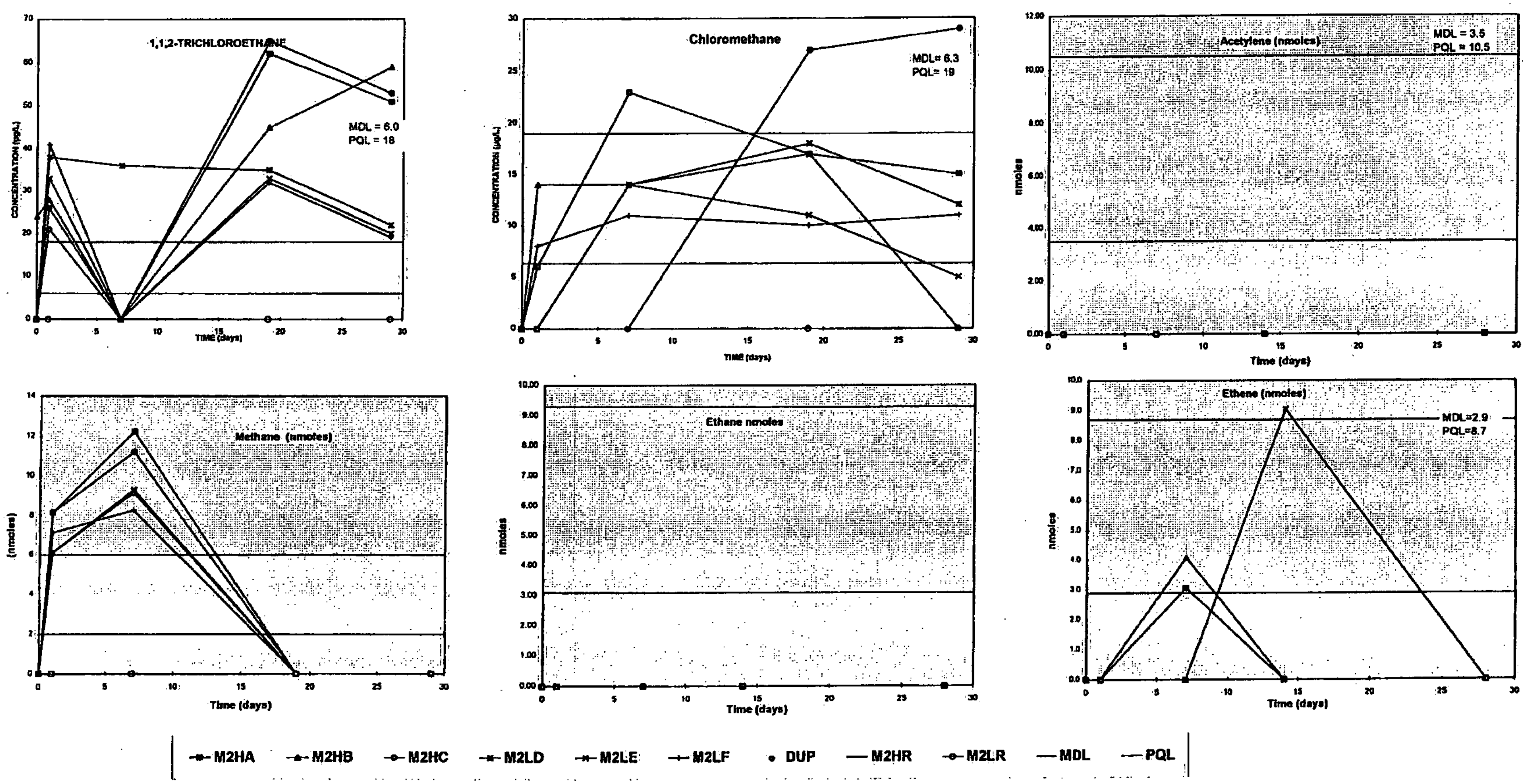


Figure 6

presence of B12 (half-life of 2.3 ± 0.3 days for the high level water and 2.6 ± 0.4 days for the low level). TeCA was transformed to *cis* and *trans*-DCE and 1,1,2-trichloroethane. Many analytical problems were experienced around day 7, which means that the accuracy of the data points on that day are less than for the rest. Nonetheless, the trends remained the same after that period.

There were very little observed losses of PERC and TCE throughout the incubation period and the losses that were, could potentially be attributed to venting. Indeed, similar to what had been observed for M1, glucose was degraded to CO_2 which had to be vented. This effect is very evident for methane, and somewhat less dramatic for the chlorinated compounds. There was very little vinyl chloride, ethene or ethane produced, supporting the fact that there was in fact no degradation of the chlorinated ethenes.

Glucose consumption (Figure 3) was comparable to M1a however there were generally lower amounts of VFAs produced, except for formate which was generated in concentrations double those found in the M1a series (Figure 4). Acetate production, on the other hand, was delayed and not detected until day 19. Lactate concentrations were lower than in M1a, and propionate and butyrate were not detected in the 29 day incubation period. As a result of the lower concentration of acids produced, the pH decreased a final pH of 6.4 as compared to 5.5 in M1a. CO_2 production was much lower in M2 microcosms with an average volume of 55 mL of gas vented from M2 vials as compared to 293 mL vented from M1a microcosms. One significant difference between M1a and M2 microcosms, apart from the vitamin B_{12} addition, was the amount of titanium added. M1a microcosms contained an average of 20 mM titanium, while M2 and all subsequent microcosms had 30 mM titanium added. Although the reducing solution was prepared in the same manner for all of the microcosms, it is possible that in the particular batch used for microcosm M1a, the oxalate had a shorter reaction time with the titanium metal. To prevent further inconsistencies in future batches, the exact concentration of titanium oxalate was measured prior to preparing the microcosms. Increased concentrations of titanium in M2 microcosms may have had an inhibitory effect on the indigenous microorganisms hence lower CO_2 production and decreased concentrations of acid metabolites.

In summary then, the presence of vitamin B12 was essential to achieve the degradation of chlorinated ethenes and to the complete degradation of carbon tetrachloride.

4. *Microcosm 3 (titanium citrate and yeast extract)*

The purpose of microcosm 3 was to create favorable conditions for anaerobic methanogenic bacteria which are known to be able to dechlorinate ethenes and ethanes. It was also useful as a comparison to M2, because there was no glucose added, and therefore no large amount of CO_2 present to create a sparging effect. However, because there was no glucose, titanium citrate was rapidly used by the bacteria present. Therefore any reduction reaction had to occur within the first four days. Afterward, any further transformation would be more likely the product of biological activity.

The results are summarized on Figure 7. The rate of degradation of TeCA was similar to M2 (half-lives 2.4± 0.6 days for the high concentration and 1.7± 0.8, for the low concentration site water). Similarly all the carbon tetrachloride was transformed to chloroform within 1 day and to dichloromethane within the following sampling. Dichloromethane was not degraded further. Cis and trans-DCE appeared concurrently and this coincided almost exactly with the disappearance of TeCA. The production of vinyl chloride was only evident after 15 days. There was no degradation of TCE, but some PERC was lost in the high level microcosms after 15 days.

As predicted, without glucose amendments, citrate was degraded rapidly to less than PQL by day 1 (Figure 3). CO_2 generation was strong until citrate was completely utilized and then was negligible for the remainder of the monitoring period. The pH was relatively stable, between 7 and 8, over the course of monitoring.

Summary Microcosm 3

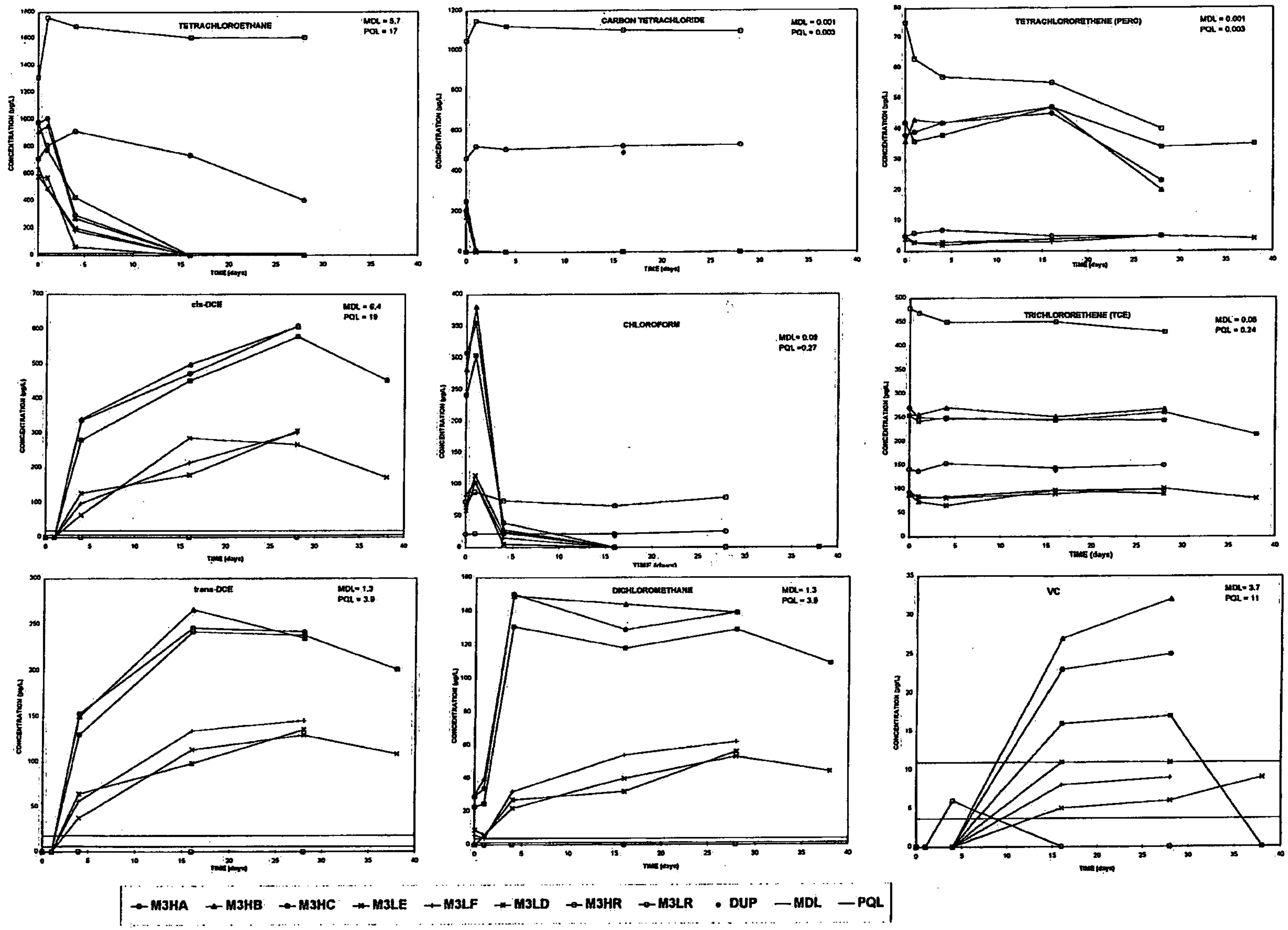


Figure 7

Summary Microcosm 3

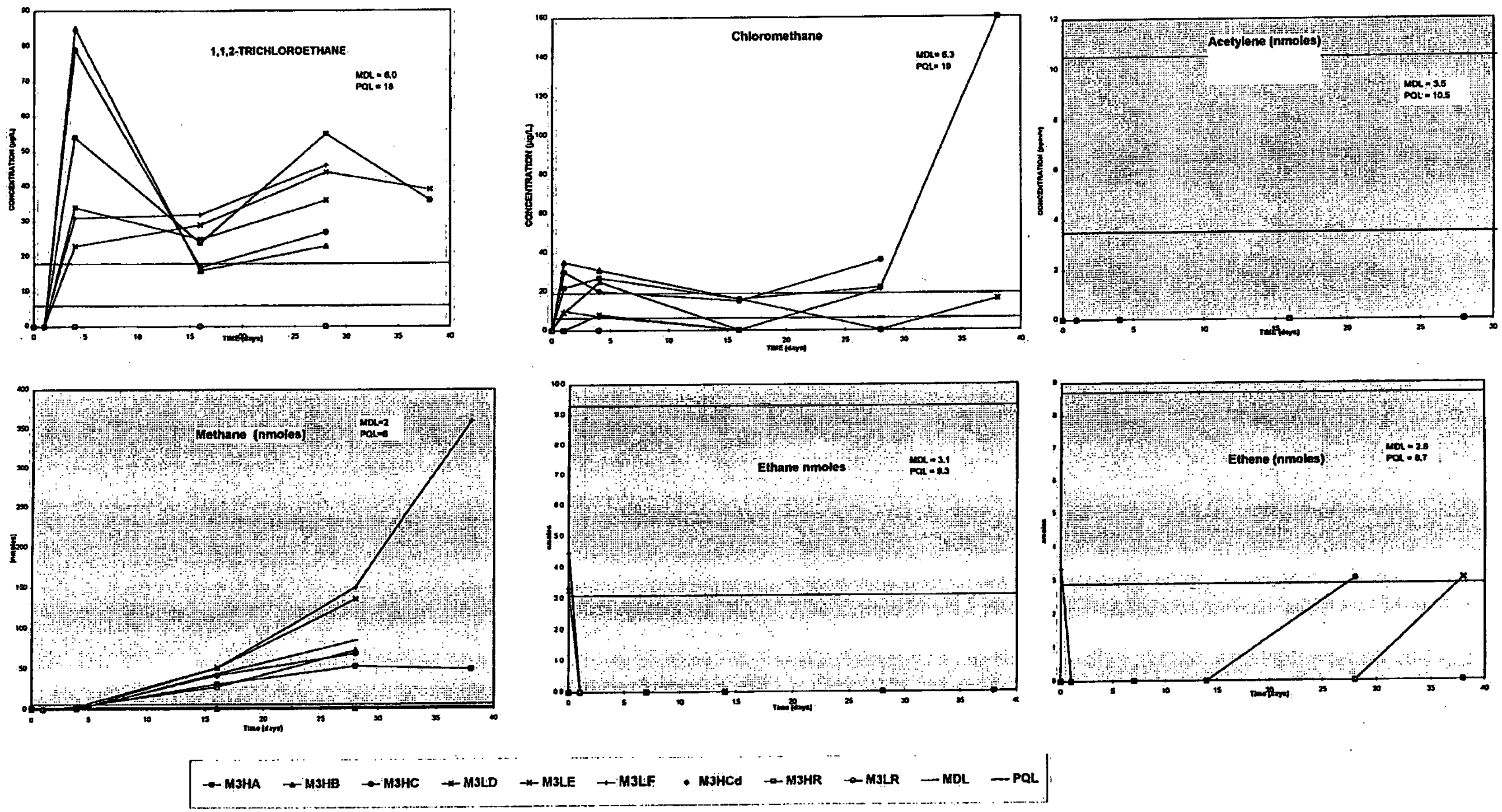


Figure 7

Because the amount of methane was still increasing after 28 days, the microcosms were kept intact and monitored after 38 days. More methane was present than in any of the other treatments. It is therefore apparent that a methanogenic population was being established. Although the concentration of *cis* and *trans*-DCE started to decrease, the rate of dechlorination was not very rapid.

In summary, methanogenic conditions were not obtained as rapidly as hoped and therefore biological degradation did not occur even within an extended period. This led to residual concentrations of dichloromethane, PCE, TCE and vinyl chloride.

5. *Microcosm 4 (γ- irradiated soil -vitamin B12, titanium citrate and glucose)*

The purpose of microcosm 4 was to be able to differentiate between the chemical and biological components of the dechlorination reaction and to provide an environment where no CO_2 would be produced and therefore where losses to the gas phase would be minimal. A preliminary sample of soil, site water and reagents was sent to the irradiation facility at McMaster University (Hamilton, Ontario) to see the effect of irradiation alone. While there were no visible changes in the soil and in any of the dry chemicals, the irradiation completely destroyed all the contaminants in site water. Alternatives such as sterilizing the site water and respiking contaminants, or irradiating the soil but filtering the site water were considered. The latter method was retained.

The soil was rinsed four times with titanium citrate in Milli-Q water before it was sent to the facility. When the sterilized reagents returned, they were used to make up titanium citrate in site water that was filtered through a 0.2 µm filter. All transfers were made in a laminar flow hood. In addition, to prevent contamination during sampling and GC analyses, the syringe needles were rinsed in pure ethanol.

The results (Figure 8) in the first few days were very similar to those in M1a, that is the degradation of TeCA, carbon tetrachloride and PERC all occurred within the first

Summary M4

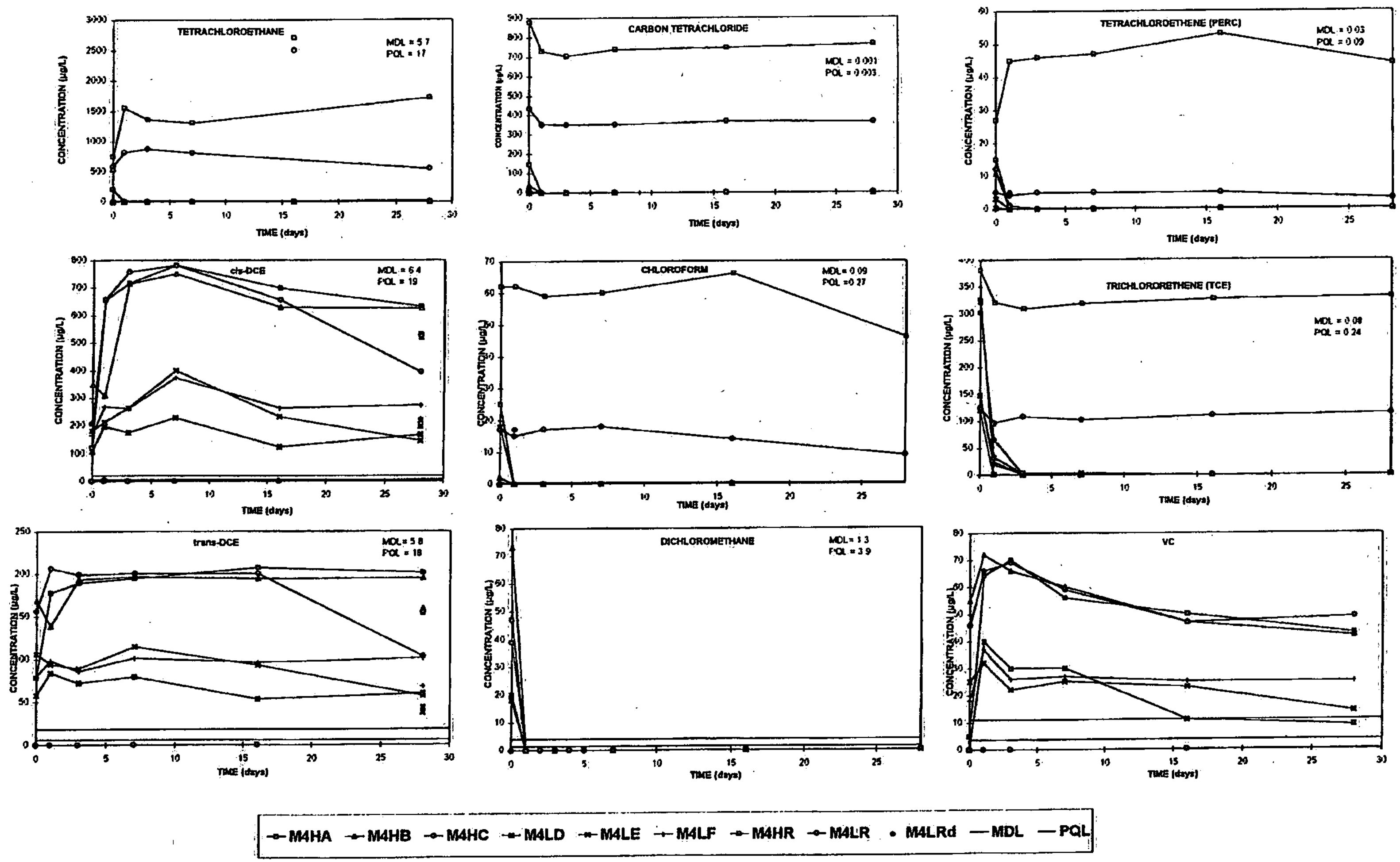


Figure 8

Summary M4

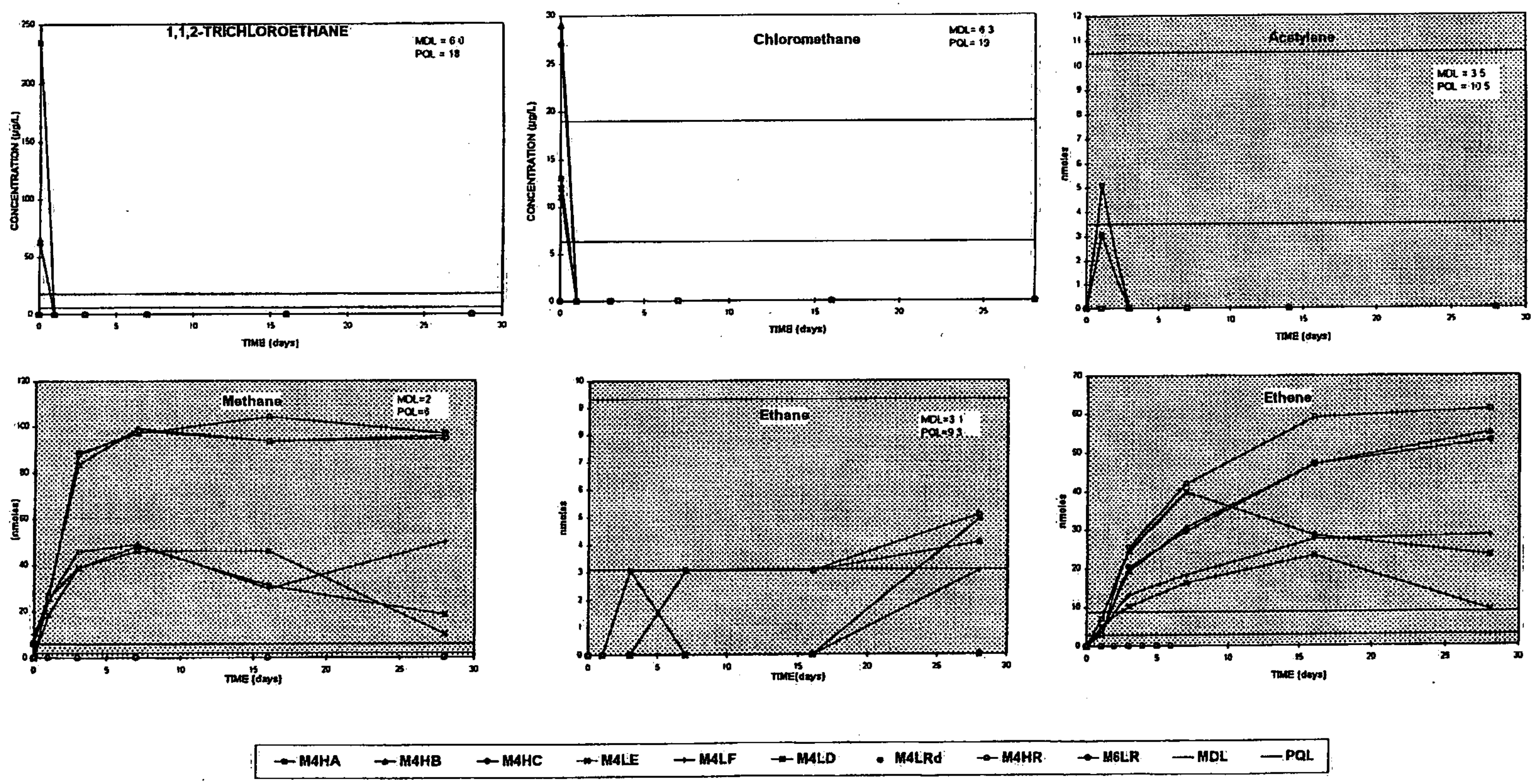


Figure 8

few hours. Measurable half-lives were obtained for carbon tetrachloride high only (21 min), PERC (high, 4 hours; low, 15 min) and TCE (high, 8 hours; low, 11.5 hours). After two days, the only chlorinated products present were *cis* and *trans*-DCE and vinyl chloride. During the whole period, there was no degradation of *trans*-DCE, a little of cis and slightly more of vinyl chloride. The apparent low results for cis-DCE of the M4HA bottle seems to be an analytical anomaly, because, as can be seen in the tabulated results, the concentrations calculated on the FID were closer to those of the two other high replicates. Similarly, the methane and ethene formed remained stable once formed, except for D and E after 7 and 15 days respectively.

No losses in citrate were observed over a 28 day period, however by day 7 the microcosms had lost their reducing conditions as was apparent by a colorless, as opposed to brown, supernatant. To restore reducing conditions, 10 mL of the supernatant was removed and replaced with a fresh sterile concentrate of Ti(III)-citrate, hence the increase in citrate noted on day 16. Sterility appeared to be maintained in all but two of the microcosms, M4LD and M4LE, in which glucose degradation products, acetate and formate, were detected by days 7 and 28, respectively. Lactate was not detected despite the complete removal of glucose. In addition, CO_2 was measurable solely in M4LD and M4LE.

This confirms that the reductive dechlorination reaction that was observed in the other vitamin B12 containing microcosms was indeed abiotic and that the later losses when glucose was present were attributable to venting to the gas phase. This also means that the vitamin B12 catalyzed reaction is not very effective in degrading *cis* and *trans*-DCE in this situation.

6. *Microcosm 5 (glucose)*

The purpose of this microcosm was to find out if the bacteria occurring naturally at the site could induce reductive dechlorination when given a carbon source.

Summary Microcosm 5

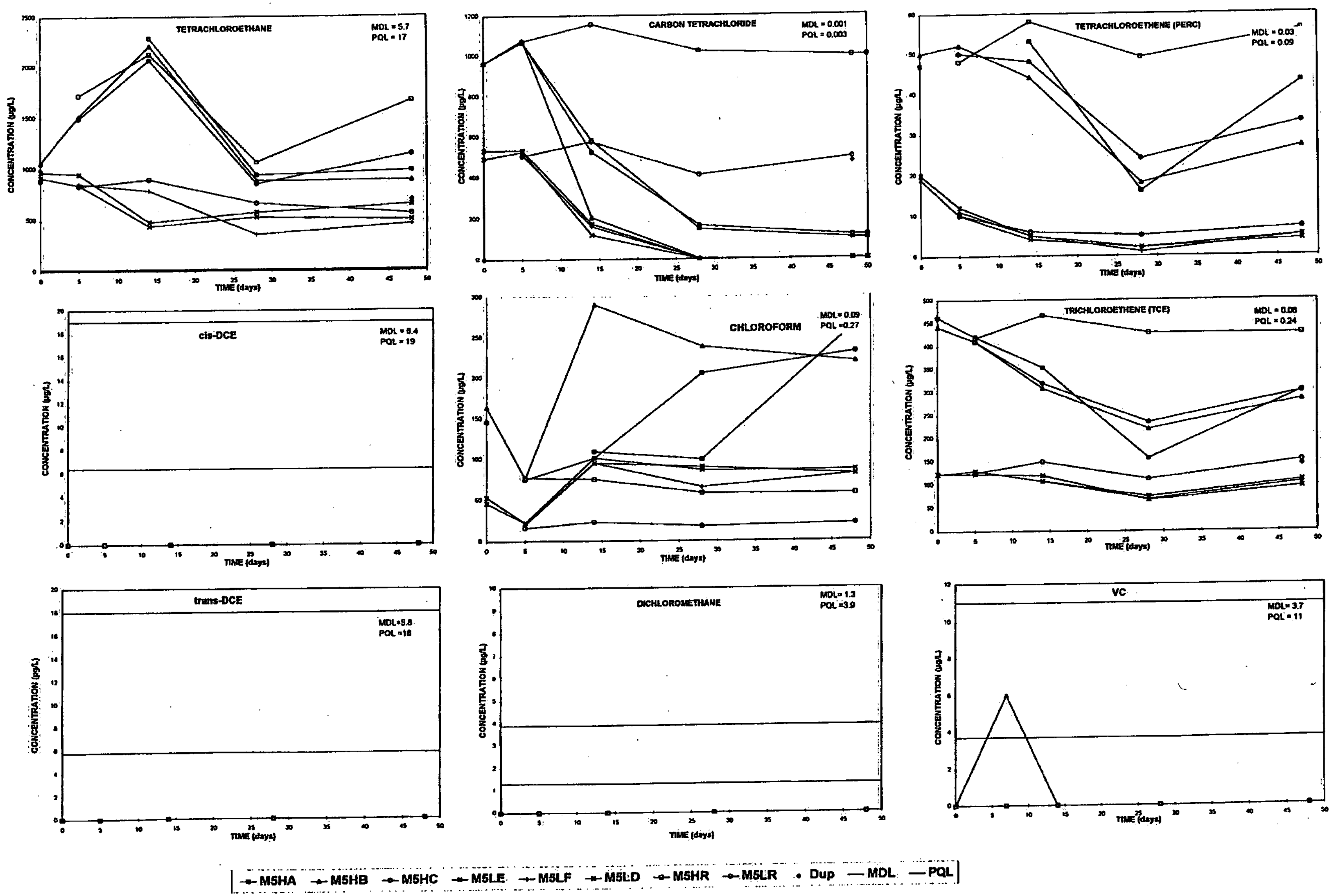


Figure 9

Summary Microcosm 5

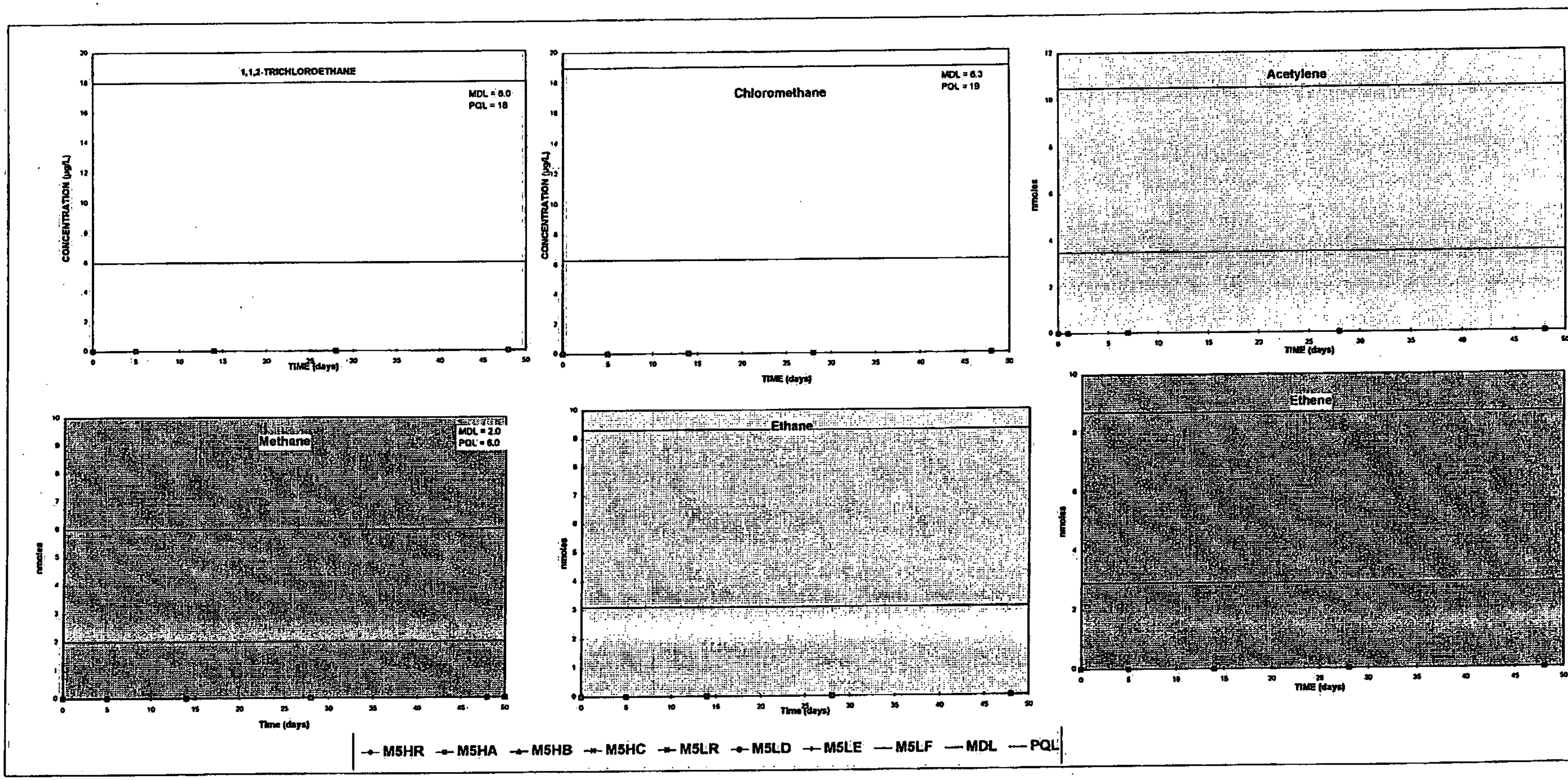


Figure 9

The results are shown on Figure 9. As expected, for the first few days, no reaction occurred. After 14 days a flocculate type growth was visible in the microcosms while glucose concentrations were beginning to decrease, with consequent production of lactate, acetate, formate and CO_2. As these microcosms were meant as a control for chloride, glucose was re-spiked at day 15 in accordance to its addition to M1a and M2 microcosms. It appeared however, that bacterial activity was lost shortly after this time as glucose concentrations remained stable over the next 28 days. This cease in growth was likely a result of inhibitory low pH values as the initial pH of the site water, 5, dropped to 4 by day 14, and between 3-4 by day 28.

After 14 days, the concentration of carbon tetrachloride started to drop with a concurrent increase in chloroform. There was no effect on any of the other chlorinated compounds and the chloroform was not degraded further, even after 48 days. Therefore, it is unlikely that the sole addition of a carbon source will be sufficient to produce conditions where the site contaminants will be biodegraded.

7. *Microcosm 6 (vitamin B12, titanium citrate and glucose, yeast extract added after 2 days)*

The purpose of this treatment was to try to induce methanogenic conditions after most of the chlorinated ethanes had been removed by the vitamin B12 treatment. This was to verify if the lack of intrinsic remediation at the site was due to the toxicity of some of the compounds to bacteria. The toxicity of trichloroethane and of chloroform to methanogens has been well documented.

Therefore for the first two days, the conditions were virtually identical to those in M1a, except that the titanium was higher due to some variability in the strength of the titanium oxalate solution. The results (Figure 10) were virtually identical as well. TeCA, carbon tetrachloride, chloroform and PERC disappeared within hours, and the TCE within one day. The measured half-lives were 15 and 48 min for PERC in the low and high site

Summary M6

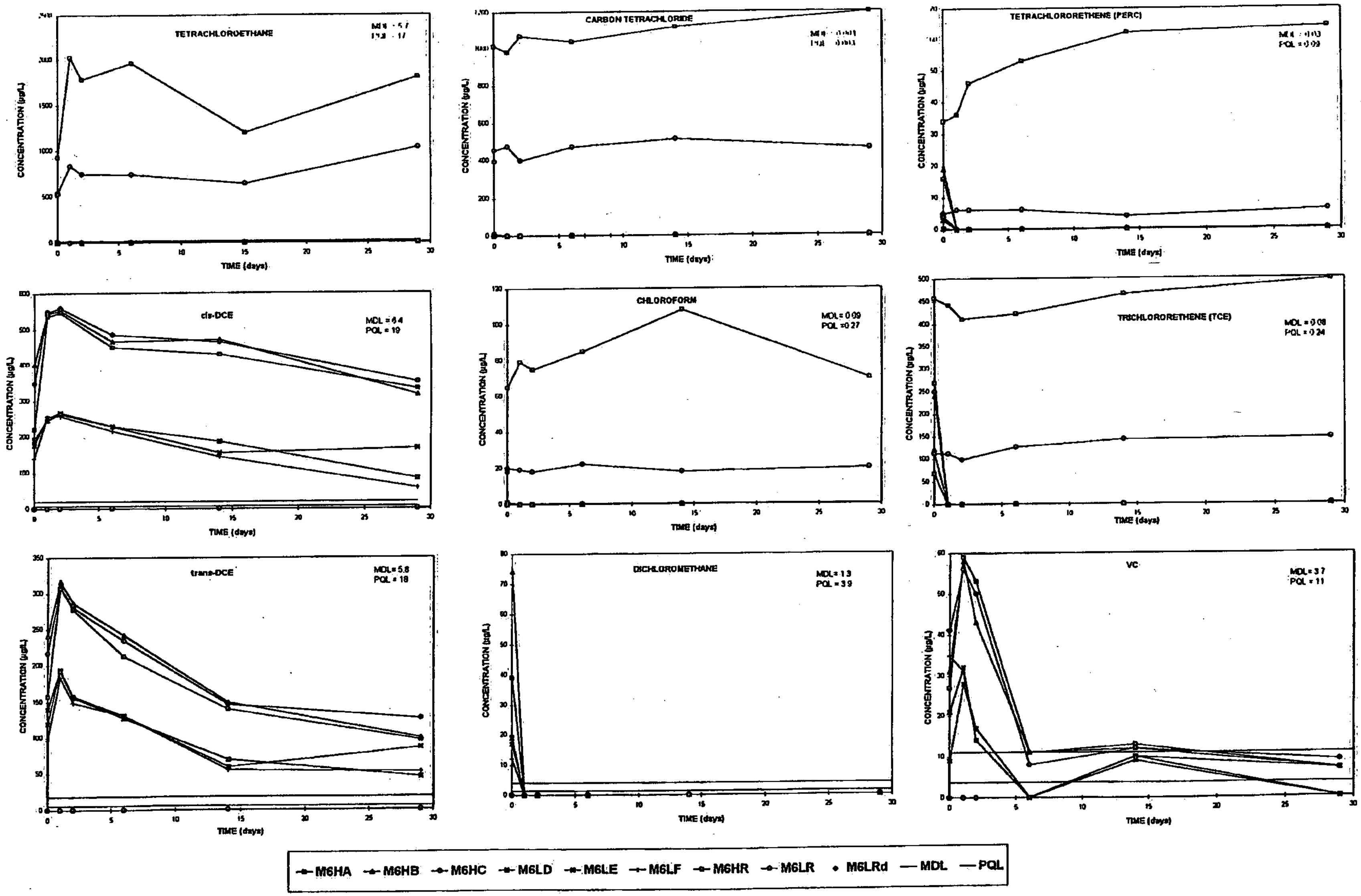


Figure 10

Summary M6

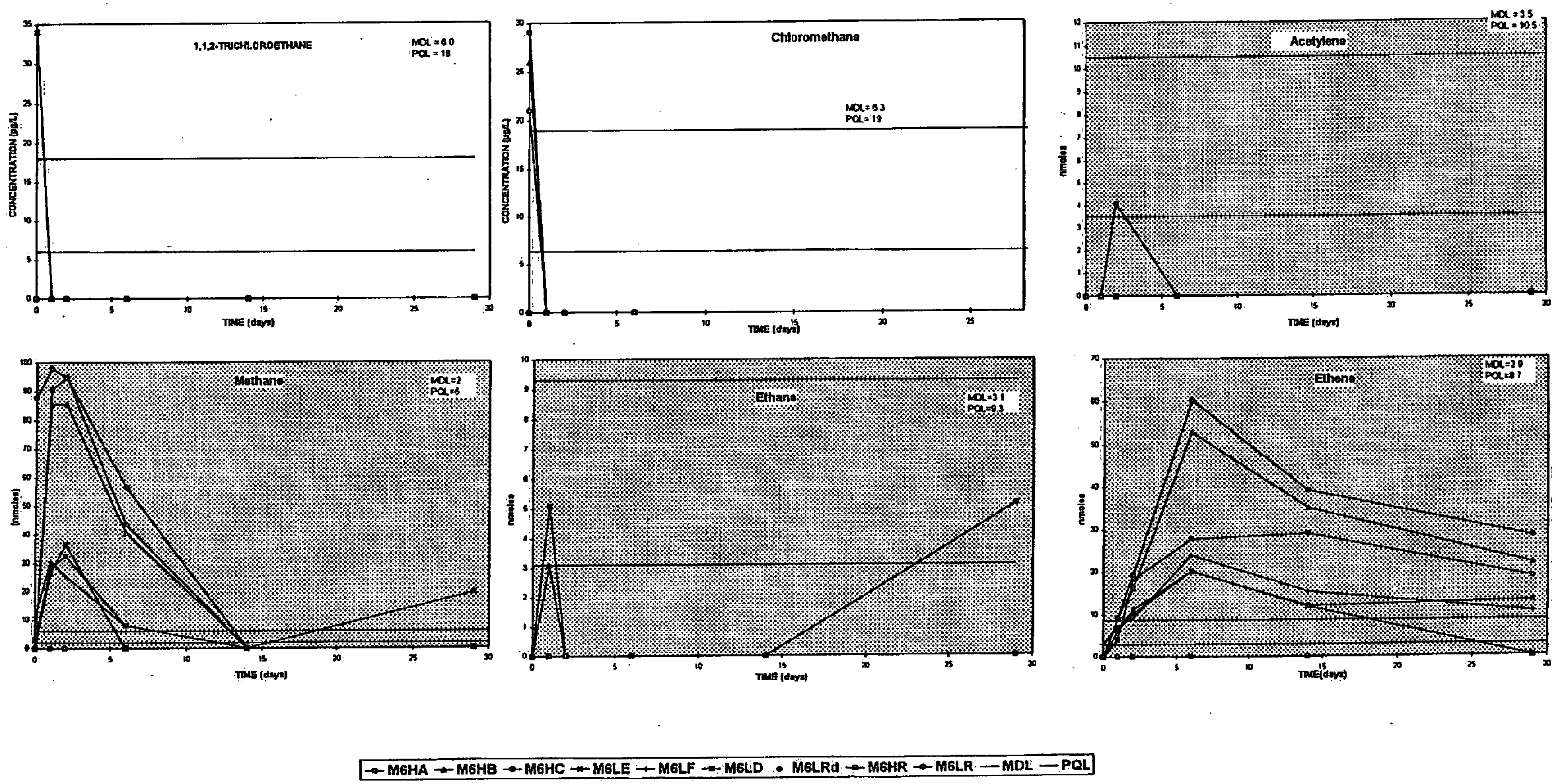


Figure 10

water and 2.4 (low) and 3.5 (high) hours for TCE. Therefore, when yeast extract was added, there were only *cis* and *trans*-DCE and vinyl chloride left to degrade.

The added glucose in M6 was sufficient to prevent citrate utilization for more than 14 days with losses notable in four of six of the microcosms on day 29. Degradation of glucose however, resulted in the generation of much more CO_2 than in the microcosms lacking glucose. Glucose metabolism is generally to lactate with smaller amounts of acetate and ethanol produced, while acetate is the major product of citrate degradation with no lactate being formed. High acetate concentrations coincided with those microcosms in M6 that exhibited significant citrate degradation by day 29. As formate is also generated from glucose, concentrations in M6 were double that of M3 and M8. The pH of the microcosms was relatively stable, between 7 and 8, over the course of monitoring.

Methanogenic conditions were not established within the 29 days of the study in this system. Since M6LE did exhibit a slight increase in methane on the last day, it was monitored again on day 50. The concentration of methane had doubled, without any significant effect on the concentration of the chlorinated compounds.

