BMR RECORD 1992/52

LIGHT HYDROCARBON GEOCHEMISTRY OF THE GIPPSLAND, NORTH BASS, BASS, OTWAY AND STANSBURY BASINS AND THE TORQUAY SUB-BASIN, SOUTH-EASTERN AUSTRALIA

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MARINE GEOSCIENCE AND PETROLEUM GEOLOGY PROGRAM

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BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS, AUSTRALIA

DEPARTMENT OF PRIMARY INDUSTRIES AND ENERGY

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EXECUTIVE SUMMARY

As part of its surface geochemical research program, the Marine Geoscience and Petroleum Geology Group of the Australian Bureau of Mineral Resources is evaluating the potential of the Direct Hydrocarbon Detection (DHD) method, commonly known as a geochemical 'sniffer', as a complementary exploration tool for hydrocarbons on the Australian continental margin. This technique involves the underway analysis of the light hydrocarbon concentrations in bottom-waters of the continental shelf that overly continental margin sedimentary basins.

The first survey to use the DHD technique aboard Rig Seismic was carried out as part of a co-operative geochemical survey with Transglobal Environmental Geoscience (TEG) of Leucadia, California, USA, in south-eastern Australia between February 2 and March 2, 1989. This program was the first to be carried out as part of a joint research Agreement between the BMR and TEG (Heggie et al., 1990) to conduct research into the origin, sources and nature of hydrocarbon seepage around the Australian continental margin.

The survey collected approximately 3570 kms of DHD data in the water columns of the Gippsland, North Bass, Bass, Otway and Stansbury Basins and the Torquay Sub-basin (see Figures 1-5). The North Bass Basin, the Bass Basin, the Stansbury Basin and the Torquay Sub-basin surveys were carried out as proprietary programs for AMOCO Production Company (Bass-Stansbury) and Shell Development Australia Pty Ltd (Torquay). The program in the Gippsland Basin was conducted, in part, as a 'calibration' survey, to test for bottom-water hydrocarbon anomalies in Australia's primary hydrocarbon province.

In addition to the DHD program, sediment samples were collected for light hydrocarbon gas analysis in the Gippsland Basin. During this program, 6 grabs, 30 gravity cores and 3 vibrocores were taken. These data will not be discussed in detail in this report.

Gippsland Basin (Victoria)
The 280 km DHD program in the Gippsland Basin consisted of 17 regional lines which linked the Barracouta, Seahorse, Sunfish, Snapper, Tuna and Sole hydrocarbon accumulations. In addition, a limited program was carried out in the southern Gippsland Basin, with a single survey line passing over the Kingfish Field.

Four strong thermogenic hydrocarbon anomalies were detected during the survey, while an additional four anomalies were classified as weak. Two of the strong anomalies, which were located just north-west of the Barracouta Field, were propane-rich and may be related to hydrocarbon discharge from production facilities in the basin (although the process(es) that results in fractionation of the hydrocarbon mixtures remains unknown). The other two strong anomalies had more typical C_2^+ hydrocarbon abundances and probably represent natural hydrocarbon seepage across the seafloor of the Gippsland Basin. The compositional trends in these anomalies, which were all concentrated along the trend of the Rosedale Fault in the northern Gippsland Basin, suggest that they were sourced from an oil reservoir or an oil-prone source rock.

The remaining four anomalies were all weak and appear to be due to the raising of the DHD tow-fish above the thermocline. In the near-surface layer, thermogenic hydrocarbons (perhaps from shipping activity) appear to be present, which results in a weak "thermogenic" hydrocarbon signature which is independent of the underlying geology.

No bottom-water hydrocarbon anomalies were detected during the single pass over the Kingfish Field.

North Bass Basin (Victoria)
The DHD program in the North Bass Basin consisted of 7 lines with a total survey length of 310 line kilometres. No thermogenic hydrocarbons were detected in the water column in the North Bass Basin.

Bass Basin (Tasmania)
The DHD program in the Bass Basin consisted of 61 lines with a total survey length of 2445 line kilometres. No thermogenic hydrocarbons were detected in the water column in the Bass Basin.

Torquay Sub-basin (Victoria)
The survey in the Torquay Sub-basin consisted of three lines, with a total survey length of 210 km. The majority of the data collected in the Torquay Sub-basin were of background concentration and composition. However, one weak THC and methane anomaly was associated with a seafloor pockmark overlying an anticline. Moreover, a seismic "white-out" zone (on a single channel high resolution seismic monitor record) was indicative of a gas chimney within the sediments underlying the pockmark. A small amount of ethane was associated with this anomaly.

To the north-east of this anomaly, high concentrations of both ethane and propane were also found in the bottom-waters. However, these ethane and propane anomalies were not found on a subsequent transit across this area and it is not known if these anomalies represent seepage from the seafloor or perhaps an unknown anthropogenic source.

Otway Basin (Victoria)
The data acquired in the eastern Otway Basin (Mussel Platform) comprised only two transit lines (total 172 km). A weak propane and butane anomaly, with elevated hydrocarbon wetness values, was detected to the west of Cape Otway.

Stansbury Basin (South Australia)
Six survey lines were acquired in the Stansbury Basin in St Vincent's Gulf, South Australia. No thermogenic hydrocarbon anomalies were present in the 150 km of data collected.

INTRODUCTION

Surface geochemistry and offshore exploration for hydrocarbons

The aim of surface geochemical techniques in offshore petroleum exploration is: (a) to detect direct evidence for thermogenic generation of hydrocarbons in a sedimentary basin, (b) to assist in locating sub-surface hydrocarbon accumulations, and (c) to provide information on the likely composition of hydrocarbon accumulations within a given geologic province. The most common technique used to detect hydrocarbon seepage offshore involves towing a submerged 'fish' close to the seafloor which continuously pumps seawater into a geochemical laboratory in the tow-vessel. There, hydrocarbons are extracted and measured by gas chromatography. This equipment, commonly known as a geochemical 'sniffer' (Schink et al. 1971; Sigalove and Pearlman 1975) - or what we refer to as Direct Hydrocarbon Detection (DHD) - has been widely used overseas for offshore petroleum exploration. InterOcean Systems Inc., a US-based corporation has collected over 1.5 million line kilometres of data from about 140 surveys around the world. However, most of the data gathered by contractors for clients remains proprietary and the opinions expressed publicly (about surface 'sniffer' geochemical techniques) by the petroleum exploration community are divided. Schiener et al. (1985) have commented about the use of the geochemical 'sniffer' in the North Sea.

Within Australia, the 'sniffer' has been a relatively under-utilised tool in offshore hydrocarbon exploration, with only four surveys being carried out prior to 1988. To better evaluate the usefulness of the DHD technique to hydrocarbon exploration, the Australian Bureau of Mineral Resources (BMR), as part its Continental Margins Program (and under the auspices of a Joint Agreement with Transglobal Environmental Geoscience (TEG) of Leucadia California (Heggie et al., 1990)), has been conducting surface geochemical (bottom-water DHD and sediment [hydrocarbon-head space] geochemistry) surveys around the Australian continental margin. Part of this work includes research into the origins (biogenic or thermogenic?), 'sources' (liquids, condensate or gas?), bottom-water and seafloor expressions of seepage and their relationships to the surface and sub-seafloor geology, including hydrocarbon accumulations and source rock types and distributions.

BMR surface geochemistry: overall program objectives

The overall objective of the BMR offshore surface geochemistry program is to evaluate the application of surface geochemical techniques (both direct hydrocarbon detection (DHD) and sediment (hydrocarbon-headspace) techniques, to hydrocarbon exploration around the Australian continental margin. Specific objectives include:

1. To collect, via reconnaissance surveys, new information on the thermal generation of hydrocarbons in under-explored Australian basins.
2. To test the application of both bottom-water DHD and sediment geochemical techniques to hydrocarbon prospect ('target') evaluations in both known hydrocarbon provinces and frontier basins.
3. To test, develop and refine criteria to recognise thermally generated migrated hydrocarbons from background biogenic hydrocarbons in both seawater and sediments.
4. To examine the relationship between hydrocarbon generation and migration by relating the surface and sub-seafloor expressions of hydrocarbon seeps to the sub-seafloor geology and probable locations and type(s) of source rocks.
5. To relate the chemical and isotopic compositions of seeps to 'source' characteristics, i.e. gas, condensate, liquids, and to predictions from geohistory and maturation modelling of different source rock types.
6. To test bottom-water DHD and sediment geochemistry techniques in the search for hydrocarbons sealed by stratigraphic traps.
7. To examine the biogenic processes influencing the concentrations, distributions and chemical compositions of hydrocarbon seeps in bottom-waters and the near surface sediments.
8. To examine oceanographic dispersal processes of seeps.

To achieve this, multi-disciplinary programs involving the simultaneous collection of bottom-water DHD, seismic reflection, gravity, magnetic and side-scan sonar data have, and will be, carried out by the *Rig Seismic* (and occasionally other vessels) around the Australian continental margin. These data are both integrated with each other, and also with sediment geochemical data which may be collected during the surveys.

The geochemical analysis system (Direct Hydrocarbon Detection or DHD) that has been installed aboard the BMR's research vessel *Rig Seismic* as part of the Agreement is shown schematically in Figure II-1 of Appendix II. The laboratory system analyses a variety of gases extracted from seawater, including C_1-C_8 hydrocarbons with facilities to collect gases for shore-based isotopic analyses. Complete details of both the DHD system and the interpretative methodologies used during the program, are given in Appendices II and III.

The DHD system on *Rig Seismic* is deployed amid-ships and hence is designed to be used routinely in conjunction with remote sensing techniques, such as multi-channel seismic reflection systems, 3.5 and 12 kHz sub-bottom profilers, side-scan sonar, and magnetometers.

This BMR Record deals with the results obtained from DHD acquisition in south-eastern Australia during Survey 89 (February-March 1989). Other aspects, such as sediment sampling and sediment hydrocarbon geochemistry, are only briefly discussed, while the side scan sonar and high resolution seismic program are not dealt with at all.

South-eastern Australia: Previous work and program objectives

As part of the Bureau of Mineral Resources Continental Margin Program, a 30-day geochemical research program (Figures 1-5; Enclosure 1) was conducted in conjunction with Transglobal Environmental Geoscience (TEG) of Leucadia, California, USA in south-eastern Australia in February-March 1989.

The general objectives of the program were to:-

❒ Develop new information on source-rocks, maturation, and hydrocarbon migration within the Gippsland, North Bass, Bass, Otway, Stansbury Basins and the Torquay Sub-Basin.

❒ Test the relationship between variations in source-rock maturation (as derived from well data and geohistory analyses) and the hydrocarbon gas composition and distribution within the overlying water and surface sediments from the basins.

❒ Evaluate the usefulness and applicability of DHD in assessing basin prospectivity. The method was examined with respect to:-

  ❒❒ predicting the presence of and remotely detecting hydrocarbon accumulations.

  ❒❒ determining regional and local variations in source rock type and/or maturity from the compositional characteristics of seeps.

The objectives with respect to individual basins included:

Gippsland Basin

The Gippsland Basin is Australia's premier hydrocarbon province and contains several giant oil fields. Since the initial discovery of the Barracouta gas/oil field in 1964, over 3.2 billion barrels of oil and 0.8 billion barrels of condensate and gas liquid reserves have been discovered (Brown 1986). Of these, approximately 2 billion barrels of oil have been produced. The basin itself can be loosely sub-divided into three tectonic provinces: the Northern and Southern Platforms (where the Late Cretaceous-Early Tertiary Latrobe Group is thin to absent) and the Central Deep, which was a major Latrobe Group depocentre.

Two small water column geochemical programs were carried out in the Gippsland Basin prior to BMR's survey in 1989. Both of these programs were conducted for Esso Australia in 1983 by InterOcean Systems Inc.. The first survey (May 1983) consisted of 391 km of 'geochemical sniffer' data which was collected over several known oil and gas accumulations. This survey discovered two significant anomalies (near the Kingfish Field and in the vicinity of the Salmon 1 and Swordfish 1 wells) and, as a consequence, a follow-up survey was carried out in November 1983. The follow-up survey was originally planned to collect about 1600 km of data, but because the previously detected anomalies could not be reproduced, and because of general uncertainty over the cause of the anomalies, this second survey was reduced to 500 km (Burns & Emmett, 1984). The second survey did, however, detect several significant anomalies, including anomalies associated with the Marlin and Kingfish Fields.

Esso Australia concluded that most of the anomalies were due to hydrocarbons discharged from the platforms in the area (Burns & Emmett 1984). Several anomalies detected during the survey could not, however, be definitely assigned an anthropogenic origin. The anthropogenic input of hydrocarbons into the Gippsland Basin water column provides a potential complication to the interpretation of DHD data from this area. Part of the rationale for carrying out our program in the Gippsland Basin was to determine whether these potential complications could be accounted for during data interpretation.

North Bass Basin

Little is known about the hydrocarbon prospectivity of the North Bass Basin. The area is an area of shallow basement with a thin potential source rock (Eastern View Coal Measures) sequence (see Smith 1986). The DHD program, which was carried out in conjunction with TEG and AMOCO Production Company, was designed to shed light on the source potential of the North Bass Basin.

Bass Basin

Superficially, the Bass Basin contains a generally similar stratigraphic succession to the highly productive Gippsland Basin, which is located just to the east. As such, it may be expected that the potential for major oil discoveries within the Bass Basin would be high. In spite of this, however, to date only two non-commercial (Pelican and Yolla) gas condensate discoveries have been made. Some workers (Smith 1986) consider that this lack of success is due to a lack of juxtaposition of favourable factors, such as source, reservoir, and structure, in the basin. In contrast, other workers (Williamson & Pigram 1986) suggest that the lack of success is due to a lack of vertical migration within the basin, and that large accumulations may be present within the deeper parts of the basin.

The DHD survey in the Bass Basin was carried out by TEG with assistance from BMR as part of a proprietary study for AMOCO Production Company. This program was designed to address exploration within AMOCO's lease areas in the Bass Basin (exploration permits T/14P, -15P, -18P, -22P). In particular, the DHD program might be used to pin-point mature source rock "fairways" within the basin and provide information as to the most likely locations for oil (as opposed to gas condensate) discoveries, providing that suitable migration pathways are present.

Torquay Sub-basin

The Torquay Sub-Basin is a rank wildcat area in which only two exploration wells, Snail 1 and Nerita 1, have been drilled. The sedimentary sequence in the Torquay Sub-Basin consists of Early Cretaceous syn-rift sediments which are unconformably overlain by a thick sequence of latest Cretaceous and Tertiary sediments. In excess of 3000 m of latest Cretaceous-Paleocene fluvio-deltaic sediments (the Eastern View Coal Measures) may be present within the Torquay Sub-Basin. Potential hydrocarbon source rocks may exist within Early Cretaceous lacustrine sediments near the base of the sedimentary sequence, and within the Eastern View Coal Measures (EVCM). The maturity of the EVCM may be marginal, however.

The DHD program, which was carried out in collaboration with Shell Development Australia, could potentially provide information on the maturity of the source rocks present and thereby provide an advance in our understanding of the region's prospectivity.

Otway Basin

A number of factors suggested that the Otway Basin would be an attractive area for the application of the DHD technique. Firstly, gas seeps have been observed (on echo-sounder and side scan records) in the offshore Otway Basin (Sprigg, 1986). Secondly, two seeps were located during a 1634 km InterOcean Systems 'sniffer' survey conducted in 1981 for Shoreline Exploration Company and Ultramar Australia Ltd in EPP-18 (South Australia). Thirdly, bitumen strandings are common along the coasts of Victoria and South Australia (Sprigg, 1986). These strandings are more common after earthquakes, suggesting that reservoired oil is migrating to the seafloor along fault planes reactivated by the tectonic activity. The strandings are most common in the western Otway Basin, where faulting can extend all the way through the Tertiary sequence to the sea-floor (Williamson et al., 1987). Finally, sediment geochemical data (Heggie et al., 1988; Heggie & O'Brien 1988; O'Brien & Heggie 1989) suggest that systematic variations in source rock maturity exist across the Otway Basin, a proposal that could be tested using the DHD.

Stansbury Basin

The Stansbury Basin in South Australia consists of a Cambrian sedimentary sequence. Total organic carbon contents are generally low (up to 0.4 wt%) and Rock Eval yields are poor (SADME Report 1986). Consequently, the risk on source in this area is high. The DHD program in the area, which was conducted for AMOCO Production Company as a proprietary survey, sought to address the source risk.

DHD RESULTS

The following section presents the results obtained during the survey on a basin-by-basin basis. Several data plots are included which summarise the salient points in each basin. The complete set of results for the entire survey are given in Appendix I, which includes:

- ❐ Line summary sheets, which present the light hydrocarbon statistics and characteristics of each survey line, and the locations of the start and end of each line and brief statements about data for that line.

- Charts showing the distribution of the C_1 to C_3 hydrocarbons (fish depth, altitude and water depth) along each survey line.

Floppy diskette(s) containing geochemical and navigation data in an ASCII format are included in Enclosure 2.

The classification scheme used for describing hydrocarbon anomalies in this report is as follows. Anomalies are called "weak" when the individual C_1-C_4 hydrocarbons show a less than five-fold increase above the background concentration. "Moderate" anomalies display a 5-10 fold increase in the C_1-C_4 hydrocarbons above background, whereas the C_1-C_4 hydrocarbons in "strong' anomalies increase by more than an order of magnitude above the background concentration. Full details of the acquisition methods used and the interpretative methodologies employed are given in Appendices II and III The various types of data acquired on the survey are summarised in Table 1.

Gippsland Basin

The work program in the Gippsland Basin consisted of 17 lines with a total survey length of 280 km. The DHD program consisted principally of regional lines (Figures 1 & 2; Enclosure 1) which linked the Barracouta, Seahorse, Snapper, Tuna Sunfish and Sole hydrocarbon accumulations. Several lines ran close to the trend of the Rosedale Fault, the major northern fault separating the Northern Platform from the Central Deep. In addition, a limited program was carried out in the southern Gippsland Basin, which included a single survey line over the Kingfish Field.

The survey results are shown in the line summary charts (Figures 6a-h), which show the sum of C_1-C_4, methane, ethane, propane, butane, pentane as well as ethylene and propylene concentrations by survey line. 'Typical' background concentrations are evident for comparison with concentrations in anomalies. A total of 8 hydrocarbon anomalies were detected in the Gippsland Basin: 4 were strong, while the remaining four were weak (see Table 2).

The anomalies which were found on Line 89/82 (Anomalies 1 & 2, Table 2) just north of the Barracouta Field and to the east of Seahorse, show C_1/C_2 ratios <20 (Fig. 7a), and are more enriched in propane than the other anomalies. In fact, propane exceeds ethane in the

Line 89/82 anomalies (see Fig. 7b), which is apparently atypical of the natural abundances for these hydrocarbons in hydrocarbon accumulations. In addition, when ethane, propane and butane are plotted against methane for all of the data in the Gippsland Basin (Figures 8a, 8b & 8c), the anomalies on Line 89/82 all fall outside (and above) the general trend in the Gippsland Basin. A similar trend is evident from the plot of ethane versus propane (Figure 9) for the Gippsland Basin data:- the anomalies on Line 89/82 fall well outside the other Gippsland Basin trend. Also, the anomalies on Line 89/82 are distinct from the other Gippsland Basin anomalies in their i-C_5 abundances (Fig. 6h), with i-C_5 exceeding n-C_5 in this anomaly, whereas elsewhere, n-C_5 exceeds i-C_5.

Water co-produced with oil on the Kingfish and Halibut Platforms has previously been discharged into the sea at a depth of about 20 m (Burns & Emmett 1984). This is similar to, but somewhat less than, the depth of the DHD fish (>25 m) on Line 89/82 when the anomalies were detected. This observation, when combined with a distinctly different molecular composition suggests that the anomalies on Line 89/82 may be of anthropogenic origin associated with production activities, although what processes might fractionate the ethane and propane and pentane abundances are unknown.

The anomalies found on Line 89/83-84 and Line 89/85-86 (Figs. 6a-6e, 6h, 7, 8a,b, & c, 9), are of a composition more typical of natural hydrocarbon abundances in hydrocarbon accumulations, and are interpreted to represent hydrocarbon seepage from the seafloor of the Gippsland Basin. The anomaly on Line 89/83-84 is located between the Sunfish and Tuna fields, while the anomaly on Line 89/85-86 is located to the north of the Rosedale Fault, in the vicinity of the Wahoo 1 well.

The remaining four anomalies, which are located on Lines 89/87-88, 89/93-94, 89/95 and 89/96-97, were all weak. The anomaly on Line 89/95 was found when the DHD fish was being raised (while the ship was underway) to obtain a vertical profile of the hydrocarbon distributions in the water column. The other three anomalies also correspond to periods when the fish depth decreased (generally because of shallower water depths, see Appendix I). Some of these weak anomalies can be explained from the vertical profiles of hydrocarbons in the water column (see below).

The vertical profiles of temperature and conductivity are shown in Figures 10 a,b. These data reflect a two-layer water column: a surface-water layer that is stratified to about 50 m water depth, and a bottom-water layer that is well mixed from 50 m water depth to the seafloor. Typical 'background' concentrations are: methane = 7 ppm; ethane = 0.03 ppm and propane =0.02 ppm. Relatively high methane (13 ppm) and slightly elevated ethane concentrations (0.05 ppm) and propane (0.04 ppm) are associated with shallow water depths < 10 m (Figs. 11a,b, & c). A weak mid-depth minimum in methane, ethane and propane concentrations exists near the base of the thermocline. This is an important observation because it suggests the possibility of two (a surface-water and a near bottom-water), hydrocarbon source(s), and explains why weak "anomalies" appear that are related to the raising of the fish (sometimes above the local thermocline). Thermogenic hydrocarbons which may be present above the thermocline in the Gippsland Basin complicate the interpretation of the data, such that seepage from the seafloor cannot easily be distinguished from surface-water anthropogenic sources (particularly when the DHD tow-fish is raised to shallow depths because of a shoaling water depth). Apparent weak "thermogenic" hydrocarbon signatures, that may result from surface-water anthropogenic sources, are not genetically-related to the underlying geology.

Both the ethylene and propylene concentrations (see Figures 6f & 6g) are relatively high at the beginning of the Gippsland Basin program (Lines 89/80 to 89/83). This is because the water depths (and hence DHD fish depths) on Lines 89/80 to 89/83 was generally much shallower on these lines compared to the rest of the survey.

Hydrocarbon 'source'

A plot of hydrocarbon wetness (see Appendix III for interpretative rationale) versus methane is shown in Figure 12. This plot includes all the data collected in the Gippsland Basin, and shows that hydrocarbon wetness increases with increasing methane concentration. The bottom-water anomalies are also reflected in variations in percent hydrocarbon wetness and variations in a related ratio, the Bernard parameter (Figs. 13 a,b). The suspected anthropogenic anomalies on Line 89/82 are very "wet" (up to 25%; see Figure 13 a), and plot (Fig. 12) away from the bulk of the other Gippsland data at higher percent wetness values (for comparable methane concentrations). This plot indicates that the strong anomalies on Lines 89/83-84 and 89/85-86, and all other weak anomalies detected elsewhere (that are probably related to seepage from the seafloor), are from oil-prone, rather than gas-prone, 'sources'.

Samples for carbon isotope measurements were collected from only those strong anomalies detected on the survey. Carbon isotopic analyses were conducted by Don Rigby at CSIRO Division of Exploration Geoscience in Sydney. The results are summarised in Table 3.

Thermogenic hydrocarbons are enriched in the heavy isotope of carbon, so that the ratio of $^{13}C/^{12}C$ ($\delta^{13}C$)[1] in methane ranges between about -55 and -25 (Bernard et al. 1976;

Bernard et al. 1977; Fuex 1977). Biogenic gases, in contrast, are enriched in the light isotope of carbon and the $\delta^{13}C$ values of methane range between -55 and -90. The molecular composition of thermogenic hydrocarbons are characterised by relatively high proportions of C_2+ hydrocarbons, with Bernard parameters ($C_1/[C_2+C_3]$) of less than 100, whereas biogenic gases are dominated by methane with only minor quantities of C_2+ hydrocarbons and therefore the Bernard parameter is typically greater than 1000 (Bernard et al. 1976; Bernard et al. 1977).

Only the anomalies located near Seahorse and Barracouta, and between Sunfish and Tuna had sufficiently high gas concentrations to permit isotopic analysis. The seep near Seahorse had $\delta^{13}C$ values of methane which varied between -44.3 and -45.1 (Table 3), while the Bernard parameters of the gas mixtures varied between 3.6 and 5.3. The seep detected between Sunfish and Tuna had $\delta^{13}C$ values of methane which ranged between -37.1 and -37.8 (Table 3), and the Bernard parameter of the gas mixtures was 12. The carbon isotopic compositions of methane in the gas extracted from seawater and the molecular compositions of the anomalies confirm the thermogenic origin of the strong anomalies near Seahorse and Barracouta and between Sunfish and Tuna.

North Bass Basin (Victoria)

The DHD program in the North Bass Basin consisted of eight lines with a total of 310 line kilometres (Figure 3). No thermogenic hydrocarbons were detected in the water column of the North Bass Basin, as is evident from the survey summary plots, which show the sum C_1-C_4, methane, ethane, propane, ethylene and propylene concentrations, the Bernard parameter (C_1/C_2+C_3), ratios C_1/C_2, C_2/C_3 and percent hydrocarbon wetness along the various lines (Figures 14a-k). Both ethane and propane (Figures 14 c & d) show about two-fold increases in concentration above the local background for brief intervals on Lines 89/64 and 89/69. However, these changes are accompanied by increases in both ethylene and propylene (the biogenic hydrocarbons).

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[1] The carbon isotopic composition of methane is reported relative to the Pee Dee Belemnite (PDB) standard.

$d^{13}C_{sample}$ (o/oo) = $R_{sample}/R_{standard}$ -1) x 100

where R = $^{13}C/^{12}C$ measured on the mass spectrometer as isotopic peaks of masses 45 and 44 respectively.

Bass Basin (Tasmania)

The DHD program in the Bass Basin consisted of 61 lines with a total of 2445 km (Figure 3). These data were acquired in AMOCO's permit areas T/14P, T/18P and T/22P. No saturated hydrocarbon anomalies were detected in the water column in the Bass Basin, in spite of the fact that the survey traversed the known gas/condensate discoveries in the area (e.g. the Yolla and Pelican Fields). The survey data is summarised in Figures 15a-l, which show the, sum C_1-C_4, methane, ethane, propane, ethylene and propylene concentrations, the Bernard Parameter, butanes and ratios C_1/C_2, C_2/C_3 and the percent hydrocarbon wetness along the survey lines in the Bass Basin. It appears that the relatively unfaulted nature of the Bass Basin restricts the ability of the generated hydrocarbons to migrate to the surface.

Both the ethylene and propylene concentrations show systematic variations in concentration along the survey lines (Figures 15e & f). These variations are principally due to variations in water depth and DHD fish depth over the survey area.

The large amount of data collected, and the large area covered, when combined with the lack of detected anomalies, suggests that the opportunities for vertical hydrocarbon migration are very limited within the Bass Basin.

Torquay Sub-Basin (Victoria)

The survey in the Torquay Sub-Basin consisted of three lines, with a total survey length of approximately 210 km (Figure 4). The majority of the data collected in the Torquay Sub-Basin were characteristically of background concentration and composition. The data for sum C_1-C_4, methane, ethane, propane, ethylene and propylene, the Bernard Parameter, butane, C_1/C_2, C_2/C_3 and percent hydrocarbon wetness for the Torquay lines are shown on Figures 16a-l. On Line 89/70, both ethane and propane (Figures 16c & d) showed significant increase in concentration (which were largely independent of methane) to the north-east. This survey line had to be terminated, and these anomalies could not be detected when a transit was made across this area later in the survey. The source of these apparent anomalies remains unknown: one possibility may be anthropogenic hydrocarbons from Port Philip Bay which surge into Bass Strait under tidal influences.

A small methane anomaly was present on Line 89/73, but no elevated ethane or propane concentrations were found (Fig. 16a- d). On Line 89/72, however, one weak THC and methane anomaly was associated with a slight seafloor depression overlying an anticline (Fig. 16m). Moreover, the depression in the seafloor, a side scan sonar record that indicated more relief than the surrounding seafloor and the rising reflectors in the high resolution seismic record (Fig. 16n) are all associated with the bottom-water geochemical anomaly. The bottom-water anomaly had minor ethane associated with it, and was reproducible on resurveying, but the concentrations were too low to determine whether the anomaly was of thermogenic or biogenic origin.

Otway Basin (Victoria)

The proposed program, which consisted of two long regional lines traversing the entire basin, was curtailed because of time constraints and a conflict with the crayfish fishing season. The completed program only consisted of two lines (total 172 km) across the eastern Mussel Platform from Portland, Victoria, to Cape Otway, Victoria. The survey data are summarised in Figures 17a-l. Total C_1-C_4 hydrocarbon concentrations generally remained at background concentrations along the lines, but a single, weak propane (about two-fold background, Fig. 17d) and butane anomaly (with no associated methane or ethane enrichment) was found to the west of Cape Otway on survey line Otway 68a (Figures 17a-l). This anomaly was not associated with the unsaturated propylene. The anomaly is also reflected in plots of the Bernard parameter (where the Bernard parameter decreased to values < 150), the ratio of C_2/C_3 (< 0.5) and in hydrocarbon wetness. An increase in wetness from background values less than < 0.5 % to 1.3 % accompanied the weak propane and butane anomaly.

This anomaly, which extended for about 2-3 km, is located offshore from the gas and condensate discoveries in North Paaratte (economic and developed), Flaxmans and Port Campbell (sub-economic and undeveloped; Miyazaki et al. 1990). Although the propane anomaly was weak, it is consistent with other propane-rich bottom-water anomalies detected off Cape Northumberland and Lake Bonney during the InterOcean Systems Inc. survey during 1981 (Sprigg 1986). Recent data on light hydrocarbon distributions in the surface sediments of the Otway Basin (Heggie et al. 1988; Heggie & O'Brien 1988; O'Brien & Heggie 1989), and the results of geohistory and maturation modelling studies (Williamson et al. 1987), suggested that variations in the wet gas contents of surface sediment samples are consistent with the distribution and maturity of basal Early Cretaceous (Pretty Hill Sandstone) source rocks. Furthermore, the highest wet gas contents in the sediment (hydrocarbon - headspace) anomalies were found on the Mussel Platform, where the basal Early Cretaceous is located in the present day oil window

(O'Brien & Heggie 1989). A more recent integration of the surface geochemical data with maturation modelling considerations (Williamson et al. in press) suggested that a potential oil hydrocarbon exploration play is present margin-ward of Pecten 1, towards the Cape Otway-King Island High. Collectively, these studies and the weak propane anomaly near Cape Otway, suggest that additional surface geochemistry (bottom-water DHD and sediment geochemistry) could provide new clues to exploration in this basin.

Stansbury Basin (South Australia)

Six DHD survey lines (151 km) were acquired over the Cambrian Stansbury Basin in St Vincent's Gulf off Adelaide, South Australia (Figure 5). The survey data are summarised in Figures 18 a-k. No thermogenic anomalies were found and the hydrocarbon concentrations are consistent with background levels. Subtle variations in the sum C_1-C_4, methane, ethylene and propylene concentrations (Figures 18a, b, e & f) are attributable to variations in the biogenic production at different water depths and localities.

Sediment hydrocarbon headspace analyses: Gippsland Basin

In addition to the DHD program, sediment samples were collected for light hydrocarbon gas analysis in the Gippsland Basin. The seafloor sampling was conducted with discussion and suggestions from Petrofina, BHP and Shell Australia. During this program, 6 grabs, 30 gravity cores and 3 vibrocores were taken and analysed at sea, via head space techniques, for light hydrocarbon concentrations. The results of the sediment sampling program are summarised in Tables 4a,b, & c. The results of the light hydrocarbon analyses are presented in Table 5.

The core recovery results indicate that gravity coring is not a reliable seafloor sampling tool in the Gippsland Basin in water depths of less than about 300 m. Three vibrocores each recovered approximately 1.5 m of sediment from water depths less than 300 m. Several gravity cores in water depths greater than 300 m successfully penetrated the seafloor and recovered sediments.

SUMMARY

- Approximately 3570 line-km of DHD were acquired in south-eastern Australia. Several bottom-water light hydrocarbon anomalies were detected during this program.
- No bottom-water anomalies were detected during 2445 line-km of DHD surveying in the Bass Basin, even though known gas-condensate accumulations were traversed. This null result suggests that the opportunity for vertical hydrocarbon migration is limited in this region.
- No bottom-water hydrocarbon anomalies were found in the North Bass or Stansbury Basins. As there are no known hydrocarbon accumulations in these areas, the DHD results support the generally held belief that these areas have low hydrocarbon prospectivity.
- A weak THC, methane and trace ethane anomaly was found in the Torquay Sub-basin. This anomaly was associated with a seafloor pockmark which overlies a possible (seismically-defined) gas "chimney". Because of the weakness of this anomaly, its hydrocarbon source could not be identified by hydrocarbon cross-plot methods.
- A weak propane and butane anomaly was found to the west of Cape Otway, on the Mussel Platform, Otway Basin.
- Eight bottom-water anomalies were found in the Gippsland Basin. Four of these anomalies were strong, although two strong anomalies (near Barracouta) may be of anthropogenic origin. The other two strong anomalies, which were probably due to natural hydrocarbon seepage from the seafloor, were found between Sunfish and Tuna, and near the Wahoo exploration well, respectively. No bottom-water anomalies were detected in a single pass over the Kingfish Field.
- In the Gippsland Basin, the discharge of hydrocarbons from production platforms (and other possible anthropogenic sources) contributes low levels of hydrocarbons to the surface layer. It seems likely that the four weak anomalies which were detected in the north-eastern part of the Gippsland Basin may be artefacts related to the raising of the tow-fish into a surface-water layer containing non-seep (anthropogenic-sourced) hydrocarbons, though a bottom-water 'source' for these anomalies cannot be *categorically* ruled out. Consequently, in areas with active hydrocarbon production, DHD data obtained from shallow water depths (particularly when obtained from above the local thermocline), should be interpreted with caution. An understanding of the structure of the water column helps interpretation greatly.
- The two strong anomalies in the Gippsland Basin were significantly higher in concentration, hydrocarbon "wetness" and extent, than the other weak anomalies in the Torquay Sub-Basin and the eastern Otway Basin. As such, the DHD data, taken on its

own, would indicate that the most petroliferous region in south-eastern Australia would be the Gippsland Basin. From that perspective, the survey indicated that the DHD technique is useful in identifying major petroleum provinces.

The overall results of this study are summarised in Table 6.

REFERENCES

Bernard, B.B., Brooks, J.M. & Sackett, W.M. (1976), Natural gas seepage in the Gulf of Mexico, *Earth and Planetary Science Letters* 31, 48-54.

Bernard, B.B., Brooks, J.M. & Sackett, W.M. (1977), A geochemical model for characterisation of hydrocarbon gas sources in marine sediments. In: 9 the *Offshore Technology Conference*, Houston, Texas, OTC 2934, 435-438.

Brown, B.R. (1986), Offshore Gippsland Silver Jubilee. In: *Second South-Eastern Australia Oil Exploration Symposium*, Glenie, R.C. (ed.), 1986, 29-56.

Burns, B.J. & Emmet, J.K. (1984), Final report GE 83B geochemical (sniffer) survey Gippsland Basin offshore. November 1983. Esso Australia Ltd, *Unpublished Geochemical Report*, August 1984. Bureau of Mineral Resources P(SL)A 83/47.

Fuex, A.N. (1977), The use of stable carbon isotopes in hydrocarbon exploration. *Journal of Geochemical Exploration*, 7,155-188.

Heggie, D.T., McKirdy, D., Exon, N.F. & Lee, C.S. (1988), Hydrocarbon gases, heat-flow and development of the offshore Otway Basin. *Petroleum Exploration Society of Australia Journal*, 13, 32-42.

Heggie, D.T. & O'Brien, G.W. (1988), Hydrocarbon gas geochemistry in sediments of the offshore Otway and Gippsland Basins. *Bureau of Mineral Resources Record* 1988/32, 149pp.

Heggie, D.T., O'Brien, G.W., Bickford, G.P., & Bishop, J.H. (1991a), Direct hydrocarbon detection in bottom waters of the Australian continental margin: application to offshore hydrocarbon exploration. *Petroleum Exploration Society of Australia Journal*, 16 (Sept.), 75-91.

Heggie, D.T., O'Brien, G.W., Bickford, G.P. & Bishop, J.H. (1991b), Surface geochemistry and offshore hydrocarbon exploration on the Australian continental margin: a status report. In: Crisp et al. (eds) *Offshore Australia Conference Proceedings*. Australian Exhibition Services Pty. Ltd., III, 1-24.

Hovland, M. & Judd, A.G. (1988), *Seabed Pockmarks and Seepages Impact on Geology, Biology and the Marine Environment.* Graham and Trotman, Ltd. London., 293pp.

O'Brien, G.W. & Heggie, D.T. (1989), Hydrocarbon gases in seafloor sediments, Otway and Gippsland Basins: implications for petroleum exploration. *Australian Petroleum Exploration Association Journal* 29, 96-113.

Ozimic, S., Nicholas, E., Pain, S. & Vuckovic V. (1987), *Australian Petroleum Accumulations, Report No. 3. Gippsland Basin, Victoria.* Bureau of Mineral Resources, Geology and Geophysics, 252 pp.

Sackett, W.M. (1977), Use of hydrocarbon sniffing in offshore exploration. *Journal. Geochemical. Exploration,* 7, 243-254.

SADME Report (1986), Petroleum exploration and development in South Australia. Report prepared by the *Oil, Gas and Coal Division, SADME*, 4th Edition, April 1986.

Schiener, E.J., Stober, G. & Faber, E. (1985), Surface geochemical exploration for hydrocarbons in offshore areas- principles, methods and results. In: B.M. Thomas et al (eds) Petroleum Geochemistry in Exploration of the Norwegian Shelf. *Norwegian Petroleum Society.*, 223-238, Graham & Trotman, Ltd, London.

Schink, D.R., Guinasso, N.L. Jr., Sigalove, J.J. & Cima, B.E. (1971), Hydrocarbons under the sea- a new survey technique. In: 3rd *Annual Offshore Technology Conference Houston*, Texas, OTC 1339, 1-15.

Sigalove, J.J. & Pearlman, M.D. (1975), Geochemical Seep Detection for Offshore Oil and Gas Exploration. In: 7th *Annual Offshore Technology Conference* Houston, Texas, OTC 2344, 95-100.

Smith G.C. (1986), Bass Basin geology and petroleum exploration. In: Glenie, R.C. (ed) *Second South-Eastern Australia Oil Exploration Symposium, Petroleum Exploration Society of Australia,* 257-284.

Sprigg, R.C. (1986), A history of the search for commercial hydrocarbons in the Otway Basin complex. In: Glenie, R.C. (ed) *Second South-Eastern Australia Oil Exploration Symposium, Petroleum Exploration Society of Australia*, 173-200.

Williamson, P.E., O'Brien, G.W., Swift, M.G., Felton, E.A., Scherl., A.S., Exon, N.F., Lock, J. & Falvey, D.A. (1987), Hydrocarbon potential of the offshore Otway Basin, *Australian Petroleum Exploration Association Journal* 27, 173-194.

Williamson, P.E. & Pigram, C.J. (1986), Subsidence and maturation history of the Bass Basin from geohistory calculations. In: Glenie, R.C. (ed) *Second South-Eastern Australia Oil Exploration Symposium, Petroleum Exploration Society of Australia*, 285-302.

Williamson, P.E., O'Brien, G.W. & Swift, M. Petroleum maturation, structural and subsidence history of the offshore Otway Basin, southeastern Australia:- implications for explortion. *American Association of Petroleum Geologists Bulletin* (in press subject to revision).

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LIST OF TABLES

Table 1. Summary of data collected during *Rig Seismic* Survey 89.

Location.	Line-km	Comment
Bass Basin	2445	Geochem lines Bass 1- 61
		Side scan sonar lines 25-27; 34-37
North Bass Basin	310	Geochem lines N.Bass 62-69
Stansbury Basin	151	Geochem lines Stans 64-66
Otway Basin	172	Geochem lines Otway 68,69
	30	High res.seismic, lines 501-504
Torquay Sub-basin	210	Geochem lines Torq. 70-73
	42	Side scan sonar line 505 (Geochem 72)
	39	High res. seismic line 506 (Geochem 70)
Gippsland Basin	280	Geochem lines Gipps 80-97.

The high resolution seismic and side scan sonar data lines have been numbered arbitrarily to distinguish them from geochemical line numbers.

Table 2. Hydrocarbon anomalies detected in the Gippsland Basin. Included are typical background hydrocarbon concentrations.

Anomaly #	Line #	Characteristic	Strength	Location	Proposed Origin
1	89/82	Methane, Ethane, Propane, Butane. Propane-rich	Strong (C1 to 69, C2 to 7.6, C3 to 9.8, C4 to 1.9). Some C5+ enrichment	Near Barracouta Field)	Probably anthropogenic
2	89/82	Methane, Ethane, Propane, Butane Propane-rich	Strong (C1 to 59, C2 to 4.4, C3 to 4.5, C4 to 0.96). Some C5+ enrichment	Near Barracouta and Seahorse Fields	Probably anthropogenic or mixed anthropogenic and natural seepage
3	89/83-84	Methane, Ethane, Propane, Butane	Strong (C1 to 53, C2 to 3.1, C3 to 1.3, C4 to 0.35). Some C5+ enrichment.	Between Sunfish and Tuna Platforms	Natural Seepage
4	89/85-86	Methane, Ethane, Propane, Butane	Strong (C1 to 29, C2 to 1.4, C3 to 0.77, C4 to 0.19). Some C5+ enrichment.	Near Wahoo 1 well	Natural Seepage
5	89/87-88	Methane, Ethane, Propane, Butane	Very weak (C1 to 7.1, C2 to 0.16, C3 to 0.09, C4 to 0.026).		Related to variation in fish depth
6	89/93-94	Methane, Ethane, Propane, Butane	Very weak (C1 to 7.7, C2 to 0.10, C3 to 0.07, C4 to 0.02).		Related to variation in fish depth
7	89/95	Methane, Ethane, Propane,	Very weak (C1 to 7.5, C2 to 0.07, C3 to .05.		Vertical profile: depth variations in hydrocarbons
8	89/96-97	Methane, Ethane, Propane, Butane depth	Very weak (C1 to 12.8, C2 to 0.21, C3 to 0.11, C4 to 0.027).		Possible artefact of fish depth: tow-fish above the local thermocline
Representative Background Concentrations		Methane Ethane Ethylene Propane Propylene Butanes	7 ppm 0.03 ppm 0.1 ppm 0.02 ppm 0.1 ppm <0.01 ppm		

Table 3. Summary of carbon isotopic data from bottom-water anomalies in the Gippsland Basin.

SIRA Analysis carbon v PDB

Sample	$\delta 13C_1$ o/oo	$\delta 13C_2$ o/oo	$\delta 13C_3$ o/oo
89/83-1	-37.8	n.m.	n.m.
89/83-2	-37.1	n.m.	n.m.
89/82-1	-45.1	-29.5	-26.6
89/82-2	-44.3	-23.3	-26.4
89/82-3	-45.0	-23.4	-27.9

n.m.- not measured (sample too small)

* Standard deviation = 0.3%

Table 4a. Seafloor sampling results in the vicinity of the Basker and Manta exploration wells.

Sample No	Latitude	Longitude	W.D.	Recovery	Nav. Type
89/GC/001	38°18.40	148°39.71	197	1.44	DR
89/GC/002	38°17.98	148°40.13	173	5 gms shells	GPS
89/GC/003	38°17.89	148°40.30	176	250 gms shells	GPS
89/GC/004	38°19.89	148°40.85	278	NIL	GPS
89/GC/005	38°19.89	148°40.85	279	NIL	GPS
89/GC/006	38°19.91	148°40.64	280	30 cms	GPS
89/GC/007	38°19.89	148°40.85	280	NIL	GPS
89/GC/008	38°19.41	148°41.19	278	NIL	GPS
89/GC/009	38°18.94	148°41.52	223	NIL	GPS
89/GC/010	38°18.46	148°41.84	161	4 kgs	GPS
89/GC/011	38°19.90	148°40.88	259	NIL	DR
89/GC/012	38°19.90	148°40.88	259	100 gms shells	DR
89/GS/001	38°20.006	148°40.878	316	2 bags 4 kgs	RN
89/GS/002	38°19.45	148°41.129	263	NIL	RN
89/GS/003	38°18.94	148°41.52	256	2 kgs	DR
89/GS/004	38°18.472	148°41.786	160	"	RN
89/GS/005	38°17.529	148°42.557	138	"	RN
89/GS/006	38°16.58	148°41.52	127	"	RN

Navigation type:

DR = Dead reckoning
GPS = Global positioning system
RN = Radio navigation (Hifix)

Table 4b. Seafloor sampling results in the vicinity of the Hapuku exploration wells.

Sample No	Latitude	Longitude	W.D.	Recovery	Nav. Type
89/GC/013	38°25.504	148°35.640	460 m	1.9 m	RN
89/GC/014	38°02.75	148°03.81	852 m	2.65 m	RN
89/GC/015	38°30.58	148°32.32	377 m	0.23 cms	RN
89/GC/016	38°31.58	148°36.07	568 m	3.8 m	RN
89/GC/017	38°33.34	148°32.94	370 m	5 gms shells	RN
89/GC/018	38°33.31	148°32.80	367 m	NIL	RN
89/GC/019	38°32.95	148°32.61	367 m	NIL	RN
89/GC/020	38°33.59	148°33.14	423 m	NIL	GPS
89/GC/027	38°31.59	148°36.0	543 m	0.94	RN
89/GC/028	38°30.44	148°36.84	726 m	2.85	RN
89/GC/029	38°30.84	148°35.1	642 m	5 gms rock fragments	DR
89/GC/030	38°27.55	148°38.08	854 m	3.25	RN

Navigation type:

DR = Dead reckoning
GPS = Global positioning system
RN = Radio navigation (Hifix)

Table 4c. Seafloor sampling results from the Gippsland Basin, south-eastern Australia. This program was conducted in collaboration with Petrofina Australia Pty. Ltd.

Sample No	Latitude	Longitude	W.D.	Recovery	Nav. Type
89/GC/021	38°37.65	148°26.87	250 m	NIL	GPS
89/GC/022	38°37.80	148°07.00	275 m	NIL	GPS
89/GC/023	38°39.28	148°27.10	247 m	NIL	GPS
89/GC/024	38°39.6	148°26.89	290 m	NIL	GPS
89/GC/025	38°39.52	148°26.52	272 m	NIL	GPS
89/GC/026	38°39.5	148°26.17	232 m	NIL	RN
89/VC/01	38°39.46	148°26.13	230 m	1.4 m	RN
89/VC/02	38°39.65	148°26.36	273 m	1.65 m	DR
89/VC/03	38°37.67	148°27.03	265 m	1.85 m	RN

Navigation type:

DR = Dead reckoning
GPS = Global positioning system
RN = Radio navigation (Hifix)

Table 5. Light hydrocarbon data from near-surface sediments within the offshore Gippsland Basin.

BMR Line	Core	Latitude	Longitude	Water Depth (m)	Depth in Core (cm)	Mean Depth (cm)	C1	C2	C2:1	C3	C3:1	iC4	nC4	C1-C4	Wet Gas %	C1/ C2+C3	C2/ C2:1	C3/ C3:1	iC4/ nC4	iC5/ nC5
GRAVITY	CORES																			
	89GC 1	38.30568	148.65985	197	80-90	85	1.14	0.07	0.03	0.06	0.02	0.01	0.03	1.31	12.56	8.58	2.18	2.64	0.29	0.22
	89GC 1	38.30568	148.65985	197	101-111	106	0.96	0.09	0.08	0.09	0.1	0.01	0.03	1.17	18.39	5.28	1.16	0.96	0.32	0.26
	89GC 6	38.33183	148.67712	282	10 to 20	15	0.37	0.05	0.2	0.09	0.1	0.01	0.03	0.54	31.39	2.69	0.22	0.92	0.32	0.37
	89GC 10	38.30733	148.6973	162	0 to 10	5	0.44	0.06	0.12	0.11	0.07	0.01	0.03	0.69	25.22	3.58	0.59	0.87	0.49	0.20
	89GC 10	38.30733	148.6973	162	0 to 10	5	0.52	0.08	0.14	0.06	0.07	0.01	0.03	0.64	31.02	2.66	0.50	1.51	0.40	0.19
	89GC 13	38.4249	148.59448	460	10 to 20	15.00	0.58	0.05	0.08	0.07	0.02	0.01	0.02	0.72	19.46	4.82	0.61	2.87	0.31	0.13
	89GC 13	38.4249	148.59448	460	40-50	45	0.68	0.07	0.07	0.08	0.02	0.01	0.03	0.86	20.19	4.65	1.04	3.62	0.25	0.22
	89GC 13	38.4249	148.59448	460	70-80	75	1.36	0.08	0.07	0.09	0.02	0.01	0.03	1.56	12.79	7.85	1.20	4.05	0.36	0.00
	89GC 13	38.4249	148.59448	460	110-120	115	0.49	0.06	0.05	0.07	0.02	0.00	0.02	0.64	23.23	3.82	1.15	3.79	0.24	0.29
	89GC 13	38.4249	148.59448	460	140-150	145	1.36	0.07	0.05	0.07	0.02	0.01	0.02	1.51	10.34	10.01	1.24	3.63	0.29	0.11
	89GC 13	38.4249	148.59448	460	170-180	175	1.19	0.10	0.08	0.11	0.03	0.01	0.03	1.44	16.87	5.58	1.23	3.79	0.27	0.27
	89GC 14	38.45917	148.63433	855	10 to 20	15	2.47	0.17	0.13	0.22	0.04	0.01	0.05	2.90	14.82	6.47	1.27	5.02	0.27	0.21
	89GC 14	38.45917	148.63433	855	30-40	35	5.41	0.12	0.09	0.13	0.02	0.01	0.04	5.70	5.15	20.98	1.33	5.61	0.23	0.00
	89GC 14	38.45917	148.63433	855	50-60	55	16.42	0.18	0.10	0.15	0.03	0.01	0.03	16.78	2.15	50.32	1.77	5.36	0.29	0.18
	89GC 14	38.45917	148.63433	855	80-90	85	26.07	0.16	0.04	0.07	0.01	0.00	0.02	26.31	0.92	117.04	3.91	7.16	0.21	0.16
	89GC 14	38.45917	148.63433	855	110-120	115	46.97	0.26	0.04	0.08	0.01	0.00	0.02	47.32	0.75	140.22	5.94	6.23	0.00	0.18
	89GC 14	38.45917	148.63433	855	140-150	145	83.60	0.43	0.05	0.09	0.01	0.00	0.03	84.15	0.65	162.28	9.37	7.08	0.11	0.12
	89GC 14	38.45917	148.63433	855	170-180	175	130.13	0.70	0.06	0.14	0.02	0.01	0.03	131.01	0.67	154.47	10.94	6.12	0.20	0.12
	89GC 14	38.45917	148.63433	855	200-210	205	164.20	0.88	0.03	0.07	0.01	0.00	0.02	165.17	0.59	174.09	27.59	6.70	0.16	0.00
	89GC 14	38.45917	148.63433	855	220-230	225	199.93	1.12	0.04	0.09	0.01	0.00	0.03	201.17	0.62	165.35	27.97	7.19	0.14	0.00
	89GC 15	38.51035	148.53962	377	3 to 13	8	0.55	0.03	0.09	0.10	0.04	0.01	0.02	0.71	22.45	4.10	0.36	2.26	0.52	0.33
	89GC 16	38.52525	148.60198	573	20-30	25	1.15	0.06	0.09	0.07	0.03	0.01	0.02	1.30	11.89	8.54	0.71	2.18	0.36	0.09
	89GC 16	38.52525	148.60198	573	50-60	55	1.28	0.07	0.07	0.07	0.02	0.01	0.03	1.46	12.18	8.60	1.14	3.35	0.30	0.20
	89GC 16	38.52525	148.60198	573	80-90	85	1.67	0.08	0.07	0.09	0.03	0.01	0.03	1.87	10.69	9.59	1.24	3.57	0.30	0.22
	89GC 16	38.52525	148.60198	573	100-110	105	1.67	0.07	0.06	0.07	0.02	0.01	0.02	1.84	9.10	11.58	1.27	3.62	0.32	0.26
	89GC 16	38.52525	148.60198	573	140-150	145	1.82	0.07	0.05	0.07	0.02	0.01	0.02	1.98	7.97	13.40	1.46	3.80	0.62	0.14
	89GC 16	38.52525	148.60198	573	170-180	175	1.58	0.08	0.05	0.08	0.02	0.01	0.02	1.76	10.24	9.90	1.48	4.69	0.45	0.27
	89GC 16	38.52525	148.60198	573	210-220	215	2.75	0.07	0.04	0.06	0.01	0.01	0.03	2.93	5.94	19.73	1.68	4.58	0.19	0.00

	89GC 16	38.52525	148.60198	573	240-250	245	2.99	0.08	0.05	0.08	0.02	0.01	0.02	3.16	5.56	18.92	1.77	4.72	0.31	0.24
	89GC 16	38.52525	148.60198	573	270-280	275	3.58	0.09	0.05	0.08	0.02	0.01	0.03	3.77	5.04	21.82	1.72	4.54	0.29	0.00
	89GC 16	38.52525	148.60198	573	310-320	315	6.67	0.28	0.24	0.27	0.09	0.02	0.06	7.28	8.41	12.11	1.16	3.08	0.24	0.29
	89GC 16	38.52525	148.60198	573	330-340	335	4.42	0.08	0.03	0.05	0.01	0.00	0.02	4.57	3.13	35.08	2.48	4.80	0.24	0.00
	89GC 16	38.52525	148.60198	573	350-360	355	6.95	0.13	0.04	0.10	0.02	0.01	0.03	7.20	3.54	30.27	3.41	6.10	0.38	0.14
	89GC 27	38.52295	148.5998	543	27-37	32	0.87	0.03	0.07	0.05	0.02	0.00	0.01	0.96	9.48	11.00	0.43	2.97	0.26	0.00
	89GC 27	38.52295	148.5998	543	60-70	65	1.09	0.06	0.07	0.05	0.02	0.00	0.01	1.22	10.51	9.52	0.96	3.16	0.32	0.00
	89GC 28	38.50732	148.61362	705	17-27	22	3.03	0.09	0.06	0.10	0.02	0.01	0.02	3.24	6.27	16.60	1.37	4.43	0.29	0.05
	89GC 28	38.50732	148.61362	705	40-50	45	3.03	0.13	0.08	0.14	0.02	0.01	0.03	3.32	8.70	11.56	1.58	5.55	0.27	0.08
	89GC 28	38.50732	148.61362	705	66-76	71	3.55	0.11	0.09	0.13	0.02	0.01	0.03	3.83	7.18	14.44	1.30	5.86	0.26	0.00
	89GC 28	38.50732	148.61362	705	102-112	107	10.70	0.13	0.06	0.08	0.01	0.00	0.02	10.93	2.10	50.33	2.25	6.66	0.22	0.24
	89GC 28	38.50732	148.61362	705	142-152	147	18.14	0.21	0.06	0.10	0.02	0.01	0.02	18.47	1.78	59.33	3.54	4.77	0.24	0.10
	89GC 28	38.50732	148.61362	705	172-182	177	17.32	0.21	0.05	0.09	0.02	0.00	0.02	17.64	1.80	58.34	3.80	5.30	0.22	0.22
	89GC 28	38.50732	148.61362	705	192-202	197	18.03	0.21	0.04	0.06	0.01	0.00	0.02	18.32	1.60	65.15	4.76	4.43	0.29	0.21
	89GC 28	38.50732	148.61362	705	220-230	225	22.61	0.35	0.04	0.06	0.02	0.00	0.02	23.04	1.86	55.00	8.81	3.94	0.22	0.24
	89GC 28	38.50732	148.61362	705	250-260	255	26.28	0.59	0.04	0.05	0.02	0.00	0.01	26.93	2.42	41.23	15.44	2.62	0.31	0.00
	89GC 30	38.45825	148.63815	854	20-30	25	4.12	0.13	0.10	0.16	0.03	0.01	0.03	4.44	7.28	14.17	1.29	5.85	0.27	0.34
	89GC 30	38.45825	148.63815	854	56-66	61	7.39	0.07	0.06	0.08	0.01	0.00	0.02	7.56	2.21	49.49	1.29	5.79	0.28	0.27
	89GC 30	38.45825	148.63815	854	86-96	91	16.03	0.12	0.08	0.12	0.02	0.01	0.03	16.31	1.67	65.29	1.65	6.11	0.26	0.21
	89GC 30	38.45825	148.63815	854	115-125	120	46.33	0.24	0.14	0.21	0.04	0.01	0.05	46.84	1.08	101.45	1.80	4.73	0.29	0.35
	89GC 30	38.45825	148.63815	854	153-163	158	50.00	0.18	0.07	0.12	0.02	0.01	0.03	50.33	0.66	167.37	2.41	5.44	0.19	0.35
	89GC 30	38.45825	148.63815	854	185-195	190	67.30	0.27	0.13	0.21	0.04	0.01	0.05	67.84	0.79	137.86	2.16	6.01	0.26	0.23
	89GC 30	38.45825	148.63815	854	215-225	220	46.40	0.21	0.12	0.18	0.03	0.01	0.04	46.83	0.91	119.57	1.77	5.25	0.27	0.00
	89GC 30	38.45825	148.63815	854	245-255	250	26.24	0.14	0.05	0.06	0.01	0.00	0.02	48.99	0.46	237.98	2.72	6.98	0.00	0.09
	89GC 30	38.45825	148.63815	854	280-290	285	66.03	0.23	0.09	0.15	0.03	0.01	0.04	66.45	0.62	175.83	2.41	5.61	0.24	0.12
	89GC 30	38.45825	148.63815	854	303-313	308	50.87	0.13	0.04	0.05	0.01	0.00	0.01	51.06	0.37	293.09	3.19	6.12	0.00	0.00
GRABS																				
	89GS01	38.33658	148.67623	316	0 to 10	5	0.50	0.03	0.13	0.04	0.04	0.01	0.02	0.41	16.65	6.01	0.27	1.03	0.38	0.14
	89GSO1	38.33658	148.67623	316	0 to 10	5	0.34	0.03	0.1	0.03	0.03	0	0.01	0.59	15.82	6.48	0.26	1.16	0.42	0.20
	89GS02	38.32803	148.67682	262	0 to 10	5	0.45	0.03	0.1	0.03	0.03	0	0.01	1.52	12.98	25.93	0.31	1.09	0.52	0.00
	89GS02	38.32803	148.67682	262	0 to 10	5	1.45	0.03	0.09	0.03	0.03	0.01	0.02	0.52	5.13	7.83	0.27	1.20	0.00	0.15

Table 5 continued

	89GS03	38.3157	148.692	252	0 to 10	5	0.52	0.02	0.1	0.02	0.02	0	0.01	0.69	9.26	11.98	0.21	1.07	0.34	0.00
	89GS03	38.3157	148.692	252	0 to 10	5	0.62	0.02	0.11	0.03	0.03	0	0.01	0.57	9.54	11.15	0.22	1.07	0.00	0.00
	89GS04	38.3081	148.69687	159	0 to 10	5	0.55	0.04	0.13	0.03	0.03	0.02	0	0.52	11.50	9.96	0.21	0.78	0.27	0.00
	89GS04	38.3081	148.69687	159	0 to 10	5	0.46	0.02	0.1	0.02	0.03	0	0.01	0.63	11.77	7.49	0.31	0.97	0.00	0.00
	89GS05	38.29122	148.70908	137	0 to 10	5	0.99	0.02	0.1	0.03	0.02	0.01	0	0.33	6.50	14.38	0.20	0.80	0.00	0.00
	89GS05	38.29122	148.70908	137	0 to 10	5	0.31	0.01	0.05	0.01	0.01	0	0	1.04	4.96	19.14	0.24	1.19	0.00	0.00
	89GS06	38.27875	148.7201	128	0 to 10	5	2.30	0.01	0.14	0.03	0.04	0.01	0.01	2.00	3.74	29.41	0.22	1.18	0.00	0.09
	89GS06	38.27875	148.7201	128	0 to 10	5	1.92	0.03	0.13	0.04	0.03	0	0.01	2.36	2.60	48.29	0.11	0.82	0.41	0.00
VIBRO	CORES																			
	89VC 01	38.65768	148.4357	270	31-44	37	1.70	0.07	0.09	0.05	0.06	0.01	0.03	1.85	8.34	13.46	0.80	0.92	0.36	0.00
	89VC 01	38.65768	148.4357	270	54-67	61	5.88	0.16	0.12	0.11	0.05	0.02	0.07	6.22	5.45	21.57	1.34	2.35	0.32	0.29
	89VC 01	38.65768	148.4357	270	77-90	83	1.79	0.06	0.07	0.04	0.02	0.01	0.02	1.90	5.87	19.62	0.82	1.53	0.29	0.35
	89VC 01	38.65768	148.4357	270	100-110	105	6.44	0.15	0.08	0.08	0.03	0.01	0.05	6.72	4.15	28.06	1.94	2.47	0.17	0.31
	89VC 01	38.65768	148.4357	270	112-125	118	8.79	0.20	0.08	0.10	0.03	0.01	0.05	9.13	3.76	29.83	2.51	2.77	0.27	0.36
	89VC 02	38.66097	148.43857	273	42-55	48	1.80	0.06	0.07	0.05	0.03	0.01	0.02	1.94	6.98	15.76	0.91	1.91	0.34	0.47
	89VC 02	38.66097	148.43857	273	65-78	71	2.96	0.09	0.09	0.07	0.03	0.01	0.04	3.15	6.15	18.67	0.96	2.01	0.28	0.10
	89VC 02	38.66097	148.43857	273	90-103	96	5.78	0.14	0.07	0.08	0.02	0.01	0.05	6.05	4.52	25.39	2.21	3.51	0.32	0.37
	89VC 02	38.66097	148.43857	273	132-145	138	8.76	0.18	0.06	0.10	0.02	0.01	0.05	9.10	3.69	31.07	3.14	4.26	0.20	0.33
	89VC 02	38.66097	148.43857	273	155-168	161	5.72	0.21	0.09	0.12	0.04	0.02	0.06	6.11	6.32	17.39	2.28	3.35	0.27	0.36
	89VC 03	38.62828	148.45098	264	20-33	26	34.00	0.44	0.21	0.15	0.09	0.01	0.10	34.69	1.99	57.83	2.10	1.64	0.14	0.34
	89VC 03	38.62828	148.45098	264	50-63	56	2.45	0.09	0.06	0.05	0.02	0.01	0.02	2.62	6.44	17.03	1.49	2.33	0.24	0.32
	89VC 03	38.62828	148.45098	264	80-93	86	3.71	0.11	0.08	0.07	0.03	0.01	0.03	3.92	5.42	20.11	1.47	2.52	0.26	0.30
	89VC 03	38.62828	148.45098	264	112-125	118	11.91	0.28	0.13	0.14	0.05	0.01	0.09	12.42	4.09	28.41	2.19	3.12	0.15	0.30
	89VC 03	38.62828	148.45098	264	137-150	143	18.84	0.42	0.20	0.16	0.07	0.01	0.12	19.54	3.56	32.62	2.10	2.48	0.12	0.26
	89VC 03	38.62828	148.45098	264	160-173	166	19.99	0.50	0.28	0.21	0.10	0.02	0.15	20.85	4.13	27.96	1.77	2.20	0.12	0.35

Table 5 continued

Table 6. Basin summary chart showing the relationship between DHD anomalies and known basin prospectivity.

Basin	Kilometres DHD Acquired During Present Study	Existing Hydrocarbon Discoveries? (Y,N)*	Seeps Discovered? (Y,N,I)**	Anthropogenic Hydrocarbons Present? (Y,N,I)*
Gippsland Basin	280	Y	Y	Y
North Bass Basin	310	N	N	N
Bass Basin	2445	Y	N	N
Torquay Sub-Basin	210	N	Y	I
Otway Basin	172	Y	Y	N
Stansbury Basin	151	N	N	N

* Y=Yes; N= No

**Y=Yes; N= No; I = Indeterminate with present data set

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Figure 8b. Methane versus propane concentration for all water column geochemical data acquired in the Gippsland Basin.

Figure 8c. Methane versus butane concentration for all water column geochemical data acquired in the Gippsland Basin.

Figure 9. Ethane versus propane concentrations for all Gippsland Basin data. Data points characterised by high propane concentrations relative to ethane are all from survey line 89/82.

Figure 10a. Vertical profile of temperature versus fish depth for Line 89/95.

Figure 10b. Vertical profile of conductivity (salinity) versus fish depth for Line 89/95.

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Figure 13a. Hydrocarbon wetness versus line number for all the Gippsland Basin data, showing that the wettest anomalies (up to 25% wet) were found on line 89/82 .

Figure 13b. Bernard parameter versus line number, Gippsland basin.

North Bass Basin.

Figure 14a. Sum C1-C4 hydrocarbon concentration along the survey lines in the North Bass Basin.
Figure 14b. Methane concentrations along the survey lines in the North Bass Basin.
Figure 14c. Ethane concentrations along the survey lines in the North Bass Basin.

Figure 14d. Propane concentrations along the survey lines in the North Bass Basin.
Figure 14e. Ethylene concentrations along the survey lines in the North Bass Basin.
Figure 14f. Propylene concentrations along the survey lines in the North Bass Basin.

Figure 14g. Bernard Parameter along the survey lines in the North Bass Basin.

Figure 14h. Butanes along the survey lines in the North Bass Basin.

Figure 14j. Methane/ethane along the survey lines in the North Bass Basin.

Figure 14k. Ethane/propane along the survey lines in the North Bass Basin.

Figure 14l Percent hydrocarbon wetness along all of the survey lines in the North Bass Basin.

Bass Basin

Figure 15a. Sum C1-C4 hydrocarbon concentration along all of the survey lines in the Bass Basin.

Figure 15b. Methane concentrations along all of the survey lines in the BassBasin.

Figure 15c. Ethane concentrations along all of the survey lines in the BassBasin.

Figure 15d. Propane concentrations along all of the survey lines in the Bass Basin.

Figure 15e. Ethylene concentrations along all of the survey lines in the Bass Basin.

Figure 15f. Propylene concentrations along all of the survey lines in the Bass Basin.

Figure 15g. Bernard Parameter along all of the survey lines in the Bass Basin.

Figure 15h. Butanes along all of the survey lines in the Bass Basin.

Figure 15j. Methane/ethane along all of the survey lines in the Bass Basin.

Figure 15k. Ethane/propane along all of the survey lines in the Bass Basin.

Figure 15l. Percent hydrocarbon wetness along all of the survey lines in the Bass Basin.

Torquay Sub-basin

Figure 16a. Sum C1-C4 hydrocarbon concentration along the survey lines in the Torquay Sub-basin.

Figure 16b. Methane concentrations along the survey lines in the Torquay Sub-basin.
Figure 16c. Ethane concentrations along the survey lines in the Torquay Sub-basin.

Figure 16d. Propane concentrations along the survey lines in the Torquay Sub-basin.
Figure 16e. Ethylene concentrations along the survey lines in the Torquay Sub-basin.

Figure 16f. Propylene concentrations along the survey lines in the Torquay Sub-basin.

Figure 16g. Bernard Parameter along the survey lines in the Torquay Sub-basin.

Figure 16h. Butanes along the survey lines in the Torquay Sub-basin.

Figure 16j. Methane/ethane along the survey lines in the Torquay Sub-basin.

Figure 16k. Ethane/propane along the survey lines in the Torquay Sub-basin.

Figure 16l. Percent hydrocabon wetness along all of the survey lines in the Torquay Sub-basin.

Figure 16m. Methane concentration, seafloor bathymetry and the high resolution seismic record in the vicinity of the intersection of survey Lines Torq 70 and 72.

Figure 16n. The high resolution seismic record and the side scan sonar record in the area of the bottom-water geochemical anomaly.

Otway Basin

Figure 17a. Sum C1-C4 hydrocarbon concentration along the survey lines in the Otway Basin.

Figure 17b. Methane concentrations along the survey lines in the Otway Basin.

Figure 17c. Ethane concentrations along the survey lines in the Otway Basin.

Figure 17d. Propane concentrations along the survey lines in the Otway Basin.

Figure 17e. Ethylene concentrations along the survey lines in the Otway Basin.

Figure 17f. Propylene concentrtions along the survey lines in the Otway basin.

Figure 17g. Bernard Parameter along the survey lines in the Otway Basin.

Figure 17h. Butane along the survey lines in the Otway Basin.

Figure 17j. Methane/ethane along the survey lines in the Otway Basin.

Figure 17k. Ethane/propane along the survey lines in the Otway Basin.

Figure 17l. Percent hydrocarbon wetness along the survey lines in the Otway Basin.

Stansbury Basin

Figure 18a. Sum C1-C4 hydrocarbon concentration along all of the survey lines in the Stansbury Basin.

Figure 18b. Methane concentrations along the survey lines in the Stansbury Basin.

Figure 18c. Ethane concentrations along the survey lines in the Stansbury Basin.

Figure 18d. Propane concentrations along the survey lines in the Stansbury Basin.

Figure 18e. Ethylene concentrations along the survey lines in the Stansbury Basin.

Figure 18f. Propylene concentrations along the survey lines in the Stansbury Basin.

Figure 18g. Bernard Parameter along the survey lines in the Stansbury Basin.

Figure 18h. Methane/ethane along the survey lines in the Stansbury Basin.

Figure 18j. Ethane/propane along the survey lines in the Stansbury Basin

Figure 18k. Percent hydrocarbon wetness along all of the survey lines in the Stansbury Basin

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LIST OF APPENDIX FIGURES

APPENDIX I

THC, Methane versus shotpoint for all individual lines.

Methane, ethane and ethylene versus shotpoint for all individual lines. Propane, propylene and butane are given for the Gippsland Basin only.

Fish depth, water depth and fish altitude versus shotpoint for all individual lines.

APPENDIX II

APPENDIX III

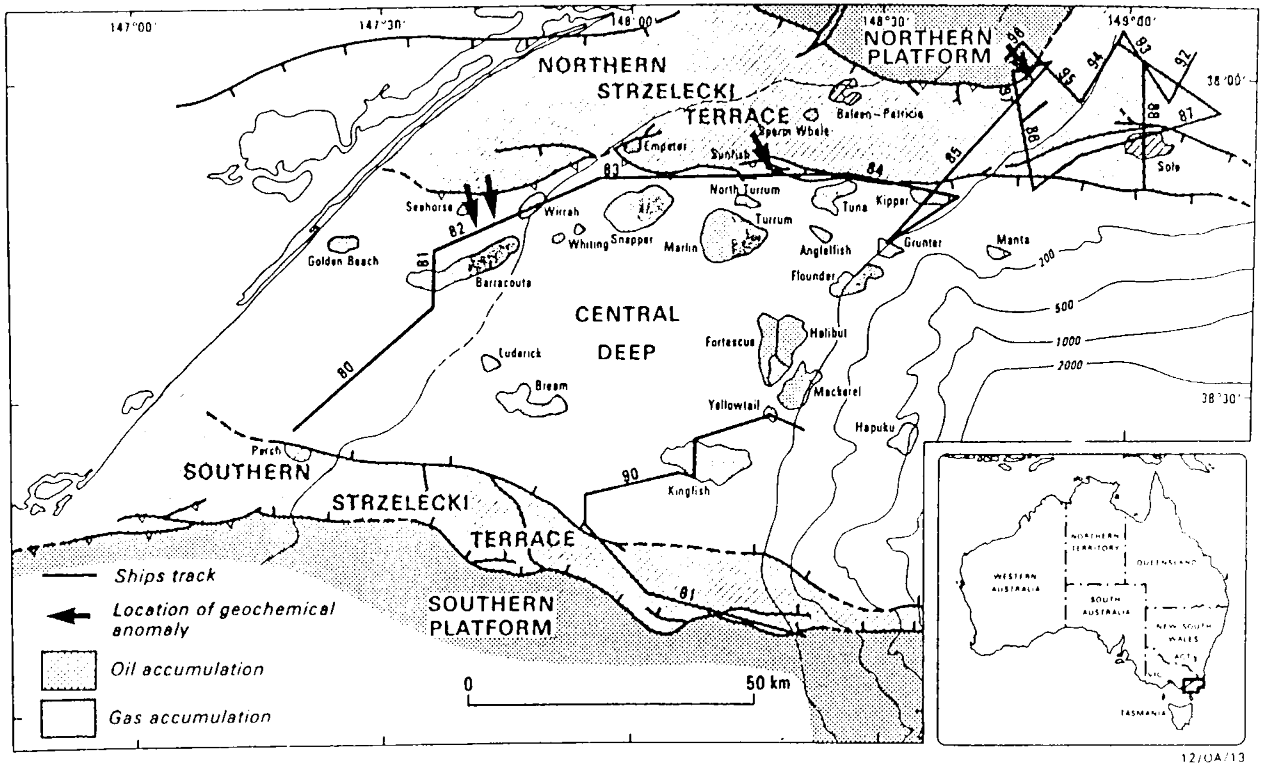


Figure 1. Survey 89 cruise track in the Gippsland Basin, showing the location of the major petroleum accumulations and the approximate locations (delineated by arrows) of the major hydrocarbon anomalies which were detected.

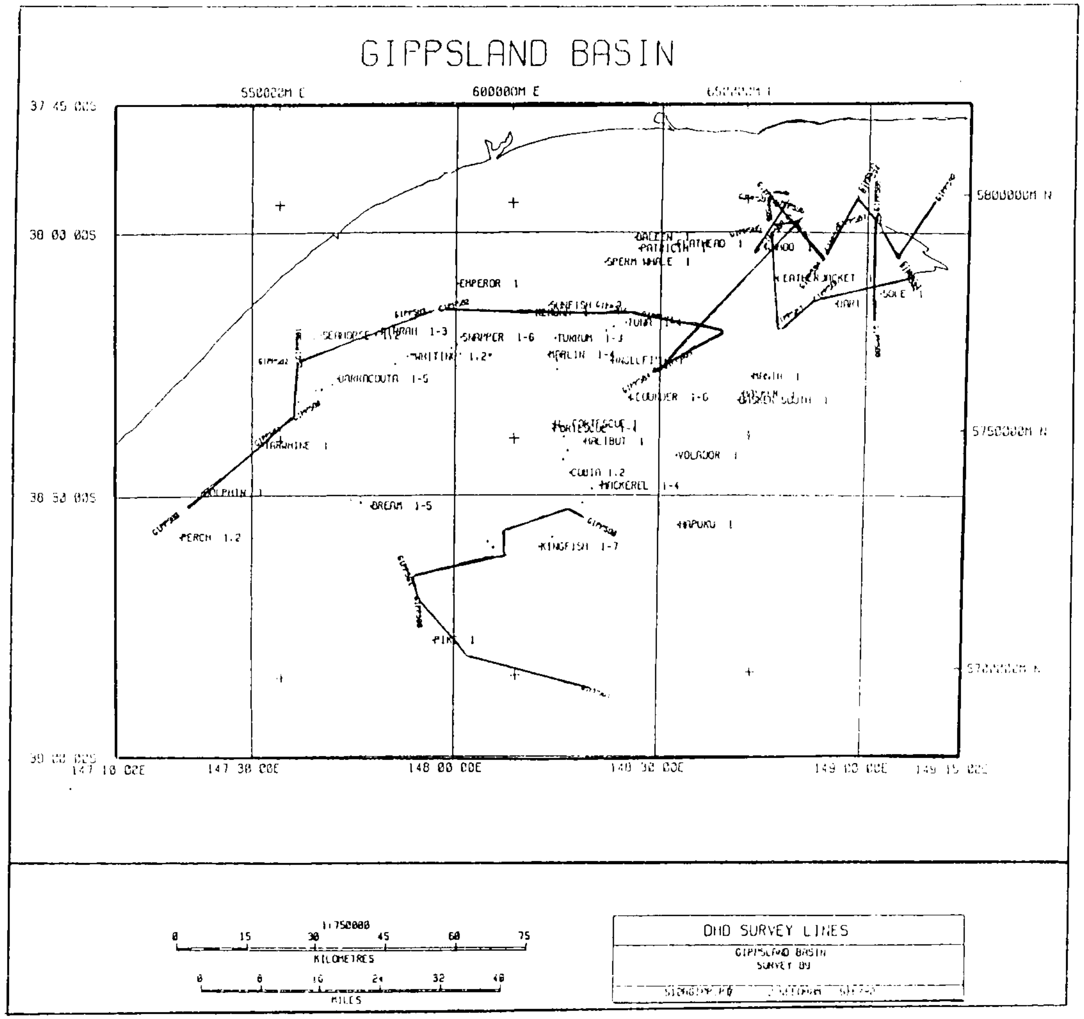


Figure 2. Map showing the location of the geochemical survey lines in the Gippsland Basin, south-eastern Australia.