8. *Microcosm 7 (vitamin B12, new titanium chelate)*

The purpose of this set was to evaluate the reactivity and stability of a new product that was developed by a chemical company. The premise was that this would be just as reactive as titanium citrate, but hopefully not degraded as rapidly, hence it could dispense us of adding the glucose. Because there was a lot of uncertainty associated with this treatment it was only tried with Q52 water.

The method that was used to make up this solution was different than with citrate and resulted in the site water being brought to pH 12 for a few minutes. As can be seen on Figure 11, this was sufficient to transform all the TeCA to TCE. The half-life of TCE was 2.3 ± 0.8 days. The disappearance of carbon tetrachloride was too rapid to be measured (half-life < 5 min.) and that of PERC was 70 min. Very little vinyl chloride was formed and

Summary M7

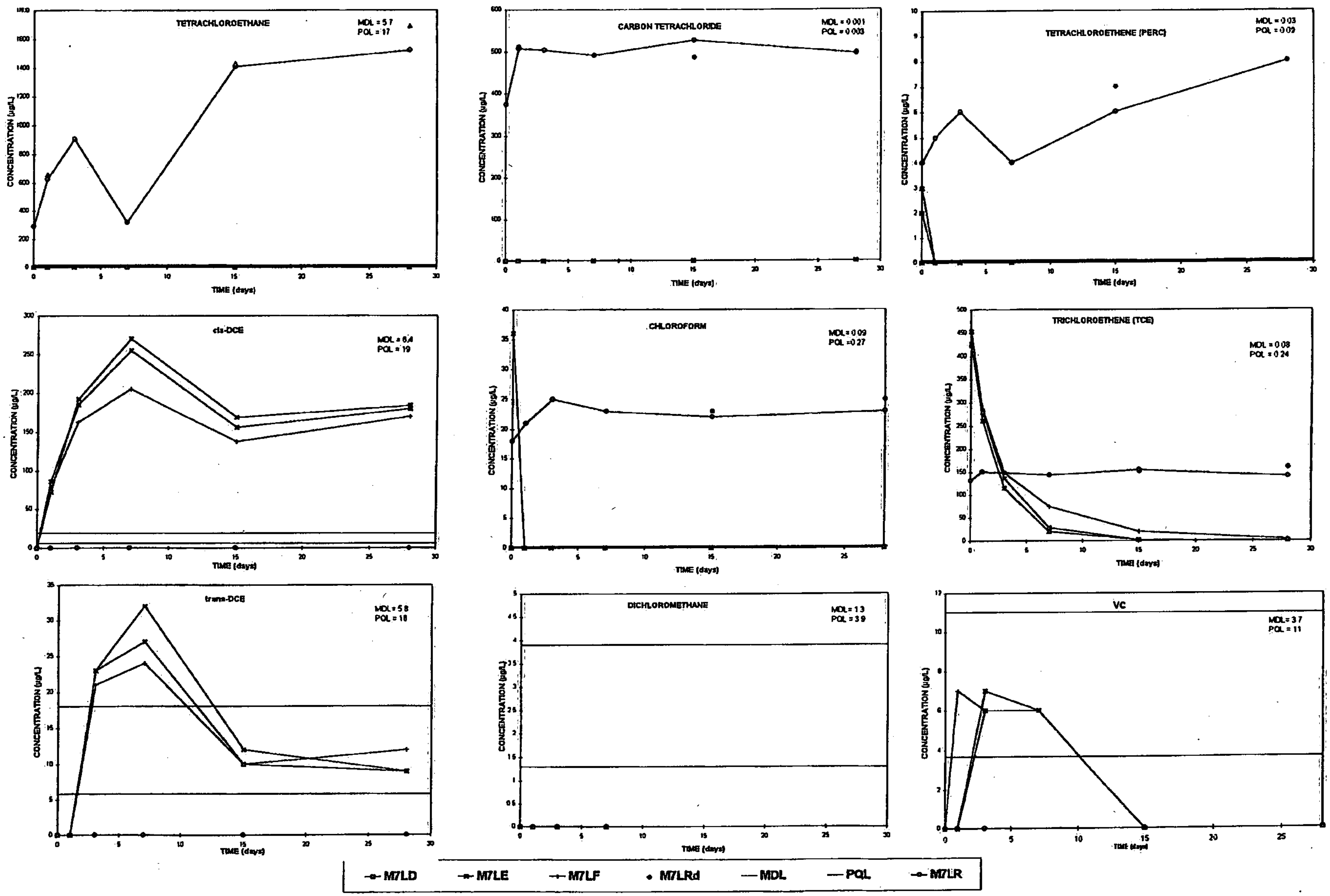


Figure 11

Summary M7

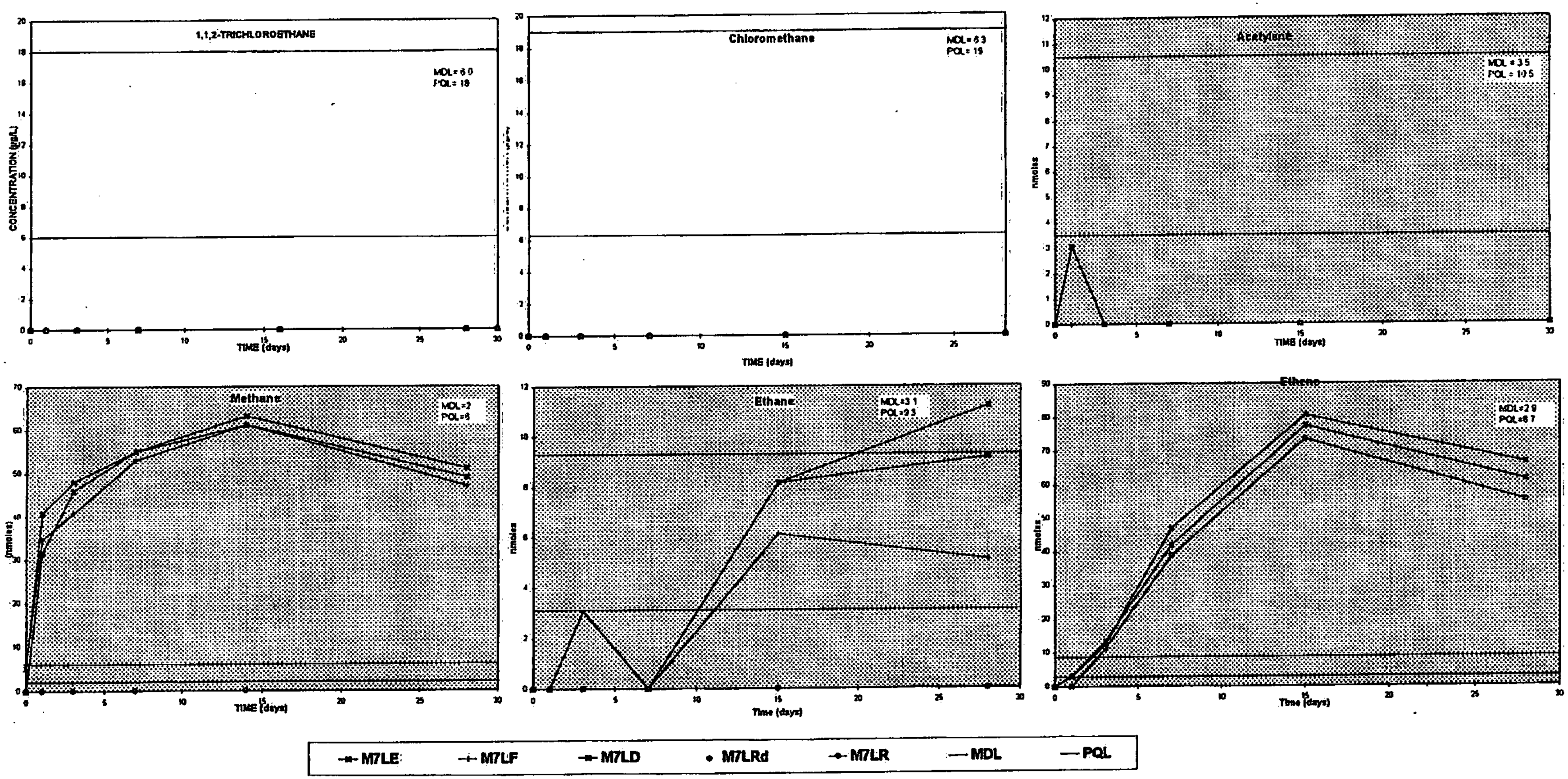


Figure 11

it was a transient species. The rate of formation of ethene was almost identical to the rate of degradation of TCE (k= 0.2 compared to -0.3 $days^{-1}$).

This chelate was chosen because it was anticipated to be less biodegradable than citrate, such that glucose amendments to the remedial solution would be unnecessary. As this compound was not measurable using the ion chromatography methods, its degradation could only be assessed by the appearance of degradation products that were measurable. Reducing conditions were maintained throughout the 28 day analysis period with the supernatant remaining dark and clear with visually no evidence of bacterial growth, such as clouding of the supernatant due to cell proliferation. On day 28 very small amounts of formate were measured, yet no other VFAs were detected. No gas generated in any of these microcosms.

Based on information for compounds with a similar chemical structure, this product is expected to have low toxicity and would be an excellent alternative to citrate. Because it is a metal chelating agent, however, there may be restrictions in its use in some areas because it could mobilize toxic metals. However, it is not yet commercially available. Therefore it was decided to continue to use citrate and glucose for the column study.

9. *Microcosm 8 (Titanium citrate, yeast extract, vitamin B12)*

This microcosm was added at the end, when it was noted that microcosm 3 had generated some methane but that the dechlorination was relatively slow. Since it is known that the anaerobic bacteria responsible for dechlorination require vitamin B12 as a growth factor, it was decided to try this combination. In addition, the presence of vitamin B12 would cause a rapid abiotic dechlorination of chloroform, carbon tetrachloride and tetrachloroethane that may have inhibitory effects on this microbial population. Only low site water was used for this set.

The results (Figure 12) were very similar to those of M4, the sterile control, in that there was no loss of cis and trans-DCE to the gas phase. However, since glucose had not been added, not all the TCE was degraded because citrate was lost after one day. The half-

Summary M8

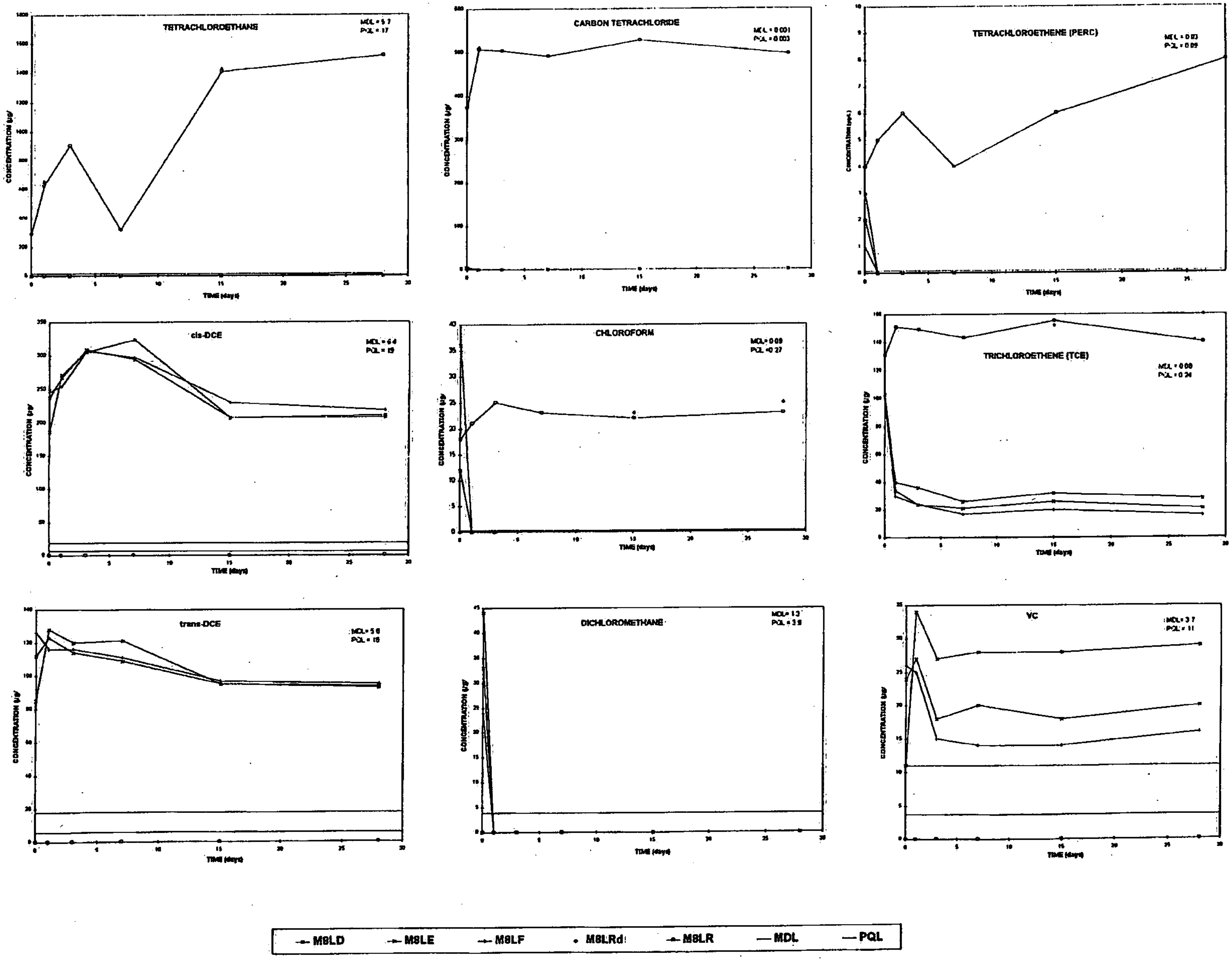


Figure 12

Summary M8

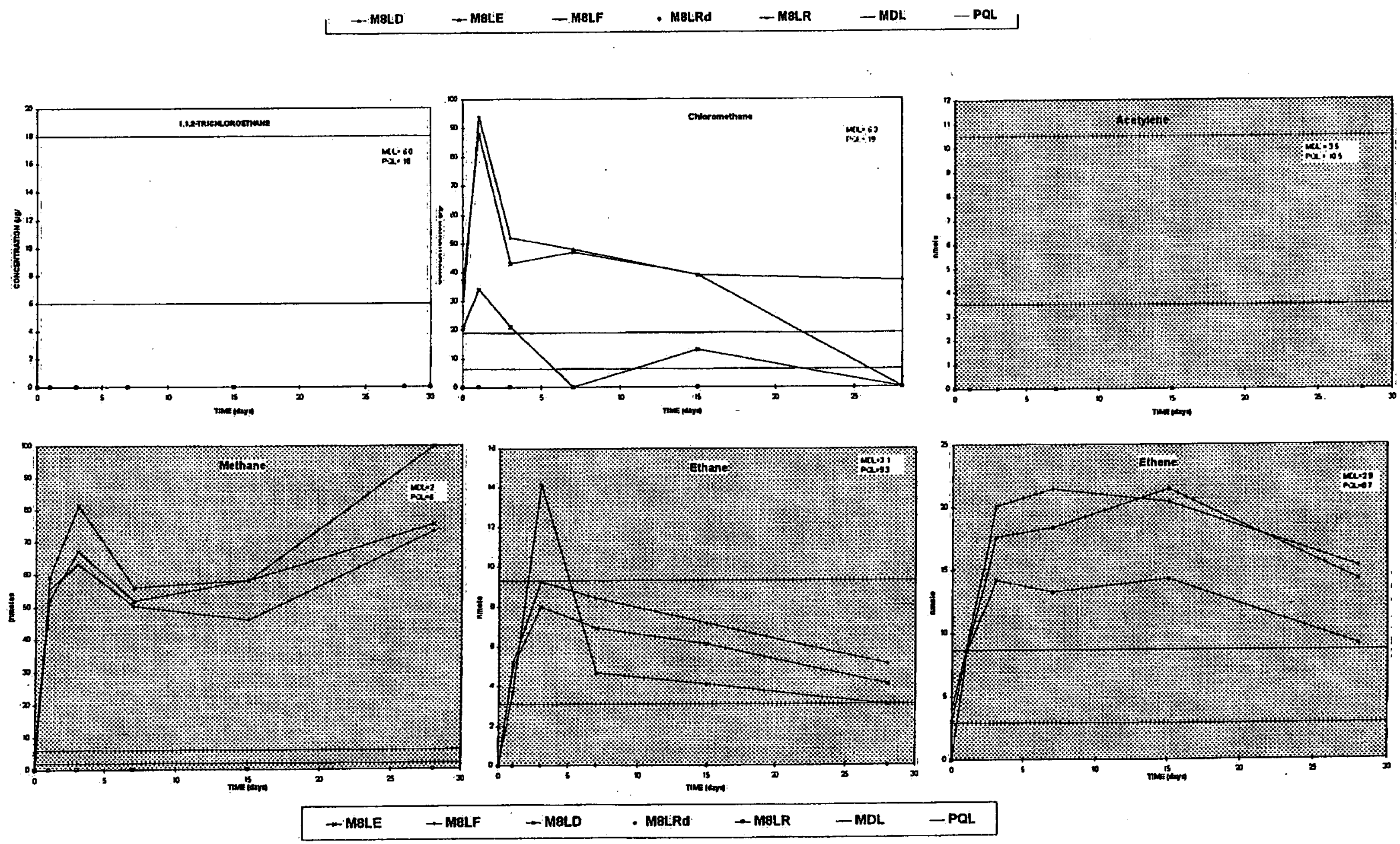


Figure 12

life for PERC was 65 min, whereas for TCE it was 1.4 ± 0.25 days, if the first 3 days of data only are considered. The results were also comparable to the first few days of M6, save the TCE. When compared to M3 (yeast extract and titanium citrate), the difference was in the B12-catalyzed degradation of PCE, TCE and TeCA. The amount of methane formed after 28 days was not higher than in M3 and could still all be attributed to the degradation of carbon tetrachloride (maximum potential of 320 nmoles/bottle) and not to methanogenesis.

As predicted, without glucose amendments, citrate was degraded rapidly to less than PQL by day 3 (Figure 3). CO_2 generation was strong until citrate was completely utilized and then was negligible for the remainder of the monitoring period. Acetate concentrations were in excess of 4 g/L upon complete degradation of citrate. Formate was generated also from citrate but it appeared that the bacteria were utilizing it as concentrations were decreasing over the last 2-3 weeks of analyses. The pH remained between 7 and 8, over the whole incubation period.

In summary, the presence of vitamin B12 did not significantly impact the methanogenesis or the rate of dechlorination in these microcosms. The absence of glucose resulted in the rapid disappearance of citrate, stopping the degradation of TCE.

10. Post-microcosm reactions

After the end of the incubation period, the supernatant was transferred to 40 mL volatile vials and 10 mLs were sampled with an autosampler for purge-and-trap GC/MS analysis to confirm the presence/absence of target compounds for which the MDL was below the MAC using the SRI GC, and to identify other compounds formed.

After a 11 days, the headspace was sampled again and analysed for *cis* and *trans*-DCE using the Photovac. The results are therefore semi-quantitative. In many of the bottles of M1a, the ratio of *trans/cis* DCE had decreased significantly and some new early eluting peaks, having the same retention time as acetone and ethanol were formed. After three more days, *trans*-DCE was at the detection limit in one of the bottles. A month later, *cis* and *trans*-DCE had disappeared completely. This did not happen at the same rate in all the microcosms. The same phenomenon was observed in M4. After 45 days, *cis* and *trans*-DCE had decreased in M4LF and M4HB. Two weeks later their concentration was low in all but one (M4HC). The glucose was gone in all of them, but not the citrate. Acetate and formate was high in all, and propionate disappeared. The Eh was negative in all of them. There was no correlation between the concentration of the fatty acids and the disappearance of *cis* and *trans*-DCE. It is therefore possible that bioremediation will occur in the aquifer after the vitamin B12 treatment. The column experiments will provide a better indication of this possibility.

IV. Conclusions

This series of experiments showed that the vitamin-B12/titanium citrate reaction was effective in treating all the compounds present in the Graces Quarter site. The rate of degradation of the chlorinated ethanes and of tetrachloroethene was very rapid. The final products were *cis* and *trans*-DCE which remained above their maximum acceptable concentration after 28 days. There was no difference in reaction rates between high and low site water. The addition of titanium citrate alone, without vitamin B12, did degrade some of the contaminants, but at a much reduced rate. The γ-irradiated control showed that most of the dechlorination observed was abiotic. The degradation of glucose under these anaerobic conditions produced large amounts of CO_2, which contributed to the removal of some of the chlorinated products.

V. References

Lesage, S., Brown, S. and K. Millar. 1996. "Vitamin B_{12}-Catalyzed Dechlorination of Perchloroethylene present as Residual DNAPL" *Groundwater Monitoring and Remediation,* Fall issue, 76-85.

Lesage, S., Brown, S. and K. Millar 1997. "Method for Dehalogenating Contaminated Water and Soil" U.S. Patent 5,645,374. Date of issue: July 8, 1997.

Millar, K. and S. Lesage. 1997. "Bio-compatibility of the Vitamin B_{12}-catalyzed Reductive Dechlorination of Tetrachloroethylene". In: *In Situ* and On-Site Bioremediation, B. Alleman and A. Leeson, chairs. *Proceedings of the Fourth International Symposium on In Situ and On Site Bioremediation*, New Orleans, Louisiana, April 28-May 1, 1997. Vol 4(4), 471-477.

VI. Appendix A

Microcosm 1a

Vitamin B12, titanium citrate, glucose

Microcosm 2

Titanium citrate, glucose

Microcosm 3

Titanium citrate, yeast extract

Microcosm 4

Irradiated, vitamin B12, titanium citrate, glucose

Microcosm 5

Glucose

Microcosm 6

Vitamin B12, titanium citrate, glucose, yeast at day 3

Microcosm 7

Alternate chelator and titanium, vitamin B12

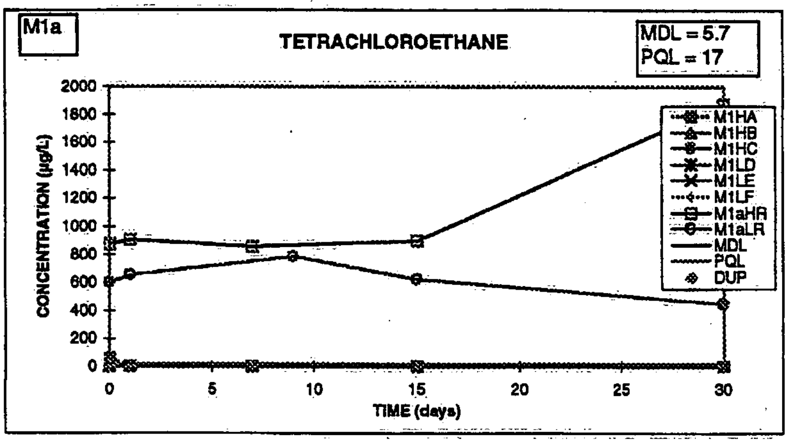
Microcosm 8

Vitamin B12, titanium citrate, yeast extract

Tetrachloroethane (TeCA) **Microcosm 1a**

Result concentration in µg/L

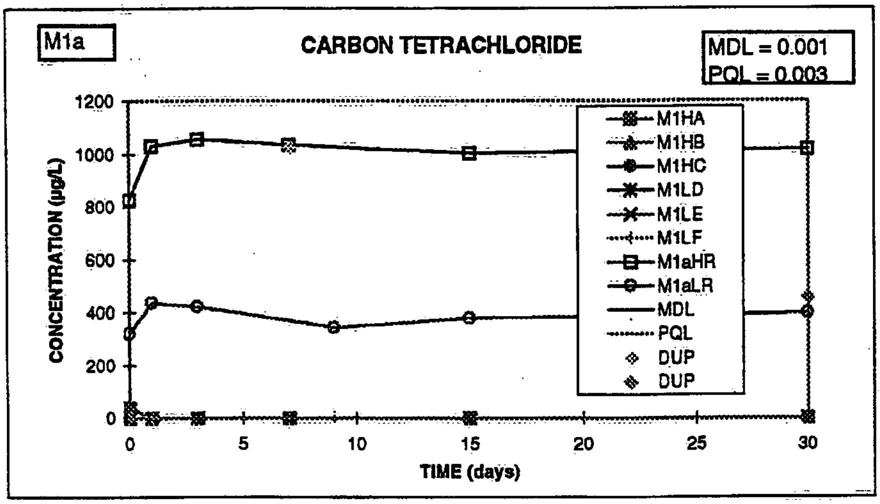
SITE WATER	2114					695				
Time	M1aHR	M1HA	M1HB	M1HC	M1aLR	M1LD	M1LE	M1LF	M1aLRd	r^2 (if< 0.99)
0	875	61			601	n.d.				0.82 (when including initial calibration data)
0.04			n.d.				n.d.			
0.08				n.d.				n.d.		
1	908	n.d.	n.d.	n.d.	656	n.d.	n.d.	n.d.		
7	858	n.d.	n.d.	n.d.		n.d.	n.d.	n.d.		
9					786					
15	895	n.d.	n.d.	n.d.	624	n.d.	n.d.	n.d.		0.951
30	1875	n.d.	n.d.	n.d.	449	n.d.	n.d.	n.d.	456	



Carbon tetrachloride **Microcosm 1a**

Result concentration in µg/L

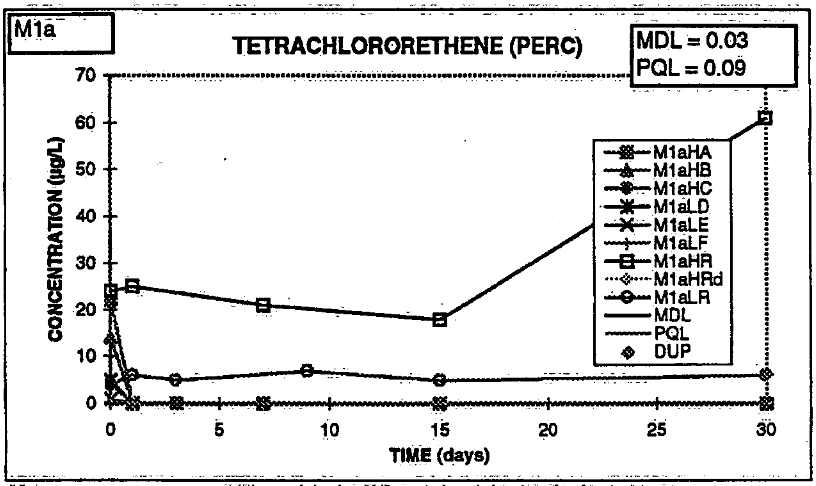
SITE WATER		904				364				
Time	M1aHR	M1HA	M1HB	M1HC	M1aLR	M1LD	M1LE	M1LF	M1HRd	M1aLRd
0	825	41			319	n.d.				
0.04			n.d.				n.d.			
0.08				n.d.				n.d.		
1	1029	n.d.	n.d.	n.d.	435	n.d.	n.d.	n.d.		
3	1055	n.d.	n.d.	n.d.	421	n.d.	n.d.	n.d.		
7	1035	n.d.	n.d.	n.d.		n.d.	n.d.	n.d.	1024	
9					344					
15	1004	n.d.	n.d.	n.d.	378	n.d.	n.d.	n.d.		
30	1017	n.d.	n.d.	n.d.	398	n.d.	n.d.	n.d.		390



TETRACHLORORETHENE (PERC) **Microcosm 1a**

Result concentration in µg/L

	M1aHR	M1aHA	M1aHB	M1aHC	M1aLR	M1aHD	M1aHE	M1aHF	M1aLRd	r^2 (if < 0.99)
SITE WATER		35				6				
Time	M1aHR	M1aHA	M1aHB	M1aHC	M1aLR	M1aHD	M1aHE	M1aHF	M1aLRd	r^2 (if < 0.99)
0	24	22			4	5				0.97
0.04			14				1			0.93 (lowest range)
0.08				4				0.4		
1	25	n.d.	n.d.	n.d.	6	n.d.	n.d.	n.d.		0.96
3		n.d.	n.d.	n.d.	5	n.d.	n.d.	n.d.		
7	21	n.d.	n.d.	n.d.		n.d.	n.d.	n.d.		0.96
					7					
15	18	n.d.	n.d.	n.d.	5	n.d.	n.d.	n.d.		0.902; 0.982
30	61	n.d.	n.d.	n.d.	6	n.d.	n.d.	n.d.	6	0.938

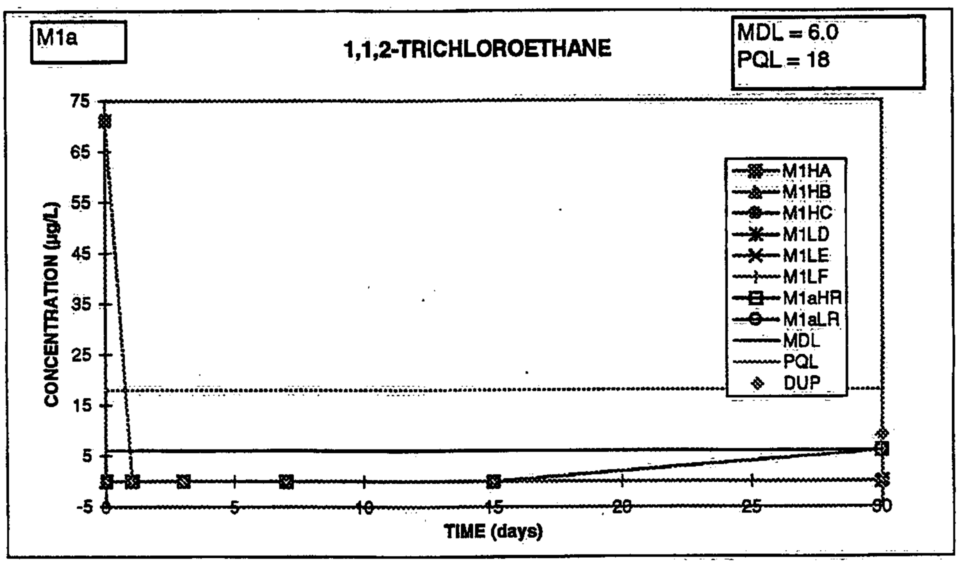


1,1,2- Trichloroethane **Microcosm 1a**

Result concentration in µg/L

SITE WATER

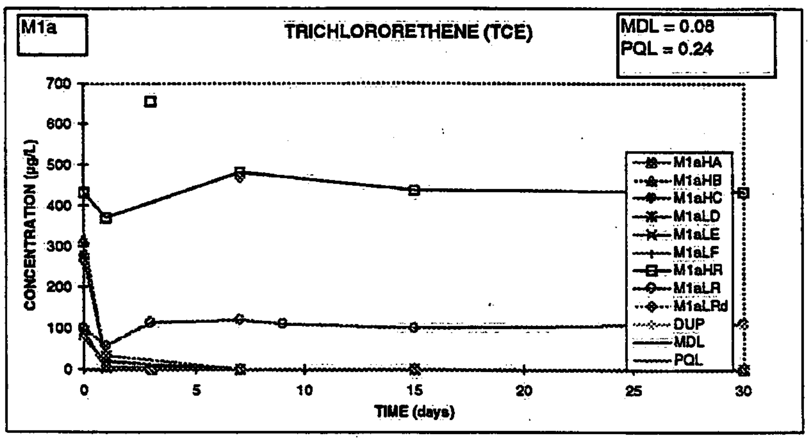
Time	M1aHR	M1HA	M1HB	M1HC	M1aLR	M1LD	M1LE	M1LF	M1aLRd
0	n.d.	71			n.d.	n.d.			
0.04			n.d.				n.d.		
0.08				n.d.				n.d.	
1	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	
3	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	
7	n.d.	n.d.	n.d.	n.d.		n.d.	n.d.	n.d.	
9					n.d.				
15	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	
30	6j	n.d.	n.d.	n.d. 6j		n.d.	n.d.	n.d. 9j	



TRICHLOROETHENE (TCE) **Microcosm 1a**

Result concentration in µg/L

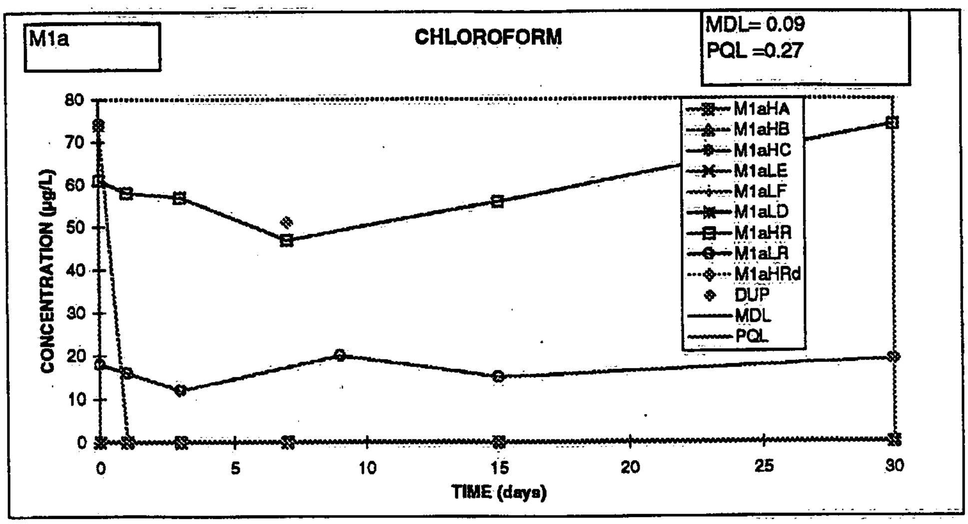
Time	M1aHR	M1aHA	M1aHB	M1aHC	M1aLR	M1aLD	M1aLE	M1aLF	M1aHRd	M1aLRd	r^2 (if not 0.99)
SITE WATER		197				86					
0	432	269			99	85					
0.04			319				93				
0.08				276				80			
1	371	32	17	18	57	6	4	3			.88 in calibration range B
3	656	n.d.	n.d.	n.d.	114	n.d.	n.d.	n.d.			
7	479	n.d.	n.d.	n.d.	119	n.d.	n.d.	n.d.	469		
9					110						
15	437	n.d.	n.d.	n.d.	99	n.d.	n.d.	n.d.			
30	434	n.d.	n.d.	n.d.	111	n.d.	n.d.	n.d.		109	



CHLOROFORM **Microcosm 1a**

Result concentration in µg/L

Time	M1aHR	M1aHA	M1aHB	M1aHC	M1aLR	M1aLD	M1aLE	M1aLF	M1aHRd	M1aLRd	r^2 (if<0.99)
SITE WATER		71				20					
0	61	74			18	n.d.					0.97
0.04			0.1				n.d.				
0.08				n.d.				n.d.			
1	58	n.d.	n.d.	n.d.	16	n.d.	n.d.	n.d.			0.967
3	57	n.d.	n.d.	n.d.	12	n.d.	n.d.	n.d.			
7	47	n.d.	n.d.	n.d.		n.d.	n.d.	n.d.	51		
9					20						
15	56	n.d.	n.d.	n.d.	15	n.d.	n.d.	n.d.			0.974
30	74	n.d.	n.d.	n.d.	19	n.d.	n.d.	n.d.		19	0.979

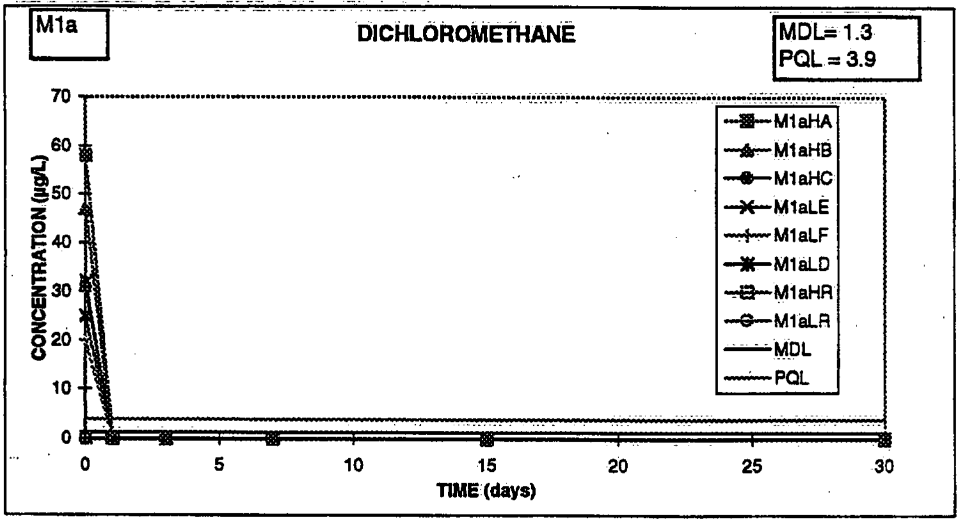


DICHLOROMETHANE **Microcosm 1a** MAC = 5 µg/L

Result concentration in µg/L

SITE WATER <PQL <PQL

Time	M1aHR	M1aHA	M1aHB	M1aHC	M1aLR	M1aLD	M1aLE	M1aLF
0	n.d.	58			n.d.	32		
0.04			47				25	
0.08				31				20
1	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
3	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
7	n.d.	n.d.	n.d.	n.d.		n.d.	n.d.	n.d.
9					n.d.			
15	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
30	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.

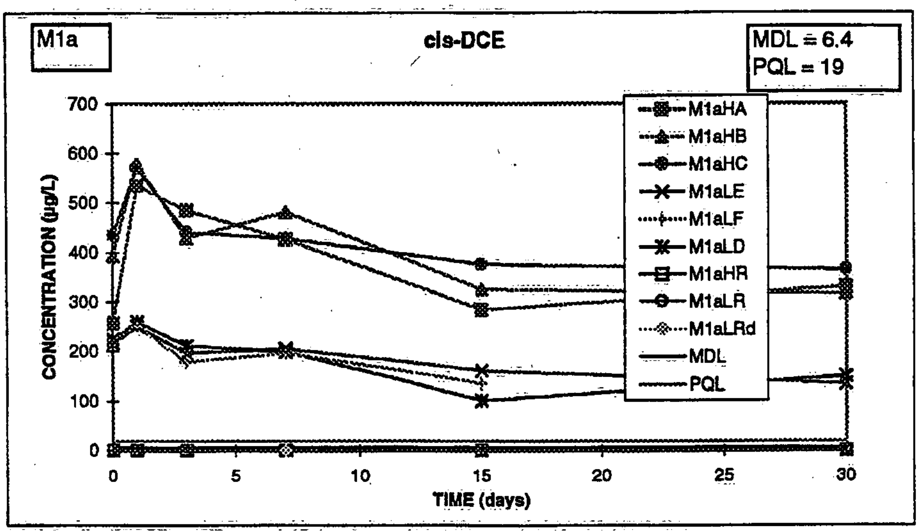


cis-DICHLOROETHENE **Microcosm 1a** MAC = 70 µg/L

Result concentration in µg/L

SITE WATER <PQL <PQL

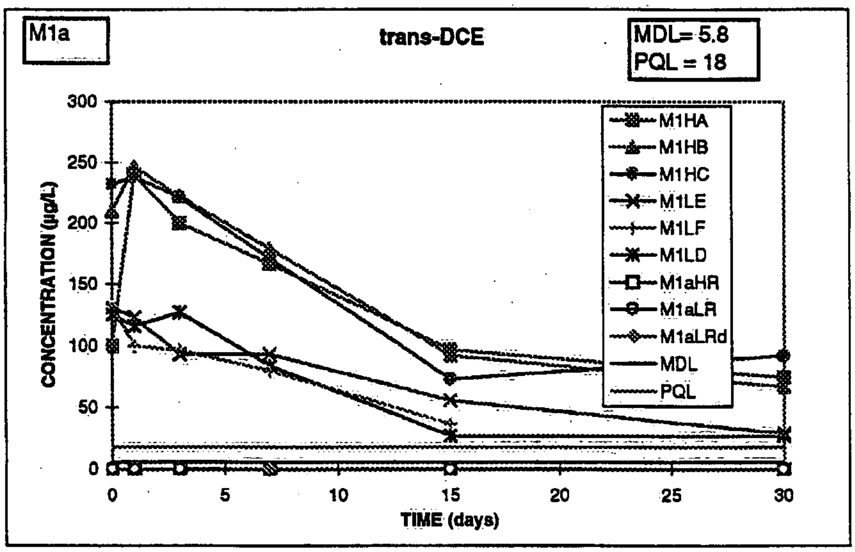
Time	M1aHR	M1aHA	M1aHB	M1aHC	M1aLR	M1aLD	M1aLE	M1aLF	M1aHRd	M1aLRd
0	n.d.	257			n.d.	224				
0.04			392				215			
0.08				434				223		
1	n.d.	535	580	571	n.d.	260	251	251		
3	n.d.	485	429	440	n.d.	211	196	179		
7	n.d.	427	481	428		199	205	196	n.d.	
9					n.d.					
15	n.d.	284	325	376	n.d.	101	161	135		
30	n.d.	331	317	365	n.d.	149	134	*exploded*		n.d.
Predicted for day 15 Based on venting day 30		304	333	300		147	198	139		



Trans-DICHLOROETHENE **Microcosm 1a** MAC = 100 µg/L

Result concentration in µg/L

Time	M1aHR	M1HA	M1HB	M1HC	M1aLR	M1LD	M1LE	M1LF	M1aHRd
SITE WATER	<PQL					<PQL			
0	n.d.	100			n.d.	125			
0.04			210				131		
0.08				232				133	
1	<PQL	240	246	238	n.d.	116	123	100	
3	n.d.	200	222	221	n.d.	127	93	96	
7	n.d.	167	179	171		84	93	80	n.d.
9					n.d.				
15	n.d.	97	92	73	n.d.	27	56	37	
30	n.d.	75	67	92	n.d.	27	29		
Predicted for day 15 Based on venting		70	68	68		40	87	33	



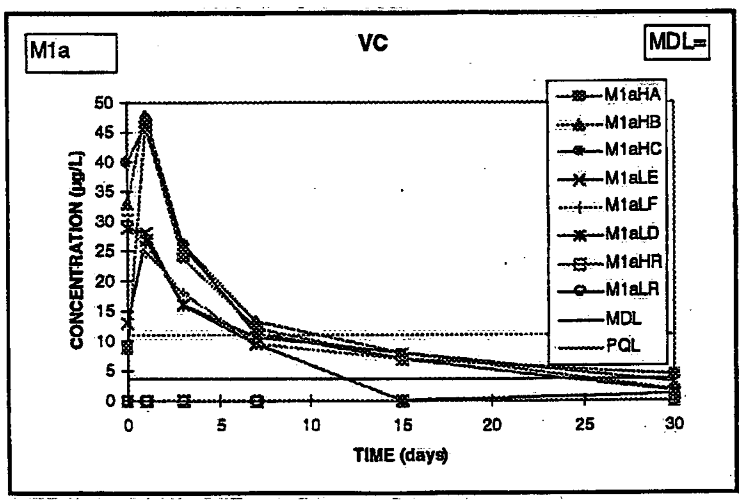
VINYL CHLORIDE (VC) **Microcosm 1a** PQL = 11 µg/L

Result concentration in µg/L

SITE WATER <PQL <PQL

Time	M1aHR	M1aHA	M1aHB	M1aHC	M1aLR	M1aLD	M1aLE	M1aLF	M1aHRd
0	n.d.	9			n.d.	13			
0.04			33				29		
0.08				40				31	
1	n.d.	46	48	46	n.d.	27	28	25	
3	n.d.	24	26	26	n.d.	16	16	18	
7	n.d.	12.1	13.3	11.2		9.5j	10.7j	9.5j	n.d.
9					n.d.				
15	n.d.	7j	8j	7j	n.d.	n.d.	8 j	7 j	
30	n.d.	4.9j	1.9j	1.5j	n.d.	1 j	3.0 *exceeded MS analysis		

Predicted value								
Day 15		n.d	n.d.	n.d.		n.d.	n.d	n.d.

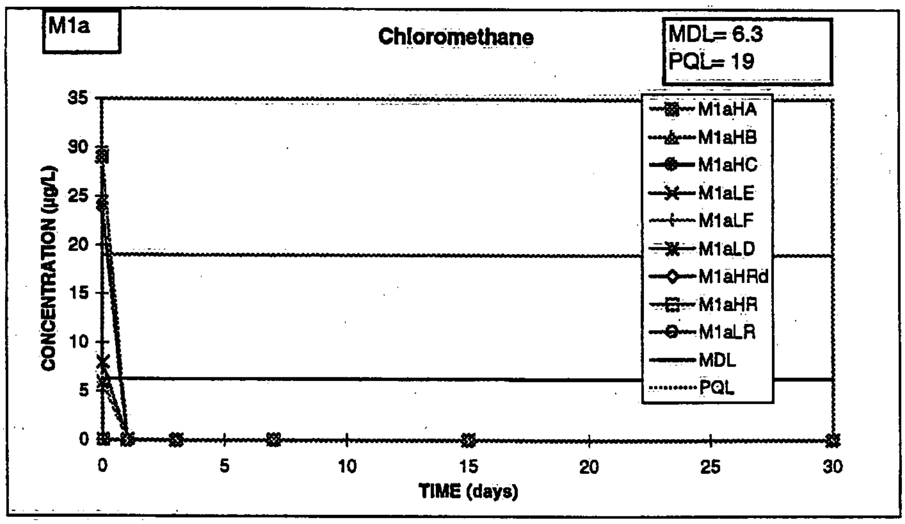


CHLOROMETHANE **Microcosm 1a**

Result concentration in µg/L

SITE WATER <PQL <PQL

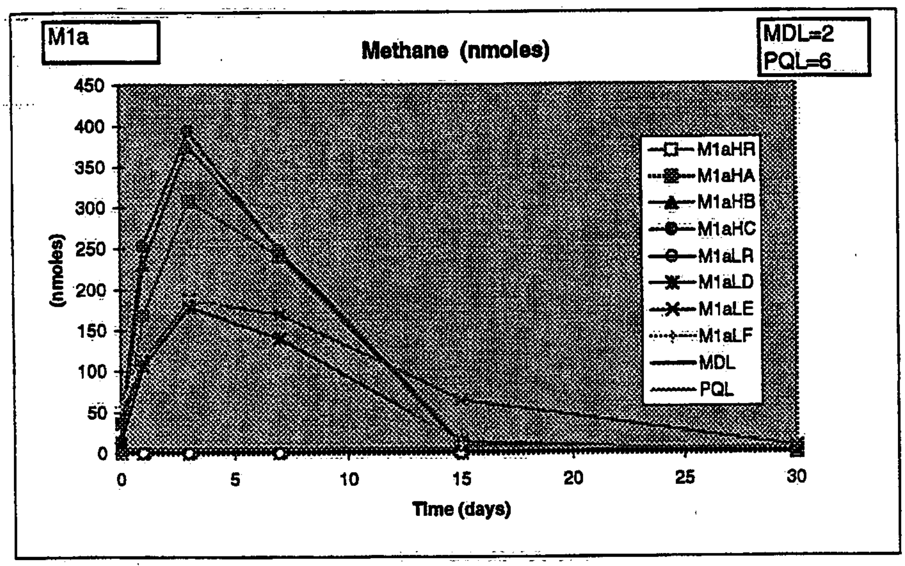
Time	M1aHR	M1aHA	M1aHB	M1aHC	M1aLR	M1aLD	M1aLE	M1aLF
0	n.d.	29			n.d.	6j		
0.04			29				8j	
0.08				24				6j
1	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
3	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
7	n.d.	n.d.	n.d.	n.d.		n.d.	n.d.	n.d.
9					n.d.			
15	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
30	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.



METHANE **Microcosm 1a**

SITE WATER	<PQL					<PQL			
				RESULTS in ppmv					
Time	M1aHR	M1aHA	M1aHB	M1aHC	M1aLR	M1aLD	M1aLE	M1aLF	M1aLRd
0	n.d.	8			2	13			
0.04			18				36		
0.08				35				56	
1	n.d.	166	226	249	n.d.	105	113	120	
3	n.d.	303	369	388	n.d.	176	185	188	
7	n.d.	150	191	122	n.d.	76	125	93	n.d.
15	n.d.	5j	4j	5j	n.d.	8	55	4j	
28	2j	n.d.	n.d.	n.d.	n.d.	n.d.	3j		

note volume is higher than 25 mL because of degassing
Predicted that all would be removed by venting

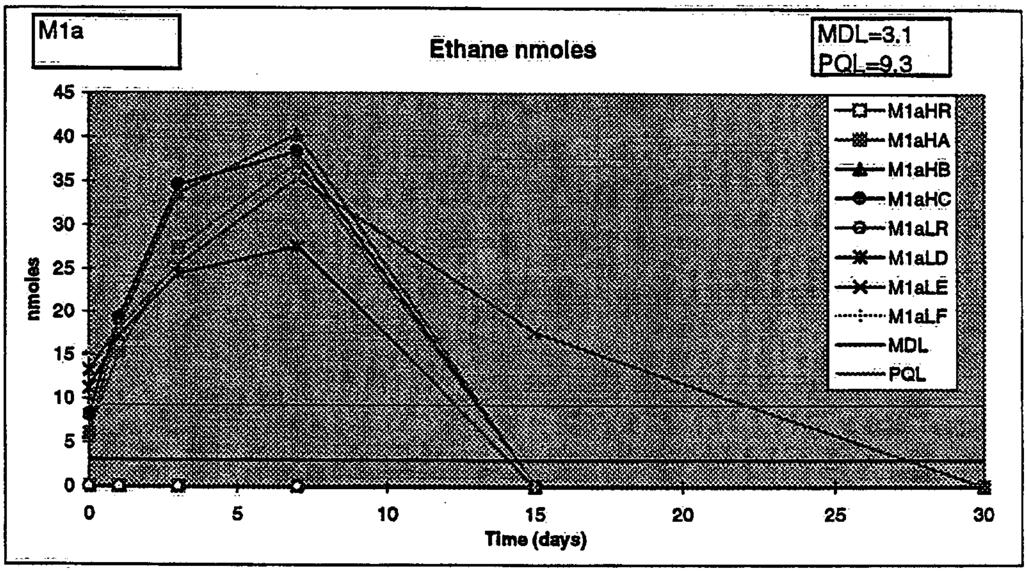


ETHANE **Microcosm 1a**

SITE WATER <PQL <PQL

Results in ppmv

Time	M1aHR	M1aHA	M1aHB	M1aHC	M1aLR	M1aLD	M1aLE	M1aLF	M1aLRd
0	n.d.	6			n.d.	11			
0.04			6				13		
0.08				8				15	
1	n.d.	15	18	19	n.d.	17	18	18	
3	n.d.	27	33	34	n.d.	24	25	26	
7	n.d.	23	31	19	n.d.	15	26	21	n.d.
15	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	15	n.d.	
30	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	*exploded*	



ETHENE **Microcosm 1a**

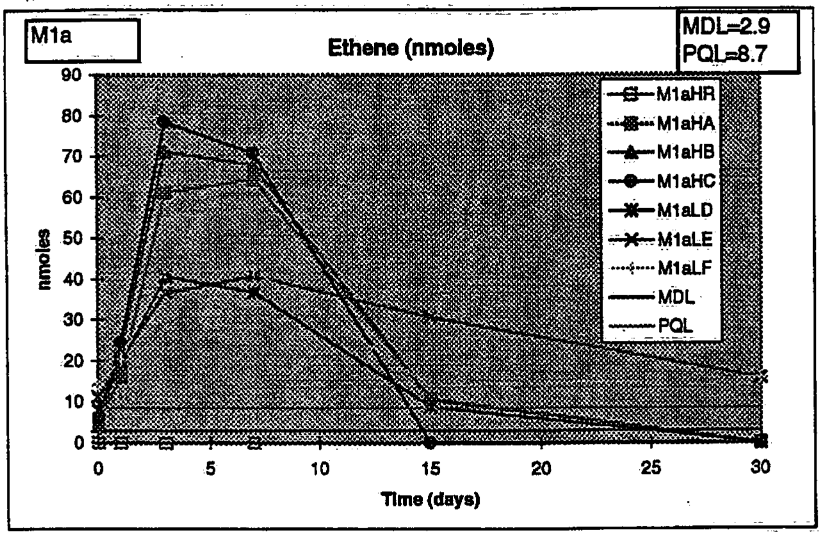
SITE WATER <PQL <PQL

Results in ppmv

Time	M1aHR	M1aHA	M1aHB	M1aHC	M1aLR	M1aLD	M1aLE	M1aLF	M1aLRd
0	n.d.	5			n.d.	8			
0.04			4				11		
0.08				6				14	
1	n.d.	16	22	24	n.d.	19	20	20	
3	n.d.	60	70	77	n.d.	40	36	41	
7	n.d.	40	52	35	n.d.	20	30	25	n.d.
15	n.d.	5j	4j	n.d.	n.d.	5j	26	5j	
30	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	6J *exploded*		

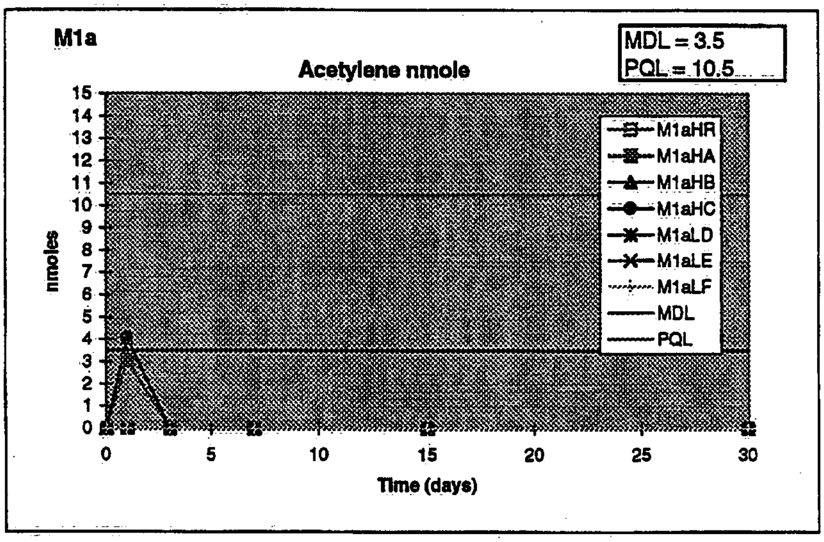
note volume has changed because of degassing

	M1aHA	M1aHB	M1aHC	M1aLD	M1aLE	M1aLF
Predicted for day 15 Based on venting	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.



ACETYLENE **Microcosm 1a**

SITE WATER	<PQL					<PQL			
				Results in ppmv					
Time	M1aHR	M1HA	M1HB	M1HC	M1aLR	M1LD	M1LE	M1LF	M1aLRd
0	n.d.	n.d.			n.d.	n.d.			
0.04			n.d.				n.d.		
0.08				n.d.				n.d.	
1	n.d.	3	4	4	n.d.	n.d.	n.d.	n.d.	
3	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	
7	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
15	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	
30	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	*exploded*	



Lactate conc. (mg/L)

day	M1aLD	M1aLE	M1aLF	M1aHA	M1aHB	M1aHC
0	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
1	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
3	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
7	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
15	597	287	555	597	588	631
30	1501	984	1475	1386	1153	1588

Formate conc. (mg/L)

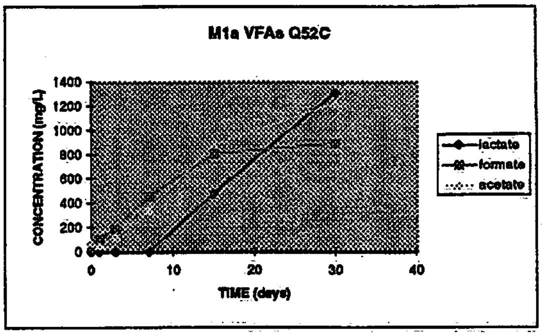
day	M1aLD	M1aLE	M1aLF	M1aHA	M1aHB	M1aHC
0	38	40	39	41	37	37
1	123	100	92	65	68	71
3	190	192	208	171	182	212
7	427	481	489	420	375	472
15	649	1086	675	731	700	718
30	758	1319	618	702	681	782

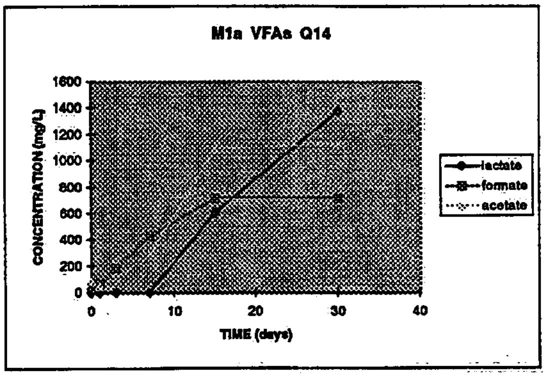
Acetate conc. (mg/L)

day	M1aLD	M1aLE	M1aLF	M1aHA	M1aHB	M1aHC
0	93	n.d.	62	n.d.	85	86
1	60	53	50	n.d.	50	48
3	128	114	134	118	116	101
7	355	298	379	309	158	375
15	1056	637	961	1096	1106	1062
30	1365	759	1541	1100	1165	1139

Propionate conc. (mg/L)

day	M1aLD	M1aLE	M1aLF	M1aHA	M1aHB	M1aHC
0	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
1	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
3	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
7	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
15	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
30	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.





Titanium conc. (mM)

day	M1aLD	M1aLE	M1aLF	M1aHA	M1aHB	M1aHC
0	14.9	15.6	15.3	14.8	15.2	15.0
30	20.9	21.5	-	21.4	21.3	19.9

Chloride conc. (mg/L)

day	M1aLD	M1aLE	M1aLF	M1aHA	M1aHB	M1aHC	M1aLR	M1aHR
0	74.6	76.1	75.6	82.6	87.1	85.3	54.3	57.3
30	31	85	-	118	76	78	5	33

Citrate M1a conc. (mg/L)

day	M1aLD	M1aLE	M1aLF	M1aHA	M1aHB	M1aHC
0	6846	6682	4400	7774	7925	7670
1	8219	7895	7399	7955	7785	8239
3	7582	8120	8155	8068	8358	8023
7	7007	7093	7817	7359	7300	7200
15	6866	6928	6800	7597	7097	6932
30	9743	9375	8618	9221	8382	9349

Glucose M1a conc. (mM)

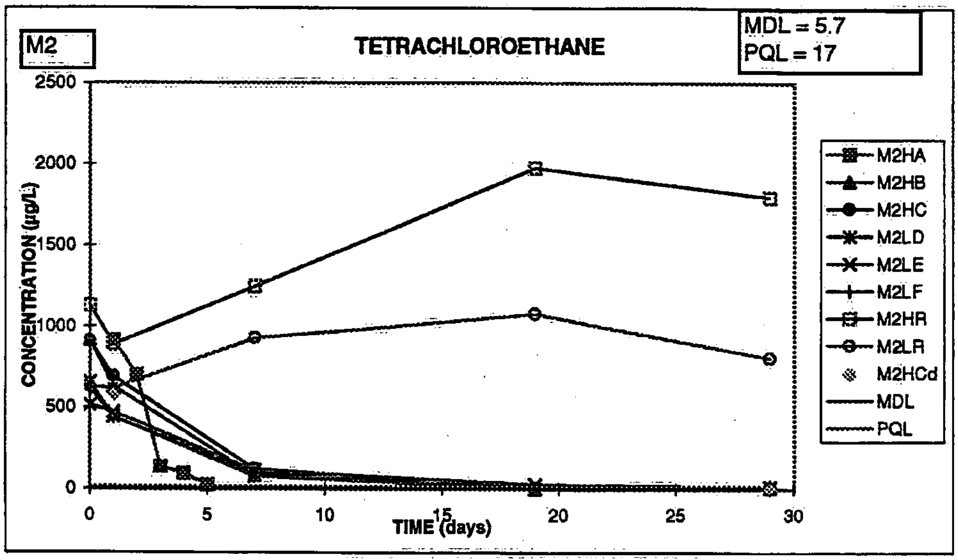
day	M1aLD	M1aLE	M1aLF	M1aHA	M1aHB	M1aHC	M1aLR	M1aHR
0	18.3	18.5	21.0	20.6	21.0	21.1	0.0	0.0
1	18.9	19.0	19.9	18.2	19.7	19.4		
3	18.6	18.0	19.7	17.5	18.8	18.5		
7	14.6	15.0	14.5	12.6	13.7	12.8		
9	10.2	10.2	10.2	8.3	10.3	6.2		
11	6.2	7.7	5.2	4.2	5.8	2.5		
14	1.7	5.1	1.9	0.8	1.7	0.0		
16	16.5	21	17.5	19.2	17.6	18.9		
22	14.4	17.1	13.6	14.6	13.0	13.7		
25	13.4	14.8	13.4	14.0	11.4	12.5		
28	10.5	11.3	4.3	11.2	8.6	10.6		
30	12	12.5	0	10.7	9.7	10.3		

N.B. Microcosm M1aLF exploded over weekend, some of culture supernatant saved and transferred. to a 60-mL serum vial (no soil present).

Tetrachloroethane (TeCA) **Microcosm 2** **(titanium citrate + glucose)**

Result concentration in µg/L

Time	M2HR	M2HA	M2HB	M2HC	M2LR	M2LD	M2LE	M2LF	Dup M2HCd	r^2
SITE WATER		2114				695				
0	1129	914	914	906	629	653	515	618		
1	888	701	626	688	614	443	469	437	580	0.95
7	1247	134	79	118	926	72	112	96		based on single point
19	1977	91	n.d.	n.d.	1076	n.d.	28	8		
29	1797	22	8	n.d.	803	11	10	16	n.d.	0.98
30										

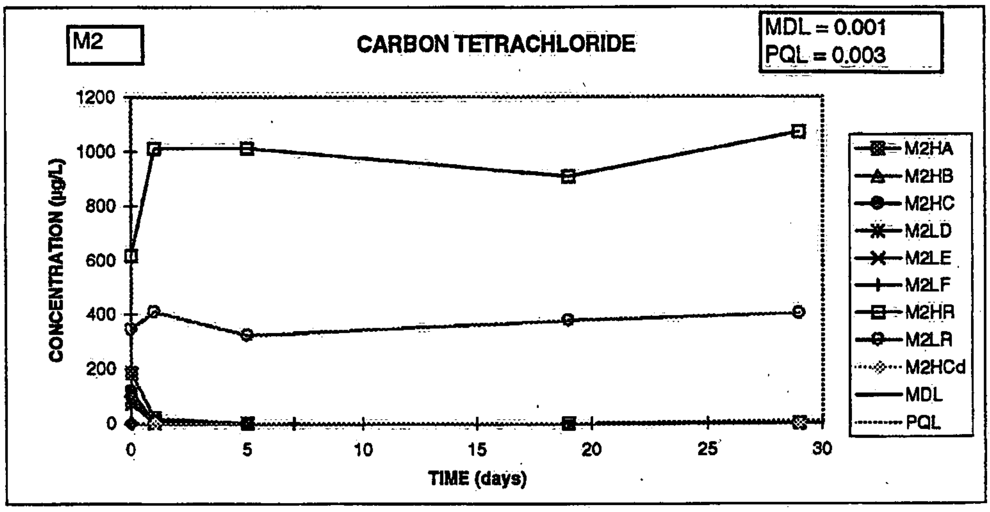


Carbon tetrachloride **Microcosm 2**

Result concentration in µg/L

SITE WATER 904 364

Time	M2HR	M2HA	M2HB	M2HC	M2LR	M2LD	M2LE	M2LF	M2HCd	r^2 (if<0.99)
0	618	186	118	117	344	71	87	74		
1	1013	18	6	n.d.	408	n.d.	7	1	n.d.	0.968
5	1011	n.d.	n.d.	n.d.	321	n.d.	n.d.	n.d.		
19	908	n.d.	n.d.	n.d.	376	n.d.	n.d.	n.d.		
29	1072	n.d.	n.d.	n.d.	402	n.d.	n.d.	n.d.	n.d.	
30										

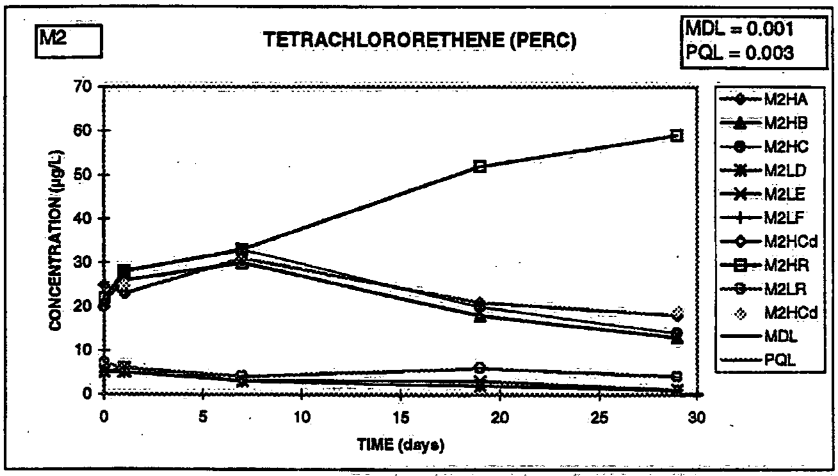


TETRACHLORORETHENE (PERC) **Microcosm 2**

Result concentration in µg/L

SITE WATER 35 6

Time	M2HR	M2HA	M2HB	M2HC	M2LR	M2LD	M2LE	M2LF	M2HCd	r^2 if less than 0.99
0	22	25	21	20	7	5	5	5		0.977 (D-F) and 0.963 (A-C)
1	28	23	26	28	6	5	6	5	25	
7	33	31	30	33	4	3	3	3		single point calibration
19	52	21	18	20	6	2	3	2		B: 0.962; C:0.938
29	59	18	13	14	4	1	1	1	19	B: 0.976; C:0.901; D:0.979
36										

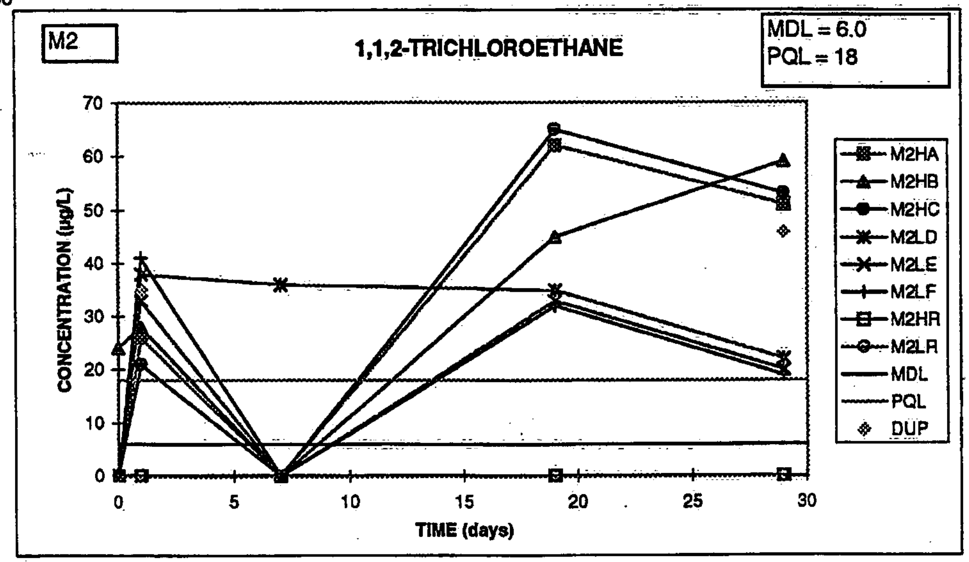


1,1,2- Trichloroethane **Microcosm 2**

Result concentration in µg/L

SITE WATER

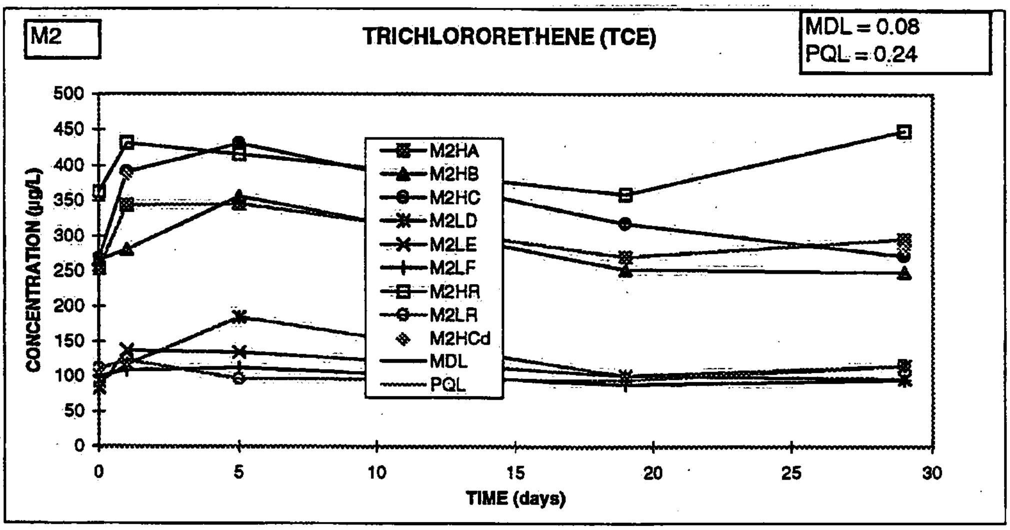
Time	M2HR	M2HA	M2HB	M2HC	M2LR	M2LD	M2LE	M2LF	DUP
0	n.d.	n.d.	24	n.d.	n.d.	n.d.	n.d.	n.d.	
1	n.d.	26	28	21	n.d.	38	33	41	35
7	n.d.	n.d.	n.d.	n.d.	n.d.	36	n.d.	n.d.	
19	n.d.	62	45	65	n.d.	35	33	32	
29	n.d.	51	59	53	n.d.	22	20	19	46
30									



TRICHLORORETHENE (TCE) **Microcosm 2**

Result concentration in µg/L

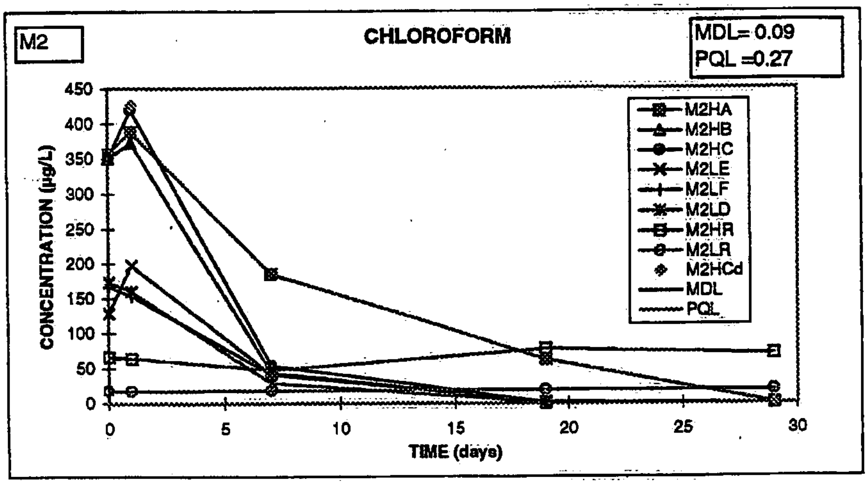
SITE WATER		197				86			
Time	M2HR	M2HA	M2HB	M2HC	M2LR	M2LD	M2LE	M2LF	M2HCd
0	363	254	266	268	111	92	83	100	
1	432	344	281	391	123	117	137	109	387
5	416	346	356	431	97	185	135	113	
19	359	270	253	317	95	101	101	89	
29	449	295	248	271	115	115	97	95	283
30									



CHLOROFORM **Microcosm 2**

Result concentration in µg/L

SITE WATER		71				20				
Time	M2HR	M2HA	M2HB	M2HC	M2LR	M2LD	M2LE	M2LF	M2HCd	r^2 if less than 0.99
0	66	356	350	351	17	174	129	167		0.977
1	64	388	372	420	17	160	198	154	426	0.972
7	47	185	44	54	18	29	41	41		single point calibration
19	78	63	n.d.	1	19	n.d.	2	n.d.		
29	71	n.d.	n.d.	n.d.	19	n.d.	n.d.	n.d.	n.d.	0.975
30										

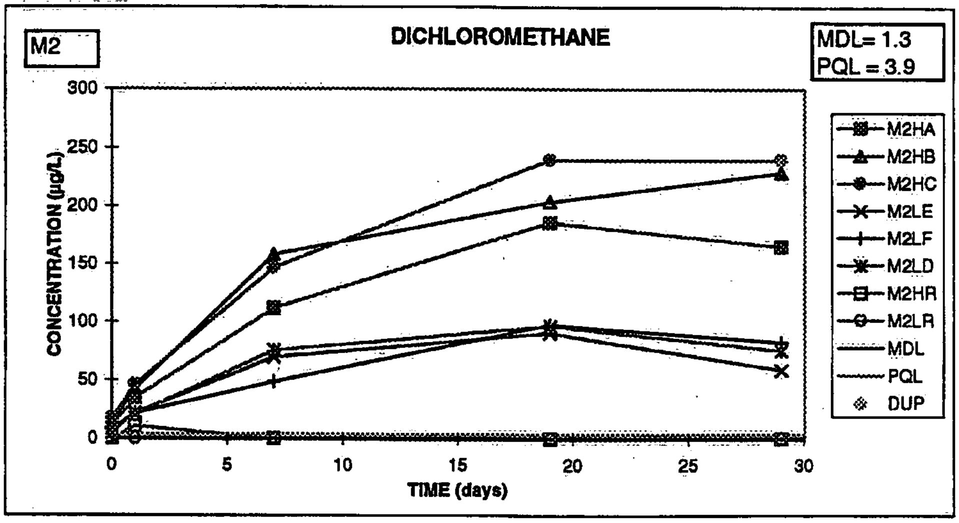


DICHLOROMETHANE **Microcosm 2** MAC = 5 µg/L

Result concentration in µg/L

SITE WATER <PQL <PQL

Time	M2HR	M2HA	M2HB	M2HC	M2LR	M2LD	M2LE	M2LF	DUP
0	n.d.	11	13	17	n.d.	6	5	8	
1	11	35	43	46	n.d.	21	22	22	
7	n.d.	112	158	147	n.d.	76	70	49	
19	n.d.	186	204	240	n.d.	97	91	98	
29	n.d.	165	229	240	n.d.	76	59	83	239
30									

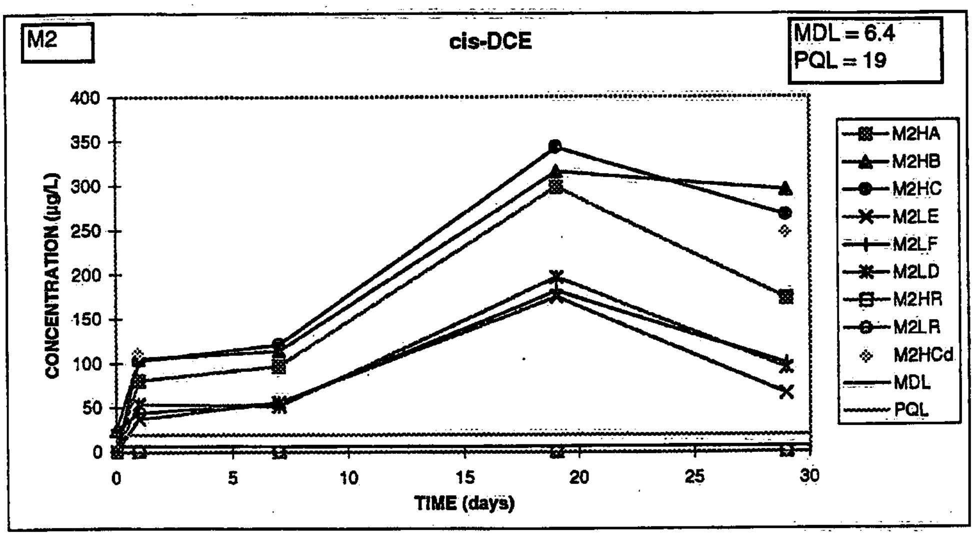


cis-DICHLOROETHENE **Microcosm 2** MAC = 70 µg/L

Result concentration in µg/L

SITE WATER <PQL <PQL

Time	M2HR	M2HA	M2HB	M2HC	M2LR	M2LD	M2LE	M2LF	M2HCd	r^2
0	n.d.	n.d.	24	n.d.	n.d.	n.d.	n.d.	25		
1	n.d.	81	105	103	n.d.	54	37	44	111	0.963
7	n.d.	97	114	121	n.d	52	56	55		single point
19	n.d.	299	316	343	n.d.	197	175	181		
29	n.d.	173	295	267	n.d.	95	66	100	247	
30										

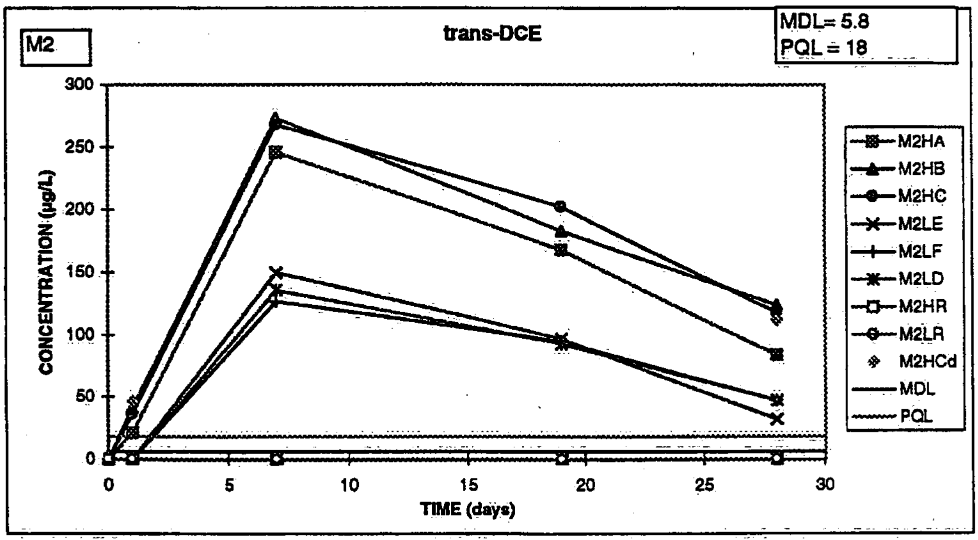


Trans-DICHLOROETHENE **Microcosm 2** MAC = 100 µg/L

Result concentration in µg/L

SITE WATER <PQL <PQL

Time	M2HR	M2HA	M2HB	M2HC	M2LR	M2LD	M2LE	M2LF	M2HCd	
0	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.		
1	n.d.	21	41	36	n.d.	n.d.	n.d.	n.d.	46	
7	n.d.	246	273	268	n.d.	136	150	127		single point calibration
19	n.d.	168	183	202	n.d.	93	97	95		
28	n.d.	84	124	118	n.d.	47	32	47	112	
30										

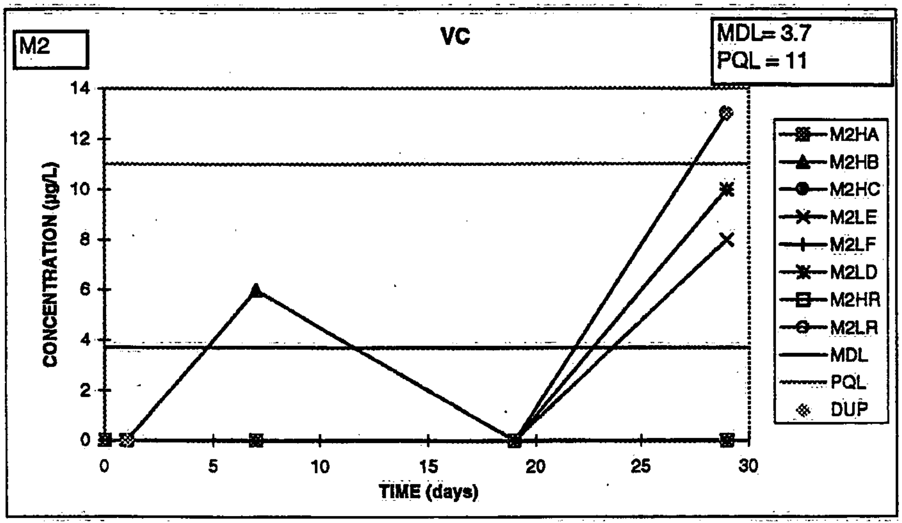


VINYL CHLORIDE (VC) **Microcosm 2**

Result concentration in µg/L

SITE WATER <PQL <PQL

Time	M2HR	M2HA	M2HB	M2HC	M2LR	M2LD	M2LE	M2LF	DUP	
0	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.		
1	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	
7	n.d.	n.d.	6	n.d.	n.d	n.d.	n.d.	n.d.		single point calibration
19	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.		
29	n.d.	n.d.	n.d.	13	n.d.	10	8	10	13	
30										

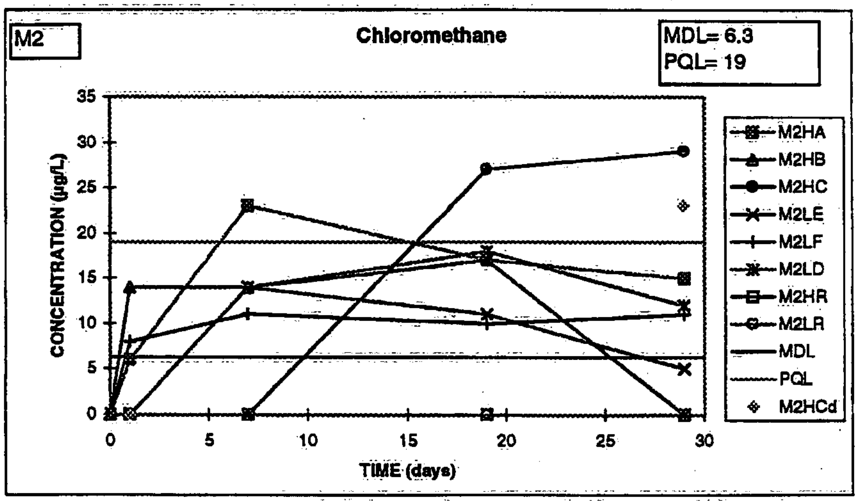


CHLOROMETHANE **Microcosm 2**

Result concentration in µg/L

SITE WATER <PQL <PQL

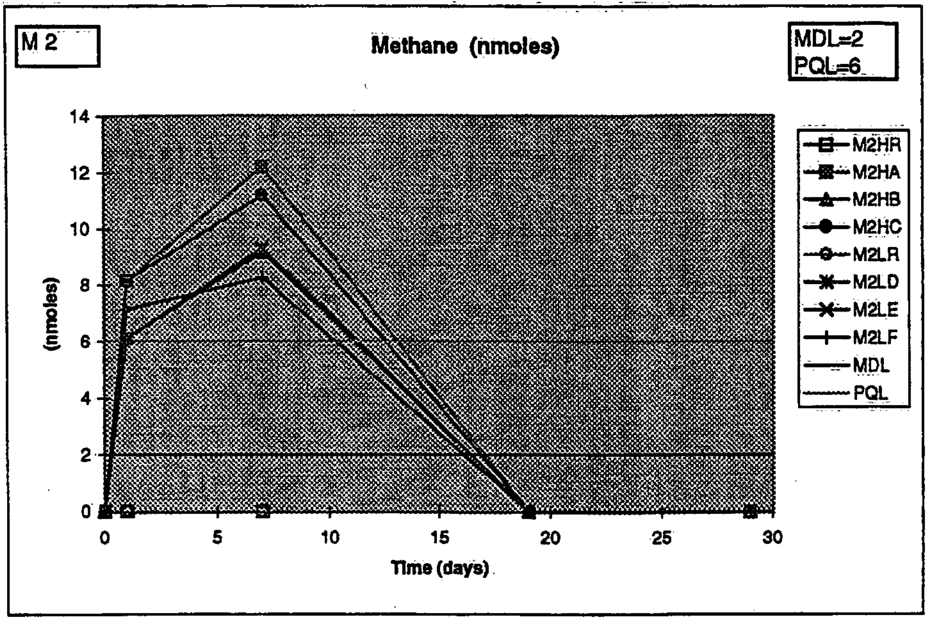
Time	M2HR	M2HA	M2HB	M2HC	M2LR	M2LD	M2LE	M2LF	M2HCd	
0	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.		
1	n.d.	6	14	n.d.	n.d.	n.d.	n.d.	8	n.d.	
7	n.d.	23	14	n.d.	n.d.	14	14	11		single point calibration
19	n.d.	17	17	27	n.d.	18	11	10		
29	n.d.	15	n.d.	29	n.d.	12	5	11	23	
30										



METHANE Microcosm 2

SITE WATER <PQL <PQL

Time	M2HR	M2HA	M2HB	M2HC	M2LR	M2LD	M2LE	M2LF	M2HCd
				nmoles					
0	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	
1	n.d.	8	6	8	n.d.	6	6	7	7
7	n.d.	12	9	11	n.d.	8	8	7	
19	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	
29	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	
30									

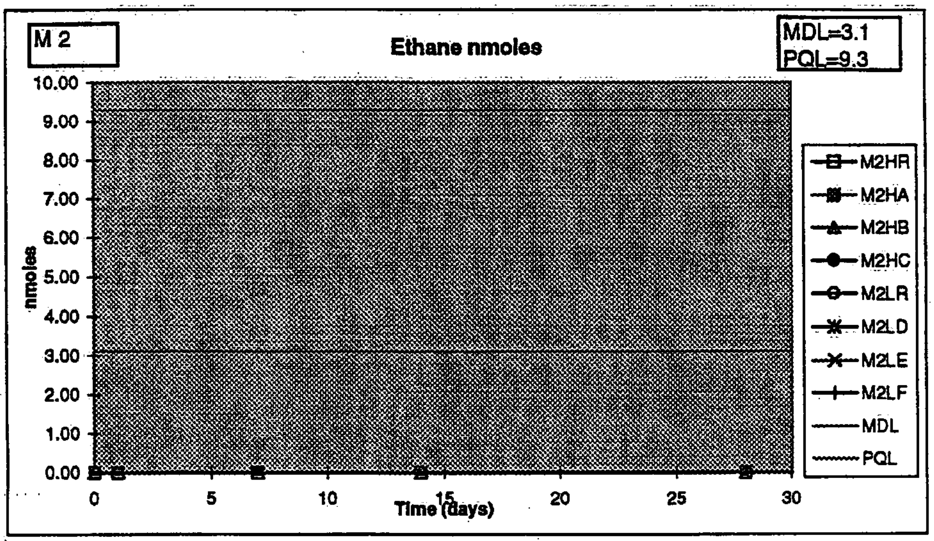


ETHANE **Microcosm 2**

SITE WATER <PQL <PQL

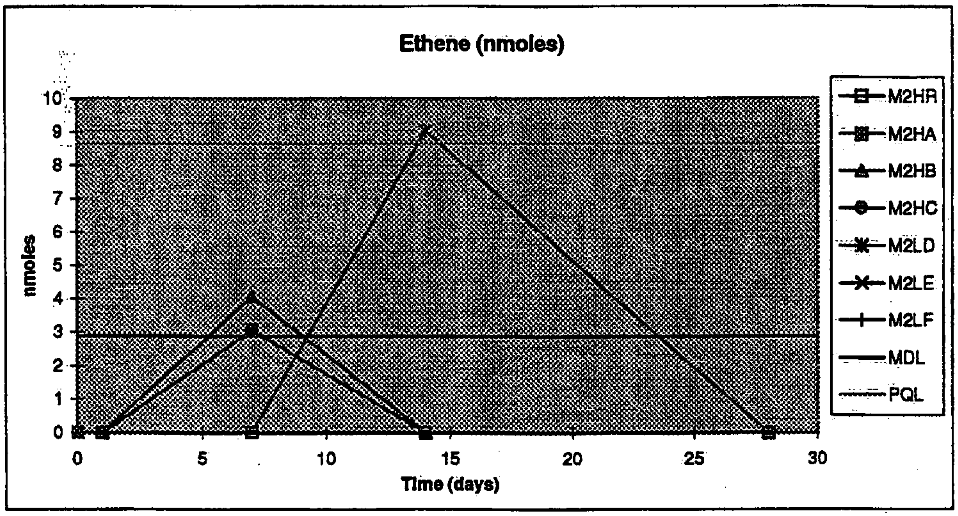
nmoles

Time	M2HR	M2HA	M2HB	M2HC	M2LR	M2LD	M2LE	M2LF	M2HCd
0	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	
1	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
7	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	
19	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	
29	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	
30									



ETHENE **Microcosm 2**

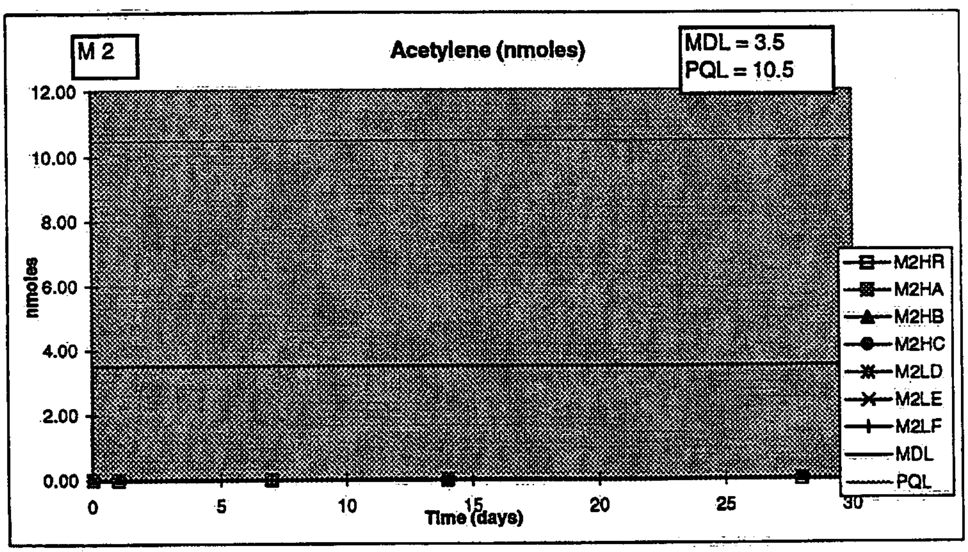
SITE WATER	<PQL				<PQL				
				nmoles					
Time	M2HR	M2HA	M2HB	M2HC	M2LR	M2LD	M2LE	M2LF	M2HCd
0	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	
1	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
7	n.d.	3	4	3	n.d.	n.d.	n.d.	n.d.	
19	n.d.	n.d.	n.d.	n.d.	n.d.	3	n.d.	n.d.	
29	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	
30									



ACETYLENE **Microcosm 2**

SITE WATER <PQL <PQL

Time	M2HR	M2HA	M2HB	M2HC	M2LR	M2LD	M2LE	M2LF	M2HCd
				nmoles					
0	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	
1	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
7	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	
19	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	
29	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	
30									



Citrate 2

conc. (mg/L)

day	M2LD	M2LE	M2LF	M2HA	M2HB	M2HC
0	6799	6919	6905	7082	6851	6802
1	7334	7092	7182	7522	7098	7531
5	7019	7126	6931	7710	7683	7389
19	9301	9821	8076	8879	9789	8934
29	9565	9575	8874	9376	8992	8730

Note: Microcosms were amended with Ti(III)citrate-reduced invertose on day 16, hence the increase in glucose and citrate concentrations.