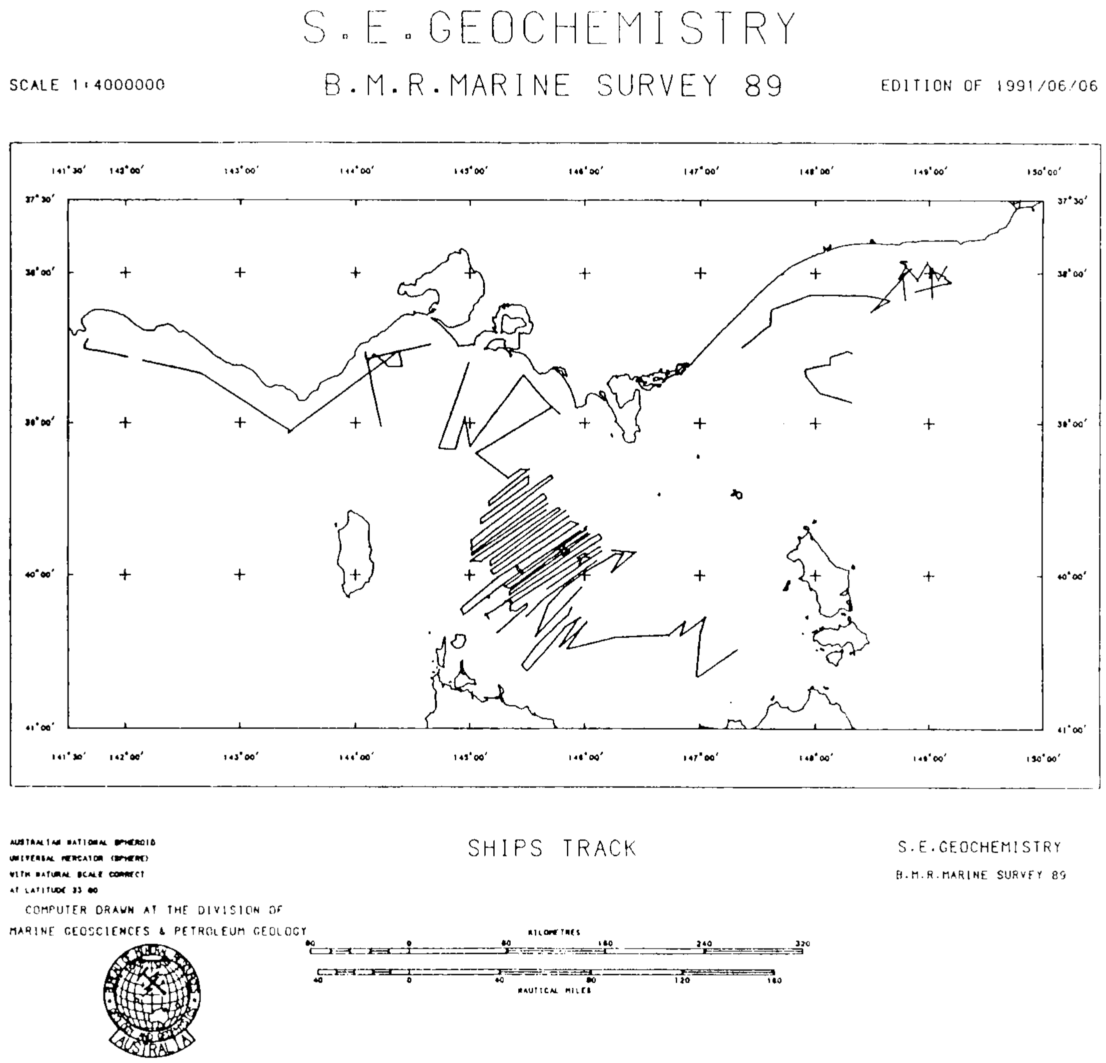


Figure 3. Map showing the location of the geochemical survey lines in the North Bass and Bass Basins, south-eastern Australia.

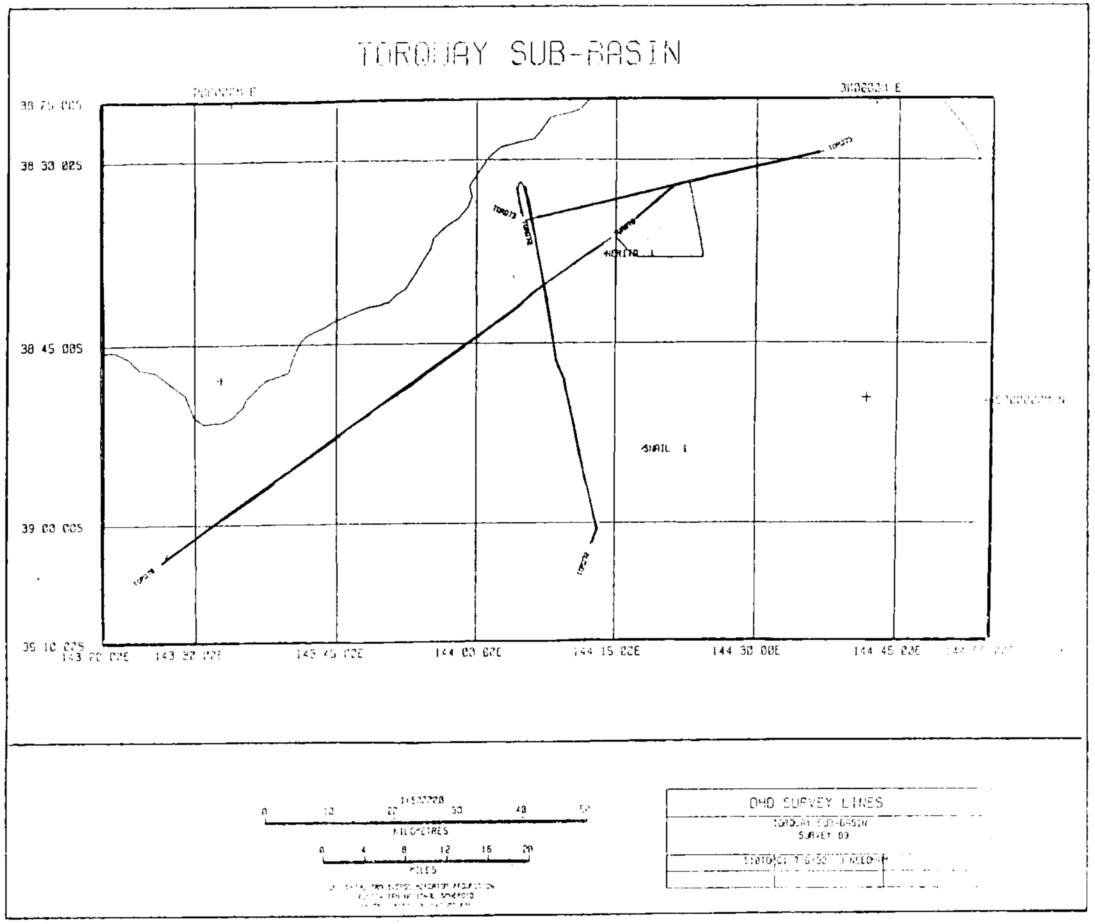


Figure 4. Map showing the location of the geochemical survey lines in the Torquay Sub-Basin, south-eastern Australia.

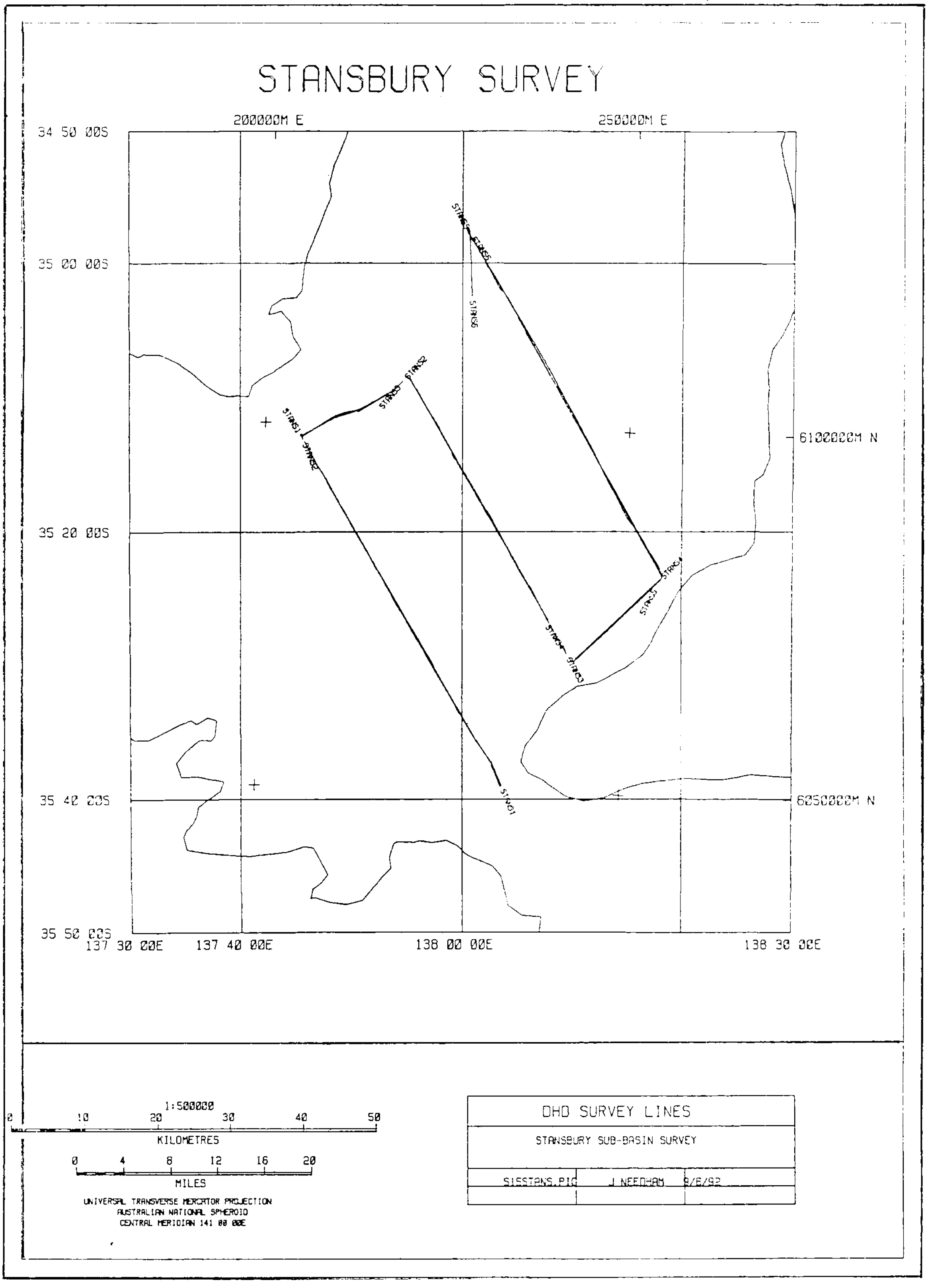


Figure 5. Map showing the location of the geochemical survey lines in the Stansbury Basin, south-eastern Australia.

GIPPSLAND BASIN PLOTS

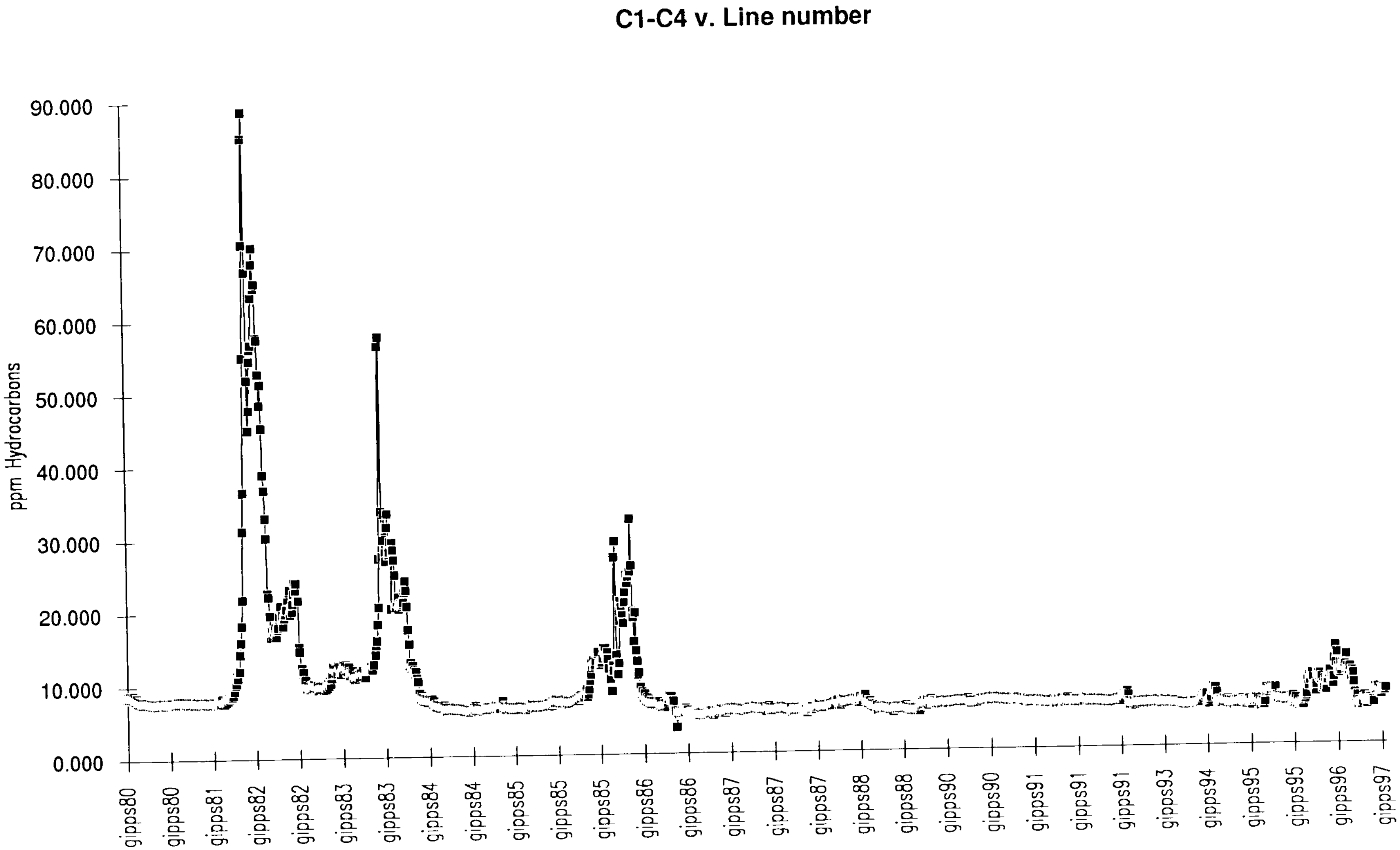


Figure 6a. Sum C_1-C_4 hydrocarbon concentrations along the survey lines in the Gippsland Basin.

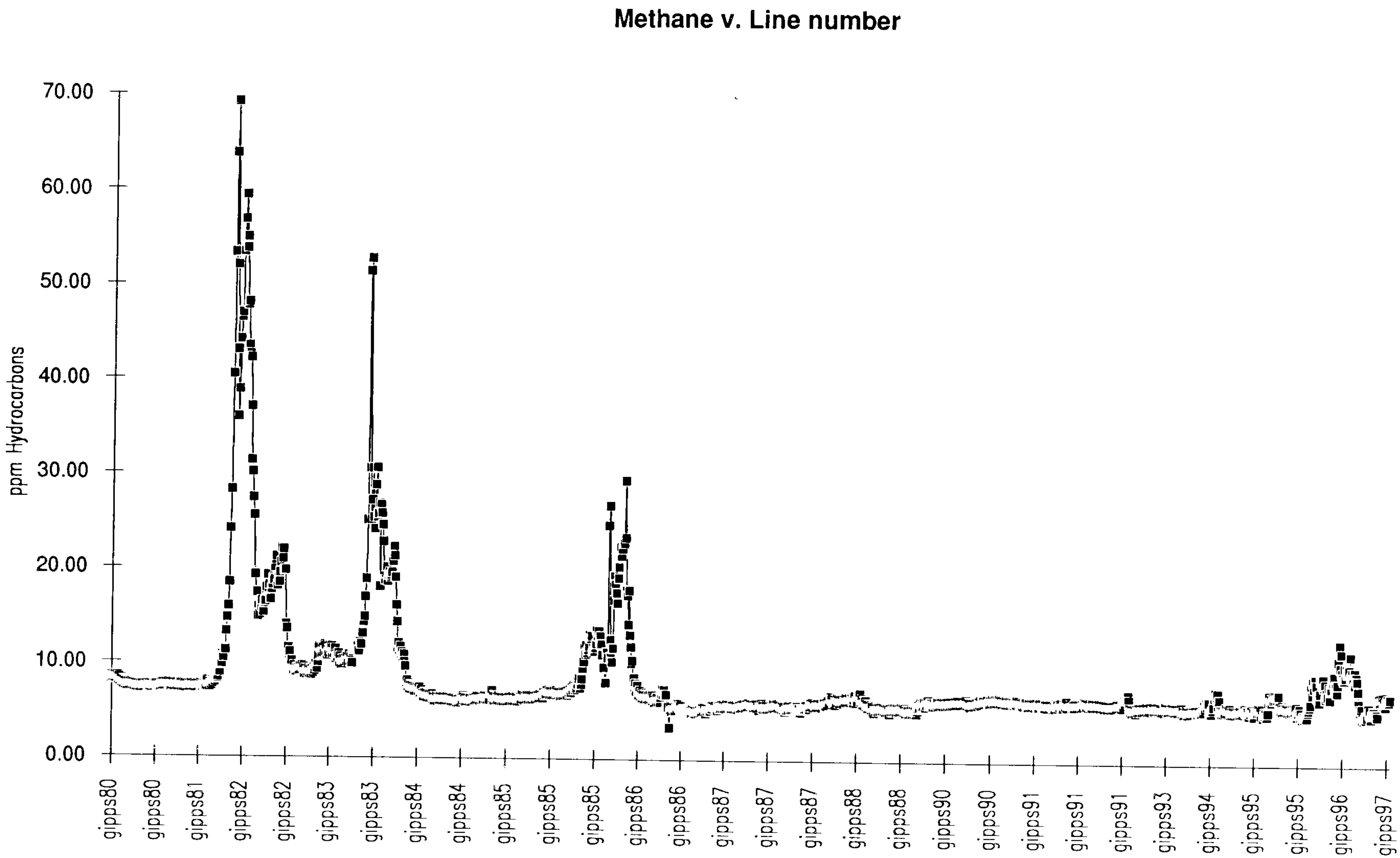


Figure 6b. Methane concentrations along the survey lines in the Gippsland Basin.

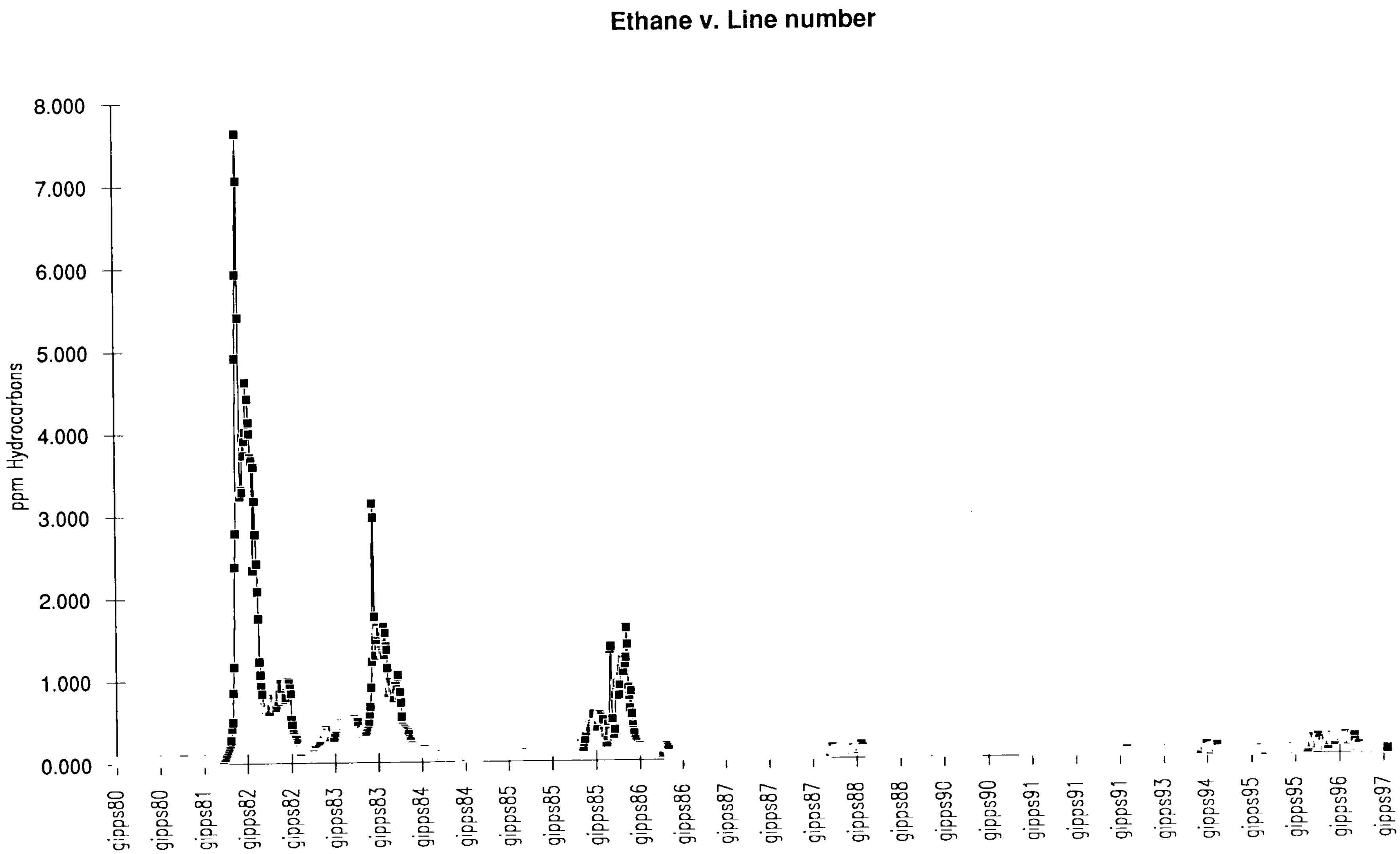


Figure 6c. Ethane concentrations along the survey lines in the Gippsland Basin.

Propane v. Line number

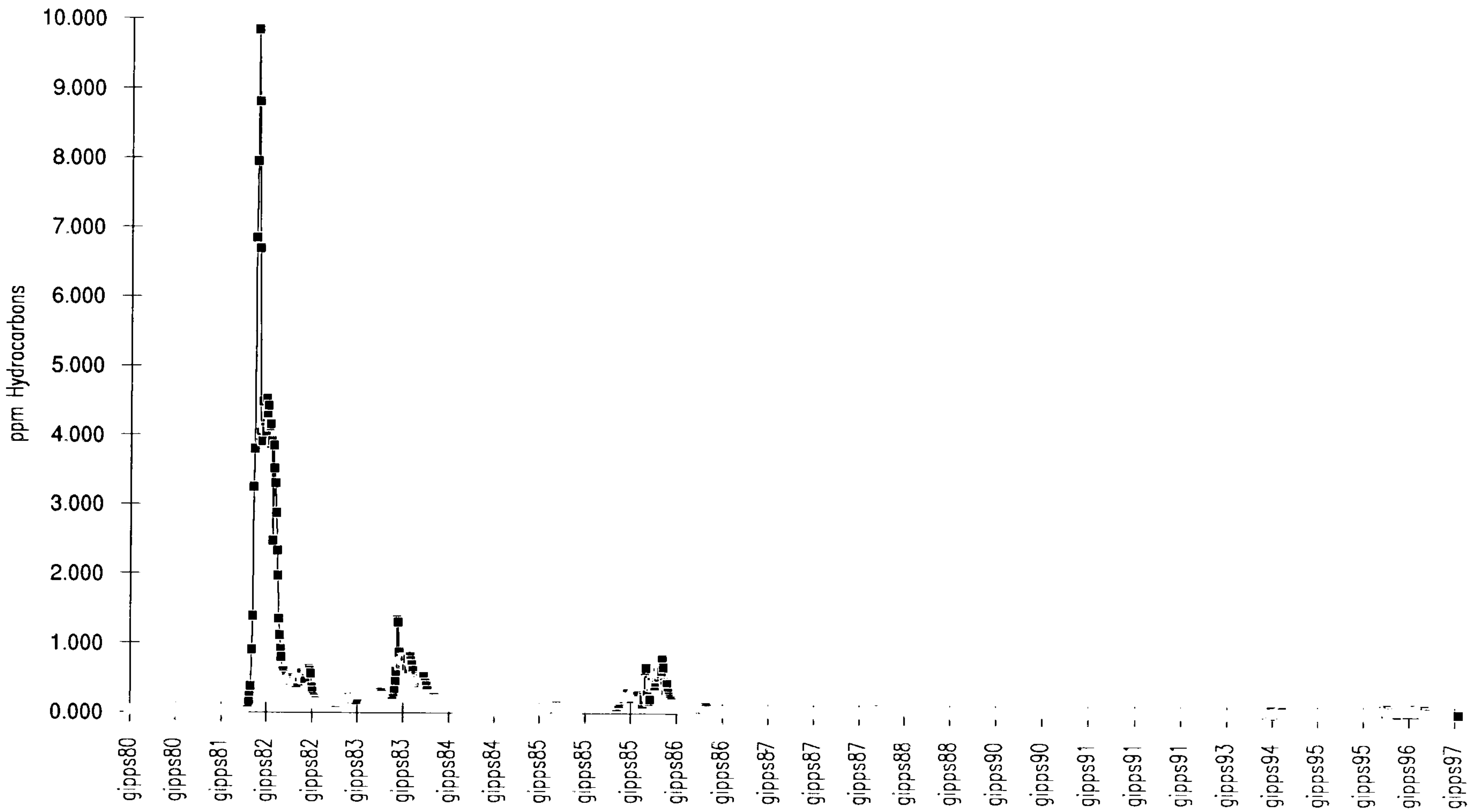


Figure 6d. Propane concentrations along the survey lines in the Gippsland Basin.

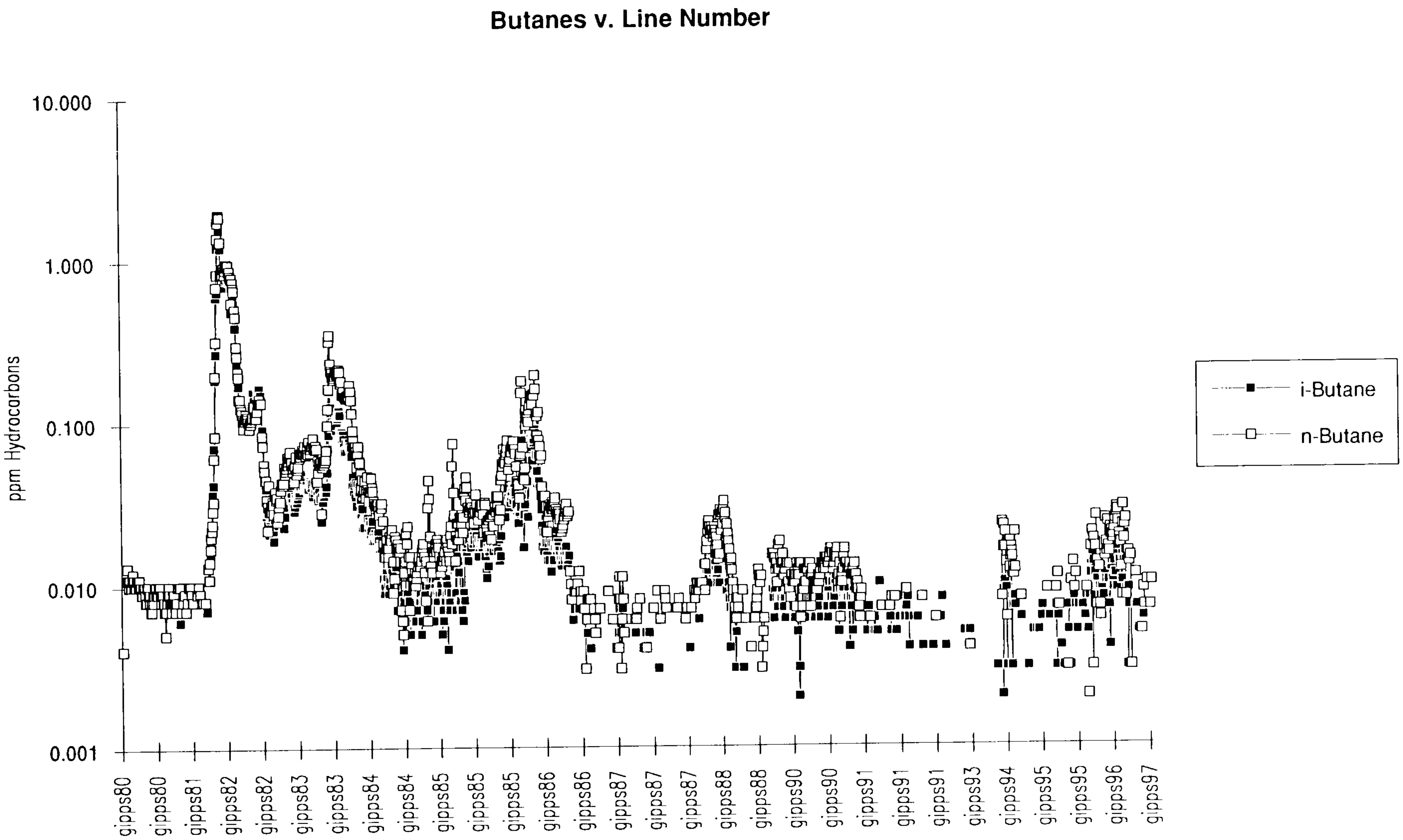


Figure 6e. Butane concentrations along the survey lines in the Gippsland Basin.

Ethylene v. Line number

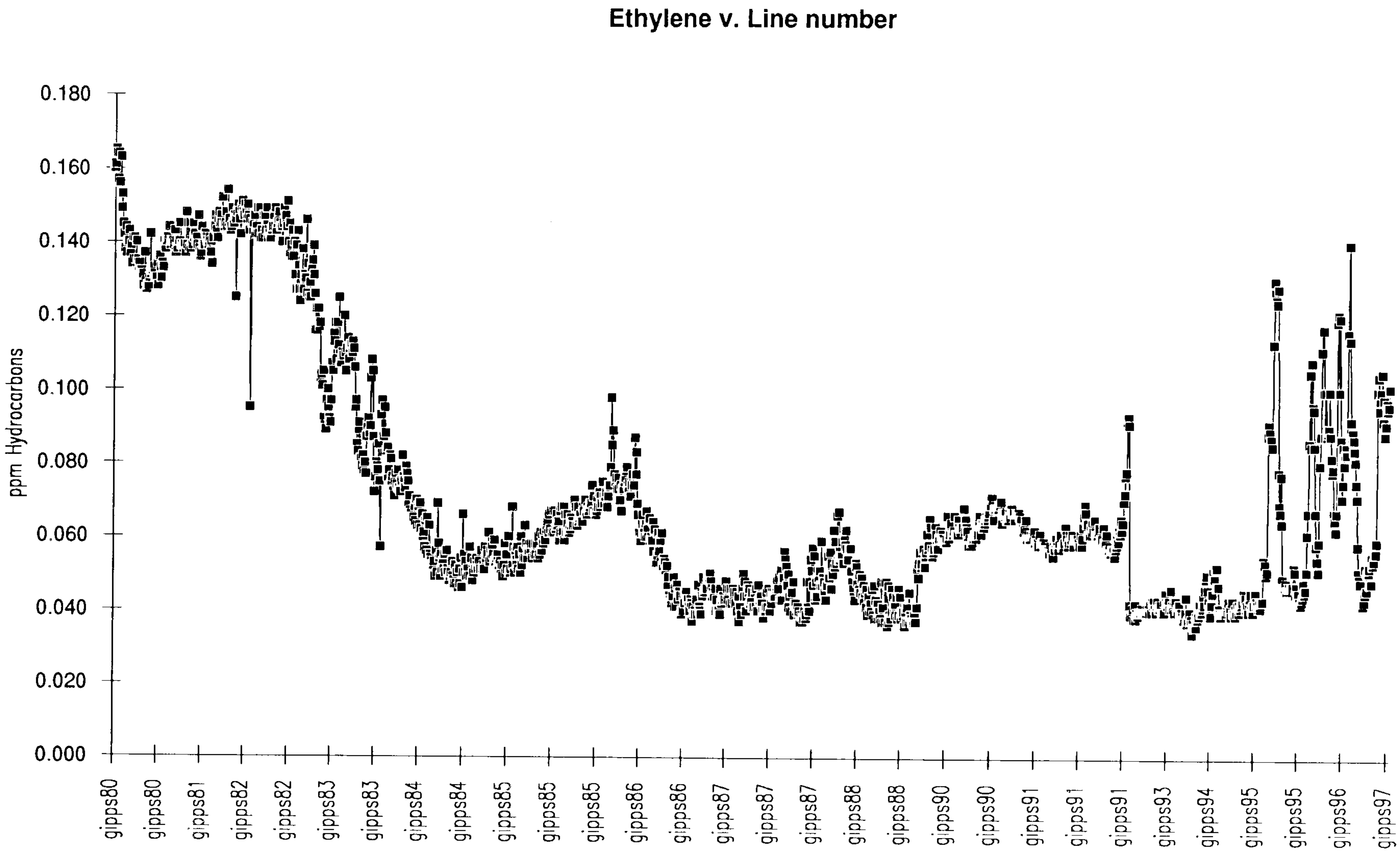


Figure 6f. Ethylene concentrations along the survey lines in the Gippsland Basin.

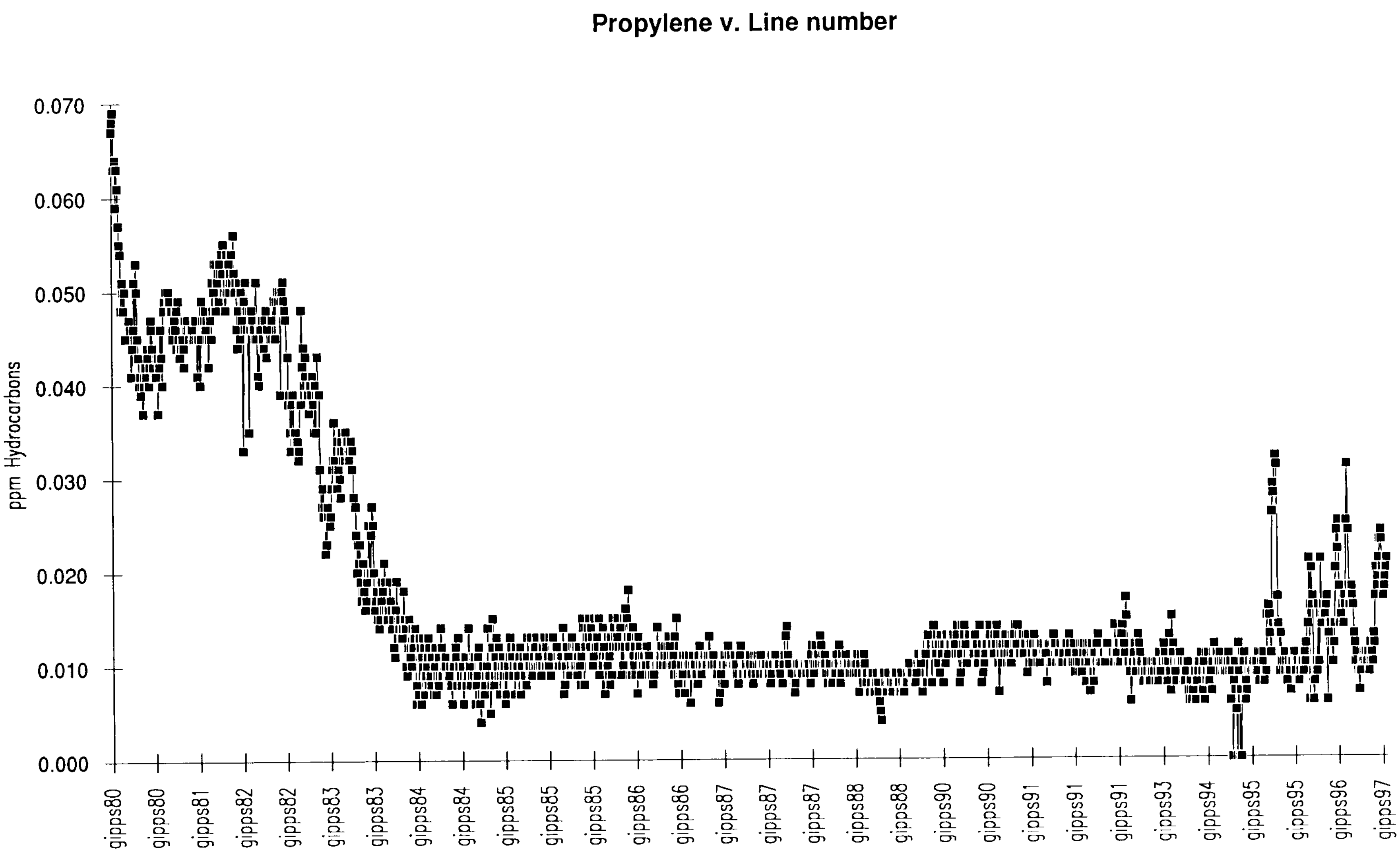


Figure 6g. Propylene concentrations along the survey lines in the Gippsland Basin.

Gippsland Basin - Pentanes

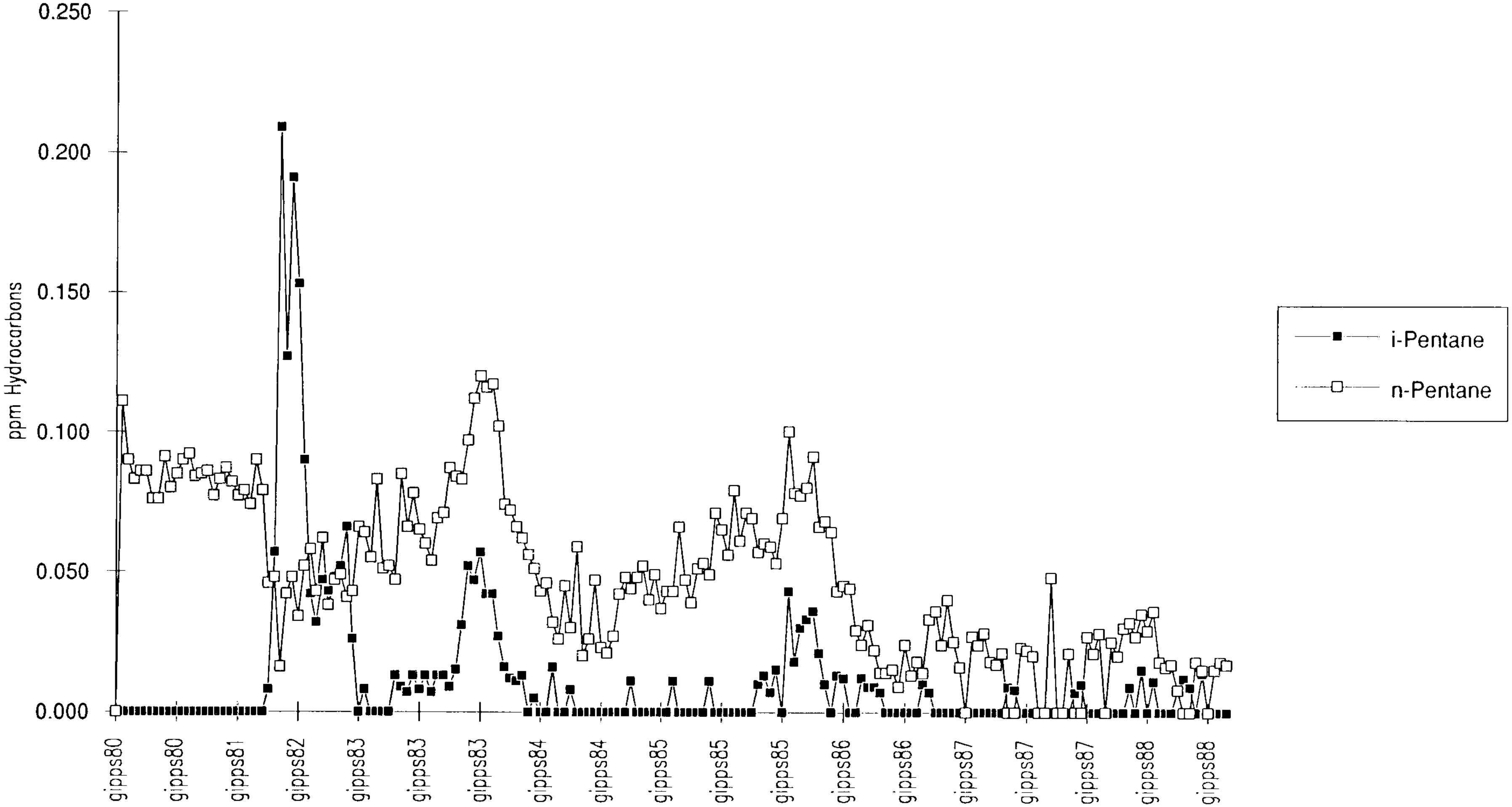


Figure 6h. Pentane concentrations along survey lines 89/80-88 in the Gippsland Basin (data from other lines not shown).

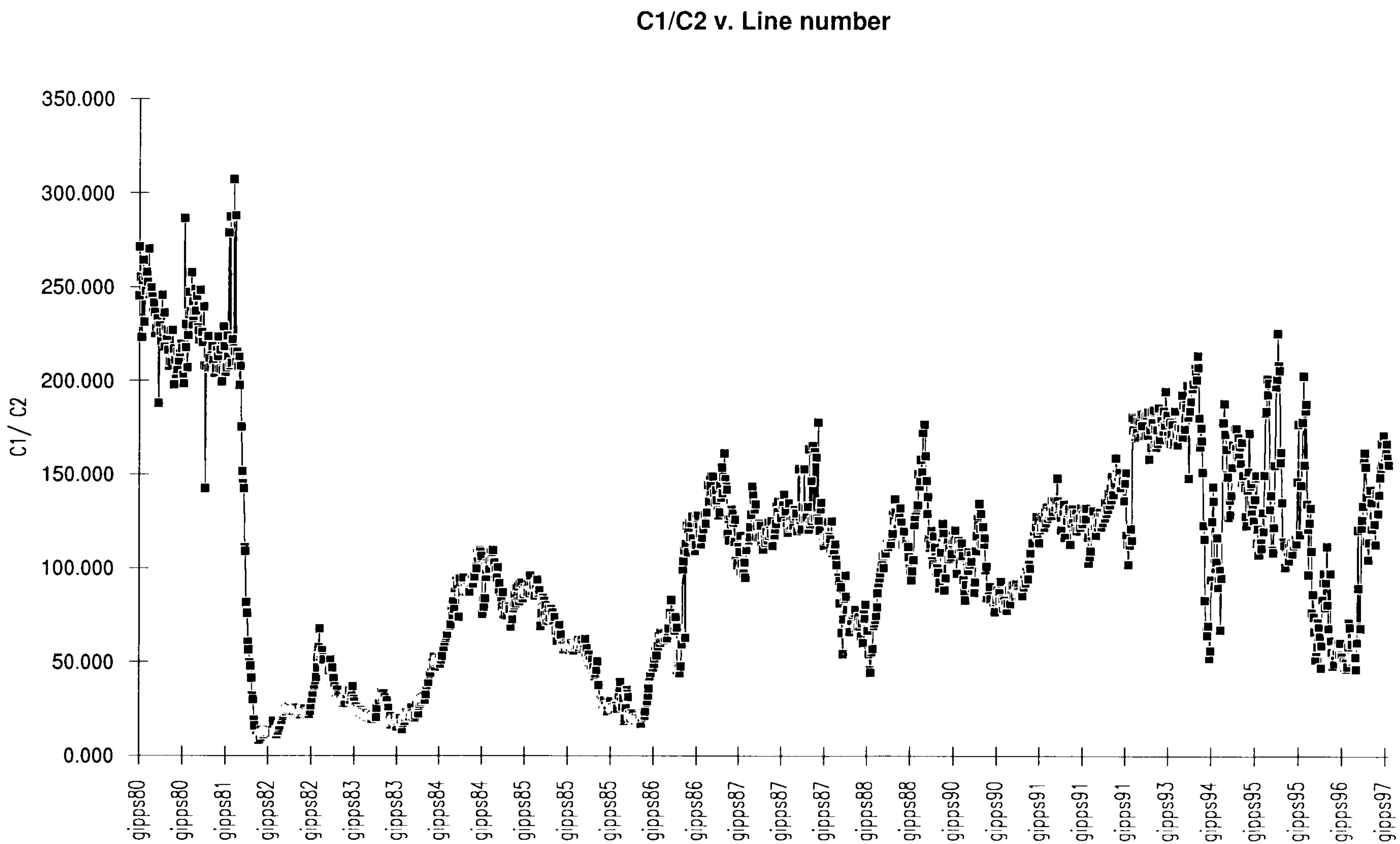


Figure 7a. Methane/ethane ratio for all survey lines in the Gippsland Basin.

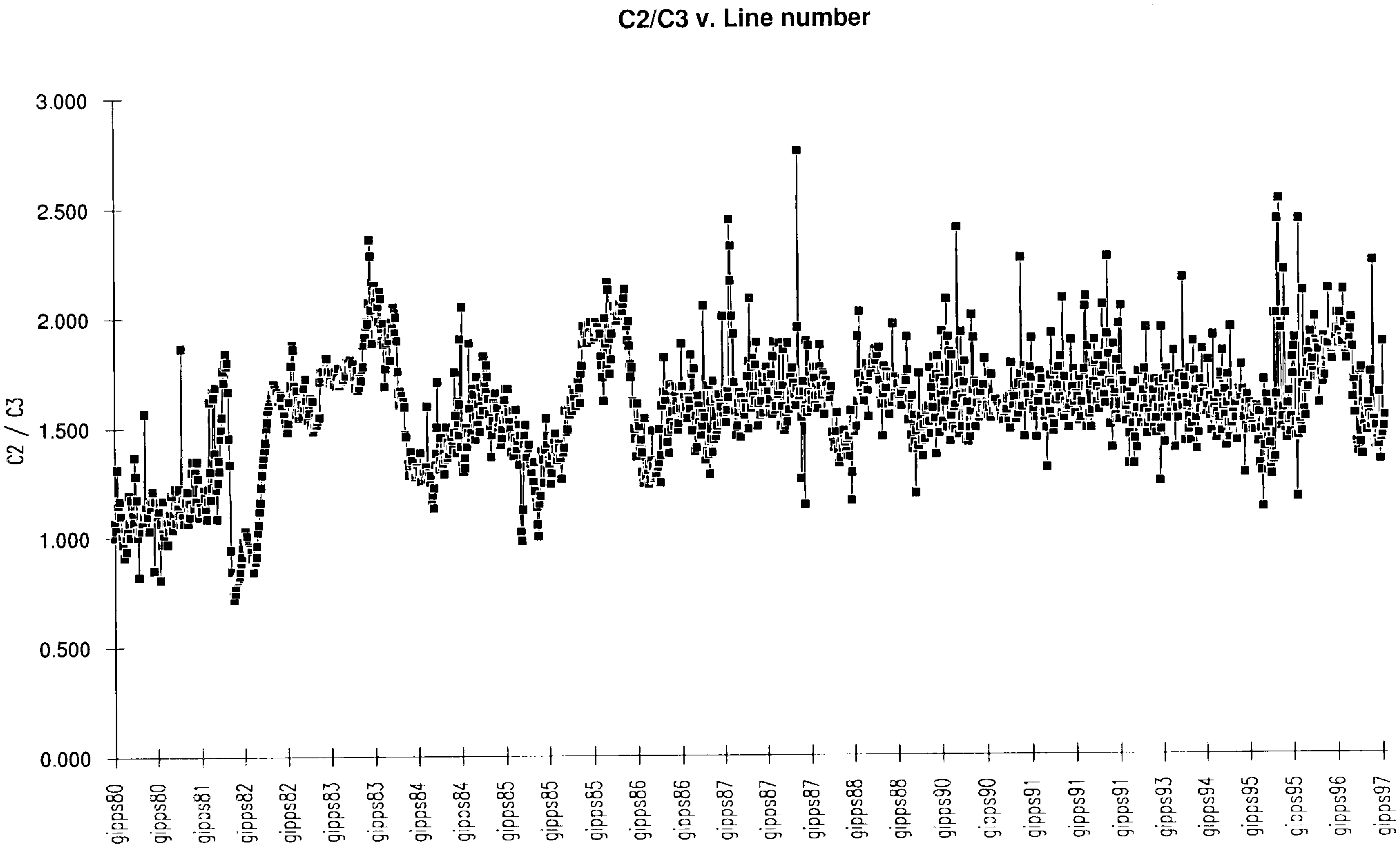


Figure 7b. Ethane/propane ratio for all of the survey lines acquired in the Gippsland Basin. The propane concentration exceeds the ethane concentration in survey line 89/82.

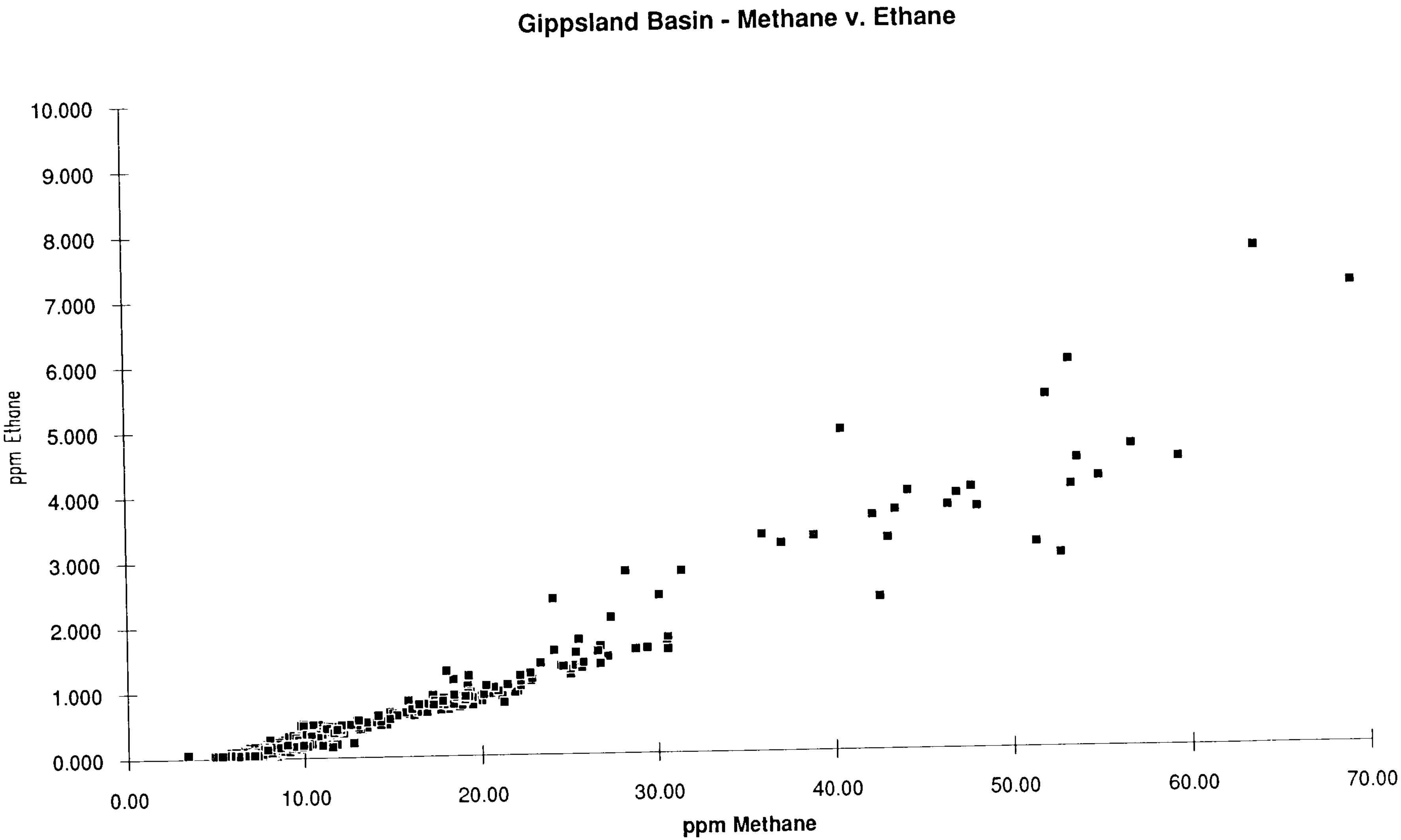


Figure 8a. Methane versus ethane concentration for all water column geochemical data acquired in the Gippsland Basin.

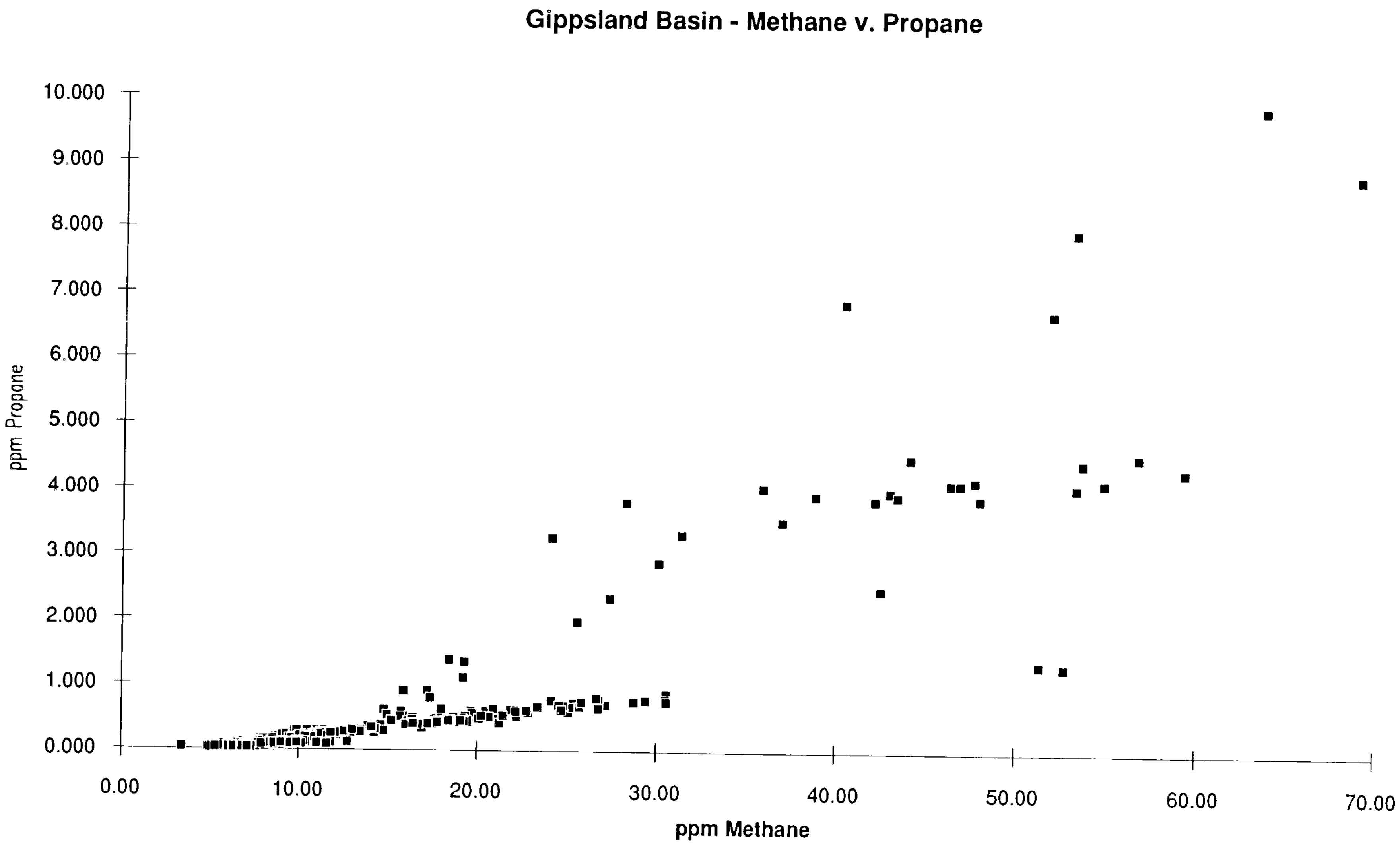


Figure 8b. Methane versus propane concentration for all water column geochemical data acquired in the Gippsland Basin.

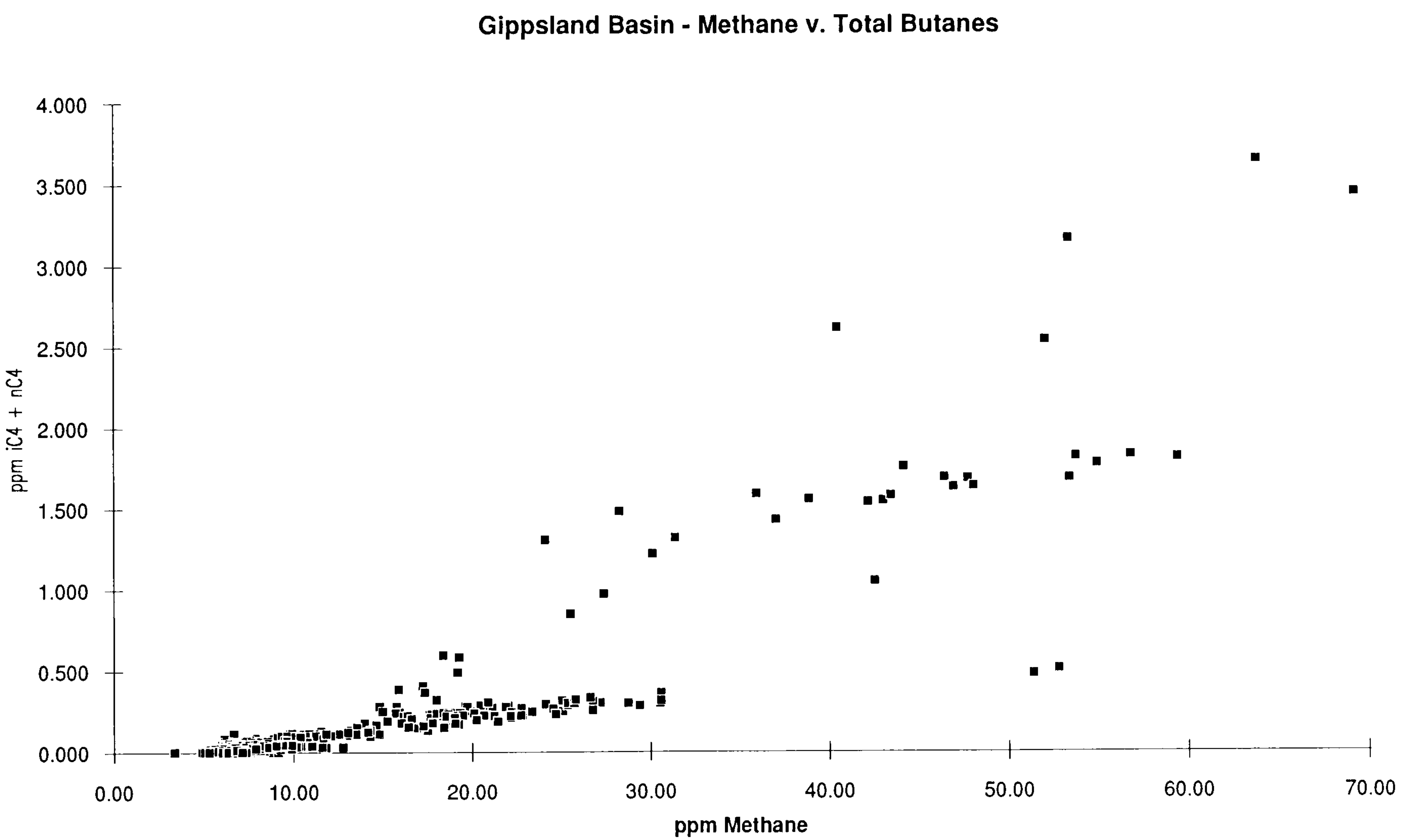


Figure 8c. Methane versus butane concentration for all water column geochemical data acquired in the Gippsland Basin.

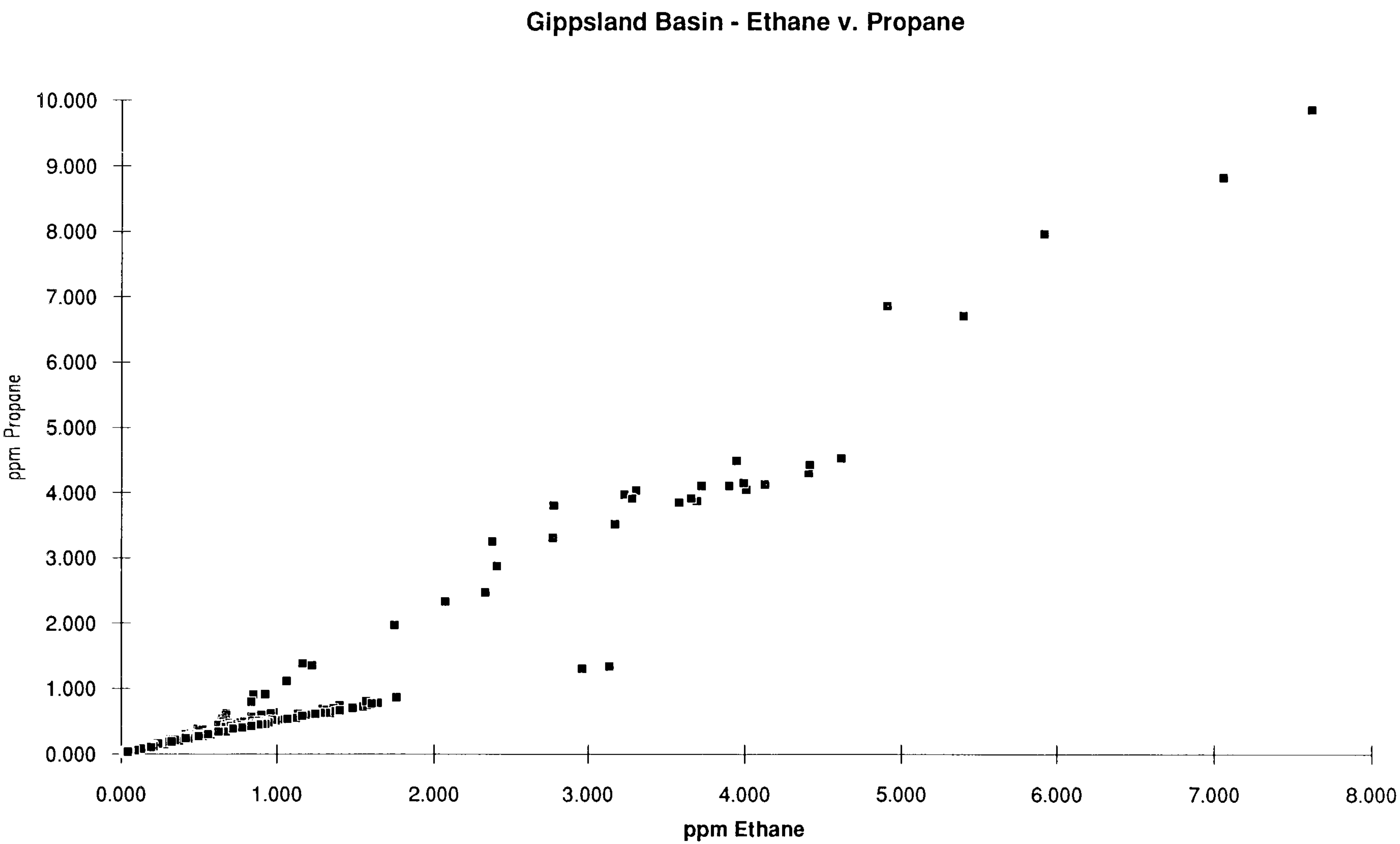


Figure 9. Ethane versus propane concentrations for all Gippsland Basin data. Data points characterised by high propane concentrations relative to ethane are all from survey line 89/82.

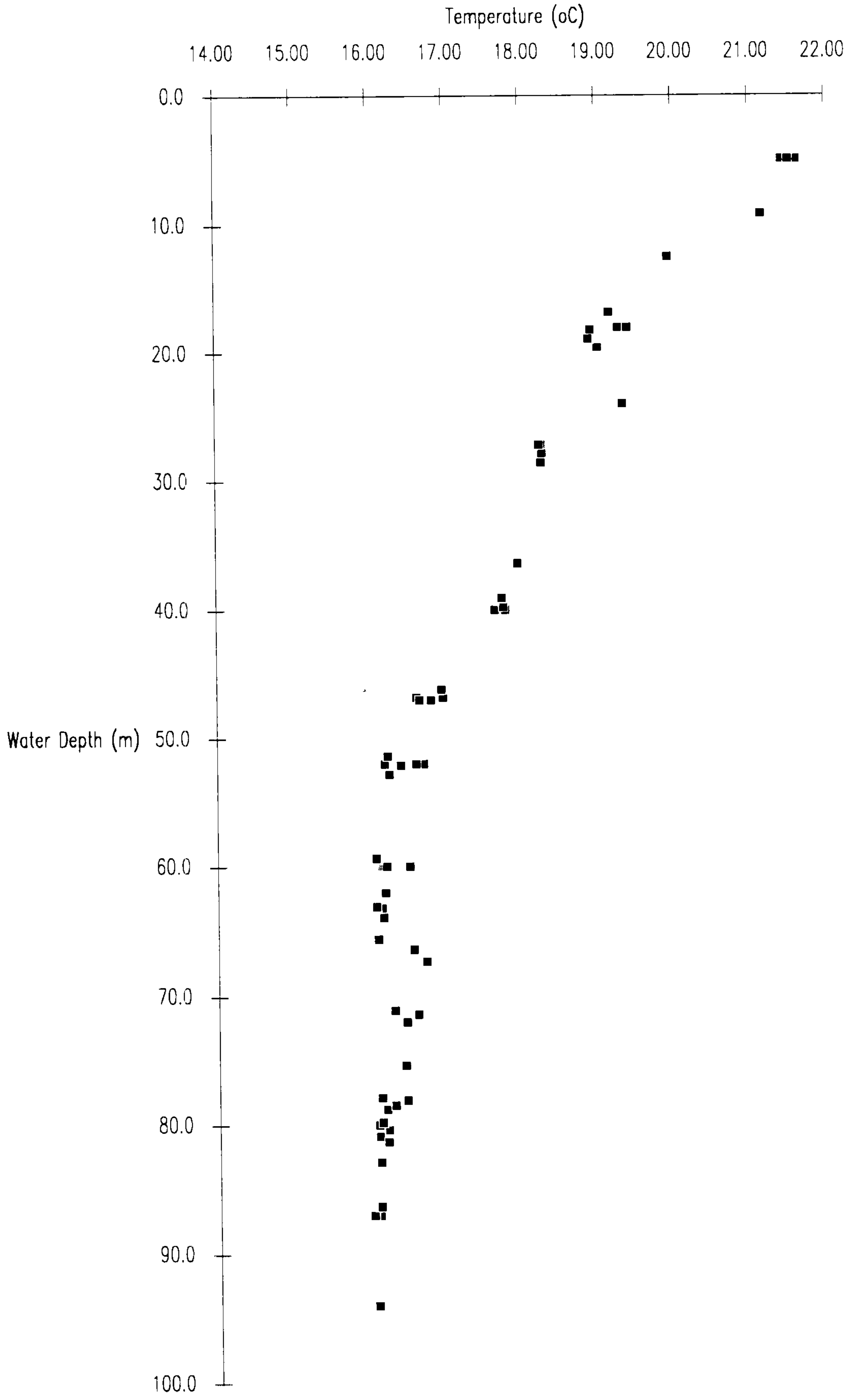


Figure 10a. Vertical profile of temperature versus fish depth for Line 89/95.

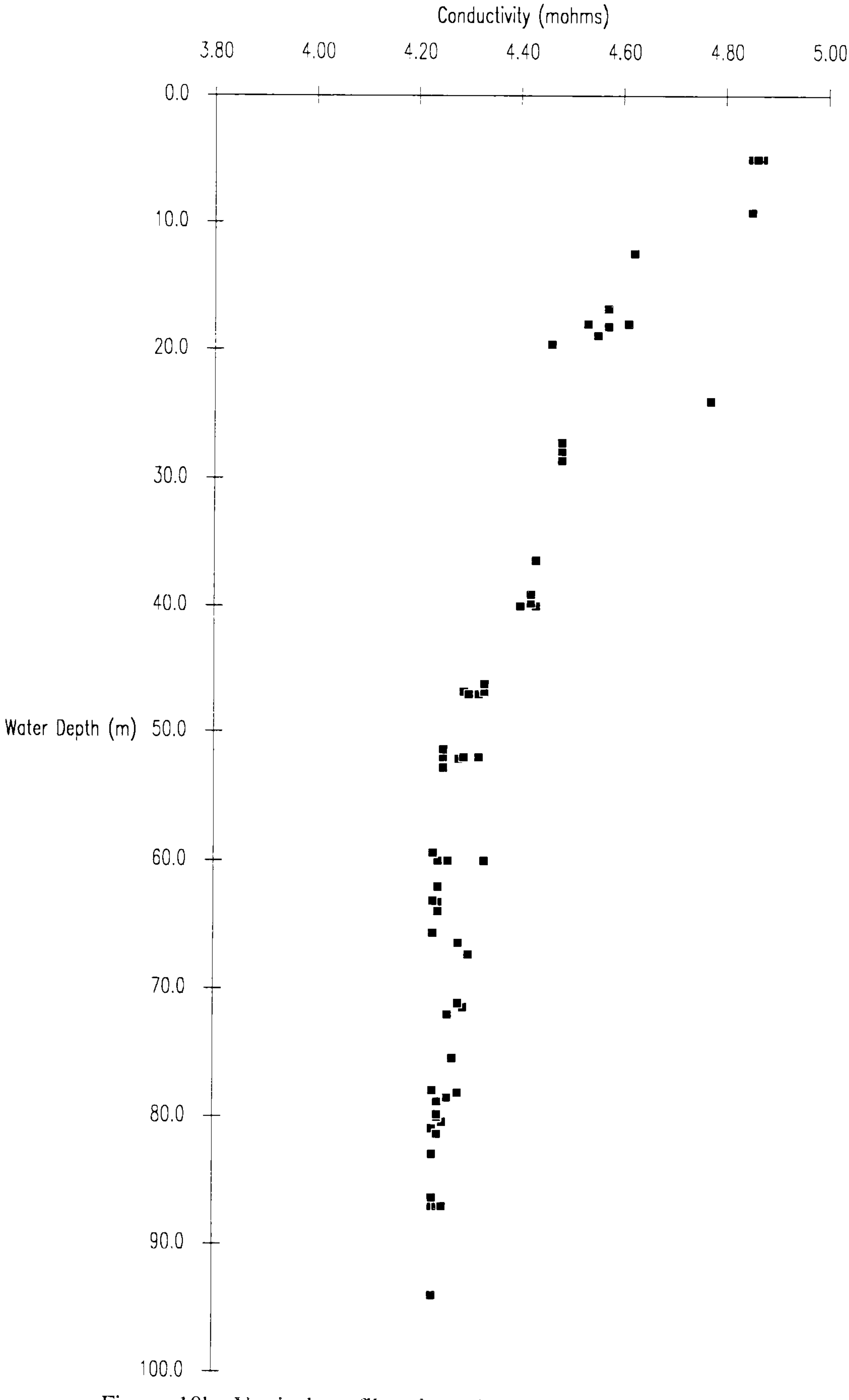


Figure 10b. Vertical profile of conductivity (salinity) versus fish depth for Line 89/95.

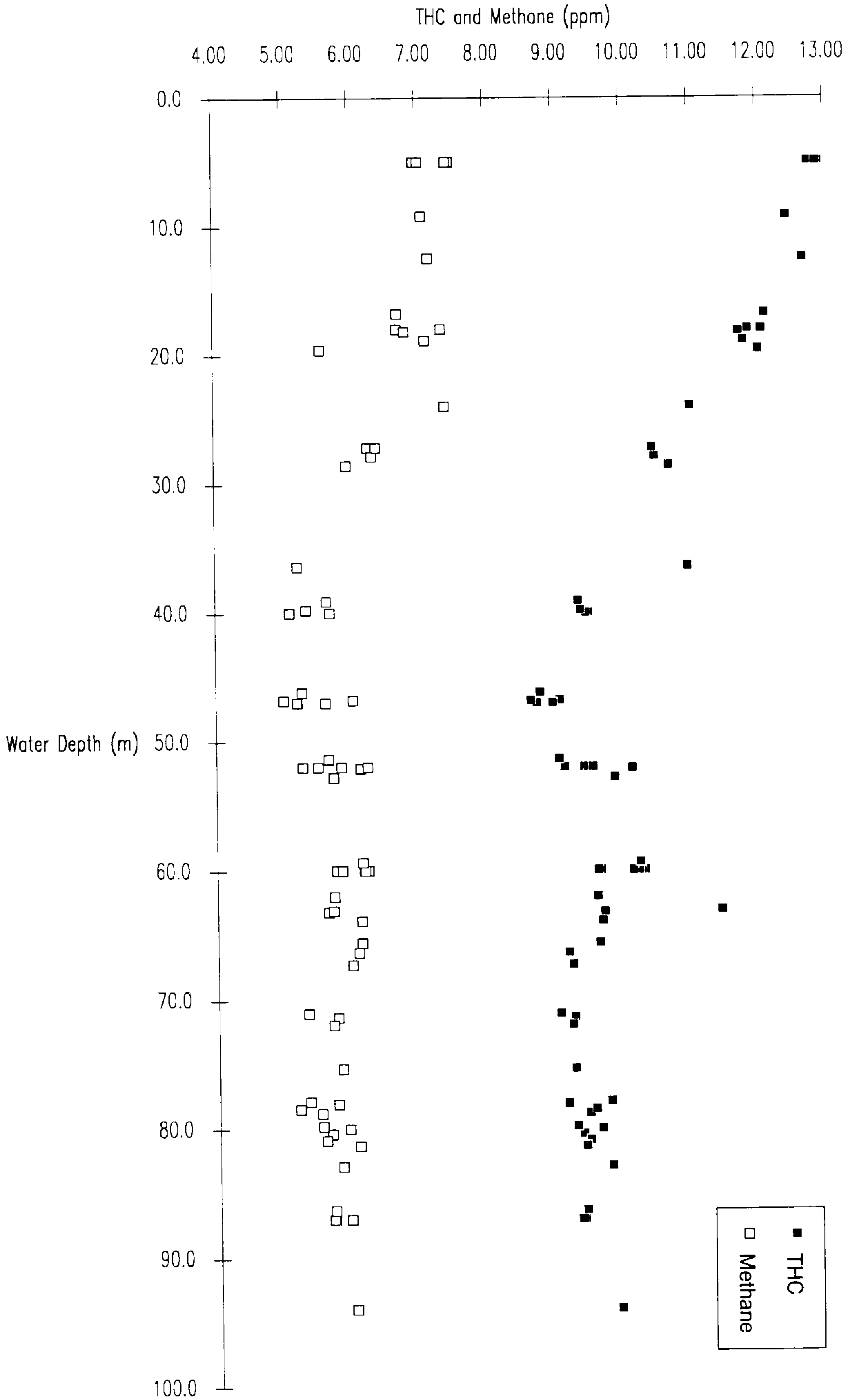


Figure 11a. Vertical profile of THC and methane for Line 89/95.

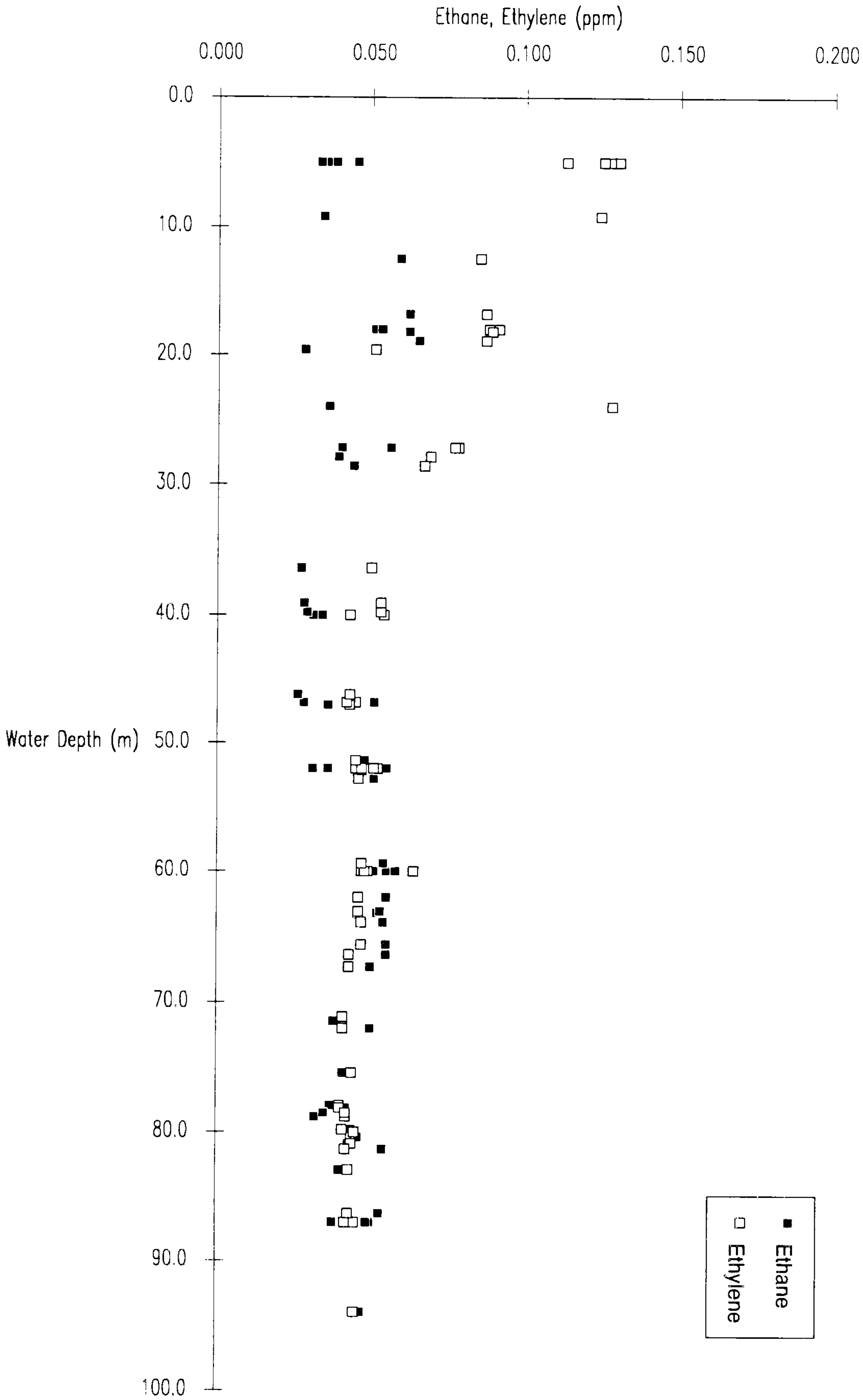


Figure 11b. Vertical profile of ethane and ethylene for Line 89/95.

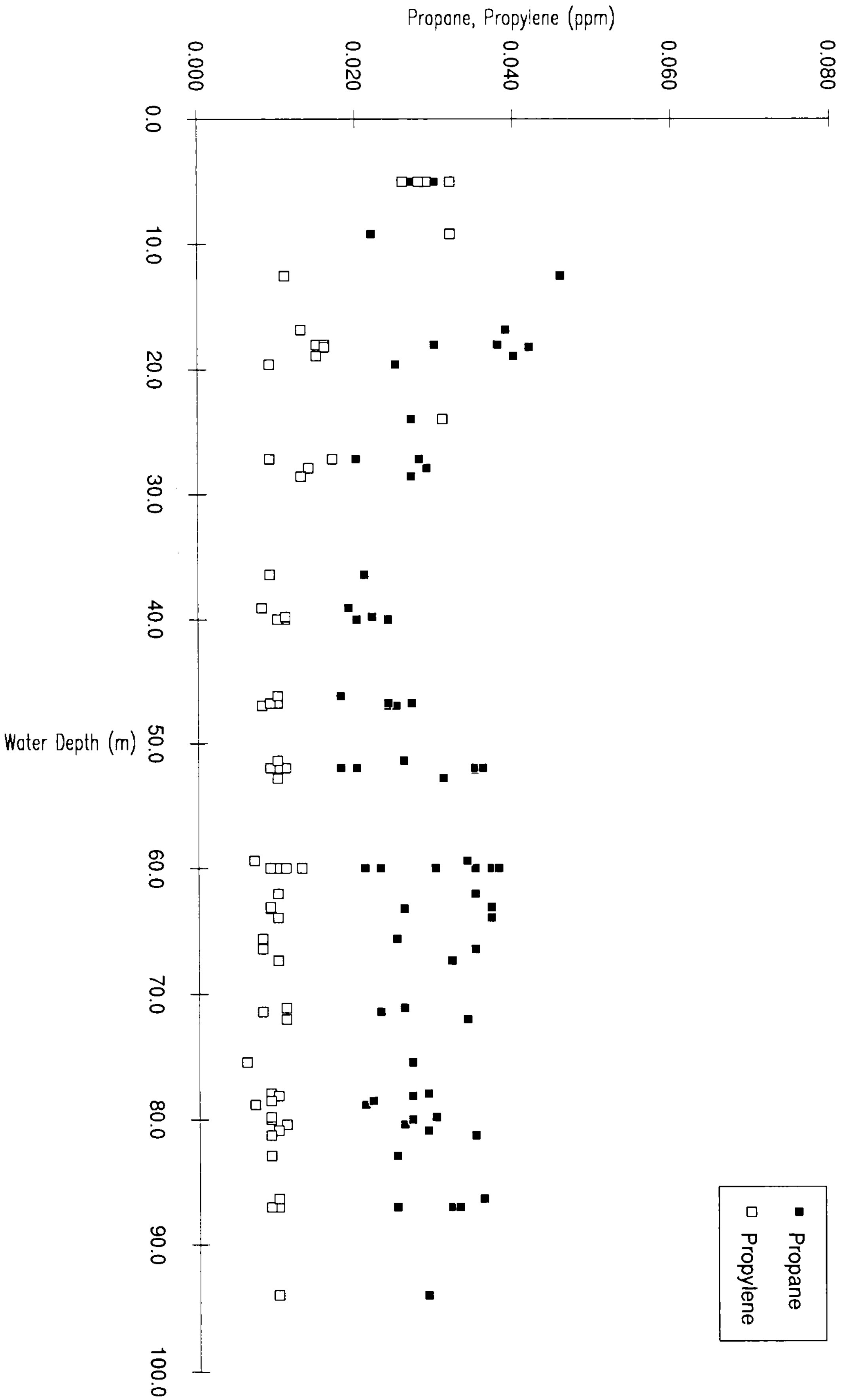


Figure 11c. Vertical profile of propane and propylene for Line 89/95.

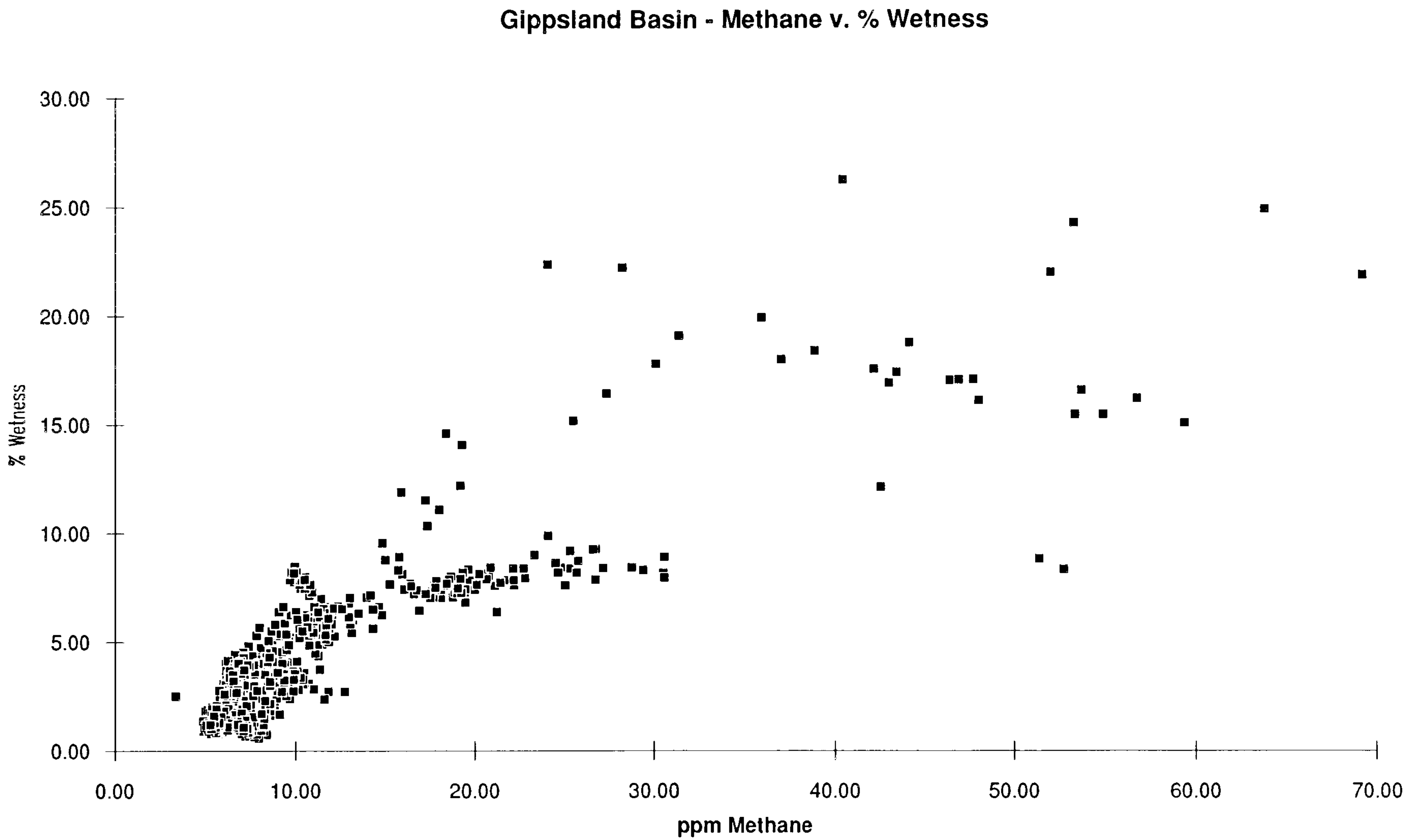


Figure 12. Methane concentration versus hydrocarbon wetness (%) for all Gippsland Basin data. Wettest values are from line 89/82.

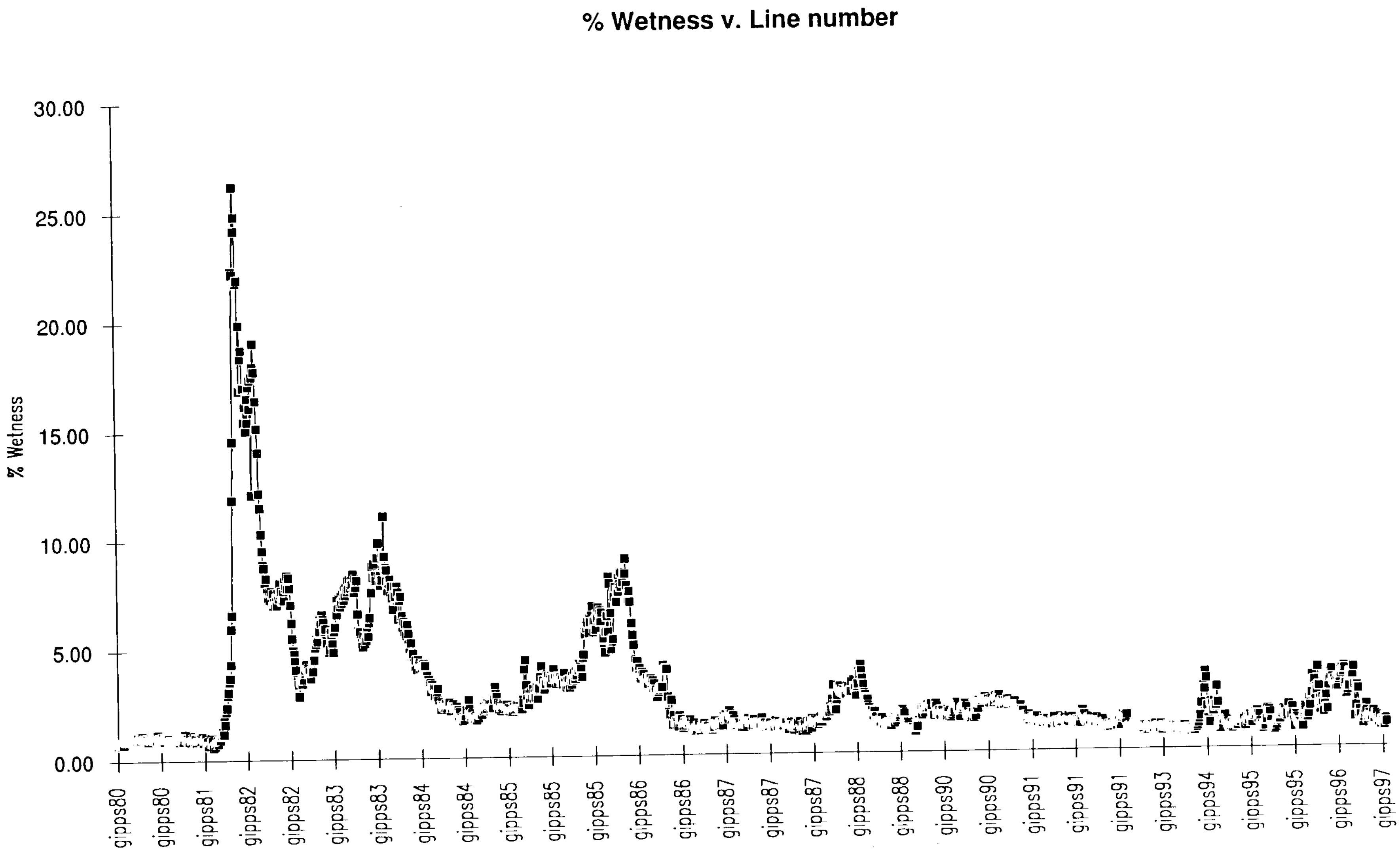


Figure 13a. Hydrocarbon wetness versus line number for all the Gippsland Basin data, showing that the wettest anomalies (up to 25% wet) were found on line 89/82 .

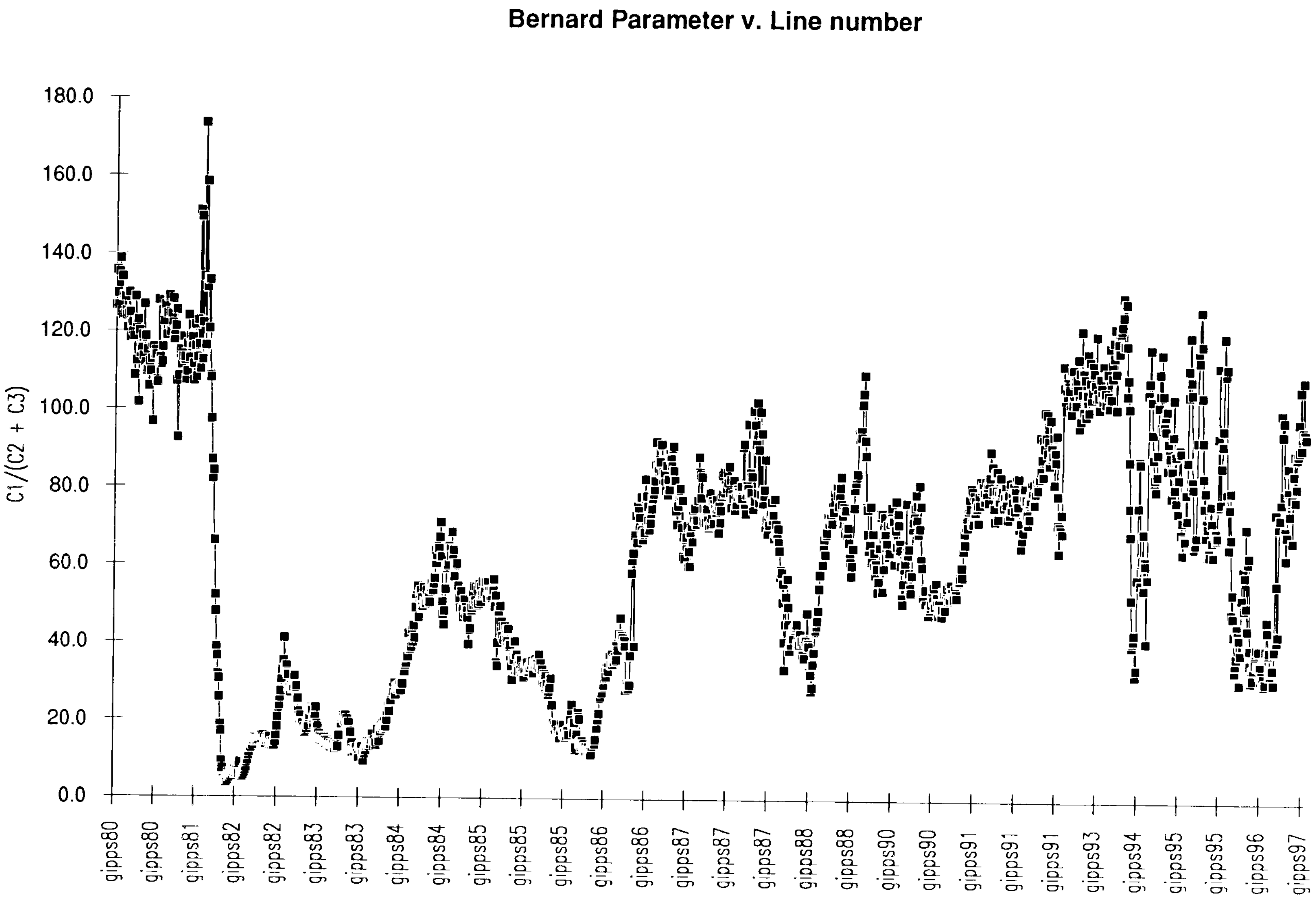


Figure 13b. Bernard parameter versus line number, Gippsland basin.

NORTH BASS BASIN PLOTS

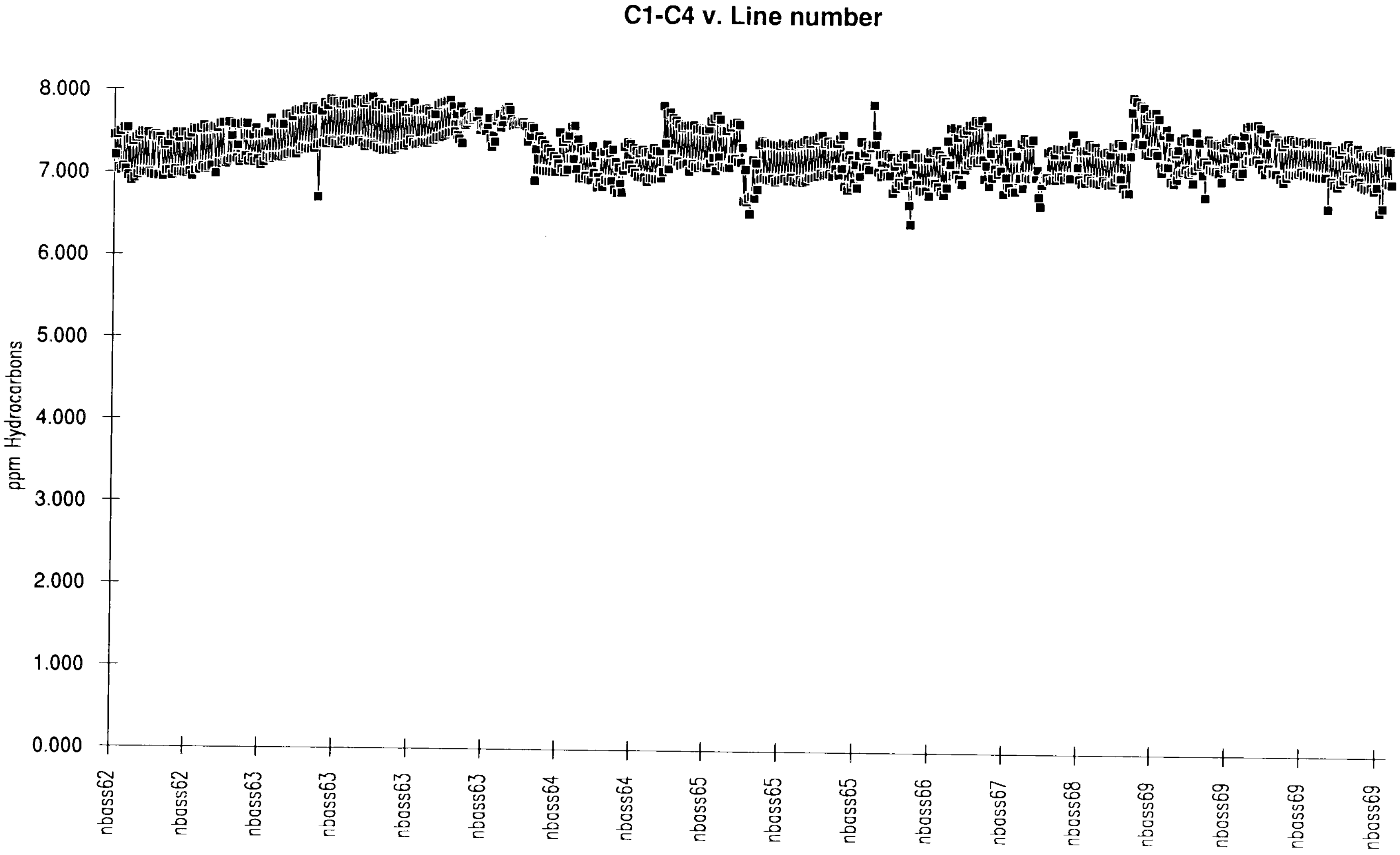


Figure 14a. Sum C1-C4 hydrocarbon concentration along the survey lines in the North Bass Basin.

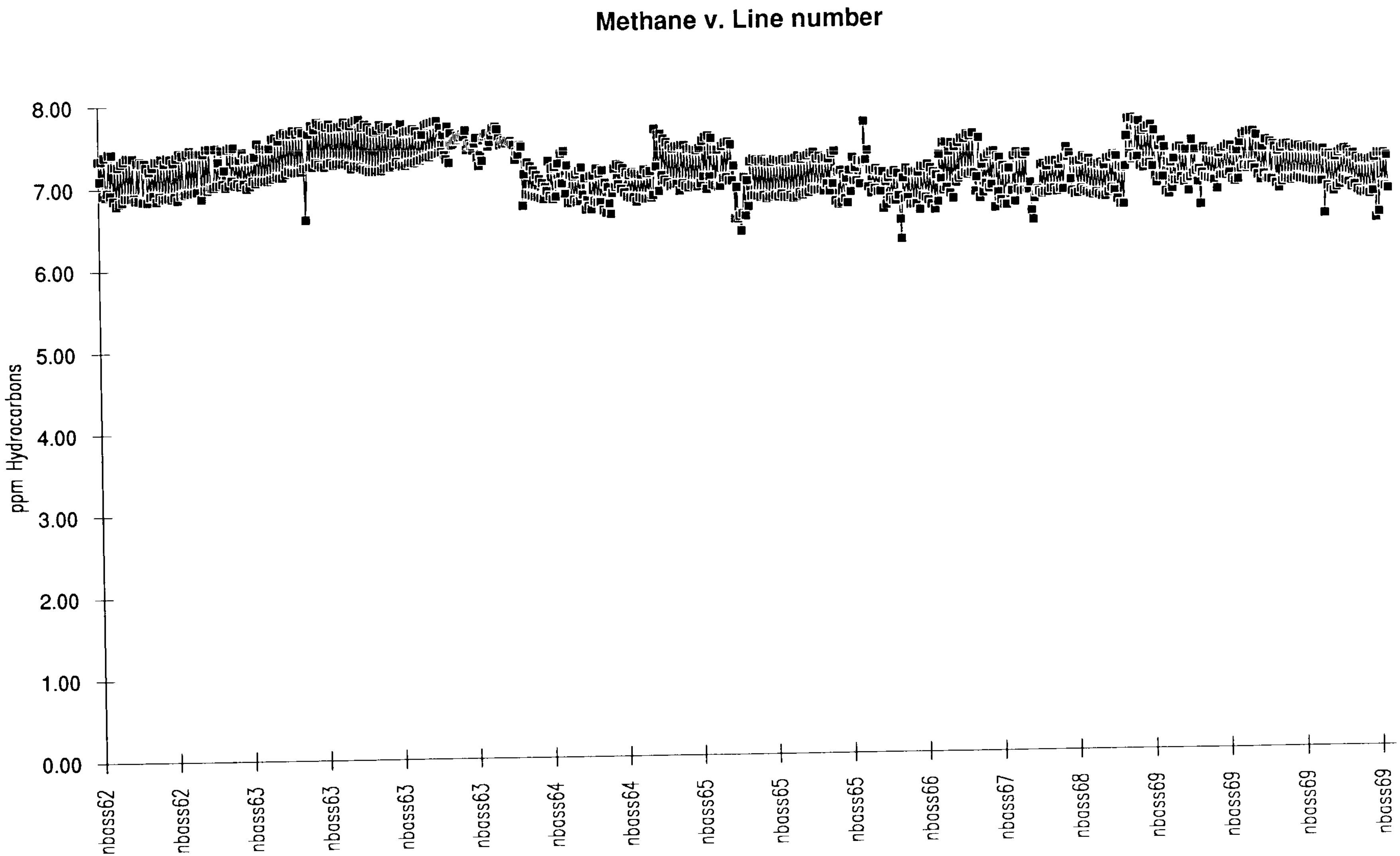


Figure 14b. Methane concentrations along the survey lines in the North Bass Basin.

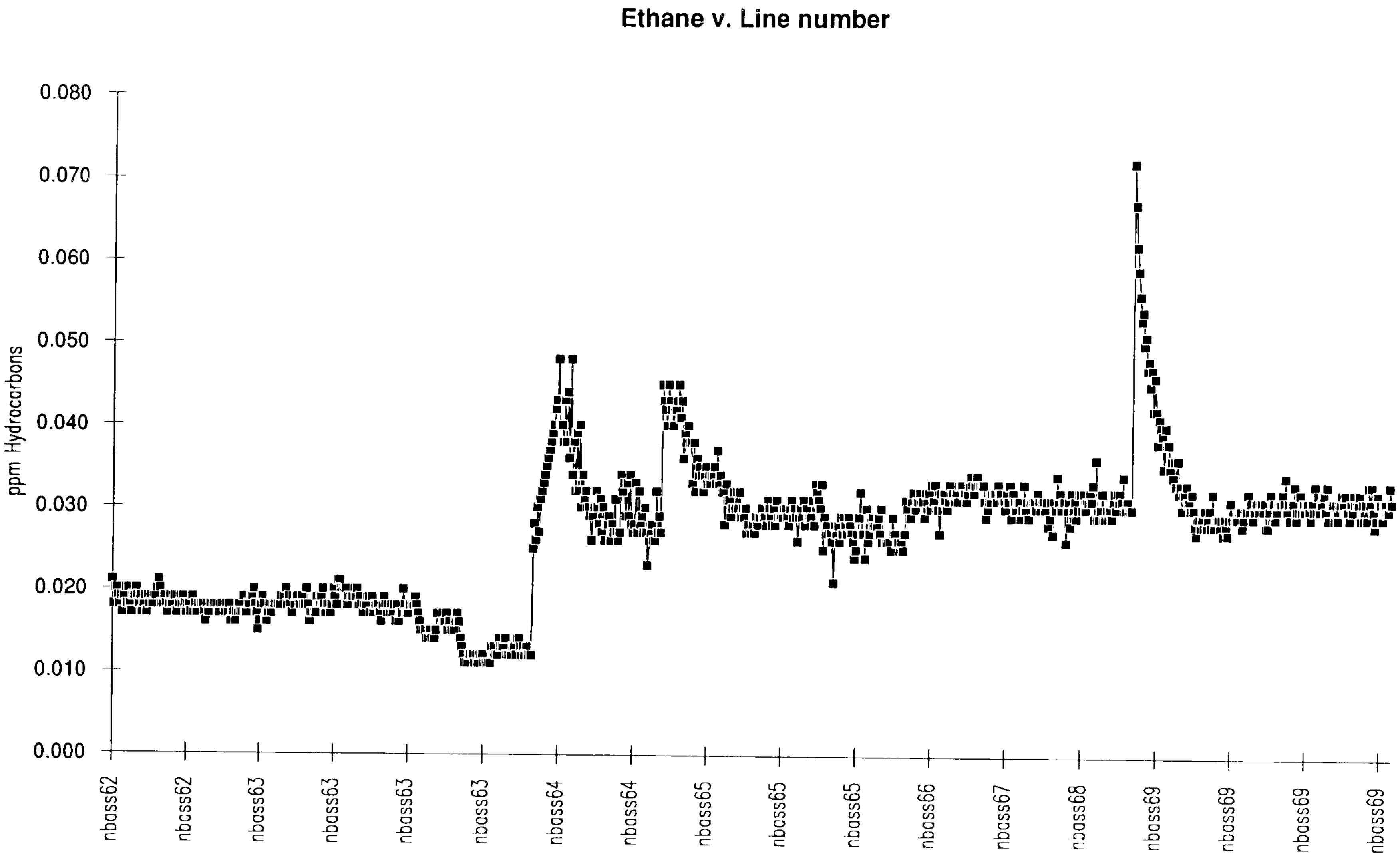


Figure 14c. Ethane concentrations along the survey lines in the North Bass Basin.

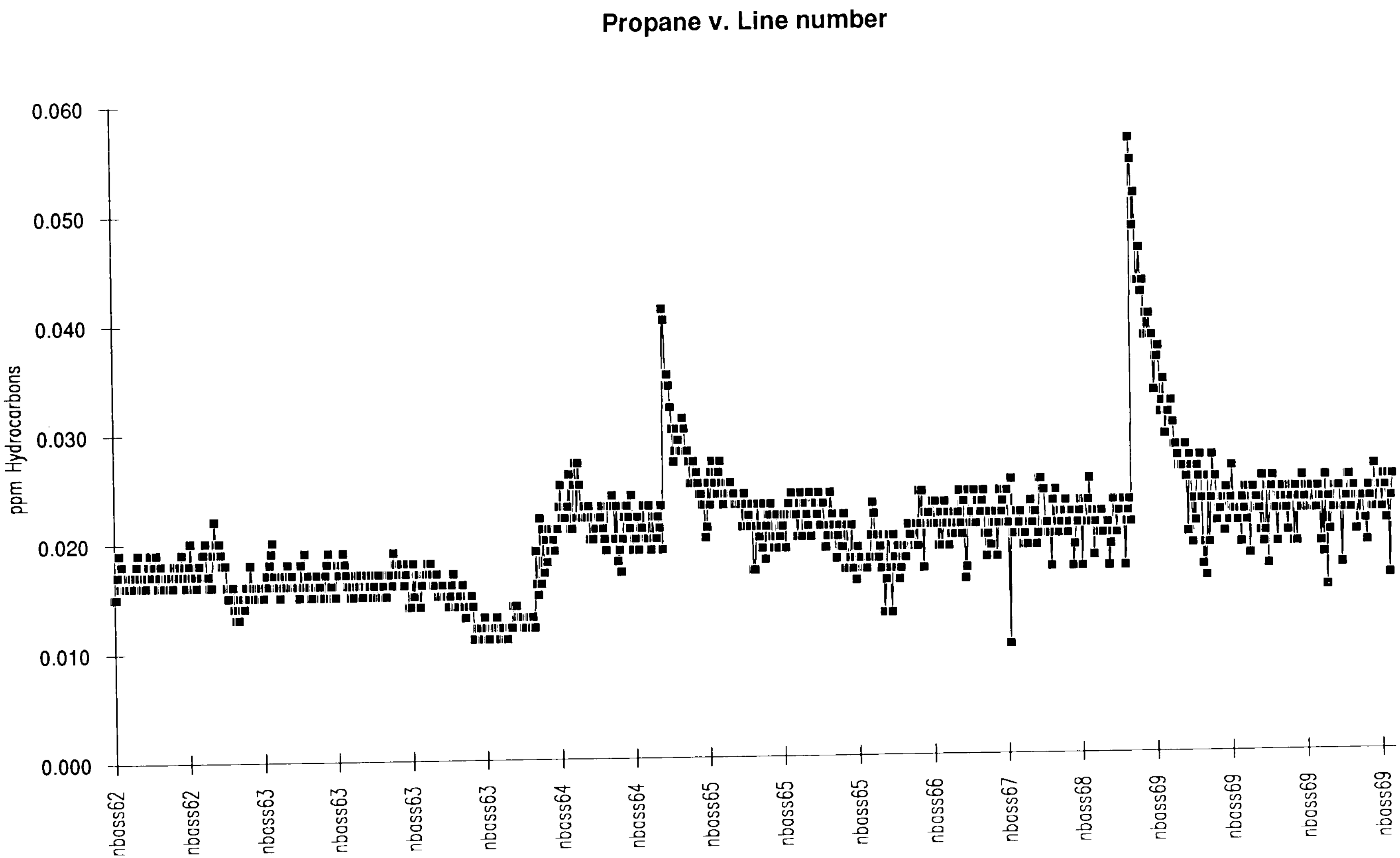


Figure 14d. Propane concentrations along the survey lines in the North Bass Basin.

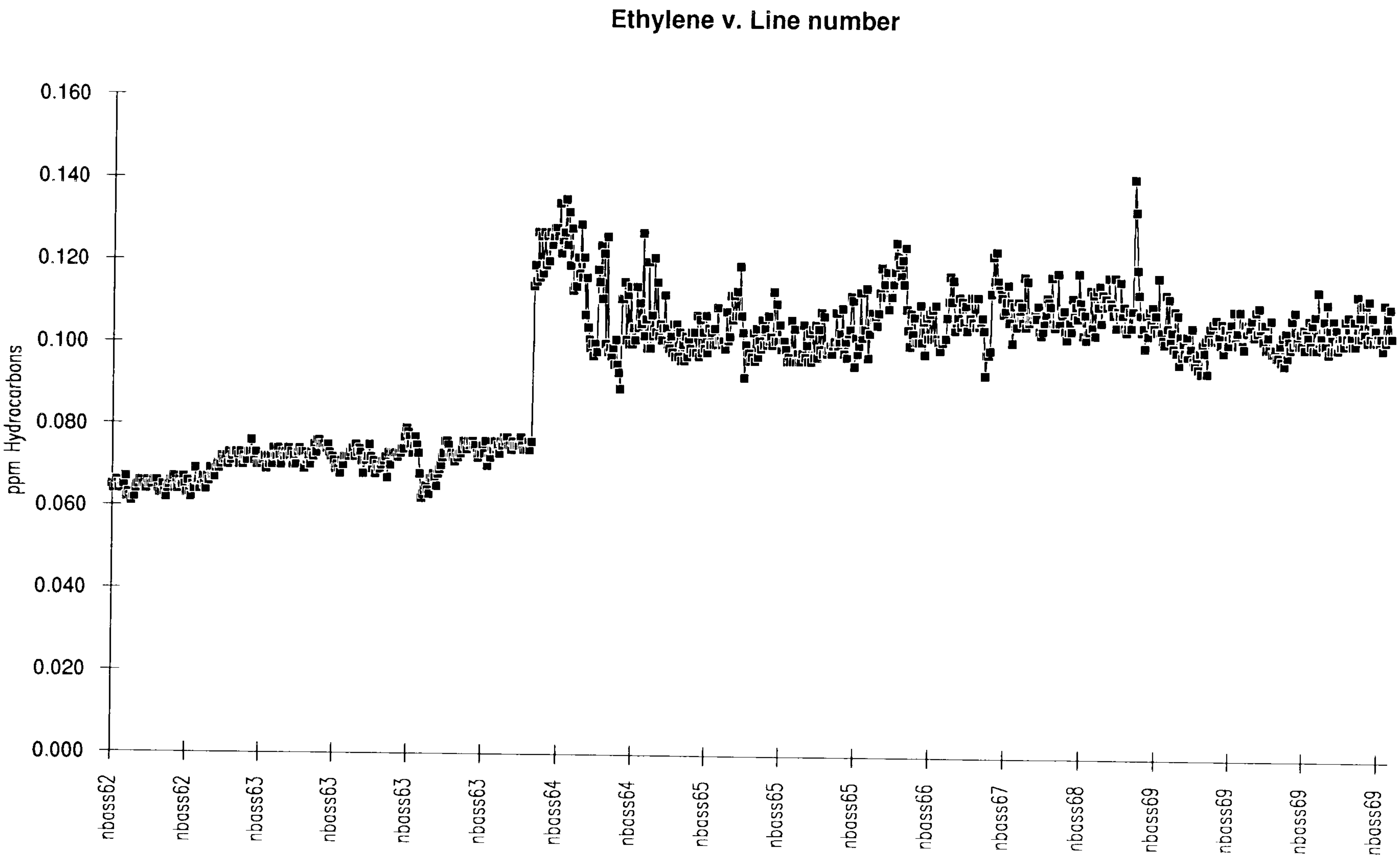


Figure 14e. Ethylene concentrations along the survey lines in the North Bass Basin.

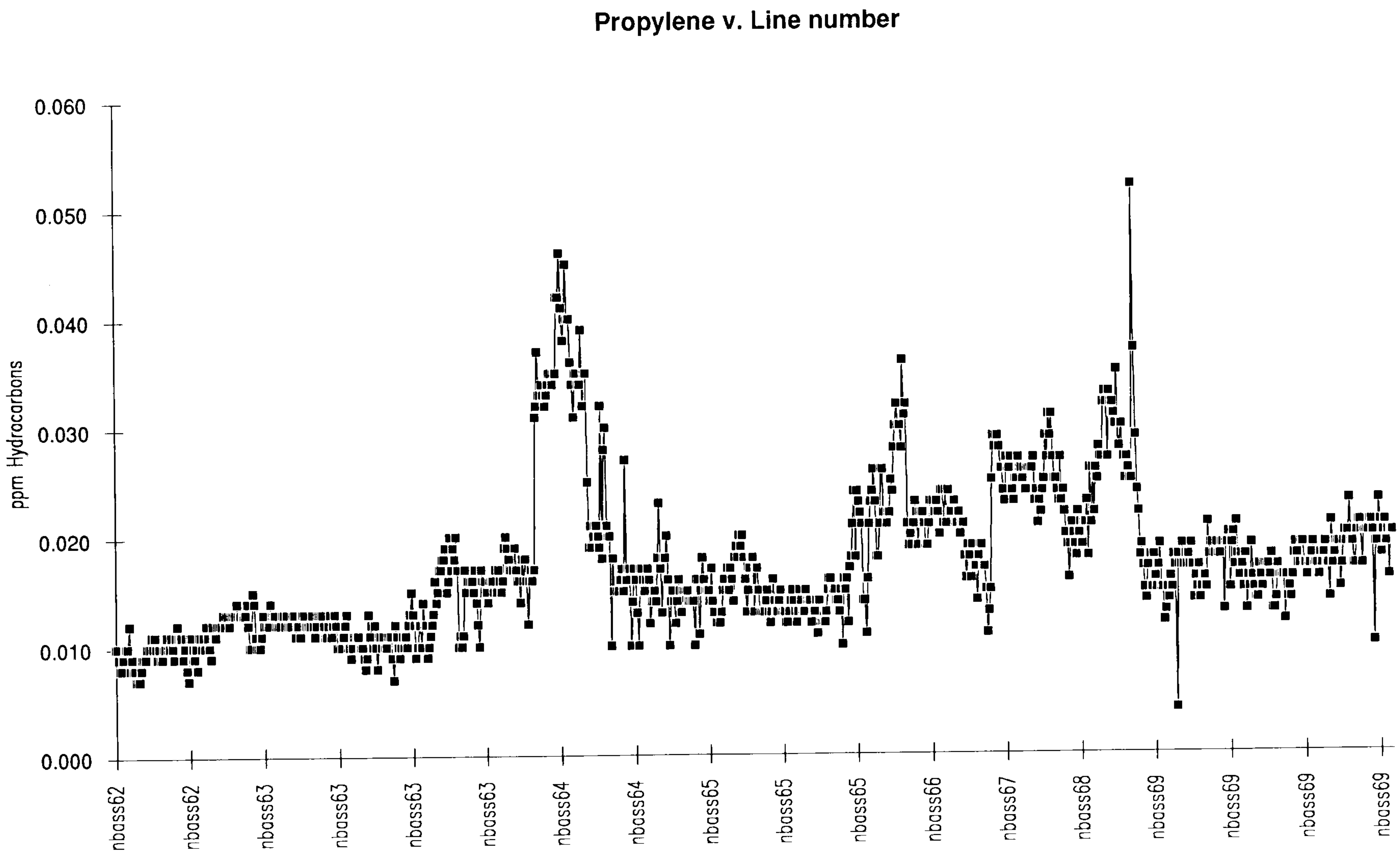


Figure 14f. Propylene concentrations along the survey lines in the North Bass Basin.

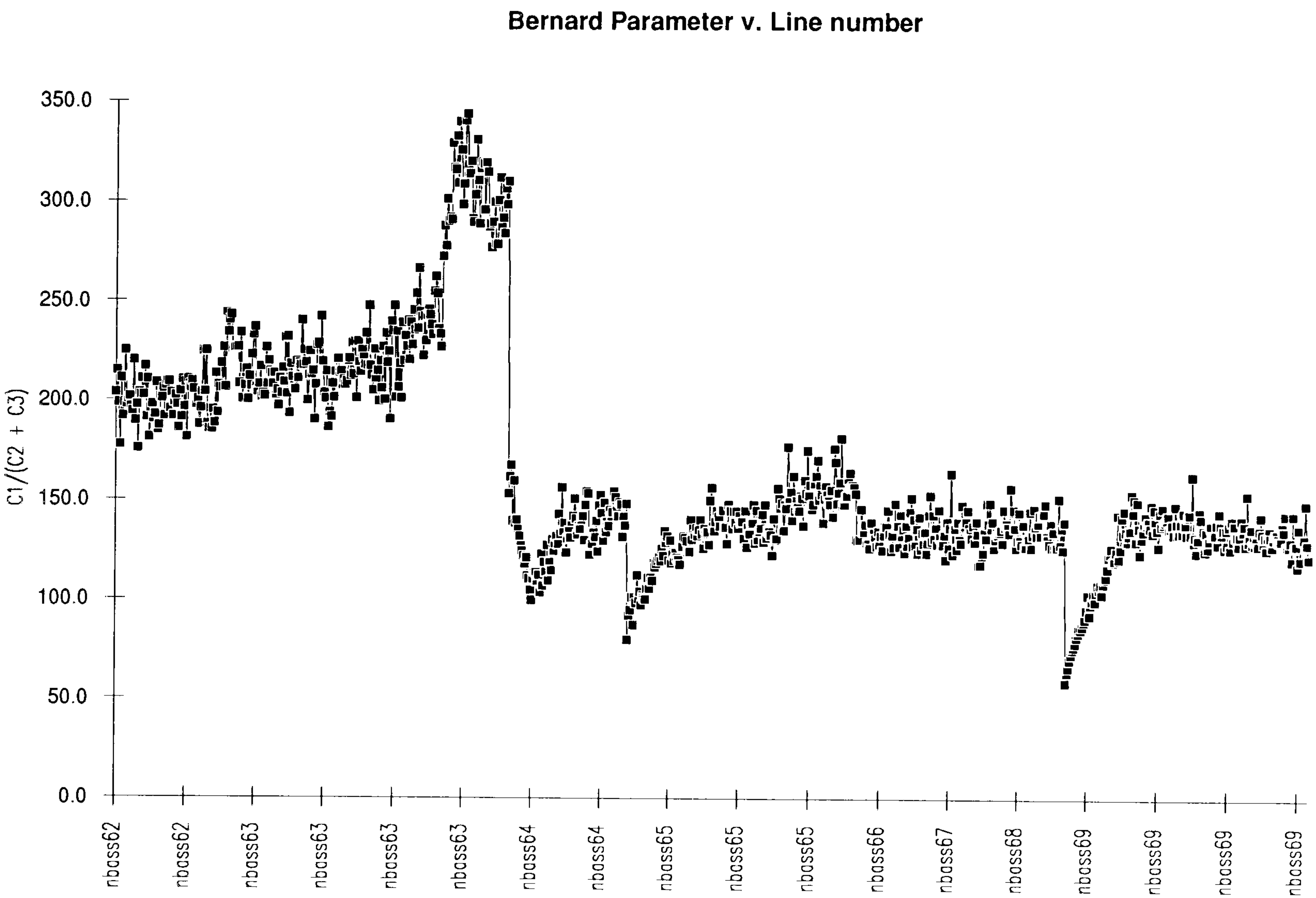


Figure 14g. Bernard Parameter along the survey lines in the North Bass Basin.

Butanes v. Line number

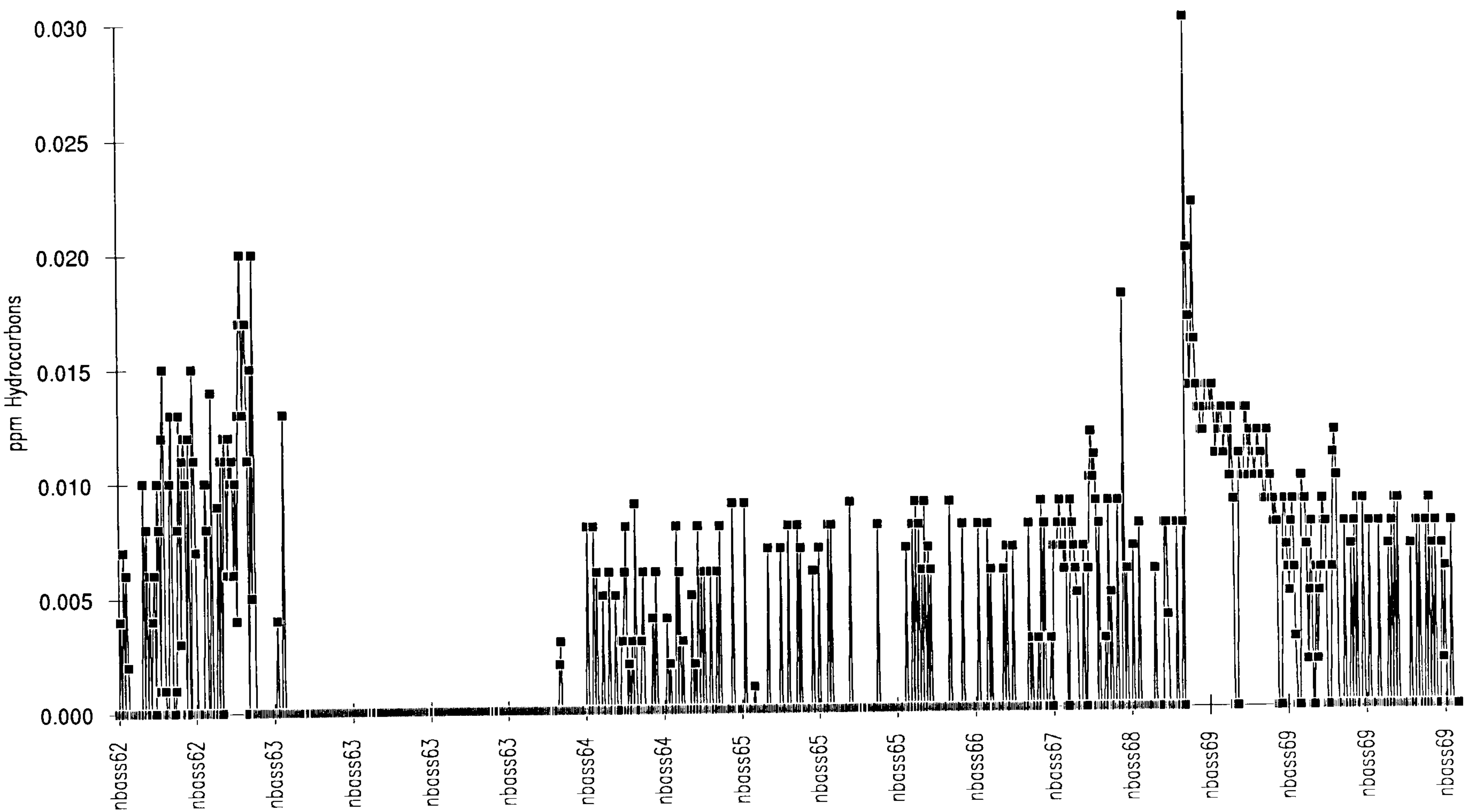


Figure 14h. Butanes along the survey lines in the North Bass Basin.

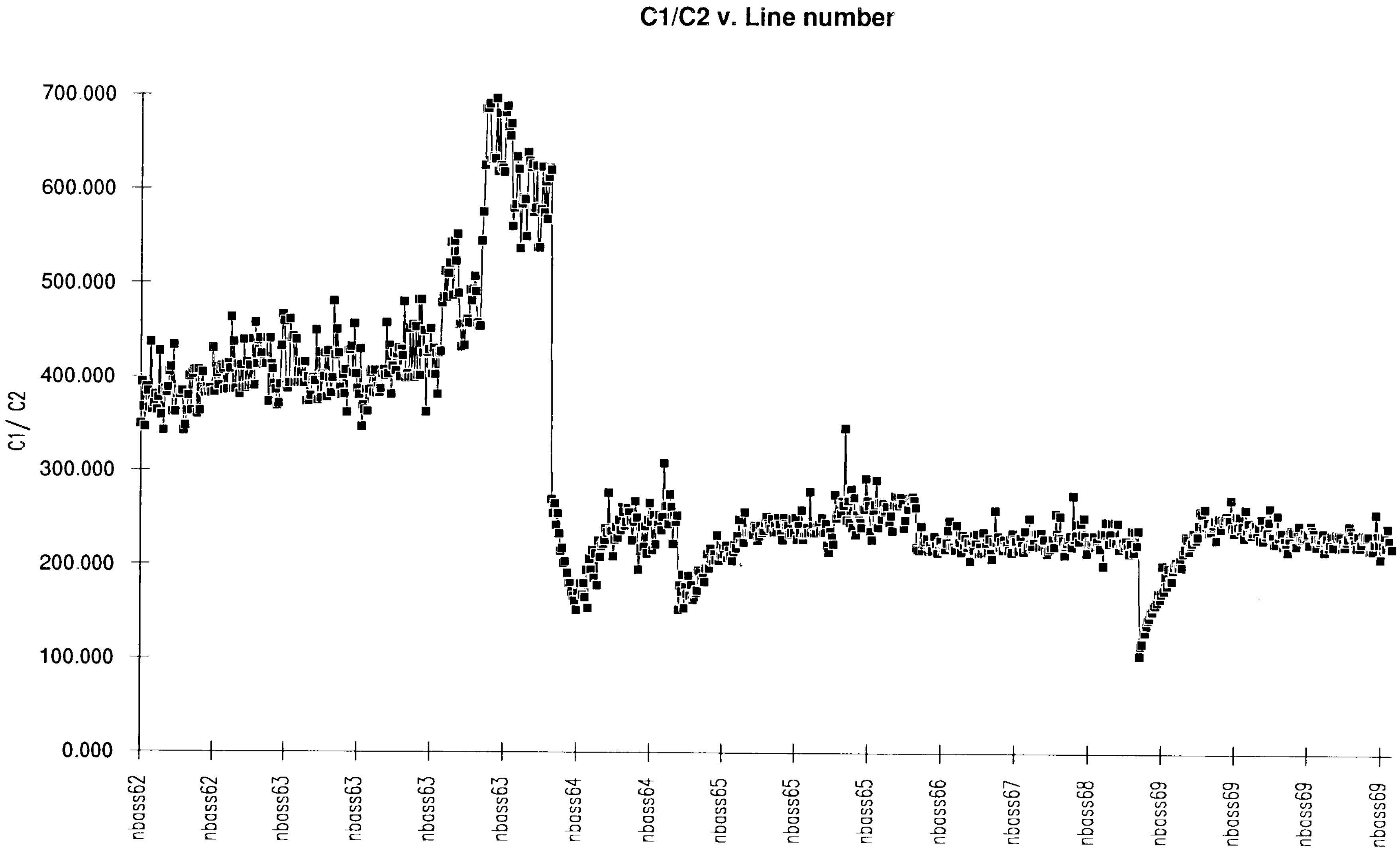


Figure 14j. C1/C2 along the survey lines in the North Bass Basin.

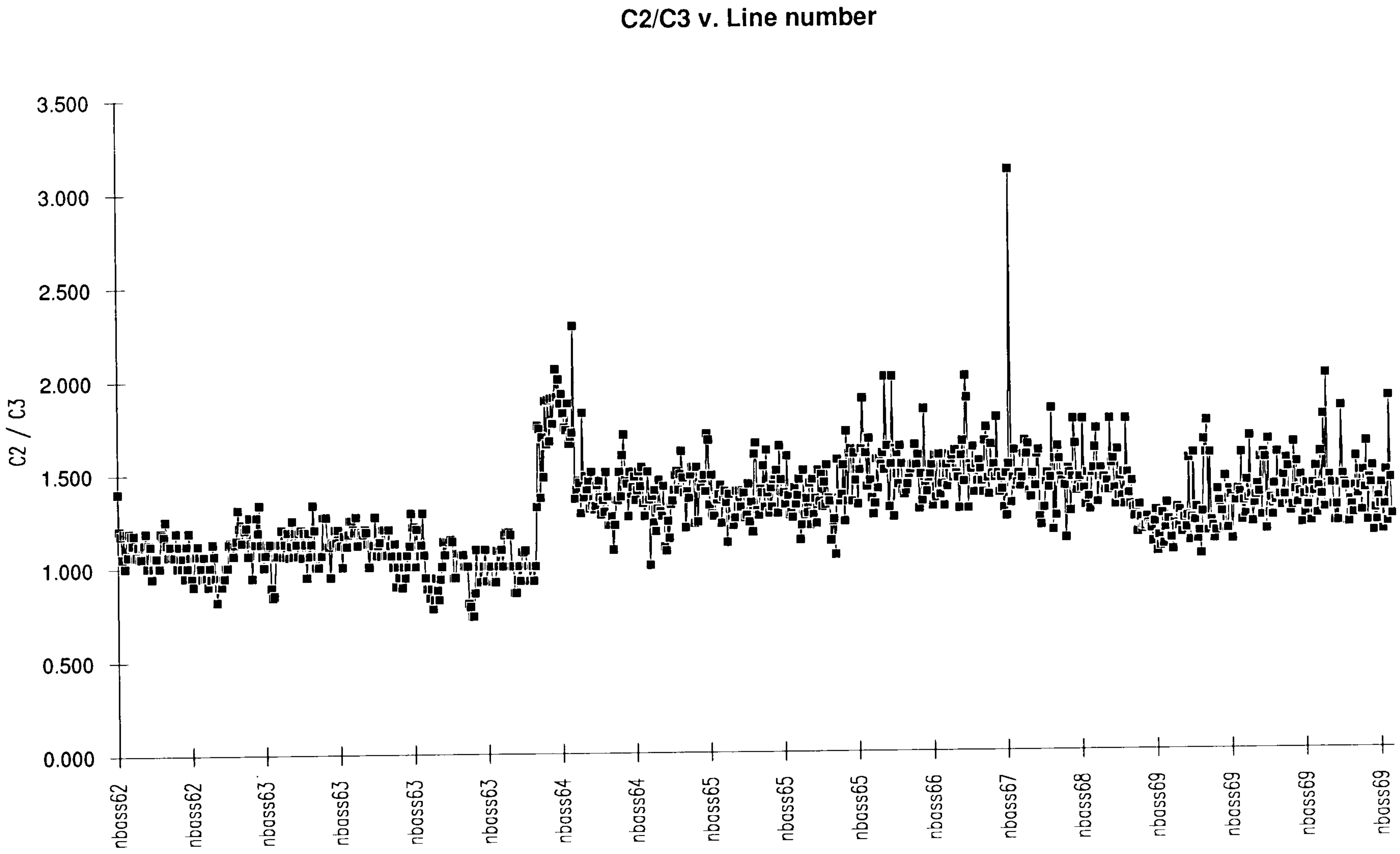


Figure 14k. C2/C3 along the survey lines in the North Bass Basin.

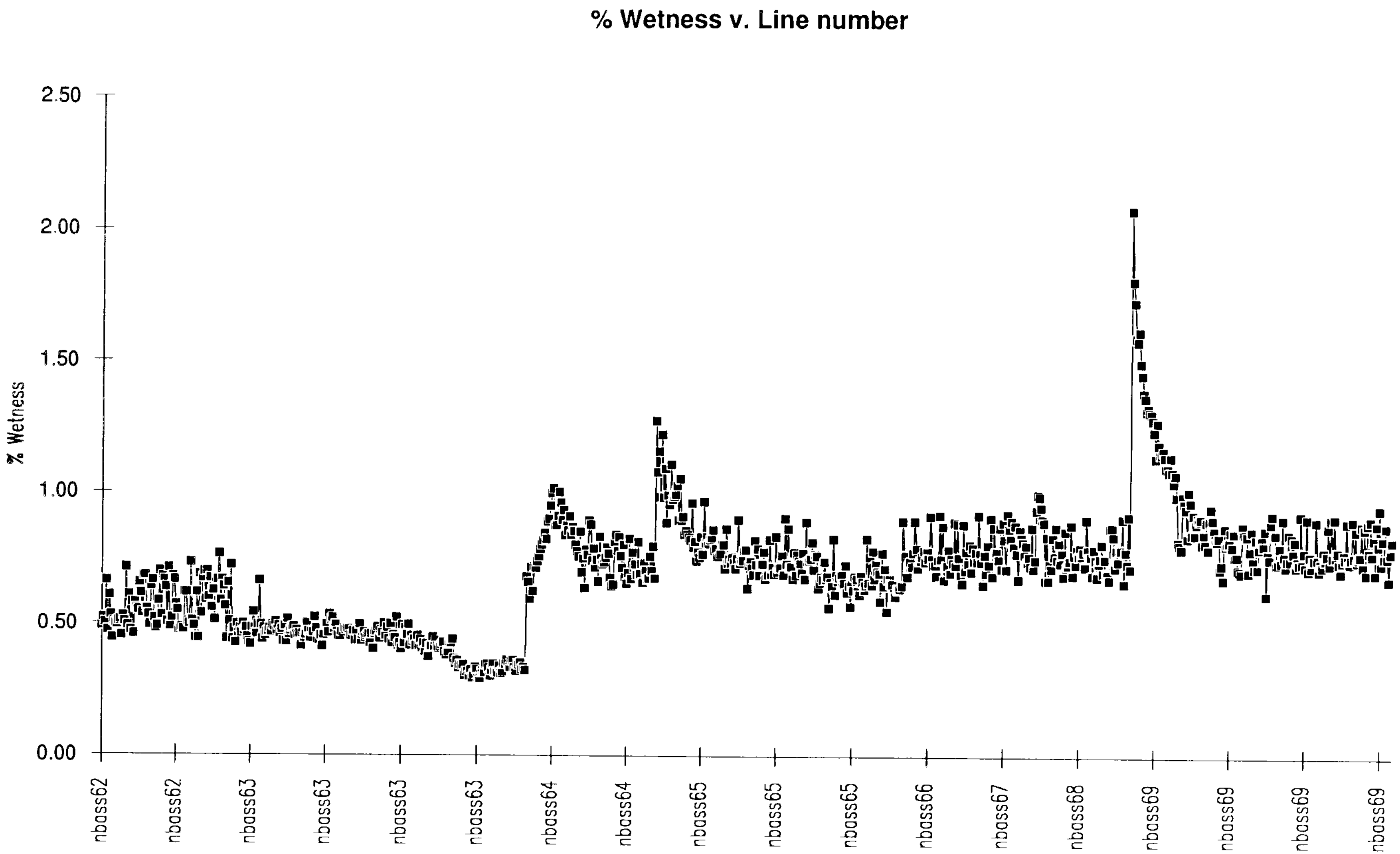


Figure 141 Percent hydrocarbon wetness along all of the survey lines in the North Bass Basin.

BASS BASIN PLOTS

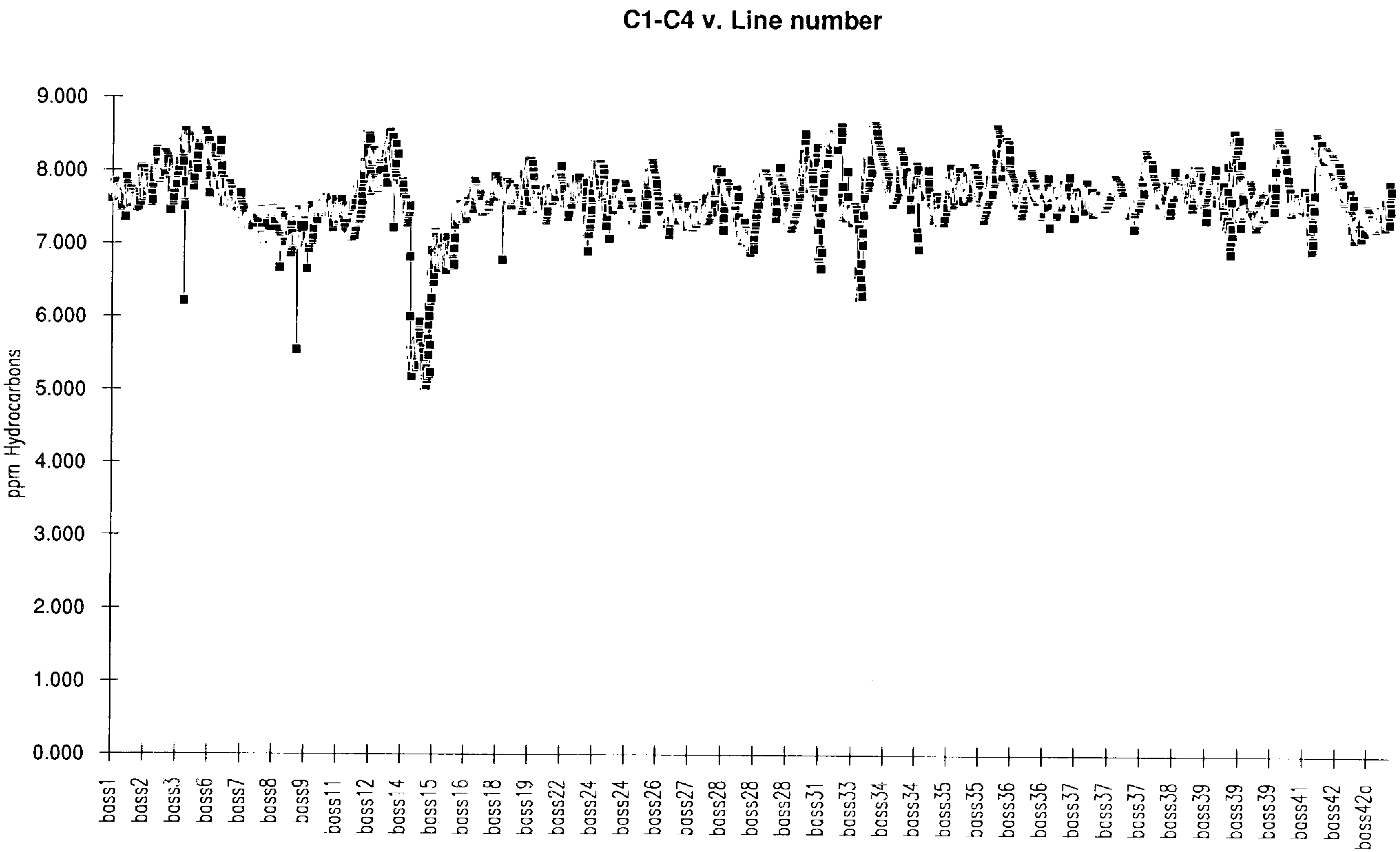
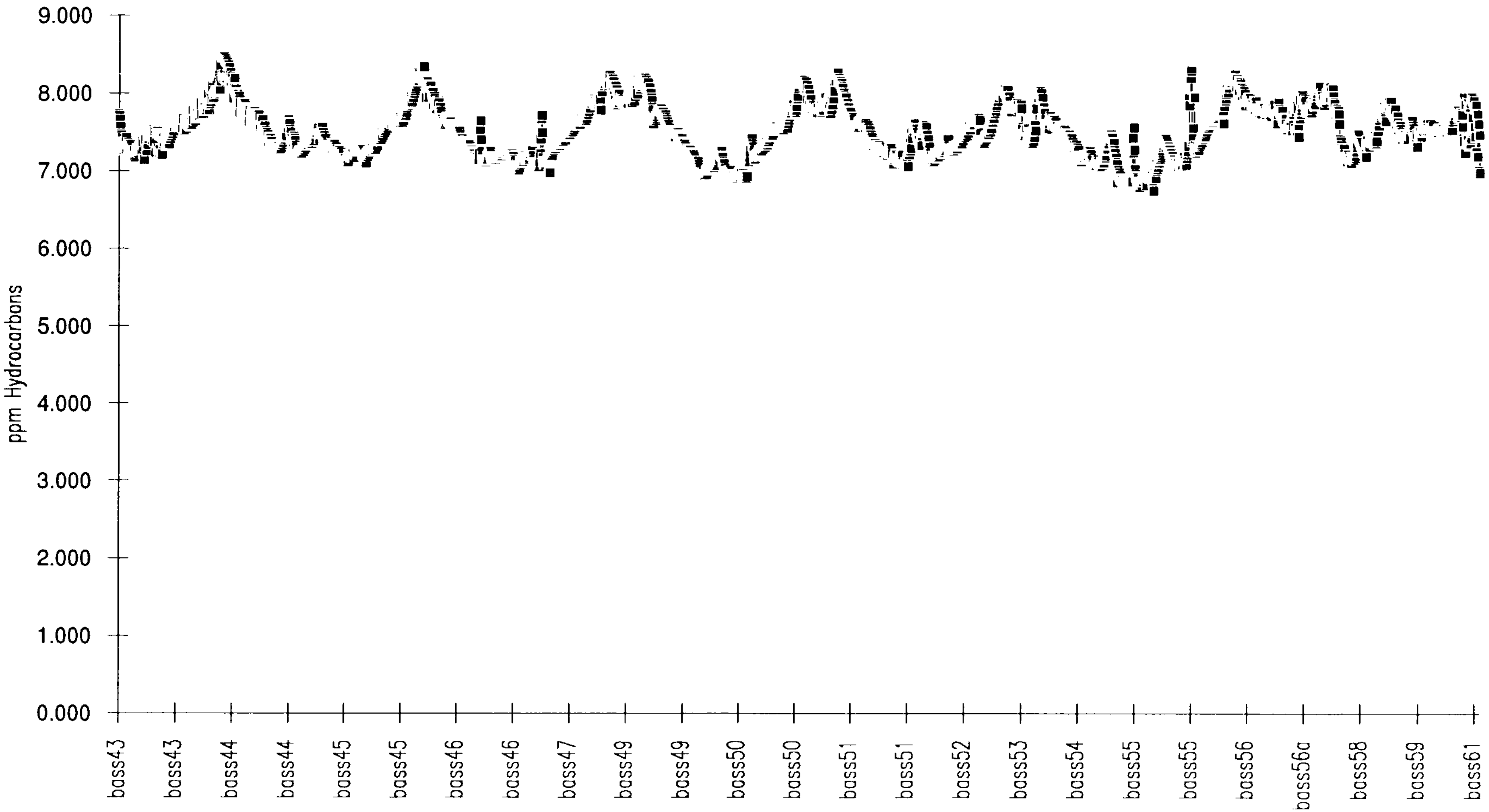


Figure 15a. Sum C1-C4 hydrocarbon concentration along all of the survey lines in the Bass Basin.

C1-C4 v. Line number



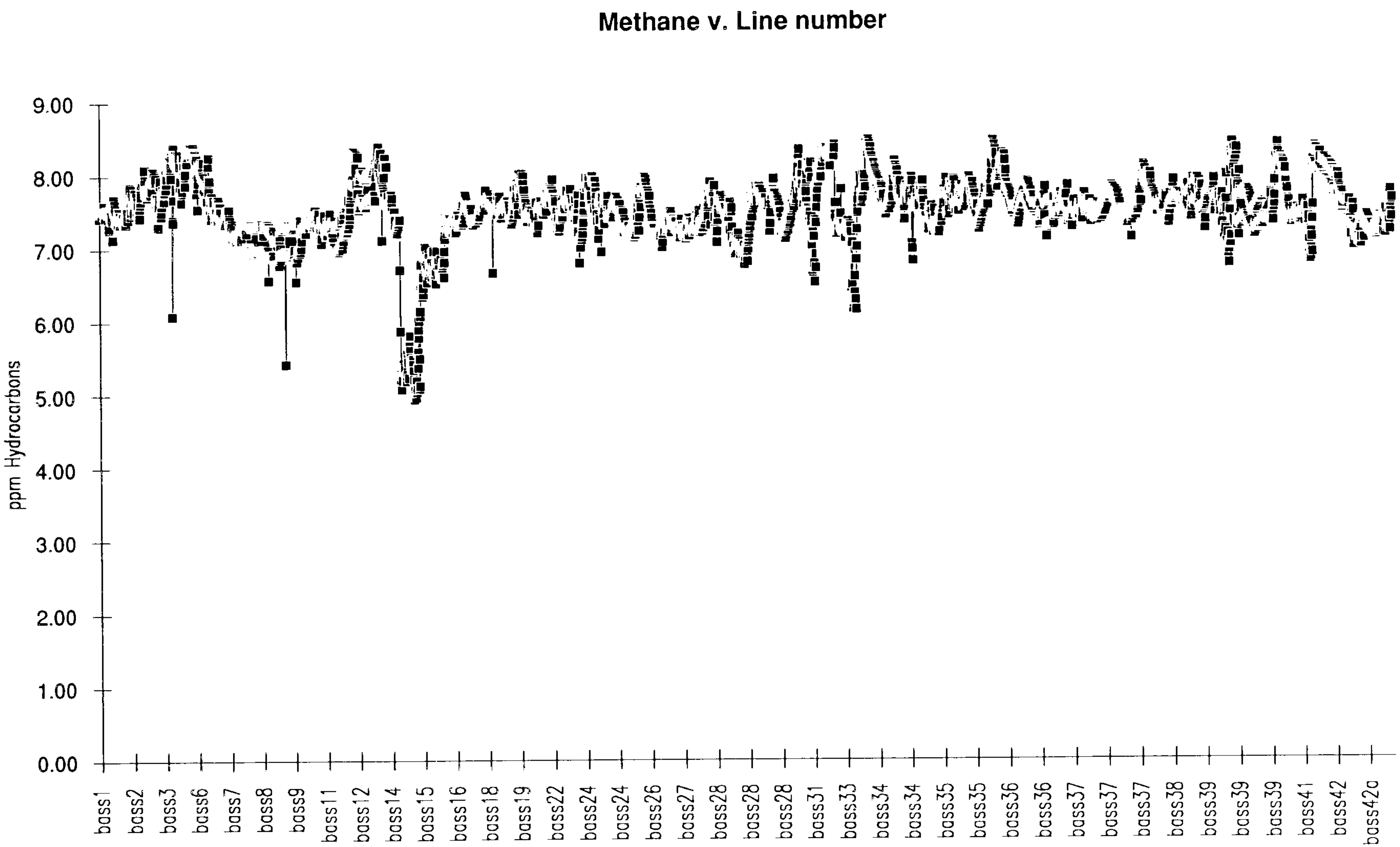
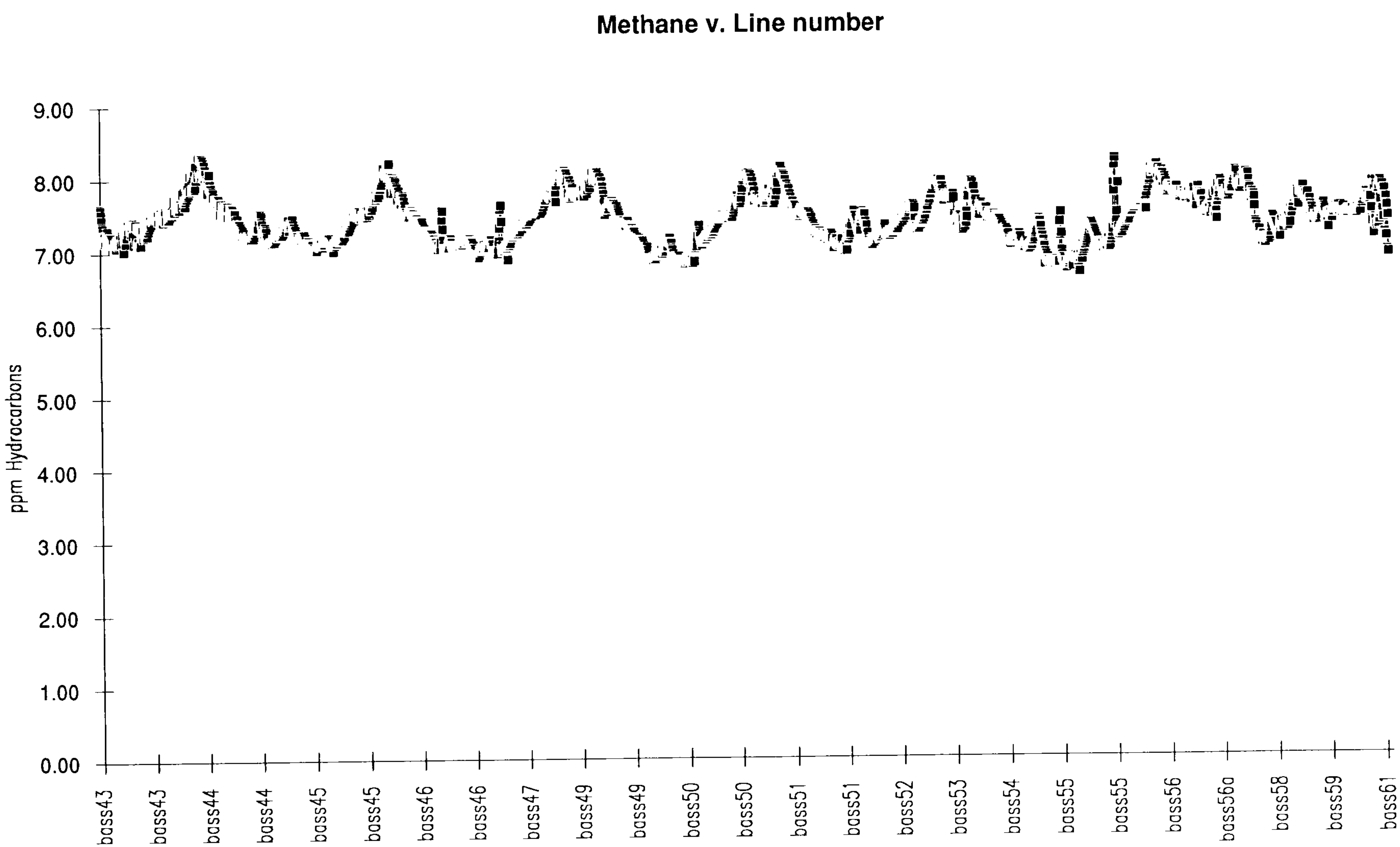


Figure 15b. Methane concentrations along all of the survey lines in the BassBasin.