Glucose 2

conc. (mM)

day	M2LD	M2LE	M2LF	M2HA	M2HB	M2HC
0	18.5	18.9	17.3	21.3	18.5	19.0
1	18.1	19.1	17.8	18.0	17.1	19.6
5	17.6	16.2	17.0	17.7	16.4	17.5
8	14.0	11.7	12.0	11.0	7.6	11.4
13	7.8	4.2	5.8	7.4	5.1	6.8
16	4.6	1.3	2.2	4.7	1.6	2.8
16	24.9	16.7	21.3	20.0	19.0	19.7
19	22.7	21.6	18.7	20.1	17.6	18.1
26	13.9	11.5	12.8	14.1	13.2	14.2
29	15.2	11.2	11.1	14.0	11.8	12.0

Volatile Fatty Acids-M2

Lactate

conc. (mg/L)

day	M2LD	M2LE	M2LF	M2HA	M2HB	M2HC
0	n.d.	n.d.	n.d.	n.d.	n.d.	n.d
1	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
5	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
19	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
29	320	872	289	184	289	296

Formate

conc. (mg/L)

day	M2LD	M2LE	M2LF	M2HA	M2HB	M2HC
0	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
1	47	n.d.	44	31	41	46
5	288	126	123	96	144	118
19	1229	1452	1097	1091	1404	1223
29	1745	1895	1632	1659	1684	1578

Acetate

conc. (mg/L)

day	M2LD	M2LE	M2LF	M2HA	M2HB	M2HC
0	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
1	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
5	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
19	584	790	516	559	717	617
29	894	1004	841	881	875	852

Propionate

conc. (mg/L)

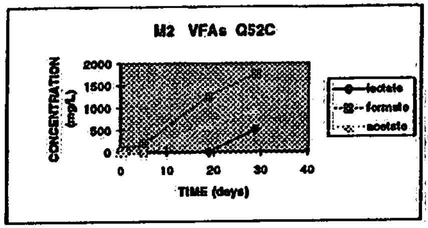
day	M2LD	M2LE	M2LF	M2HA	M2HB	M2HC
0	n.d.	n.d.	n.d	n.d.	n.d.	n.d
1	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
5	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
19	n.d.	n.d.	n.d	n.d.	n.d.	n.d.
29	n.d.	n.d.	n.d.	n.d.	n.d.	n.d

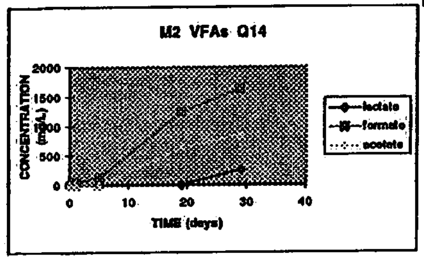
Notes: Problems with M2LD5 VFA analysis required a re-analysis of this sample on day 7. Results shown for day 5 are day 7 results.

Q52C	lactate	formate	acetate
day	lactate	formate	acetate
0	0	0	0
1	0	46	0
5	0	179	0
19	0	1260	630
29	494	1757	913

Q14

day	lactate	formate	acetate
0	0	0	0
1	0	40	0
5	0	120	0
19	0	1239	631
29	256	1640	869





Titanium

conc. (mM)

day	M2LD	M2LE	M2LF	M2HA	M2HB	M2HC
0	25.9	27.4	26.9	25.4	29.1	28.9
30	33.2	33.6	32.5	33.9	32.9	34.8

Chloride

conc. (mg/L)

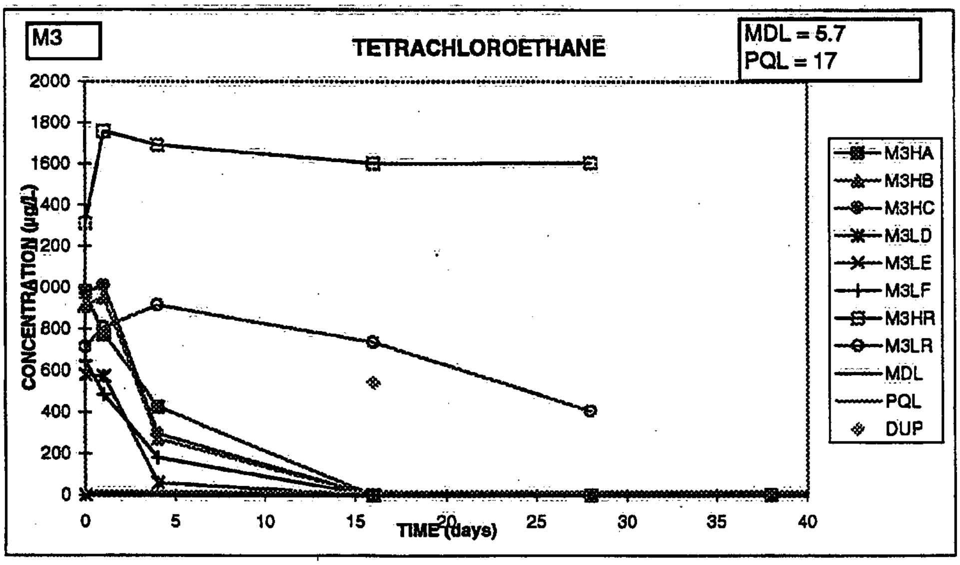
day	M2LD	M2LE	M2LF	M2HA	M2HB	M2HC	M2LR	M2HR
0	74.2	75.5	75.1	81.7	85.9	84.2	22.1	53.6

Note: Microcosms were amended with Ti(III)citrate-reduced invertose on day 16, hence the increase in glucose and citrate concentrations.

Tetrachloroethane (TeCA) **Microcosm 3** **(titanium citrate + yeast extract)**

Result concentration in μg/L

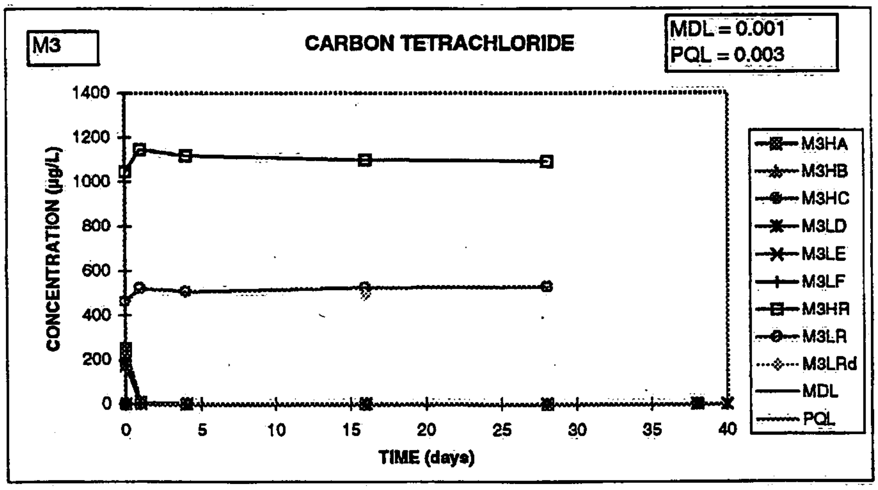
SITE WATER		2114				695					
											r^2
Time	M3HR	M3HA	M3HB	M3HC	M3LR	M3LD	M3LE	M3LF	DUP		
0	1311	978	912	978	711	578	582	645			
1	1759	773	953	1008	810	573	495	486			
4	1692	426	273	296	914	62	201	183			
16	1604	n.d.	n.d.	n.d.	735	n.d.	n.d.	7j	543		
28	1607	n.d.	n.d.	n.d.	405	n.d.	n.d.	n.d.			B: 0.974; C:0.983
38		n.d.					n.d.				
40											



Carbon tetrachloride **Microcosm 3** **(titanium citrate + yeast extract)**

Result concentration in µg/L

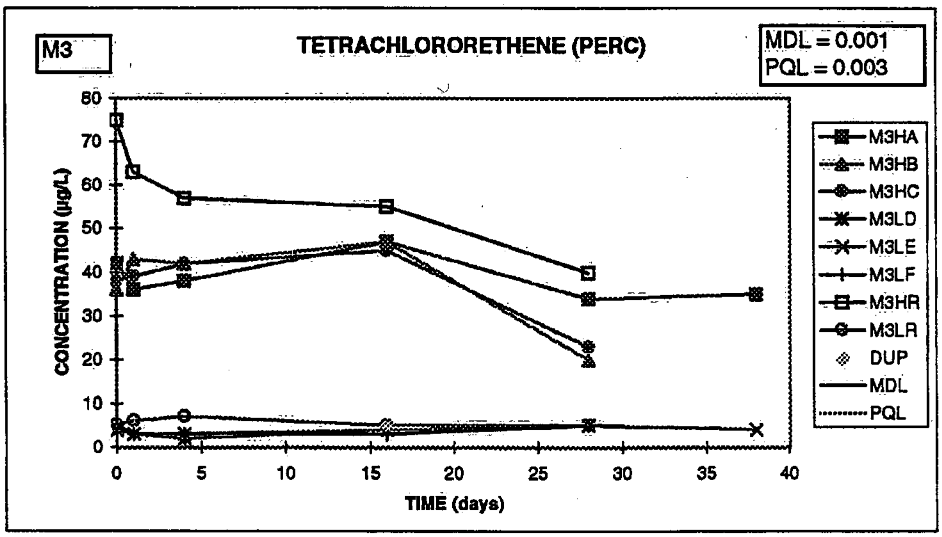
SITE WATER		904				364				
Time	M3HR	M3HA	M3HB	M3HC	M3LR	M3LD	M3LE	M3LF	M3LRd	r^2
0	1044	251	210	205	461	195	172	195		
1	1146	8	8	7	522	n.d.	n.d.	n.d.		0.963
4	1119	n.d.	n.d.	n.d.	507	n.d.	n.d.	n.d.		
16	1099	n.d.	n.d.	n.d.	524	n.d.	n.d.	3j	491	
28	1093	n.d.	n.d.	n.d.	529	n.d.	n.d.	n.d.		
38		n.d.				n.d.				
40										



Tetrachloroethene (PERC) **Microcosm 3** **(titanium citrate + yeast extract)**

Result concentration in µg/L

SITE WATER		35				6				
Time	M3HR	M3HA	M3HB	M3HC	M3LR	M3LD	M3LE	M3LF	DUP	r^2 if less than 0.99
0	75	42	36	38	5	4	4	5		B: 0.969 ; D:0.939
1	63	36	43	39	6	3	3	3		B: 0.976 ; D:0.939
4	57	38	42	42	7	2	3	3		C: 0.901; D:0.979
16	55	47	47	45	5	4	4	3	5	
28	40	34	20	23	5	5	5	5		
38		35					4			
40										

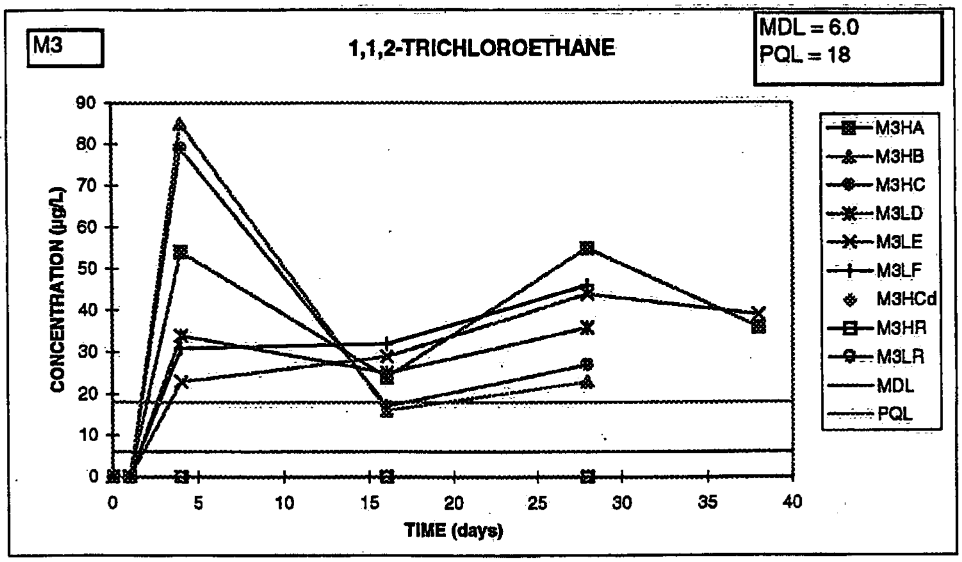


1,1,2- Trichloroethane **Microcosm 3** **(titanium citrate + yeast extract)**

Result concentration in µg/L

SITE WATER

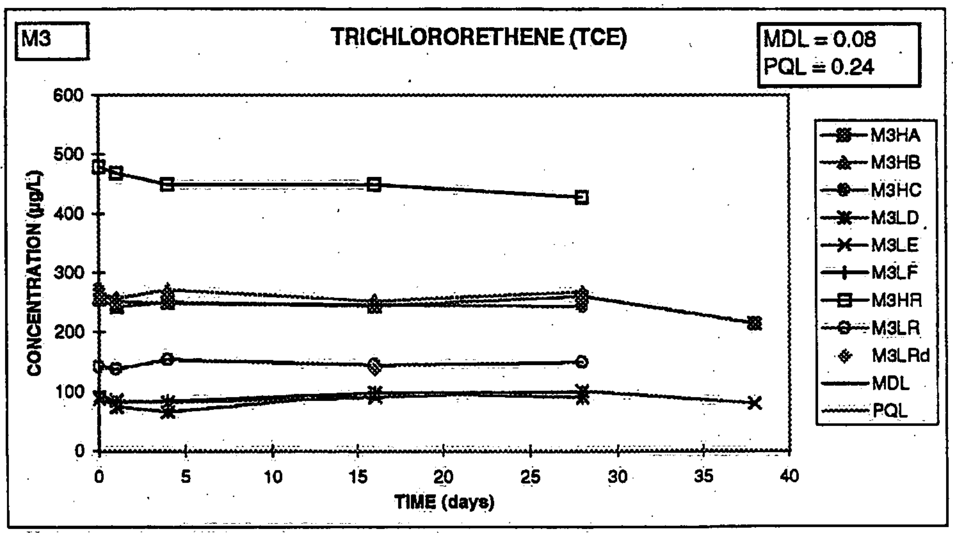
Time	M3HR	M3HA	M3HB	M3HC	M3LR	M3LD	M3LE	M3LF	M3HCd	r^2
0	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.		
1	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.		
4	n.d.	54	85	79	n.d.	34	23	31		0.964
16	n.d.	24	16	17	n.d.	25	29	32		
28	n.d.	55	23	27	n.d.	36	44	46		
38		36					39			
40										



TRICHLORORETHENE (TCE) Microcosm 3 (titanium citrate + yeast extract)

Result concentration in µg/L

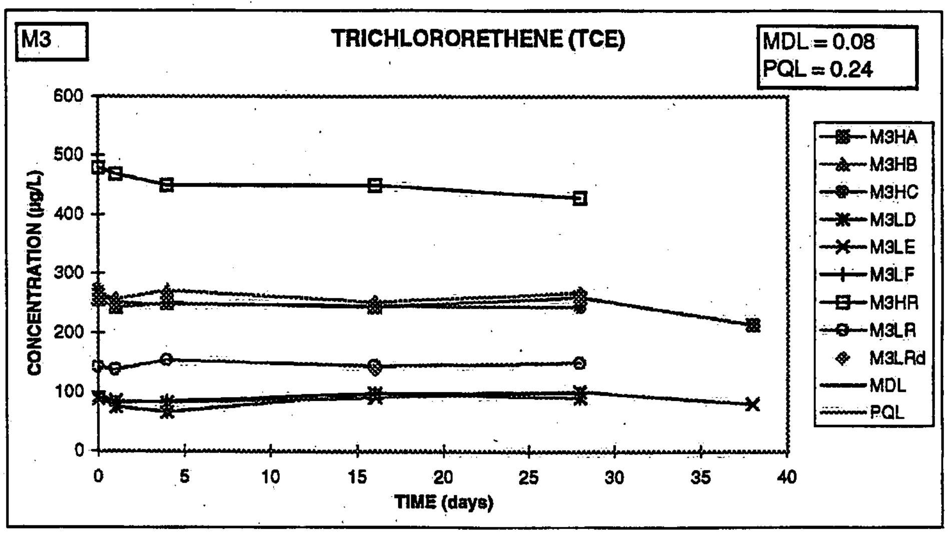
SITE WATER		197				86			
Time	M3HR	M3HA	M3HB	M3HC	M3LR	M3LD	M3LE	M3LF	M3LRd
0	479	255	257	271	142	90	88	96	
1	469	243	257	251	138	74	85	82	
4	450	250	271	248	154	66	82	84	
16	449	244	252	246	144	97	90	97	139
28	428	261	268	244	150	90	101	99	
38		214					80		
40									



TRICHLORORETHENE (TCE) Microcosm 3 (titanium citrate + yeast extract)

Result concentration in µg/L

Time	M3HR	M3HA	M3HB	M3HC	M3LR	M3LD	M3LE	M3LF	M3LRd
SITE WATER		197				86			
0	479	255	257	271	142	90	88	96	
1	469	243	257	251	138	74	85	82	
4	450	250	271	248	154	66	82	84	
16	449	244	252	246	144	97	90	97	139
28	428	261	268	244	150	90	101	99	
38		214					80		
40									

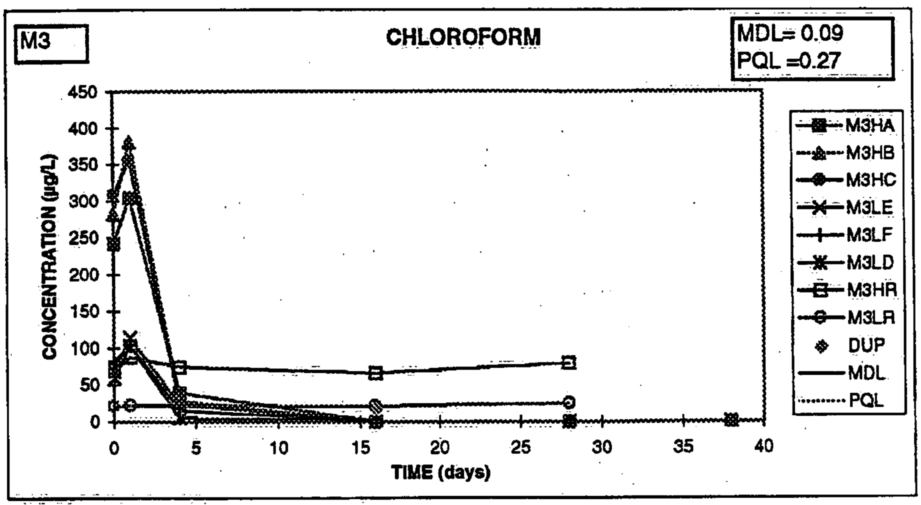


CHLOROFORM **Microcosm 3** **(titanium citrate + yeast extract)**

Result concentration in µg/L

SITE WATER 71 20

Time	M3HR	M3HA	M3HB	M3HC	M3LR	M3LD	M3LE	M3LF	DUP	r^2 if less than 0.99
0	73	242	282	308	21	59	68	82		
1	88	304	381	355	22	103	114	104		0.954
4	74	39	28	25	22	5	23	15		0.975
16	66	n.d.	n.d.	n.d.	21	n.d.	n.d.	n.d.	18	0.965
28	79	n.d.	n.d.	n.d.	25	n.d.	n.d.	n.d.		
38		n.d.					n.d.			
40										

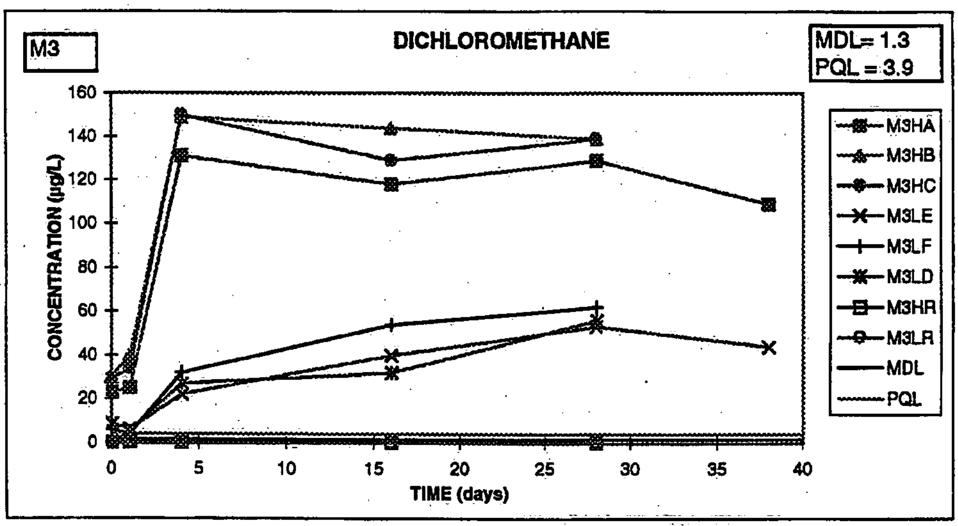


DICHLOROMETHANE **Microcosm 3** **(titanium citrate + yeast extract)** **MAC = 5 µg/L**

Result concentration in µg/L

SITE WATER <PQL <PQL

Time	M3HR	M3HA	M3HB	M3HC	M3LR	M3LD	M3LE	M3LF	M3LRd	r^2
0	n.d.	23	30	29	n.d.	n.d.	9	6		0.93
1	n.d.	25	40	34	n.d.	5	6	4		0.923
4	n.d.	131	149	150	n.d.	27	22	32		0.975
16	n.d.	118	144	129	n.d.	32	40	54	n.d.	
28	n.d.	129	139	139	n.d.	56	53	62		0.962
38		109					44			
40										

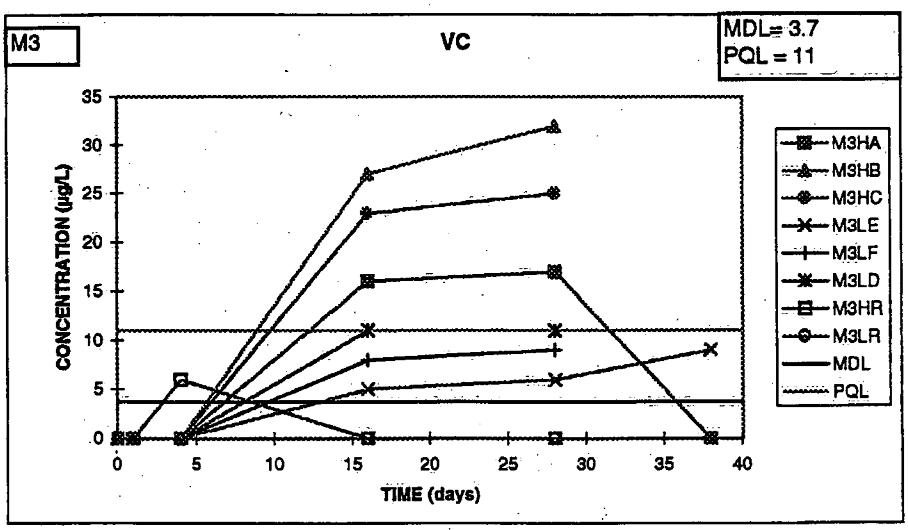


VINYL CHLORIDE (VC) **Microcosm 3** **(titanium citrate + yeast extract)**

Result concentration in µg/L

SITE WATER <PQL <PQL

Time	M3HR	M3HA	M3HB	M3HC	M3LR	M3LD	M3LE	M3LF	M3HCd
0	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	
1	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	
4	6	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	
16	n.d.	16	27	23	n.d.	11	5	8	n.d.
28	n.d.	17	32	25	n.d.	11	6	9	
38		n.d.					9		
40									



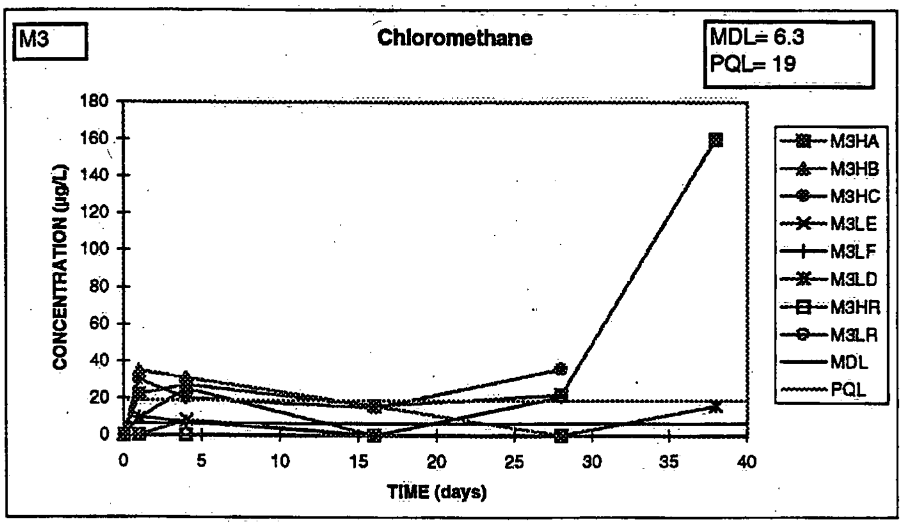
CHLOROMETHANE **Microcosm 3** **(titanium citrate + yeast extract)**

Result concentration in µg/L

SITE WATER	<PQL					<PQL			

Time	M3HR	M3HA	M3HB	M3HC	M3LR	M3LD	M3LE	M3LF	M3HCd
0	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	
1	n.d.	22	35	30	n.d.	9	n.d.	10	
4	n.d.	27	31	20	n.d.	25	8	7	
16	n.d.	16	16	15	n.d.	n.d.	n.d.	n.d.	
28	n.d.	22	n.d.	36	n.d.	n.d.	n.d.	21	
38		160				16			
40									

need to confirm by GC/MS that it is indeed chloromethane

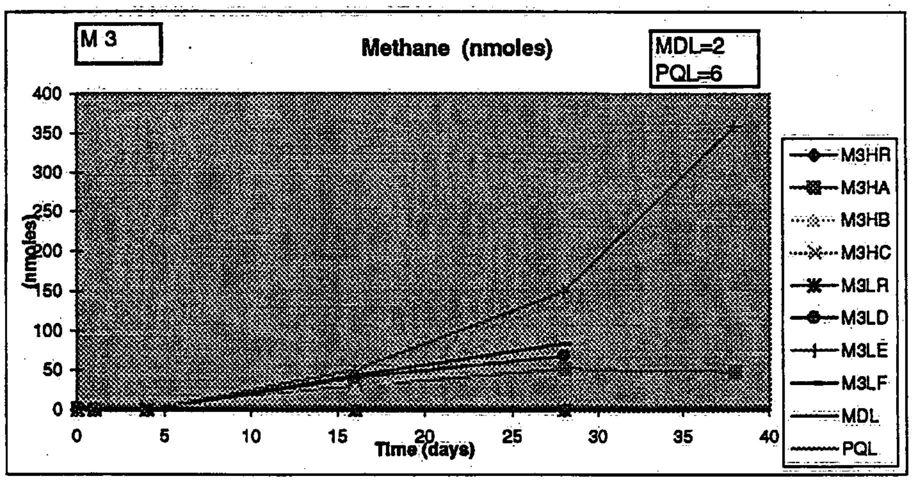


METHANE **Microcosm 3** **(titanium citrate + yeast extract)**

SITE WATER <PQL <PQL

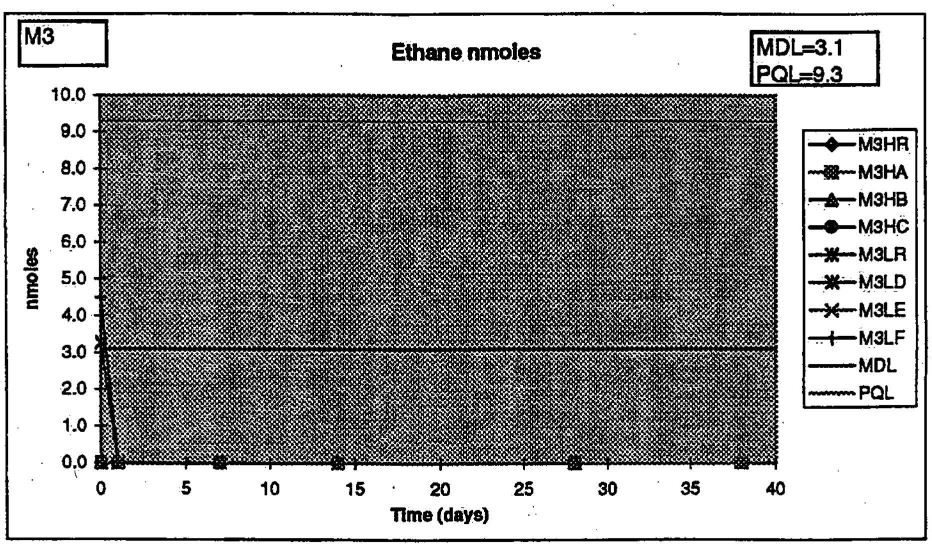
nmoles

Time	M3HR	M3HA	M3HB	M3HC	M3LR	M3LD	M3LE	M3LF	M3HCd
0	n.d.	2	n.d.	n.d.	n.d.	2	n.d.	3	
1	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	
4	n.d.	2	2	2	n.d.	n.d.	n.d.	n.d.	
16	n.d.	30	27	50	n.d.	41	50	43	n.d.
28	n.d.	52	71	133	n.d.	67	142	83	
38		48					353		
40									



ETHANE **Microcosm 3** **(titanium citrate + yeast extract)**

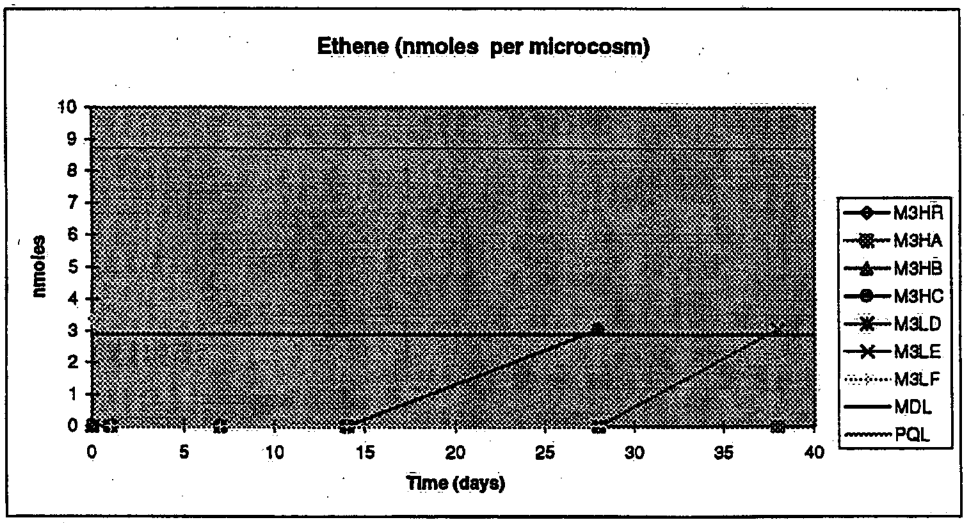
SITE WATER	<PQL				<PQL				
				nmoles					
Time	M3HR	M3HA	M3HB	M3HC	M3LR	M3LD	M3LE	M3LF	M3HCd
0	n.d.	n.d.	n.d.	n.d.	n.d.	3	n.d.	4	
1	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	
4	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	
16	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	
28	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	
38		n.d.					n.d.		
40									



ETHENE **Microcosm 3** **(titanium citrate + yeast extract)**

SITE WATER <PQL <PQL

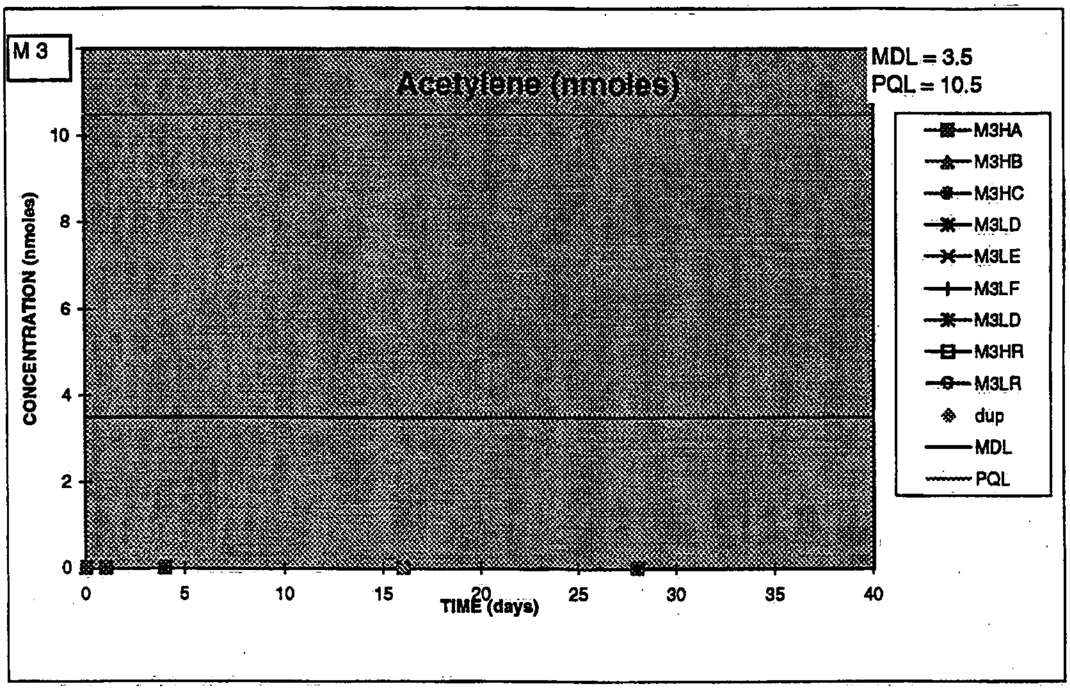
Time	M3HR	M3HA	M3HB	M3HC	M3LR	M3LD	M3LE	M3LF	M3HCd
0	n.d.	n.d.	n.d.	3	n.d.	n.d.	n.d.	3	
1	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	
4	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	
16	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	
28	n.d.	n.d.	n.d.	3	n.d.	n.d.	n.d.	n.d.	
38		n.d.					3		
40									



ACETYLENE **Microcosm 3** **(titanium citrate + yeast extract)**

SITE WATER <PQL <PQL

Time	M3HR	M3HA	M3HB	M3HC	M3LR	M3LD	M3LE	M3LF	dup
0	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	
1	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	
4	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	
16	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
28	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	
38		n.d.					n.d.		
40									



Citrate 3

day	conc. (mg/L) M3LD	M3LE	M3LF	M3HA	M3HB	M3HC
0	6722	6216	6229	6815	6920	7319
1	880j	926j	929j	902j	1018j	937j
4	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
16	938j	n.d.	n.d.	n.d.	n.d.	n.d.
28	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.

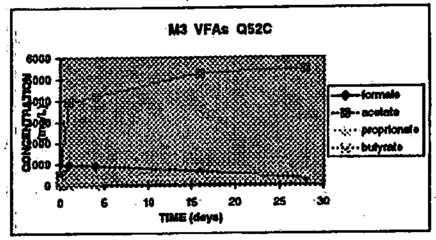
Volatile Fatty Acids-M3

Titanium

day	M3LD	M3LE	M3LF	M3HA	M3HB	M3HC
	conc. (mM)					
0	29.0	28.5	29.0	31.4	30.6	28.7

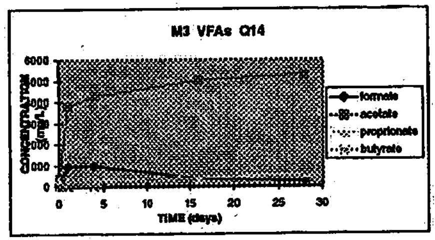
Lactate

day	M3LD	M3LE	M3LF	M3HA	M3HB	M3HC
					conc. (mg/L)	
0	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
1	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
4	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
16	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
28	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.



Formate

day	M3LD	M3LE	M3LF	M3HA	M3HB	M3HC
					conc. (mg/L)	
0	78	132	213	64	75	55
1	859	983	1025	698	1013	957
4	982	897	898	917	1056	1025
16	n.d.	650	n.d.	n.d.	n.d.	350
28	n.d.	n.d.	330	n.d.	228	n.d.



Acetate

day	M3LD	M3LE	M3LF	M3HA	M3HB	M3HC
					conc. (mg/L)	
0	307	439	654	381	397	325
1	3536	3949	4242	3640	3975	3801
4	4439	3945	4199	3952	4436	4381
16	5177	5094	5644	4353	5021	5660
28	4973	6210	5261	4793	5632	5540

Propionate

day	M3LD	M3LE	M3LF	M3HA	M3HB	M3HC
					conc. (mg/L)	
0	233j	239j	235j	274	281	n.d.
1	283	194	240j	263	302	266
4	212j	168j	226j	254	292	279
16	414	489	374	223j	421	518
28	425	603	558	429	722	600

Butyrate

day	M3LD	M3LE	M3LF	M3HA	M3HB	M3HC
					conc. (mg/L)	
0	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
1	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
4	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
16	n.d.	1733j	1693j	n.d.	n.d.	1740j
28	n.d.	1991j	1969j	n.d.	1984j	n.d.

Q52C	formate	acetate	proprionate	butyrate			
day	formate	acetate	proprionate	butyrate			
0	141	466	236	0	0	1733	1693
1	955	3909	239	0	0	1991	1969
4	926	4195	203	0			
16	650	5305	426	1142			
28	330	5481	529	1320			

Q14

day	formate	acetate	proprionate	butyrate
0	65	368	277	0
1	956	3805	277	0
4	999	4256	275	0
16	350	5011	387	580
28	228	5322	584	661.3333

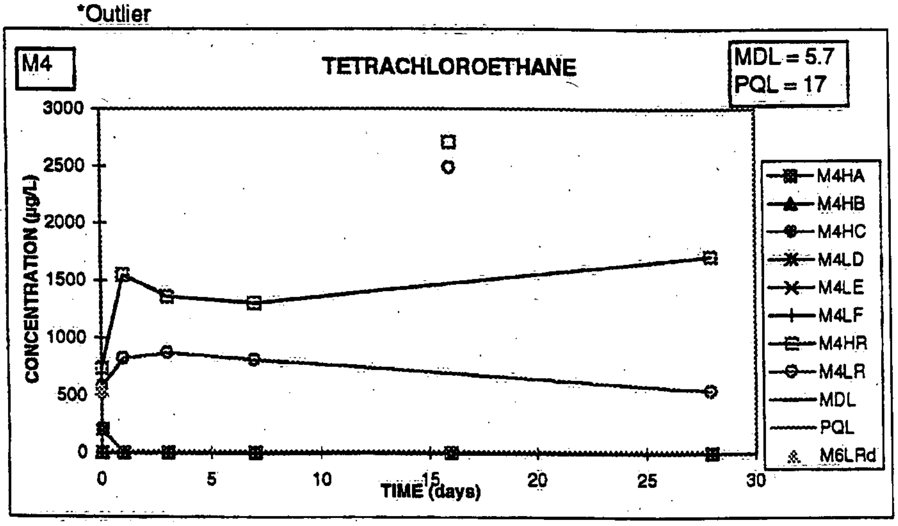
0	233	239	235	274	281	n.d.
1	283	194	240	263	302	266
4	212	168	226	254	292	279
16	414	489	374	223	421	518
28	425	603	558	429	722	600

Tetrachloroethane (TeCA) **Microcosm 4 Sterile control**

Result concentration in µg/L

Time	M4HR	M4HA	M4HB	M4HC	M4LR	M4LD	M4LE	M4LF	M4LRd	r^2 (if < 0.9
SITE WATER		2114				695				
0	740	205			579	n.d.			538	0.98
0.04			n.d.				n.d.			
0.08				n.d.				n.d.		
1	1549	n.d.	n.d.	n.d.	819	n.d.	n.d.	n.d.	881	
3	1358	n.d.	n.d.	n.d.	870	n.d.	n.d.	n.d.		0.955
7	1302	n.d.	n.d.	n.d.	810	n.d.	n.d.	n.d.		0.955
16	2711*	n.d.	n.d.	n.d.	2492*	n.d.	n.d.	n.d.		
28	5128*	n.d.	n.d.	n.d.	541	n.d.	n.d.	n.d.		
Repeat analy at day 36	1713									0.982

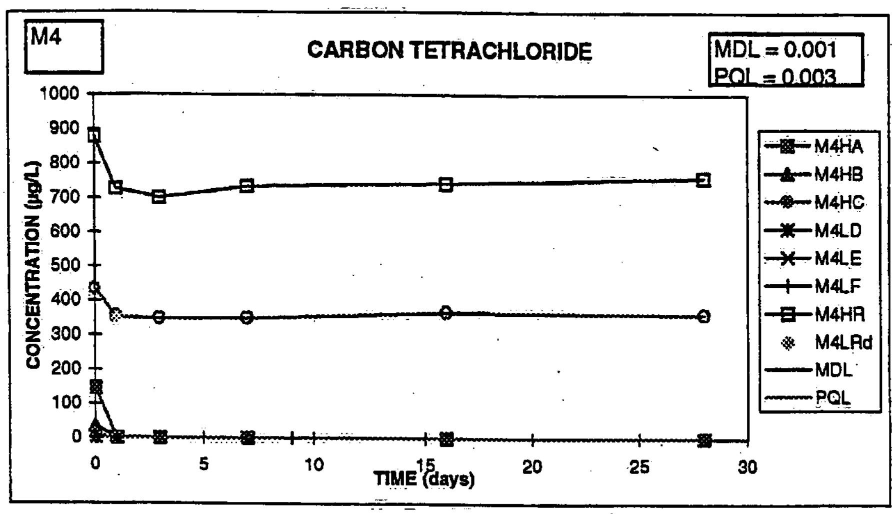
*Outlier



Carbon tetrachloride **Microcosm 4 Sterile control** MAC = 5 µg/L

Result concentration in µg/L

SITE WATER		904				364			
Time	M4HR	M4HA	M4HB	M4HC	M4LR	M4LD	M4LE	M4LF	M4LRd
0	877	147			433	n.d.			
0.04			36				n.d.		
0.08				9				n.d.	
1	727	n.d.	n.d.	n.d.	353	n.d.	n.d.	n.d.	351
3	702	n.d.	n.d.	n.d.	349	n.d.	n.d.	n.d.	
7	736	n.d.	n.d.	n.d.	350	n.d.	n.d.	n.d.	
16	744	n.d.	n.d.	n.d.	368	n.d.	n.d.	n.d.	
28	761	n.d.	n.d.	n.d.	363	n.d.	n.d.	n.d.	

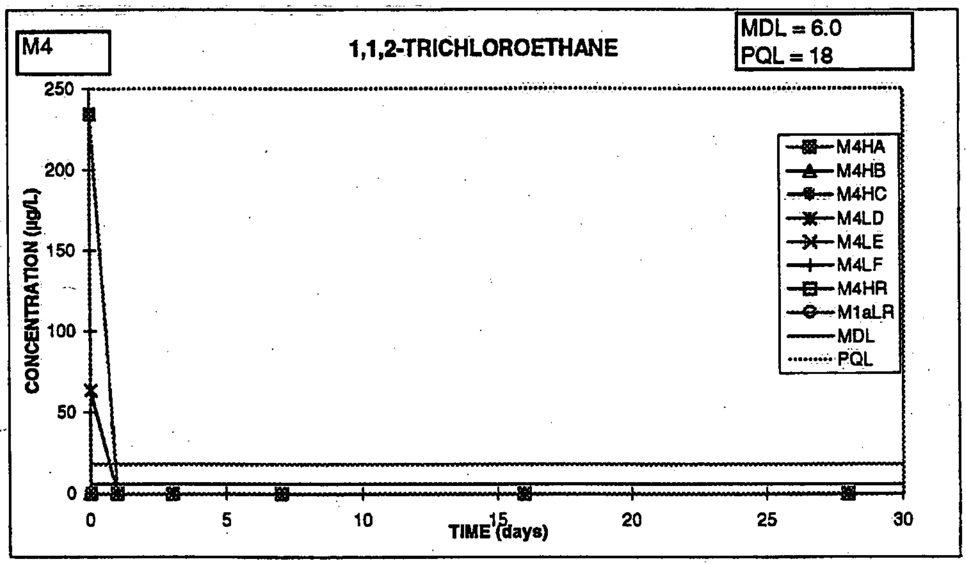


1,1,2- Trichloroethane **Microcosm 4 Sterile control**

Result concentration in µg/L

SITE WATER

Time	M4HR	M4HA	M4HB	M4HC	M4LR	M4LD	M4LE	M4LF	M4LRd
0	n.d.	234			n.d.	63			
0.04			n.d.				n.d.		
0.08				n.d.				n.d.	
1	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	
3	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	
7	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	
16	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	
28	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	

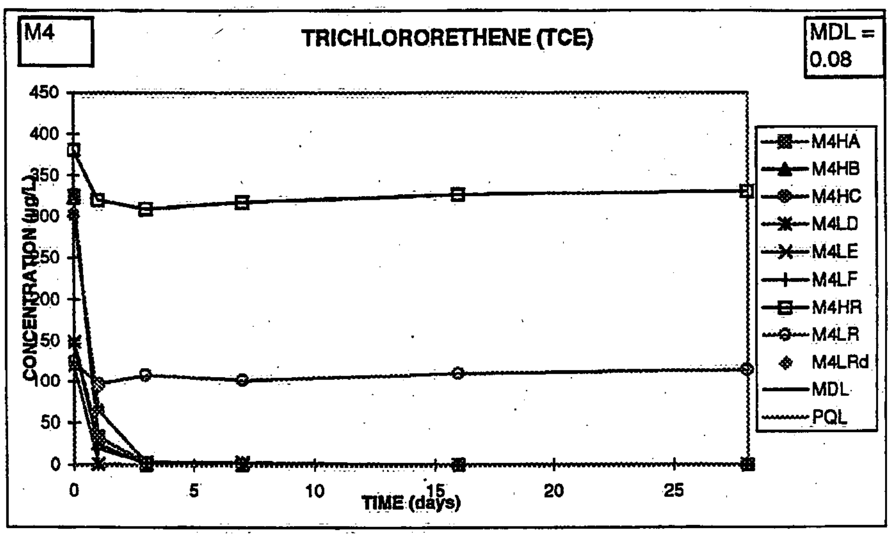


TRICHLORORETHENE (TCE) **Microcosm 4 Sterile control**

Result concentration in µg/L

SITE WATER		197				86				

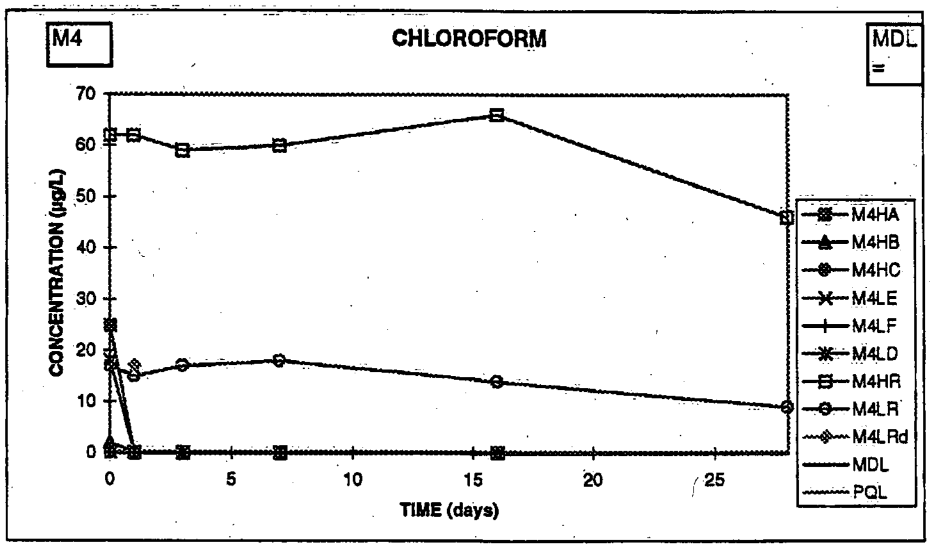
Time	M4HR	M4HA	M4HB	M4HC	M4LR	M4LD	M4LE	M4LF	M4LRd	r^2 (if not 0.99)
0	381	326			124	120				
0.04			322				148			
0.08				302				146		
1	320	34	25	65	97	1	33	19	95	0.971
3	309	n.d.	n.d.	2J	108	n.d.	3	2j		0.969
7	318	n.d.	n.d.	n.d.	102	n.d.	3	2j		
16	327	n.d.	n.d.	n.d.	110	n.d.	n.d.	n.d.		
28	331	n.d.	n.d.	n.d.	114	n.d.	n.d.	n.d.		



CHLOROFORM **Microcosm 4 Sterile control**

Result concentration in µg/L

SITE WATER		71				20				
Time	M4HR	M4HA	M4HB	M4HC	M4LR	M4LD	M4LE	M4LF	M4LRd	r^2 (if < 0.99)
0	62	25			17	18				0.971
0.04			2				n.d.			
0.08				n.d.				n.d.		
1	62	n.d.	n.d.	n.d.	15	n.d.	n.d.	n.d.	17	0.965
3	59	n.d.	n.d.	n.d.	17	n.d.	n.d.	n.d.		0.965
7	60	n.d.	n.d.	n.d.	18	n.d.	n.d.	n.d.		
16	66	n.d.	n.d.	n.d.	14	n.d.	n.d.	n.d.		
28	46	n.d.	n.d.	n.d.	9	n.d.	n.d.	n.d.		0.983

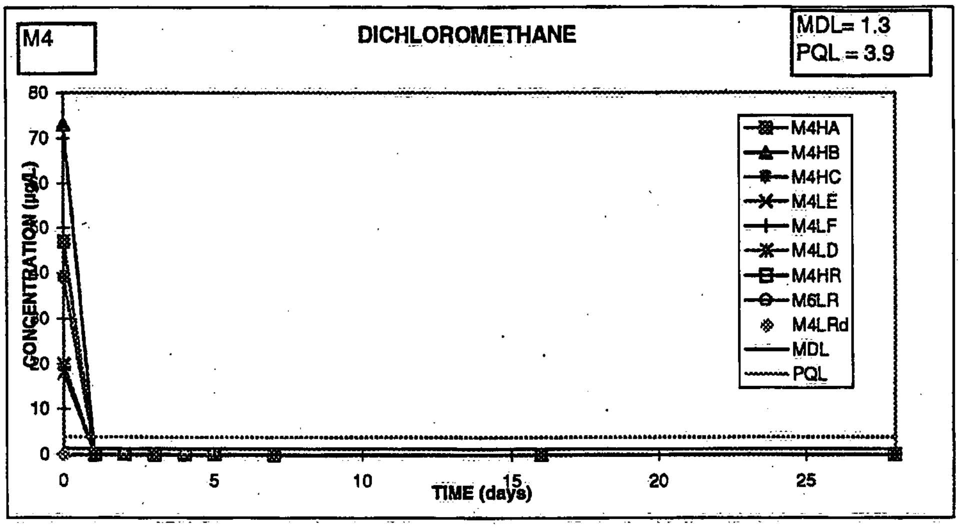


DICHLOROMETHANE **Microcosm 4 Sterile control** MAC = 5 µg/L

Result concentration in µg/L

SITE WATER <PQL <PQL

Time	M4HR	M4HA	M4HB	M4HC	M4LR	M4LD	M4LE	M4LF	M4LRd	r^2 (if < 0.99)
0	n.d.	47			n.d.	20			n.d.	b: 0.936; C: 0.982
0.04			73				18			
0.08				39				19		
1	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	
3	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.		
7	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.		
16	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.		
28	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.		



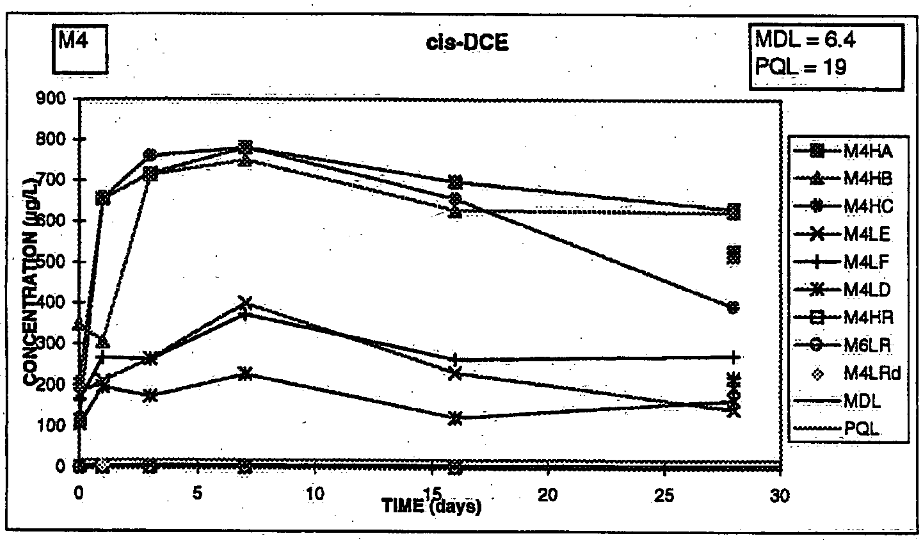
cis-DICHLOROETHENE **Microcosm 4 Sterile control** MAC = 70 µg/L

Result concentration in µg/L

SITE WATER <PQL <PQL

Time	M4HR	M4HA	M4HB	M4HC	M4LR	M4LD	M4LE	M4LF	M4LRd	r^2 (if < 0.99)
0	n.d.	119			n.d.	107				
0.04			348				181			
0.08				207				165		
1	n.d.	655	307	658	n.d.	197	212	268	n.d.	0.98
3	n.d.	716	714	759	n.d.	174	265	263		
7	n.d.	782	750	782	n.d.	228	400	373		0.978
16	n.d.	698	629	656	n.d.	124	232	265		
28	n.d.	632	625	394	n.d.	167	144	274		
FID results		530	519	527		197	219	224		

* suspect poor injection on ECD - results calculated by FID are more consistent and shown for comparison



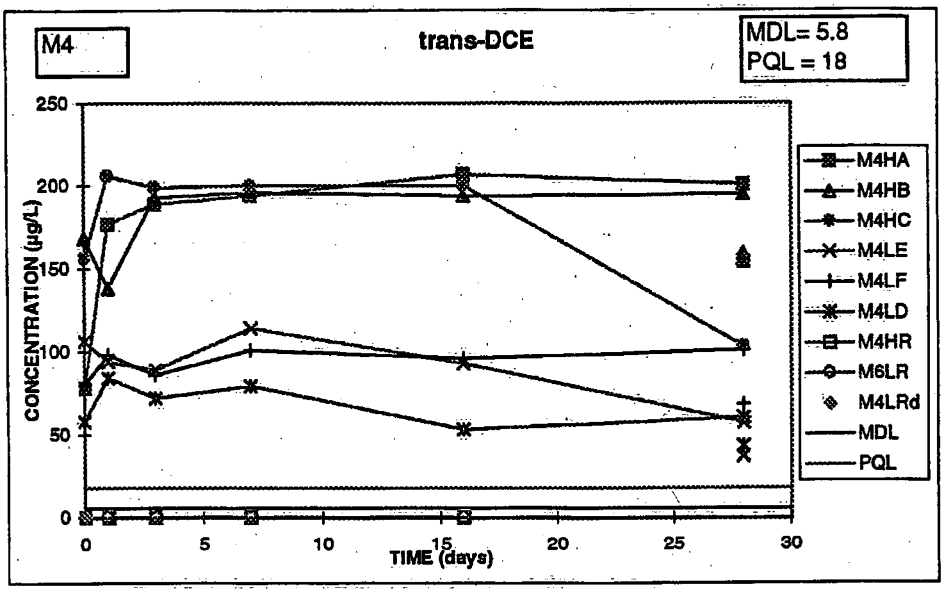
Trans-DICHLOROETHENE **Microcosm 4 Sterile control** MAC = 100 µg/L

Result concentration in µg/L

SITE WATER <PQL <PQL

Time	M4HR	M4HA	M4HB	M4HC	M4LR	M4LD	M4LE	M4LF	M4LRd	r^2 (if < 0.99)
0	n.d.	78			n.d.	**58**			n.d.	
0.04			168				106			
0.08				156				80		
1	n.d.	177	138	206	n.d.	84	94	98	n.d.	
3	n.d.	189	193	199	n.d.	72	89	86		
7	n.d.	194	196	200	n.d.	79	114	101		
16	n.d.	207	194	200	n.d.	53	93	96		0.973
28	n.d.	201	195	103	n.d.	60	57	101		
FID		154	159	155		43	37	68		

* suspect poor injection on ECD - results calculated by FID are more consistent and shown for comparison

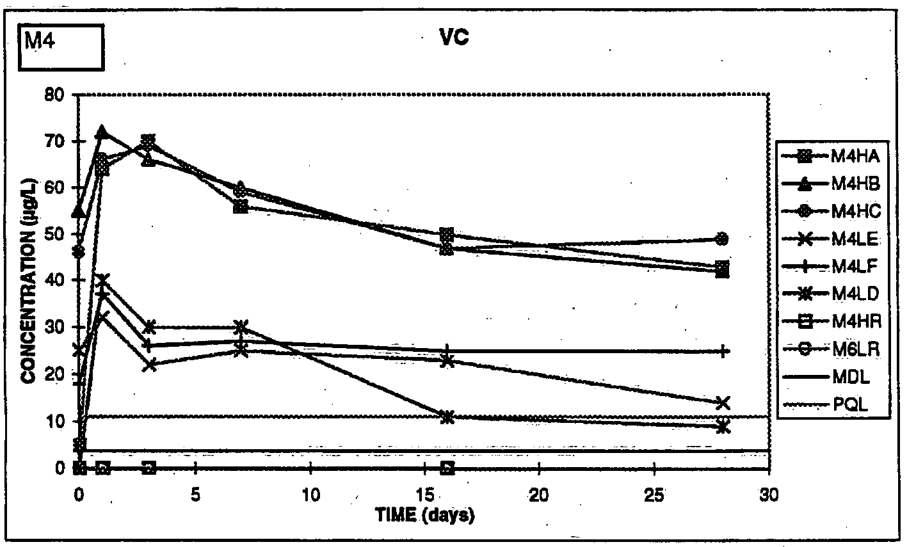


VINYL CHLORIDE (VC) **Microcosm 4 Sterile control** PQL = 11 µg/L

Result concentration in µg/L

SITE WATER <PQL <PQL

Time	M4HR	M4HA	M4HB	M4HC	M4LR	M4LD	M4LE	M4LF	M4LRd
0	n.d.	5j			n.d.	n.d.			n.d.
0.04			55				25		
0.08				46				18	
1	n.d.	64	72	66	n.d.	40	32	37	n.d.
3	n.d.	70	66	69	n.d.	30	22	26	
7	n.d.	56	60	59	n.d.	30	25	27	
16	n.d.	50	47	47	n.d.	11	23	25	
28	n.d.	43	42	49	n.d.	9j	14	25	

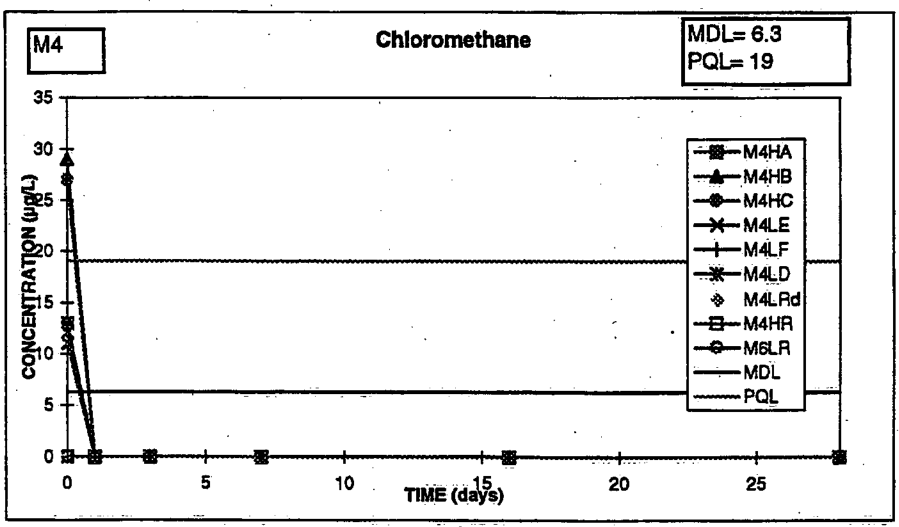


CHLOROMETHANE **Microcosm 4 Sterile control**

Result concentration in µg/L

SITE WATER <PQL <PQL

Time	M4HR	M4HA	M4HB	M4HC	M4LR	M4LD	M4LE	M4LF	M4LRd
0	n.d.	13j			n.d.	11j			
0.04			29				12j		
0.08				27				13j	
1	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
3	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	
7	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	
16	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	
28	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	

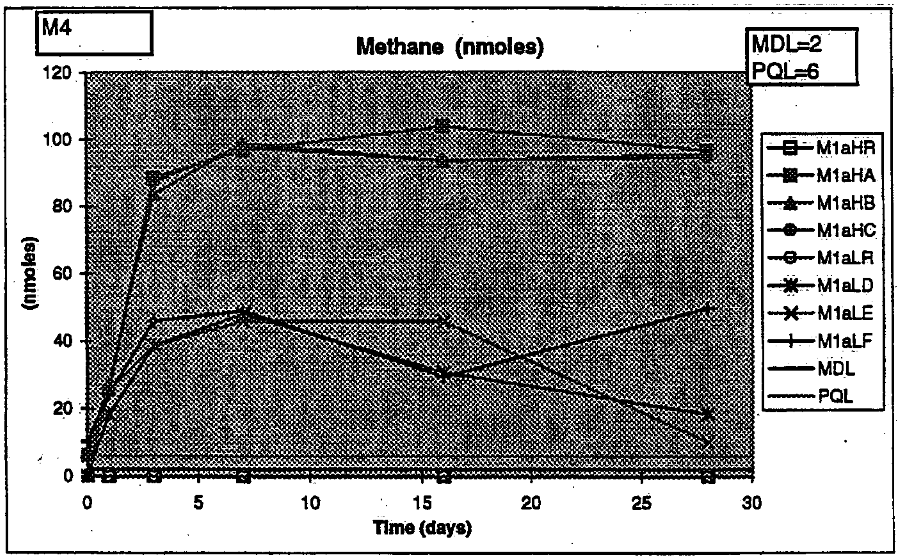


METHANE **Microcosm 4 Sterile control**

SITE WATER <PQL <PQL

RESULTS in ppmv

Time	M4HR	M4HA	M4HB	M4HC	M4LR	M4LD	M4LE	M4LF	M4LRd
0	n.d.	n.d.			n.d.	n.d.			
0.04			7				6		
0.08				6				10	
1	n.d.	25	27	25	n.d.	18	25	24	n.d.
3	n.d.	87	82	86	n.d.	38	38	45	
7	n.d.	95	97	96	n.d.	47	45	48	
16	n.d.	102	92	92	n.d.	25	45	29	
28	n.d.	95	94	93	n.d.	15	10	49	

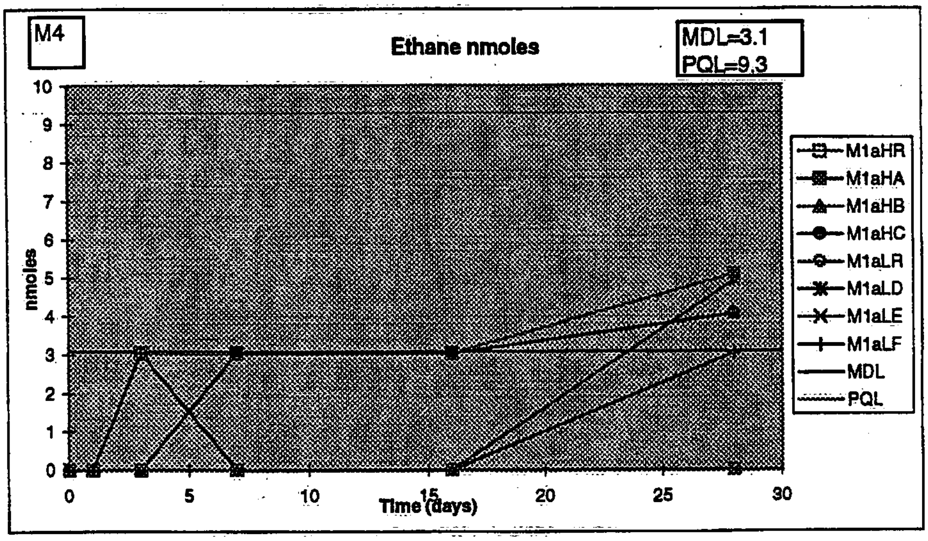


ETHANE **Microcosm 4 Sterile control**

SITE WATER <PQL <PQL

Results in ppmv

Time	M4HR	M4HA	M4HB	M4HC	M4LR	M4LD	M4LE	M4LF	M4LRd
0	n.d.	n.d.			n.d.	n.d.			
0.04			n.d.				n.d.		
0.08				n.d.				n.d.	
1	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
3	n.d.	3j	n.d.	n.d.	n.d.	n.d.	n.d.	3j	
7	n.d.	3j	3j	3j	n.d.	n.d.	n.d.	n.d.	
16	n.d.	5j	4j	4j	n.d.	4j	n.d.	3j	
28	n.d.	6j	6j	5j	n.d.	n.d.	n.d.	3j	

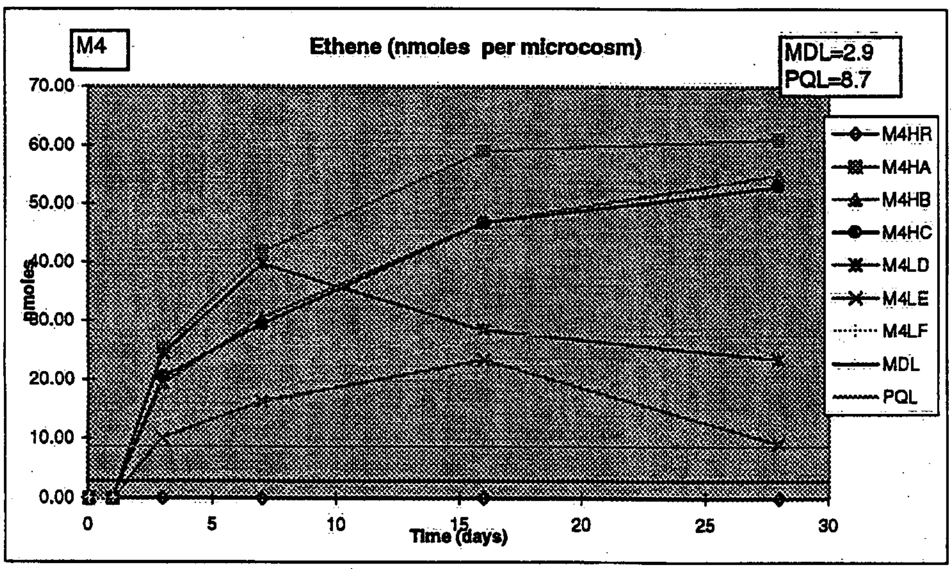


ETHENE **Microcosm 4 Sterile control**

SITE WATER <PQL <PQL

Results in ppmv

Time	M4HR	M4HA	M4HB	M4HC	M4LR	M4LD	M4LE	M4LF	M4LRd
0	n.d.	n.d.			n.d.	n.d.			
0.04			n.d.				n.d.		
0.08				n.d.				n.d.	
1	n.d.	3j	3j	3j	n.d.	7j	5j	4j	n.d.
3	n.d.	25	19	20	n.d.	24	10	13	
7	n.d.	41	30	29	n.d.	39	16	18	
16	n.d.	58	46	46	n.d.	23	23	27	
28	n.d.	60	54	52	n.d.	19	9	28	
30									

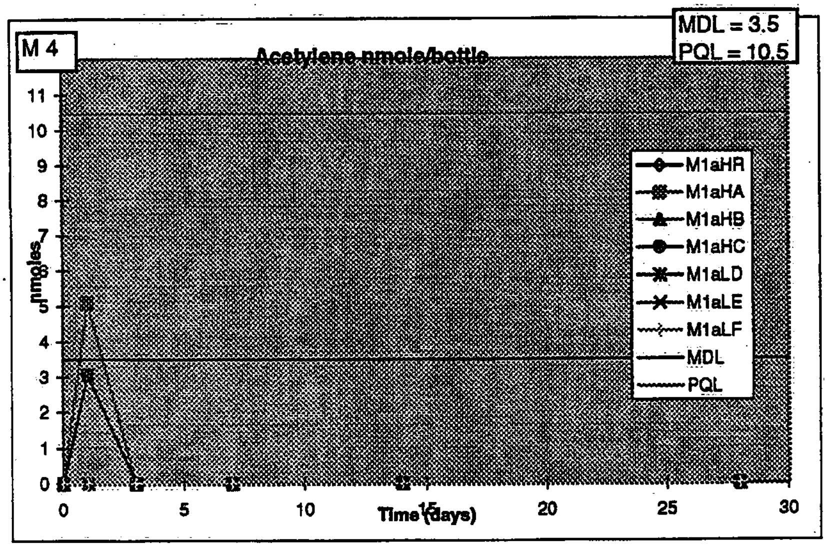


ACETYLENE **Microcosm 4 Sterile control**

SITE WATER <PQL <PQL

Results in ppmv

Time	M4HR	M4HA	M4HB	M4HC	M4LR	M4LD	M4LE	M4LF	M4LRd
0	n.d.	n.d.			n.d.	n.d.			n.d.
0.04			n.d.				n.d.		
0.08				n.d.				n.d.	
1	n.d.	5j	3j	3j	n.d.	3j	n.d.	n.d.	n.d.
3	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	
7	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	
16	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	
28	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	



Citrate

day	M4LD	M4LE	M4LF	M4HA	M4HB	M4HC
			conc. (mg/L)			
0	7532	7244	7486	7554	6648	7031
1	7224	7439	7539	7269	7684	6932
3	7835	8213	8171	7885	7488	8014
7	7644	7472	7178	6927	6976	7331
16	8092	9020	8754	8504	8702	8477
28	9998	9828	10108	9813	9407	9701

Glucose

day	M4LD	M4LE	M4LF	M4HA	M4HB	M4HC
			conc. (mM)			
0	16.8	17.5	16.5	17.3	17.6	15.5
1	18.4	18.2	19.3	18.1	17.6	17.5
3	18.1	18.0	18.0	16.8	16.9	16.9
7	11.9	17.9	18.0	16.1	16.5	17.0
16	0.0	14.8	15.7	15.3	14.2	14.0
28	0	0	15.9	15.1	13.7	14.4

Volatile Fatty Acids - M4

Lactate

day	M4LD	M4LE	M4LF	M4HA	M4HB	M4HC
			conc. (mg/L)			
0	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
1	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
3	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
7	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
16	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
28	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.

Formate

day	M4LD	M4LE	M4LF	M4HA	M4HB	M4HC
			conc. (mg/L)			
0	14	13	12	13	12	12
1	20	20	19	19	20	19
3	4j	6j	6j	4j	5j	4j
7	427	17	17	15	17	16
16	1477	20	21	18	20	21
28	2248	1883	19	13	16	16

Acetate

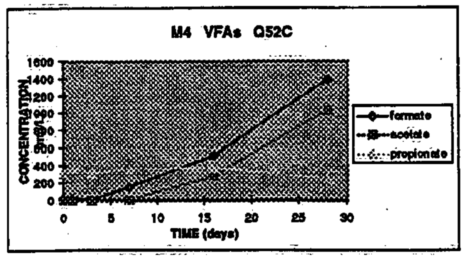
day	M4LD	M4LE	M4LF	M4HA	M4HB	M4HC
			conc. (mg/L)			
0	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
1	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
3	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
7	277	n.d.	n.d.	n.d.	n.d.	n.d.
16	831	n.d.	n.d.	n.d.	n.d.	n.d.
28	1684	1411	n.d.	n.d.	n.d.	n.d.

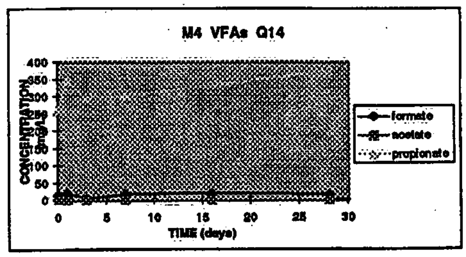
Propionate

day	M4LD	M4LE	M4LF	M4HA	M4HB	M4HC
			conc. (mg/L)			
0	346	314	265	277	238j	242
1	368	381	359	359	323	349
3	342	359	239	307	305	278
7	n.d.	384	322	289	302	306
16	257	449	397	297	350	344
28	242	n.d.	n.d.	n.d.	397	353

Titanium

day	M4LD	M4LE	M4LF	M4HA	M4HB	M4HC
			conc. (mM)			
0	27.7	27.8	28.2	27.7	28.8	27.3





Formate

day	M4LD	M4LE	M4LF	M4HA	M4HB	M4HC
			conc. (mg/L)			
0	14	13	12	13	12	12
1	20	20	19	19	20	19
3	4	6	6	4	5	4
7	427	17	17	15	17	16
16	1477	20	21	18	20	21
28	2248	1883	19	13	16	16

Q52C

day	formate	acetate	propionate
0	13	0	308
1	20	0	368
3	5	0	313
7	154	9	353
16	506	277	368
28	1383	1031.667	242

277	n.d.
831	n.d.
1684	1411

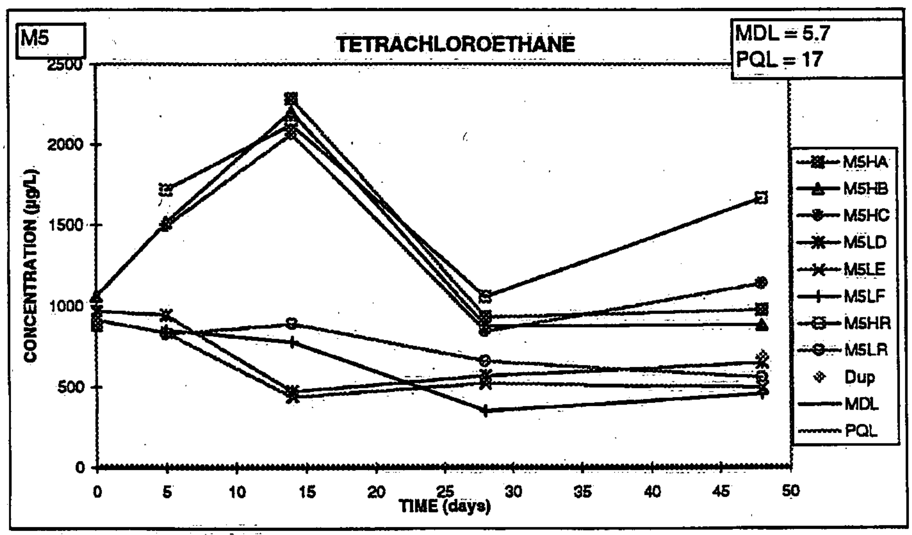
Q14

day	formate	acetate	propionate
0	12	0	259
1	20	0	344
3	4	0	298
7	16	0	299
16	19	0	330
28	15	0	375

Tetrachloroethane (TeCA) **Microcosm 5**

Result concentration in µg/L

Time	M5HR	M5HA	M5HB	M5HC	M5LR	M5LD	M5LE	M5LF	Dup	r^2
SITE WATER		2114				695				
0		885	1061			970	918			single point calibration
5	1716		1514	1492	830	945	838	852		
14	2124	2285	2206	2065	893	474	437	780		
28	1060	934	878	846	657	569	524	354		0.955
48	1667	978	884	1141	560	647	498	458	689	0.982
50										

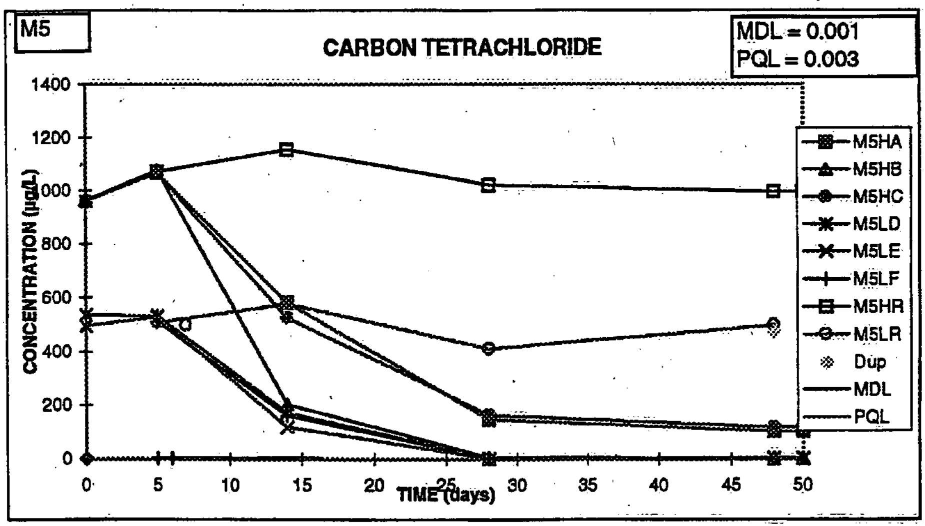


Carbon tetrachloride **Microcosm 5**

Result concentration in µg/L

SITE WATER		904				364			

Time	M5HR	M5HA	M5HB	M5HC	M5LR	M5LD	M5LE	M5LF	Dup r^2
0		962	963			535	494		
5	1072	1067	1075	1065	507	533	528	512	
14	1155	582	204	526	576	173	119	160	
28	1021	147	4	164	411	3	n.d.	n.d.	
48	997	102	3	116	498	3	n.d.	3	474
50									



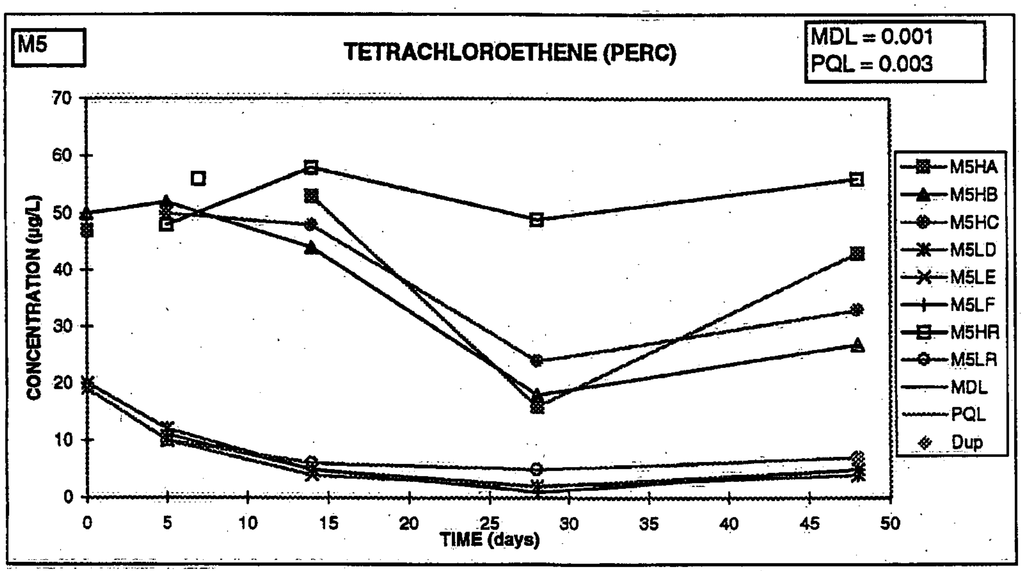
TETRACHLORORETHENE (PERC) **Microcosm 5**

Result concentration in µg/L

SITE WATER		35				6				
Time	M5HR	M5HA	M5HB	M5HC	M5LR	M5LD	M5LE	M5LF	Dup	r^2 if less than 0.99
0		47	50			20	19			
5	48		52	50	10	12	10	11		0.923
14	58	53	44	48	6	5	4	5		C: 0.981; D:0.938
28	49	16	18	24	5	2	2	1		B: 0.982; D:0.979
48	56	43	27	33	7	4	5	5	7	B: 0.924; D:0.935
50										

predicted left after gas removed

14			22	33		8	4	7
28		33	15	23		-2	1	1

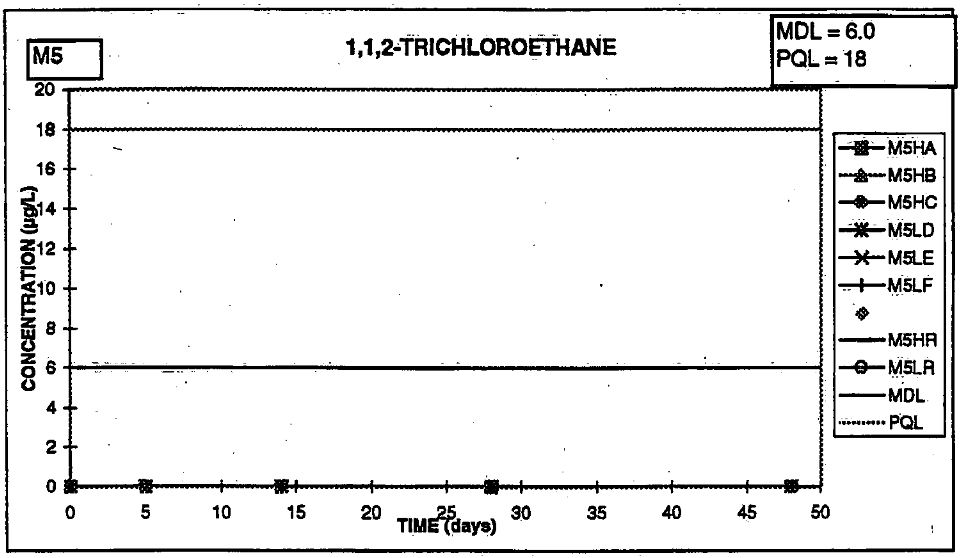


1,1,2- Trichloroethane **Microcosm 5**

Result concentration in µg/L

SITE WATER

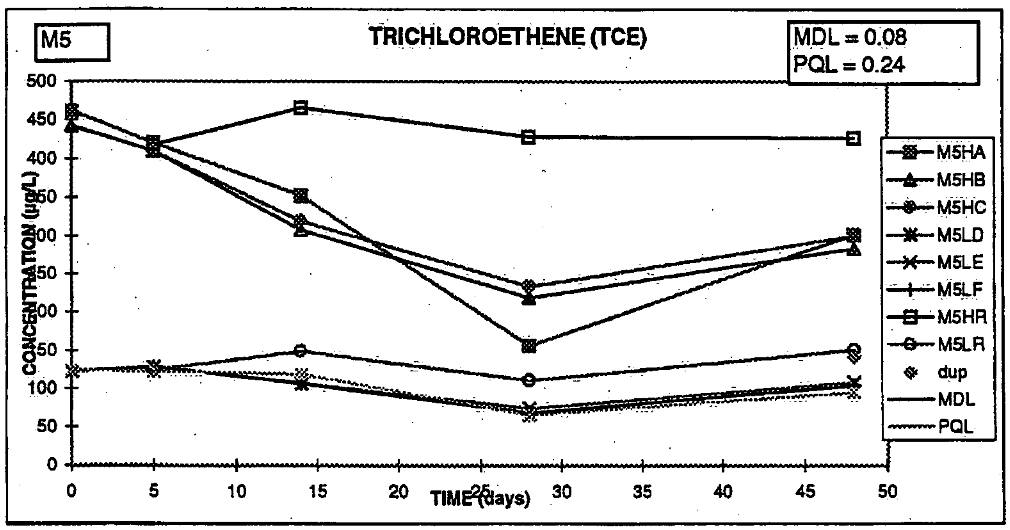
Time	M5HR	M5HA	M5HB	M5HC	M5LR	M5LD	M5LE	M5LF
0		n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
5	n.d.		12j	8j	j	17j	n.d.	7j
14	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
28	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
48	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
50								