Methane v. Line number
ppm Hydrocarbons
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
bass43
bass43
bass44
bass44
bass45
bass45
bass46
bass46
bass47
bass49
bass49
bass50
bass50
bass51
bass51
bass52
bass53
bass54
bass55
bass55
bass56
bass56a
bass58
bass59
bass61

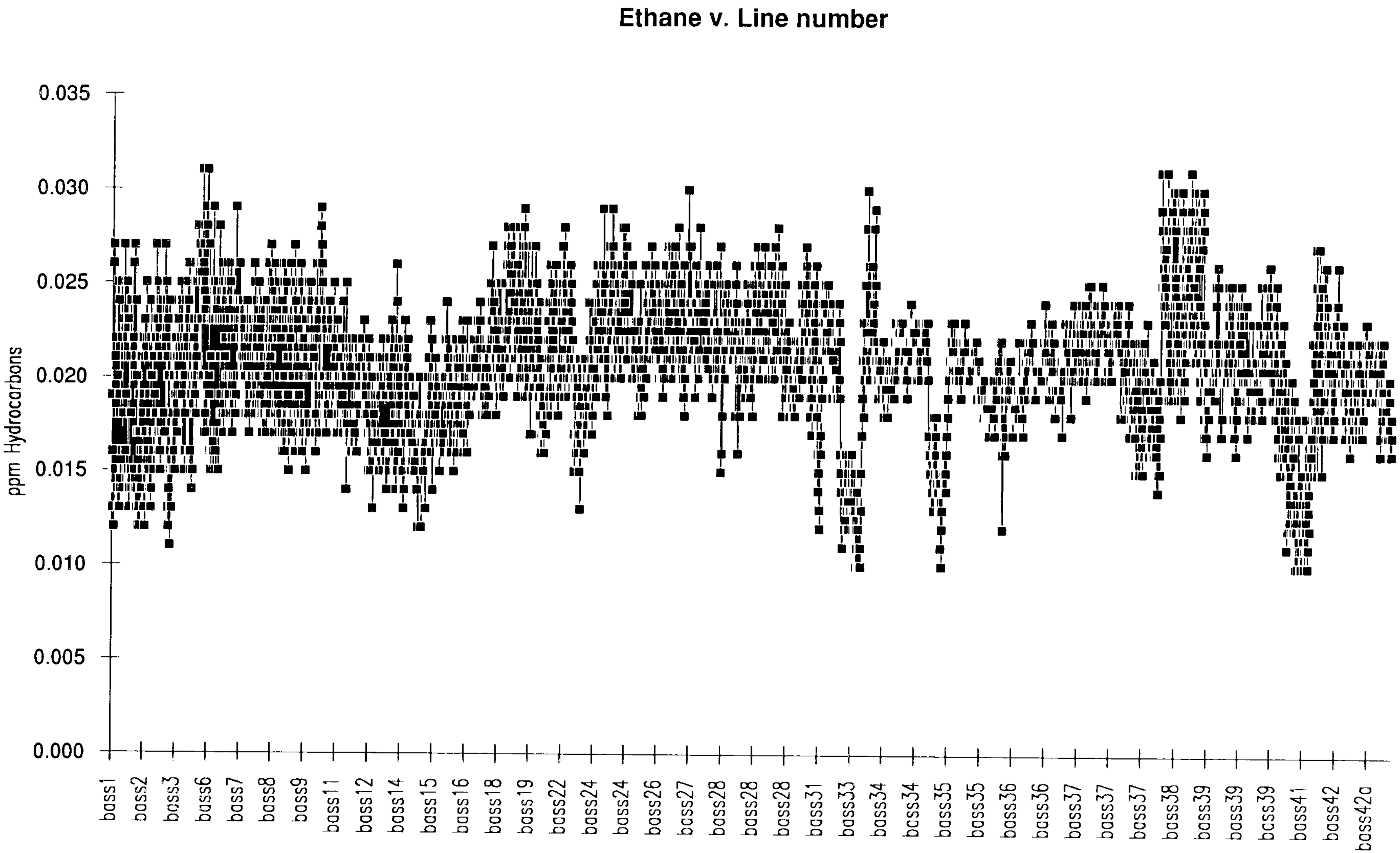
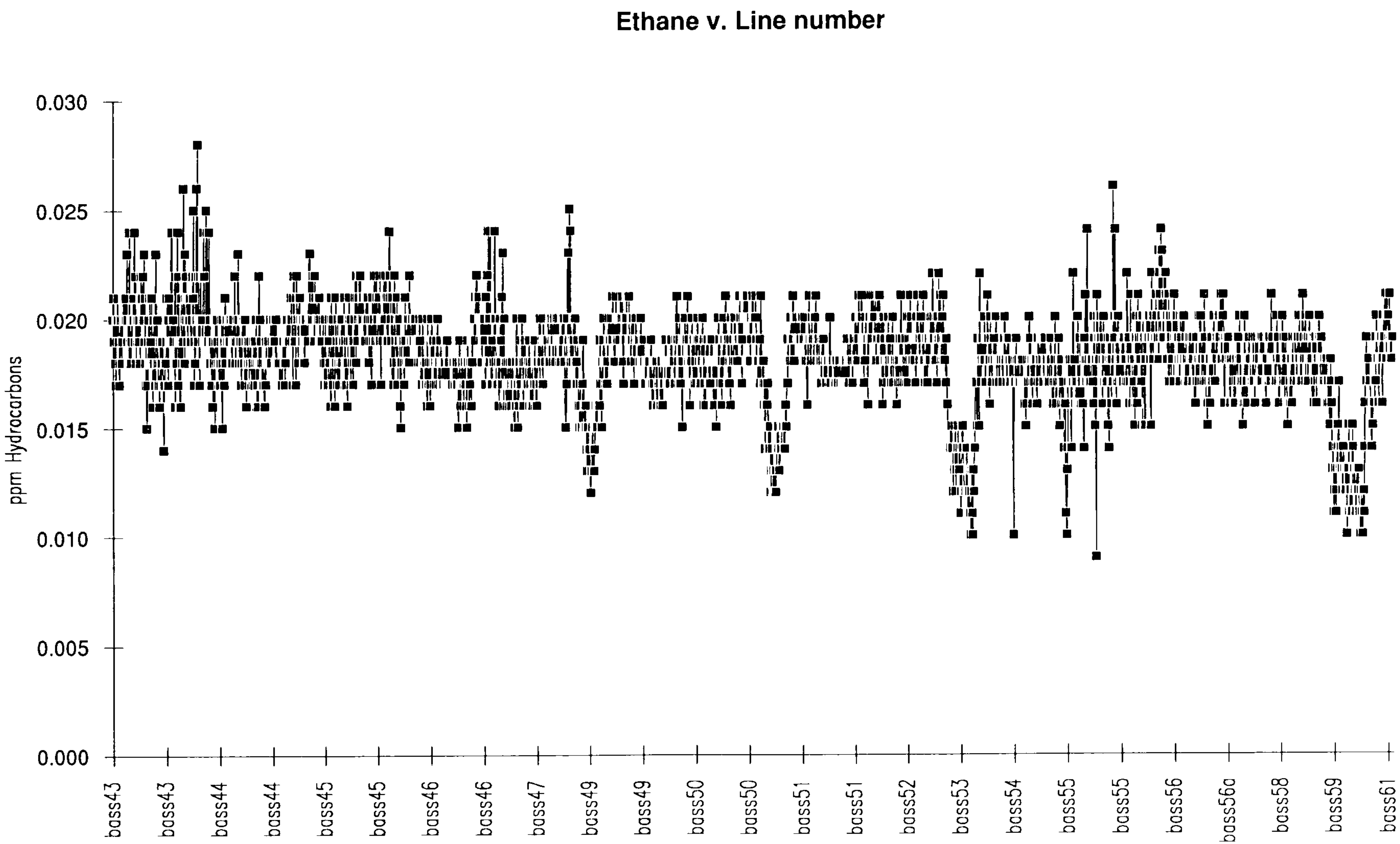


Figure 15c. Ethane concentrations along all of the survey lines in the BassBasin.


Ethane v. Line number
ppm Hydrocarbons
0.030
0.025
0.020
0.015
0.010
0.005
0.000
bass43
bass43
bass44
bass44
bass45
bass45
bass46
bass46
bass47
bass49
bass49
bass50
bass50
bass51
bass51
bass52
bass53
bass54
bass55
bass55
bass56
bass56a
bass58
bass59
bass61

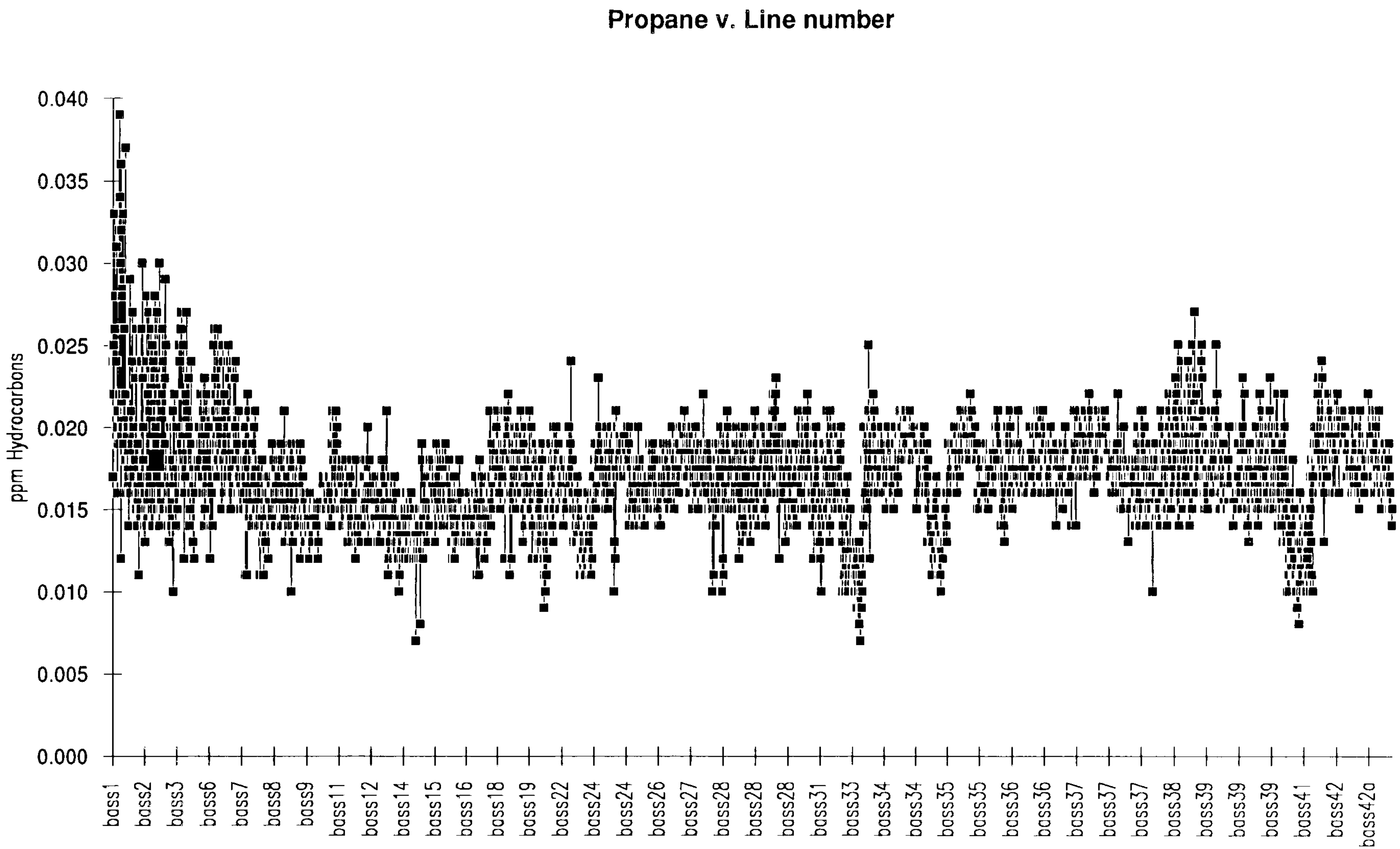
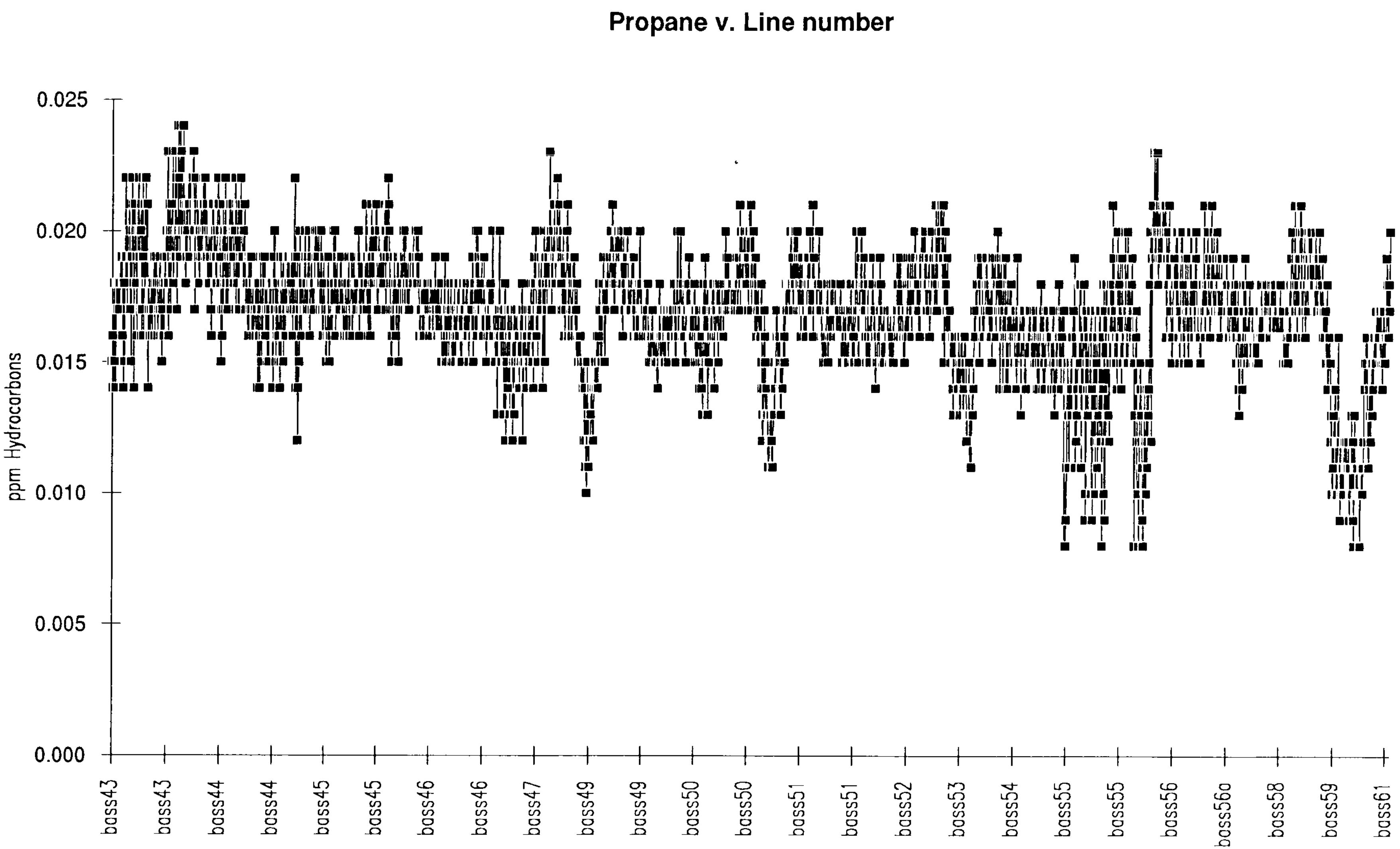


Figure 15d. Propane concentrations along all of the survey lines in the Bass Basin.


Propane v. Line number
ppm Hydrocarbons
0.025
0.020
0.015
0.010
0.005
0.000
bass43
bass43
bass44
bass44
bass45
bass45
bass46
bass46
bass47
bass49
bass49
bass50
bass50
bass51
bass51
bass52
bass53
bass54
bass55
bass55
bass56
bass56a
bass58
bass59
bass61

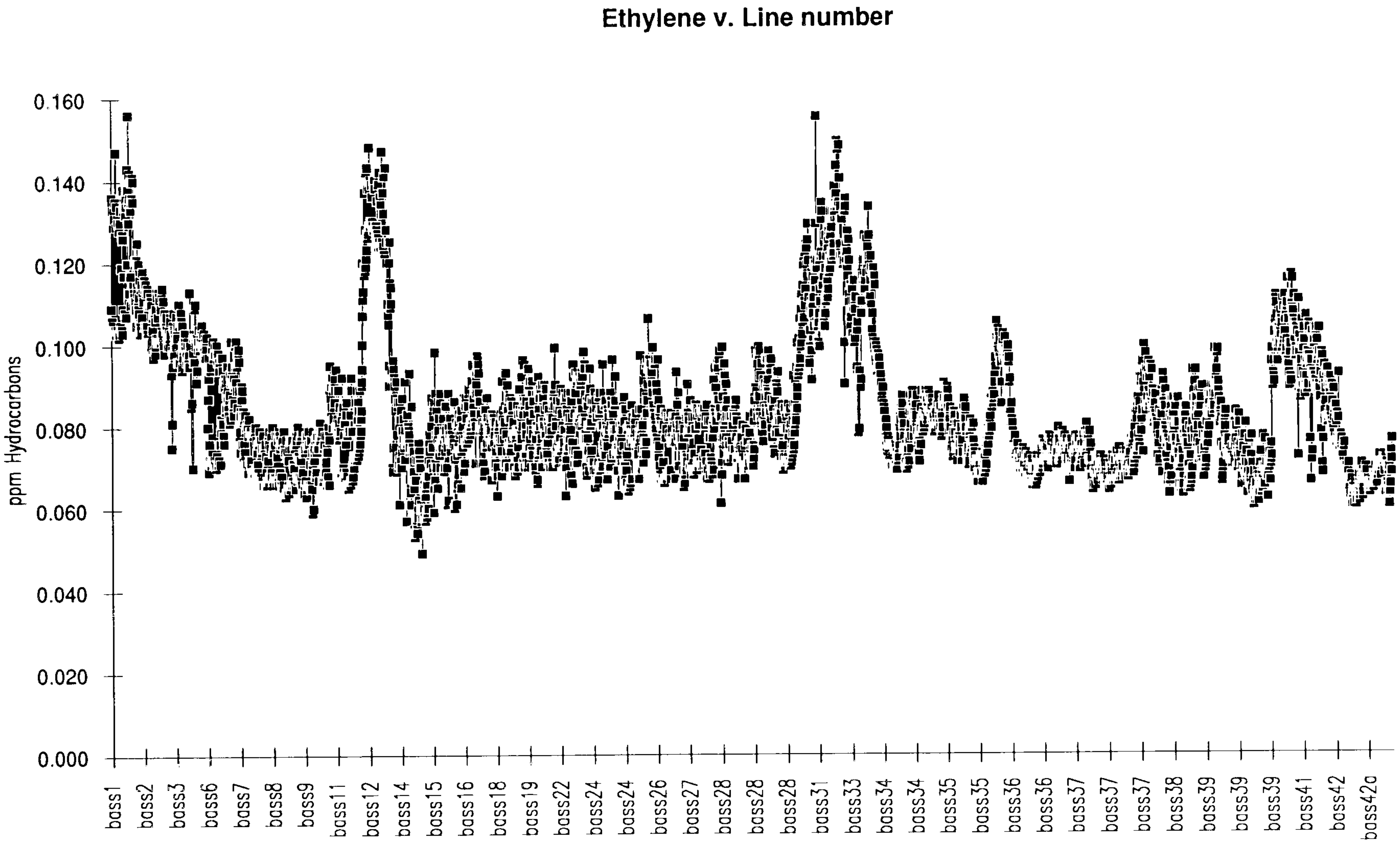
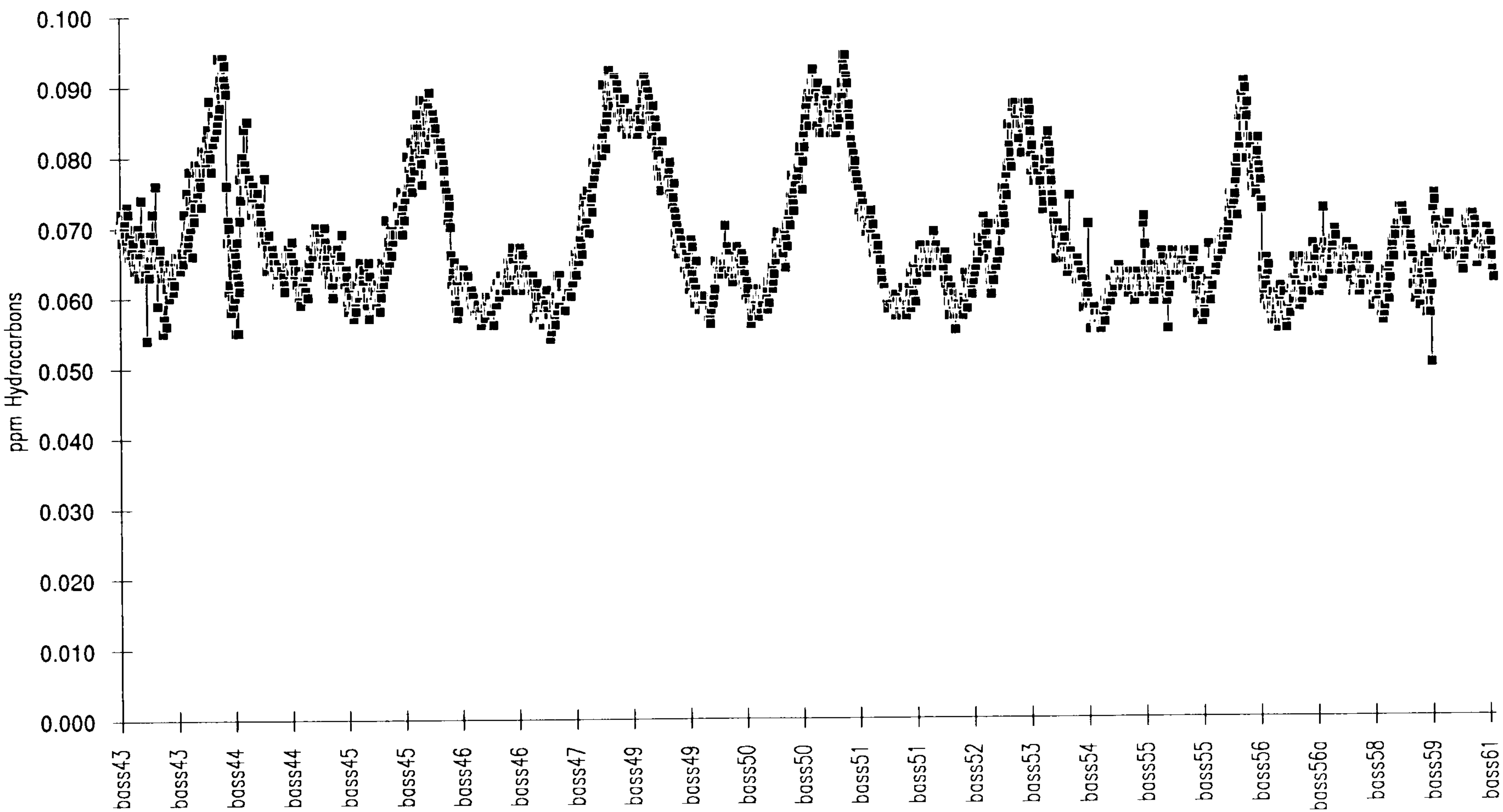


Figure 15e. Ethylene concentrations along all of the survey lines in the Bass Basin.

Ethylene v. Line number



Propylene v. Line number

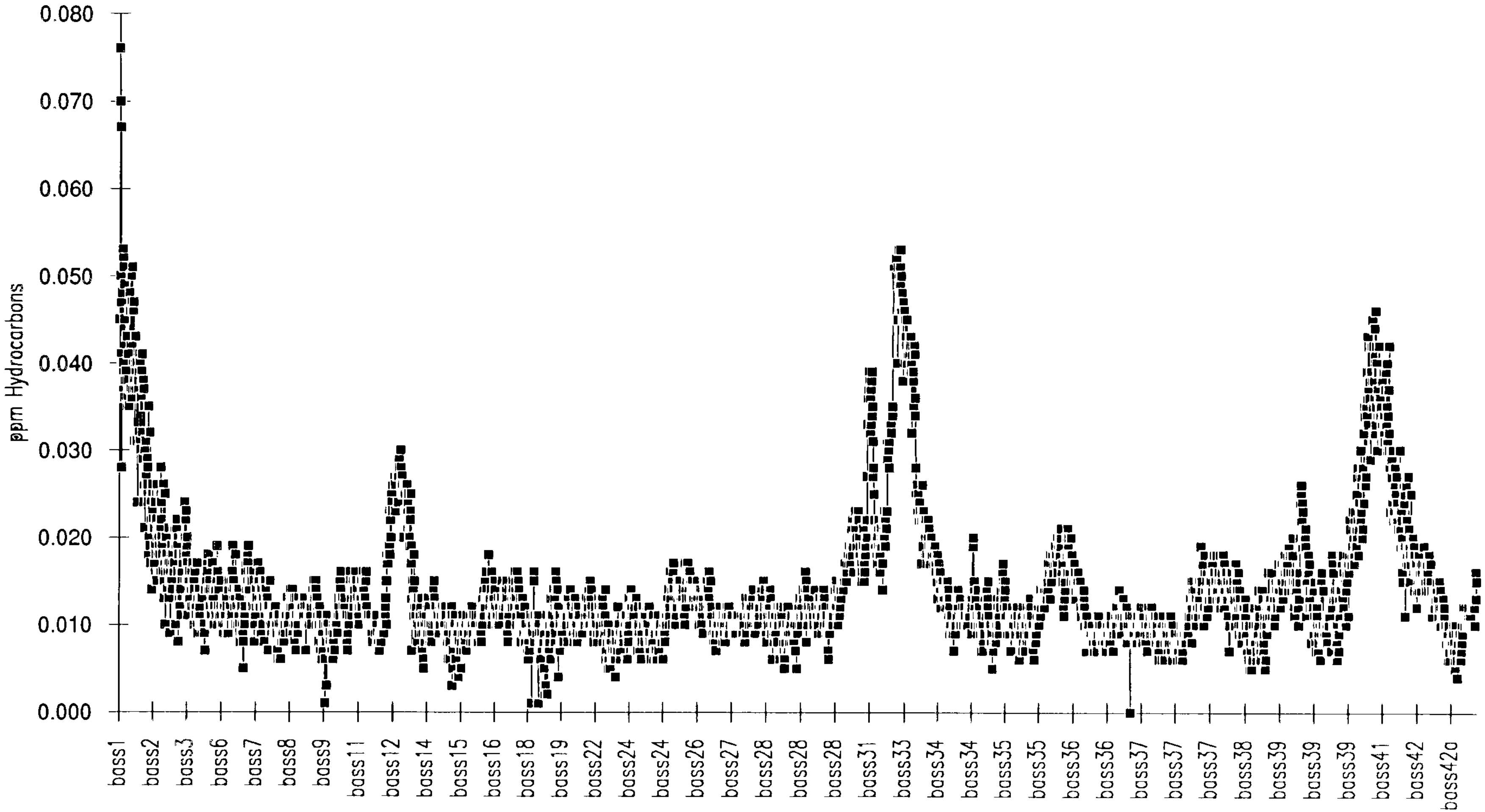
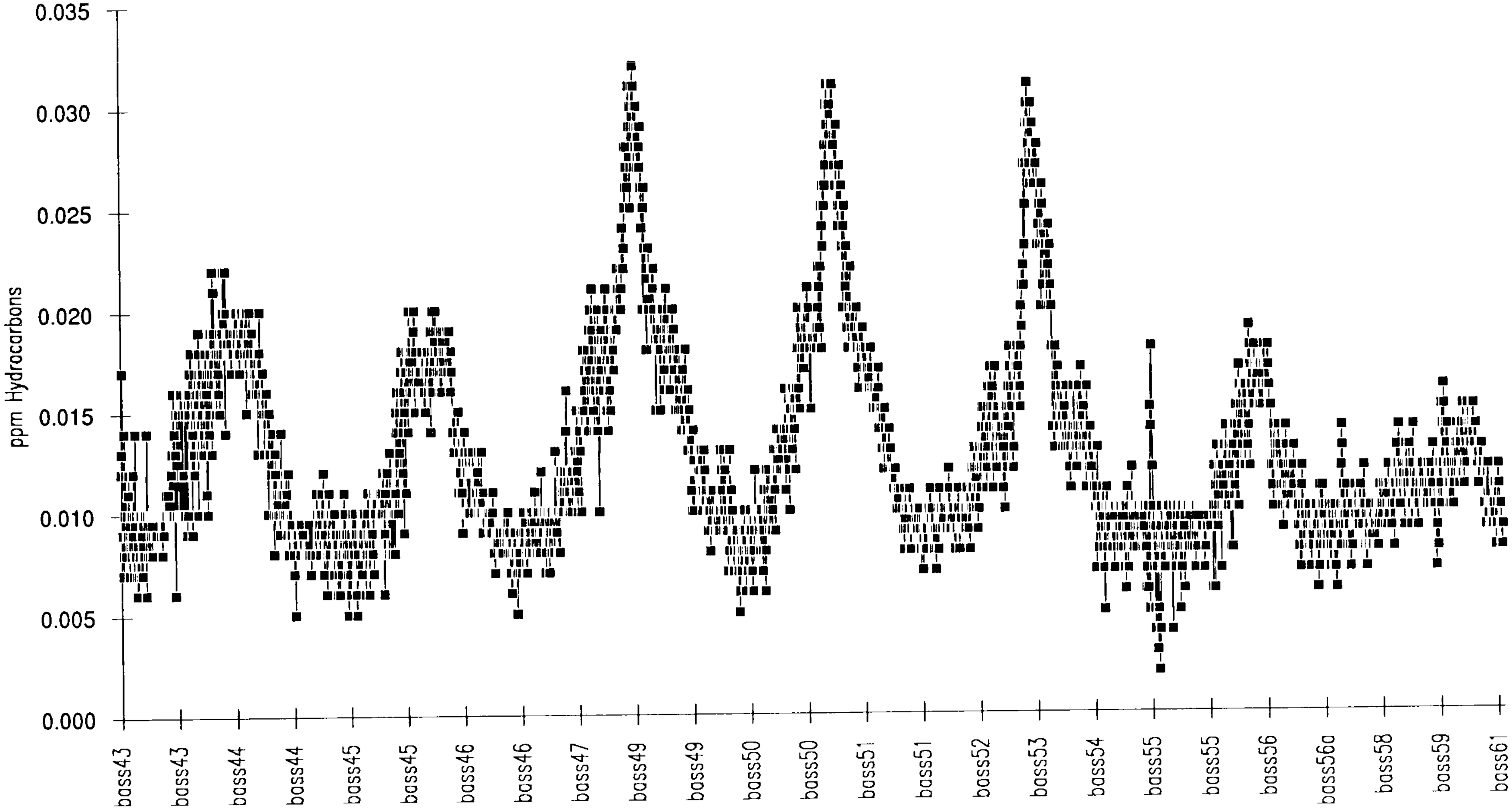


Figure 15f. Propylene concentrations along all of the survey lines in the Bass Basin.

Propylene v. Line number



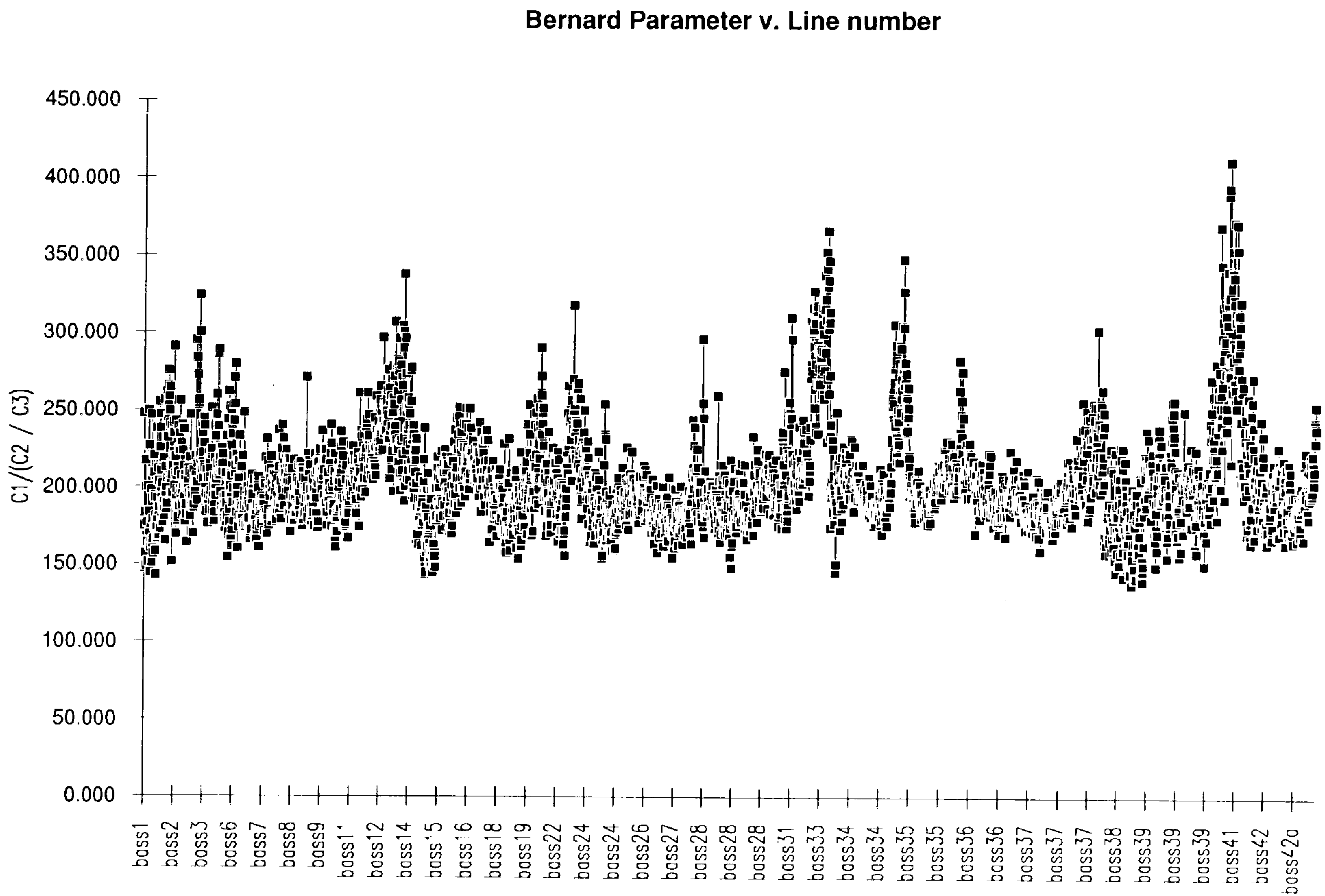
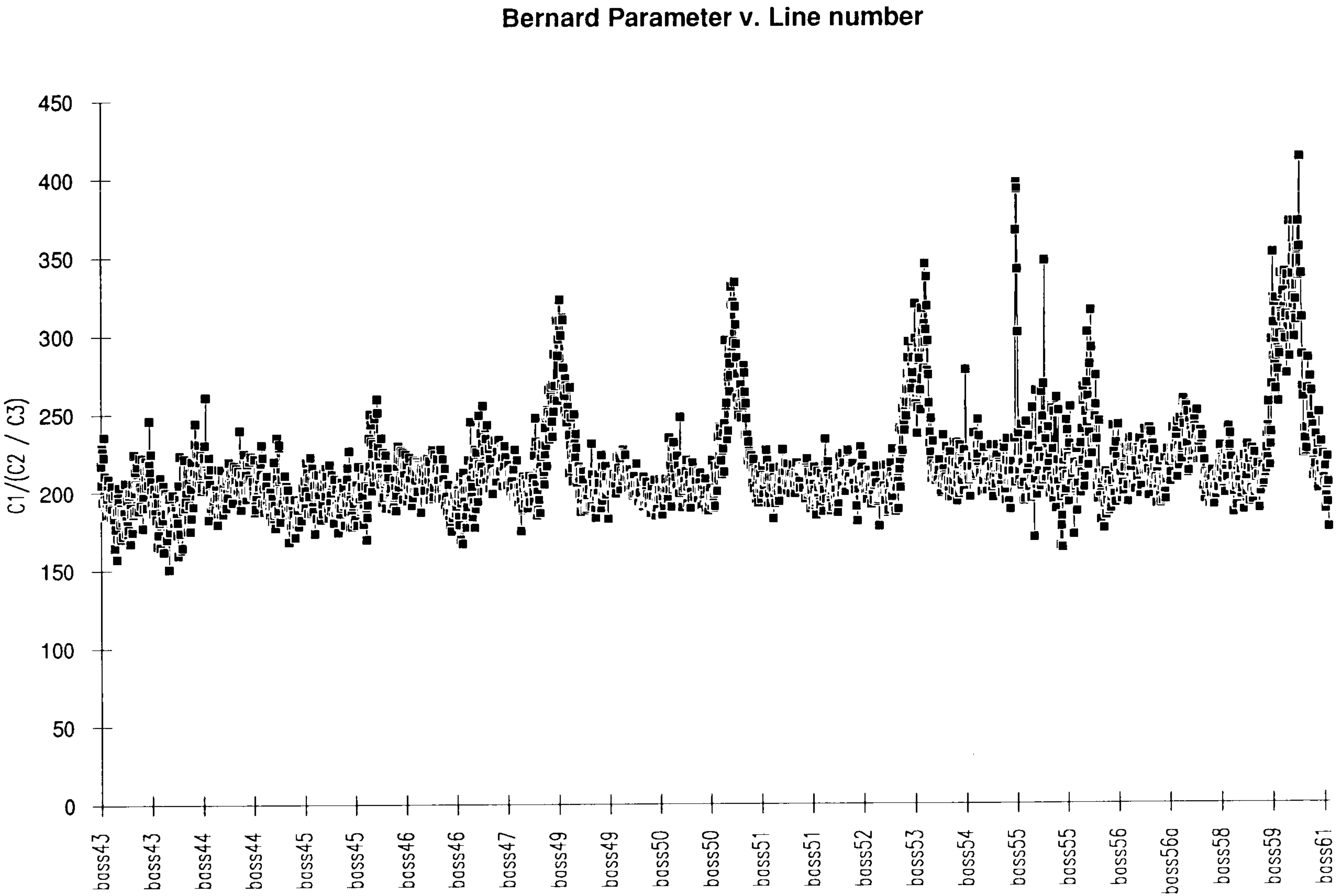


Figure 15g. Bernard Parameter along all of the survey lines in the Bass Basin.


Bernard Parameter v. Line number
C1/(C2 / C3)
450
400
350
300
250
200
150
100
50
0
bass43
bass43
bass44
bass44
bass45
bass45
bass46
bass46
bass47
bass49
bass49
bass50
bass50
bass51
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bass52
bass53
bass54
bass55
bass55
bass56
bass56a
bass58
bass59
bass61

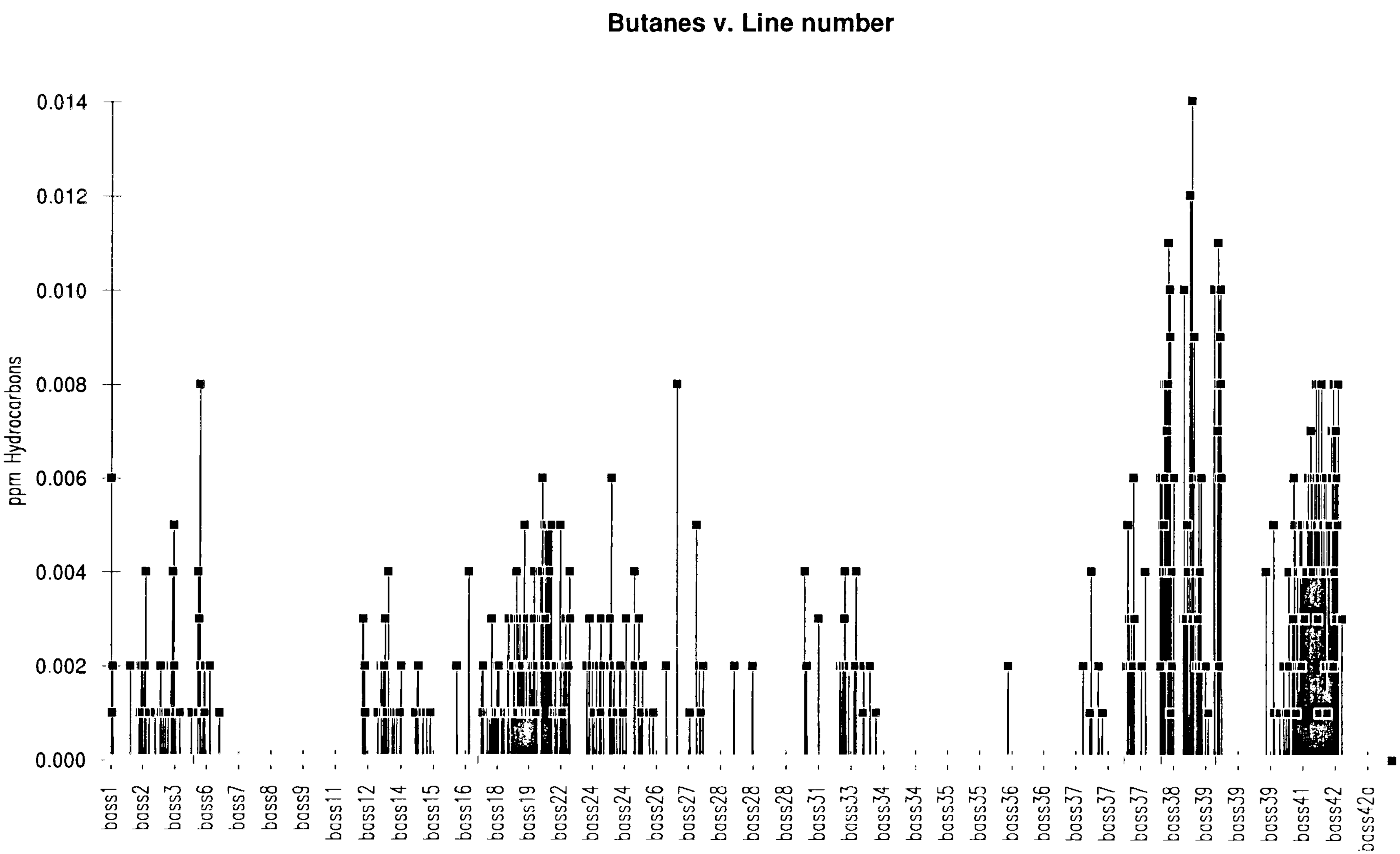
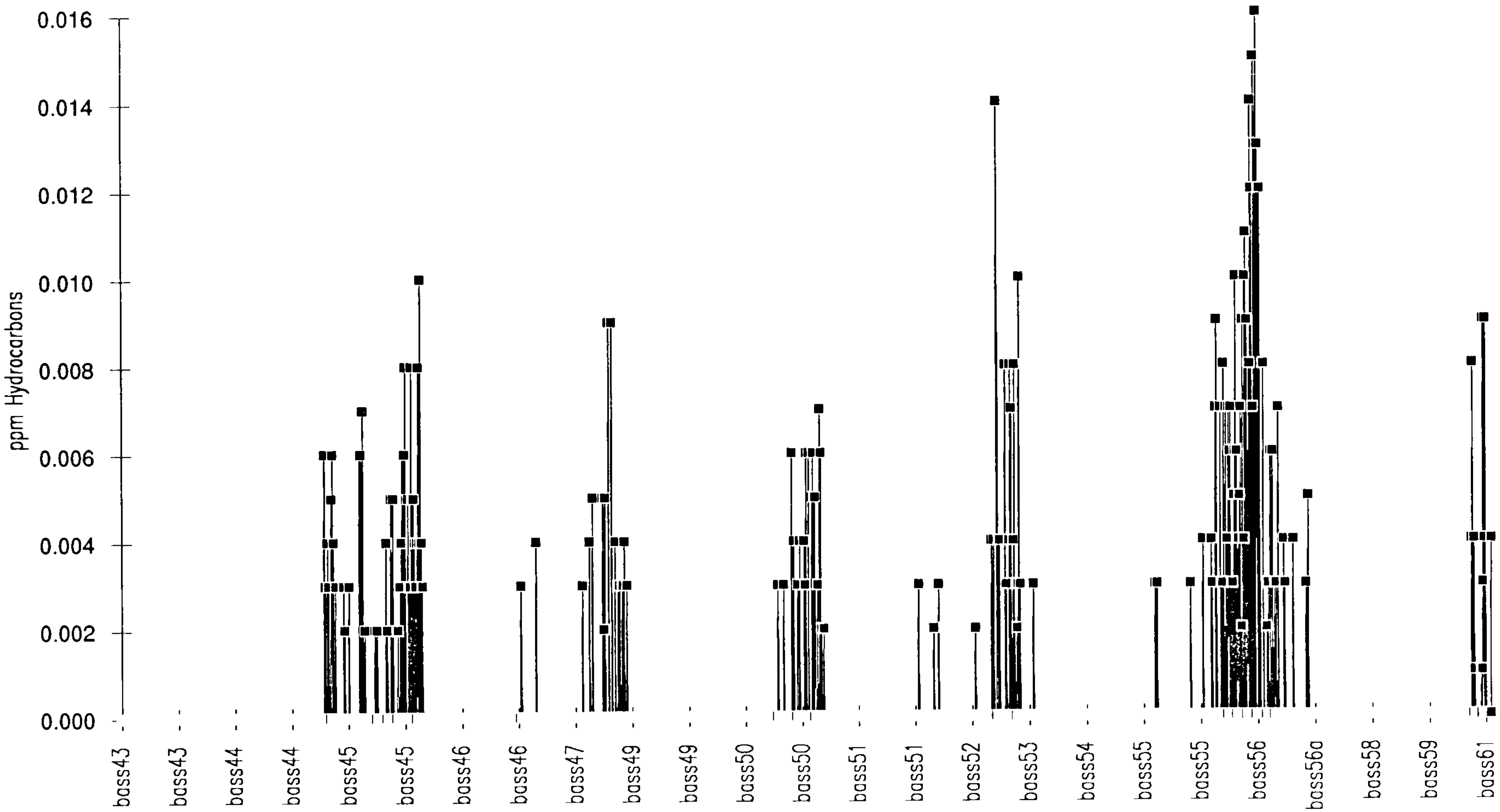


Figure 15h. Butanes along all of the survey lines in the Bass Basin.

Butanes v. Line number



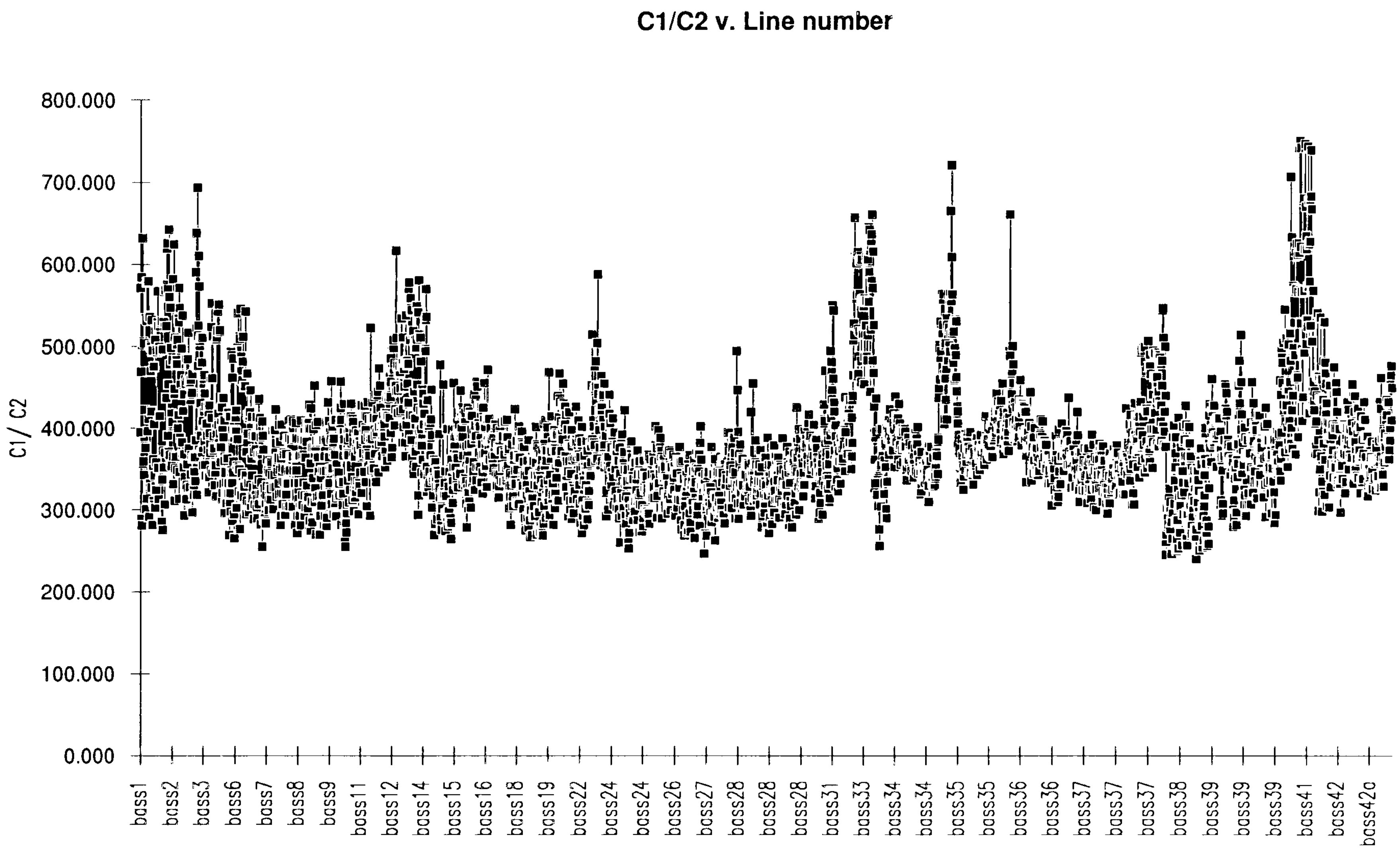
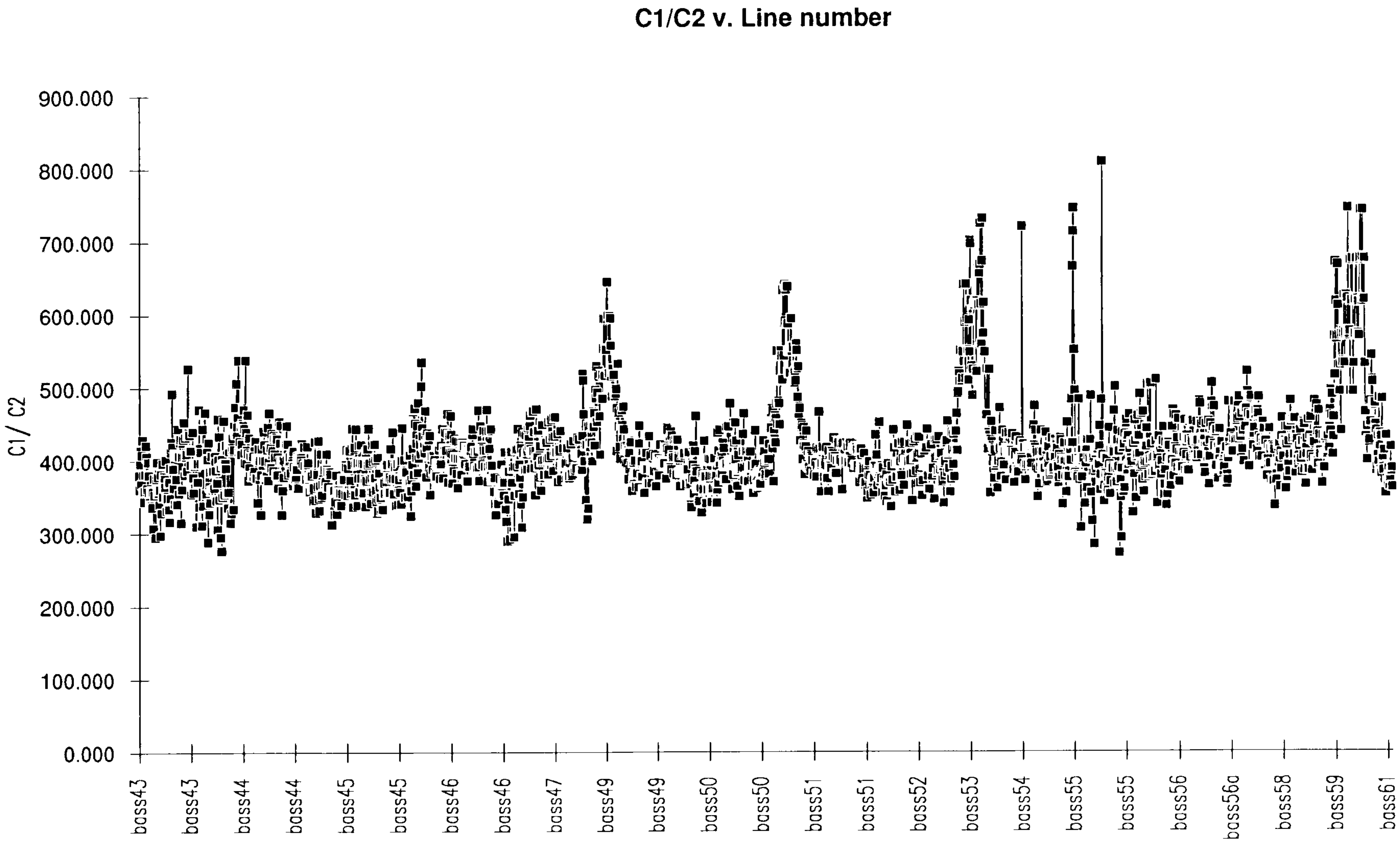


Figure 15j. C1/C2 along all of the survey lines in the Bass Basin.


C1/C2 v. Line number
C1 / C2
900.000
800.000
700.000
600.000
500.000
400.000
300.000
200.000
100.000
0.000
bass43
bass43
bass44
bass44
bass45
bass45
bass46
bass46
bass47
bass49
bass49
bass50
bass50
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bass56a
bass58
bass59
bass61

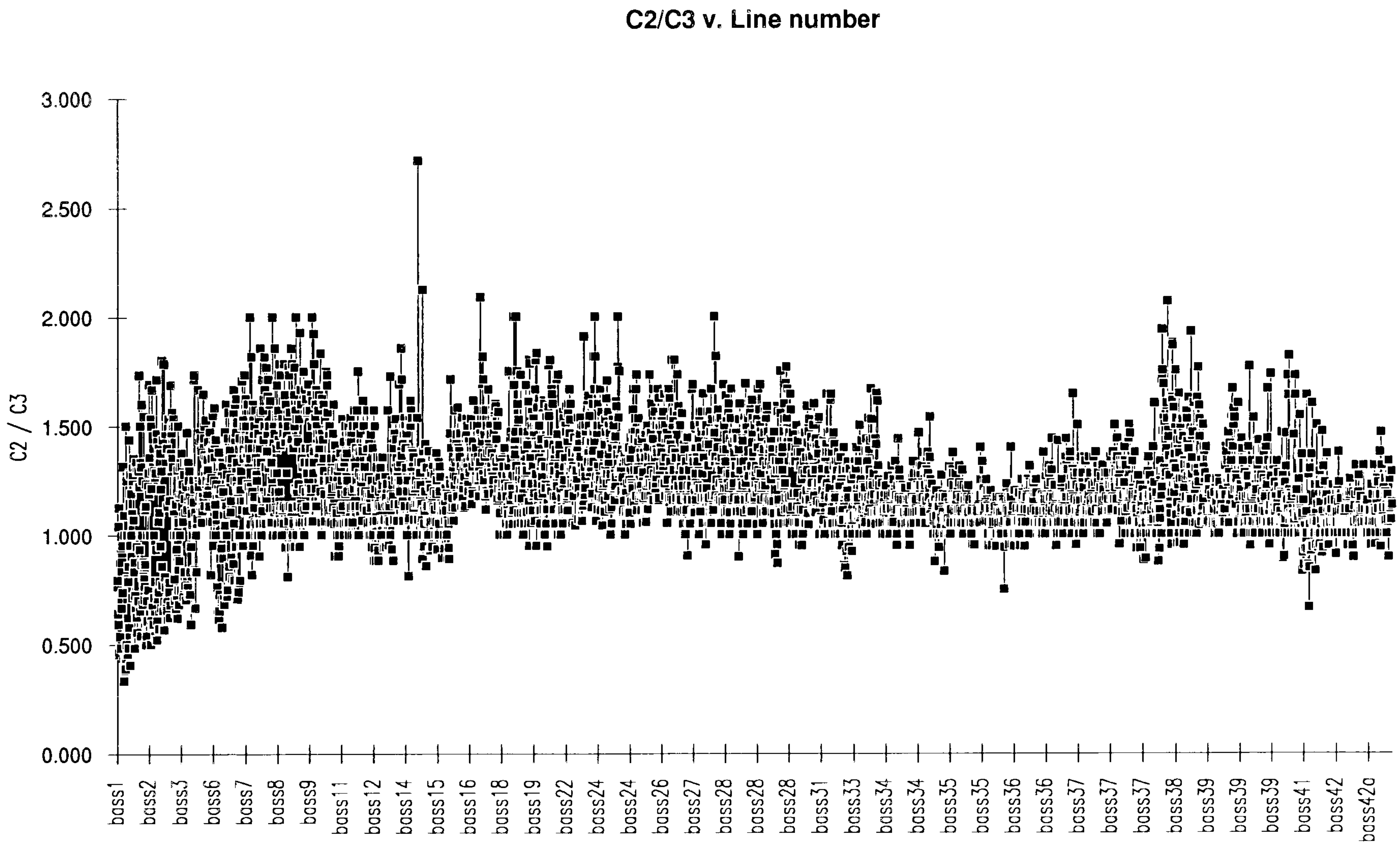
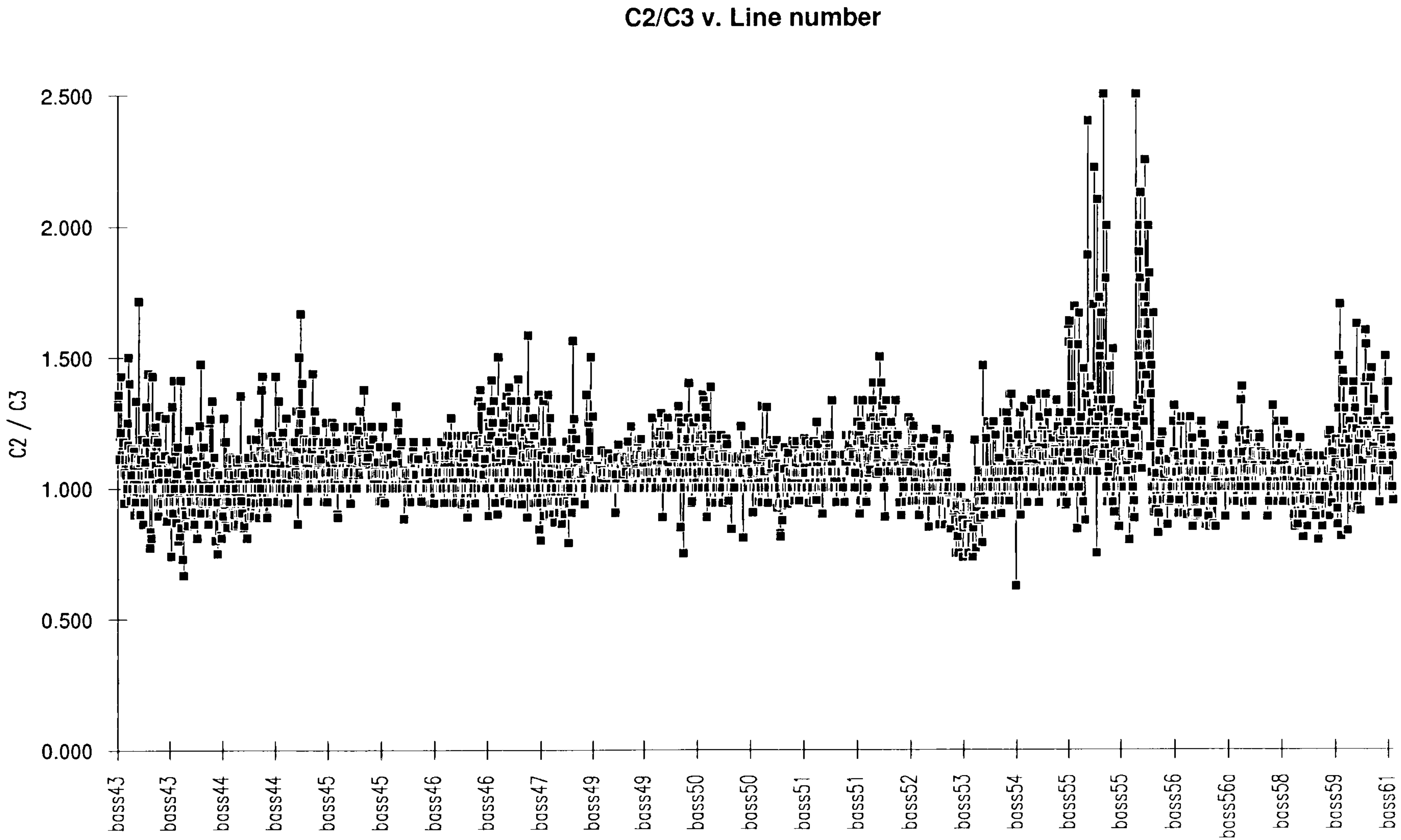


Figure 15k. C2/C3 along all of the survey lines in the Bass Basin.


C2/C3 v. Line number
C2 / C3
2.500
2.000
1.500
1.000
0.500
0.000
bass43
bass43
bass44
bass44
bass45
bass45
bass46
bass46
bass47
bass49
bass49
bass50
bass50
bass51
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bass55
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bass56
bass56a
bass58
bass59
bass61

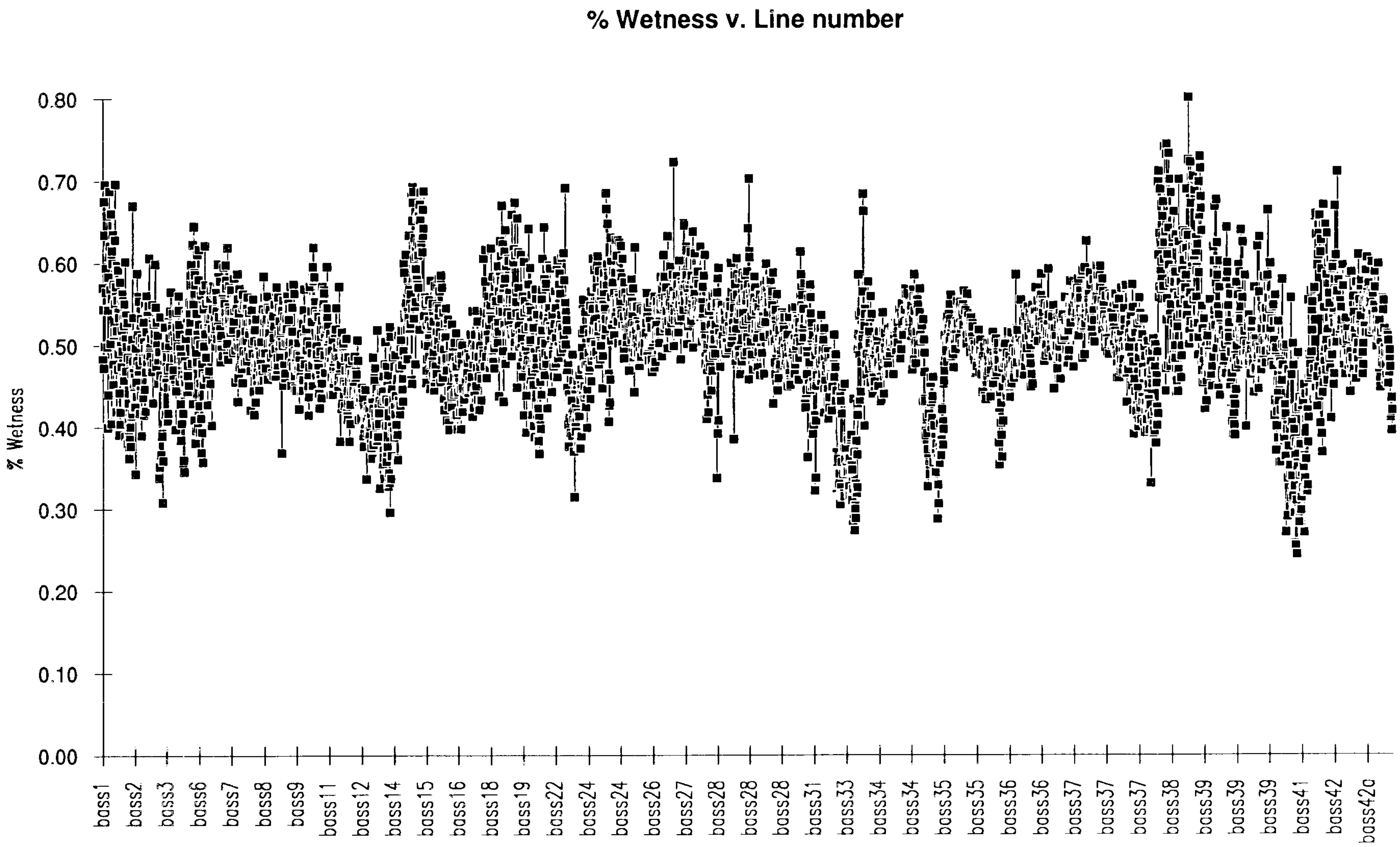
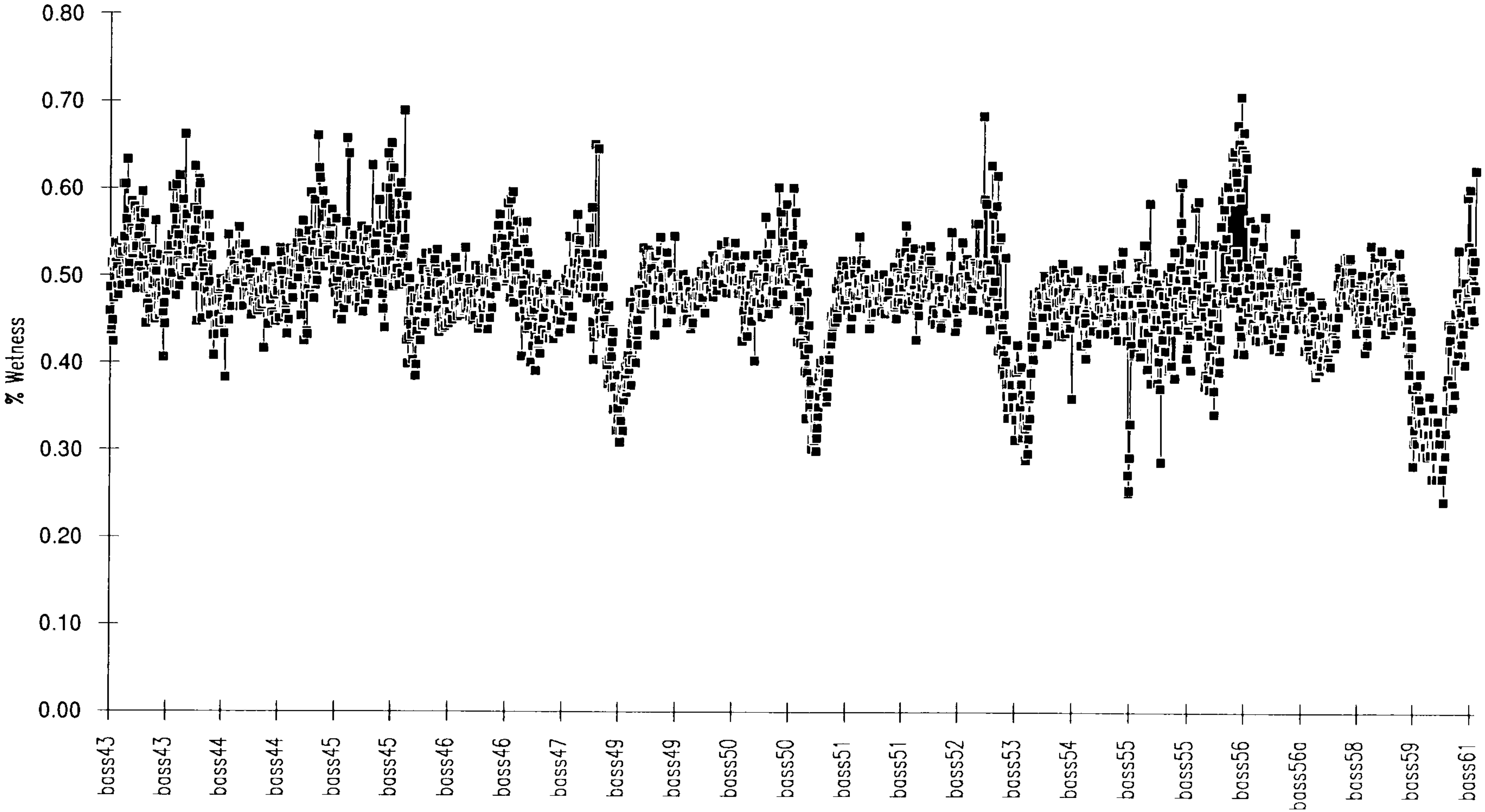


Figure 15l. Percent hydrocarbon wetness along all of the survey lines in the Bass Basin.

% Wetness v. Line number



TORQUAY SUB-BASIN PLOTS

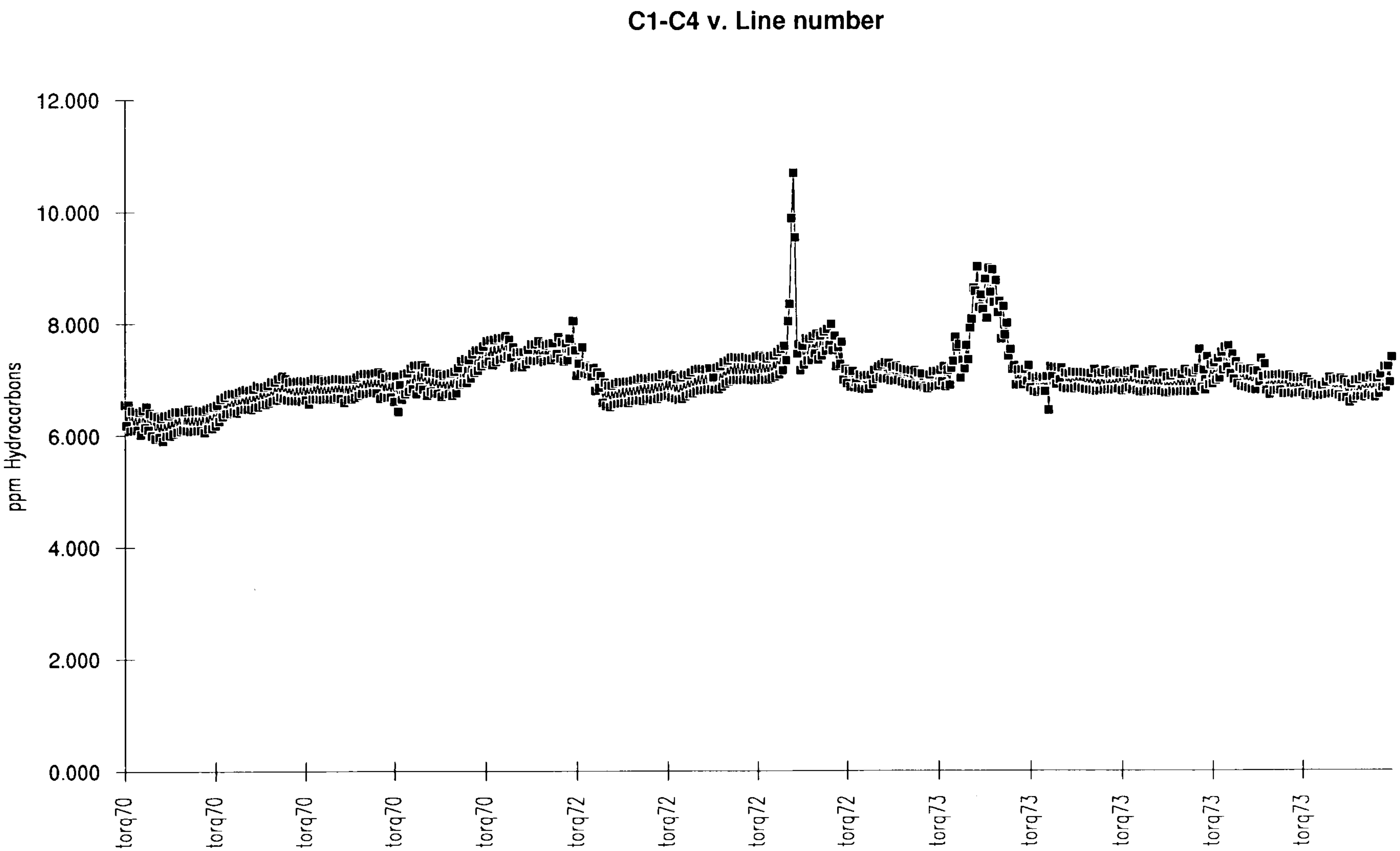


Figure 16a. Sum C1-C4 hydrocarbon concentration along the survey lines in the Torquay Sub-basin.

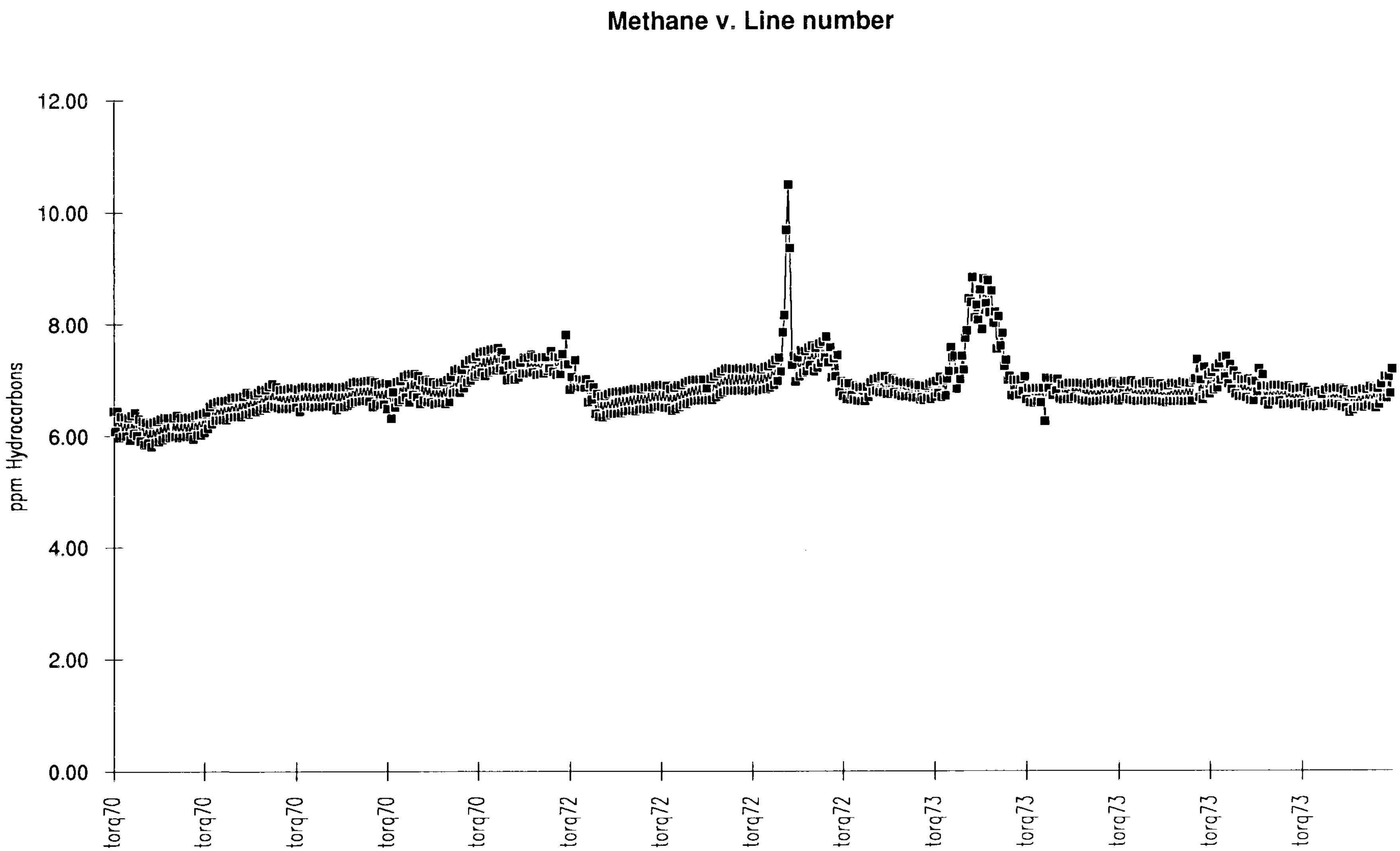


Figure 16b. Methane concentrations along the survey lines in the Torquay Sub-basin.

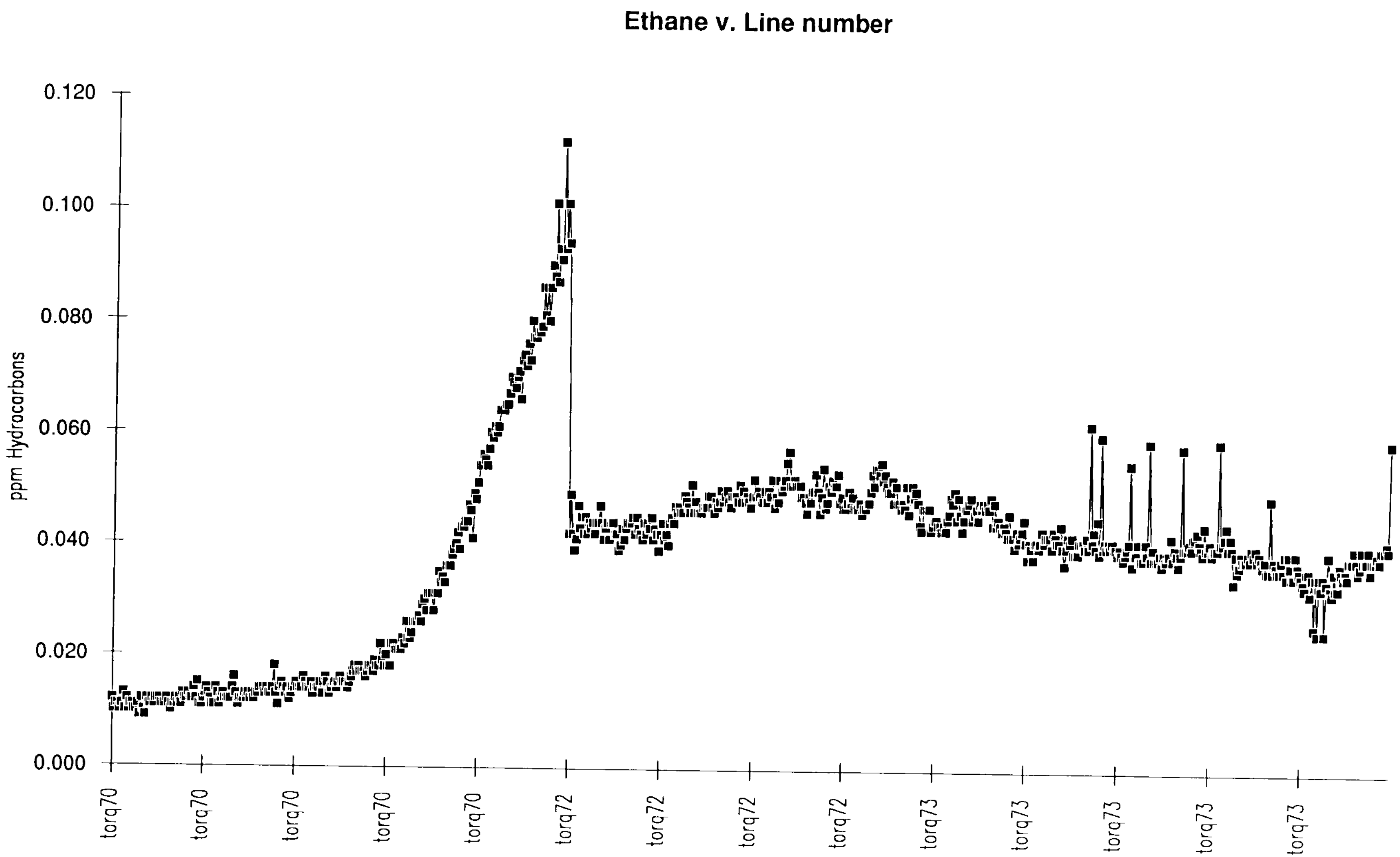


Figure 16c. Ethane concentrations along the survey lines in the Torquay Sub-basin.

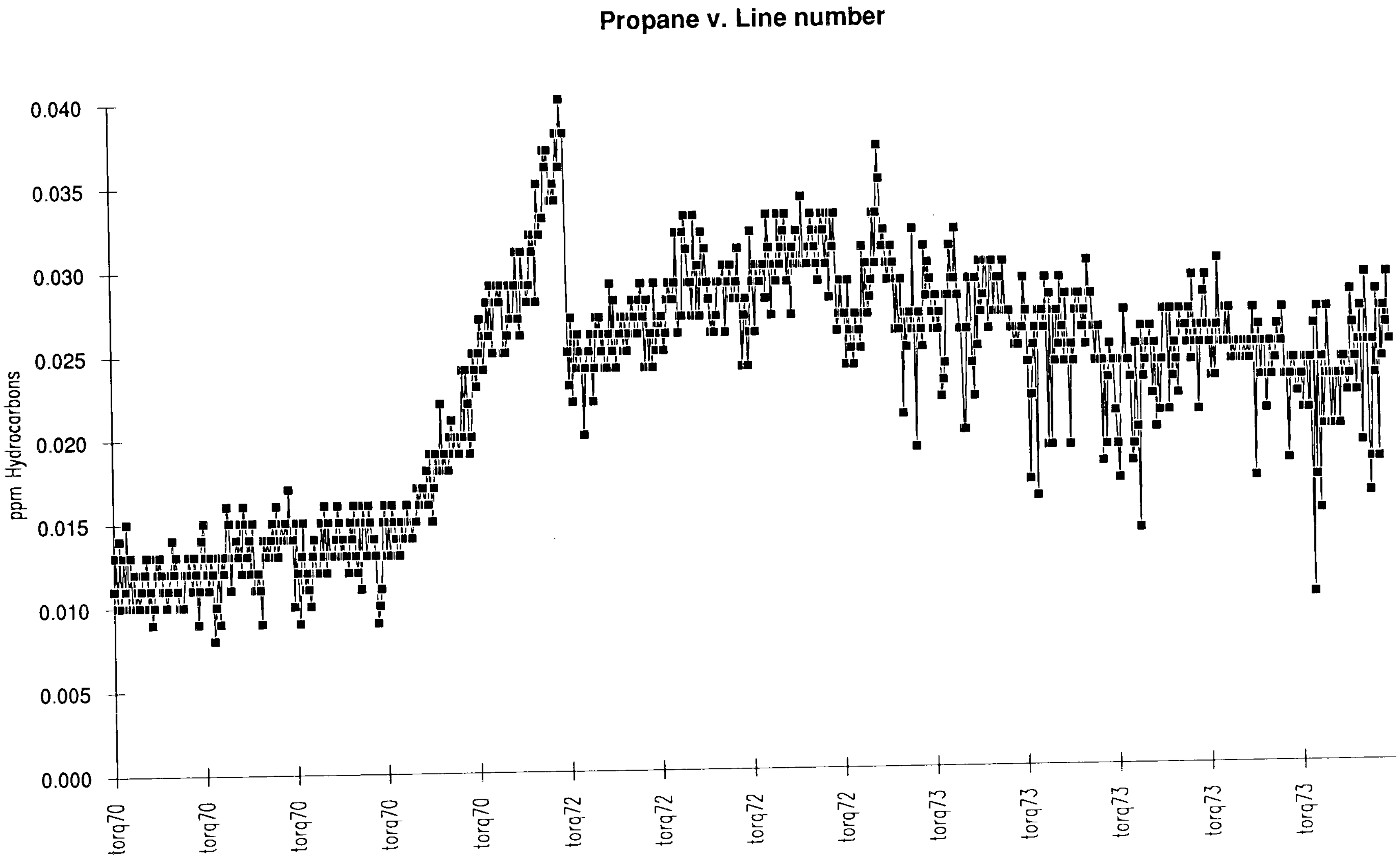


Figure 16d. Propane concentrations along the survey lines in the Torquay Sub-basin.

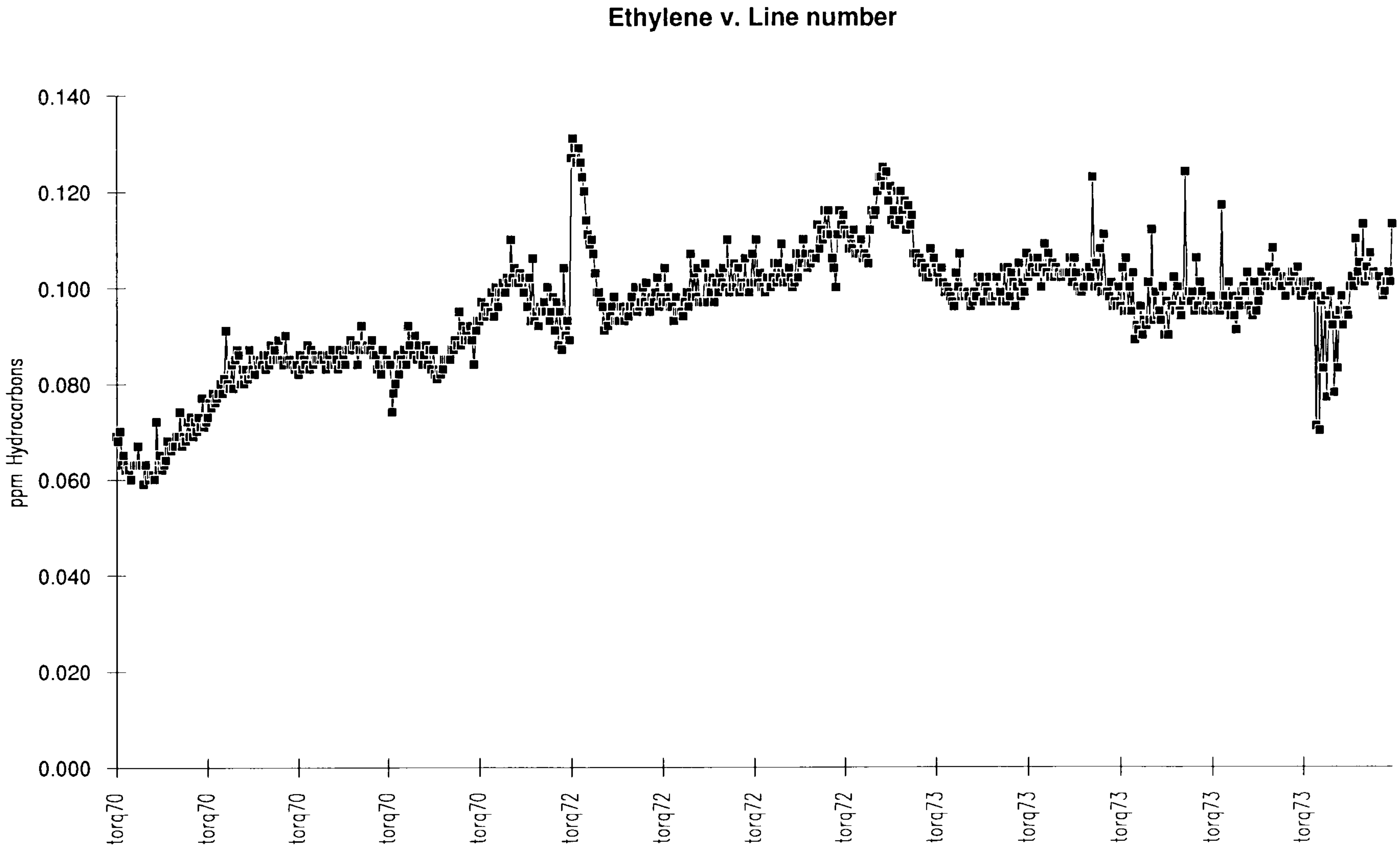


Figure 16e. Ethylene concentrations along the survey lines in the Torquay Sub-basin.

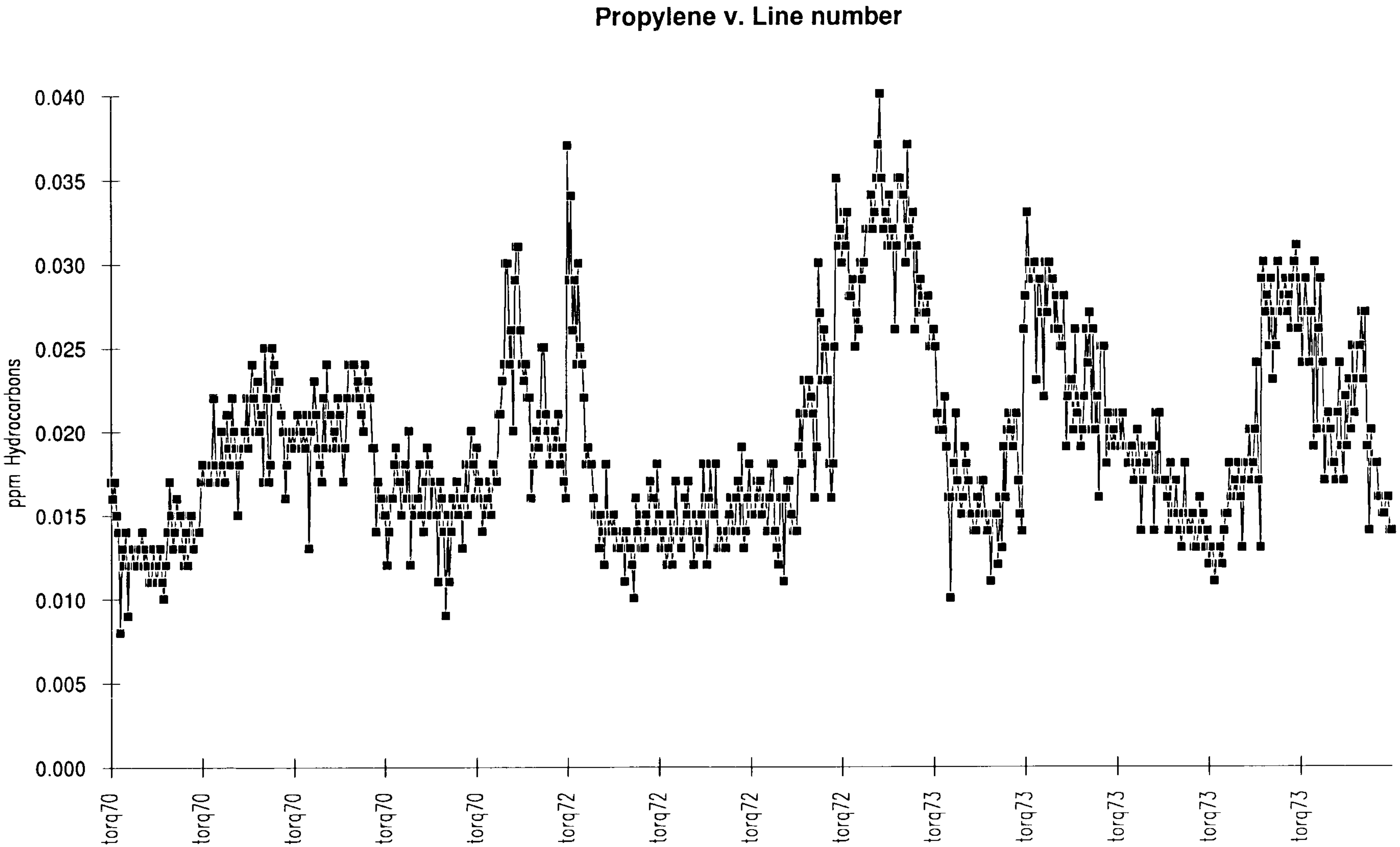


Figure 16f. Propylene concentrations along the survey lines in the Torquay Sub-basin.

Bernard Parameter v. Line number

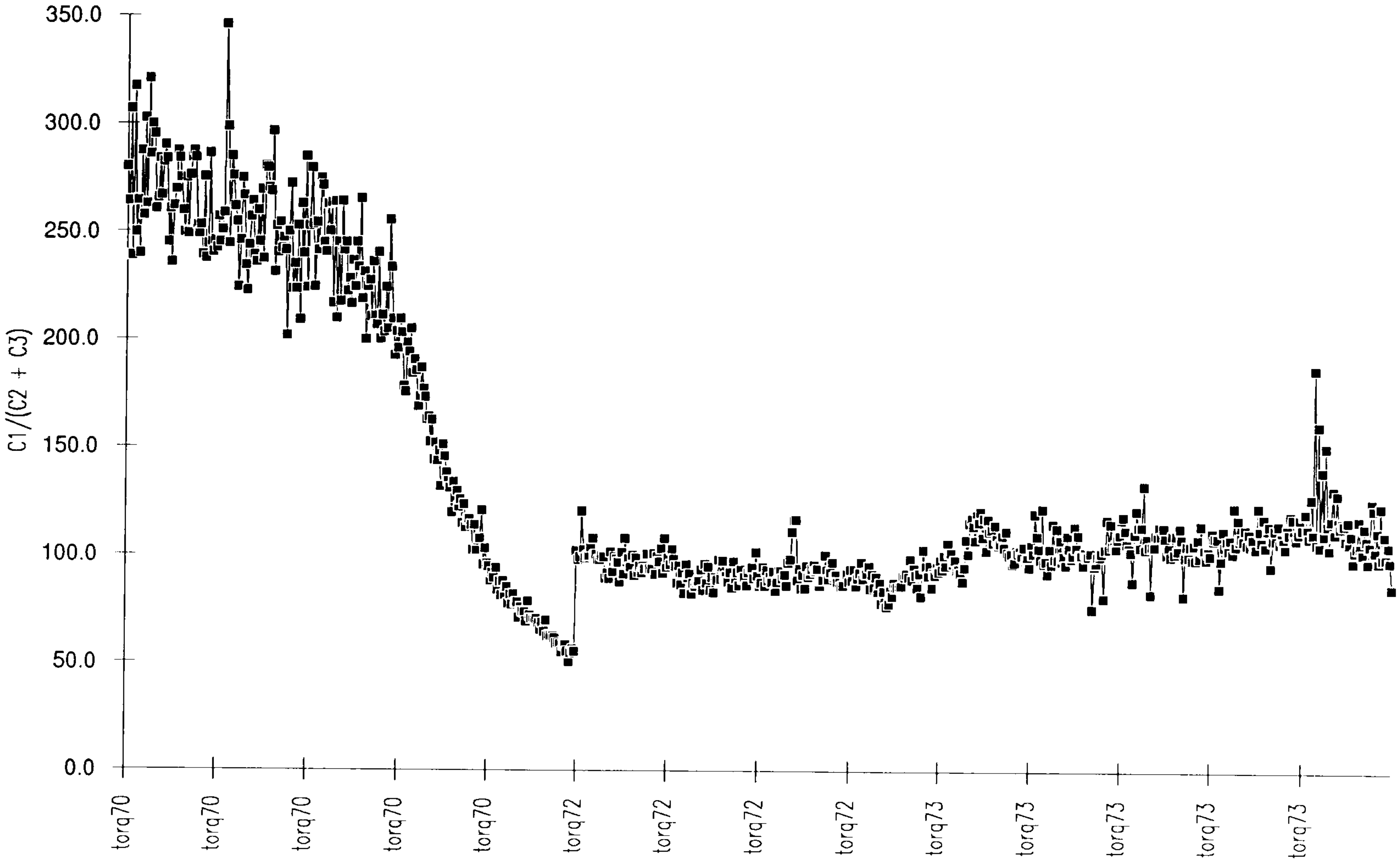


Figure 16g. Bernard Parameter along the survey lines in the Torquay Sub-basin.

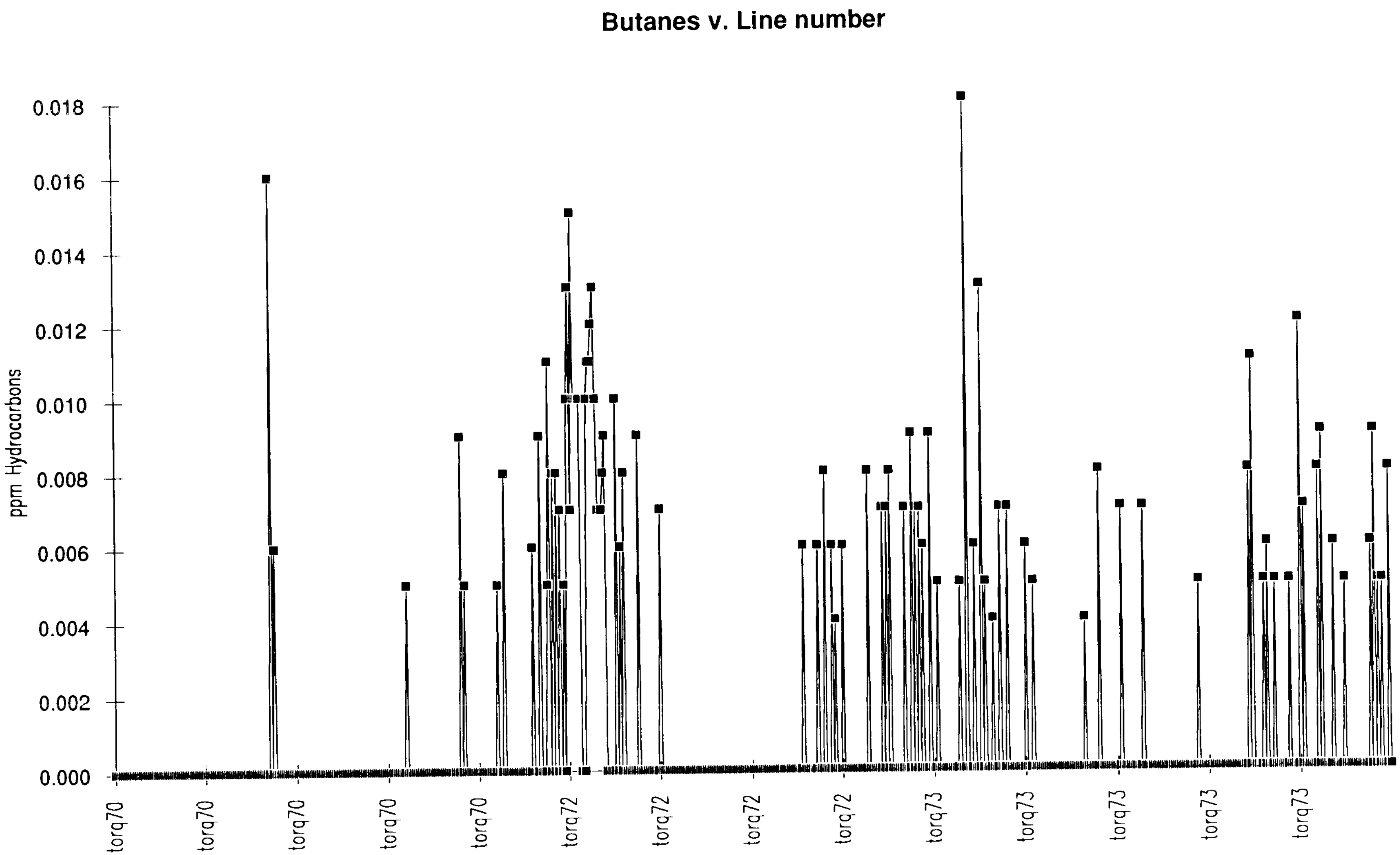


Figure 16h. Butanes along the survey lines in the Torquay Sub-basin.

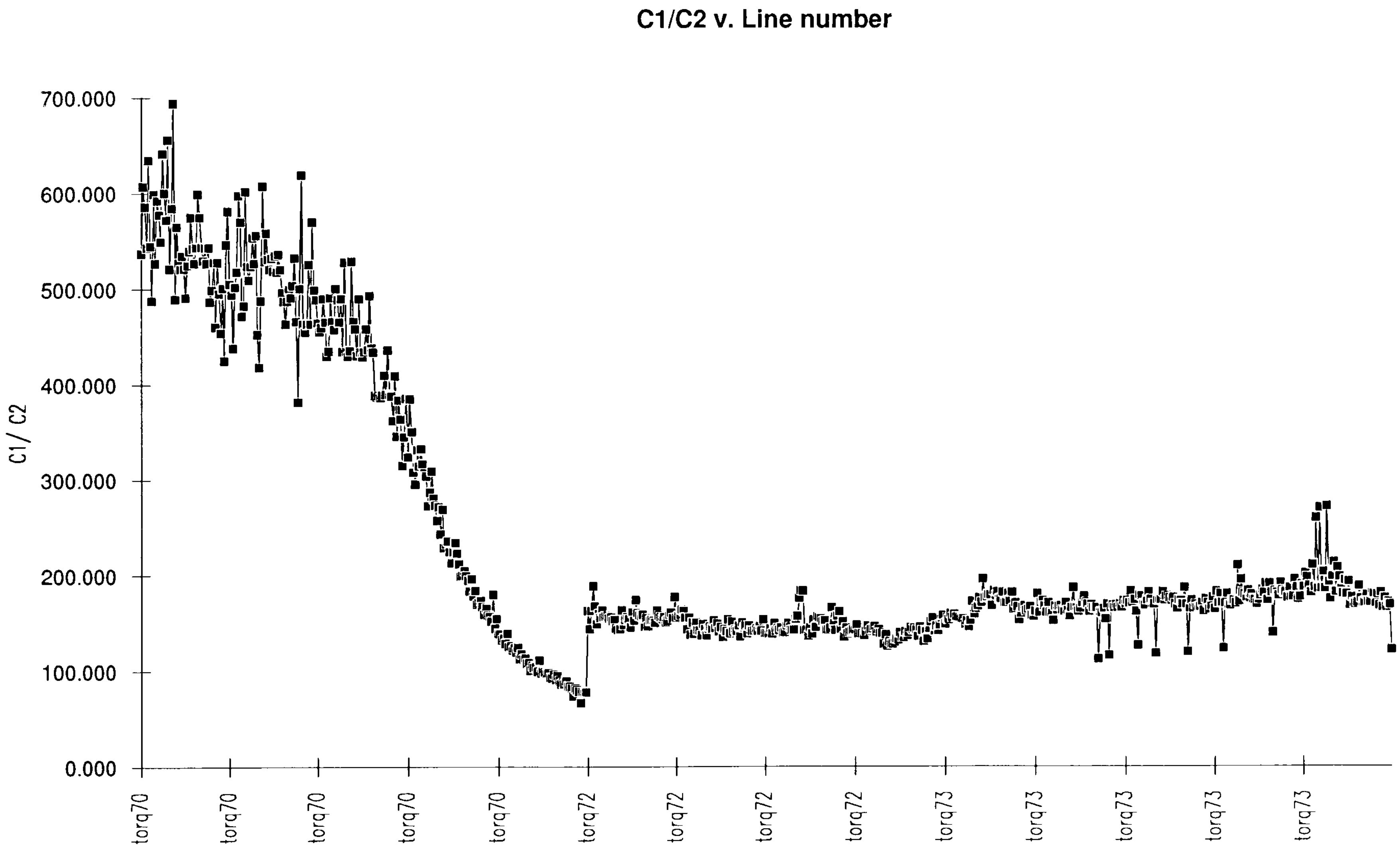


Figure 16j. C1/C2 along the survey lines in the Torquay Sub-basin.

C2/C3 v. Line number

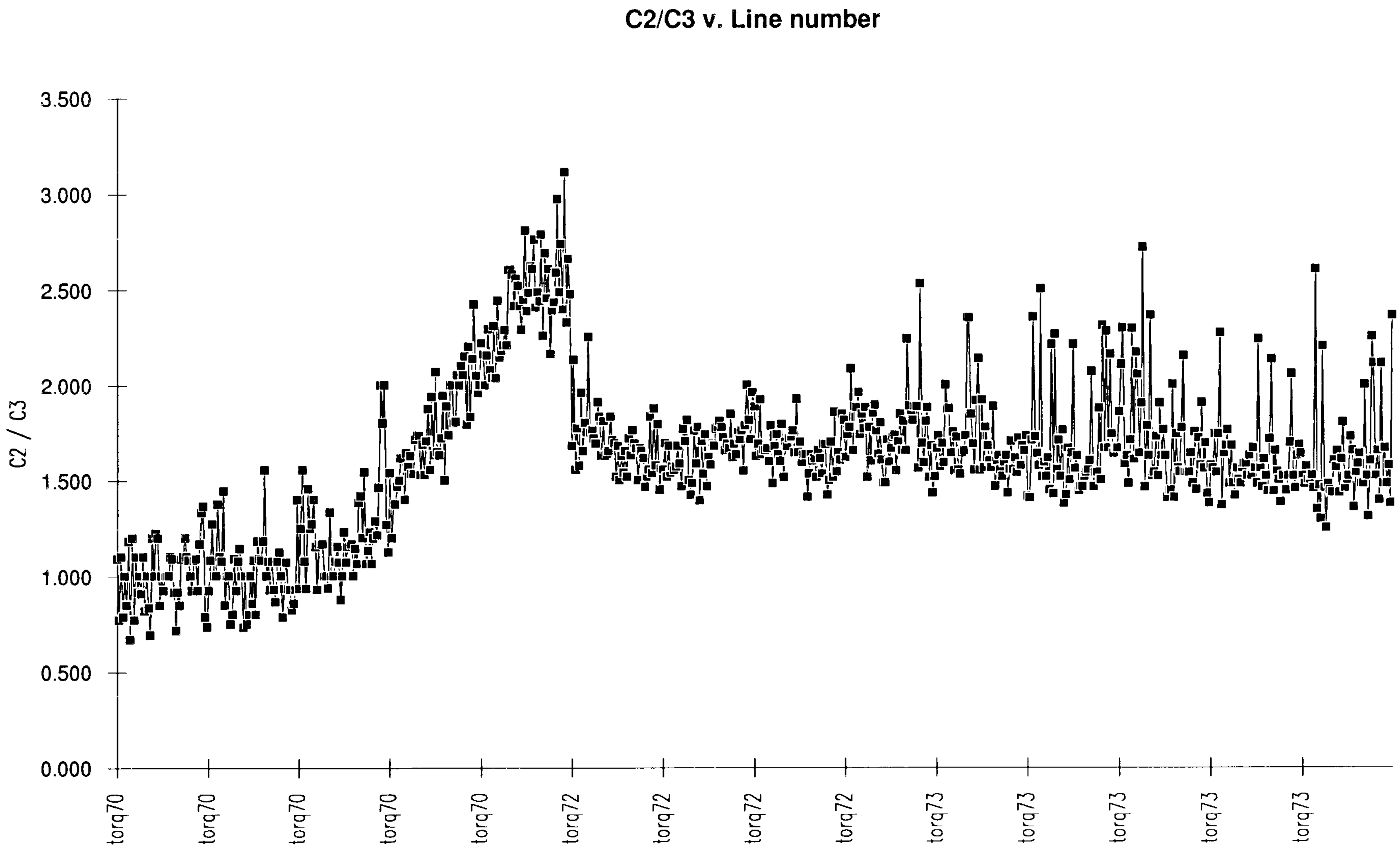


Figure 16k. C2/C3 along the survey lines in the Torquay Sub-basin.

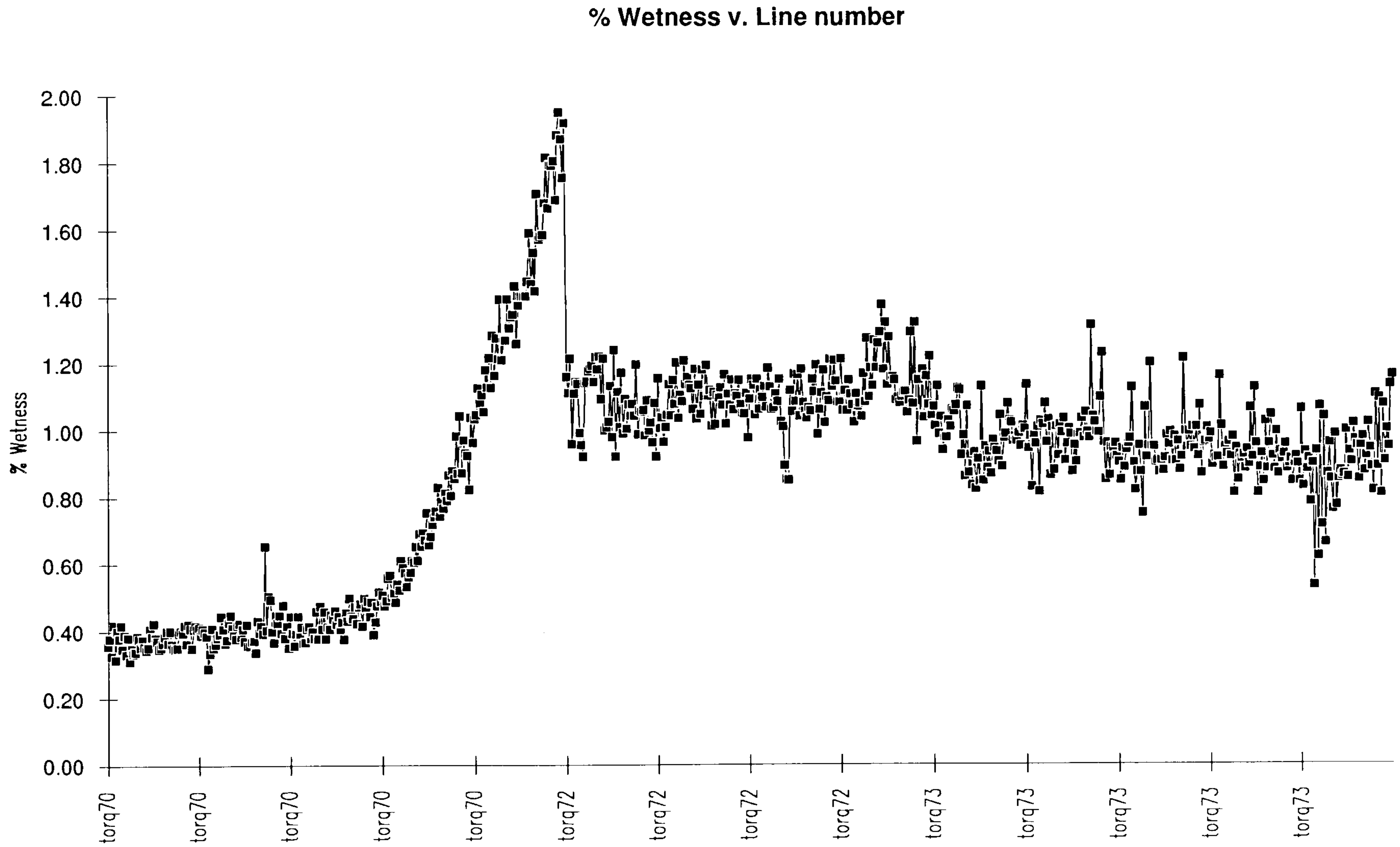


Figure 16l. Percent hydrocabon wetness along all of the survey lines in the Torquay Sub-basin.

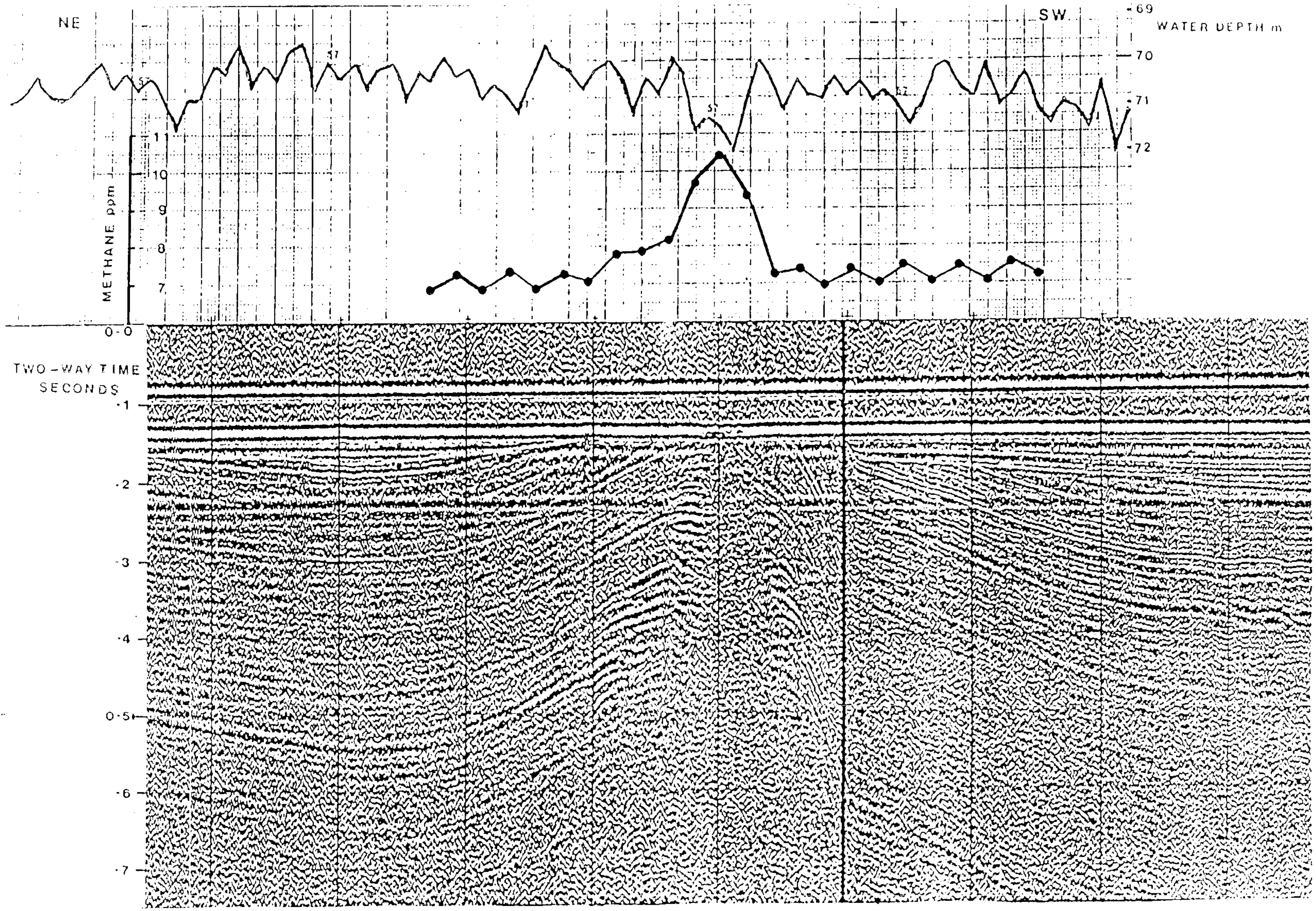


Figure 16m. Methane concentration, seafloor bathymetry and the high resolution seismic record in the vicinity of the intersection of survey Lines Torq 70 and 72.

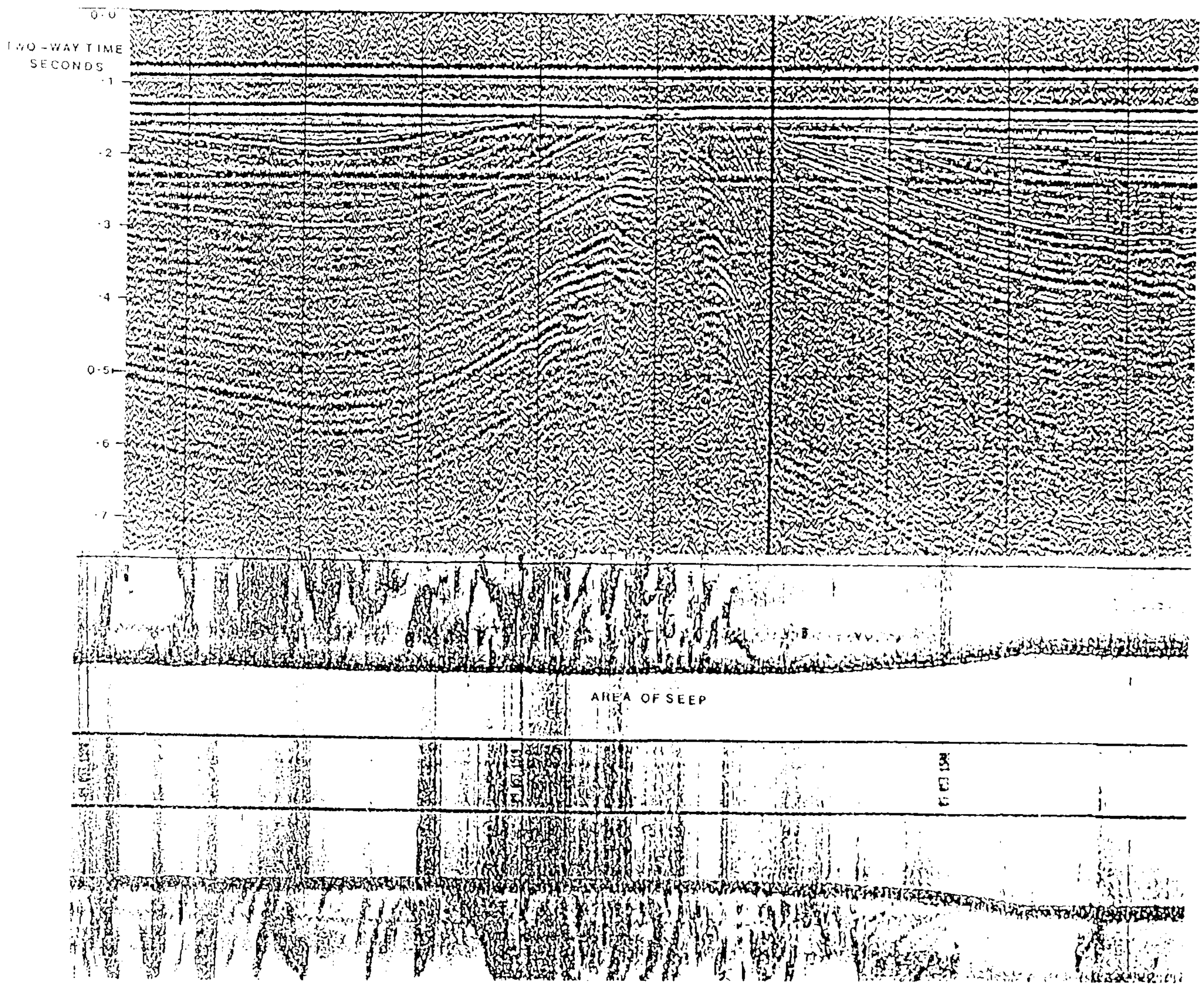


Figure 16n. The high resolution seismic record and the side scan sonar record in the area of the bottom-water geochemical anomaly.

OTWAY BASIN PLOTS

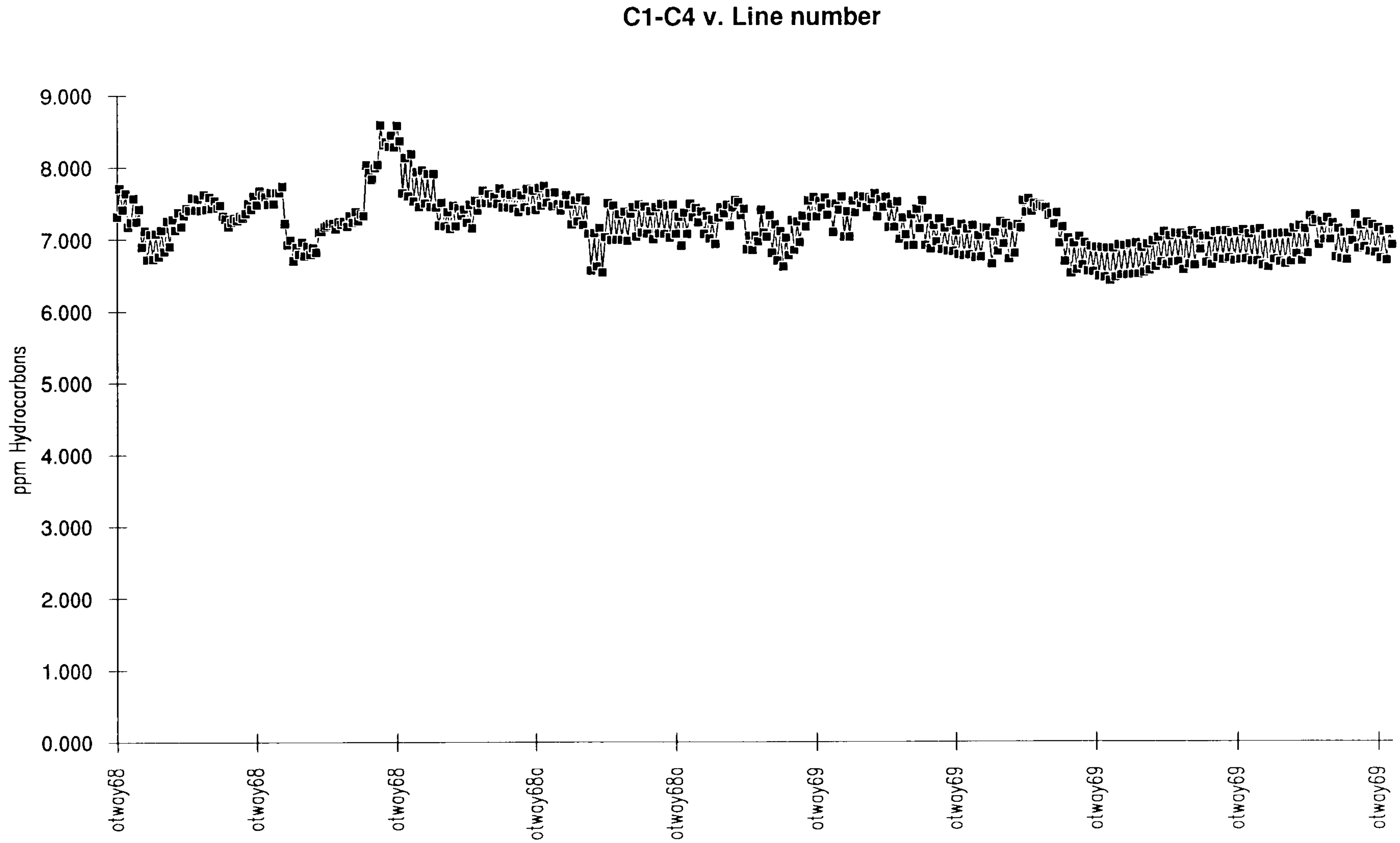


Figure 17a. Sum C1-C4 hydrocarbon concentration along the survey lines in the Otway Basin.

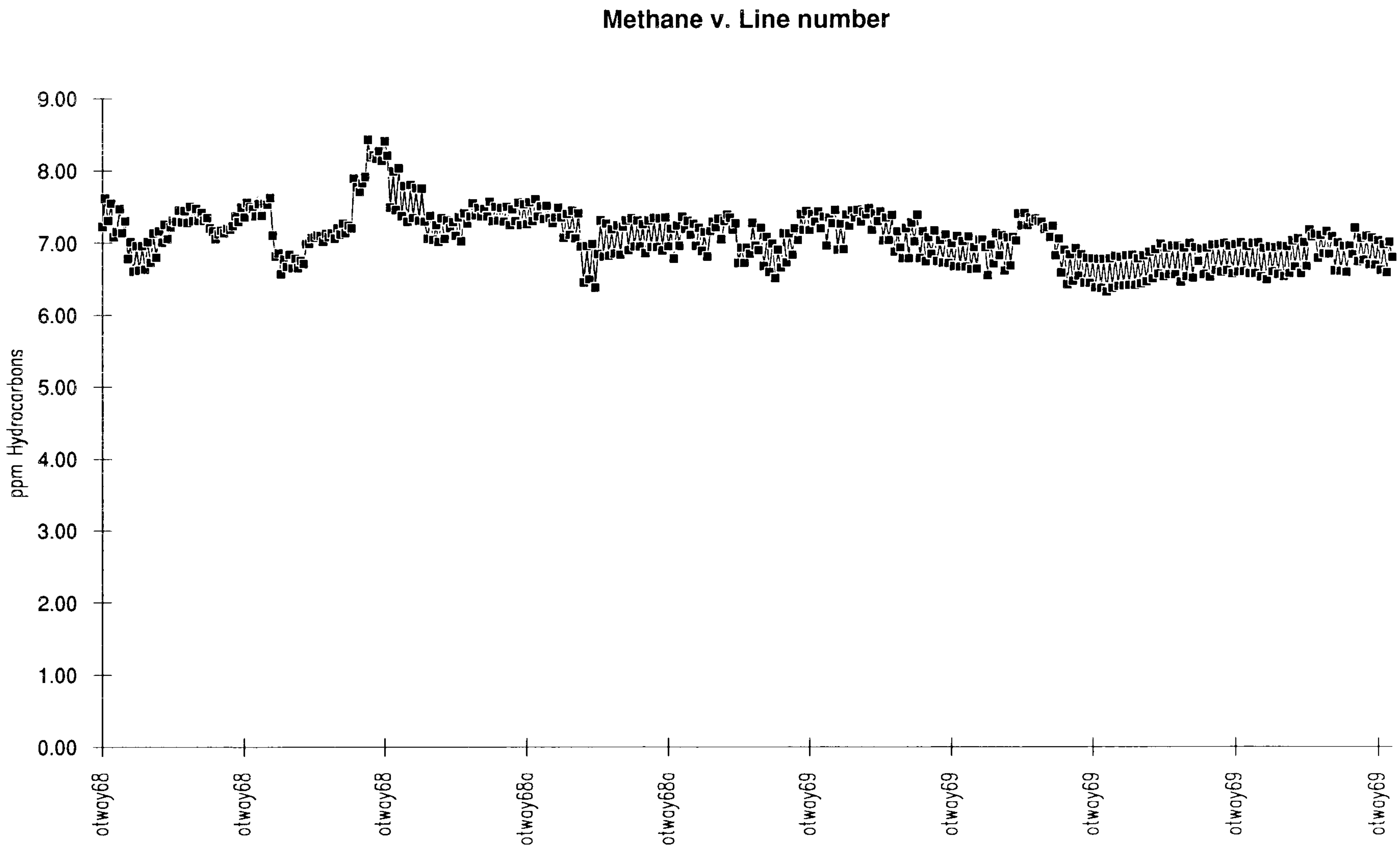


Figure 17b. Methane concentrations along the survey lines in the Otway Basin.

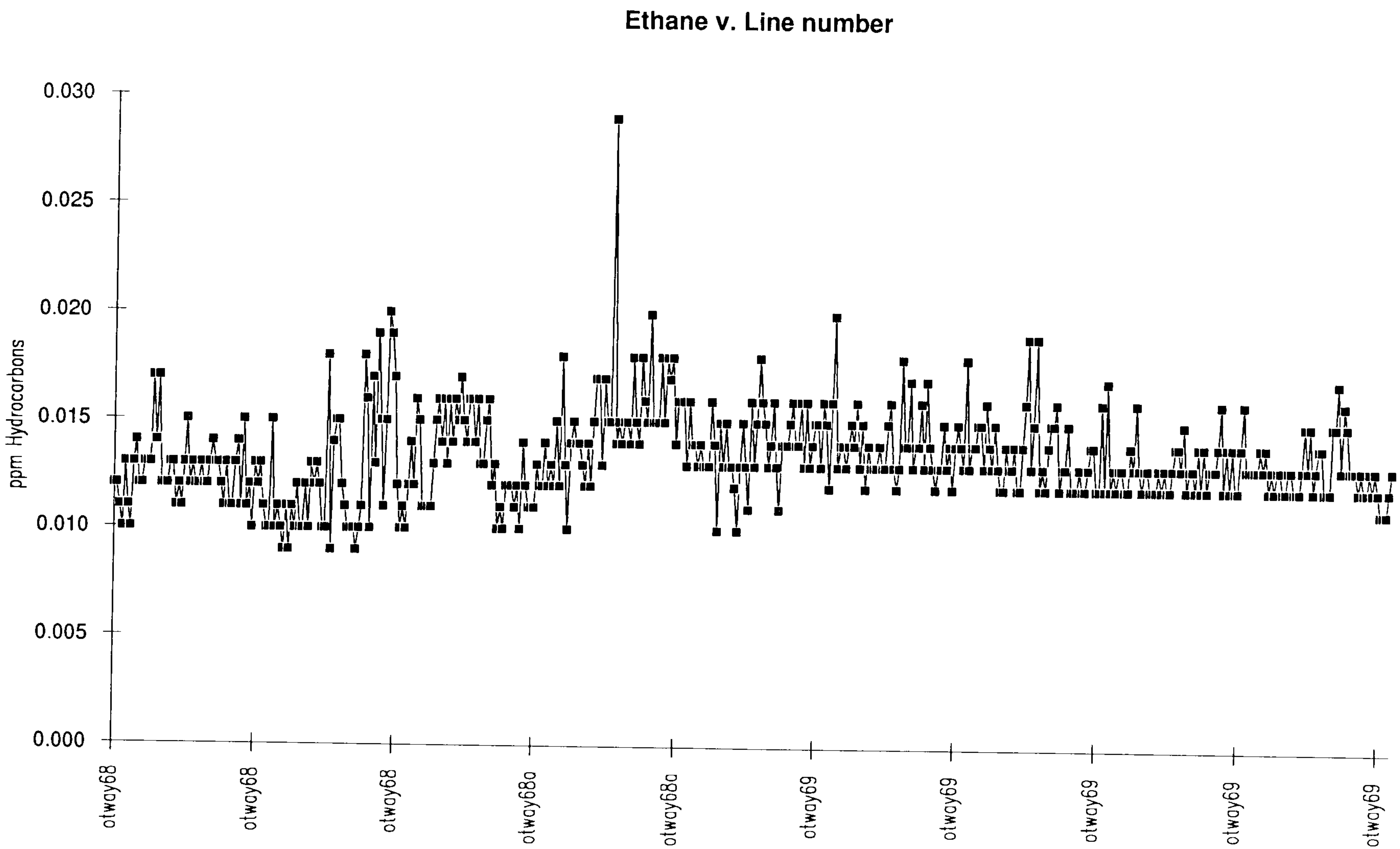


Figure 17c. Ethane concentrations along the survey lines in the Otway Basin.

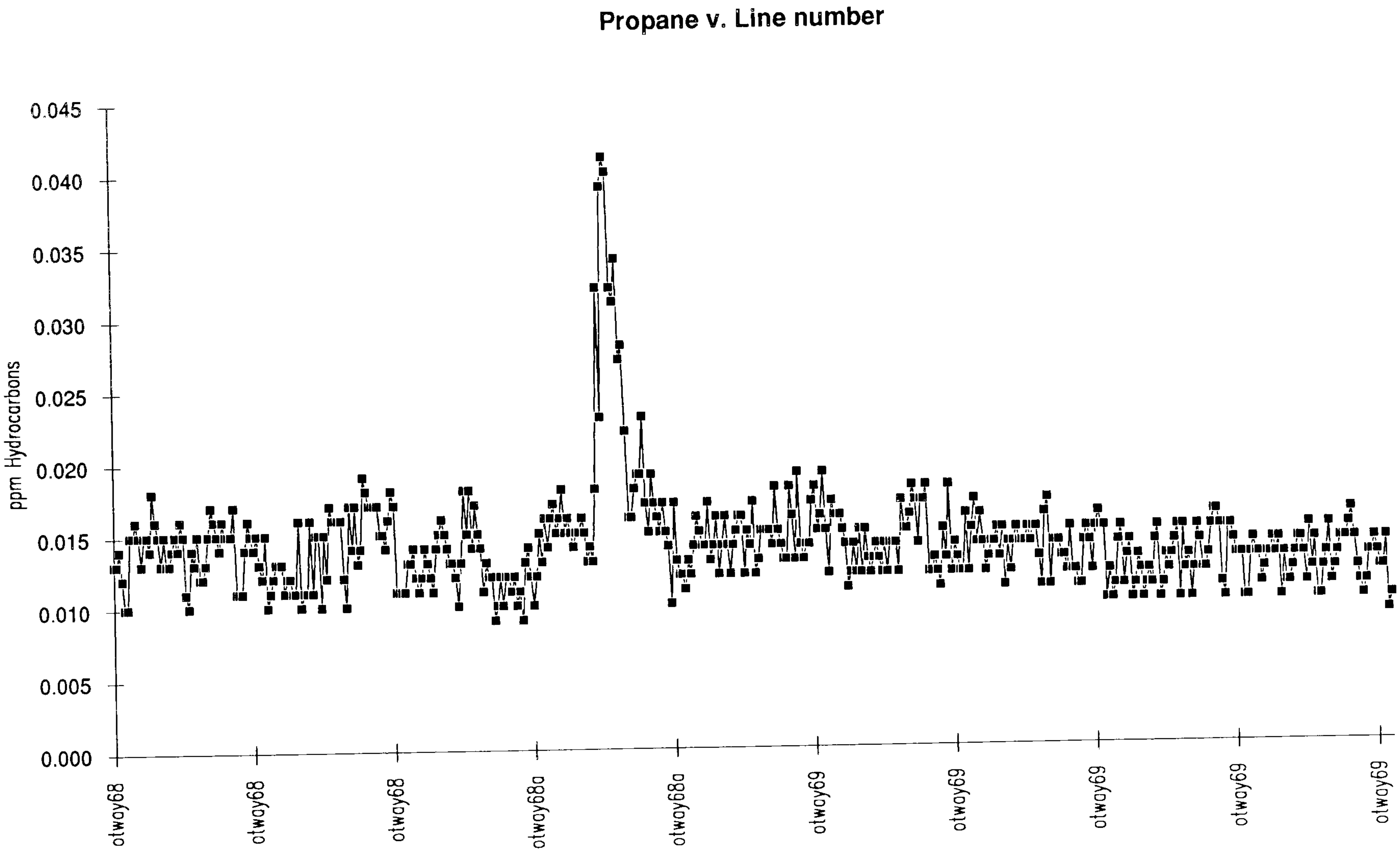


Figure 17d. Propane concentrations along the survey lines in the Otway Basin.

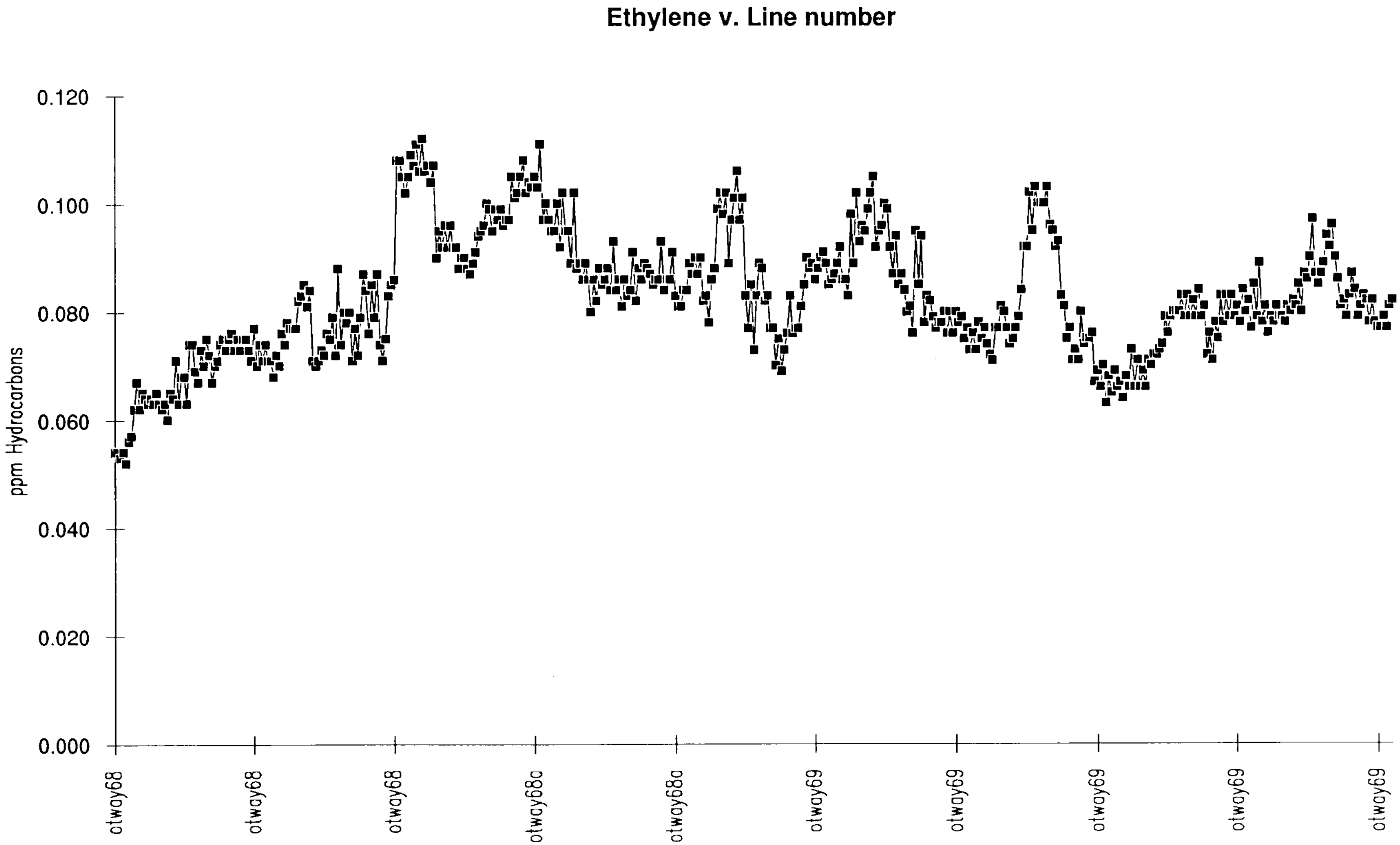


Figure 17e. Ethylene concentrations along the survey lines in the Otway Basin.

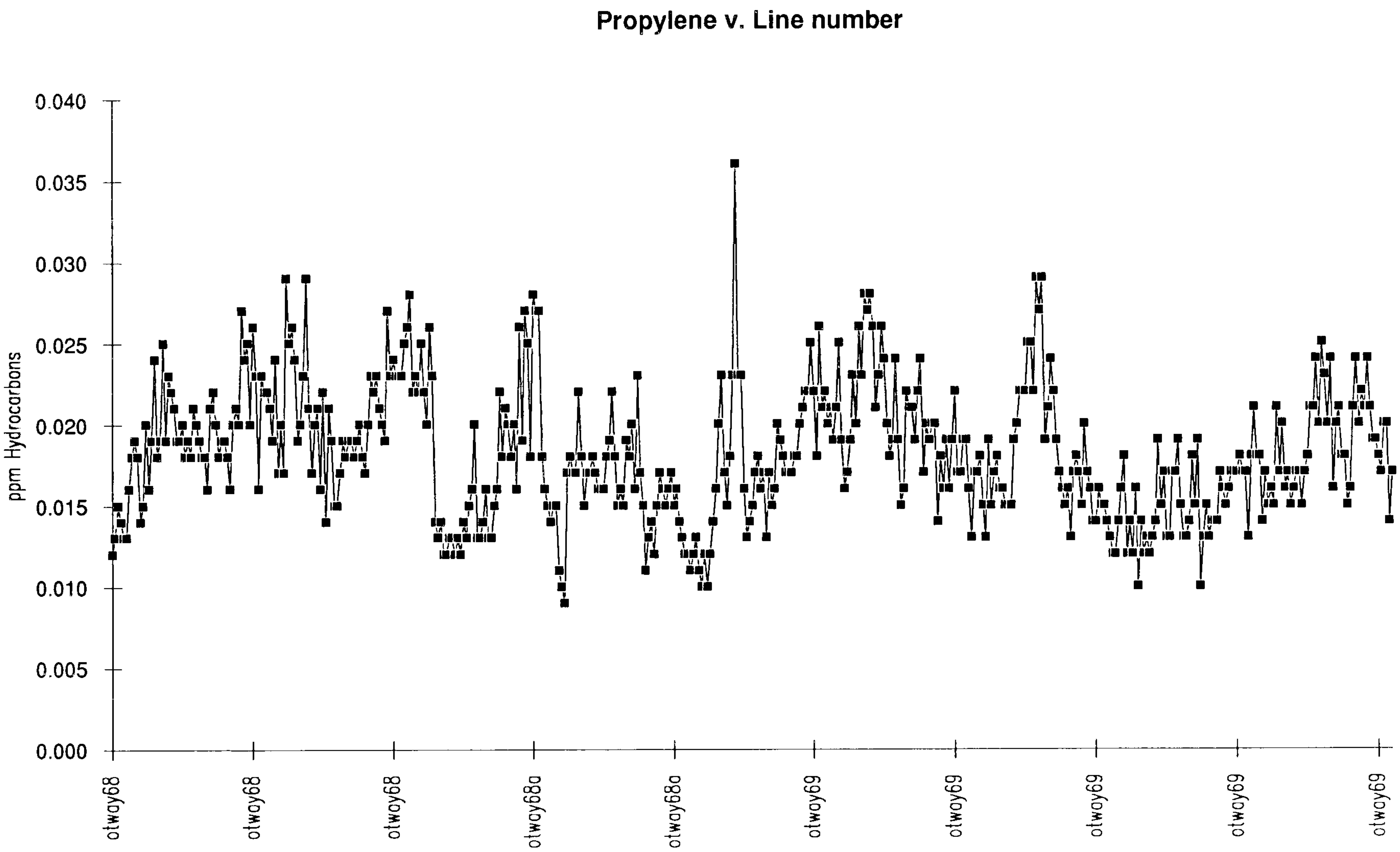


Figure 17f. Propylene concentrations along the survey lines in the Otway Basin.

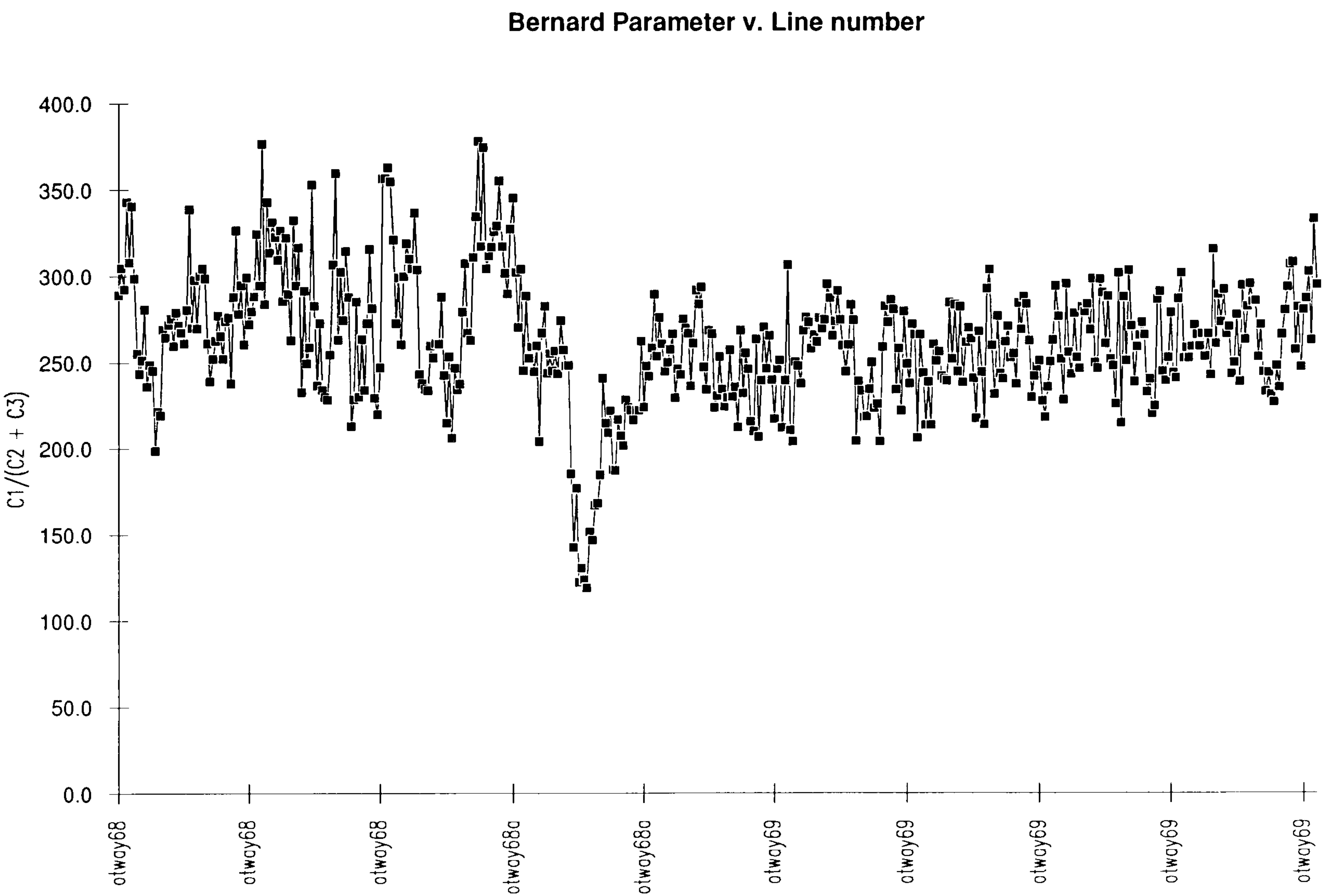


Figure 17g. Bernard Parameter along the survey lines in the Otway Basin.

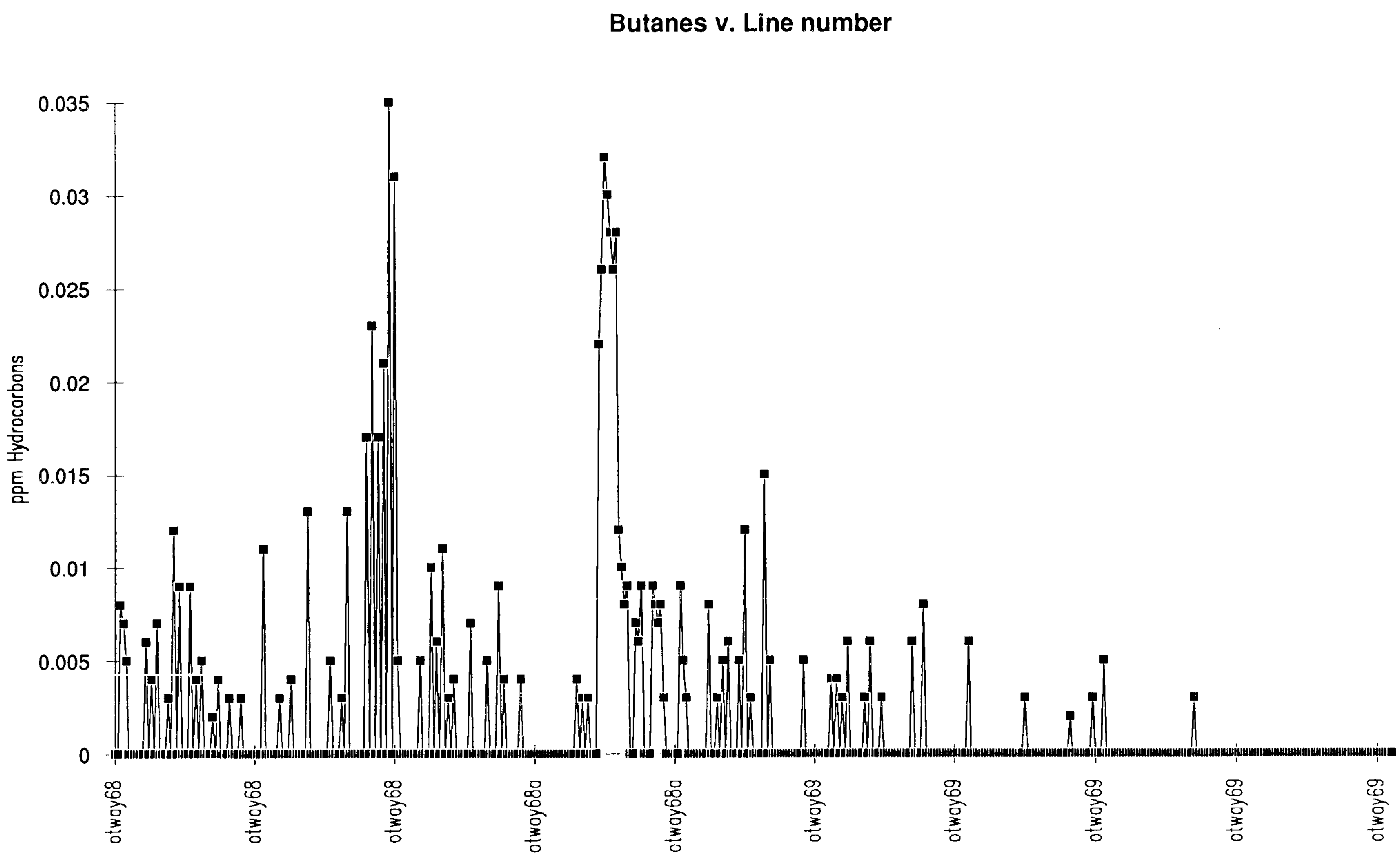


Figure 17h. Butane along the survey lines in the Otway Basin.

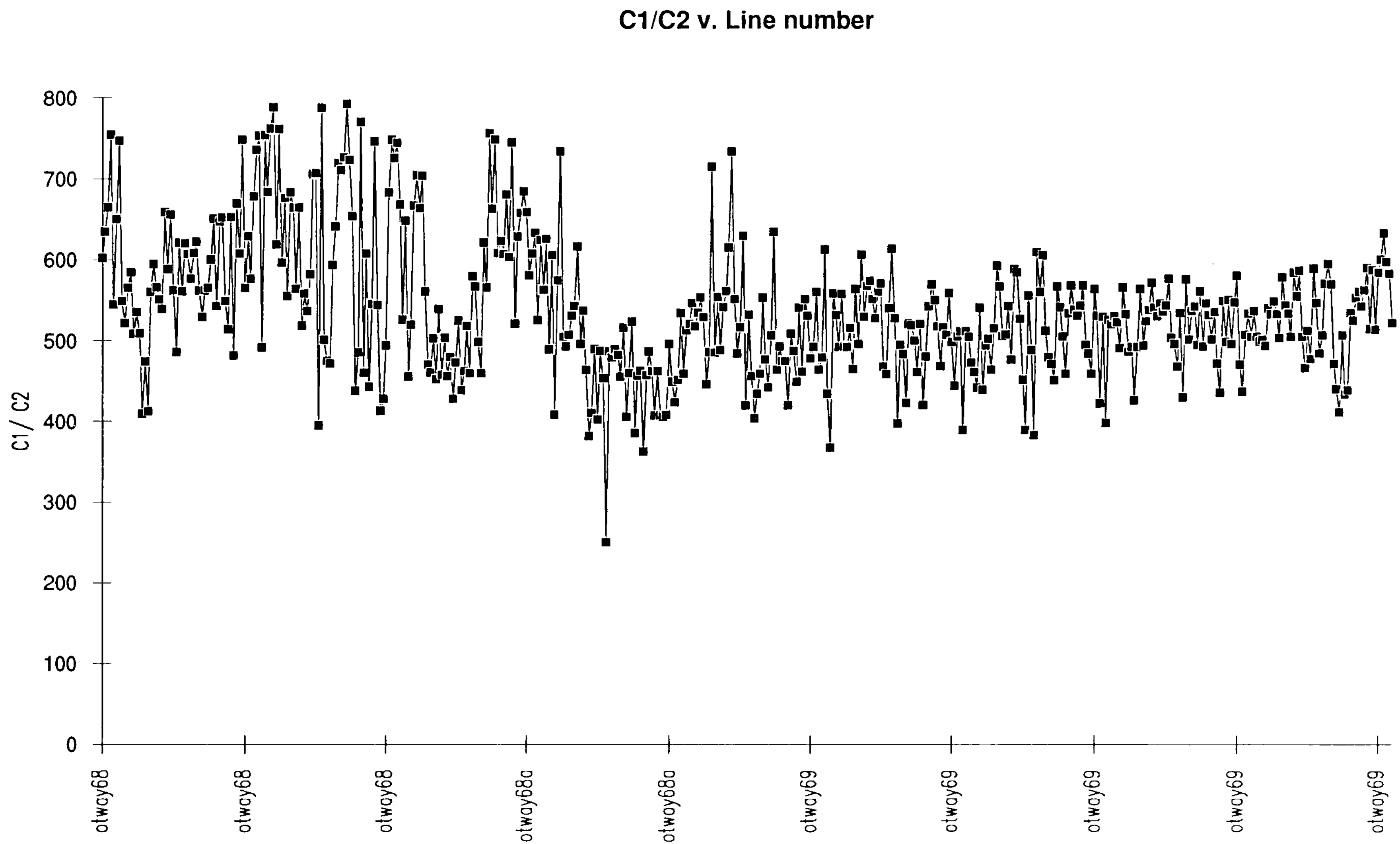


Figure 17j.C1/C2 along the survey lines in the Otway Basin.