TRICHLORORETHENE (TCE) **Microcosm 5**

Result concentration in µg/L

Time	M5HR	M5HA	M5HB	M5HC	M5LR	M5LD	M5LE	M5LF	dup
SITE WATER		197				86			
0		462	442			124	122		
5	418	420	410	410	125	123	129	129	
14	466	353	308	319	149	119	107	107	
28	428	156	219	234	111	66	74	68	
48	427	301	283	300	151	95	108	104	142
50									
Predicted left, based on venting									
14		377	279	333		99	86	103	
28		281	195	229		28	70	59	



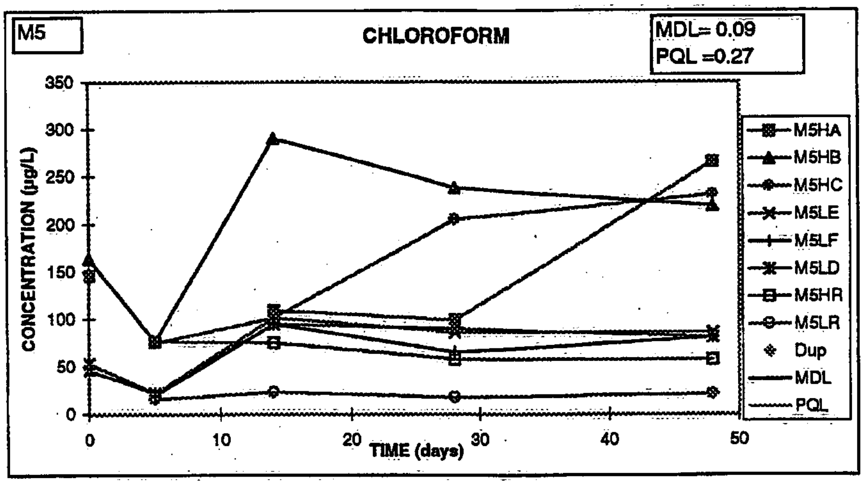
CHLOROFORM **Microcosm 5**

Result concentration in µg/L

SITE WATER		71				20				
Time	M5HR	M5HA	M5HB	M5HC	M5LR	M5LD	M5LE	M5LF	Dup	r^2 if less than 0.99
0		146	164			46	58			single point calibration
5	77		76	75	16	22	22	20		
14	75	109	290	101	23	95	101	95		0.979
28	58	99	238	205	18	90	86	65		
48	57	265	219	231	21	81	86	81	21	
50										

Amount present based on venting

14			69	71	16	21	20	19
28		102	259	93	23	74	91	82

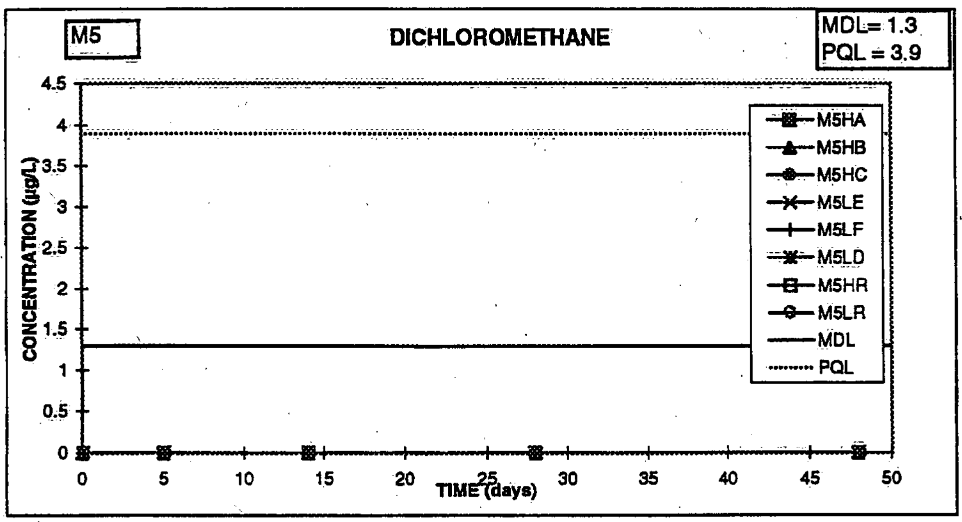


DICHLOROMETHANE **Microcosm 2** MAC = 5 µg/L

Result concentration in µg/L

SITE WATER <PQL <PQL

Time	M5HR	M5HA	M5HB	M5HC	M5LR	M5LD	M5LE	M5LF	r
0		n.d.	n.d.		n.d.	n.d.			
5	n.d.		n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	single point
14	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	
28	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	
48	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	
50									

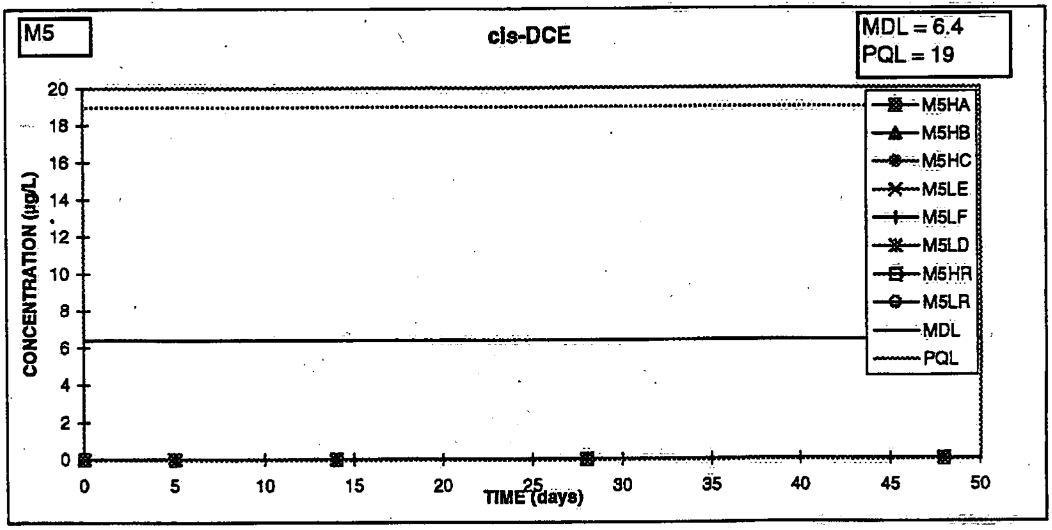


cis-DICHLOROETHENE **Microcosm 5** MAC = 70 µg/L

Result concentration in µg/L

SITE WATER <PQL <PQL

Time	M5HR	M5HA	M5HB	M5HC	M5LR	M5LD	M5LE	M5LF
0		n.d.	n.d.			n.d.	n.d.	
5	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
14	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
28	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
48	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
50								

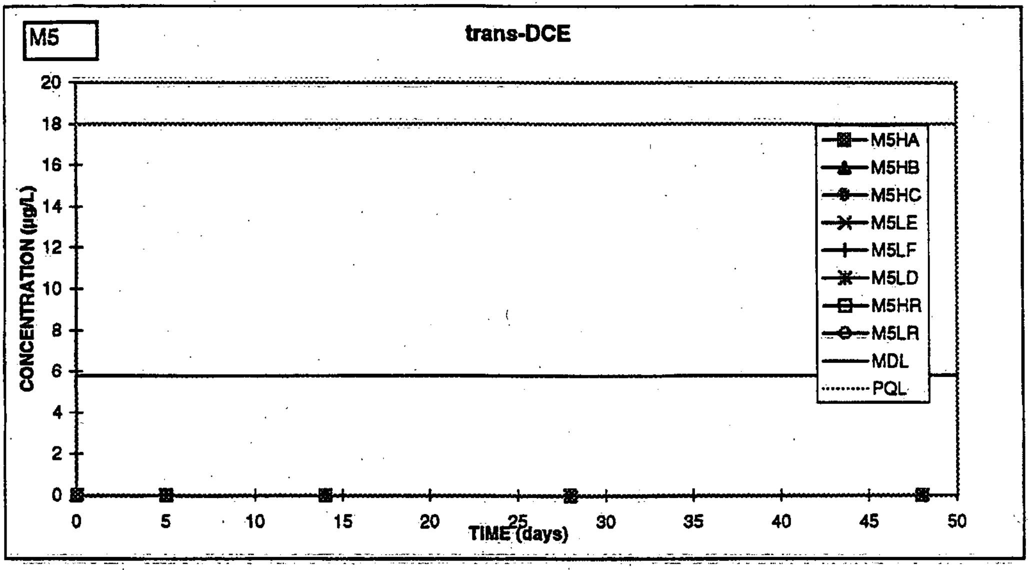


Trans-DICHLOROETHENE **Microcosm 5** MAC = 100 µg/L

Result concentration in µg/L

SITE WATER <PQL <PQL

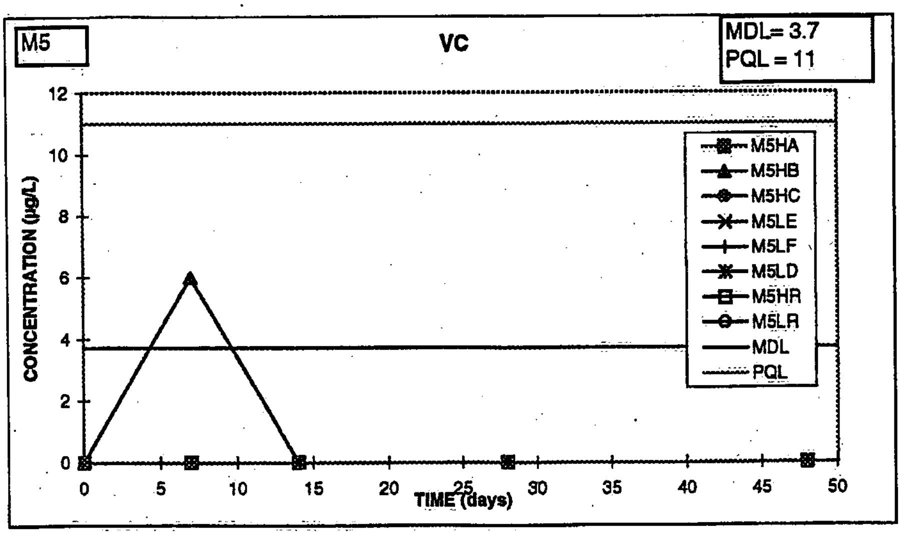
Time	M5HR	M5HA	M5HB	M5HC	M5LR	M5LD	M5LE	M5LF
0		n.d.	n.d.			n.d.	n.d.	
5	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
14	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
28	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
48	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
50								



VINYL CHLORIDE (VC) **Microcosm 5**

Result concentration in µg/L

SITE WATER	<PQL					<PQL			
Time	**M5HR**	**M5HA**	**M5HB**	**M5HC**	**M5LR**	**M5LD**	**M5LE**	**M5LF**	
0		n.d.	n.d.			n.d.	n.d.		
7	n.d.	n.d.	6	n.d.	n.d.	n.d.	n.d.	n.d.	single point calibration
14	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	
28	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	
48	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	
50									

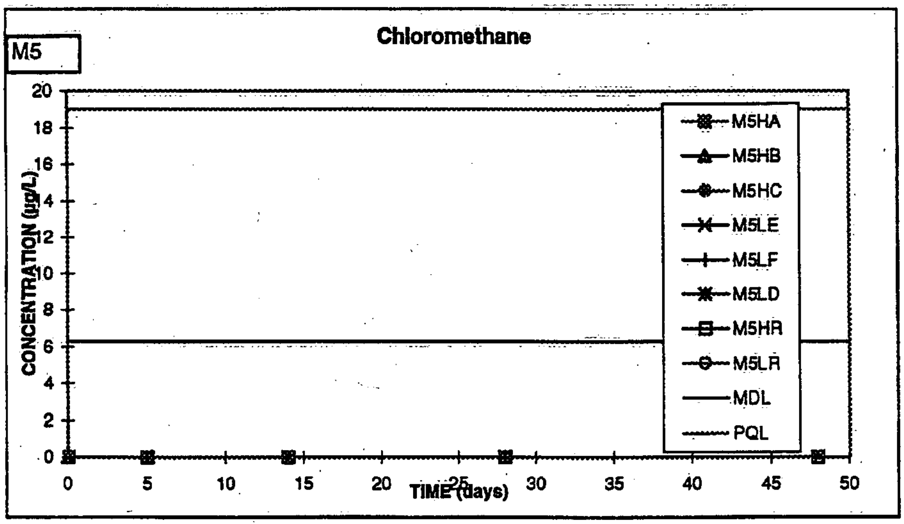


CHLOROMETHANE **Microcosm 5**

Result concentration in µg/L

SITE WATER <PQL <PQL

Time	M5HR	M5HA	M5HB	M5HC	M5LR	M5LD	M5LE	M5LF
0		n.d.	n.d.			n.d.	n.d.	
5	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
14	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
28	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
48	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
50								

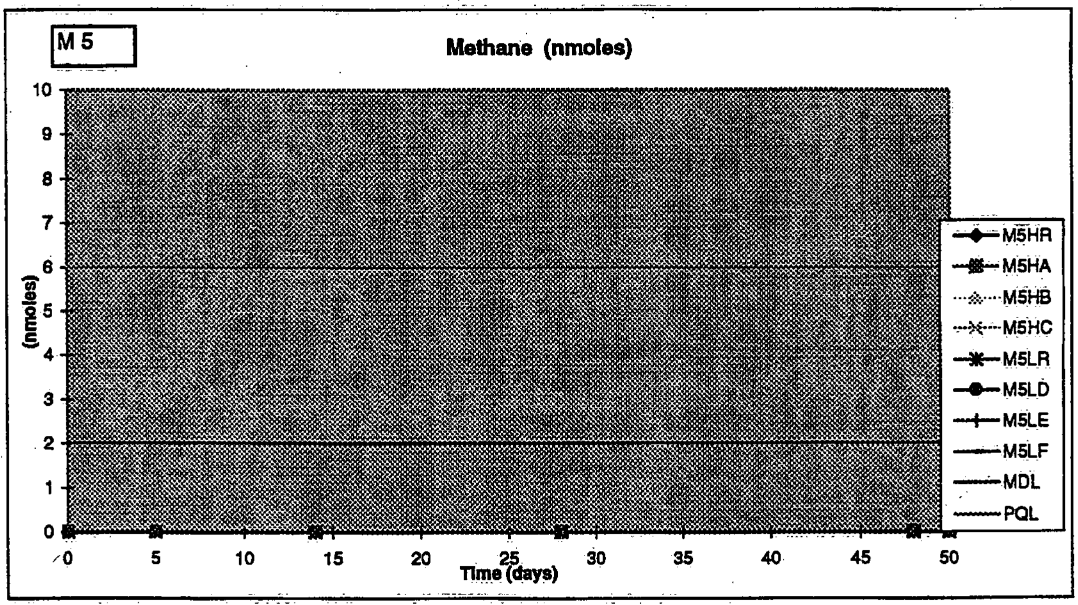


METHANE **Microcosm 5**

SITE WATER <PQL <PQL

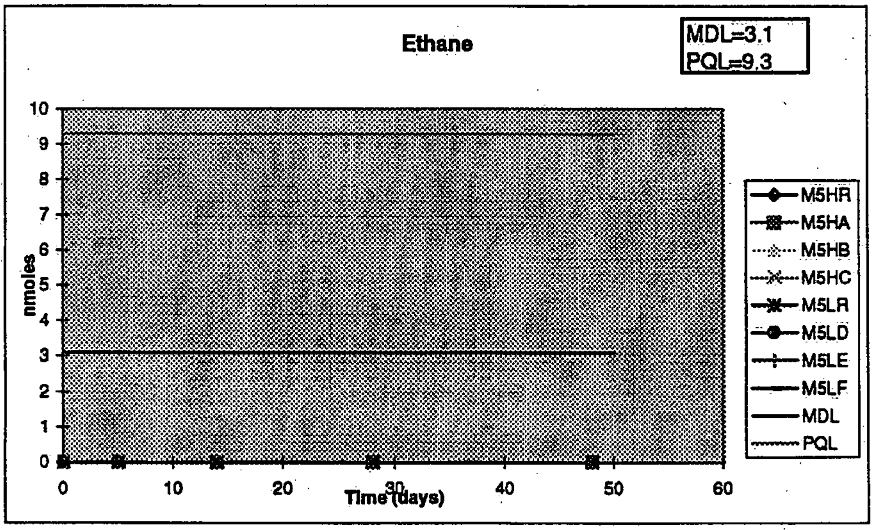
ppm/v

Time	M5HR	M5HA	M5HB	M5HC	M5LR	M5LD	M5LE	M5LF	Dup
0	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	
5	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	
14	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	
28	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	
48	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
50									



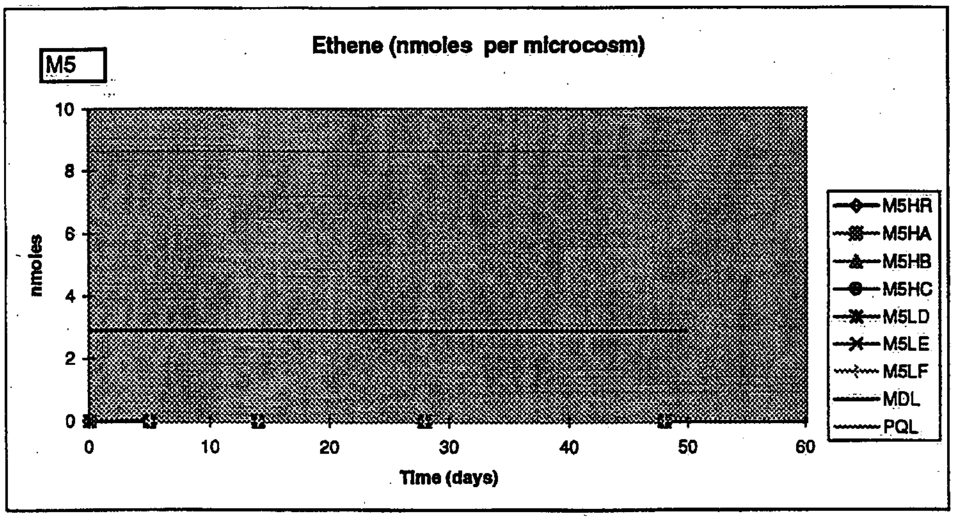
ETHANE **Microcosm 5**

SITE WATER	<PQL					<PQL		
			ppm/v					
Time	M5HR	M5HA	M5HB	M5HC	M5LR	M5LD	M5LE	M5LF
0		n.d.	n.d.			n.d.	n.d.	
5	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
14	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
28	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
48	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
50								



ETHENE **Microcosm 5**

				ppm/v				
SITE WATER		<PQL				<PQL		
Time	M5HR	M5HA	M5HB	M5HC	M5LR	M5LD	M5LE	M5LF
0		n.d.	n.d.			n.d.	n.d.	
5	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
14	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
28	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
48	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
50								

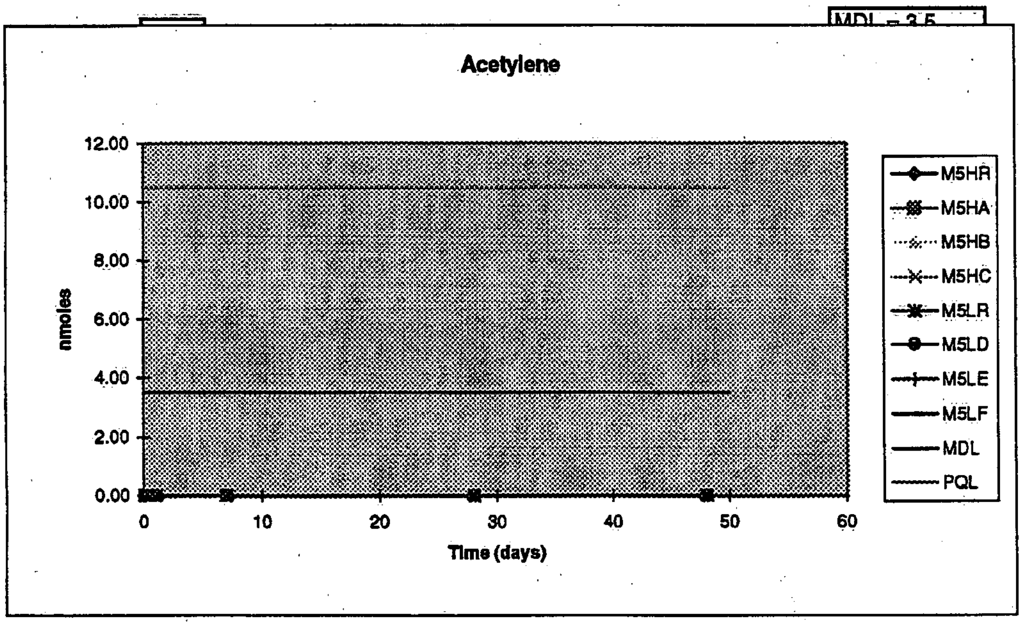


ACETYLENE **Microcosm 5**

SITE WATER <PQL <PQL

ppm/v

Time	M5HR	M5HA	M5HB	M5HC	M5LR	M5LD	M5LE	M5LF	Dup
0	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	
1	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	
7	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	
28	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	
48	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
50									



Volatile Fatty Acids-M5

Citrate None Added

Lactate

day	M5LD	M5LE	M5LF	M5HA	M5HB	M5HC
				conc. (mg/L)		
8	n.d.	n.d.	n.d.	n.d.	20j	15j
14	178	275	163	52	407	69
28	411	1498	1390	1801	1175	1718
48	607	2035	2340	2842	2169	2220

Formate

day	M5LD	M5LE	M5LF	M5HA	M5HB	M5HC
				conc. (mg/L)		
8	15	10j	13	10j	11j	13
14	57	41	38	40	43	44
28	78	61	62	56	70	99
48	101	86	76	87	88	79

Acetate

day	M5LD	M5LE	M5LF	M5HA	M5HB	M5HC
				conc. (mg/L)		
8	n.d.	n.d.	n.d.	41j	67	53
14	221	353	235	192	348	174
28	569	601	443	372	432	323
48	939	493	558	412	502	366

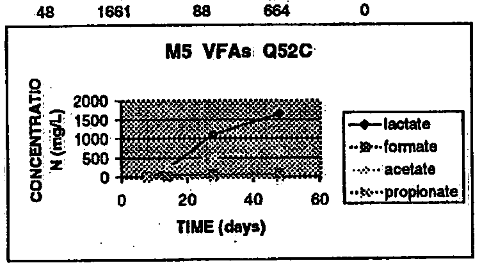
Propionate

day	M5LD	M5LE	M5LF	M5HA	M5HB	M5HC
				conc. (mg/L)		
8	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
14	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
28	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
48	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.

This data only for the purposes of graphing

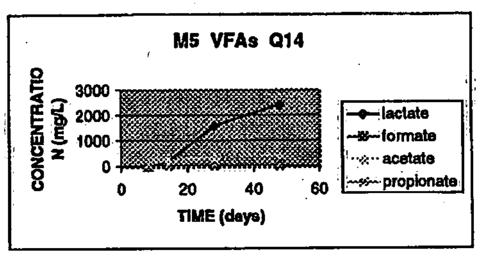
Q52C

day	lactate	formate	acetate	propionate
8	0	13	0	0
14	205	45	270	0
28	1100	67	538	0
48	1661	88	664	0



Q14

day	lactate	formate	acetate	propionate
8	12	11	54	0
14	176	42	238	0
28	1565	75	378	0
48	2411	84	427	0



Glucose

day	M5LD	M5LE	M5LF	M5HA	M5HB	M5HC
				conc. (mM)		
0	12.3	11.3	12.4	13.4	12.5	13.5
5	12.6	10.4	13.3	12.5	11	13.4
8	12.9	12.1	12.8	12.4	10.9	12.3
14	10	7.6	11.6	9.9	7.8	10.9
15	19.3	19.6	24.6	23.8	24.7	22.7
20	15.4	17.0	23.2	22.4	19.0	21.9
28	20.8	19.4	25.2	27.0	26.0	25.2
35	19.2	19.5	26.5	25.7	25.3	24.1
42	19.3	18.8	22.4	24.4	25.6	21.9
48	19.1	18.4	24.0	25.7	25.7	21.4

Titanium

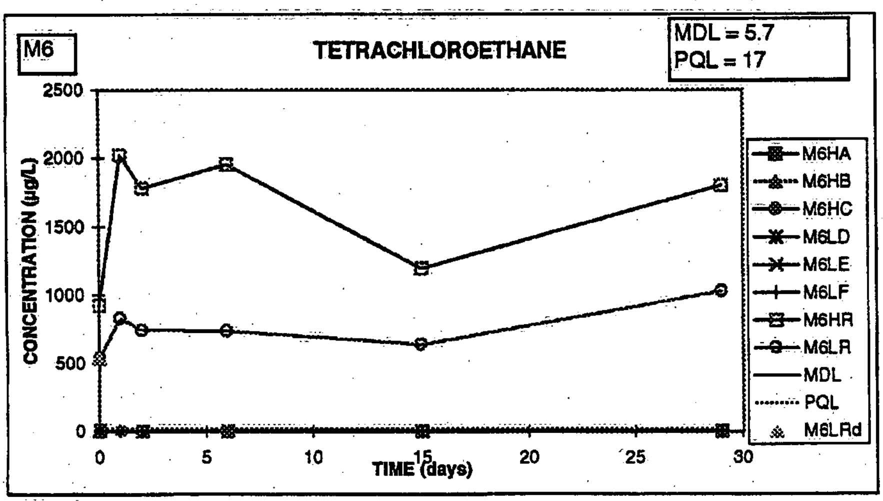
None added

Tetrachloroethane (TeCA) **Microcosm 6**

Result concentration in µg/L

SITE WATER 2114 695

Time	M6HR	M6HA	M6HB	M6HC	M6LR	M6LD	M6LE	M6LF	M6LRd	r^2 (if<0.99)
0	929	10j			540	3j			538	0.959
0.04			n.d.				n.d.			
0.08				n.d.				n.d.		
1	2021				831					0.959
2	1778	n.d.	n.d.	n.d.	746	n.d.	n.d.	n.d.		0.959
6	1955	n.d.	n.d.	n.d.	738					
14	1194	n.d.	n.d.	n.d.	639	n.d.	n.d.	n.d.		0.98
29	1802	n.d.	n.d.	n.d.	1030	n.d.	n.d.	n.d.		B: 0.981, C:0.972

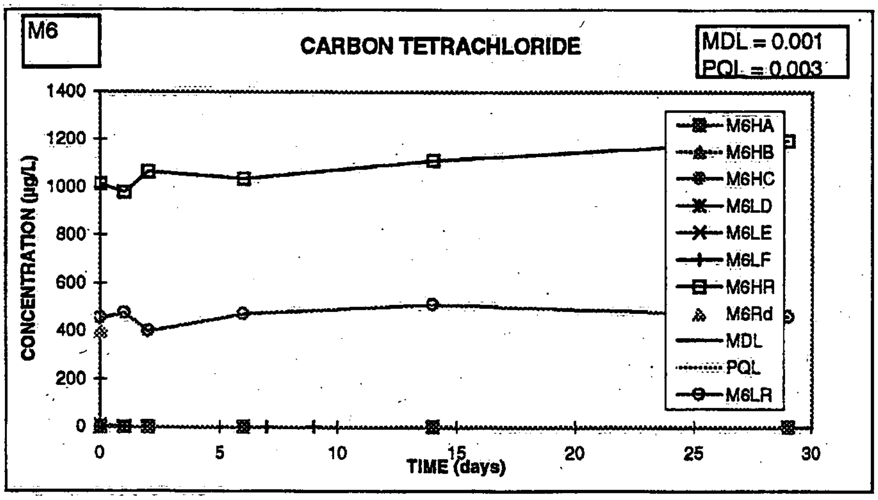


Carbon tetrachloride **Microcosm 6** MAC = 5 µg/L

Result concentration in µg/L

SITE WATER 904 364

Time	M6HR	M6HA	M6HB	M6HC	M6LR	M6LD	M6LE	M6LF	M6LRd
0	1014	0.3j			454	7			398
0.04			n.d.				3j		
0.08				0.05j				0.3j	
1	980	n.d.	n.d.	n.d.	474	n.d.	n.d.	n.d.	
2	1065	n.d.	n.d.	n.d.	397	0.05j	0.05j	0.05j	
6	1035	n.d.	n.d.	n.d.	472	n.d.	n.d.	n.d.	
14	1113	n.d.	n.d.	n.d.	510	n.d.	n.d.	n.d.	
29	1197	n.d.	n.d.	n.d.	460	n.d.	n.d.	n.d.	

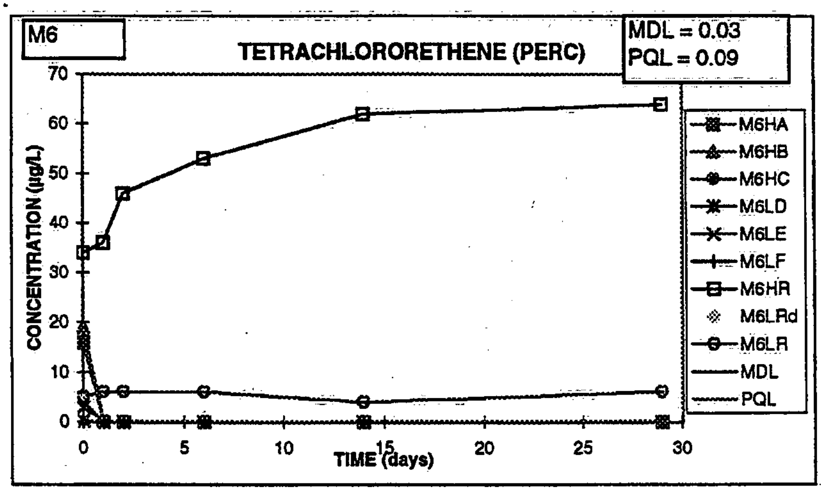


TETRACHLORORETHENE (PERC) **Microcosm 6**

Result concentration in µg/L

SITE WATER 35 6

Time	M6HR	M6HA	M6HB	M6HC	M6LR	M6LD	M6LE	M6LF	M6LRd	r^2 if less than 0.99
0	34	16			5	3			5	0.977
0.04			19				0.3			0.884
0.08				4				n.d.		
1	36	n.d.	n.d.	n.d.	6	n.d.	n.d.	n.d.		
2	46	n.d.	n.d.	n.d.	6	n.d.	n.d.	n.d.		0.923
6	53	n.d.	n.d.	n.d.	6	n.d.	n.d.	n.d.		0.938
14	62	n.d.	n.d.	n.d.	4	n.d.	n.d.	n.d.		C:0.901; D:0.939
29	64	n.d.	n.d.	n.d.	6	n.d.	n.d.	n.d.		

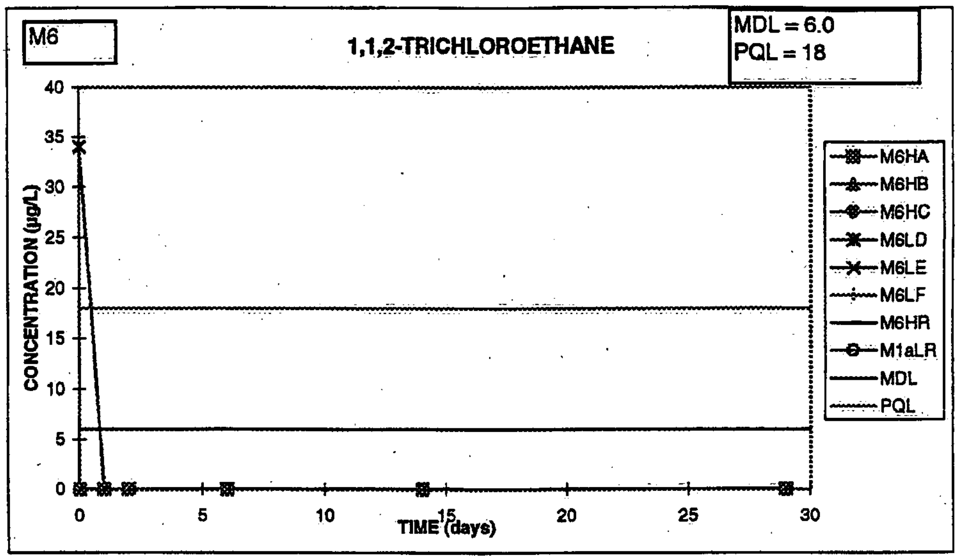


1,1,2- Trichloroethane **Microcosm 6**

Result concentration in µg/L

SITE WATER

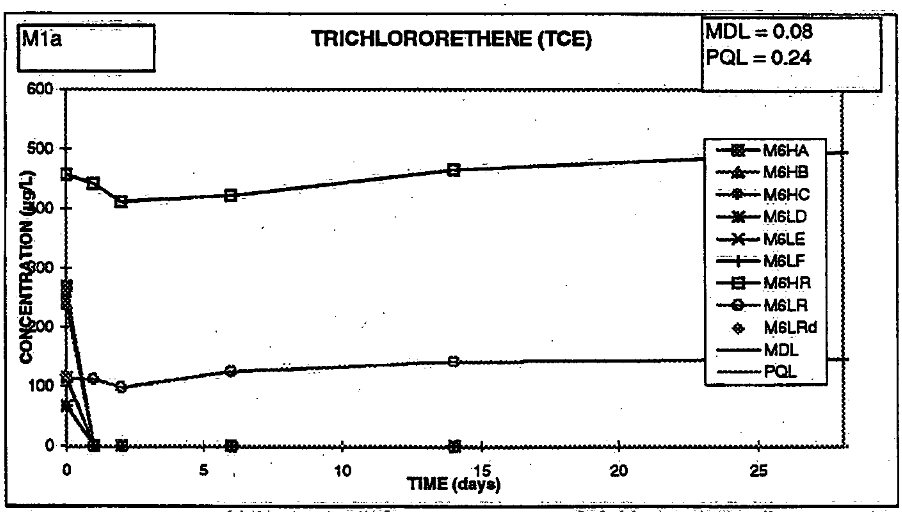
Time	M6HR	M6HA	M6HB	M6HC	M6LR	M6LD	M6LE	M6LF	M6LRd
0	n.d.	n.d.			n.d.	34			n.d.
0.04			n.d.				n.d.		
0.08				n.d.				n.d.	
1	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	
2	7j	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	
6	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	
14	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	
29	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	



TRICHLORORETHENE (TCE) **Microcosm 6**

Result concentration in µg/L

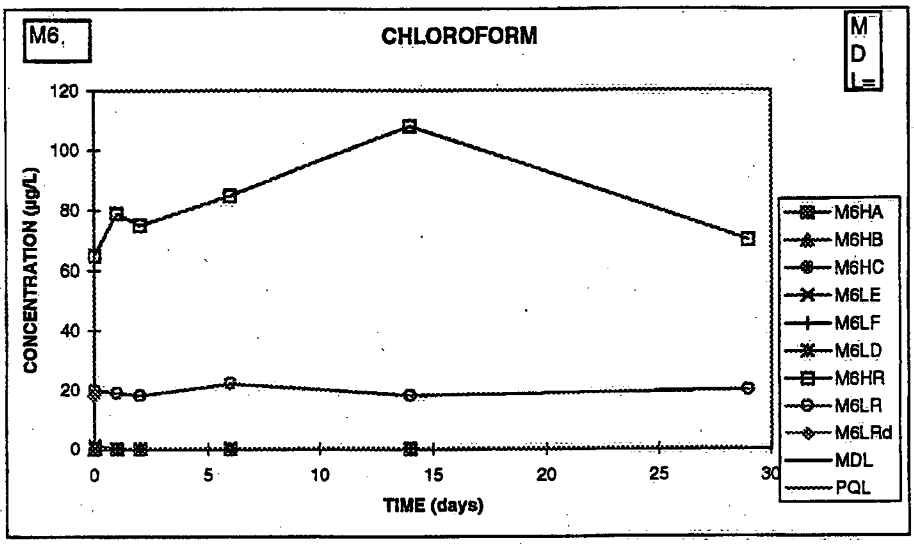
SITE WATER		197				86				
Time	M6HR	M6HA	M6HB	M6HC	M6LR	M6LD	M6LE	M6LF	M6LRd	r^2 (if not 0.99)
0	457	269			113	115			119	
0.04			240				68			
0.08				250				68		
1	442	n.d.	n.d.	n.d.	112	n.d.	n.d.	n.d.		
2	411	n.d.	n.d.	n.d.	98	n.d.	n.d.	n.d.		
6	422	n.d.	n.d.	n.d.	126	n.d.	n.d.	n.d.		
14	465	n.d.	n.d.	n.d.	142	n.d.	n.d.	n.d.		
29	497	n.d.	n.d.	n.d.	146	n.d.	n.d.	n.d.		



CHLOROFORM **Microcosm 6**

Result concentration in µg/L

Time	M6HR	M6HA	M6HB	M6HC	M6LR	M6LD	M6LE	M6LF	M6LRd	r^2 (if < 0.99)
SITE WATER		71				20				
0	65	n.d.			20	1			18	
0.04			n.d.				n.d.			
0.08				n.d.				n.d.		
1	79	n.d.	n.d.	n.d.	19	n.d.	n.d.	n.d.		0.963
2	75	n.d.	n.d.	n.d.	18	n.d.	n.d.	n.d.		0.963
6	85	n.d.	n.d.	n.d.	22	n.d.	n.d.	n.d.		
14	108	n.d.	n.d.	n.d.	18	n.d.	n.d.	n.d.		0.975
29	70	n.d.	n.d.	n.d.	20	n.d.	n.d.	n.d.		0.943

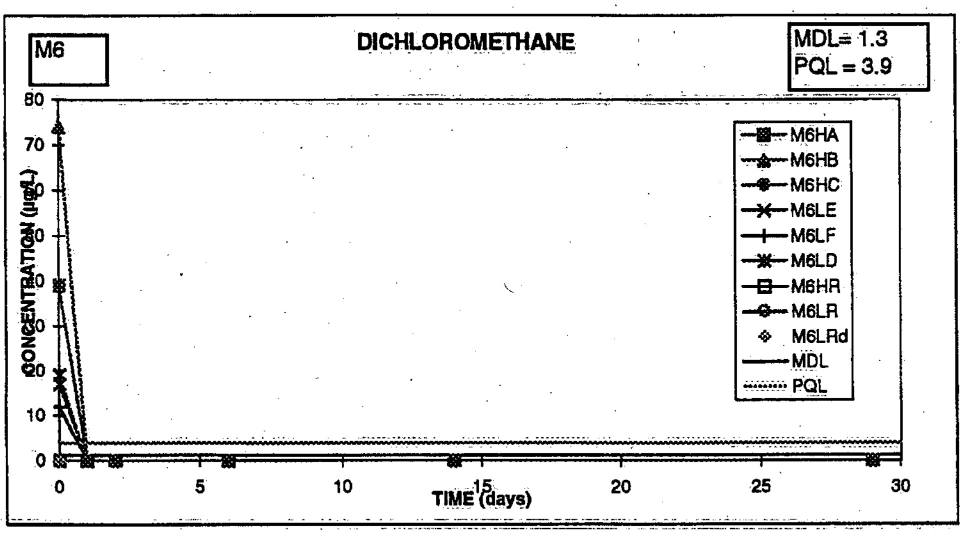


DICHLOROMETHANE **Microcosm 6** MAC = 5 µg/L

Result concentration in µg/L

SITE WATER <PQL <PQL

Time	M6HR	M6HA	M6HB	M6HC	M6LR	M6LD	M6LE	M6LF	M6LRd	r^2 (if < 0.99)
0	n.d.	39			n.d.	19			n.d.	
0.04			74				17			0.939
0.08				39				12		
1	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.		
2	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.		
6	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.		
14	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.		
29	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.		



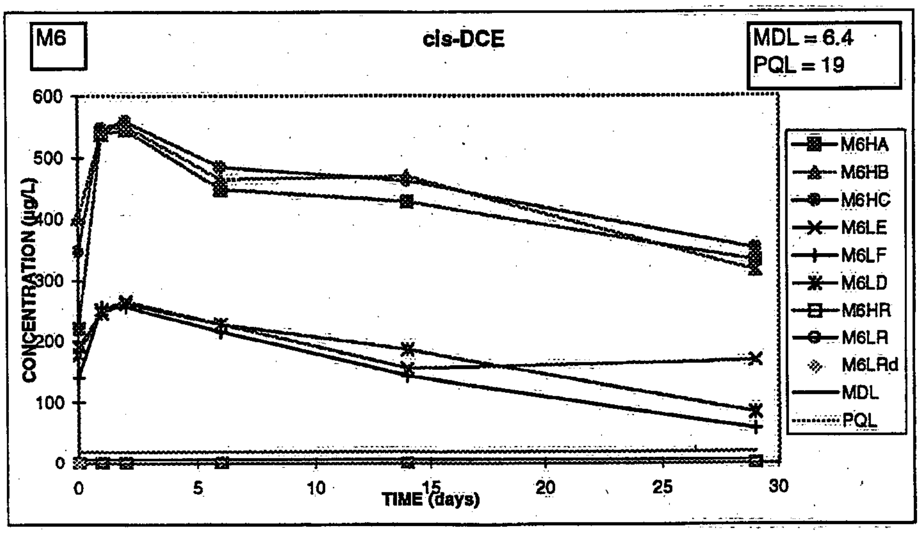
cis-DICHLOROETHENE **Microcosm 6** MAC = 70 µg/L

Result concentration in µg/L

SITE WATER <PQL <PQL

Time	M6HR	M6HA	M6HB	M6HC	M6LR	M6LD	M6LE	M6LF	M6LRd	r^2 (if < 0.99)
0	n.d.	221			n.d.	191				
0.04			401				177			
0.08				347				139		
1	n.d.	537	544	547	n.d.	246	252	255		
2	n.d.	546	552	559	n.d.	262	266	256		
6	n.d.	448	465	484	n.d.	228	228	215		
14	n.d.	429	470	463	n.d.	186	155	143		0.96
29	n.d.	332	316	352	n.d.	83	167	56		

Predicted concentration remaining at	M6HA	M6HB	M6HC	M6LD	M6LE	M6LF
day 6	403	417	439	205	205	193
day 14	414	449	435	178	150	137
DAY 29	291	280	349	72	163	55



Trans-DICHLOROETHENE **Microcosm 6** MAC = 100 µg/L

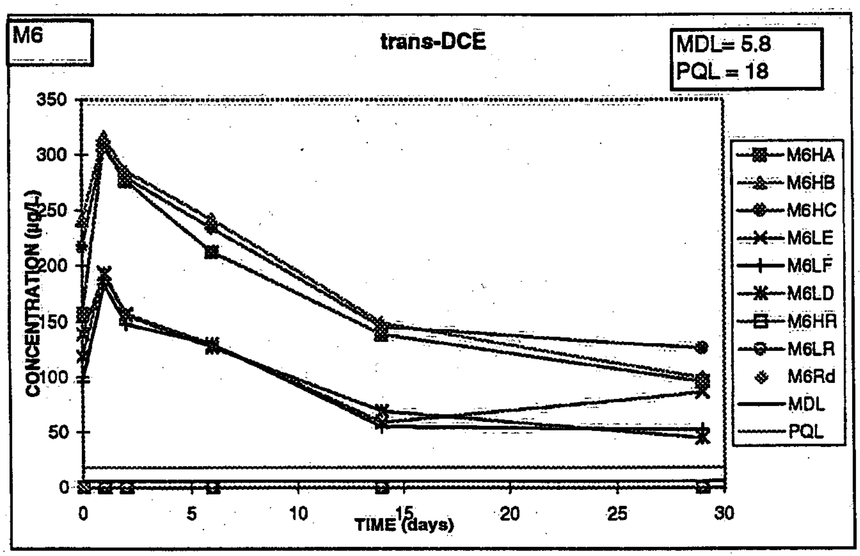
Result concentration in µg/L

SITE WATER <PQL <PQL

Time	M6HR	M6HA	M6HB	M6HC	M6LR	M6LD	M6LE	M6LF	M6LRd	r^2 (if<0.99)
0	n.d.	157			n.d.	**139**			n.d.	
0.04			241				119			
0.08				217				96		
1	n.d.	308	316	308	n.d.	193	194	184		
2	n.d.	277	286	280	n.d.	156	157	148		0.98
6	n.d.	213	242	234	n.d.	127	130	130		
14	n.d.	139	149	146	n.d.	69	59	55		
29	n.d.	96	99	126	n.d.	45	86	52		0.906

Predicted value based on amount of gas removed

	M6HA	M6HB	M6HC	M6LD	M6LE	M6LF
remaining at day 6	170	192	190	101	103	104
day 14	129	136	128	63	55	51
day 29	72	76	124	33	82	49

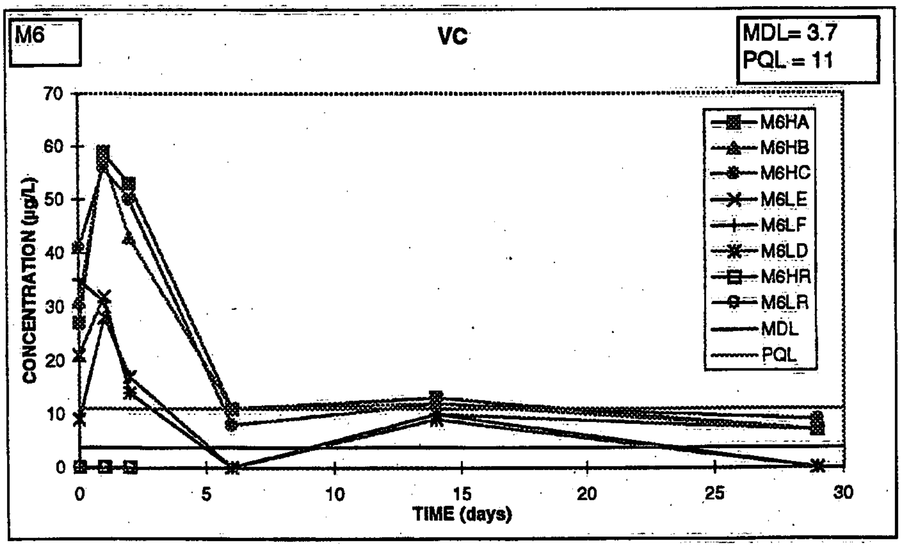


VINYL CHLORIDE (VC) **Microcosm 6** PQL = 11 µg/L

Result concentration in µg/L

SITE WATER <PQL <PQL

Time	M6HR	M6HA	M6HB	M6HC	M6LR	M6LD	M6LE	M6LF	M6LRd
0	n.d.	27			n.d.	9j			n.d.
0.04			31				21		
0.08				41				35	
1	n.d.	59	58	56	n.d.	28	32	31	
2	n.d.	53	43	50	n.d.	17	14	14	
6	n.d.	11	11	8	n.d.	n.d.	n.d.	n.d.	
14	n.d.	13	12	12	n.d.	9j	10j	10j	
29	n.d.	7j	7j	9j	n.d.	n.d.	7j	n.d.	

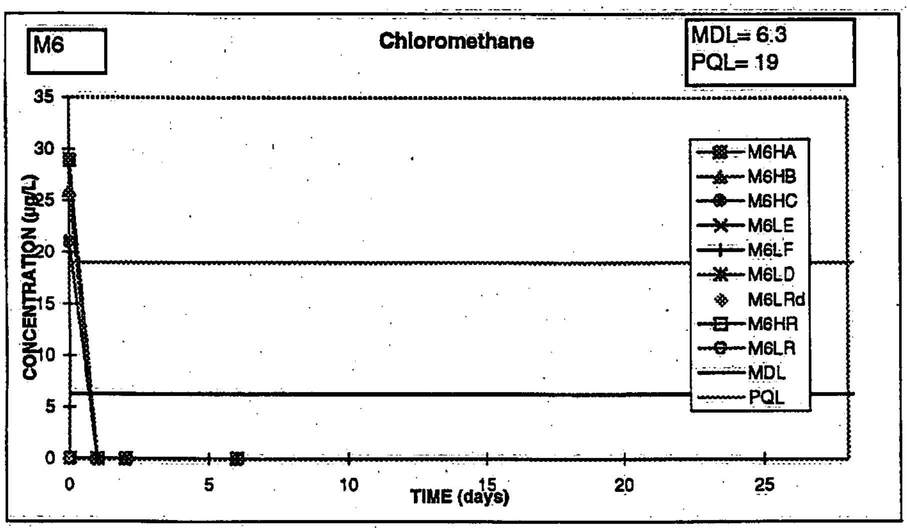


CHLOROMETHANE **Microcosm 6**

Result concentration in µg/L

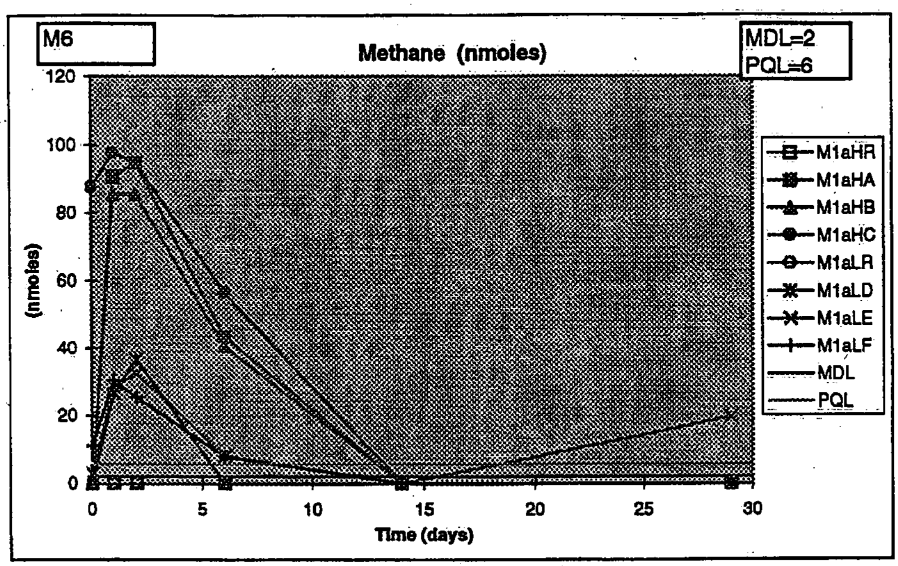
SITE WATER <PQL <PQL

Time	M6HR	M6HA	M6HB	M6HC	M6LR	M6LD	M6LE	M6LF	M6LRd
0	n.d.	29			n.d.	n.d.			n.d.
0.04			26				n.d.		
0.08				21				n.d.	
1	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	
2	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	
6	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	
14	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	
29	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	



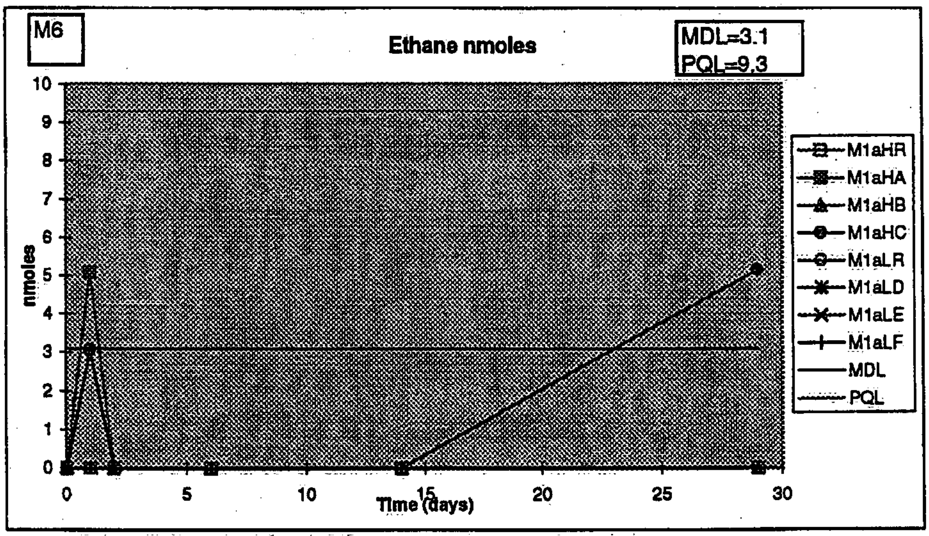
METHANE **Microcosm 6**

SITE WATER	<PQL						<PQL		
				RESULTS in ppmv					
Time	M6HR	M6HA	M6HB	M6HC	M6LR	M6LD	M6LE	M6LF	M6LRd
0	n.d.	n.d.			n.d.	n.d.			n.d.
0.04			n.d.				3j		
0.08				86				11	
1	n.d.	89	84	96	n.d.	26	28	30	
2	n.d.	93	84	93	n.d.	36	32	25	
6	n.d.	11	10	15	n.d.	n.d.	2	2	
14	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	
29	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	12	n.d.	



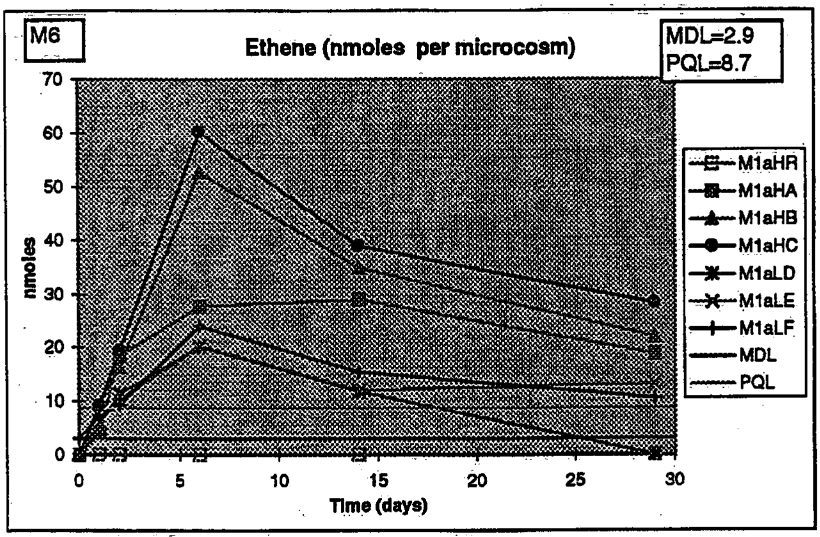
ETHANE **Microcosm 6**

SITE WATER	<PQL				<PQL				
			Results in ppmv						
Time	M6HR	M6HA	M6HB	M6HC	M6LR	M6LD	M6LE	M6LF	M6LRd
0	n.d.	n.d.			n.d.	n.d.			
0.04			n.d.				n.d.		
0.08				n.d.				n.d.	
1	n.d.	5j	5j	3j	n.d.	n.d.	n.d.	n.d.	
2	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	
6	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	
14	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	
29	n.d.	n.d.	n.d.	4j	n.d.	n.d.	n.d.	n.d.	



ETHENE **Microcosm 6**

SITE WATER		<PQL				<PQL			
			Results in ppmv						
Time	M6HR	M6HA	M6HB	M6HC	M6LR	M6LD	M6LE	M6LF	M6LRd
0	n.d.	n.d.			n.d.	n.d.			n.d.
0.04			n.d.				n.d.		
0.08				1				3	
1	n.d.	4j	9	9	n.d.	6j	6j	7j	
2	n.d.	18	16	19	n.d.	11	10	9	
6	n.d.	7j	13	16	n.d.	5j	5j	6j	
14	n.d.	14	15	14	n.d.	5j	6j	7j	
29	n.d.	4j	5j	22	n.d.	n.d.	8j	6j	

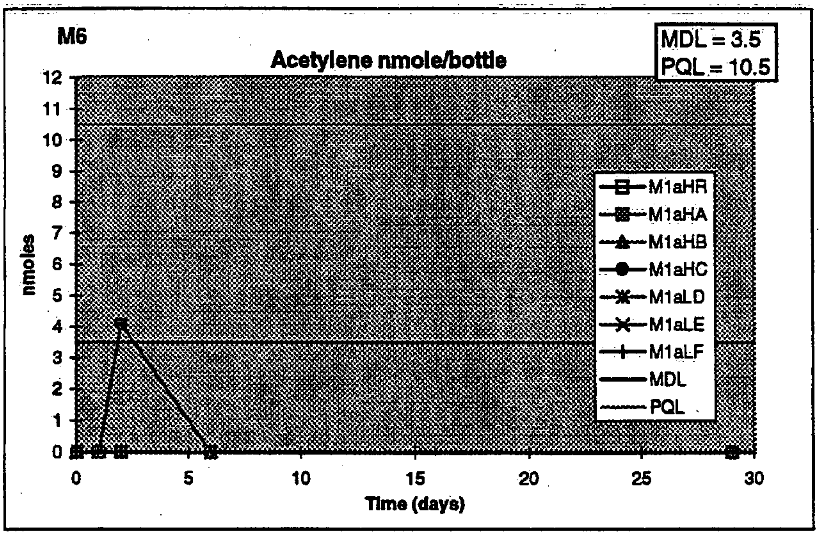


ACETYLENE **Microcosm 6**

SITE WATER <PQL <PQL

Results in ppmv

Time	M6HR	M6HA	M6HB	M6HC	M6LR	M6LD	M6LE	M6LF	M6LRd
0	n.d.	n.d.			n.d.	n.d.			n.d.
0.04			n.d.				n.d.		
0.08				n.d.				n.d.	
1	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
2	n.d.	n.d.	n.d.	4j	n.d.	n.d.	n.d.	n.d.	
6	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	
14	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	
29	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	



Volatile Fatty Acids - M6

Lactate

day	M6LD	M6LE	conc. (mg/L) M6LF	M6HA	M6HB	M6HC
0	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
1	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
2	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
6	69	111	107	101	68	97
14	76	67	74	54	80	88
29	178	97	n.d.	71	54	77

Formate

day	M6LD	M6LE	conc. (mg/L) M6LF	M6HA	M6HB	M6HC
0	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
1	28	29	28	26	25	25
2	80	77	80	73	72	62
6	1816	1736	1739	1718	1745	1719
14	2132	1914	1934	1931	2008	1958
29	2238	927	1932	2107	1898	1781

Acetate

day	M6LD	M6LE	conc. (mg/L) M6LF	M6HA	M6HB	M6HC
0	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
1	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
2	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
6	973	925	866	838	798	810
14	1137	1100	1059	1022	1049	1055
29	5930	2666	1549	5777	4828	1237

Propionate

day	M6LD	M6LE	conc. (mg/L) M6LF	M6HA	M6HB	M6HC
0	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
1	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
2	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
6	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
14	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
29	259	n.d.	168j	n.d.	112j	117j

Q52C

day	lactate	formate	acetate	propionate
0	0	0	0	0
1	0	29	0	0
2	0	79	0	0
6	96	1784	921	0
14	72	1993	1098	0
29	138	1699	3382	142.3333

Q14

day	lactate	formate	acetate	propionate
0	0	0	0	0
1	0	25	0	0
2	0	69	0	0
6	89	1728	815	0
14	73	1988	1042	0
29	67	1929	3947	78.33333

Citrate

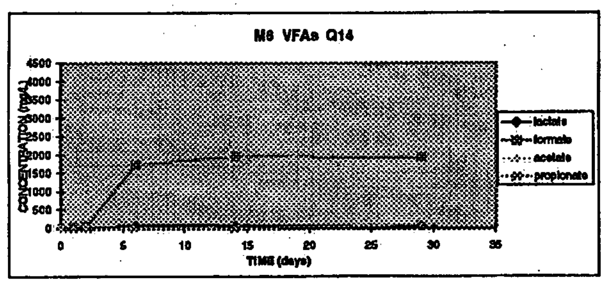
day	M6LD	M6LE	conc. (mg/L) M6LF	M6HA	M6HB	M6HC
0	6182	6732	6739	6702	6751	6711
1	7179	6954	6719	6754	6648	6639
2	7402	6820	6773	7450	7840	7185
6	6715	6302	6372	6378	6509	6419
14	7334	6962	6642	6958	6941	6930
29	726j	5452	7019	842j	599j	6339

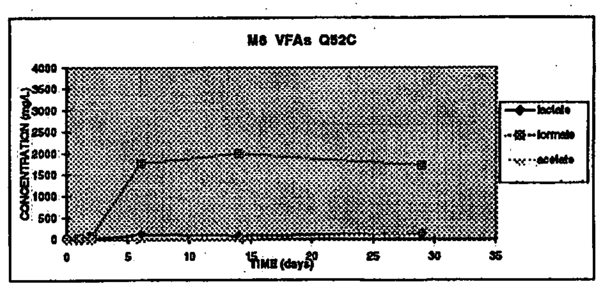
Titanium

day	M6LD	M6LE	conc. (mM) M6LF	M6HA	M6HB	M6HC
0	31.8	32.1	32.3	31.4	31.6	31.5

Glucose

day	M6LD	M6LE	conc. (mM) M6LF	M6HA	M6HB	M6HC
0	19.5	19.7	19.9	20.5	22.0	19.9
1	18.2	21.2	18.9	19.4	20.3	21.0
2	17.8	16.4	17.7	17.7	19.3	18.2
6	1.4	1.8	1.8	1.9	2.1	2.0
14	1.3	1.4	1.6	1.7	2.0	1.8
29	0.0	1.2	1.2	0.8	0.7	1.3





Glucose

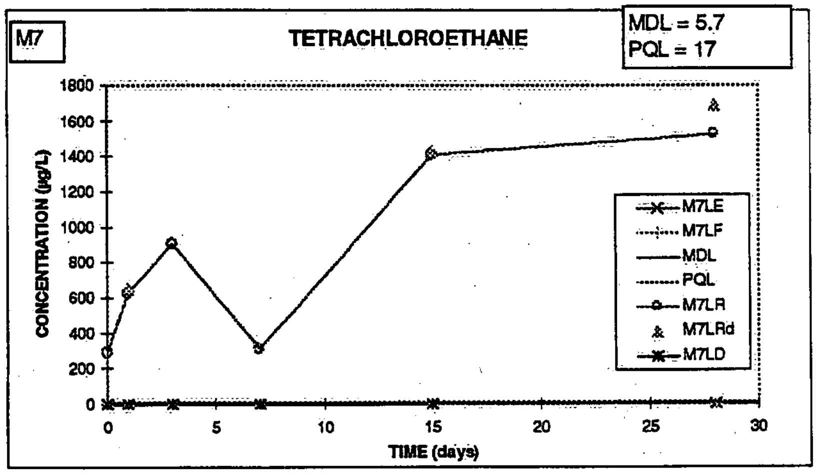
day	M6LD	M6LE	conc. (mM) M6LF	M6HA	M6HB	M6HC
0	19.5	19.7	19.9	20.5	22.0	19.9
1	18.2	21.2	18.9	19.4	20.3	21.0
2	17.8	16.4	17.7	17.7	19.3	18.2
6	1.4	1.8	1.8	1.9	2.1	2.0
14	1.3	1.4	1.6	1.7	2.0	1.8
29	0.0	1.2	1.2	0.8	0.7	1.3

Tetrachloroethane (TeCA) **Microcosm 7 Alternate chelator**

Result concentration in µg/L

SITE WATER 695

Time	M7LR	M7LD	M7LE	M7LF	Dup	r^2 (if< 0.99)
0	291	n.d.				0.981
0.04			n.d.			
0.08				n.d.		
1	627	n.d.	n.d.	n.d.	657	0.981
3	905	n.d.	n.d.	n.d.		0.974
7	317					0.974
15	1409	n.d.	n.d.	n.d.	1429	0.982
28	1518	n.d.	n.d.	n.d.	1686	0.966

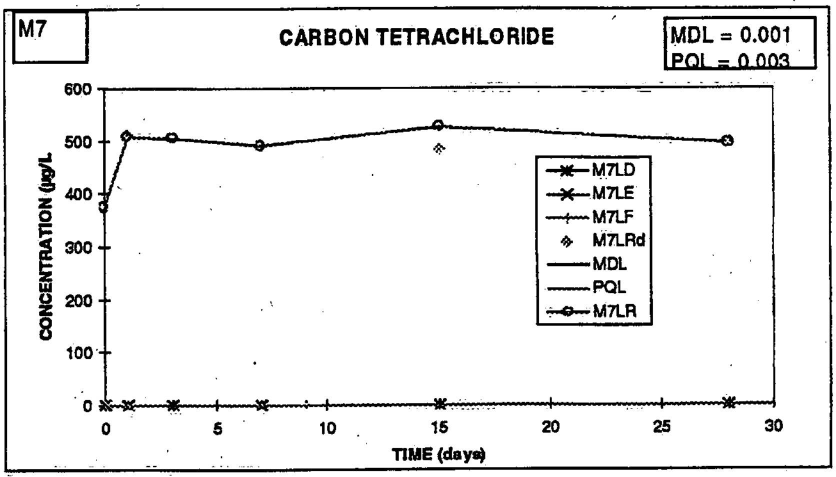


Carbon tetrachloride **Microcosm 7 Alternate chelator** MAC = 5 µg/L

Result concentration in µg/L

SITE WATER 364

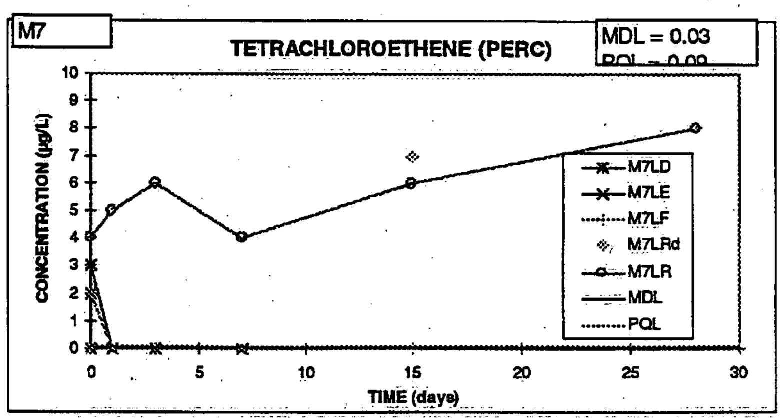
Time	M7LR	M7LD	M7LE	M7LF	Dup
0	374	n.d.			
0.04			n.d.		
0.08				n.d.	
1	506	n.d.	n.d.	n.d.	511
3	503	n.d.	n.d.	n.d.	
7	490	n.d.	n.d.	n.d.	
15	526	n.d.	n.d.	n.d.	486
28	495	n.d.	n.d.	n.d.	497



TETRACHLORORETHENE (PERC) **Microcosm 7 Alternate chelator**

Result concentration in µg/L

Time	M7LR	M7LD	M7LE	M7LF	Dup	r^2 if less than 0.99
SITE WATER		6				
0	4	3				
0.04			2			
0.08				2		
1	5	n.d.	n.d.	n.d.	5	
3	6	n.d.	n.d.	n.d.		
7	4	n.d.	n.d.	n.d.		
15	6	n.d.	n.d.	n.d.	7	
28	8	n.d.	n.d.	n.d.	8	

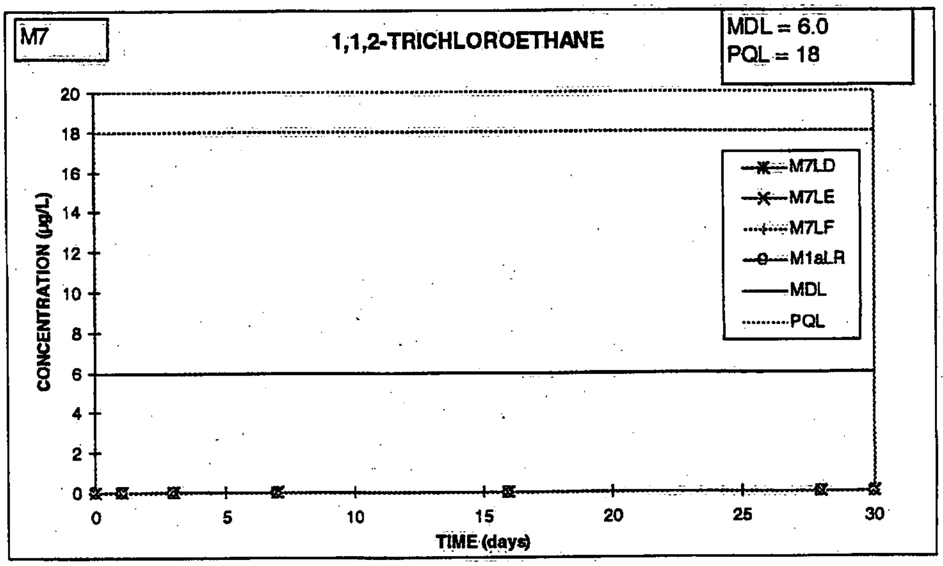


1,1,2- Trichloroethane **Microcosm 7 Alternate chelator**

Result concentration in µg/L

SITE WATER

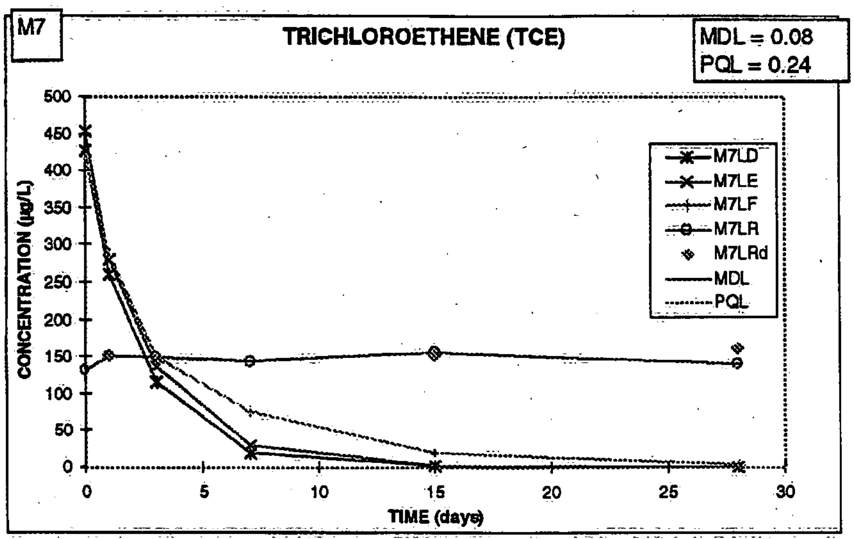
Time	M7LR	M7LD	M7LE	M7LF	Dup
0	n.d.	n.d.			
0.04			n.d.		
0.08				n.d.	
1	n.d.	n.d.	n.d.	n.d.	n.d.
3	n.d.	n.d.	n.d.	n.d.	
7	n.d.	n.d.	n.d.	n.d.	
15	n.d.	n.d.	n.d.	n.d.	n.d.
28	n.d.	n.d.	n.d.	n.d.	n.d.



TRICHLORORETHENE (TCE) **Microcosm 7 Alternate chelator**

Result concentration in µg/L

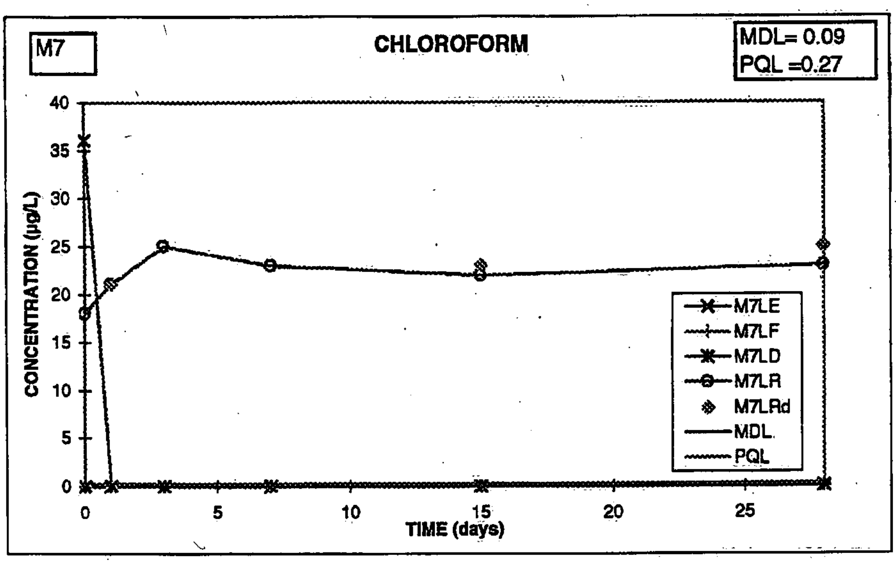
SITE WATER	86					
Time		M7LR	M7LD	M7LE	M7LF	Dup
0		131	426			
0.04				453		
0.08					419	
1		151	261	280	287	151
3		149	115	136	149	
7		143	20	29	75	
15		155	2	2	20	152
28		140	n.d	n.d.	3	160



CHLOROFORM **Microcosm 7 Alternate chelator**

Result concentration in µg/L

Time	M7LR	M7LD	M7LE	M7LF	Dup	r^2 (if < 0.99)
SITE WATER		20				
0	18	36				
0.04			n.d.			
0.08				n.d.		
1	21	n.d.	n.d.	n.d.	21	0.976
3	25	n.d.	n.d.	n.d.		
7	23	n.d.	n.d.	n.d.		
15	22	n.d.	n.d.	n.d.	23	
28	23	n.d.	n.d.	n.d.	25	

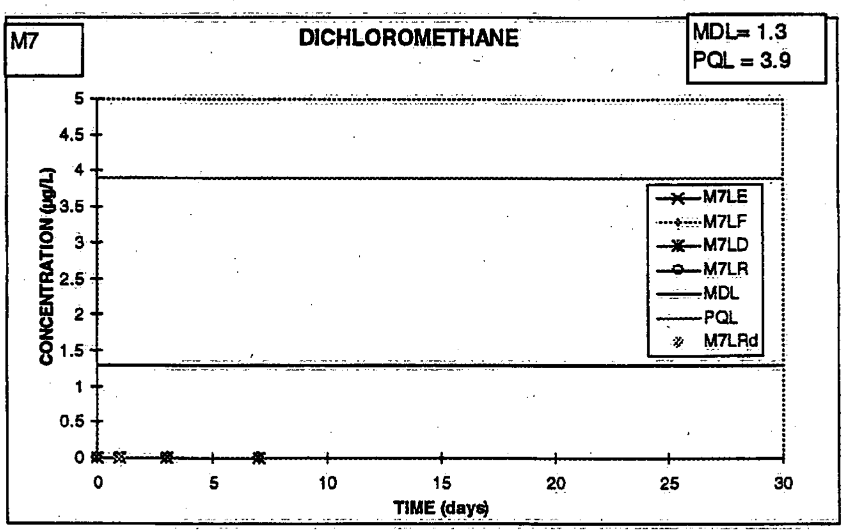


DICHLOROMETHANE **Microcosm 7 Alternate chelator** MAC = 5 µg/L

Result concentration in µg/L

SITE WATER <PQL <PQL

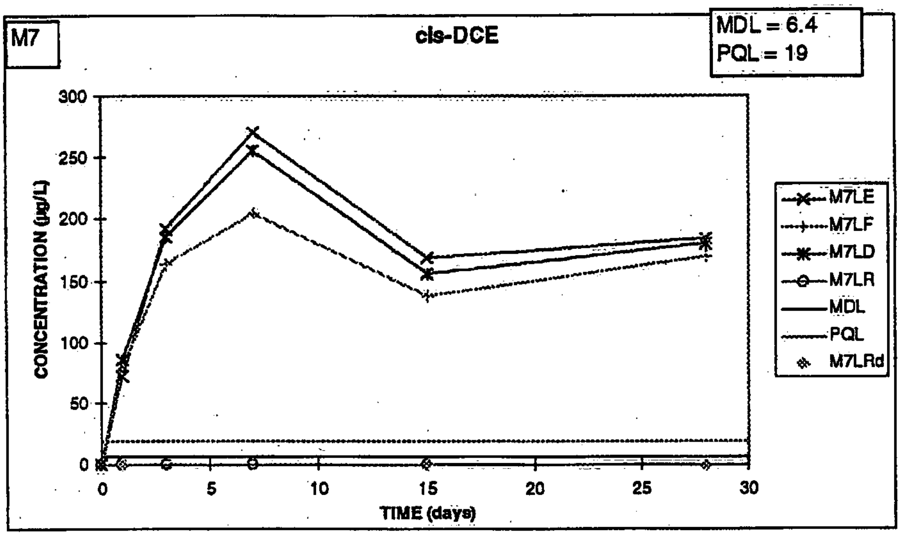
Time	M7LR	M7LD	M7LE	M7LF	Dup
0	n.d.	n.d.			
0.04			n.d.		
0.08				n.d.	
1	n.d.	n.d.	n.d.	n.d.	n.d.
3	n.d.	n.d.	n.d.	n.d.	
7	n.d.	n.d.	n.d.	n.d.	
15	n.d.	n.d.	n.d.	n.d.	
28	n.d.	n.d.	n.d.	n.d.	n.d.



cis-DICHLOROETHENE **Microcosm 7 Alternate chelator** MAC = 70 µg/L

Result concentration in µg/L

SITE WATER	<PQL		<PQL				
Time		M7LR	M7LD	M7LE	M7LF	Dup	r^2 (if < 0.99)
0		n.d.	n.d.				
0.04				n.d.			
0.08					n.d.		
1		n.d.	86	72	78	n.d.	0.982
3		n.d.	185	192	163		0.956
7		n.d.	255	270	205		0.956
15		n.d.	156	169	138	n.d.	
28		n.d.	180	184	170	n.d.	

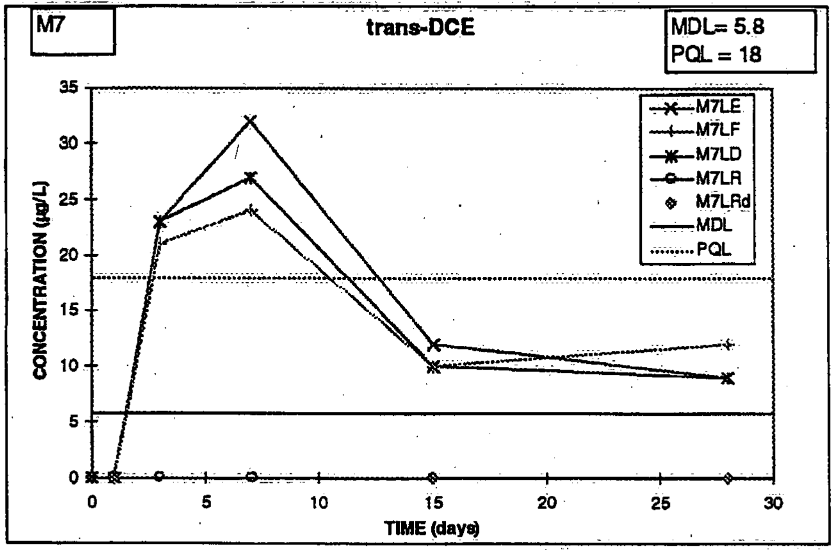


Trans-DICHLOROETHENE **Microcosm 7 Alternate chelator** MAC = 100 µg/L

Result concentration in µg/L

SITE WATER <PQL <PQL

Time	M7LR	M7LD	M7LE	M7LF	Dup	r^2 (if<0.99)
0	n.d.	n.d.				
0.04			n.d.			
0.08				n.d.		
1	n.d.	n.d.	n.d.	n.d.	n.d.	
3	n.d.	23	23	21		0.973
7	n.d.	27	32	24		
15	n.d.	10	12	10	n.d.	
28	n.d.	9j	9j	12j	n.d.	



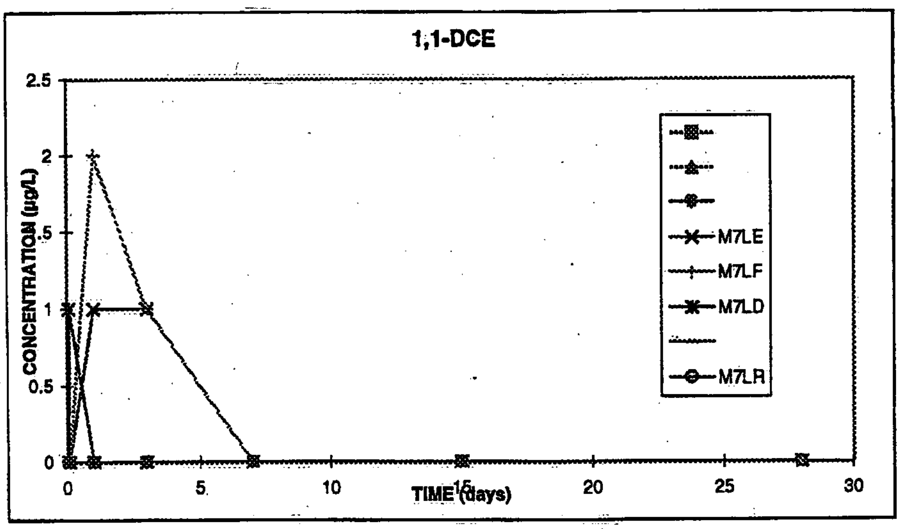
1,1_Dichloroethene **Microcosm 7 Alternate chelator** PQL = 11 µg/L

Result concentration in µg/L

SITE WATER <PQL <PQL

Time	M7LR	M7LD	M7LE	M7LF	Dup
0					
0.04					
0.08	n.d.	n.d.	n.d.	n.d.	
1	n.d.	1	1	2	n.d.
3	n.d.	n.d.	1	1	
7	n.d.	n.d.	n.d.	n.d.	
15	n.d.	n.d.	n.d.	n.d.	
28	n.d.	n.d.	n.d.	n.d.	n.d.

Note: needs to be confirmed by MS

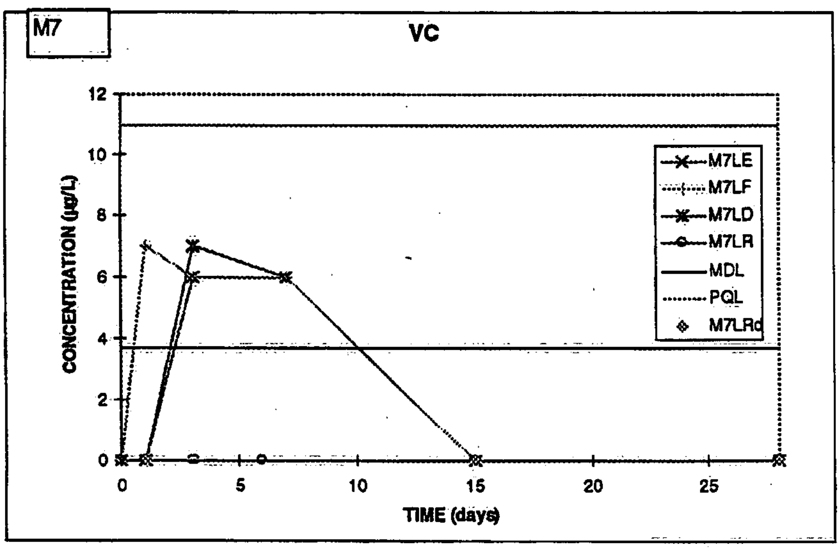


VINYL CHLORIDE (VC) **Microcosm 7 Alternate chelator** PQL = 11 µg/L

Result concentration in µg/L

SITE WATER <PQL <PQL

Time	M7LR	M7LD	M7LE	M7LF	Dup
0	n.d.	n.d.			
0.04			n.d.		
0.08				n.d.	
1	n.d.	n.d.	n.d.	n.d.	n.d.
3	n.d.	7j	6j	6j	
7	n.d.	6j	6j	6j	
15	n.d.	n.d.	n.d.	n.d.	n.d.
28	n.d.	n.d.	n.d.	n.d.	n.d.

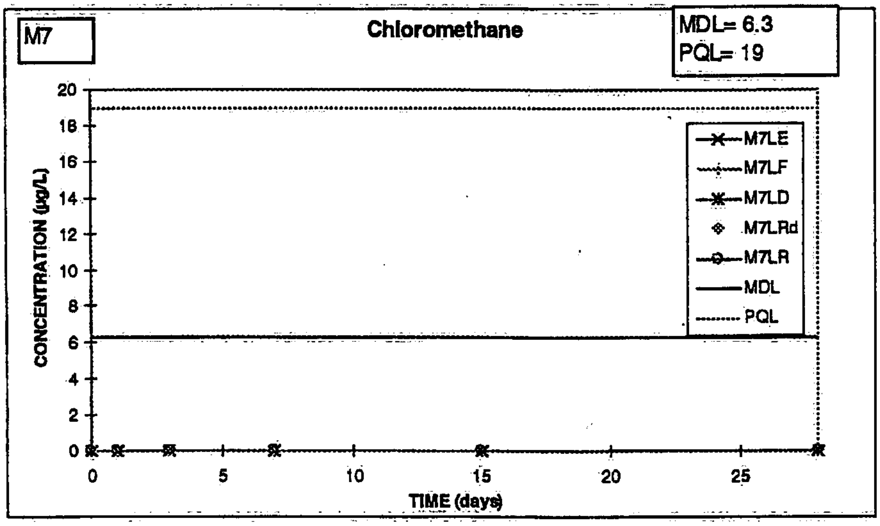


CHLOROMETHANE **Microcosm 7 Alternate chelator**

Result concentration in µg/L

SITE WATER <PQL <PQL

Time	M7LR	M7LD	M7LE	M7LF	Dup
0	n.d.	n.d.			
0.04			n.d.		
0.08				n.d.	
1	n.d.	n.d.	n.d.	n.d.	n.d.
3	n.d.	n.d.	n.d.	n.d.	
7	n.d.	n.d.	n.d.	n.d.	
15	n.d.	n.d.	n.d.	n.d.	
28	n.d.	n.d.	n.d.	n.d.	