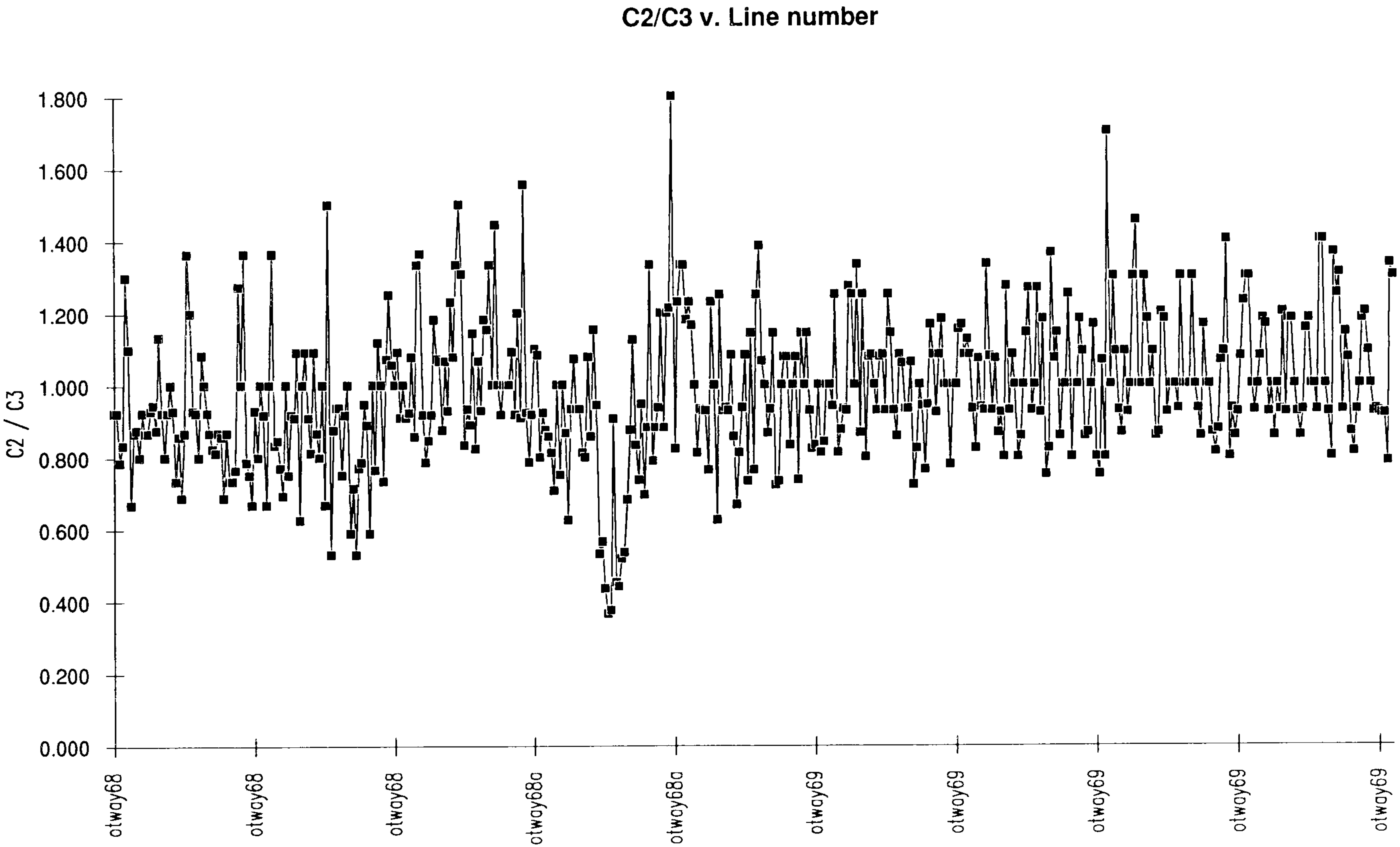


Figure 17k. C2/C3 along the survey lines in the Otway Basin.

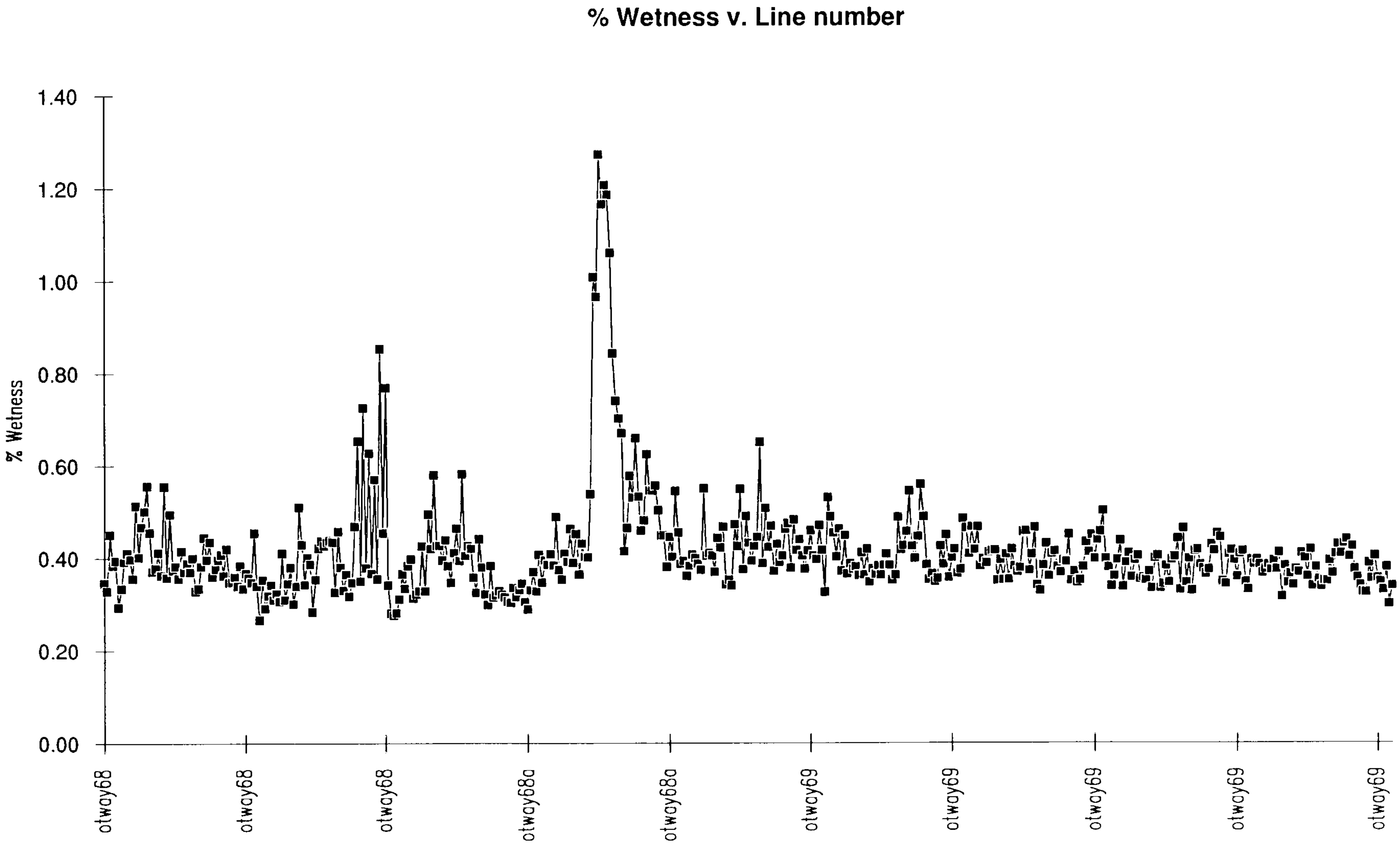


Figure 171. Percent hydrocarbon wetness along the survey lines in the Otway Basin.

STANSBURY BASIN PLOTS

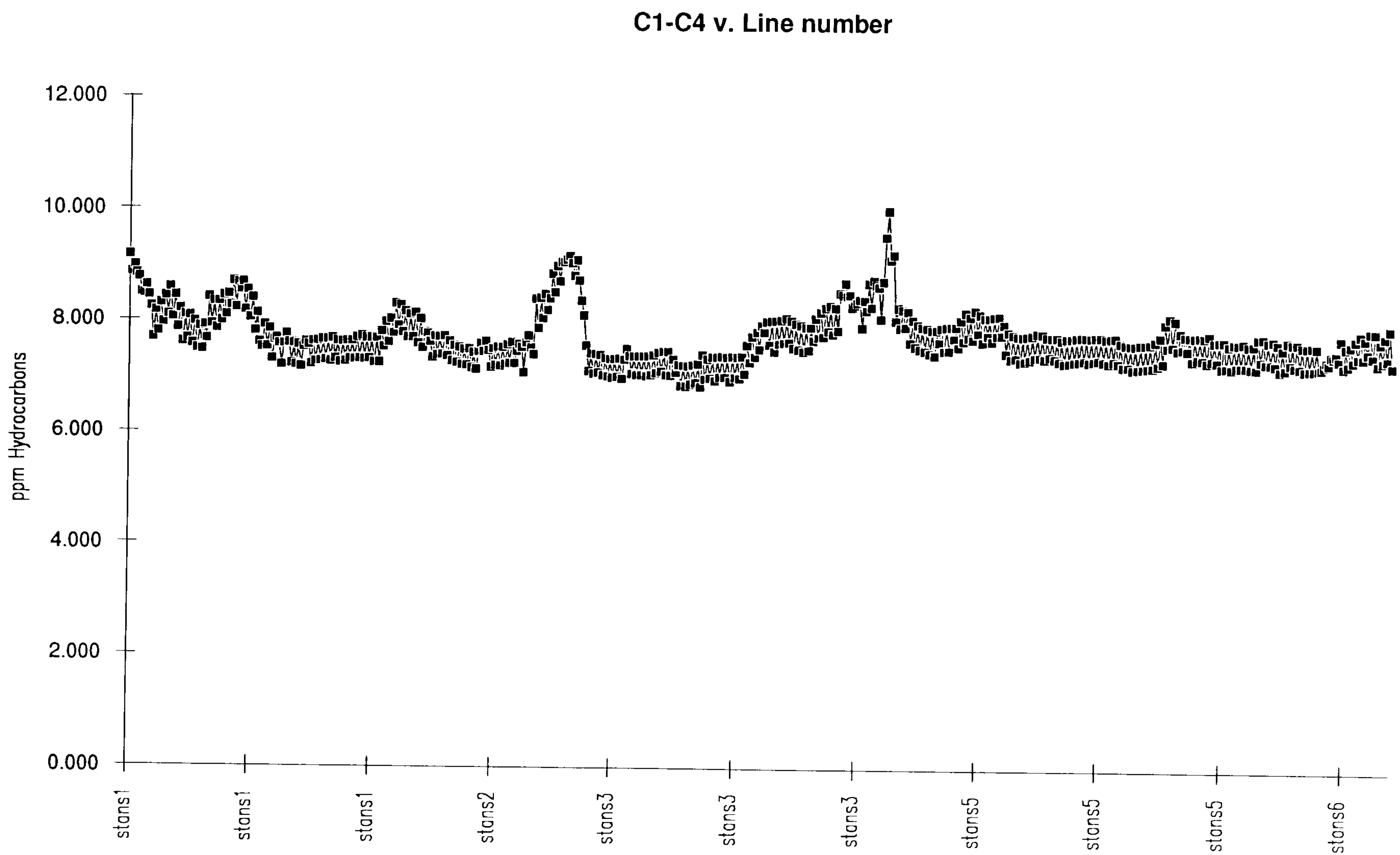


Figure 18a. Sum C1-C4 hydrocarbon concentration along all of the survey lines in the Stansbury Basin.

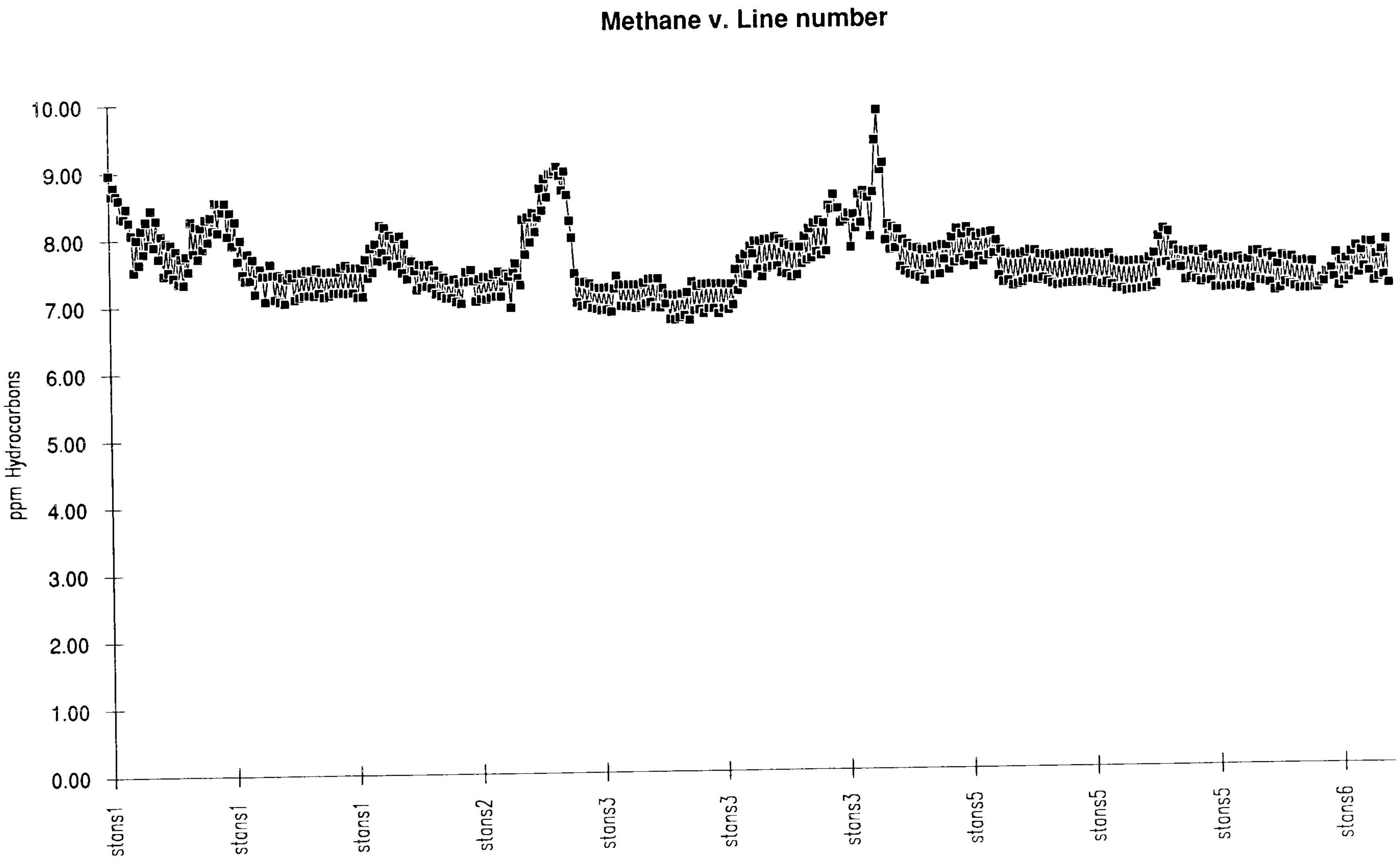


Figure 18b. Methane concentrations along all of the survey lines in the Stansbury Basin.

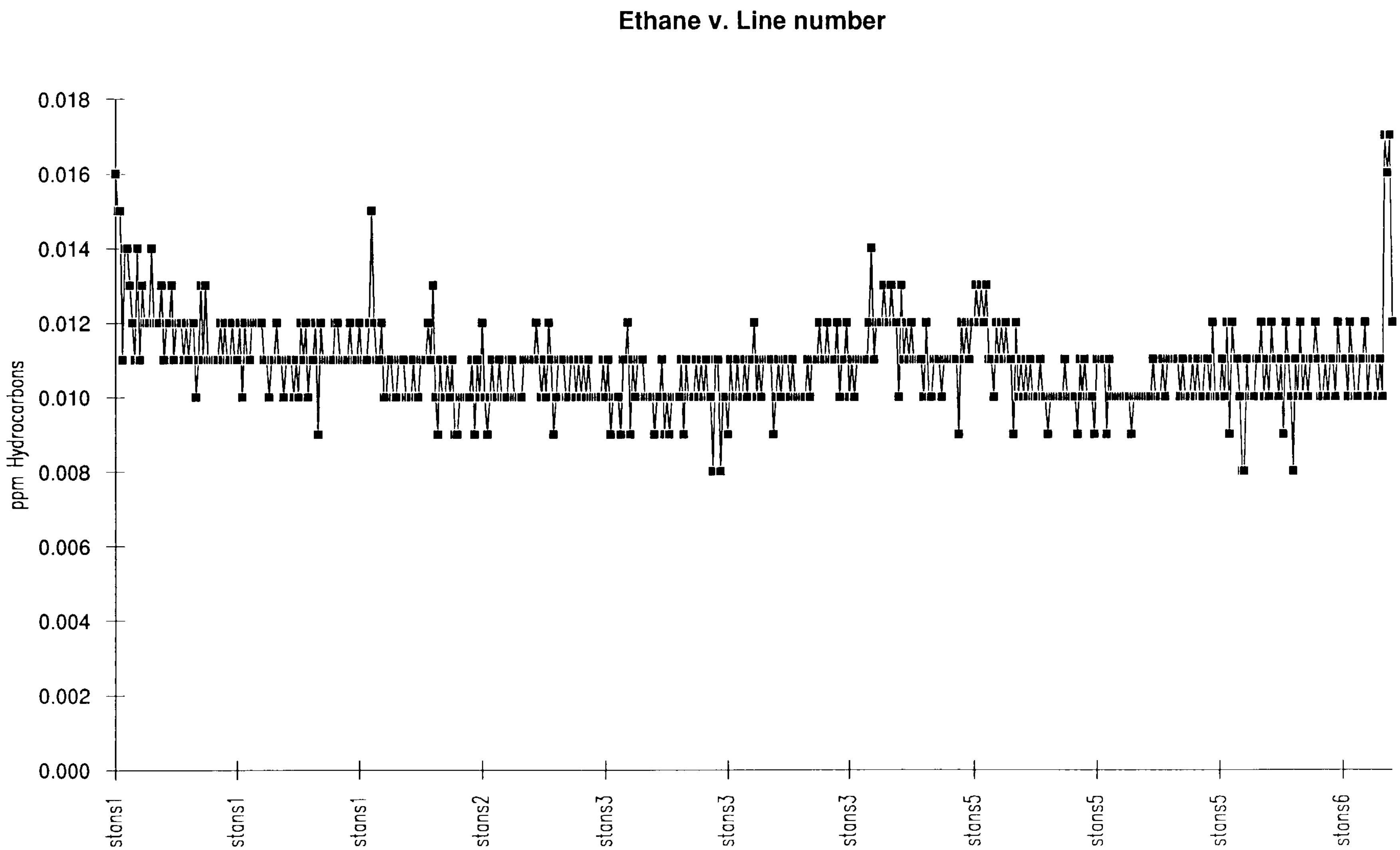


Figure 18c. Ethane concentrations along all of the survey lines in the Stansbury Basin.

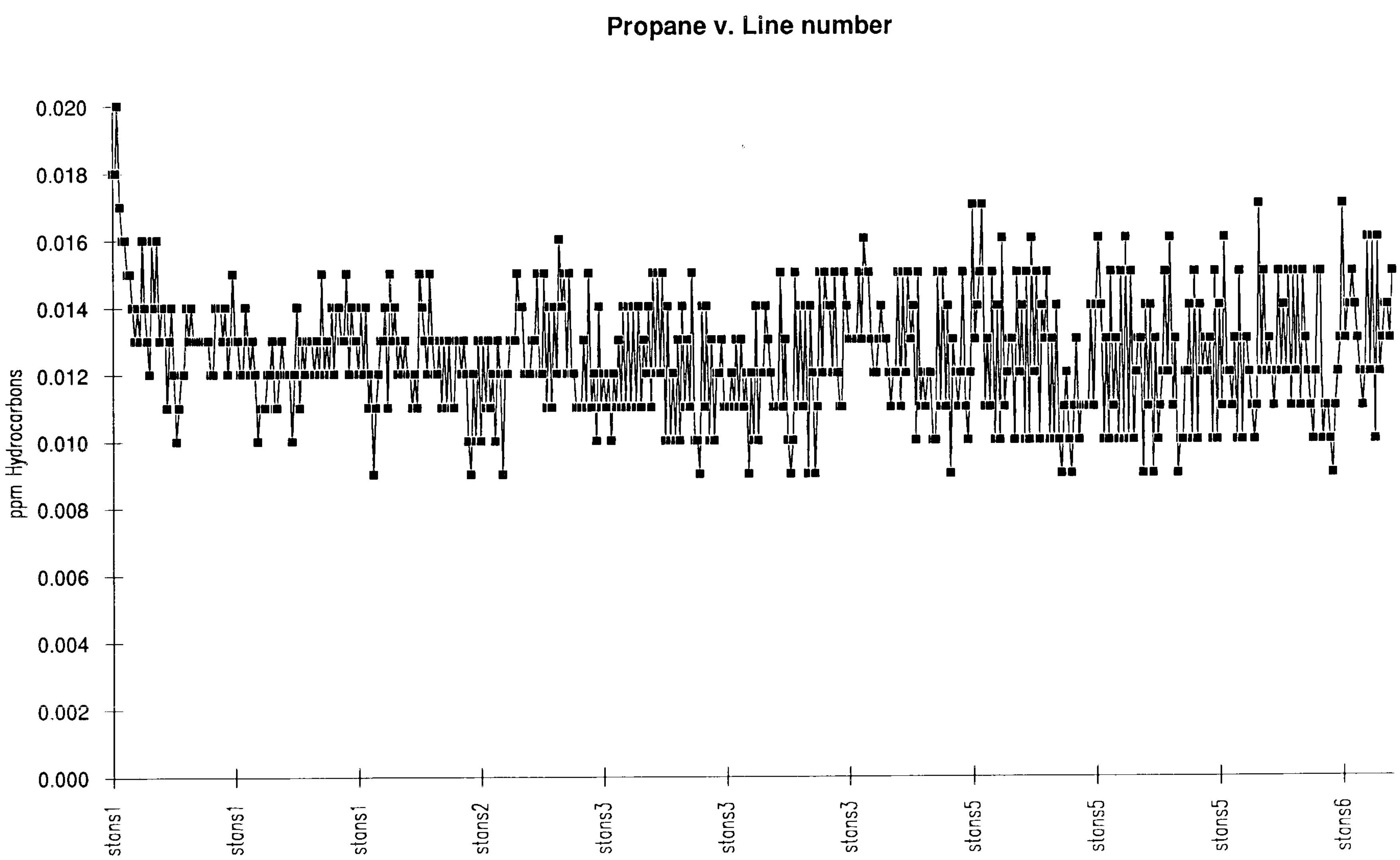


Figure 18d. Propane concentrations along all of the survey lines in the Stansbury Basin.

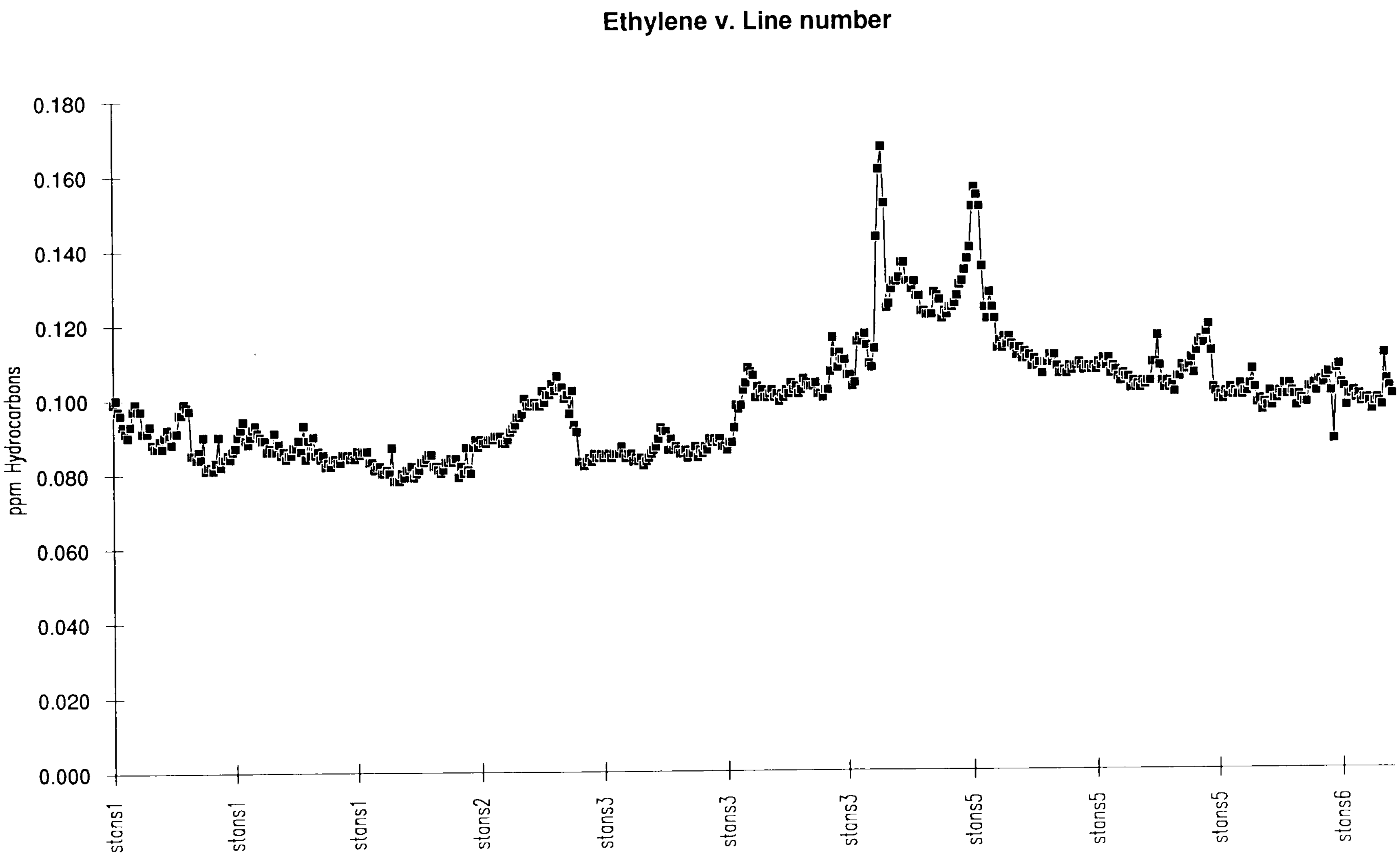


Figure 18e. Ethylene concentrations along all of the survey lines in the Stansbury Basin.

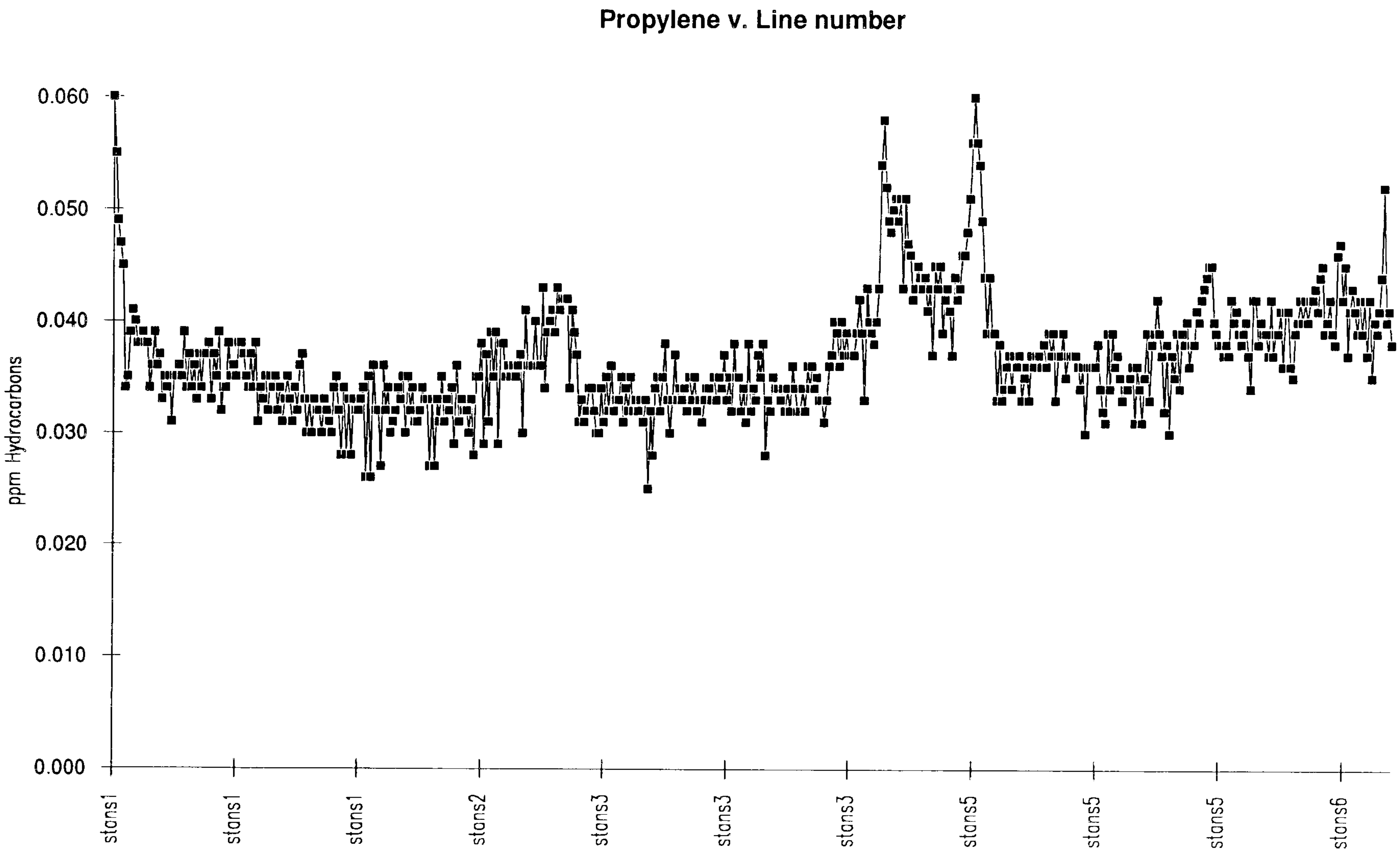


Figure 18f. Propylene concentrations along all of the survey lines in the Stansbury Basin.

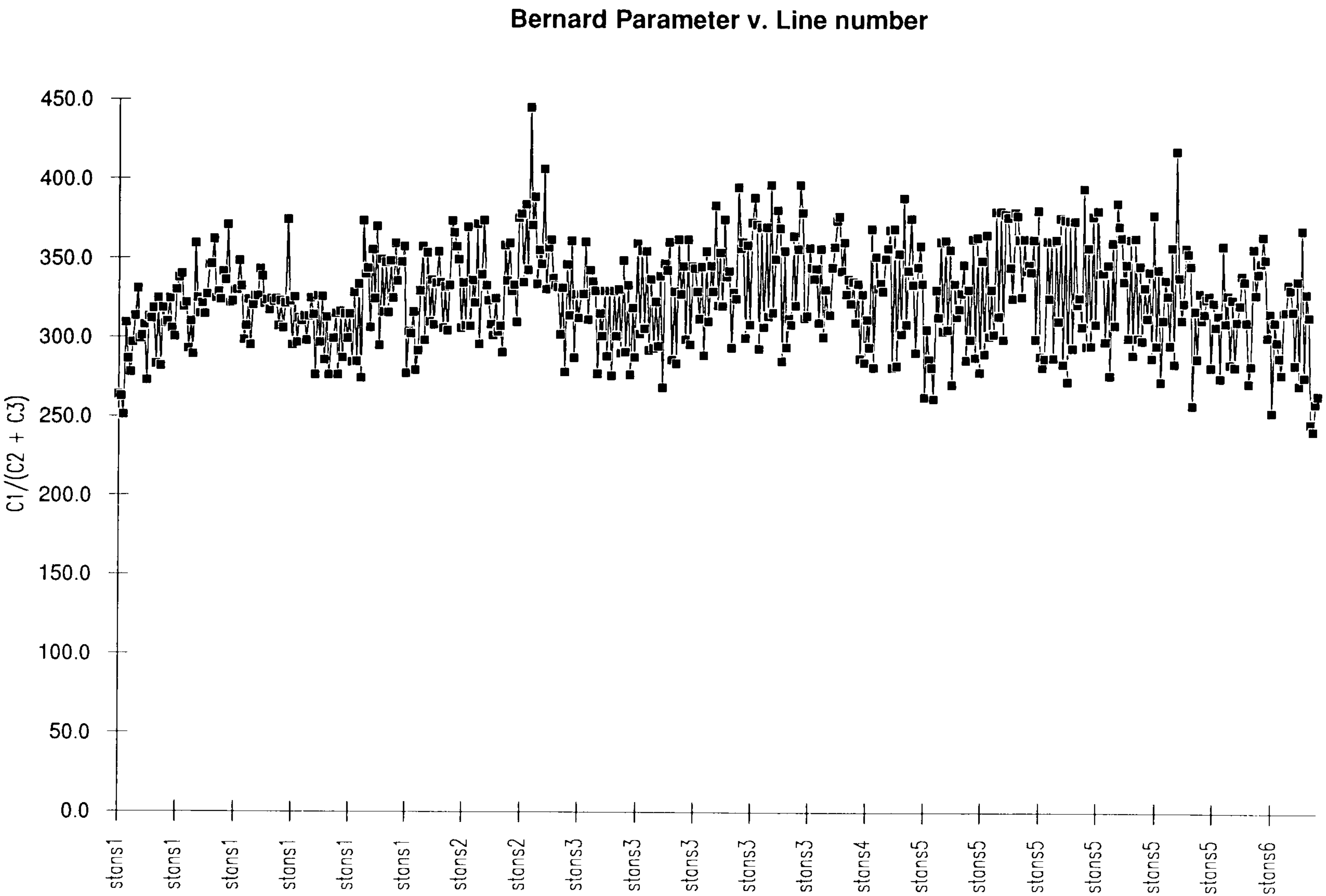


Figure 18g. Bernard Parameter along all of the survey lines in the Stansbury Basin.

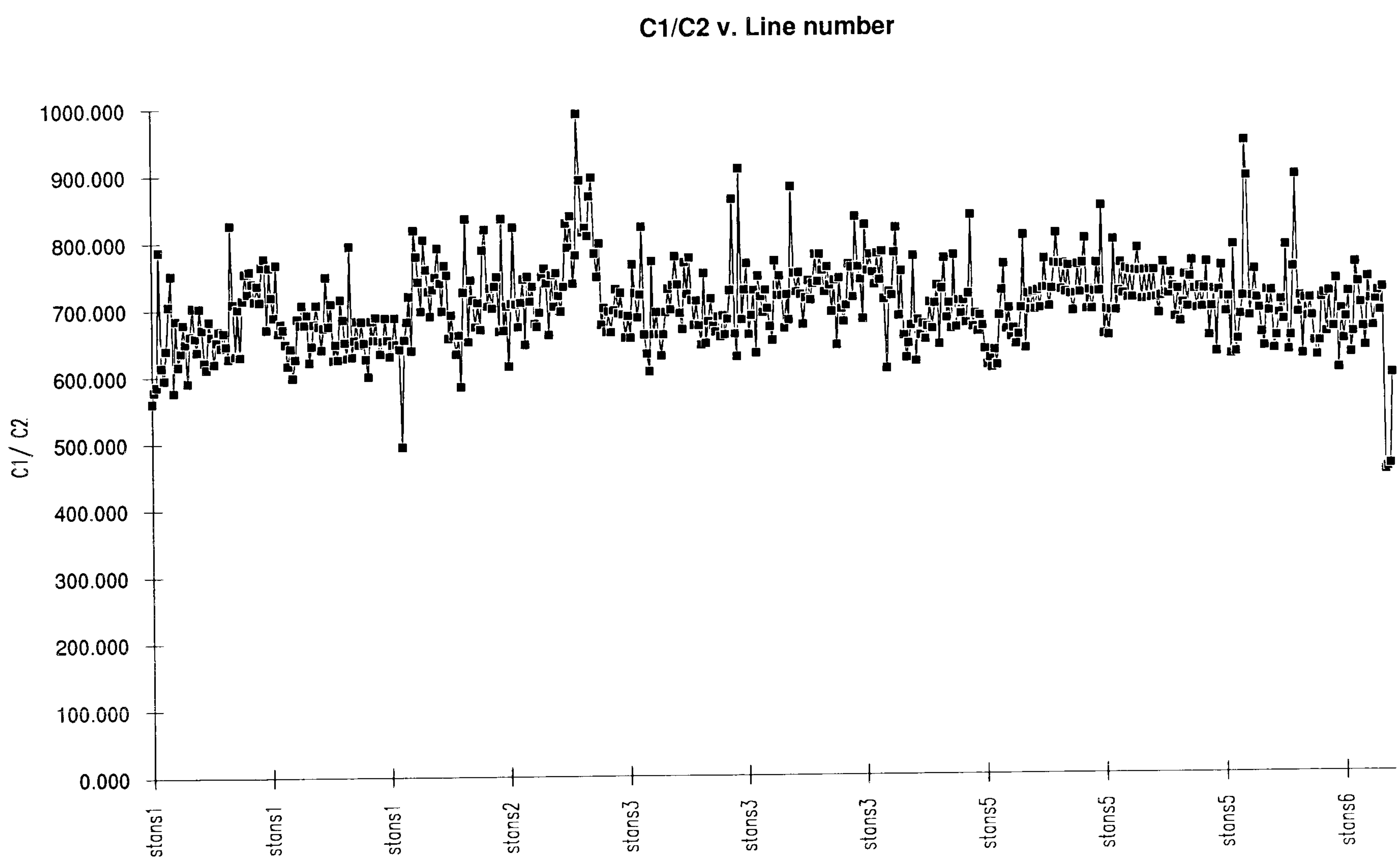


Figure 18h. C1/C2 along all of the survey lines in the Stansbury Basin.

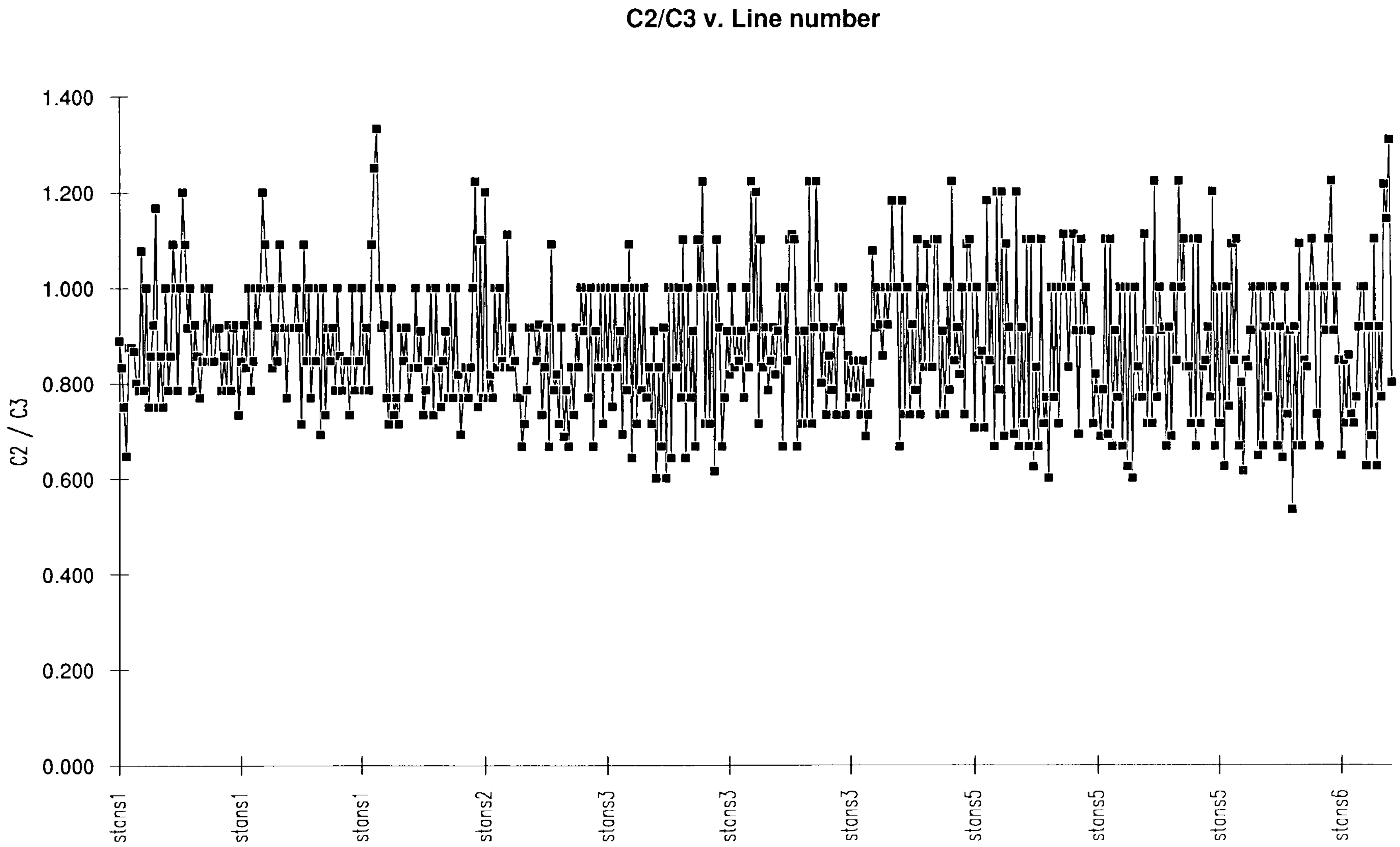


Figure 18j. C2/C3 along all of the survey lines in the Stansbury Basin

% Wetness v. Line number

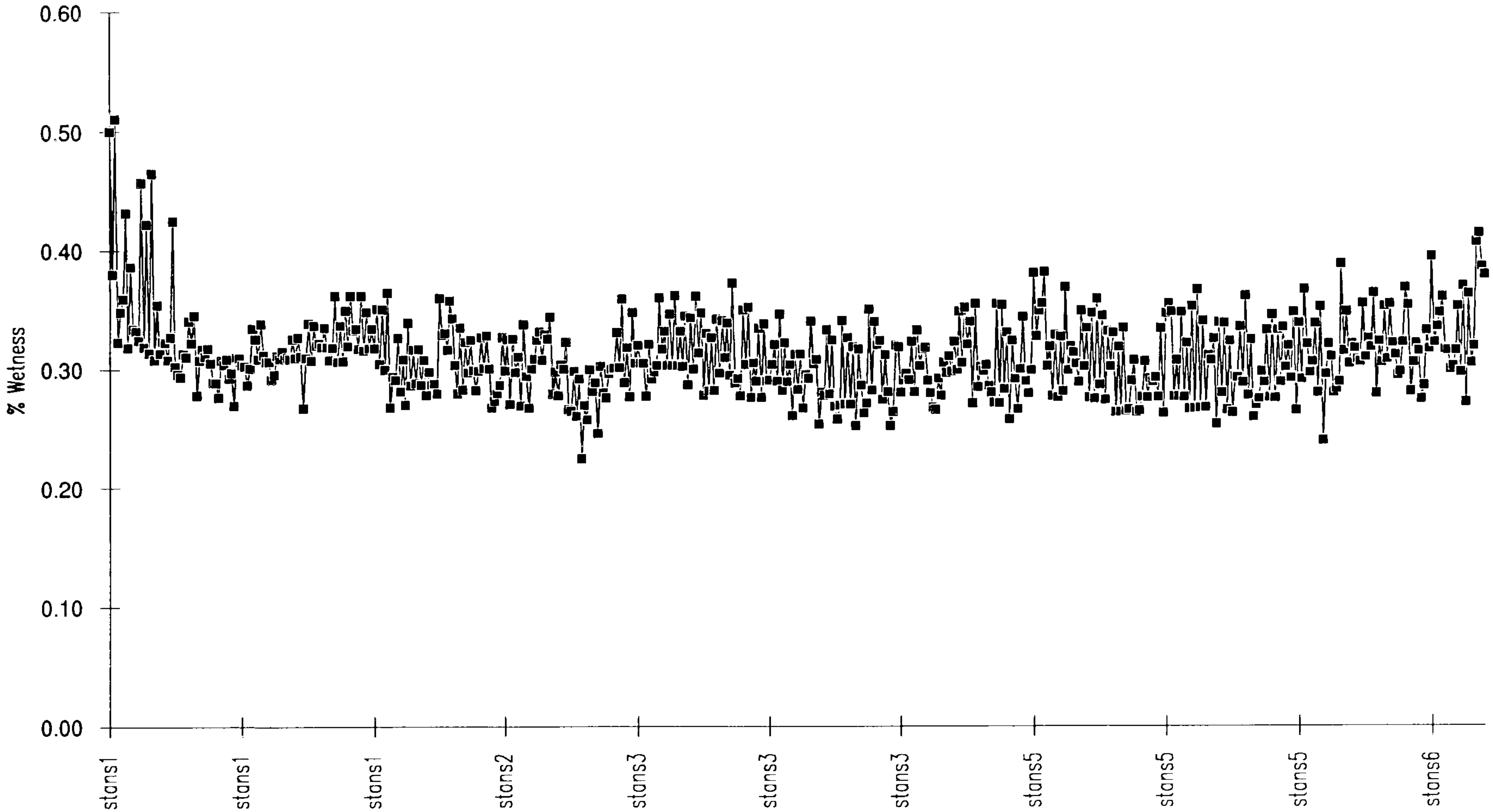


Figure 18k. Percent hydrocarbon wetness along all of the survey lines in the Stansbury Basin

APPENDIX I

This section presents the "hardcopy" results of the present study on a basin-by-basin basis. Included for each basin is:

1. A line summary sheet which provides the geochemical statistics for each line, the latitude and longitude of the start and end of each line, as well as the number of geochemical shot-points in each line.

2. Line plots which show the methane, ethane, and ethylene, propane and propylene concentrations along each line, as well as the fish depth, the water depth and the fish altitude.

GIPPSLAND BASIN DHD LINE SUMMARY SHEETS AND PLOTS

Line Summary

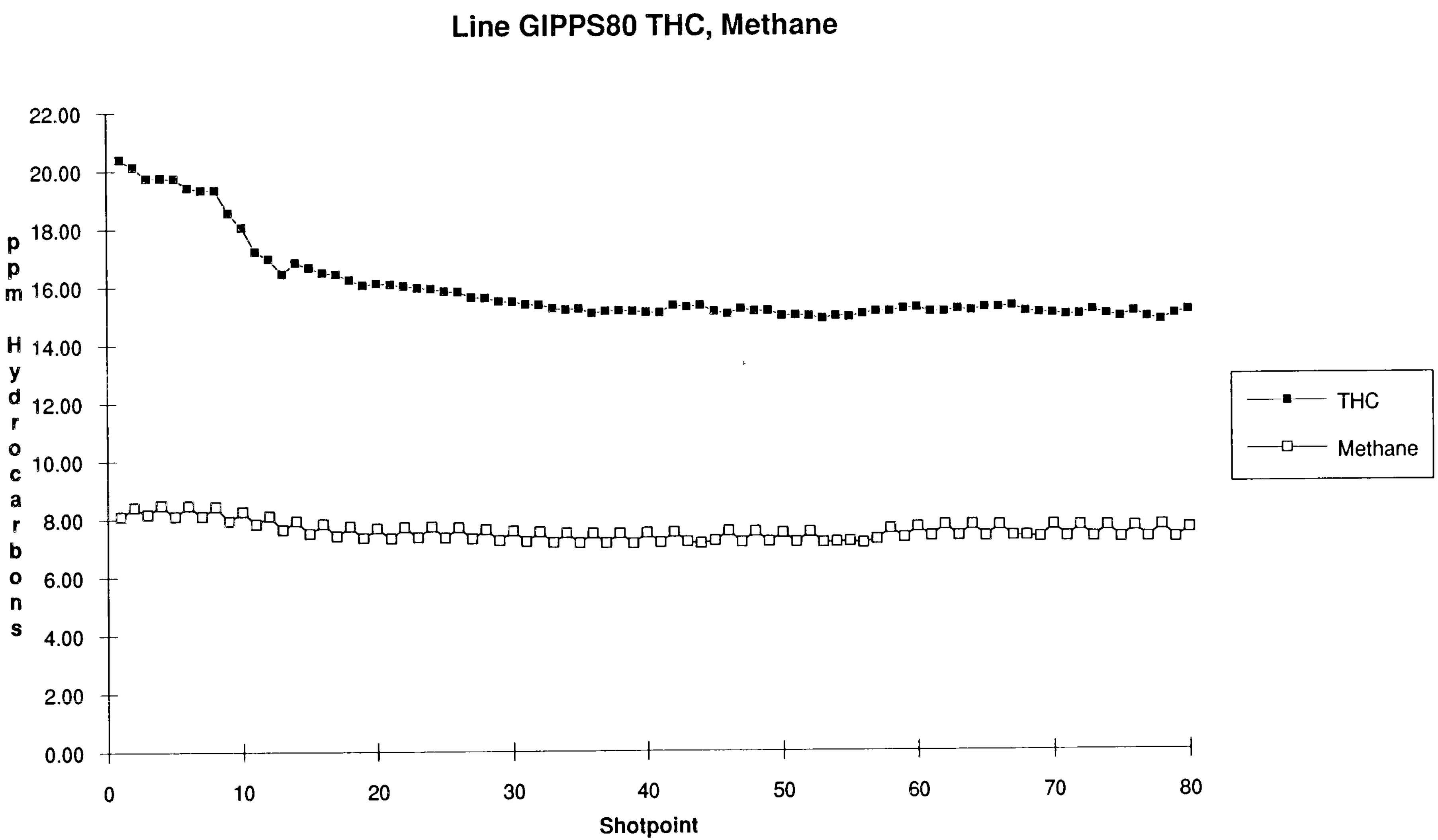
Line Number	gipps80
No. of Shotpoints	80

	Shotpoint	Date	Time	Latitude		Longitude	
Start	1	25-Feb-89	07:21:02	38	31.025	147	20.697
End	80	25-Feb-89	10:09:37	38	21.522	147	35.769

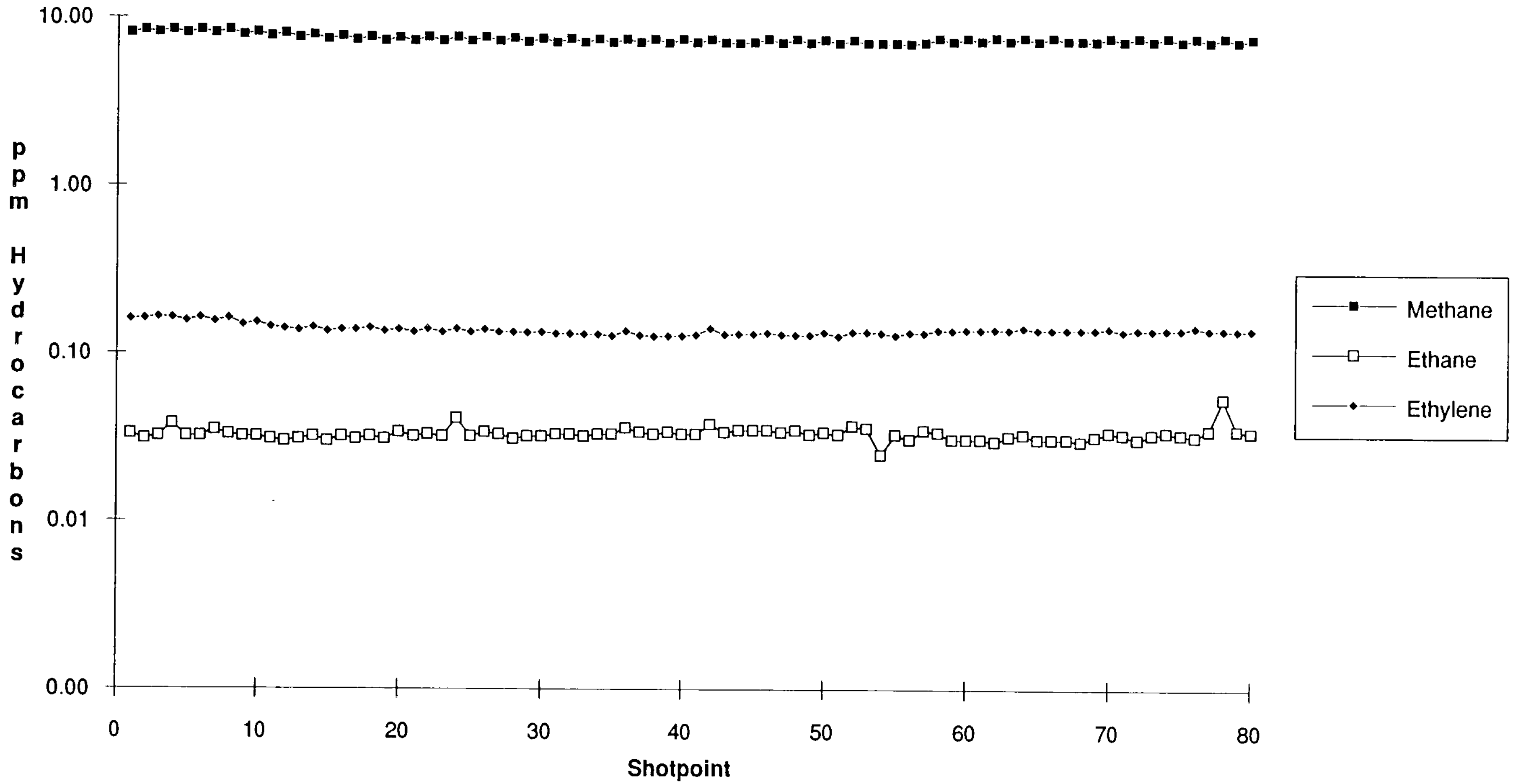
	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	15.889	7.534	0.033	0.139	0.030	0.047	0.000	0.008	N/A	N/A	N/A	N/A	0.947
Std. Dev.	1.467	0.350	0.003	0.009	0.002	0.007	0.000	0.003	N/A	N/A	N/A	N/A	0.084
Minimum	14.752	7.111	0.025	0.127	0.023	0.037	0.000	0.000	N/A	N/A	N/A	N/A	0.716
Maximum	20.383	8.472	0.054	0.165	0.040	0.069	0.000	0.013	N/A	N/A	N/A	N/A	1.170

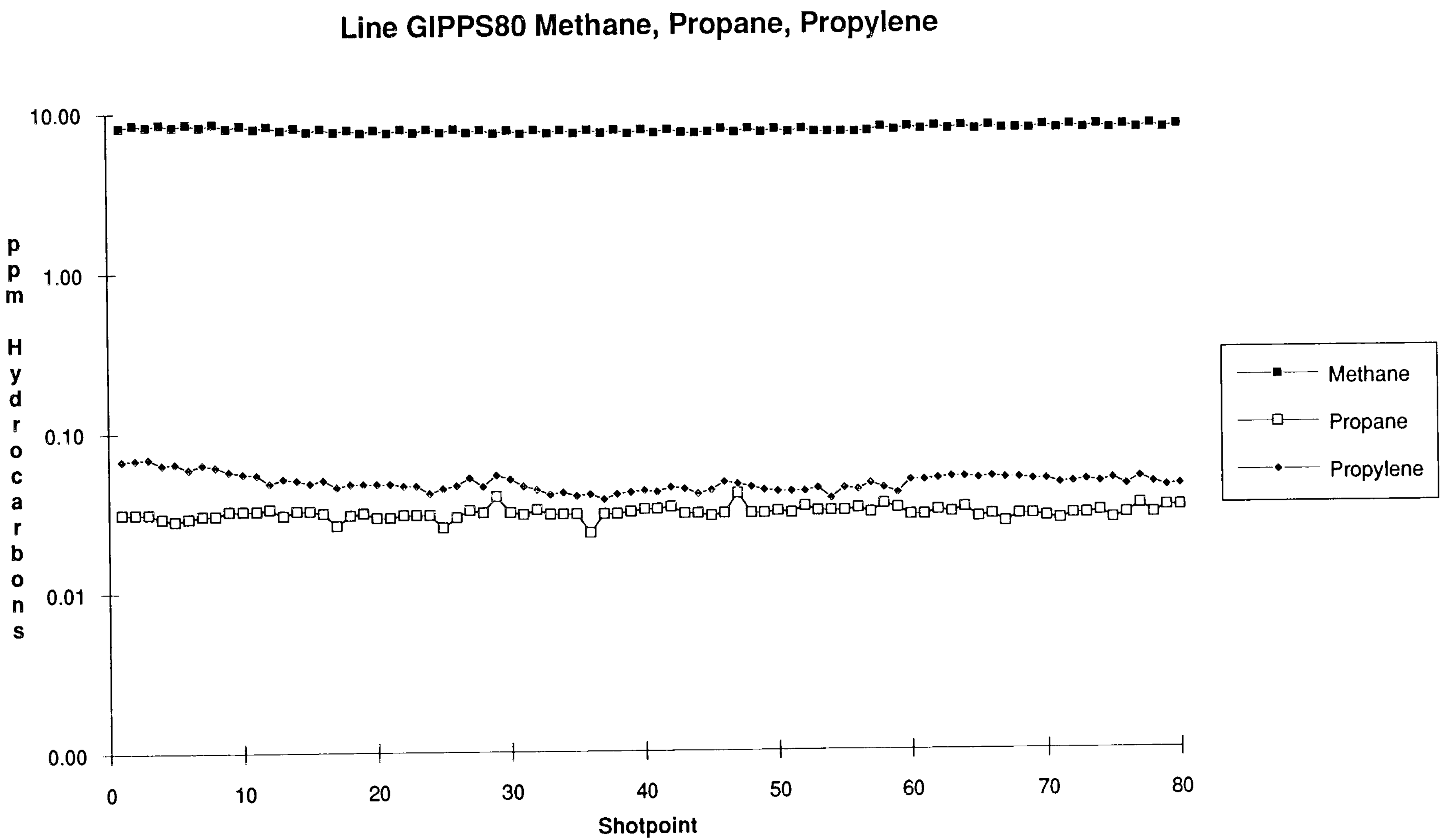
	Salinity	Temp.	F. Depth	W.Depth	Altitude
Mean	34.061	21.480	18.719	34.084	15.228
Std. Dev.	0.122	0.136	4.172	3.053	1.913
Minimum	33.880	21.290	10.000	30.000	13.000
Maximum	34.270	21.720	25.000	39.000	20.000

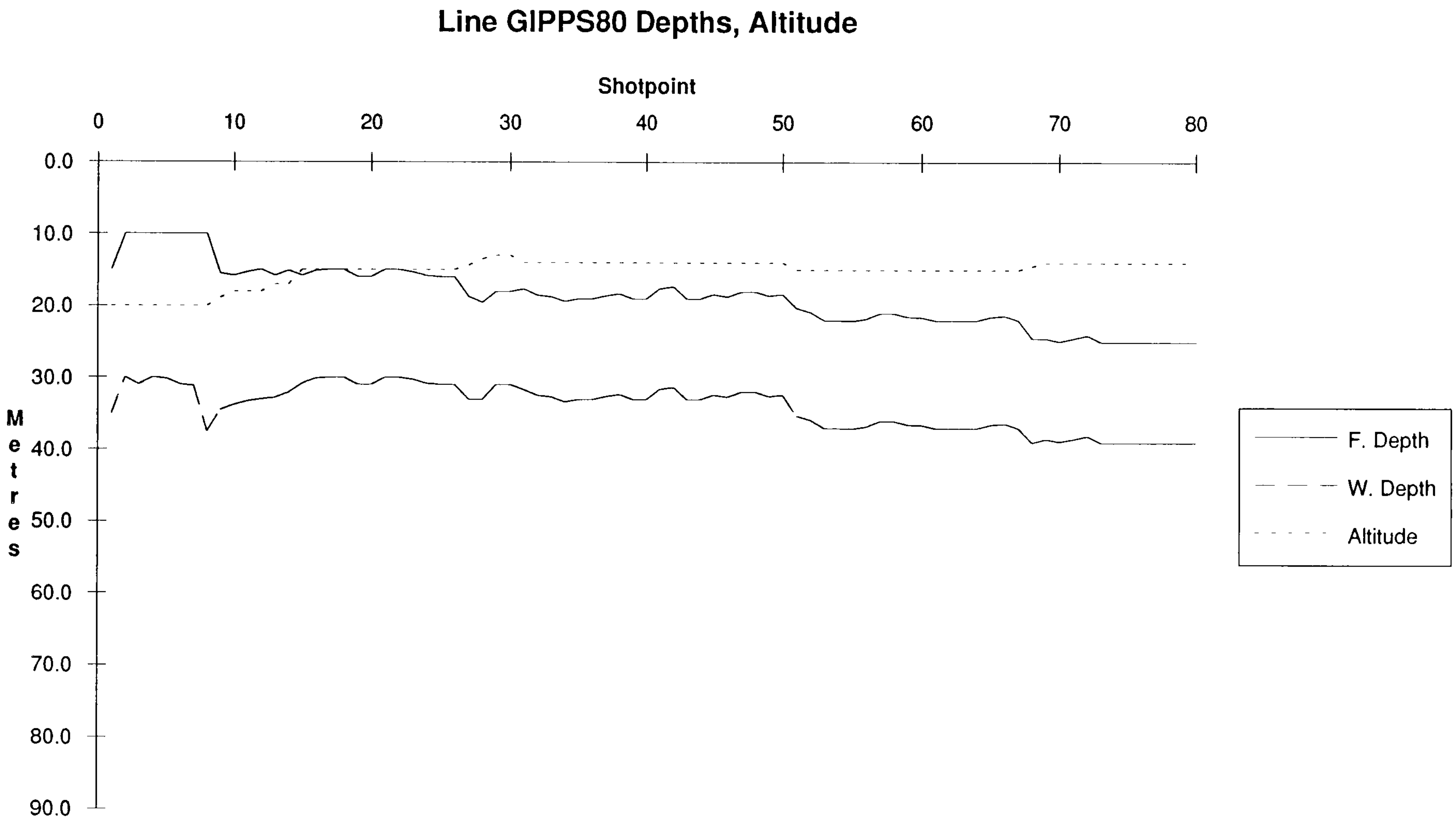
Notes No Anomalies


Line GIPPS80 THC, Methane
ppm Hydrocarbons
22.00
20.00
18.00
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
0
10
20
30
40
50
60
70
80
Shotpoint
THC
Methane

Line GIPPS80 Methane, Ethane, Ethylene




Line GIPPS80 Methane, Propane, Propylene
ppm Hydrocarbons
10.00
1.00
0.10
0.01
0.00
0
10
20
30
40
50
60
70
80
Shotpoint
Methane
Propane
Propylene


Line GIPPS80 Depths, Altitude
Shotpoint
0
10
20
30
40
50
60
70
80
0.0
10.0
20.0
30.0
40.0
50.0
60.0
70.0
80.0
90.0
Metres
F. Depth
W. Depth
Altitude

Line Summary

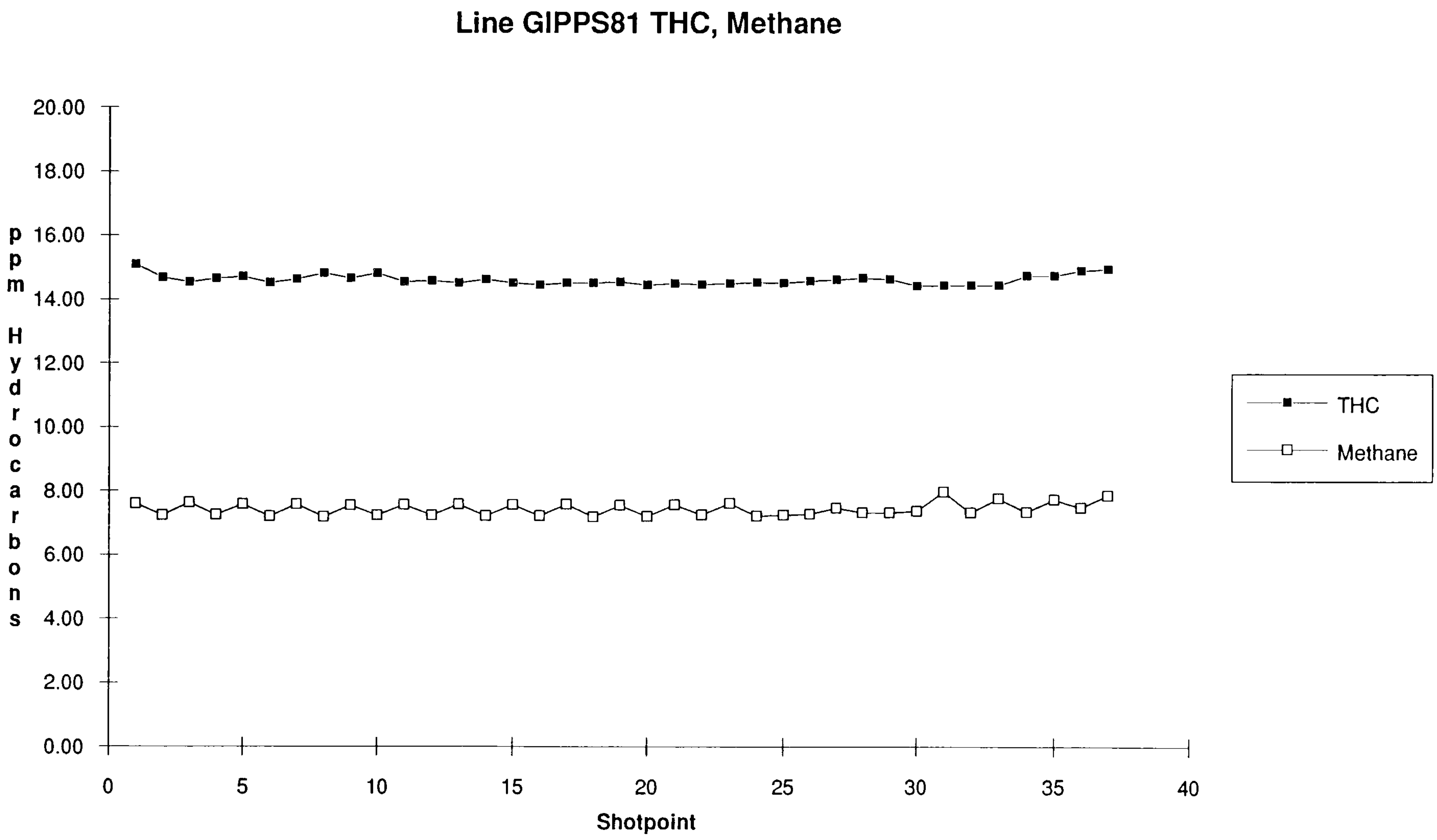
Line Number	gipps81
No. of Shotpoints	37

	Shotpoint	Date	Time	Latitude		Longitude	
Start	1	25-Feb-89	10:09:37	38	21.522	147	35.769
End	37	25-Feb-89	11:22:59	38	15.050	147	37.014

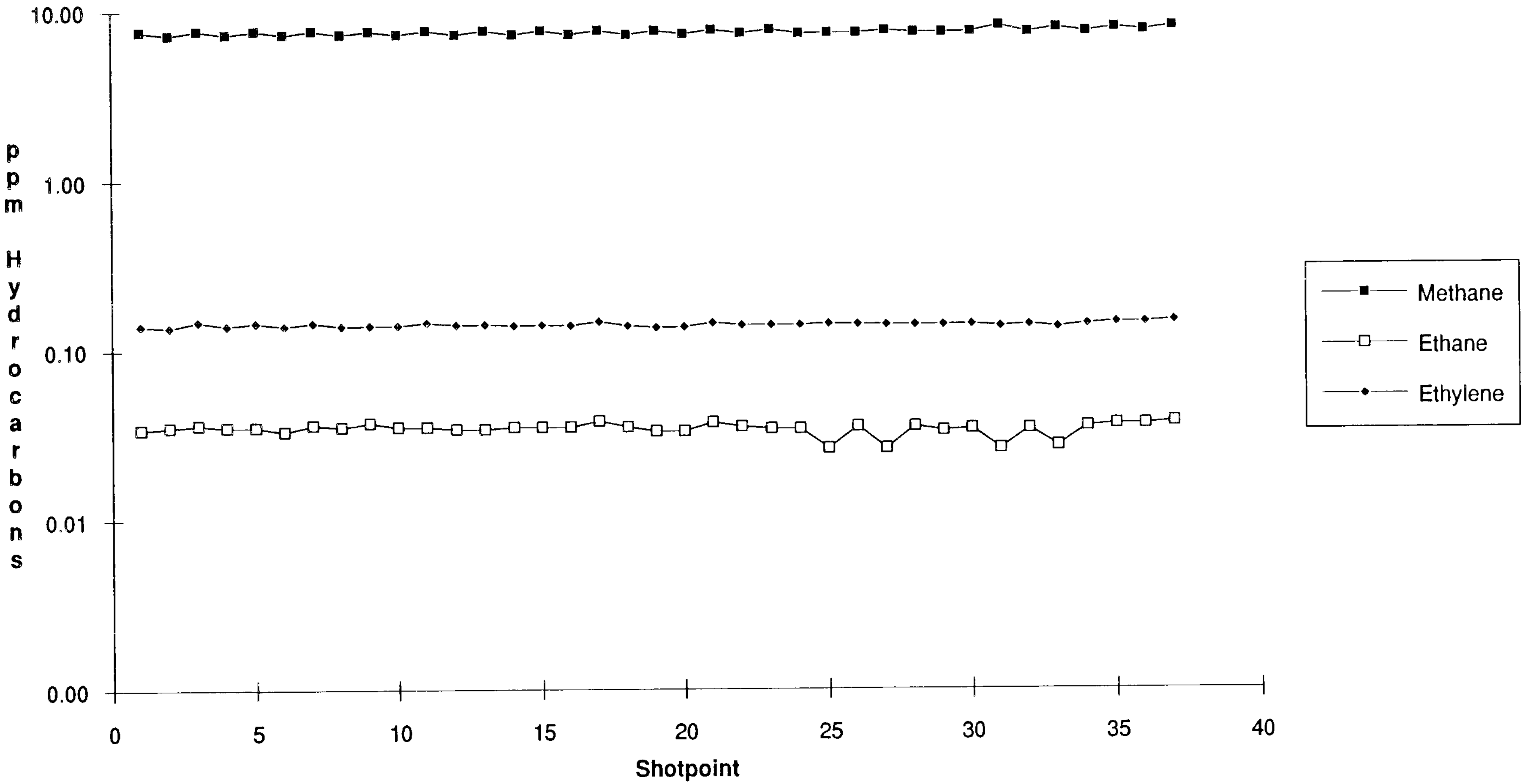
	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	14.610	7.432	0.034	0.141	0.028	0.046	0.000	0.004	N/A	N/A	N/A	N/A	0.879
Std. Dev.	0.154	0.213	0.003	0.003	0.004	0.002	0.001	0.004	N/A	N/A	N/A	N/A	0.120
Minimum	14.436	7.181	0.026	0.134	0.020	0.040	0.000	0.000	N/A	N/A	N/A	N/A	0.573
Maximum	15.079	7.980	0.038	0.148	0.033	0.051	0.006	0.010	N/A	N/A	N/A	N/A	1.093

	Salinity	Temp.	F. Depth	W.Depth	Altitude
Mean	34.129	21.582	23.495	37.495	14.000
Std. Dev.	0.071	0.077	1.517	1.517	0.000
Minimum	34.040	21.510	21.100	35.100	14.000
Maximum	34.300	21.770	25.300	39.300	14.000

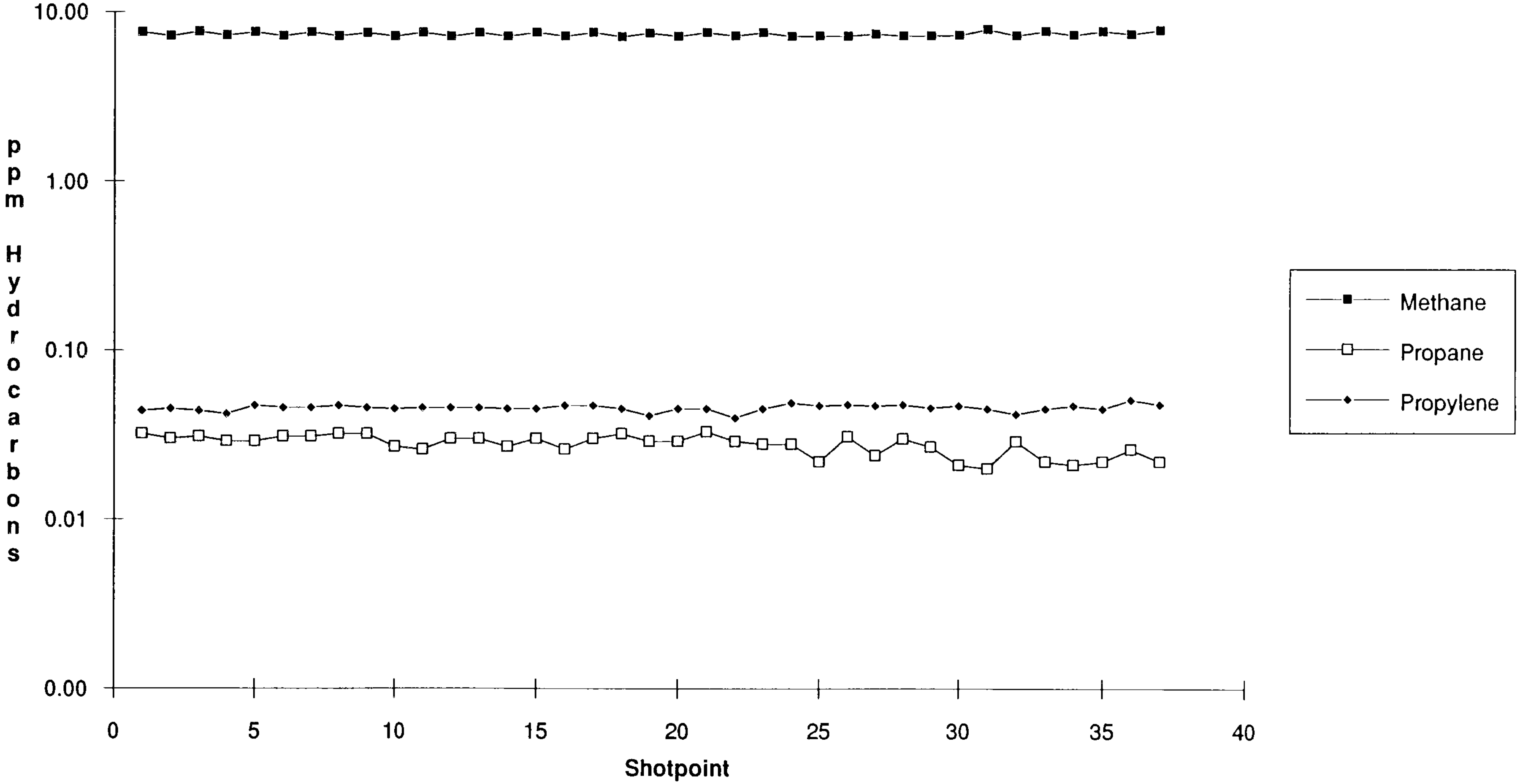
Notes: No Anomalies


Line GIPPS81 THC, Methane
ppm Hydrocarbons
20.00
18.00
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
0
5
10
15
20
25
30
35
40
Shotpoint
THC
Methane