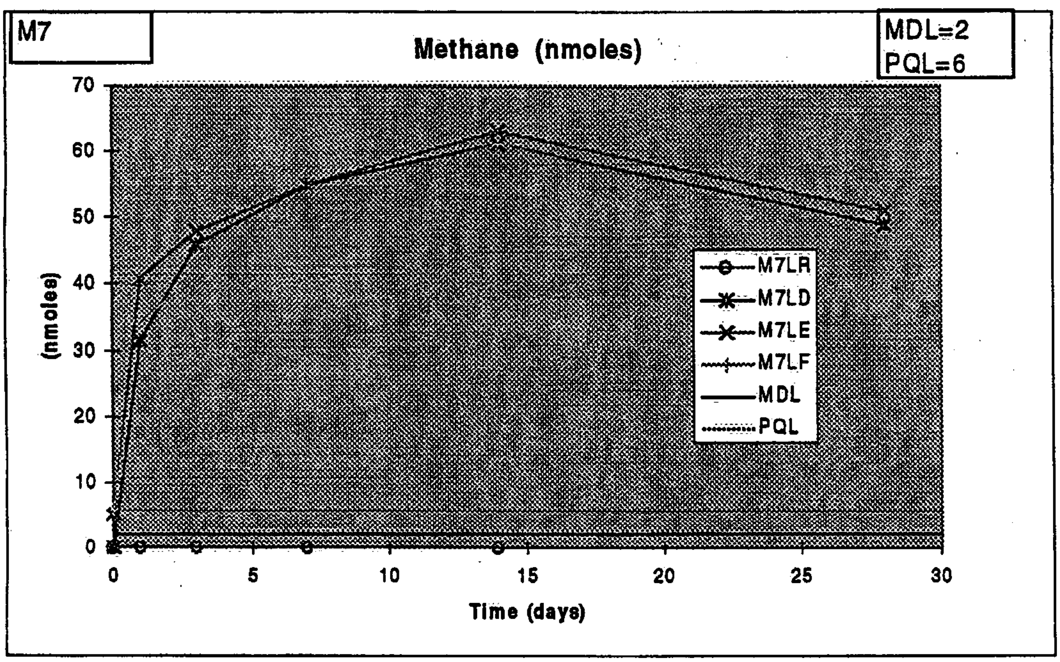


METHANE **Microcosm 7 Alternate chelator**

SITE WATER <PQL <PQL

RESULTS in ppmv

Time	M7LR	M7LD	M7LE	M7LF	Dup
0	n.d.	n.d.			
0.04			5j		
0.08				6	
1	n.d.	31	40	34	n.d.
3	n.d.	45	47	40	
7	n.d.	54	54	52	
15	n.d.	60	62	60	n.d.
28	n.d.	48	50	46	n.d.

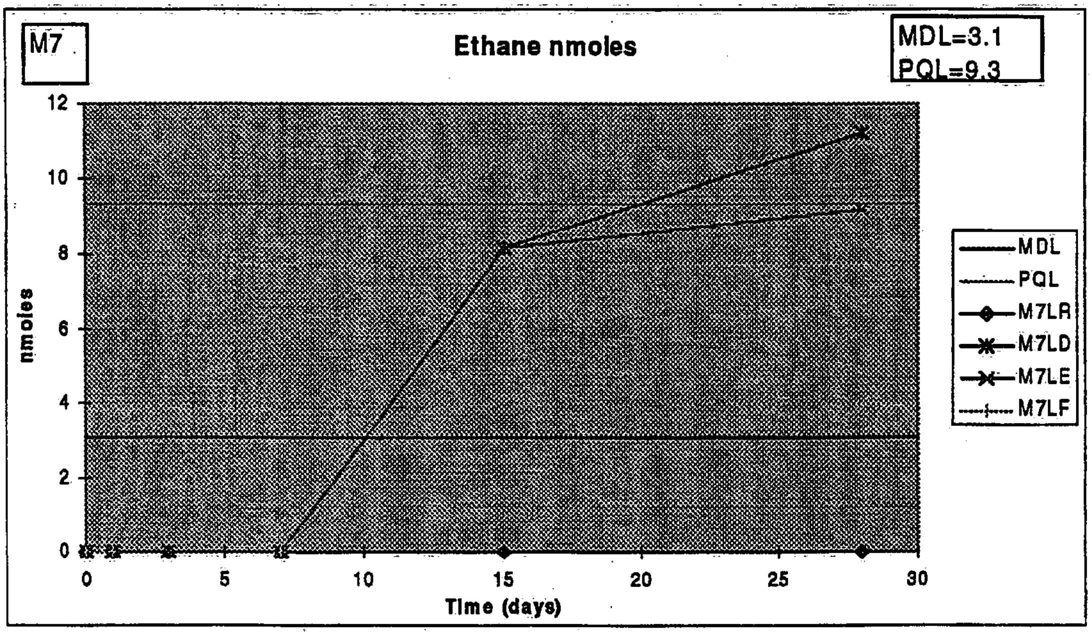


ETHANE **Microcosm 7 Alternate chelator**

SITE WATER <PQL <PQL

Results in ppmv

Time	M7LR	M7LD	M7LE	M7LF	Dup
0	n.d.	n.d.			
0.04			n.d.		
0.08				n.d.	
1	n.d.	n.d.	n.d.	n.d.	n.d.
3	n.d.	3j	3j	n.d.	
7	n.d.	n.d.	n.d.	n.d.	
15	n.d.	8j	8j	6j	n.d.
28	n.d.	11	9	5j	n.d.

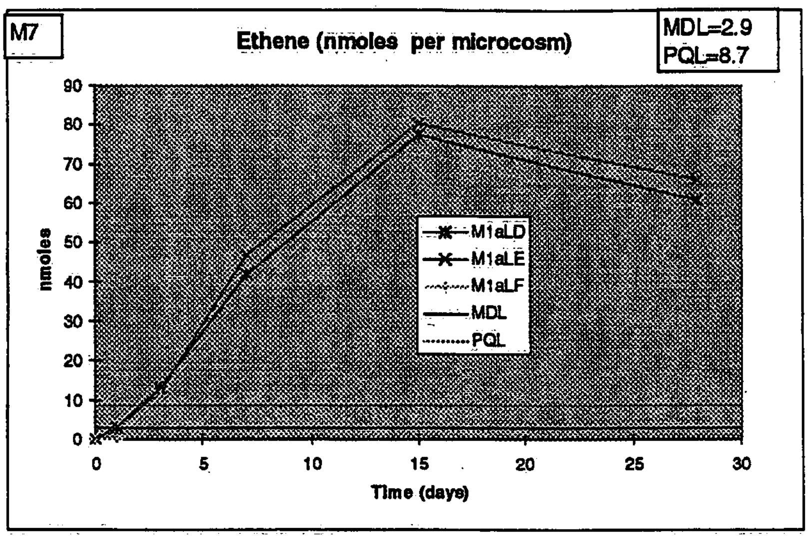


ETHENE **Microcosm 7 Alternate chelator**

SITE WATER <PQL <PQL

Results in ppmv

Time	M7LR	M7LD	M7LE	M7LF	Dup
0	n.d.	n.d.			
0.04			n.d.		
0.08				n.d.	
1	n.d.	3j	3j	n.d.	
3	n.d.	13	12	11	
7	n.d.	41	46	38	
15	n.d.	76	79	72	n.d.
28	n.d.	60	65	54	n.d.

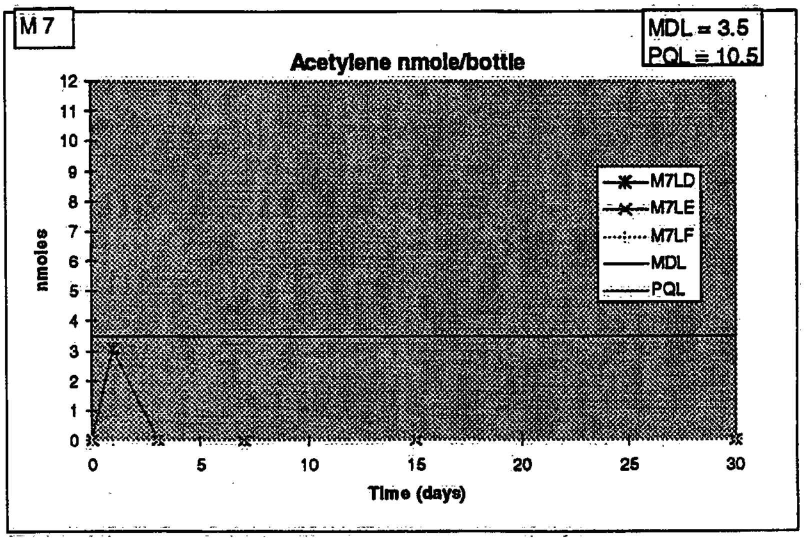


ACETYLENE **Microcosm 7 Alternate chelator**

SITE WATER <PQL <PQL

Results in ppmv

Time	M7LR	M7LD	M7LE	M7LF	Dup
0	n.d.	n.d.			
0.04			n.d.		
0.08				n.d.	
1	n.d.	3j	3j	n.d.	n.d.
3	n.d.	n.d.	n.d.	n.d.	
7	n.d.	n.d.	n.d.	n.d.	
15	n.d.	n.d.	n.d.	n.d.	
28	n.d.	n.d.	n.d.	n.d.	



Volatile Fatty Acids - M7

Citrate

day	M7LD	M7LE	M7LF
			conc. (mg/L)
0	n.d.	n.d.	n.d.
1	n.d.	n.d.	n.d.
3	n.d.	n.d.	n.d.
7	n.d.	n.d.	n.d.
15	n.d.	n.d.	n.d.
28	n.d.	n.d.	n.d.

Lactate

day	M7LD	M7LE	M7LF
			conc. (mg/L)
0	n.d.	n.d.	n.d.
1	n.d.	n.d.	n.d.
3	n.d.	n.d.	n.d.
7	n.d.	n.d.	n.d.
15	n.d.	n.d.	n.d.
28	n.d.	n.d.	n.d.

Formate

day	M7LD	M7LE	M7LF
			conc. (mg/L)
0	n.d.	n.d.	n.d.
1	n.d.	n.d.	n.d.
3	n.d.	n.d.	n.d.
7	n.d.	n.d.	n.d.
15	n.d.	n.d.	n.d.
28	31	23	26

Acetate

day	M7LD	M7LE	M7LF
			conc. (mg/L)
0	n.d.	n.d.	n.d.
1	n.d.	n.d.	n.d.
3	n.d.	n.d.	n.d.
7	n.d.	n.d.	n.d.
15	n.d.	n.d.	n.d.
28	n.d.	n.d.	n.d.

Propionate

day	M7LD	M7LE	M7LF
			conc. (mg/L)
0	n.d.	n.d.	n.d.
1	n.d.	n.d.	n.d.
3	n.d.	n.d.	n.d.
7	n.d.	n.d.	n.d.
15	n.d.	n.d.	n.d.
28	n.d.	n.d.	n.d.

Titanium

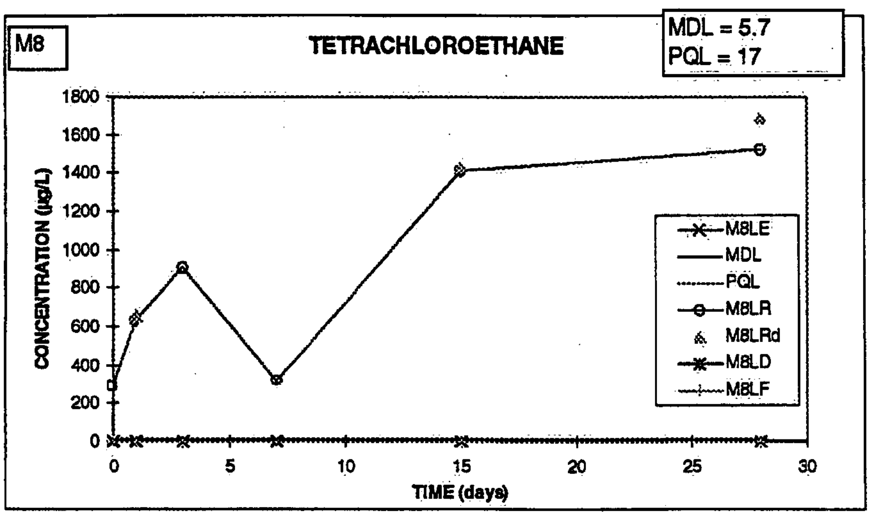
day	M7LD	M7LE	M7LF
			conc. (mM)
0	25.1	24.8	24.8

Tetrachloroethane (TeCA) **Microcosm 8 B12, Ti citrate and yeast extract**

Result concentration in μg/L

SITE WATER 695

Time	M8LR	M8LD	M8LE	M8LF		r^2 (if< 0.99)
0	291	n.d.				0.981
0.04			n.d.			
0.08				n.d.		
1	627	n.d.	n.d.	n.d.		0.981
3	905	n.d.	n.d.	n.d.		0.974
7	317	n.d.	n.d.	n.d.		0.974
15	1409	n.d.	n.d.	n.d.	1429	0.982
28	1518	n.d.	n.d.	n.d.	1686	0.966



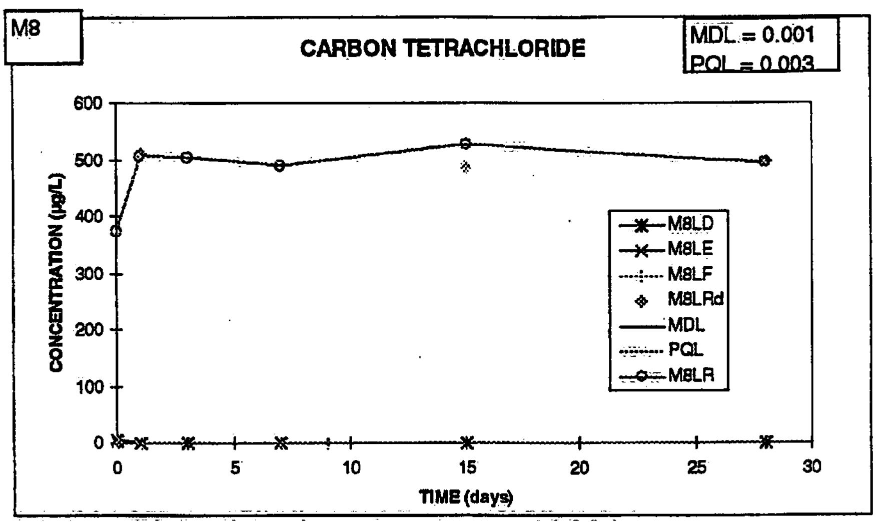
Carbon tetrachloride **Microcosm 8 B12, Ti citrate and yeast extract**

MAC = 5 µg/L

Result concentration in µg/L

SITE WATER 364

Time	M8LR	M8LD	M8LE	M8LF
0	374	5		
0.04			3j	
0.08				3j
1	506	n.d.	n.d.	n.d.
3	503	n.d.	n.d.	n.d.
7	490	n.d.	n.d.	n.d.
15	526	n.d.	n.d.	n.d.
28	495	n.d.	n.d.	n.d.

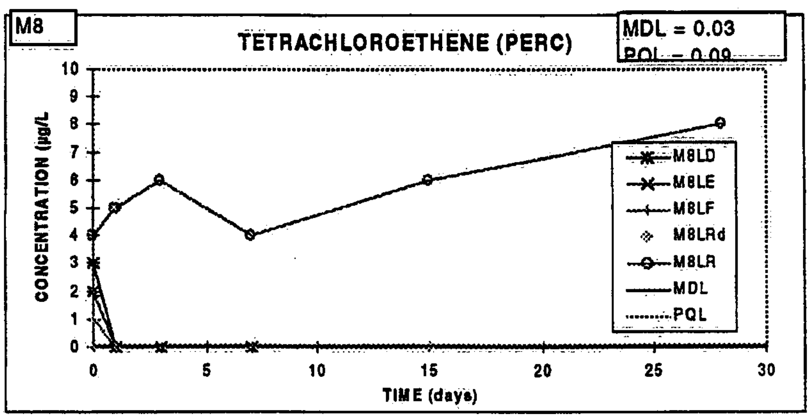


TETRACHLORORETHENE (PERC) **Microcosm 8 B12, Ti citrate and yeast extract**

Result concentration in µg/L

SITE WATER 6

Time	M8LR	M8LD	M8LE	M8LF	r^2 (if <0.99)
0	4	3			
0.04			2		
0.08				1	
1	5	n.d	n.d	n.d	5
3	6	n.d	n.d	n.d	
7	4	n.d	n.d	n.d	
15	6	n.d	n.d	n.d	
28	8	n.d	n.d	n.d	8

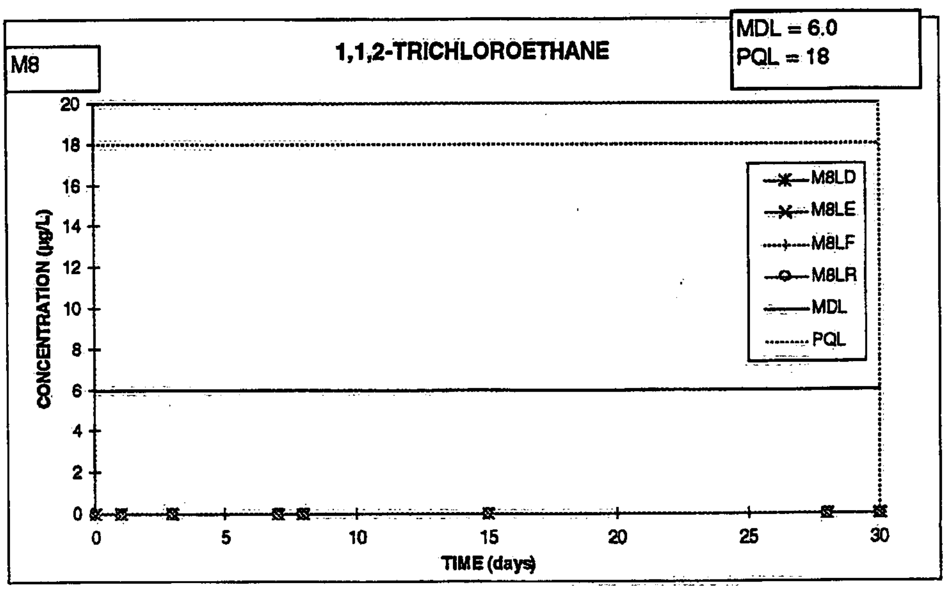


1,1,2- Trichloroethane **Microcosm 8 B12, Ti citrate and yeast extract**

Result concentration in µg/L

SITE WATER

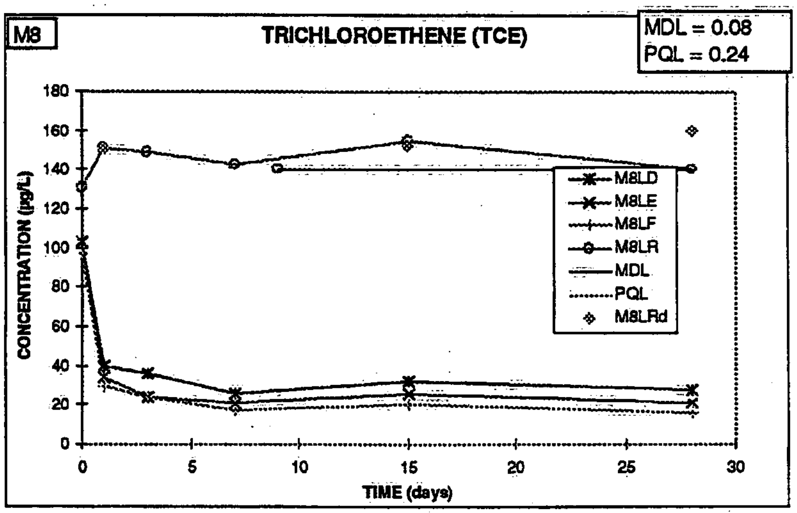
Time	M8LR	M8LD	M8LE	M8LF
0	n.d.	27		
0.04			n.d.	
0.08				n.d.
1	n.d.	n.d.	n.d.	n.d.
3	n.d.	n.d.	n.d.	n.d.
7	n.d.	n.d.	n.d.	n.d.
15	n.d.	n.d.	n.d.	n.d.
28	n.d.	n.d.	n.d.	n.d.



TRICHLORORETHENE (TCE) **Microcosm 8 B12, Ti citrate and yeast extract**

Result concentration in µg/L

SITE WATER	197		86			
Time		M8LR	M8LD	M8LE	M8LF	r^2 (if <0.99)
0		131	103			
0.04				103		
0.08					97	
1		151	40	34	30	0.98
3		149	36	24	24	0.915
7		143	26	21	17	
15		155	32	26	20	0.953
28		140	28	21	16	0.954

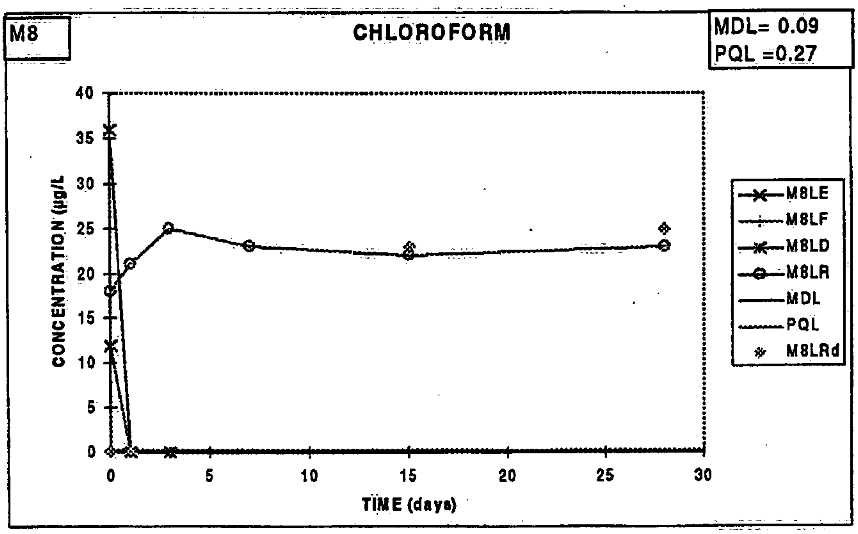


CHLOROFORM **Microcosm 8 B12, Ti citrate and yeast extract**

Result concentration in µg/L

SITE WATER 20

Time	M8LR	M8LD	M8LE	M8LF	r^2 (if < 0.99)
0	18	12			
0.04			n.d.		
0.08				n.d.	
1	21	n.d.	n.d.	n.d.	
3	25	n.d.	n.d.	n.d.	
7	23	n.d.	n.d.	n.d.	0.975
15	22	n.d.	n.d.	n.d.	
28	23	n.d.	n.d.	n.d.	

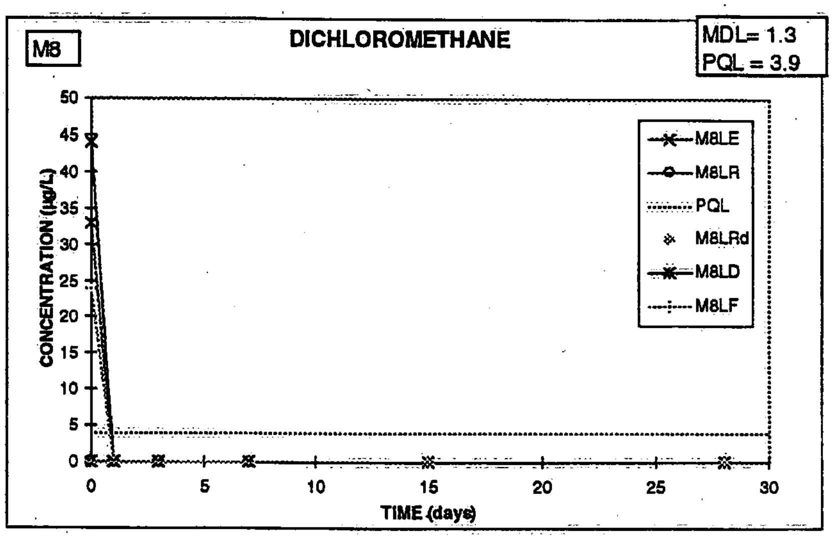


DICHLOROMETHANE **Microcosm 8 B12, Ti citrate and yeast extract**

Result concentration in µg/L MAC = 5 µg/L

SITE WATER <PQL <PQL

Time	M8LR	M8LD	M8LE	M8LF
0	n.d.	44		
0.04			33	
0.08				24
1	n.d.	n.d.	n.d.	n.d.
3	n.d.	n.d.	n.d.	n.d.
7	n.d.	n.d.	n.d.	n.d.
15	n.d.	n.d.	n.d.	n.d.
28	n.d.	n.d.	n.d.	n.d.

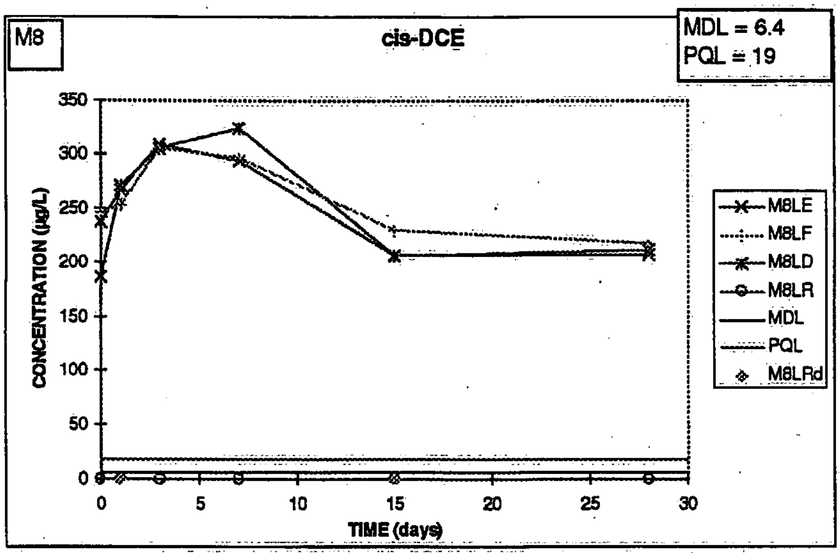


cis-DICHLOROETHENE **Microcosm 8 B12, Ti citrate and yeast extract** MAC = 70 µg/L

Result concentration in µg/L

SITE WATER <PQL <PQL

Time	M8LR	M8LD	M8LE	M8LF	r^2 (if<0.99)
0	n.d.	187			
0.04			237		
0.08				246	
1	n.d.	271	267	254	
3	n.d.	305	309	306	0.956
7	n.d.	324	294	297	0.956
15	n.d.	207	207	230	
28	n.d.	211	208	218	

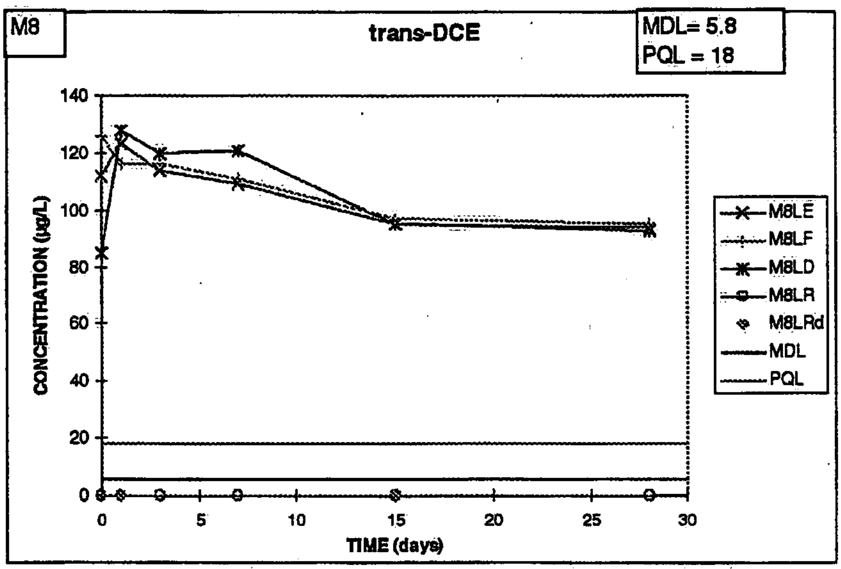


Trans-DICHLOROETHENE **Microcosm 8 B12, Ti citrate and yeast extract** MAC = 100 µg/L

Result concentration in µg/L

SITE WATER <PQL <PQL

Time	M8LR	M8LD	M8LE	M8LF	r^2 (if <0.99)
0	n.d.	85			0.975
0.04			112		
0.08				126	
1	n.d.	128	123	116	0.975
3	n.d.	120	114	116	0.973
7	n.d.	121	109	111	
15	n.d.	95	95	97	
28	n.d.	93	94	95	



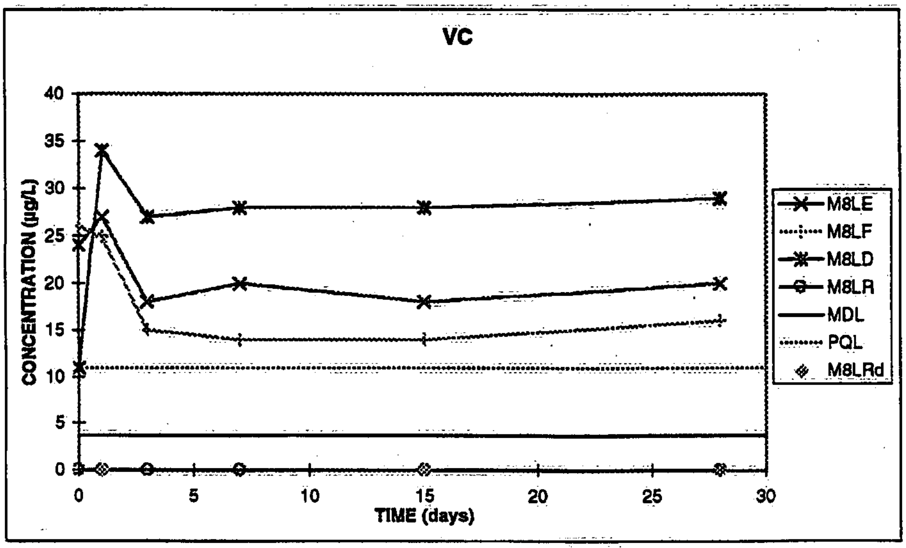
VINYL CHLORIDE (VC) **Microcosm 8 B12, Ti citrate and yeast extract**

PQL = 11 µg/L

Result concentration in µg/L

SITE WATER <PQL <PQL

Time	M8LR	M8LD	M8LE	M8LF
0	n.d.	11		
0.04			24	
0.08				26
1	n.d.	34	27	25
3	n.d.	27	18	15
7	n.d.	28	20	14
15	n.d.	28	18	14
28	n.d.	29	20	16



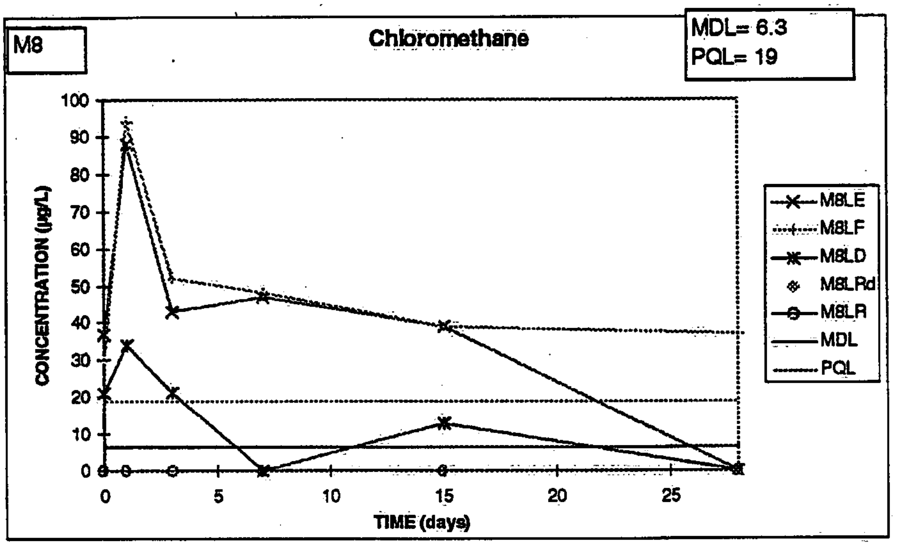
CHLOROMETHANE **Microcosm 8 B12, Ti citrate and yeast extract**

Result concentration in µg/L

SITE WATER <PQL <PQL

Time	M8LR	M8LD	M8LE	M8LF
0	n.d.	21		
0.04			37	
0.08				30
1	n.d.	34	88	94
3	n.d.	21	43	52
7	n.d.	n.d.	47	48
15	n.d.	13	39	39
28	n.d.	n.d.	n.d.	37

May be not chloromethane - need MS confirmation

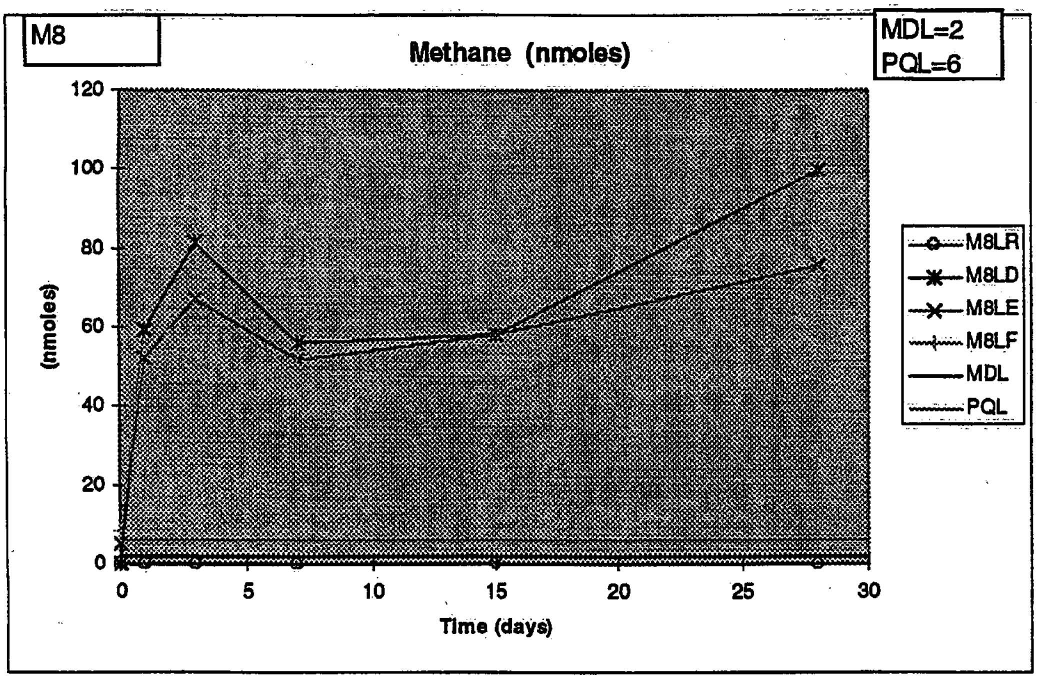


METHANE | Microcosm 8 B12, Ti citrate and yeast extract

SITE WATER <PQL <PQL

RESULTS in ppmv

Time	M8LR	M8LD	M8LE	M8LF
0	n.d.	n.d.		
0.04			5	
0.08				8
1	n.d.	48	42	43
3	n.d.	46	42	41
7	n.d.	48	45	42
15	n.d.	57	57	45
28	n.d.	98	74	72

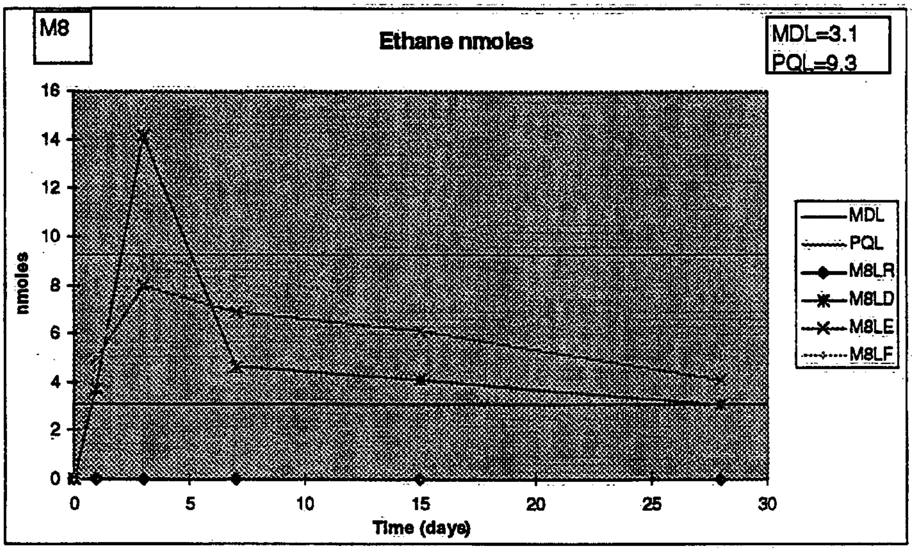


ETHANE | **Microcosm 8 B12, Ti citrate and yeast extract**

SITE WATER <PQL <PQL

Results in ppmv

Time	M8LR	M8LD	M8LE	M8LF
0	n.d.	n.d.		
0.04			n.d.	
0.08				n.d.
1	n.d.	3j	4j	4j
3	n.d.	8j	5j	6j
7	n.d.	4j	6j	7j
15	n.d.	4j	6j	7j
28	n.d.	3j	4j	5j



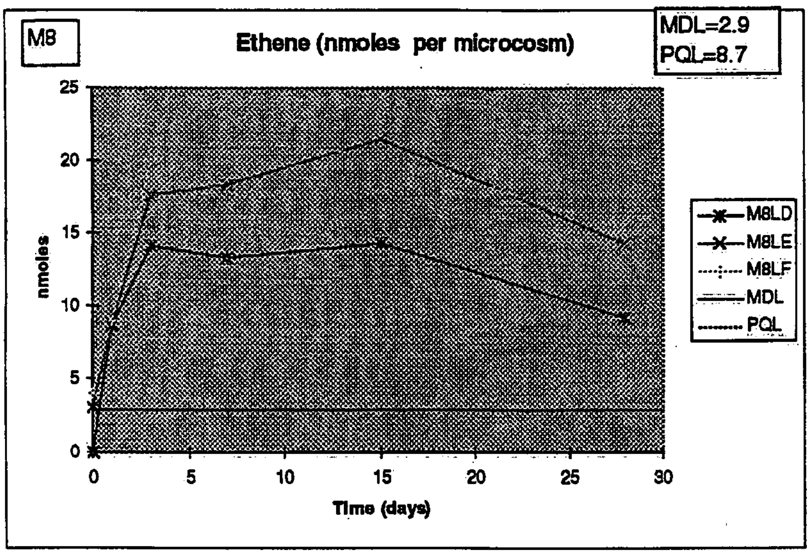
ETHENE **Microcosm 8** **B12, Ti citrate and yeast extract**

Result concentration in µg/L

SITE WATER <PQL <PQL

Results in ppmv

Time	M8LR	M8LD	M8LE	M8LF
0	n.d.	n.d.		
0.04			3j	
0.08				4j
1	n.d.	7j	7j	7j
3	n.d.	8j	11	13
7	n.d.	13	18	21
15	n.d.	14	21	20
28	n.d.	9	14	15

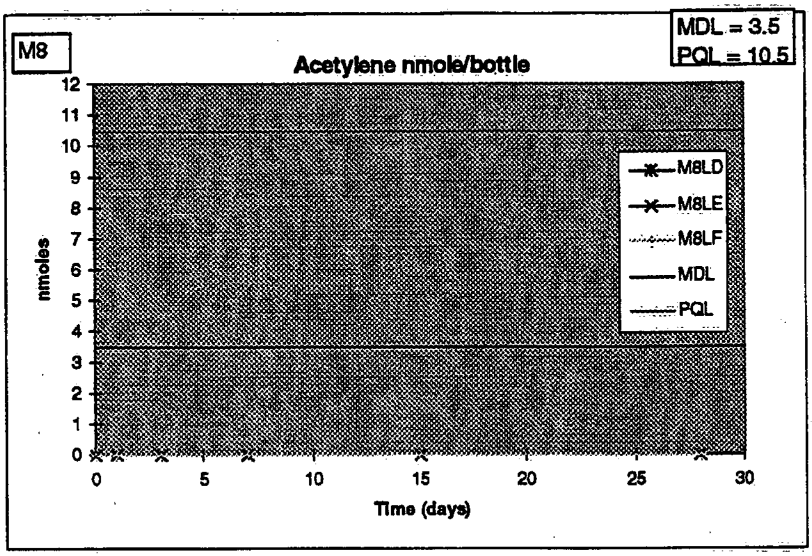


ACETYLENE **Microcosm 8 B12, Ti citrate and yeast extract**

SITE WATER <PQL <PQL

Results in ppmv

Time	M8LR	M8LD	M8LE	M8LF
0	n.d.	n.d.		
0.04			n.d.	
0.08				n.d.
1	n.d.	n.d.	n.d.	n.d.
3	n.d.	n.d.	n.d.	n.d.
7	n.d.	n.d.	n.d.	n.d.
15	n.d.	n.d.	n.d.	n.d.
28	n.d.	n.d.	n.d.	n.d.



Volatile Fatty Acids - M8

Citrate

day	M8LD	M8LE	M8LF
	conc. (mg/L)		
0	6679	6474	6678
1	2507	1387	1627
3	n.d.	n.d.	890j
7	n.d.	n.d.	n.d.
15	n.d.	n.d.	n.d.
28	n.d.	n.d.	n.d.

Titanium

day	M8LD	M8LE	M8LF
	conc. (mM)		
0	28.9	29.0	29.2

Lactate

day	M8LD	M8LE	M8LF
	conc. (mg/L)		
0	n.d.	n.d.	n.d.
1	n.d.	n.d.	n.d.
3	n.d.	n.d.	n.d.
7	n.d.	n.d.	n.d.
15	n.d.	n.d.	n.d.
28	n.d.	n.d.	n.d.

Formate

day	M8LD	M8LE	M8LF
	conc. (mg/L)		
0	38	50	46
1	603	957	982
3	936	943	1051
7	722	832	961
15	726	743	913
28	309	378	554

Acetate

day	M8LD	M8LE	M8LF
	conc. (mg/L)		
0	344	373	285
1	2554	3842	3879
3	4958	4265	4335
7	4565	5089	4913
15	4444	4992	4768
28	4941	4374	4501

Propionate

day	M8LD	M8LE	M8LF
	conc. (mg/L)		
0	265	269	241
1	403	375	359
3	414	301	267
7	313	309	292
15	364	370	310
28	494	391	408

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