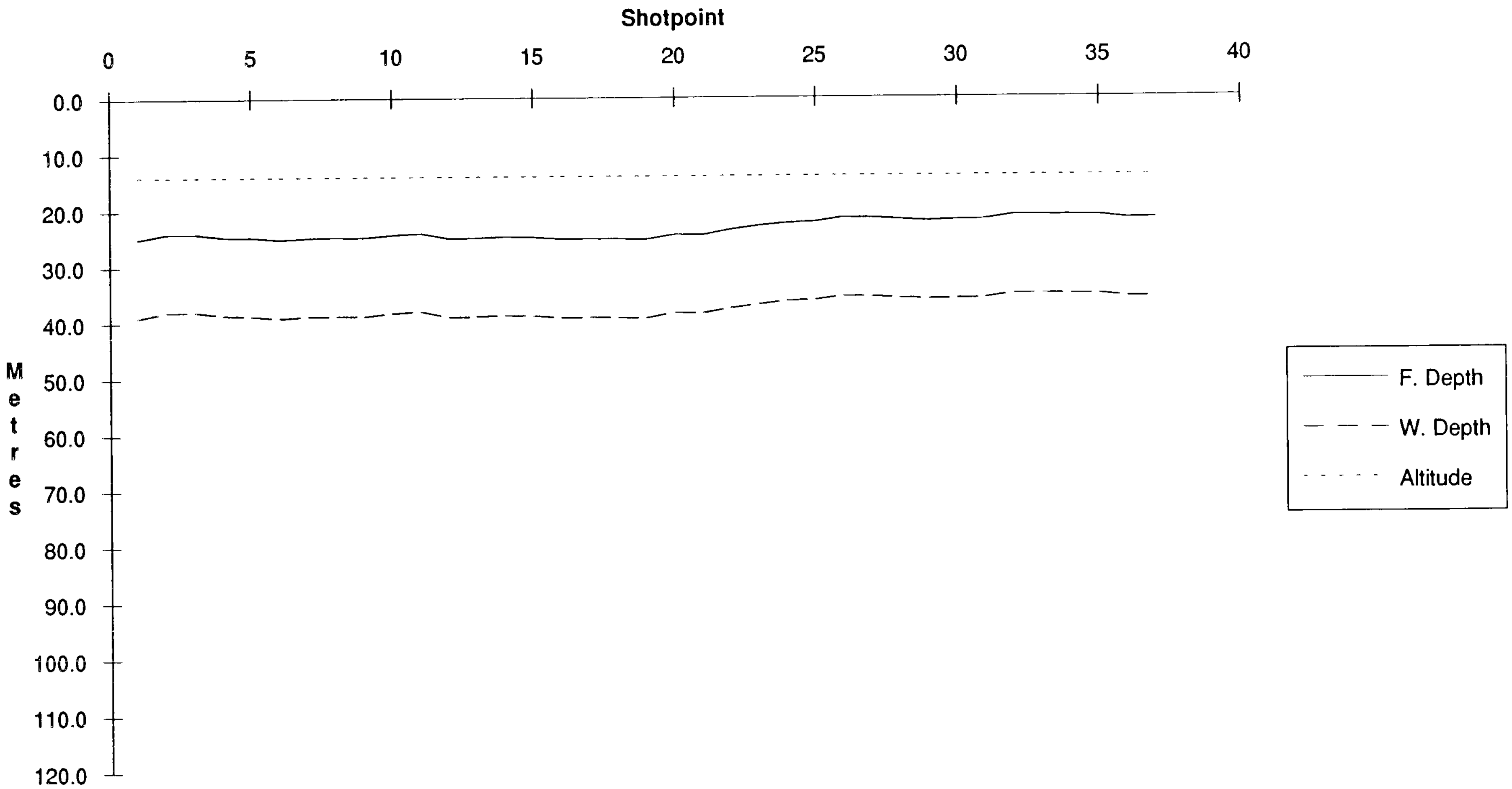
Line GIPPS81 Methane, Ethane, Ethylene



Line GIPPS81 Methane, Propane, Propylene



Line GIPPS81 Depths, Altitude



Line Summary

Line Number	gipps82
No. of Shotpoints	91

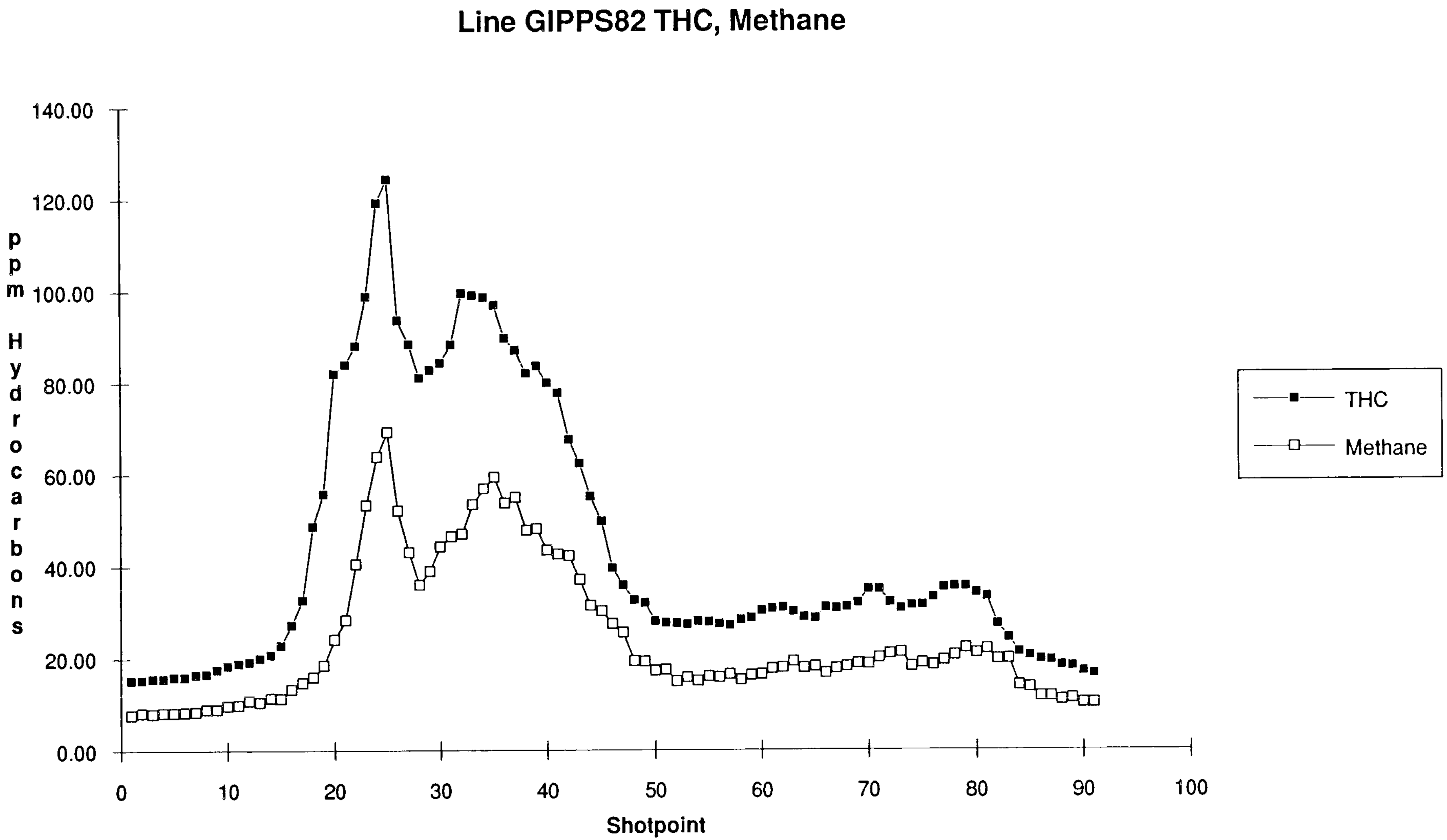
	Shotpoint	Date	Time	Latitude		Longitude	
Start	1	25-Feb-89	11:26:34	38	14.753	147	37.221
End	94	25-Feb-89	14:34:11	38	09.005	147	56.914

	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	43.906	24.051	1.590	0.144	1.663	0.047	0.326	0.358	N/A	N/A	N/A	N/A	10.158
Std. Dev.	29.116	15.424	1.731	0.007	2.159	0.005	0.388	0.451	N/A	N/A	N/A	N/A	6.405
Minimum	15.174	7.702	0.039	0.095	0.032	0.033	0.000	0.000	N/A	N/A	N/A	N/A	0.913
Maximum	124.149	69.179	7.619	0.154	9.833	0.056	1.720	1.922	N/A	N/A	N/A	N/A	26.212

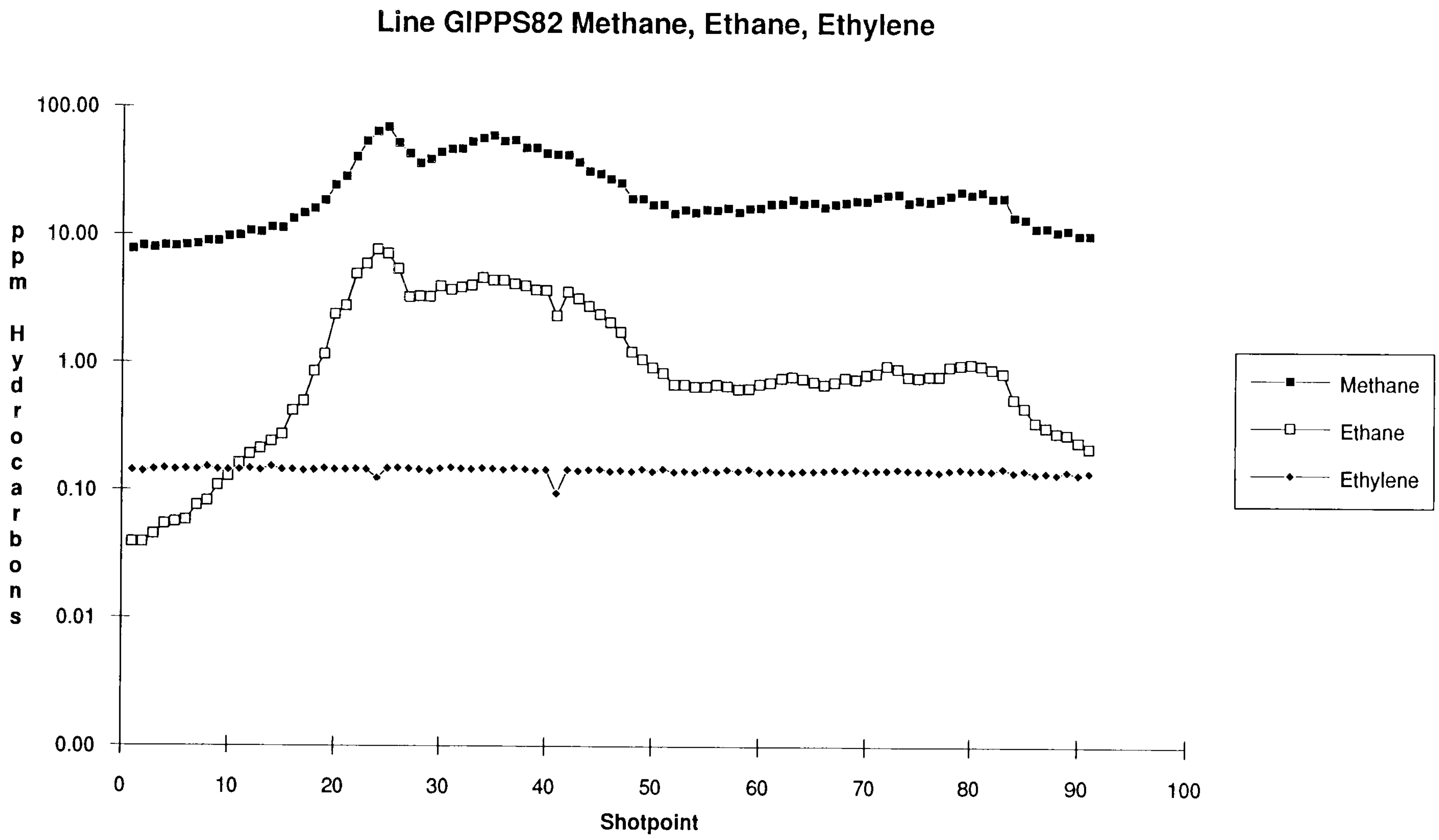
	Salinity	Temp.	F. Depth	W.Depth	Altitude
Mean	34.112	21.555	28.013	40.995	12.980
Std. Dev.	0.106	0.120	3.067	3.904	1.286
Minimum	33.880	21.320	21.000	33.000	12.000
Maximum	34.370	21.830	35.600	50.600	15.000

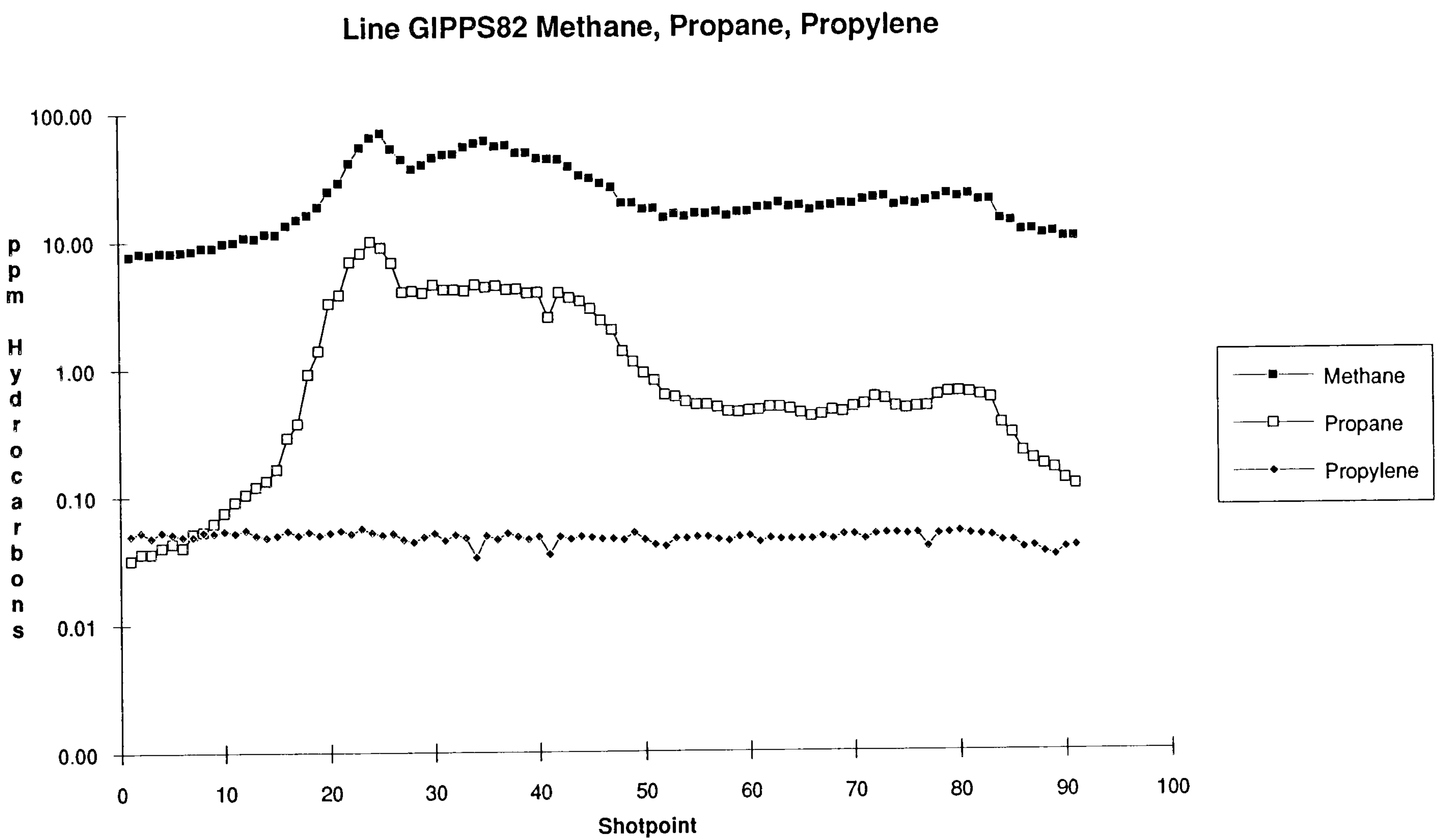
Notes

Two strong-very strong anomalies present. C1 to 69ppm, C2 to 4.4ppm, very propane-rich (C2/C3<1) with some C5+ enrichment . Probably anthropogenic, possibly due to sub-sea gas dishcharge from Marlin Platform.

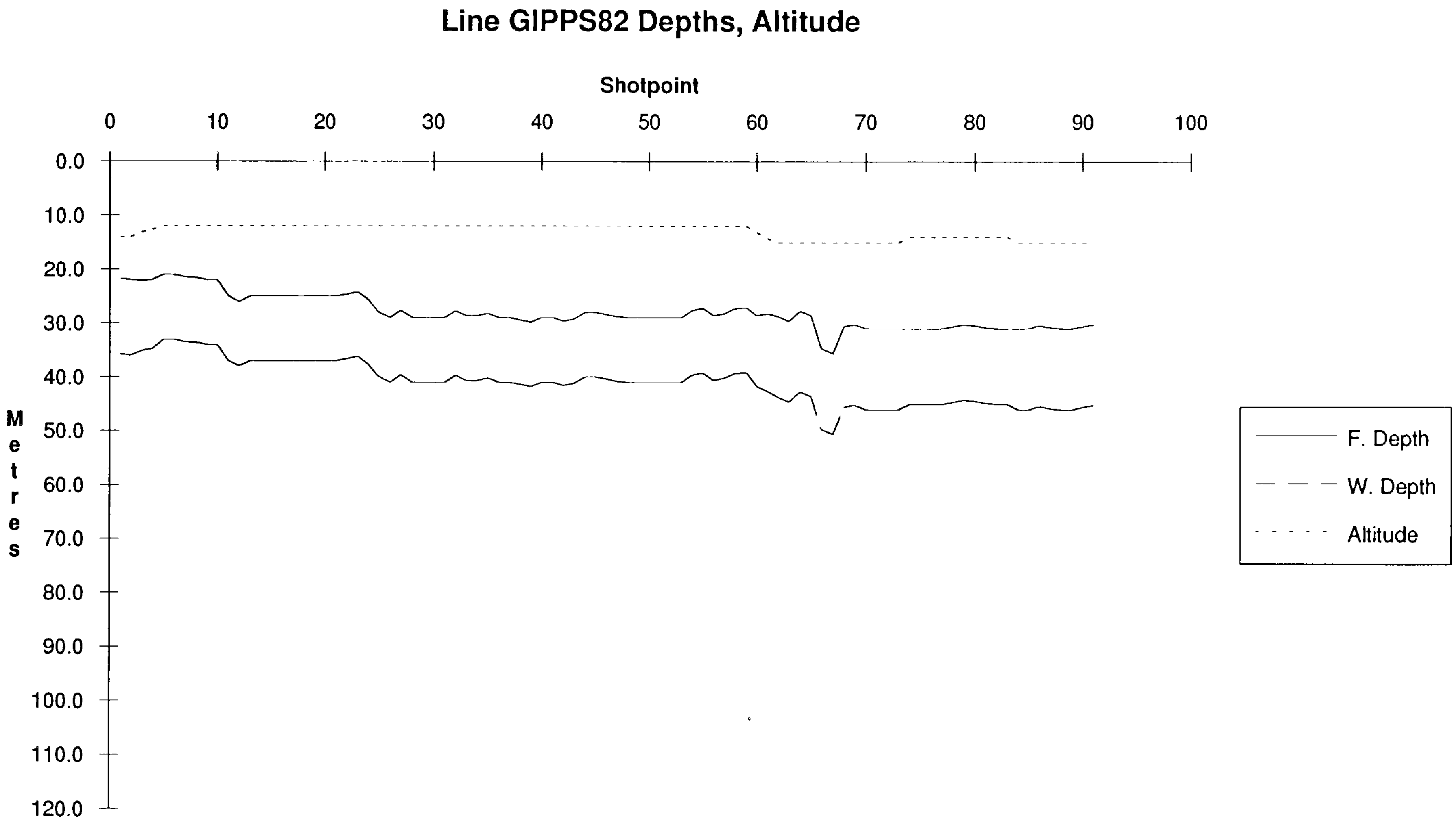


Line GIPPS82 THC, Methane
140.00
120.00
100.00
80.00
60.00
40.00
20.00
0.00
ppm Hydrocarbons
0
10
20
30
40
50
60
70
80
90
100
Shotpoint
THC
Methane


Line GIPPS82 Methane, Ethane, Ethylene
ppm Hydrocarbons
100.00
10.00
1.00
0.10
0.01
0.00
0
10
20
30
40
50
60
70
80
90
100
Shotpoint
Methane
Ethane
Ethylene



Line GIPPS82 Methane, Propane, Propylene
ppm Hydrocarbons
100.00
10.00
1.00
0.10
0.01
0.00
0
10
20
30
40
50
60
70
80
90
100
Shotpoint
Methane
Propane
Propylene



Line GIPPS82 Depths, Altitude
Shotpoint
0
10
20
30
40
50
60
70
80
90
100
Metres
0.0
10.0
20.0
30.0
40.0
50.0
60.0
70.0
80.0
90.0
100.0
110.0
120.0
F. Depth
W. Depth
Altitude

Line Summary

Line Number	gipps83
No. of Shotpoints	125

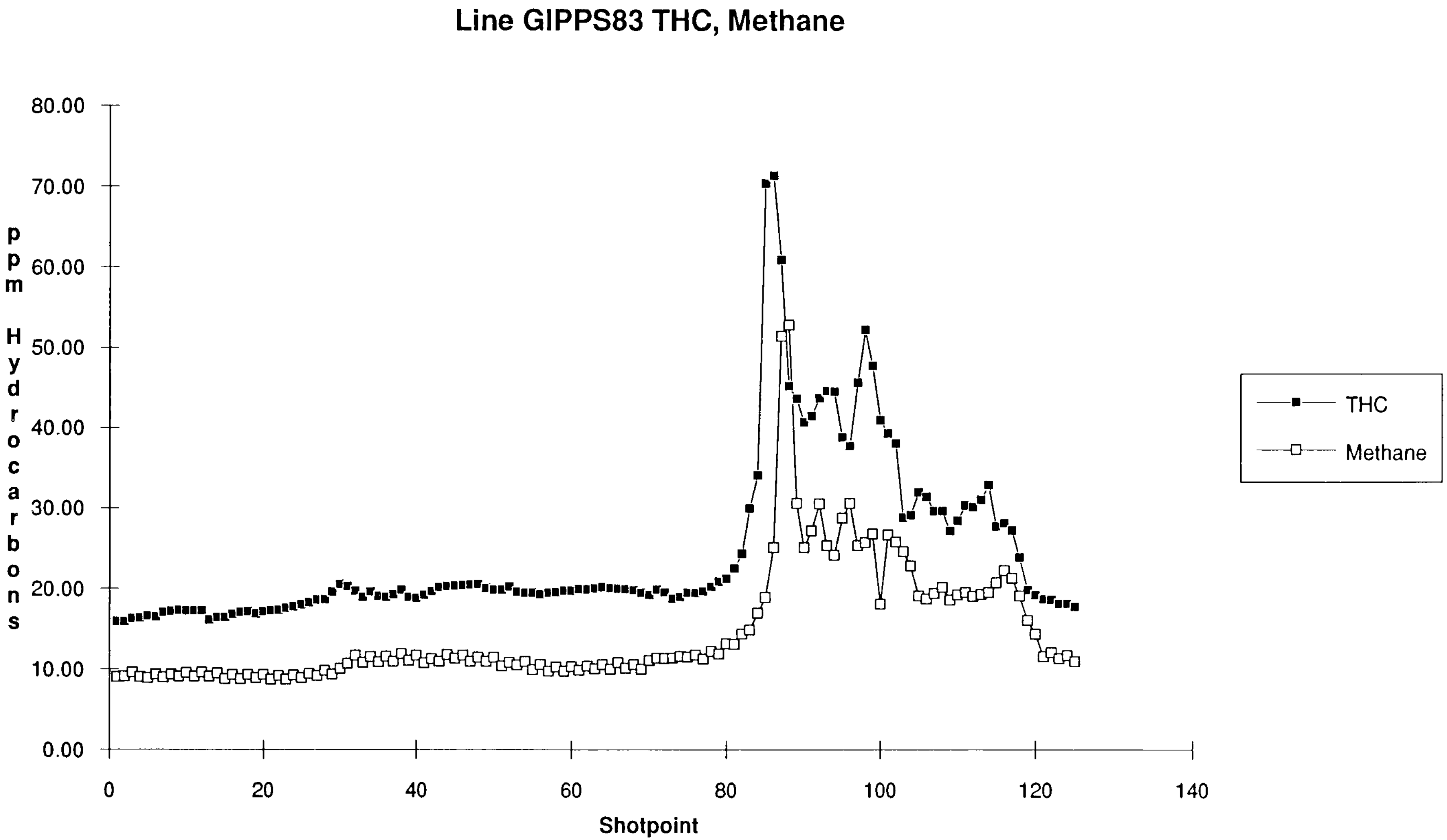
	Shotpoint	Date	Time	Latitude		Longitude	
Start	1	25-Feb-89	14:37:09	38	08.920	147	57.329
End	125	25-Feb-89	18:54:01	38	09.297	148	26.620

	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	24.463	14.486	0.621	0.101	0.330	0.027	0.051	0.091	N/A	N/A	N/A	N/A	6.478
Std. Dev.	10.805	7.628	0.513	0.021	0.228	0.009	0.029	0.064	N/A	N/A	N/A	N/A	1.654
Minimum	15.881	8.692	0.142	0.057	0.091	0.011	0.019	0.025	N/A	N/A	N/A	N/A	2.875
Maximum	71.273	52.746	3.137	0.146	1.332	0.048	0.159	0.349	N/A	N/A	N/A	N/A	11.064

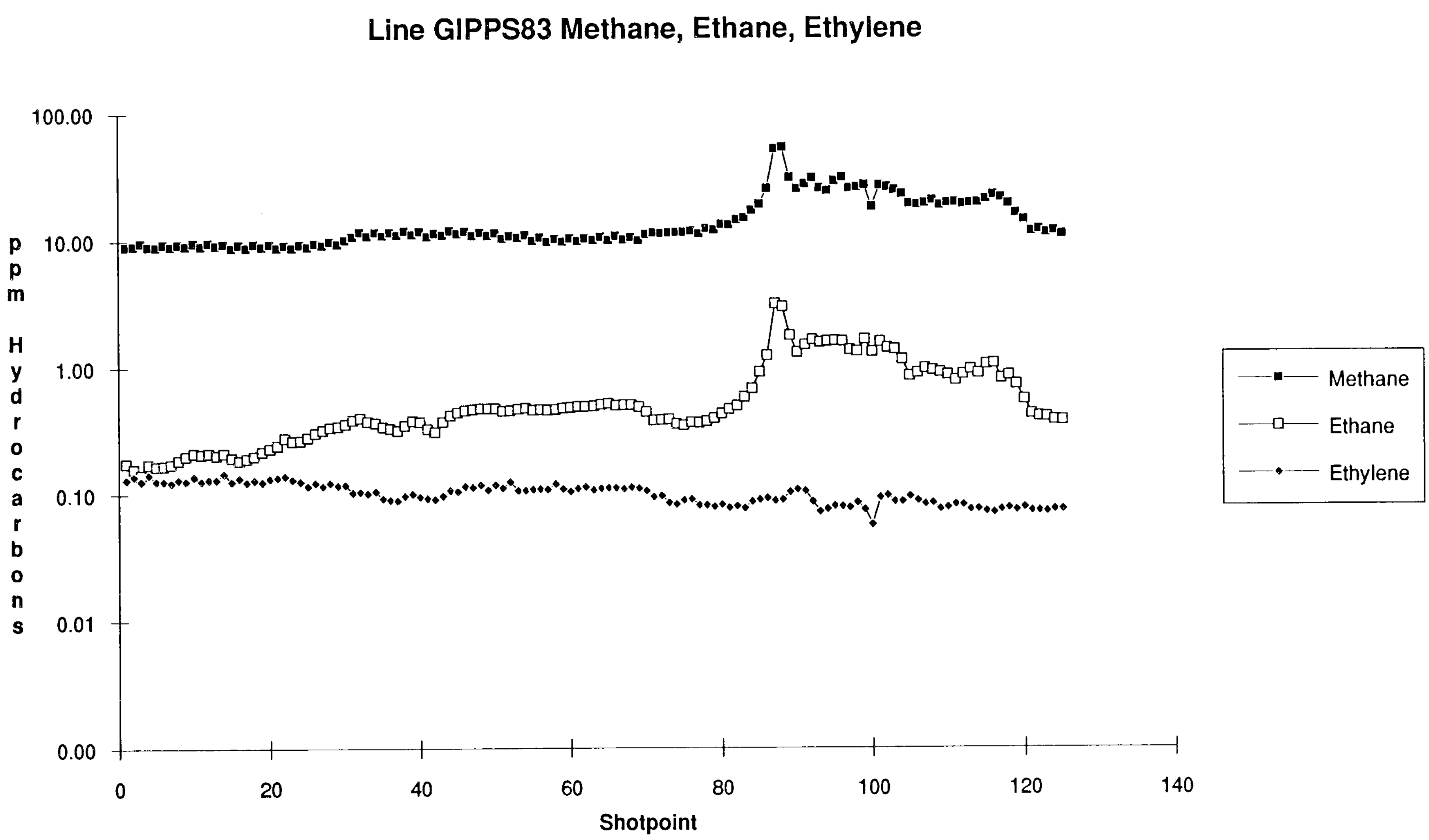
	Salinity	Temp.	F. Depth	W.Depth	Altitude
Mean	33.165	20.439	32.980	47.362	14.382
Std. Dev.	1.146	1.407	2.060	1.595	0.715
Minimum	31.500	18.380	29.200	44.200	13.000
Maximum	34.630	22.150	36.600	50.700	15.000

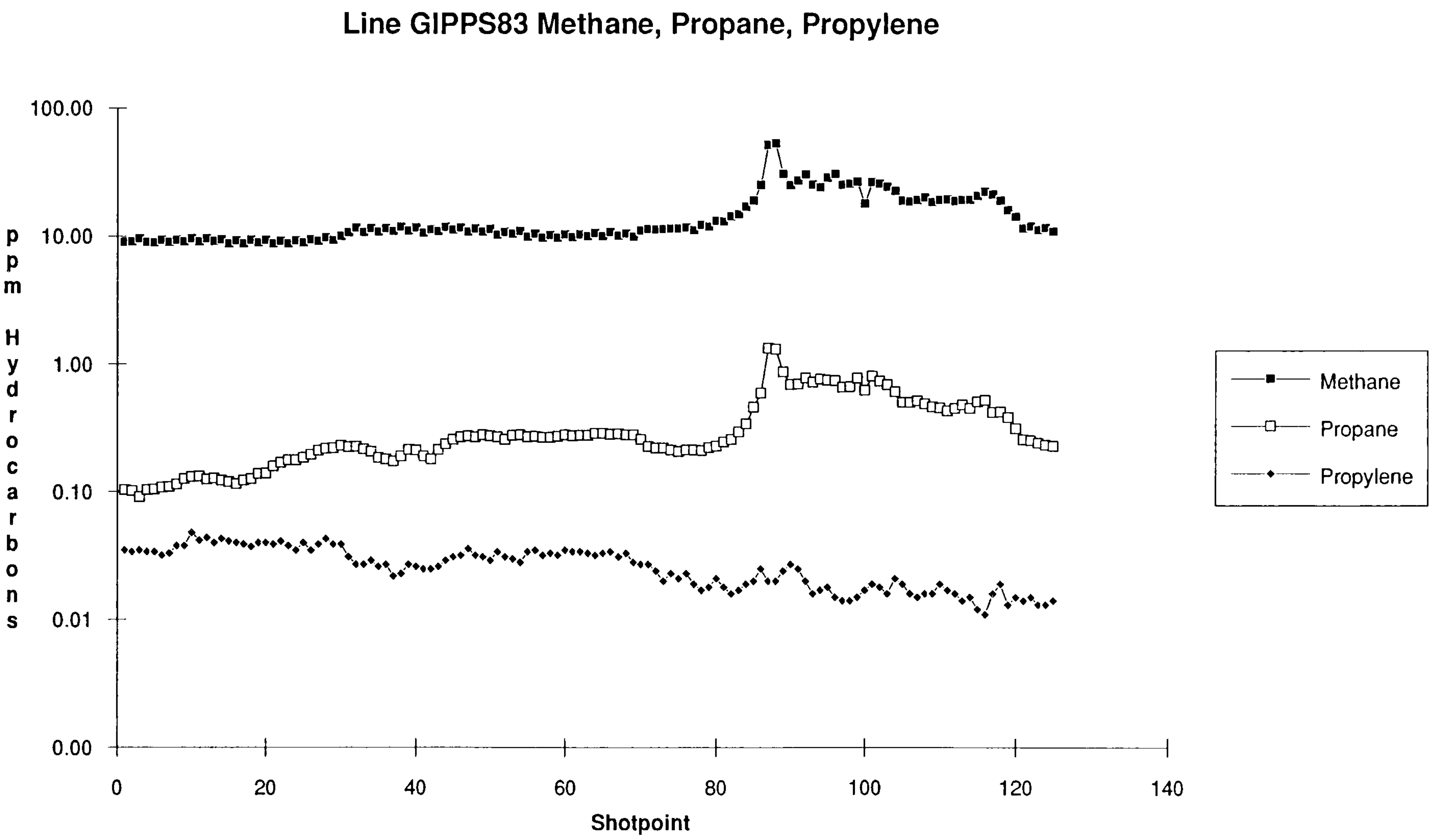
Notes

Strong anomaly towards end of line with C1 to 53ppm, C2 to 3.1ppm, some C5+ enrichment.
Probably due to natural hydrocarbon seepage.



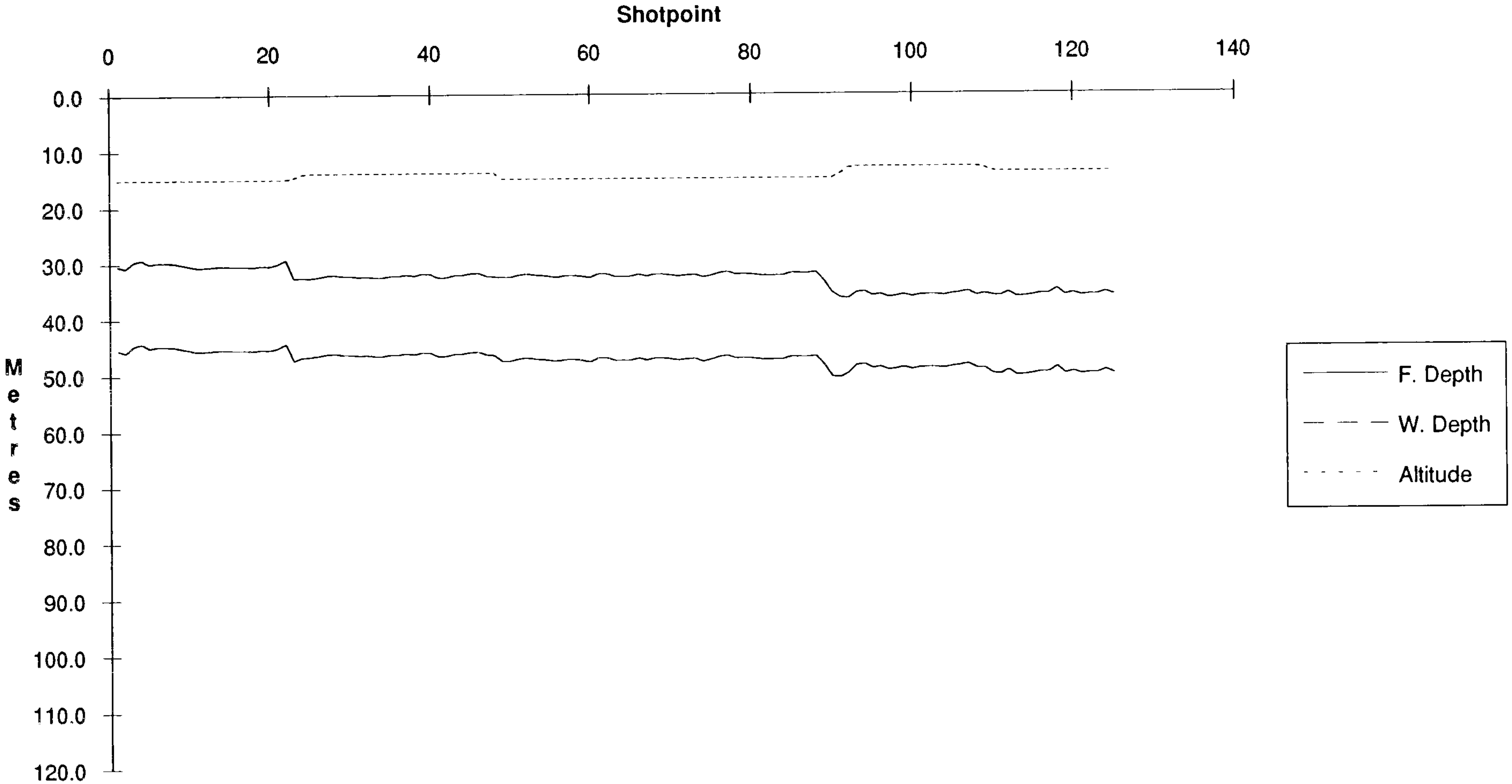
Line GIPPS83 THC, Methane
ppm Hydrocarbons
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
0
20
40
60
80
100
120
140
Shotpoint
THC
Methane


Line GIPPS83 Methane, Ethane, Ethylene
ppm Hydrocarbons
100.00
10.00
1.00
0.10
0.01
0.00
0
20
40
60
80
100
120
140
Shotpoint
Methane
Ethane
Ethylene



Line GIPPS83 Methane, Propane, Propylene
ppm Hydrocarbons
100.00
10.00
1.00
0.10
0.01
0.00
0
20
40
60
80
100
120
140
Shotpoint
Methane
Propane
Propylene

Line GIPPS83 Depths, Altitude



Line Summary

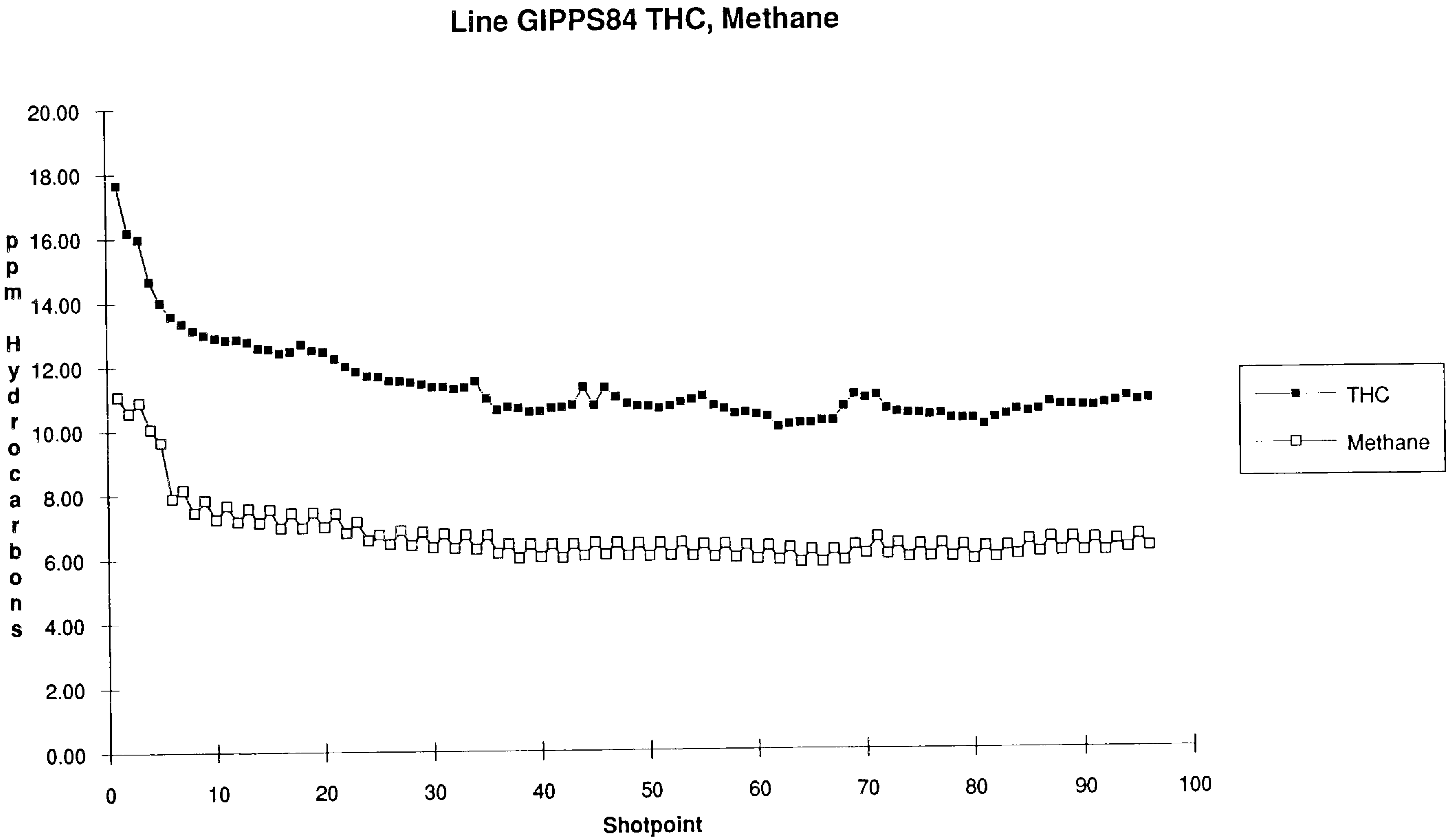
Line Number gipps84
No. of Shotpoints 96

	Shotpoint	Date	Time	Latitude		Longitude	
Start	1	25-Feb-89	18:55:29	38	09.310	148	26.718
End	96	25-Feb-89	22:12:51	38	15.582	148	30.017

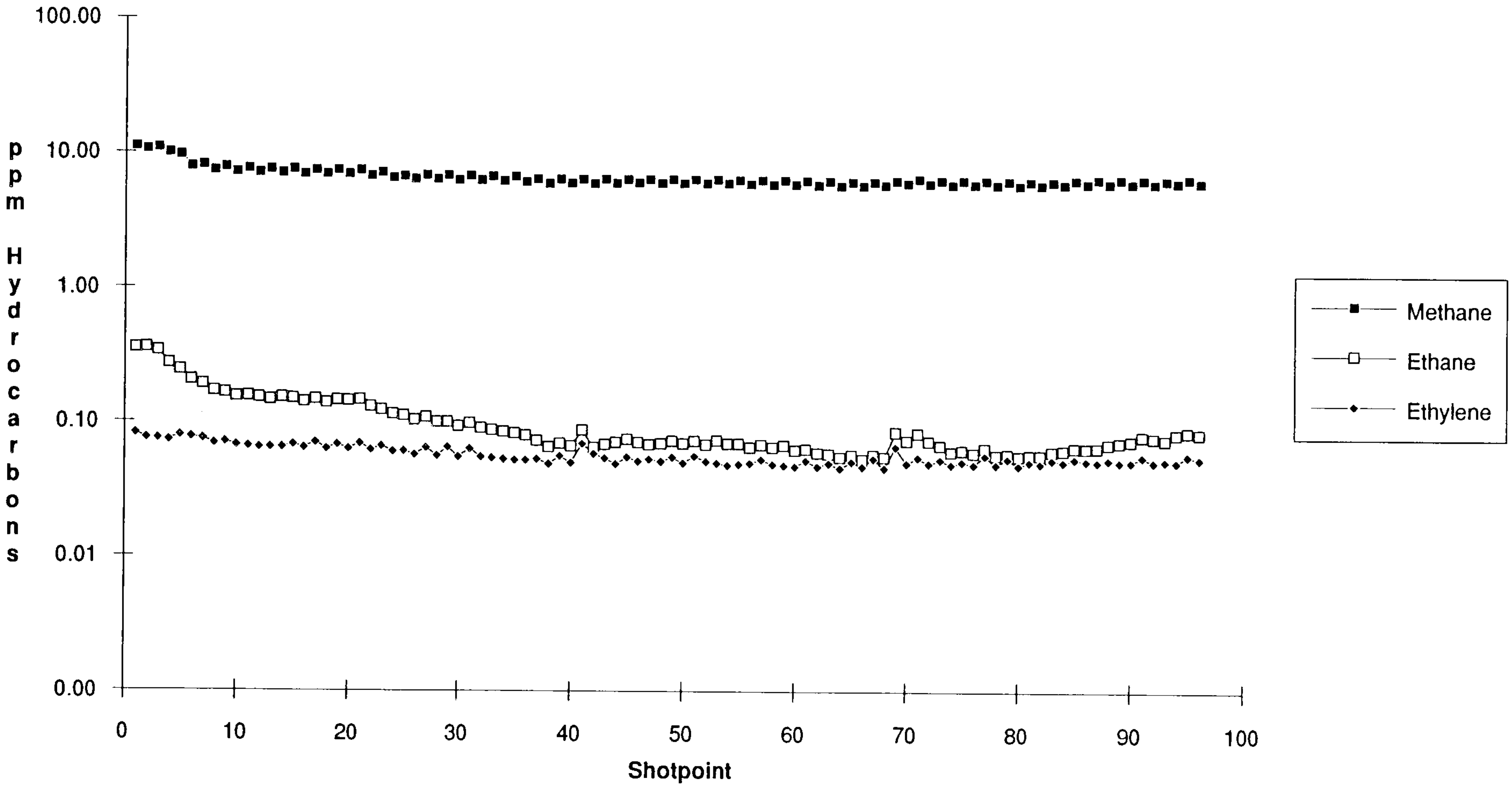
	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	11.323	6.667	0.100	0.057	0.071	0.010	0.015	0.024	N/A	N/A	N/A	N/A	2.890
Std. Dev.	1.373	1.037	0.062	0.009	0.042	0.002	0.009	0.014	N/A	N/A	N/A	N/A	1.090
Minimum	9.999	5.773	0.053	0.046	0.030	0.004	0.004	0.005	N/A	N/A	N/A	N/A	1.674
Maximum	17.648	11.076	0.357	0.082	0.221	0.018	0.042	0.072	N/A	N/A	N/A	N/A	6.090

	Salinity	Temp.	F. Depth	W.Depth	Altitude
Mean	30.811	17.498	64.757	82.266	17.506
Std. Dev.	0.398	0.503	14.145	16.596	3.037
Minimum	30.310	16.930	36.000	47.600	11.000
Maximum	32.380	19.520	79.800	99.800	20.000

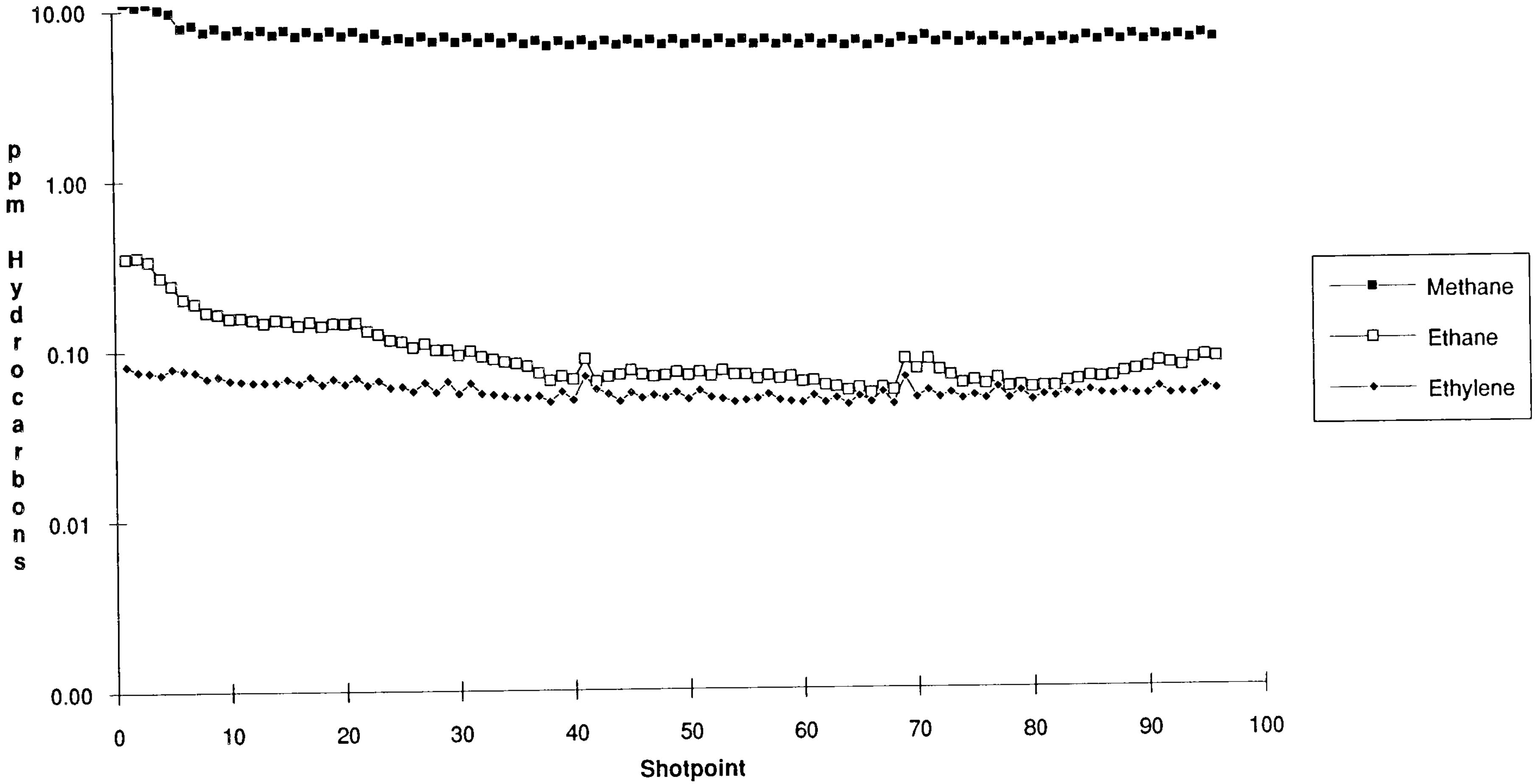
Notes Subtle anomaly at beginning of line due to anomaly which peaked at the end of Line Gipps83.

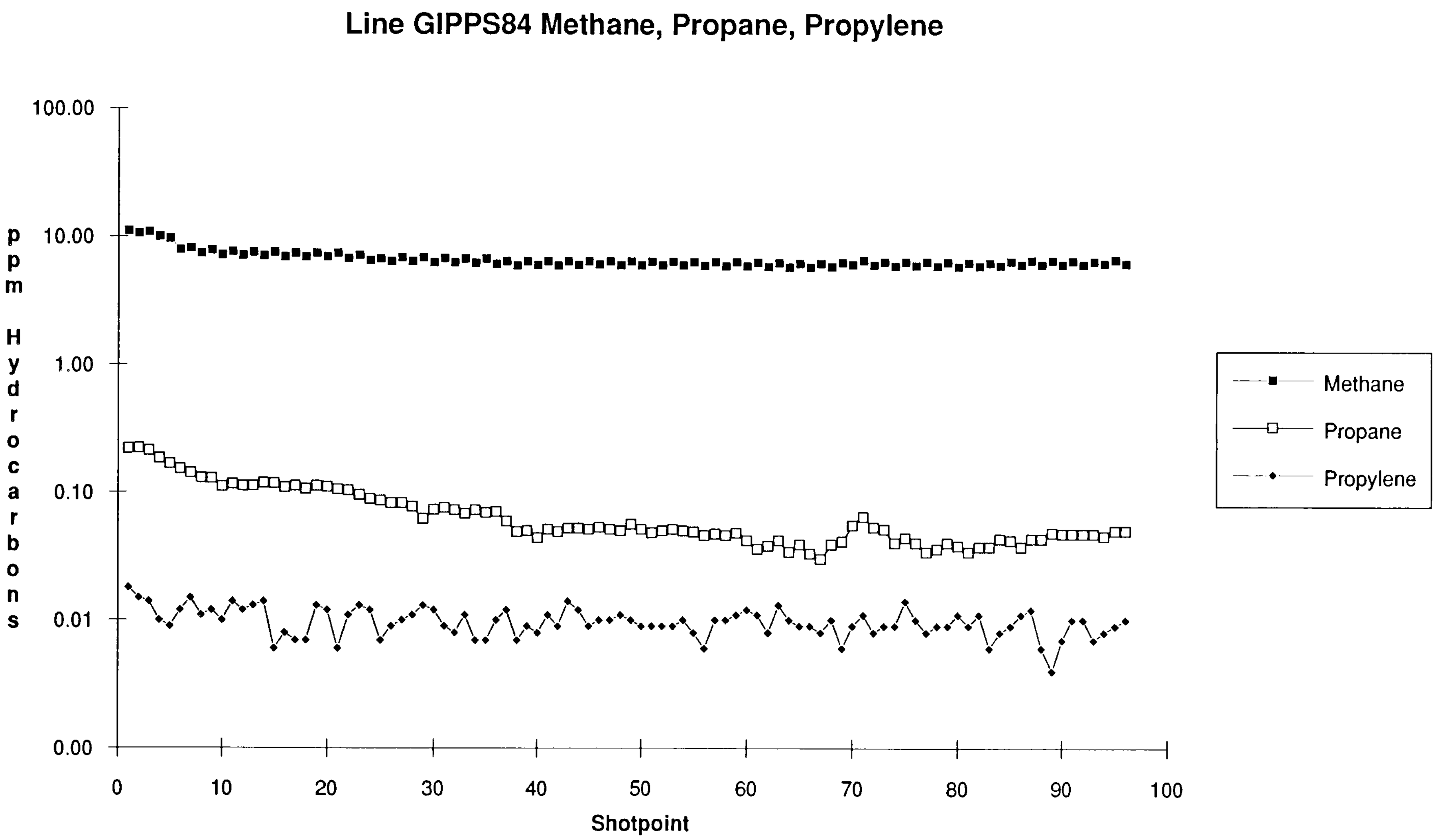

Line GIPPS84 THC, Methane
ppm Hydrocarbons
20.00
18.00
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
0
10
20
30
40
50
60
70
80
90
100
Shotpoint
THC
Methane

Line GIPPS84 Methane, Ethane, Ethylene

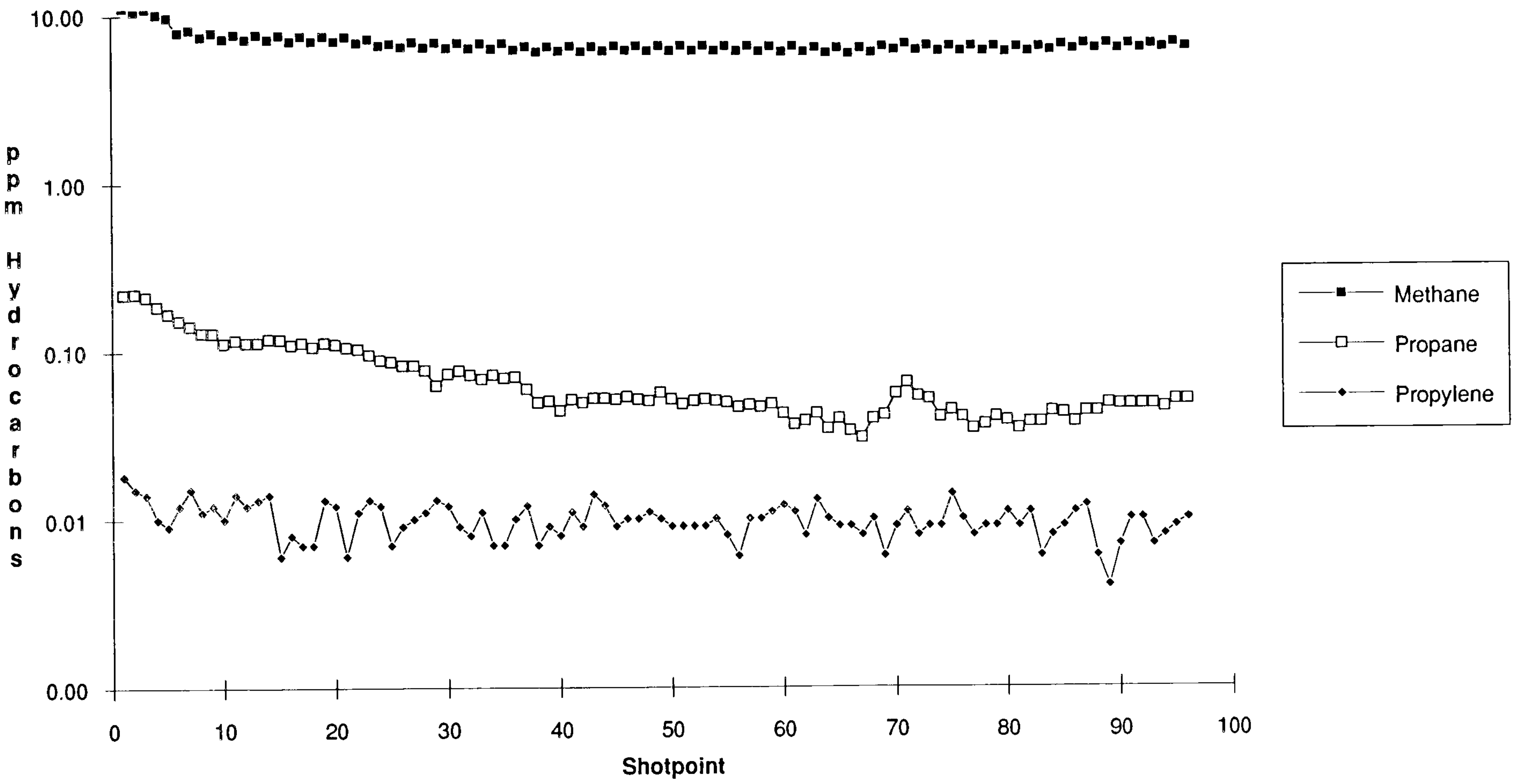


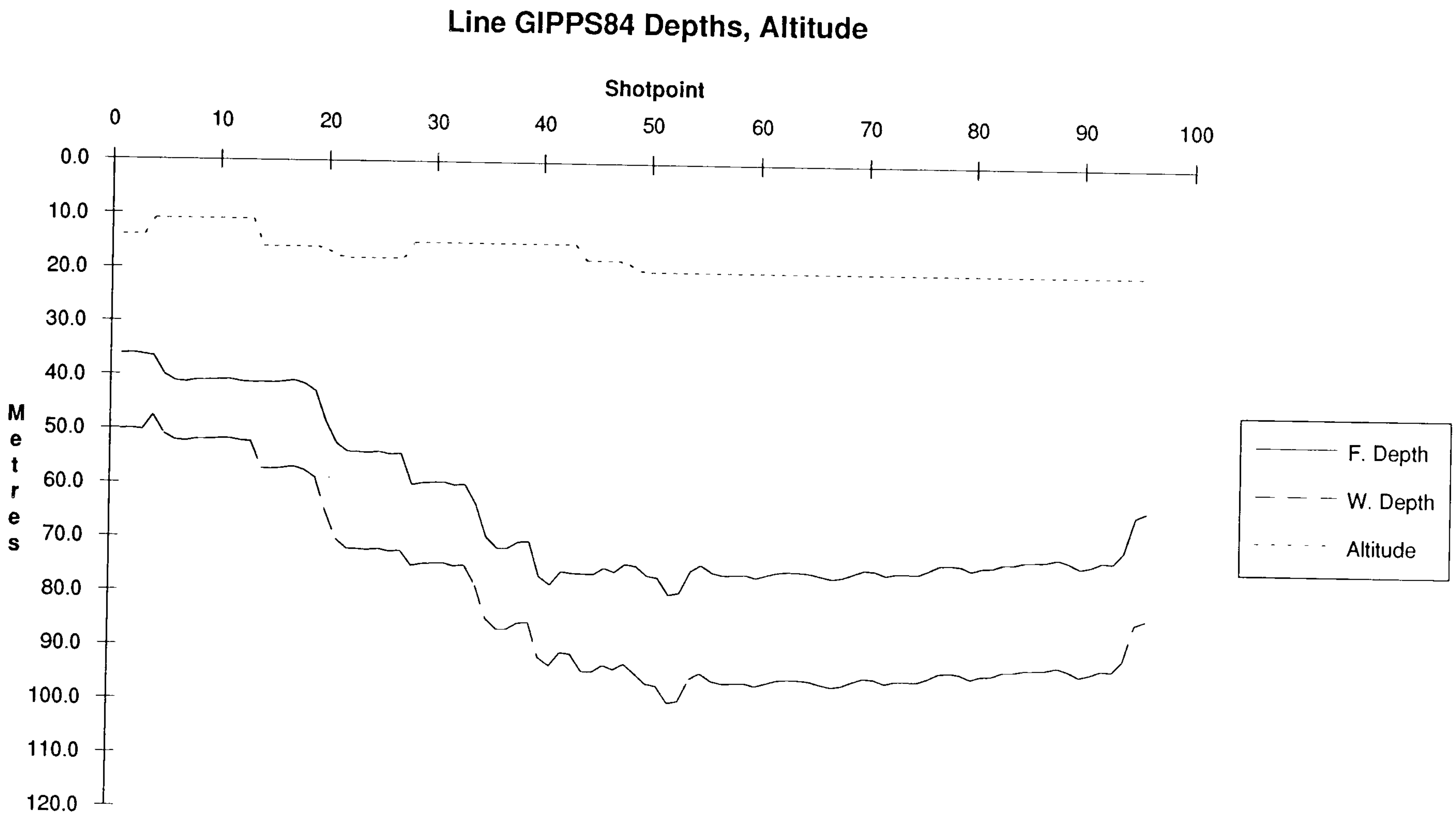
Line GIPPS84 Methane, Ethane, Ethylene




Line GIPPS84 Methane, Propane, Propylene
100.00
10.00
1.00
0.10
0.01
0.00
ppm Hydrocarbons
0
10
20
30
40
50
60
70
80
90
100
Shotpoint
Methane
Propane
Propylene

Line GIPPS84 Methane, Propane, Propylene




Line GIPPS84 Depths, Altitude
Shotpoint
0
10
20
30
40
50
60
70
80
90
100
0.0
10.0
20.0
30.0
40.0
50.0
60.0
70.0
80.0
90.0
100.0
110.0
120.0
Metres
F. Depth
W. Depth
Altitude

Line Summary

Line Number	gipps85
No. of Shotpoints	158

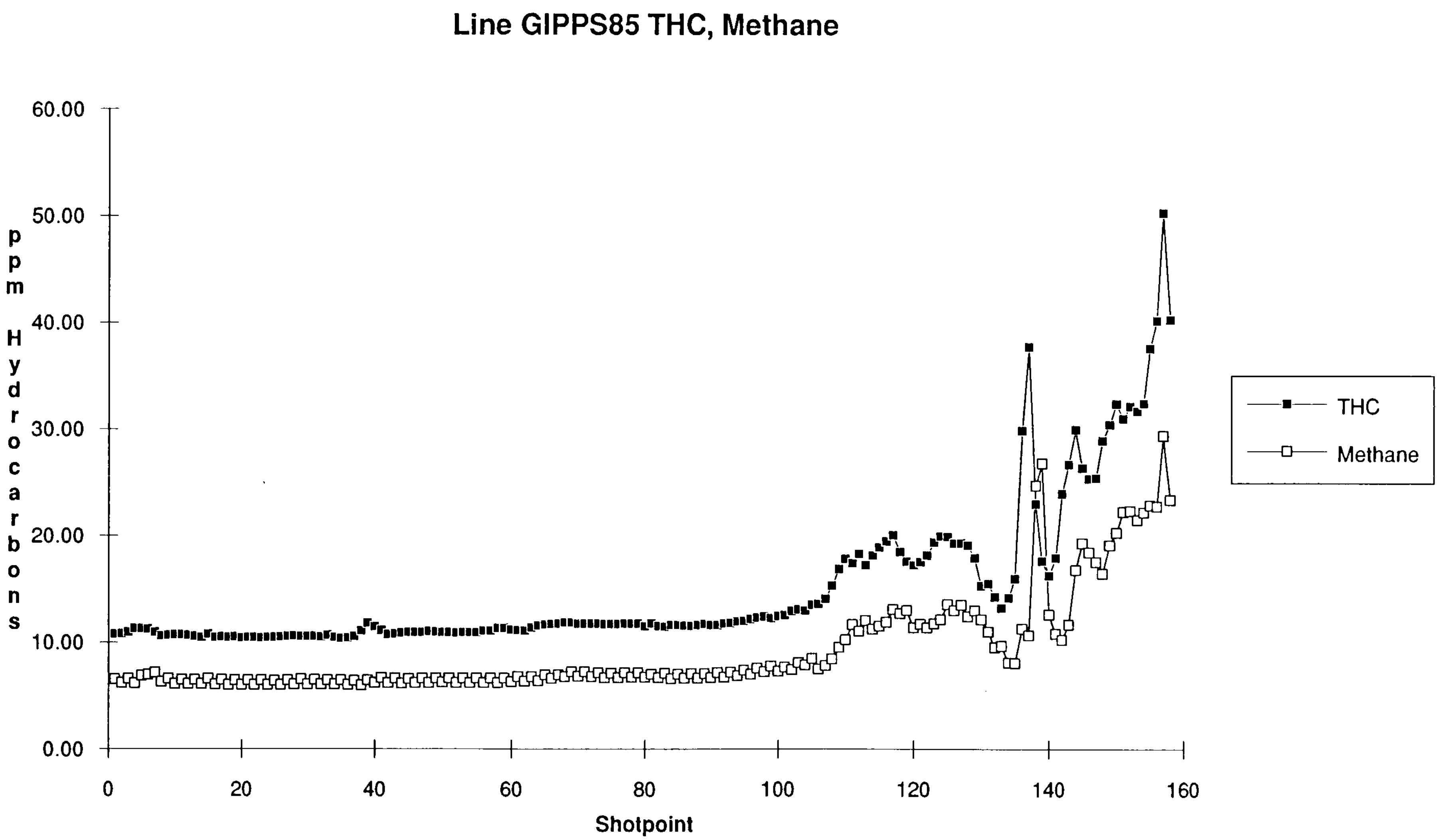
	Shotpoint	Date	Time	Latitude		Longitude	
Start	1	25-Feb-89	22:14:30	38	15.640	148	29.904
End	158	26-Feb-89	03:40:15	37	59.196	148	46.025

	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	15.107	9.262	0.275	0.063	0.152	0.011	0.023	0.043	N/A	N/A	N/A	N/A	4.136
Std. Dev.	7.268	4.863	0.330	0.008	0.154	0.002	0.018	0.037	N/A	N/A	N/A	N/A	1.844
Minimum	10.378	5.965	0.066	0.049	0.043	0.005	0.004	0.006	N/A	N/A	N/A	N/A	2.041
Maximum	50.275	29.393	1.603	0.098	0.769	0.015	0.090	0.194	N/A	N/A	N/A	N/A	8.969

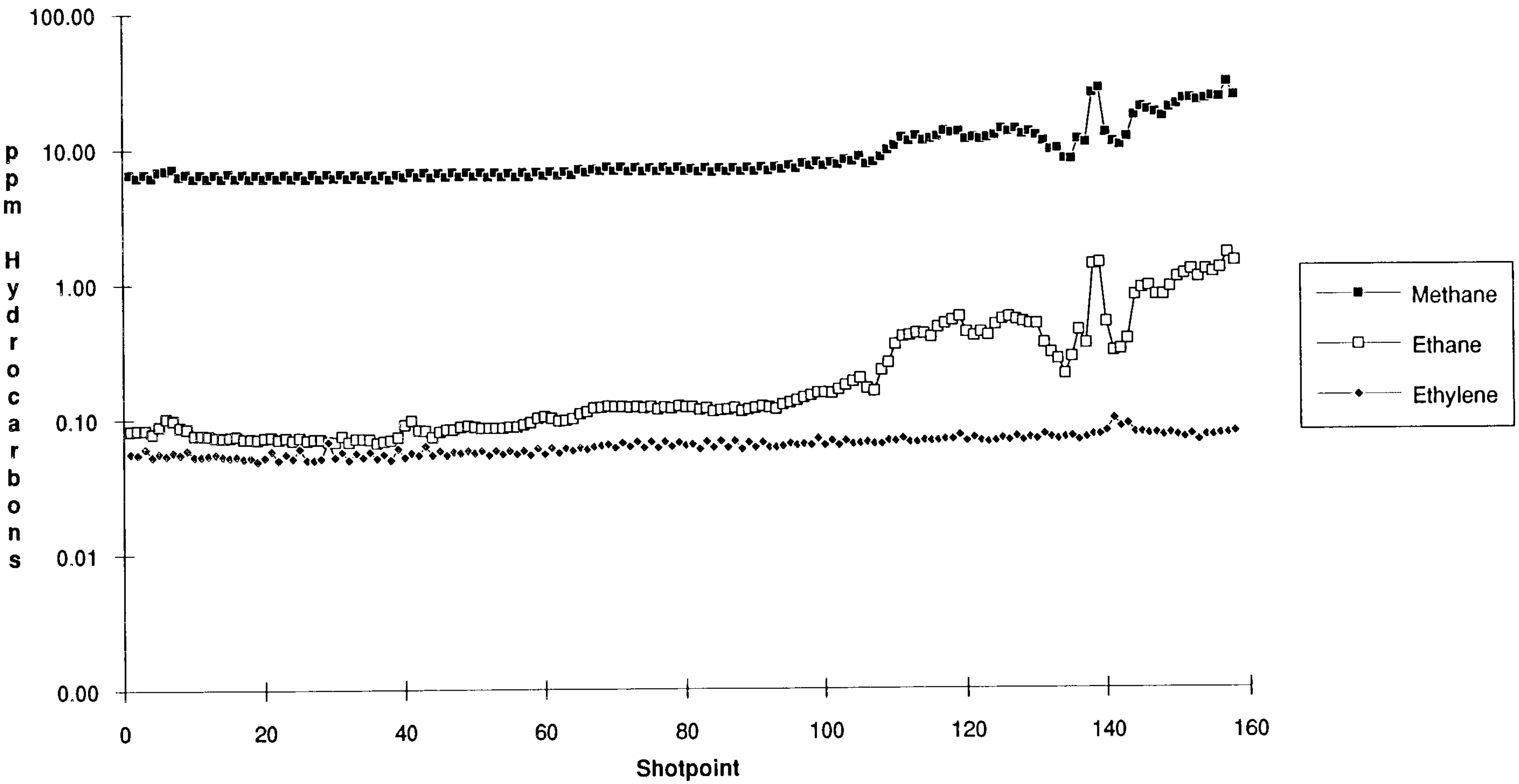
	Salinity	Temp.	F. Depth	W.Depth	Altitude
Mean	31.090	17.856	64.793	77.103	12.310
Std. Dev.	0.329	0.418	7.065	8.590	1.935
Minimum	30.600	17.190	48.000	57.000	9.000
Maximum	32.550	19.670	73.600	86.600	20.000

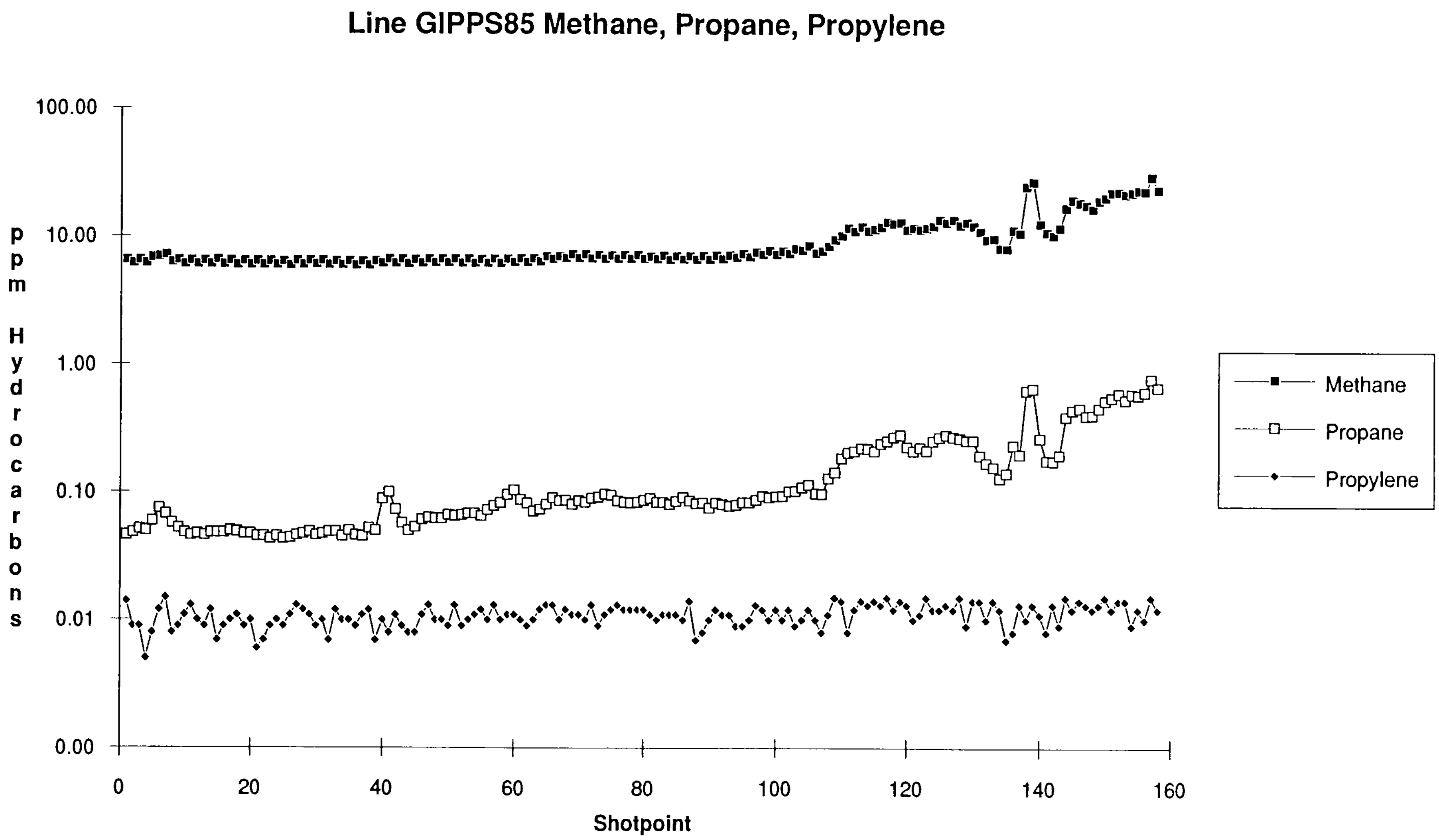
Notes

Moderately strong anomaly towards end of line with C1 to 29ppm, C2 to 1.4ppm, some C5+ enrichment.
While anomaly is associated with decreasing fish depth, it is probably due to natural hydrocarbon seepage.

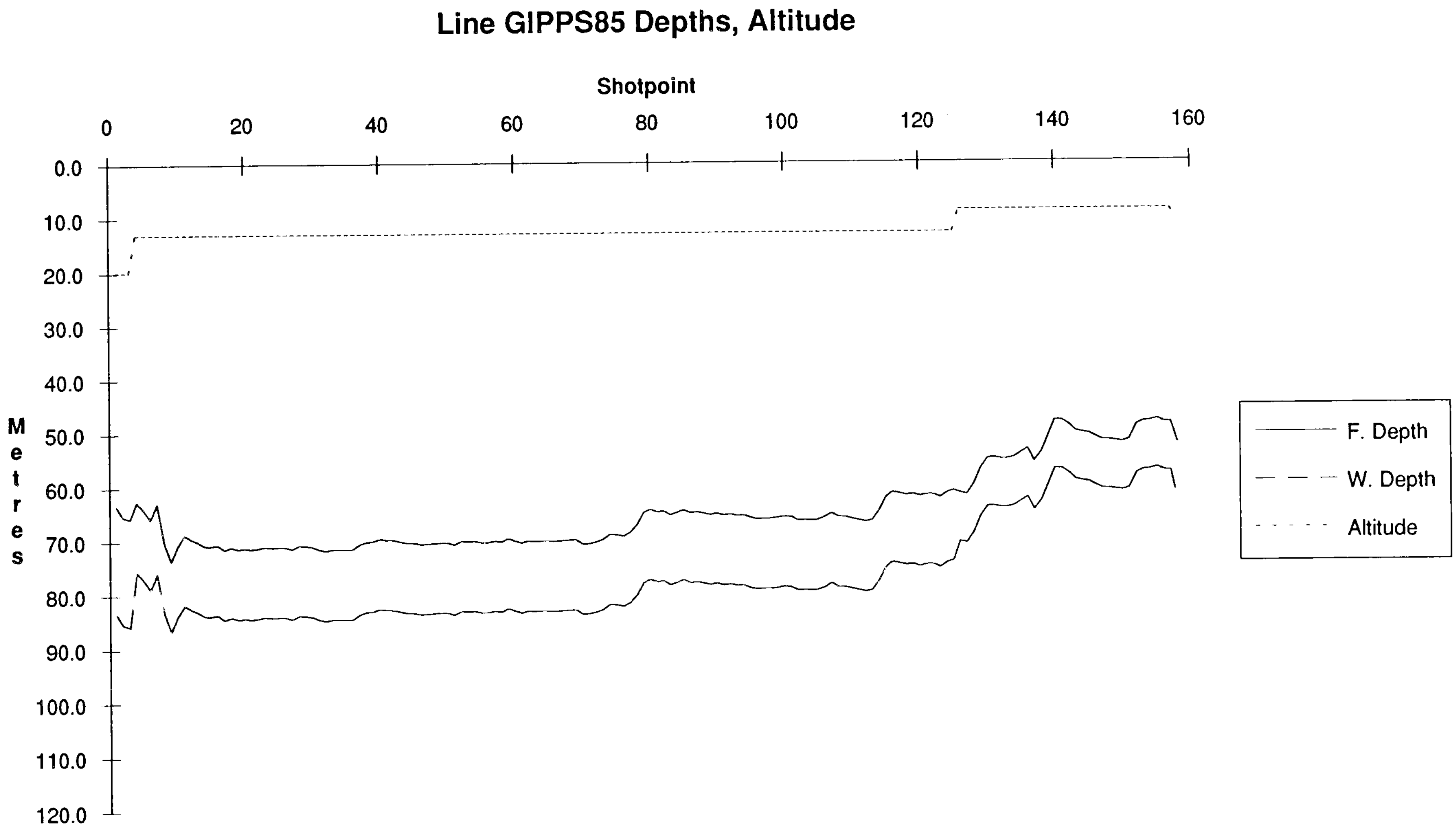

Line GIPPS85 THC, Methane
ppm Hydrocarbons
60.00
50.00
40.00
30.00
20.00
10.00
0.00
0
20
40
60
80
100
120
140
160
Shotpoint
THC
Methane

Line GIPPS85 Methane, Ethane, Ethylene





Line GIPPS85 Methane, Propane, Propylene
100.00
10.00
1.00
0.10
0.01
0.00
ppm Hydrocarbons
0
20
40
60
80
100
120
140
160
Shotpoint
Methane
Propane
Propylene


Line GIPPS85 Depths, Altitude
Shotpoint
0
20
40
60
80
100
120
140
160
0.0
10.0
20.0
30.0
40.0
50.0
60.0
70.0
80.0
90.0
100.0
110.0
120.0
Metres
F. Depth
W. Depth
Altitude

Line Summary

Line Number	gipps86
No. of Shotpoints	76

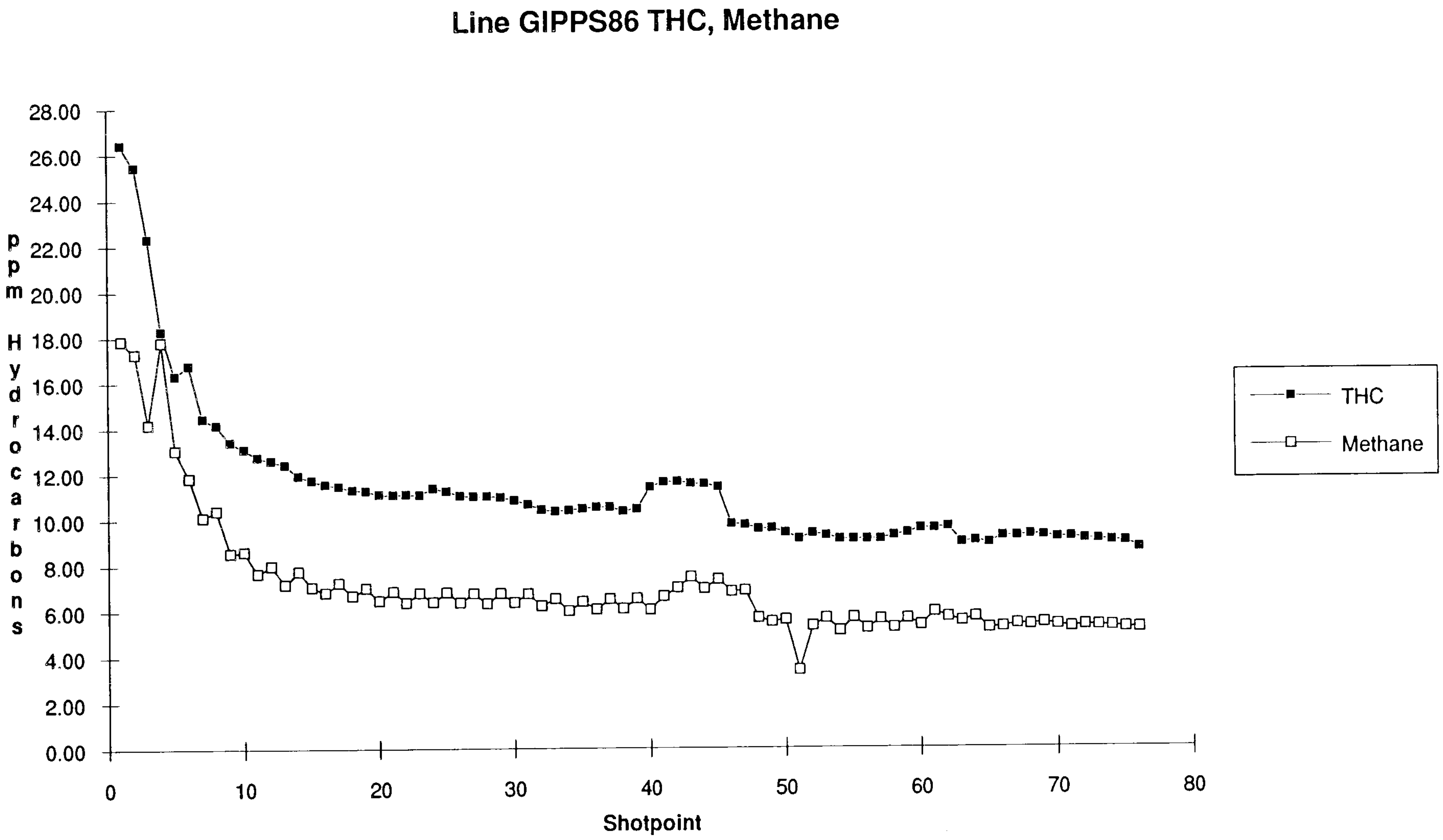
	Shotpoint	Date	Time	Latitude		Longitude	
Start	1	26-Feb-89	03:52:19	38	00.071	148	45.851
End	77	26-Feb-89	06:54:05	38	08.186	148	51.809

	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	11.293	7.022	0.143	0.056	0.088	0.011	0.014	0.025	N/A	N/A	N/A	N/A	3.087
Std. Dev.	3.320	2.765	0.177	0.012	0.090	0.002	0.014	0.025	N/A	N/A	N/A	N/A	1.646
Minimum	8.657	3.377	0.040	0.039	0.023	0.006	0.000	0.000	N/A	N/A	N/A	N/A	1.200
Maximum	26.397	17.852	0.881	0.087	0.446	0.018	0.063	0.115	N/A	N/A	N/A	N/A	7.765

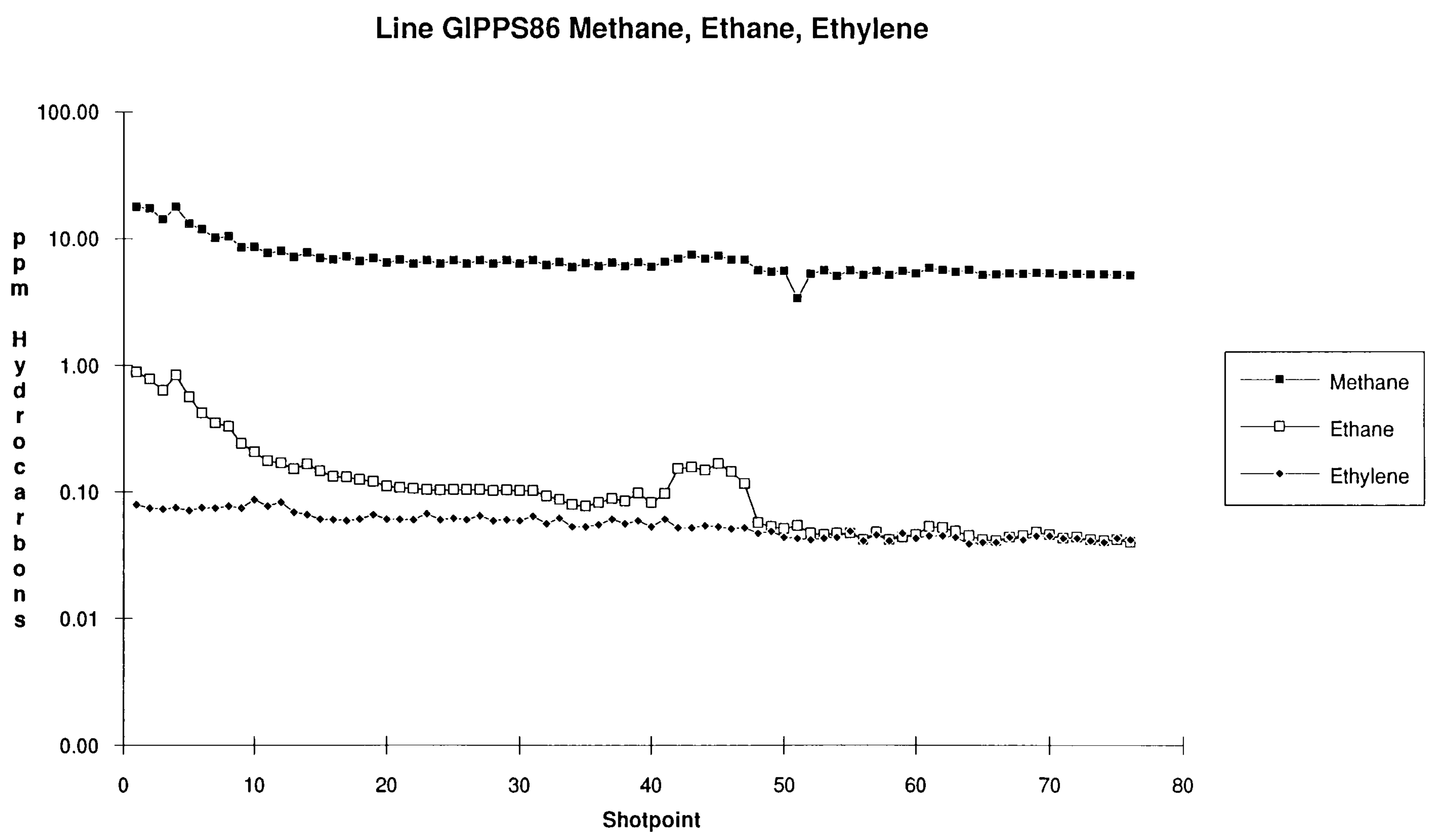
	Salinity	Temp.	F. Depth	W.Depth	Altitude
Mean	30.847	17.545	80.241	102.245	22.001
Std. Dev.	0.462	0.572	17.242	18.278	1.441
Minimum	30.270	16.820	41.500	62.500	16.000
Maximum	32.510	19.660	100.800	123.800	25.000

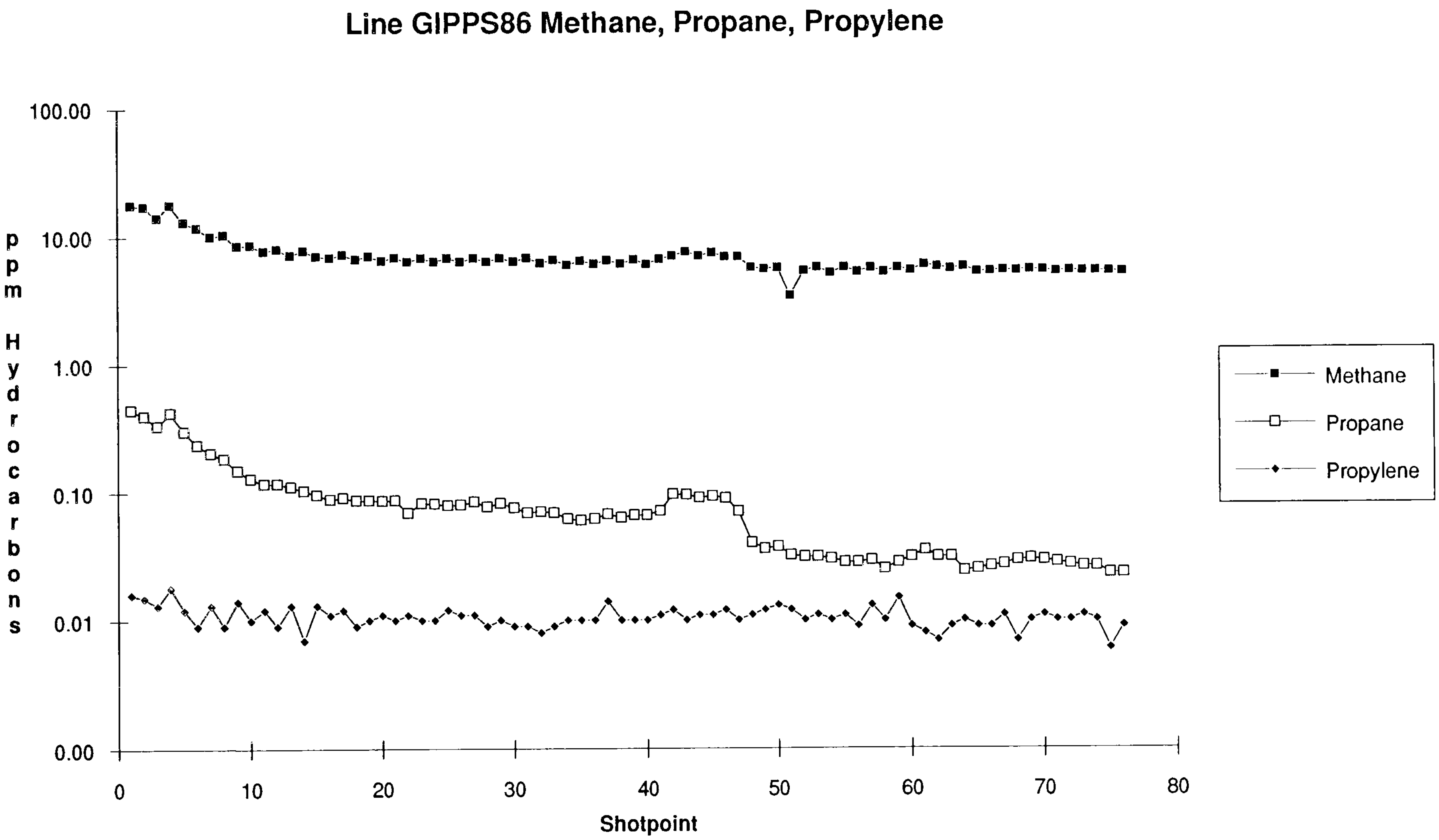
Notes

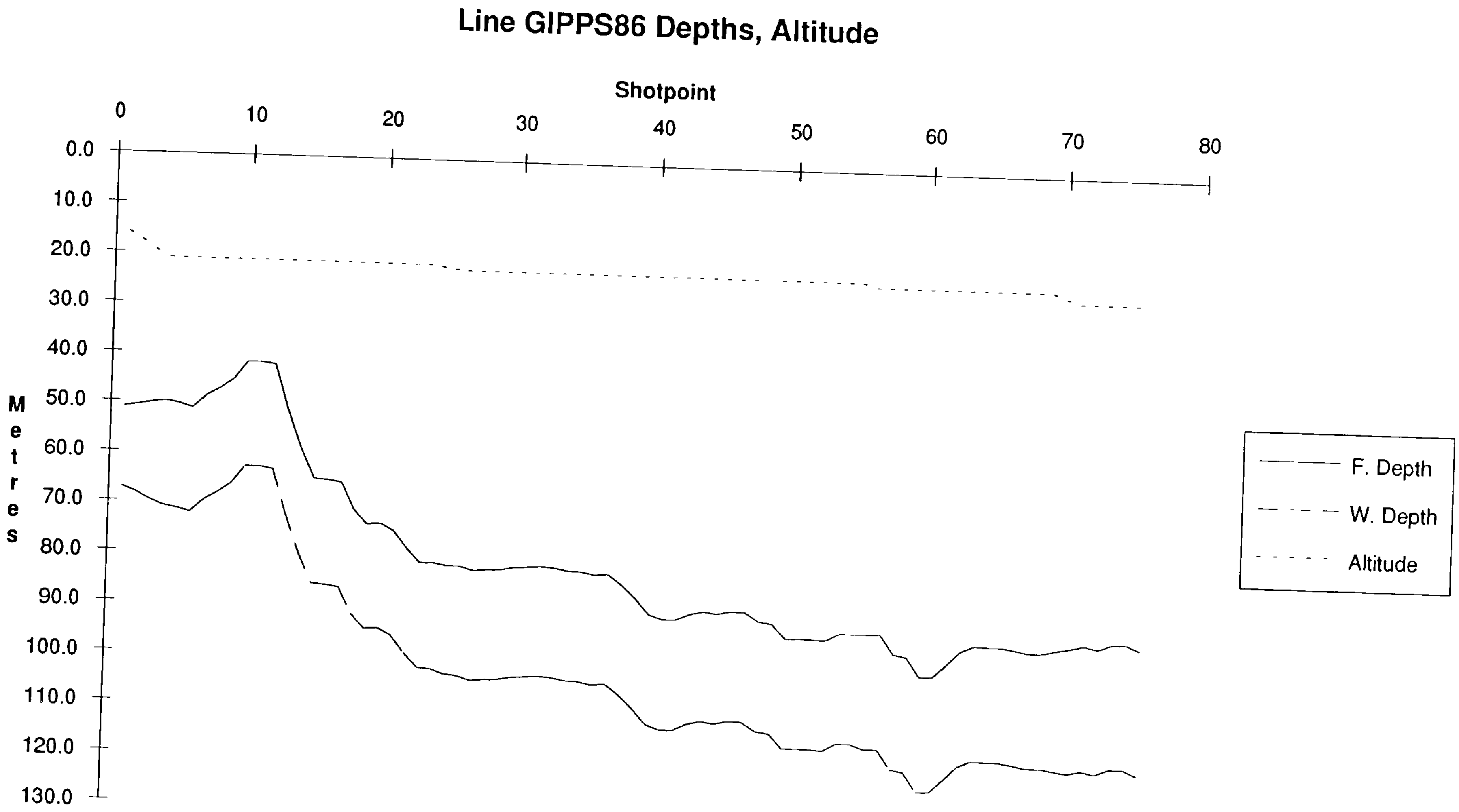
Moderately strong anomaly at beginning of line due to anomaly which peaked at the end of Line Gipps85.
End of anomaly corresponds with increasing fish depth. Probably due to natural hydrocarbon seepage.



Line GIPPS86 THC, Methane
ppm Hydrocarbons
28.00
26.00
24.00
22.00
20.00
18.00
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
0
10
20
30
40
50
60
70
80
Shotpoint
THC
Methane


Line GIPPS86 Methane, Ethane, Ethylene
ppm Hydrocarbons
100.00
10.00
1.00
0.10
0.01
0.00
0
10
20
30
40
50
60
70
80
Shotpoint
Methane
Ethane
Ethylene


Line GIPPS86 Methane, Propane, Propylene
ppm Hydrocarbons
100.00
10.00
1.00
0.10
0.01
0.00
0
10
20
30
40
50
60
70
80
Shotpoint
Methane
Propane
Propylene



Line GIPPS86 Depths, Altitude
Shotpoint
0
10
20
30
40
50
60
70
80
Metres
0.0
10.0
20.0
30.0
40.0
50.0
60.0
70.0
80.0
90.0
100.0
110.0
120.0
130.0
F. Depth
W. Depth
Altitude

Line Summary

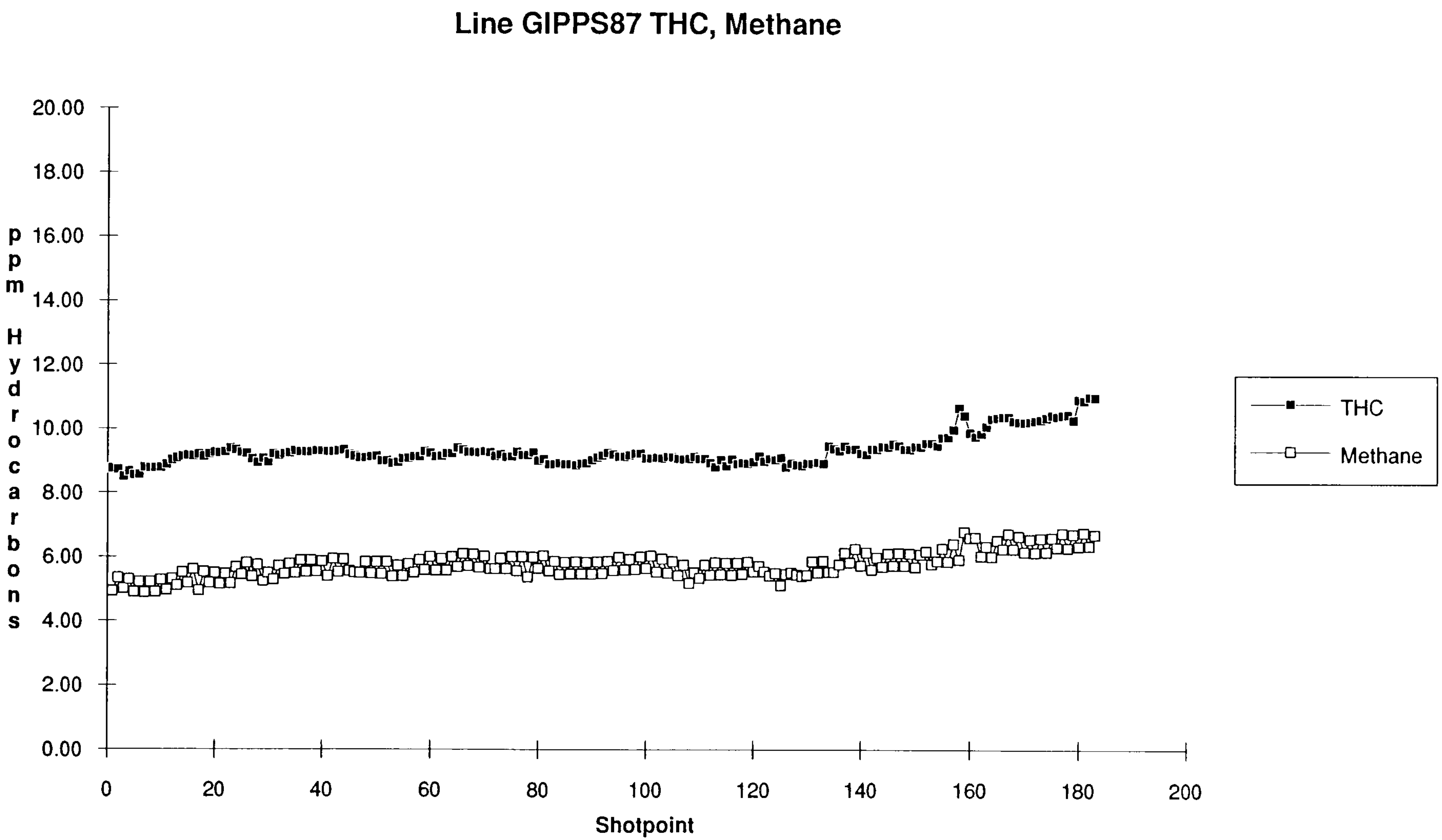
Line Number	gipps87
No. of Shotpoints	183

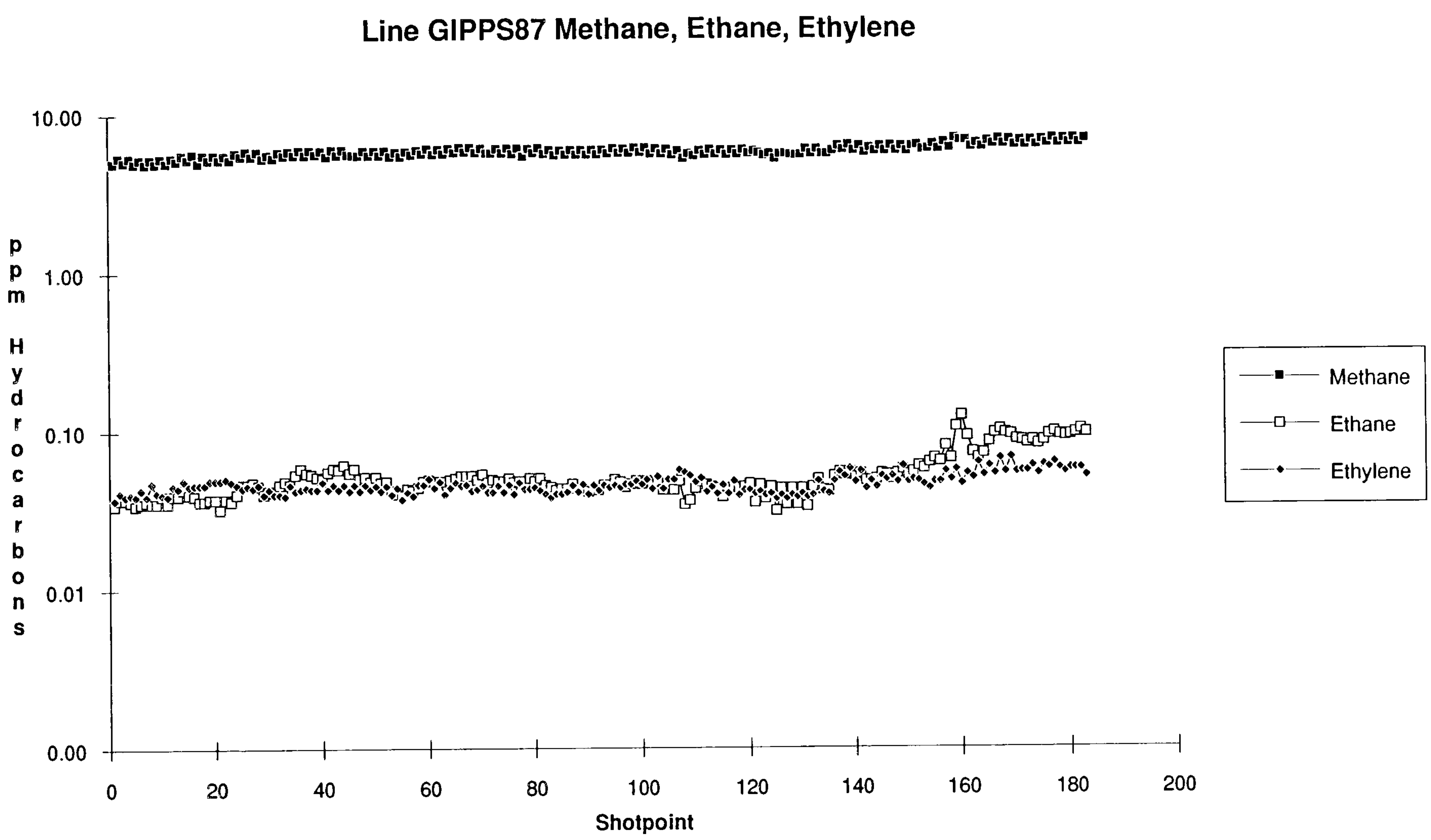
	Shotpoint	Date	Time	Latitude		Longitude	
Start	1	26-Feb-89	06:58:25	38	07.971	148	52.188
End	183	26-Feb-89	13:12:09	37	57.718	149	01.322

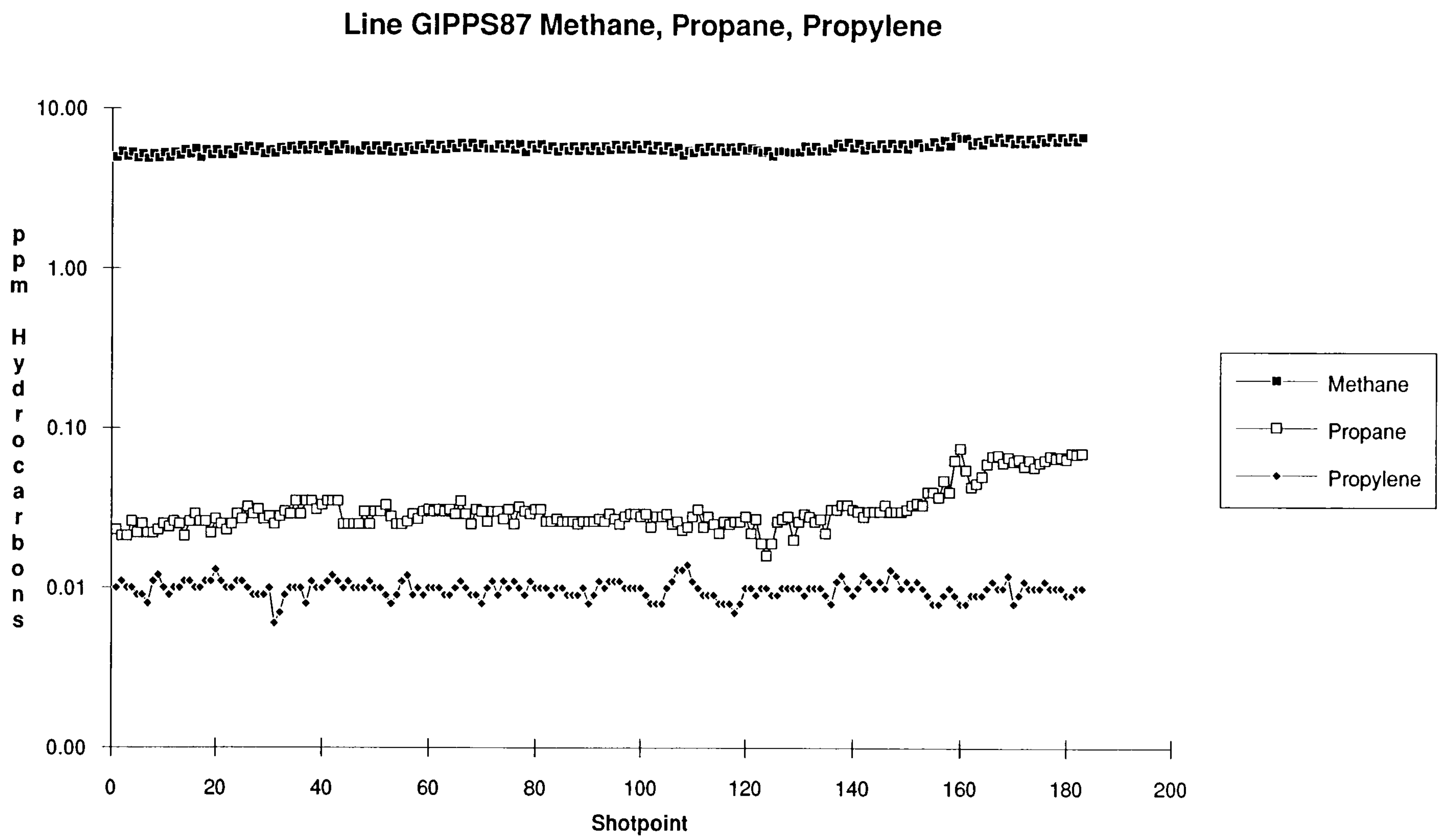
	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	9.308	5.741	0.052	0.046	0.033	0.010	0.002	0.004	N/A	N/A	N/A	N/A	1.531
Std. Dev.	0.494	0.408	0.017	0.006	0.013	0.001	0.004	0.007	N/A	N/A	N/A	N/A	0.520
Minimum	8.492	4.880	0.031	0.037	0.016	0.006	0.000	0.000	N/A	N/A	N/A	N/A	0.968
Maximum	10.997	6.783	0.122	0.067	0.075	0.014	0.015	0.026	N/A	N/A	N/A	N/A	3.206

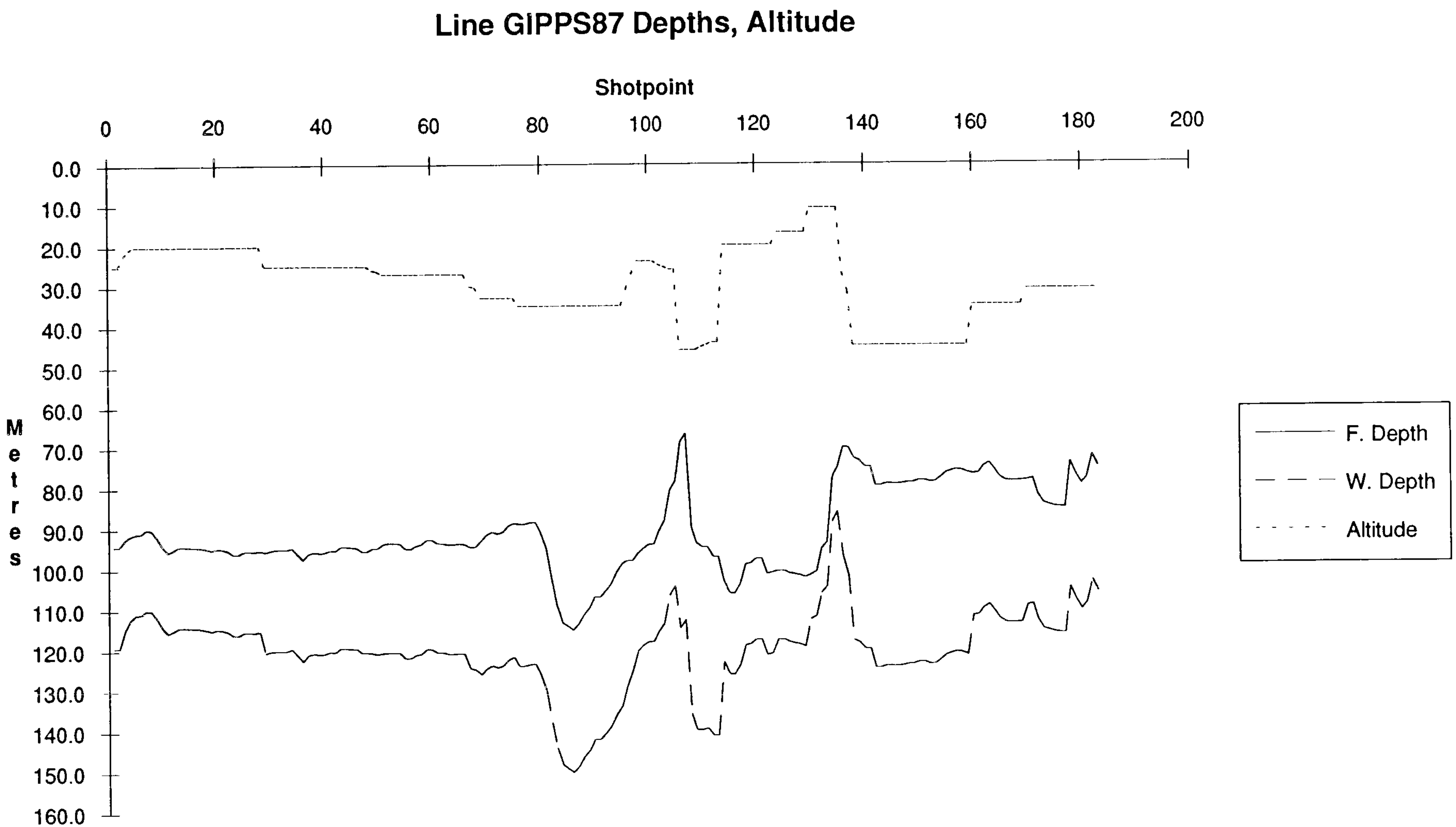
	Salinity	Temp.	F. Depth	W.Depth	Altitude
Mean	30.276	16.867	90.861	120.189	29.329
Std. Dev.	0.476	0.585	10.072	9.971	9.155
Minimum	29.630	16.090	66.700	86.200	11.000
Maximum	31.800	18.830	115.100	150.100	46.000

Notes: Very weak anomaly (C1 to C3) towards end of line correlates with decreasing fish depth. Probably an artefact of fish depth.


Line GIPPS87 THC, Methane
ppm Hydrocarbons
20.00
18.00
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
0
20
40
60
80
100
120
140
160
180
200
Shotpoint
THC
Methane


Line GIPPS87 Methane, Ethane, Ethylene
10.00
1.00
0.10
0.01
0.00
ppm Hydrocarbons
0
20
40
60
80
100
120
140
160
180
200
Shotpoint
Methane
Ethane
Ethylene


Line GIPPS87 Methane, Propane, Propylene
10.00
1.00
0.10
0.01
0.00
ppm Hydrocarbons
0
20
40
60
80
100
120
140
160
180
200
Shotpoint
Methane
Propane
Propylene


Line GIPPS87 Depths, Altitude
Shotpoint
0
20
40
60
80
100
120
140
160
180
200
Metres
0.0
10.0
20.0
30.0
40.0
50.0
60.0
70.0
80.0
90.0
100.0
110.0
120.0
130.0
140.0
150.0
160.0
F. Depth
W. Depth
Altitude

Line Summary

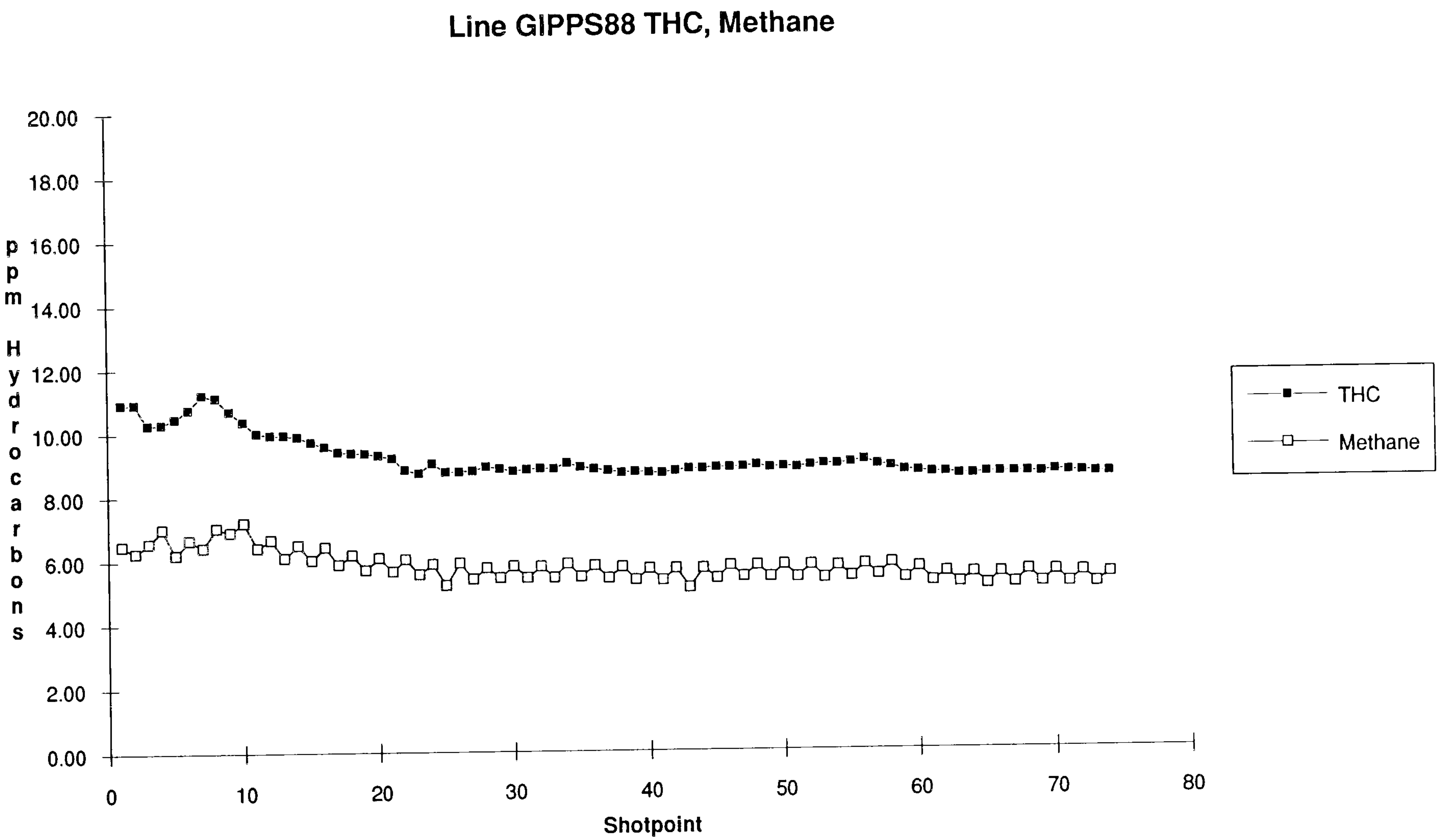
Line Number gipps88
No. of Shotpoints 74

	Shotpoint	Date	Time	Latitude		Longitude	
Start	1	26-Feb-89	13:15:36	37	58.037	149	01.192
End	74	26-Feb-89	15:44:52	38	10.100	149	01.312

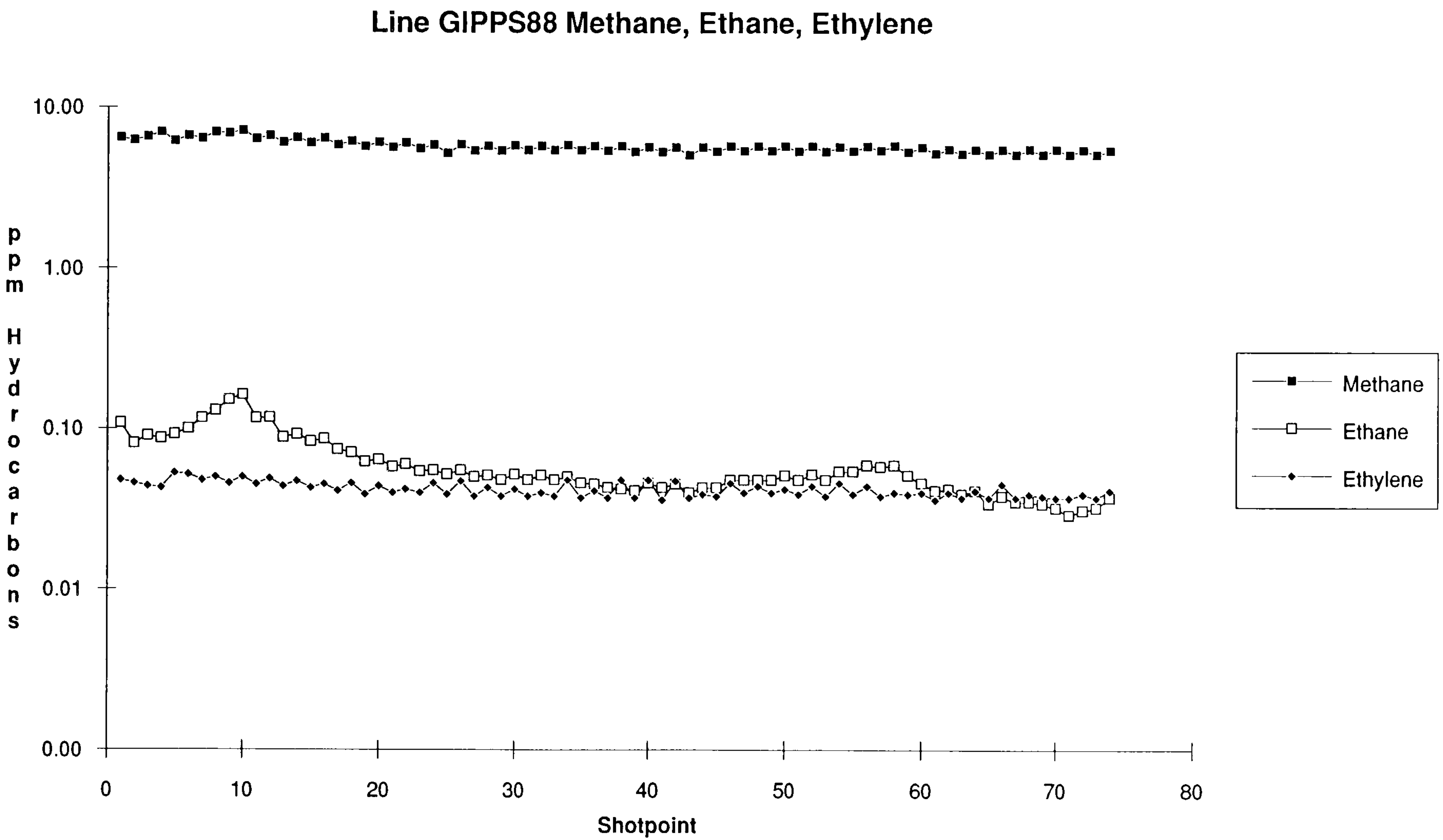
	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	9.132	5.748	0.060	0.042	0.037	0.008	0.004	0.008	N/A	N/A	N/A	N/A	1.788
Std. Dev.	0.714	0.500	0.028	0.004	0.018	0.001	0.006	0.009	N/A	N/A	N/A	N/A	0.767
Minimum	8.539	5.073	0.029	0.036	0.019	0.004	0.000	0.000	N/A	N/A	N/A	N/A	0.905
Maximum	11.198	7.176	0.162	0.053	0.094	0.011	0.017	0.032	N/A	N/A	N/A	N/A	3.991

	Salinity	Temp.	F. Depth	W.Depth	Altitude
Mean	30.091	16.627	96.100	117.692	21.595
Std. Dev.	0.341	0.400	8.233	8.002	2.807
Minimum	29.680	16.090	76.700	98.400	17.100
Maximum	30.840	17.550	105.100	132.400	30.000

Notes: Very weak anomaly at beginning of line which is part of anomaly recorded at end of line Gipps87. Probably an artefact of fish depth.

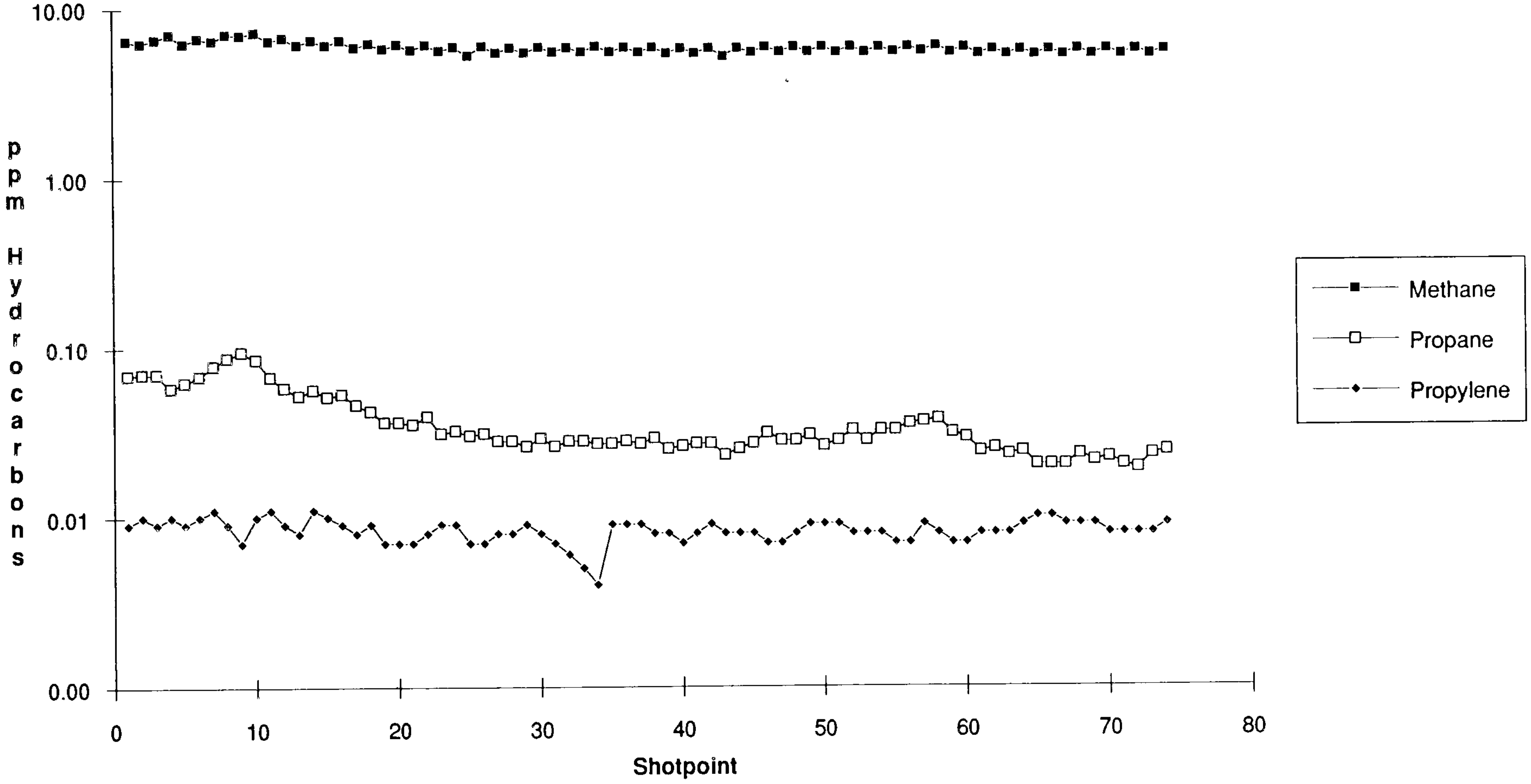


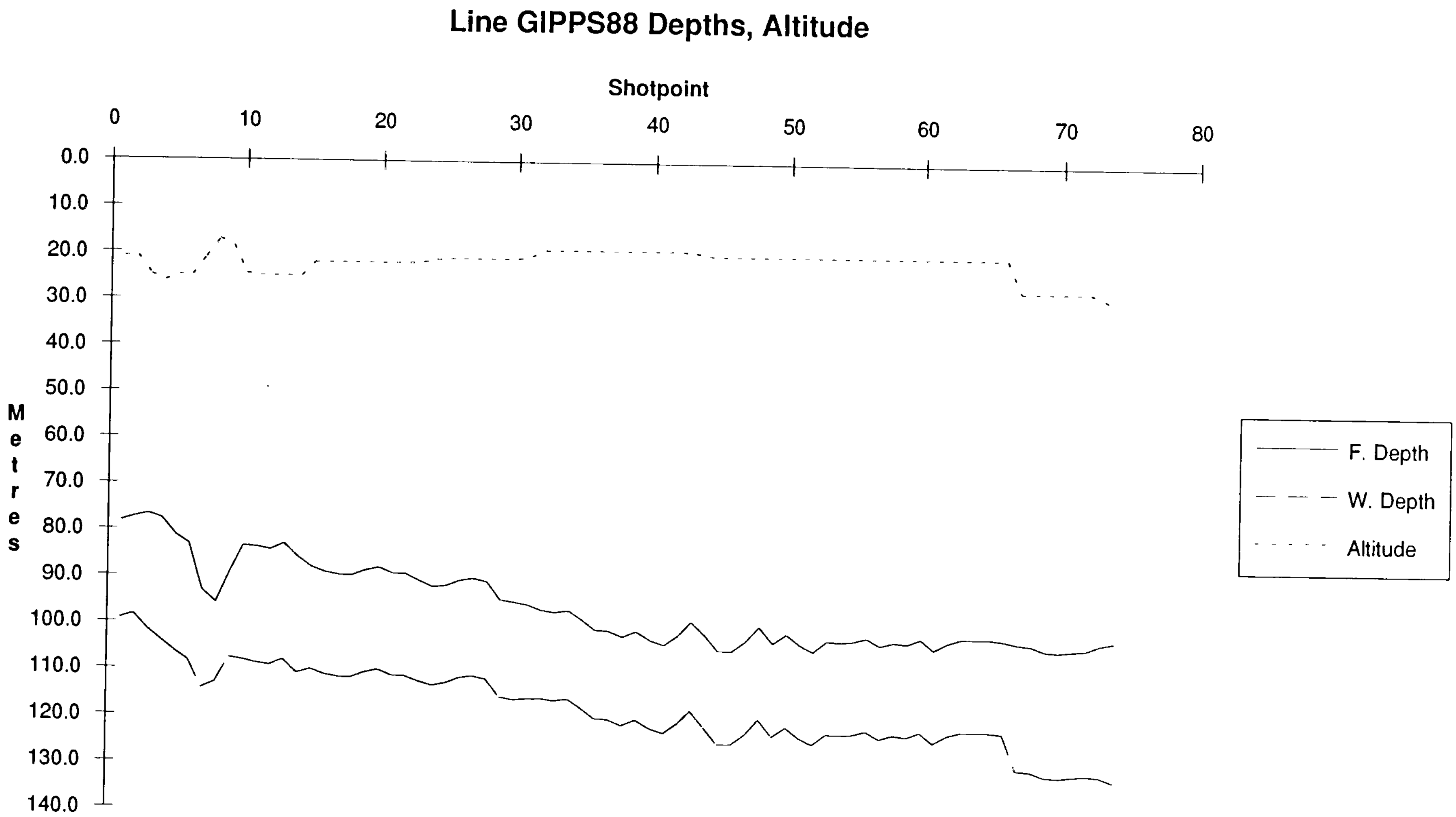
Line GIPPS88 THC, Methane
ppm Hydrocarbons
20.00
18.00
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
0
10
20
30
40
50
60
70
80
Shotpoint
THC
Methane



Line GIPPS88 Methane, Ethane, Ethylene
10.00
1.00
0.10
0.01
0.00
ppm Hydrocarbons
0
10
20
30
40
50
60
70
80
Shotpoint
Methane
Ethane
Ethylene

Line GIPPS88 Methane, Propane, Propylene




Line GIPPS88 Depths, Altitude
Shotpoint
0
10
20
30
40
50
60
70
80
0.0
10.0
20.0
30.0
40.0
50.0
60.0
70.0
80.0
90.0
100.0
110.0
120.0
130.0
140.0
Metres
F. Depth
W. Depth
Altitude

Line Summary

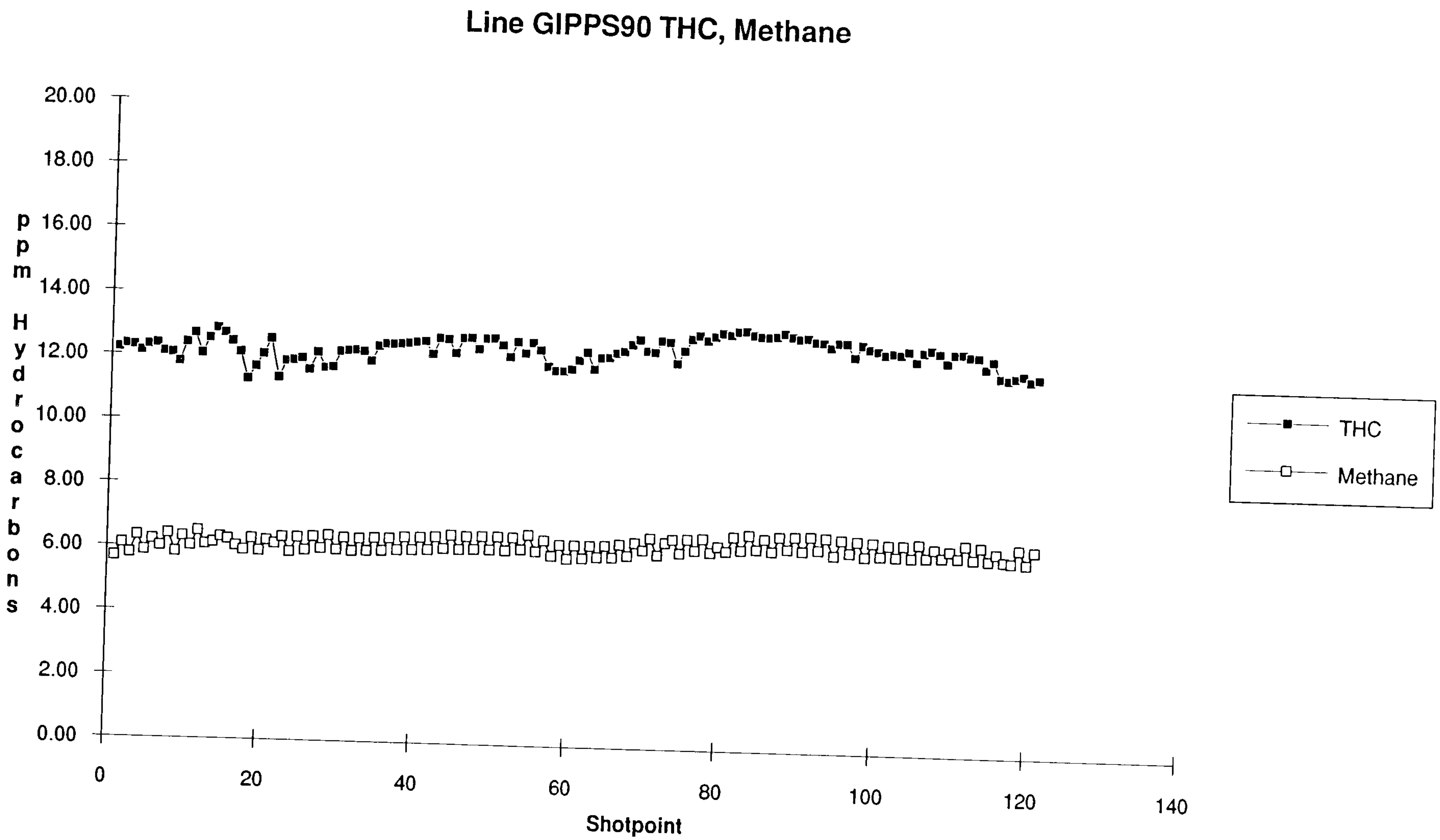
Line Number	gipps90
No. of Shotpoints	121

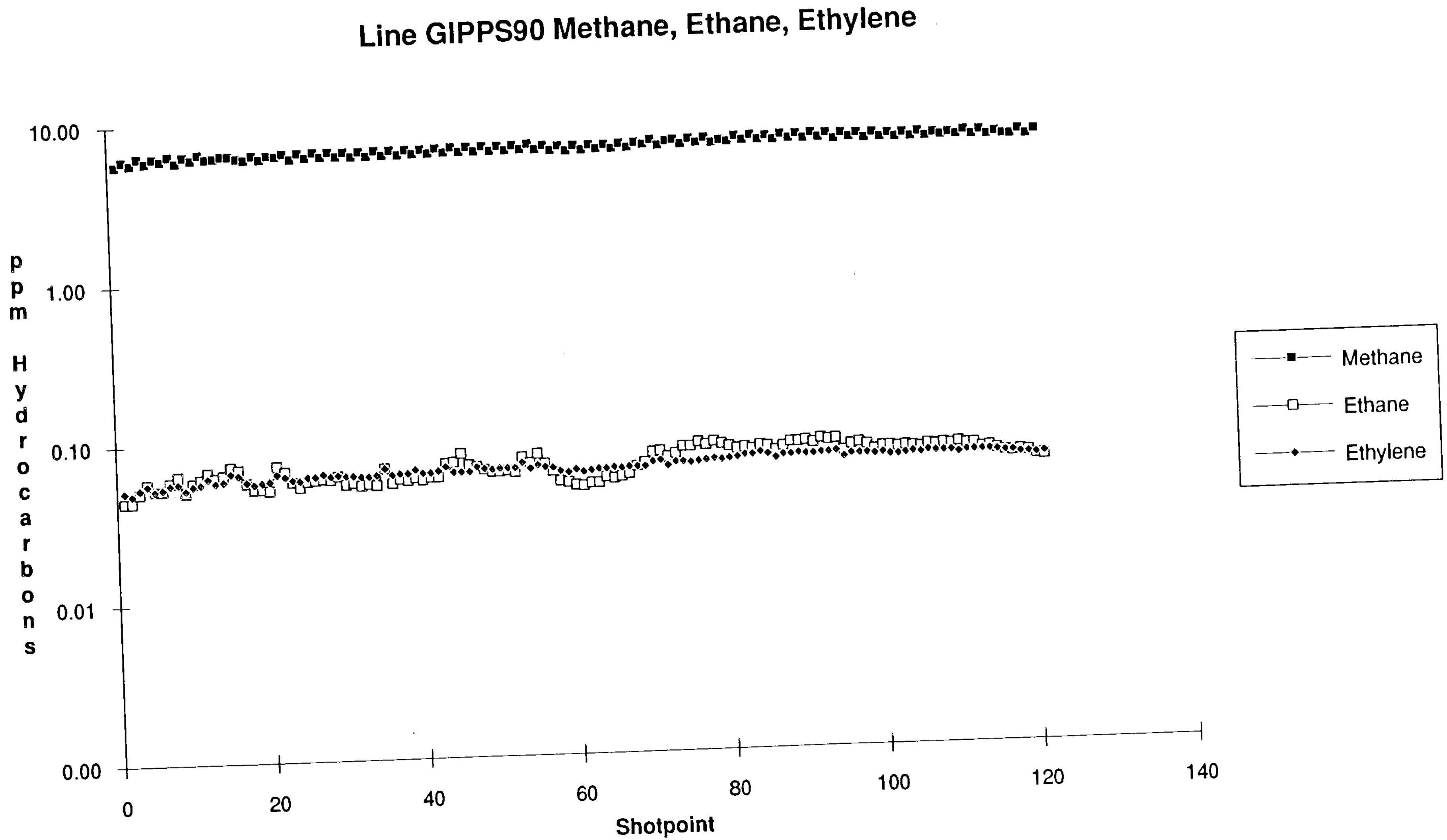
	Shotpoint	Date	Time	Latitude		Longitude	
Start	2	2-Mar-89	01:22:15	38	32.592	148	19.198
End	123	2-Mar-89	05:47:03	38	40.949	147	54.540

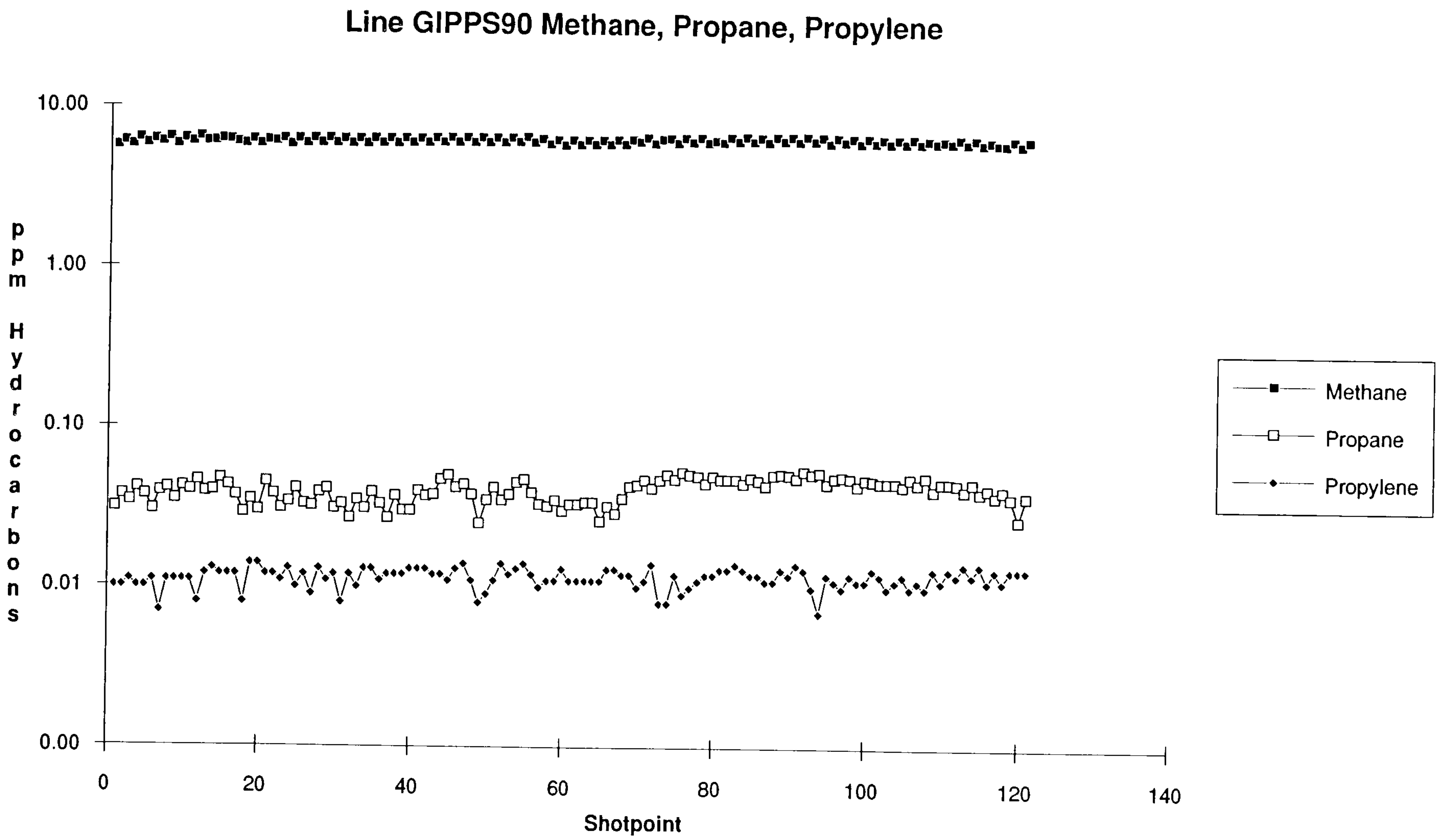
	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	12.433	6.284	0.065	0.063	0.041	0.012	0.008	0.012	N/A	N/A	N/A	N/A	1.958
Std. Dev.	0.406	0.244	0.011	0.004	0.007	0.002	0.002	0.002	N/A	N/A	N/A	N/A	0.252
Minimum	11.302	5.668	0.044	0.049	0.025	0.007	0.002	0.006	N/A	N/A	N/A	N/A	1.493
Maximum	13.167	6.774	0.084	0.071	0.054	0.014	0.013	0.018	N/A	N/A	N/A	N/A	2.501

	Salinity	Temp.	F. Depth	W.Depth	Altitude
Mean	30.617	17.290	58.212	71.095	12.882
Std. Dev.	0.193	0.231	2.879	3.281	1.845
Minimum	30.200	16.840	54.000	65.000	10.000
Maximum	31.090	18.070	70.000	83.000	17.000

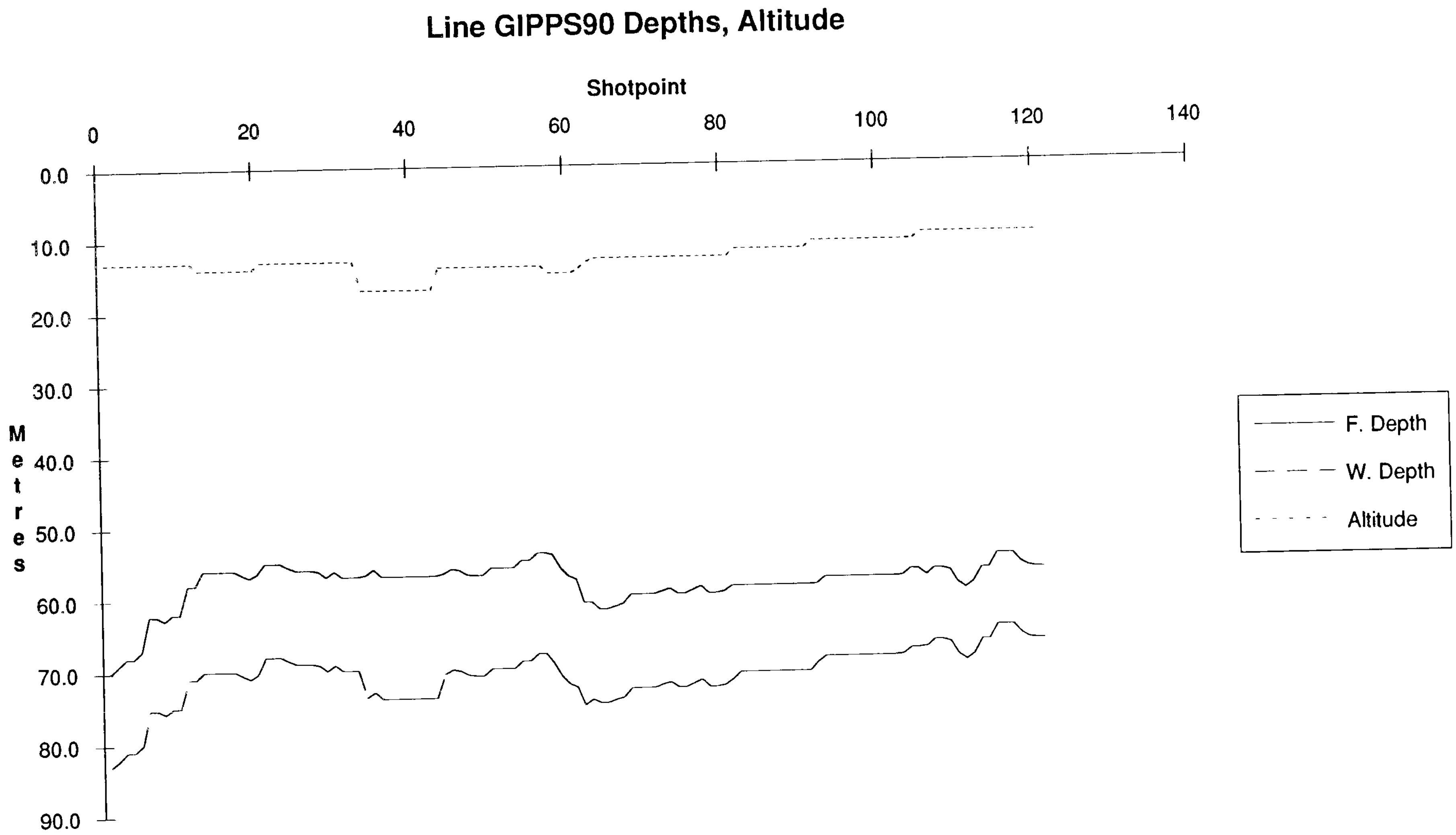
Notes No Anomalies


Line GIPPS90 THC, Methane
ppm Hydrocarbons
20.00
18.00
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
0
20
40
60
80
100
120
140
Shotpoint
THC
Methane


Line GIPPS90 Methane, Ethane, Ethylene
ppm Hydrocarbons
10.00
1.00
0.10
0.01
0.00
0
20
40
60
80
100
120
140
Shotpoint
Methane
Ethane
Ethylene



Line GIPPS90 Methane, Propane, Propylene
ppm Hydrocarbons
10.00
1.00
0.10
0.01
0.00
0
20
40
60
80
100
120
140
Shotpoint
Methane
Propane
Propylene


Line GIPPS90 Depths, Altitude
Shotpoint
0
20
40
60
80
100
120
140
0.0
10.0
20.0
30.0
40.0
50.0
60.0
70.0
80.0
90.0
Metres
F. Depth
W. Depth
Altitude

Line Summary

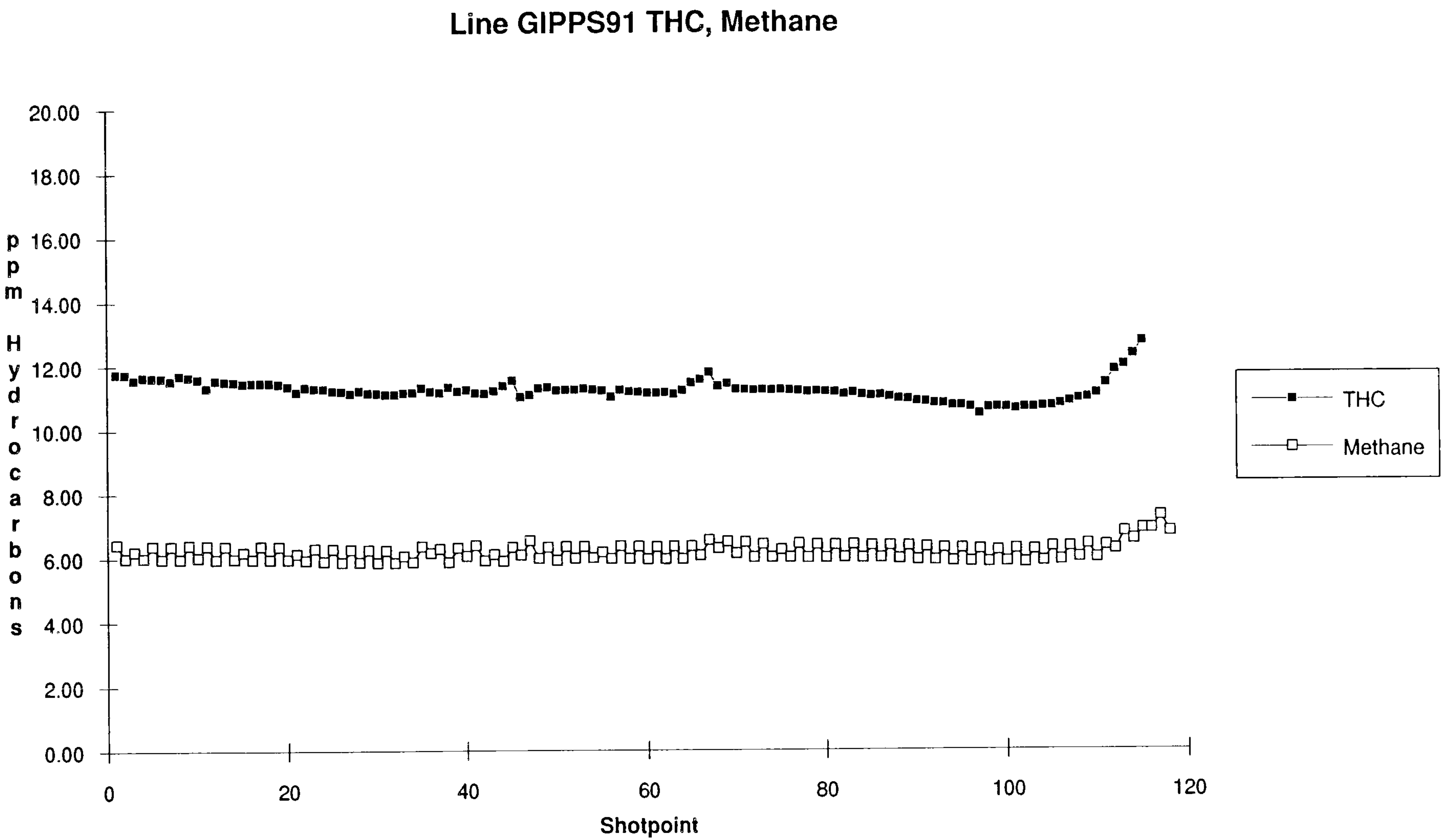
Line Number	gipps91
No. of Shotpoints	118

	Shotpoint	Date	Time	Latitude		Longitude	
Start	2	2-Mar-89	05:51:17	38	41.370	147	54.612
End	119	2-Mar-89	09:51:33	38	51.803	148	18.416

	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	11.203	6.164	0.048	0.061	0.029	0.011	0.002	0.001	N/A	N/A	N/A	N/A	1.291
Std. Dev.	0.337	0.256	0.005	0.006	0.004	0.001	0.003	0.002	N/A	N/A	N/A	N/A	0.145
Minimum	10.460	5.809	0.039	0.055	0.019	0.007	0.000	0.000	N/A	N/A	N/A	N/A	0.987
Maximum	12.678	7.251	0.064	0.093	0.039	0.017	0.010	0.009	N/A	N/A	N/A	N/A	1.757

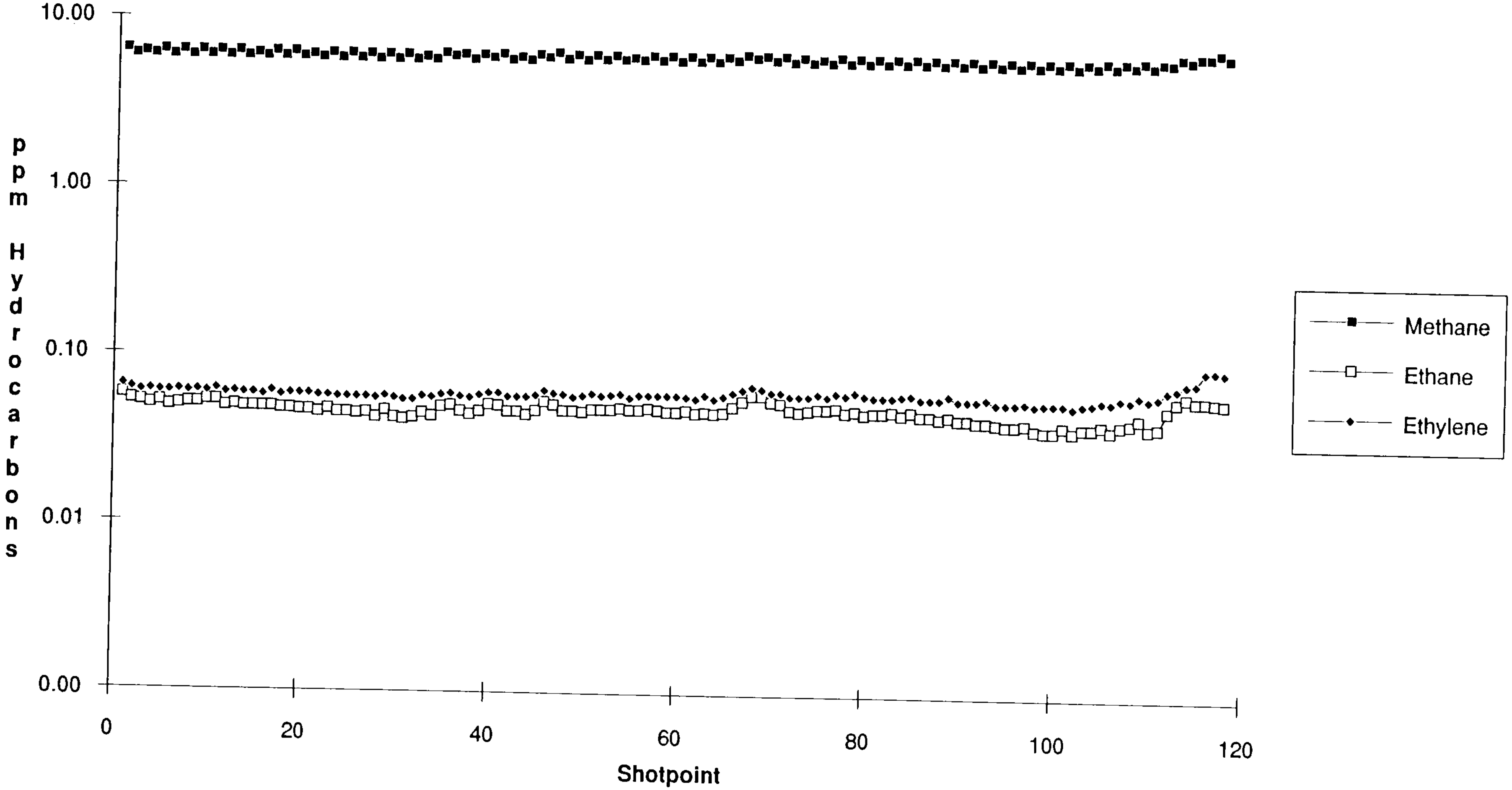
	Salinity	Temp.	F. Depth	W.Depth	Altitude
Mean	30.689	17.381	57.261	73.021	15.760
Std. Dev.	0.298	0.393	4.504	4.250	2.456
Minimum	30.410	17.010	52.000	63.000	10.800
Maximum	32.210	19.280	75.800	86.800	20.000

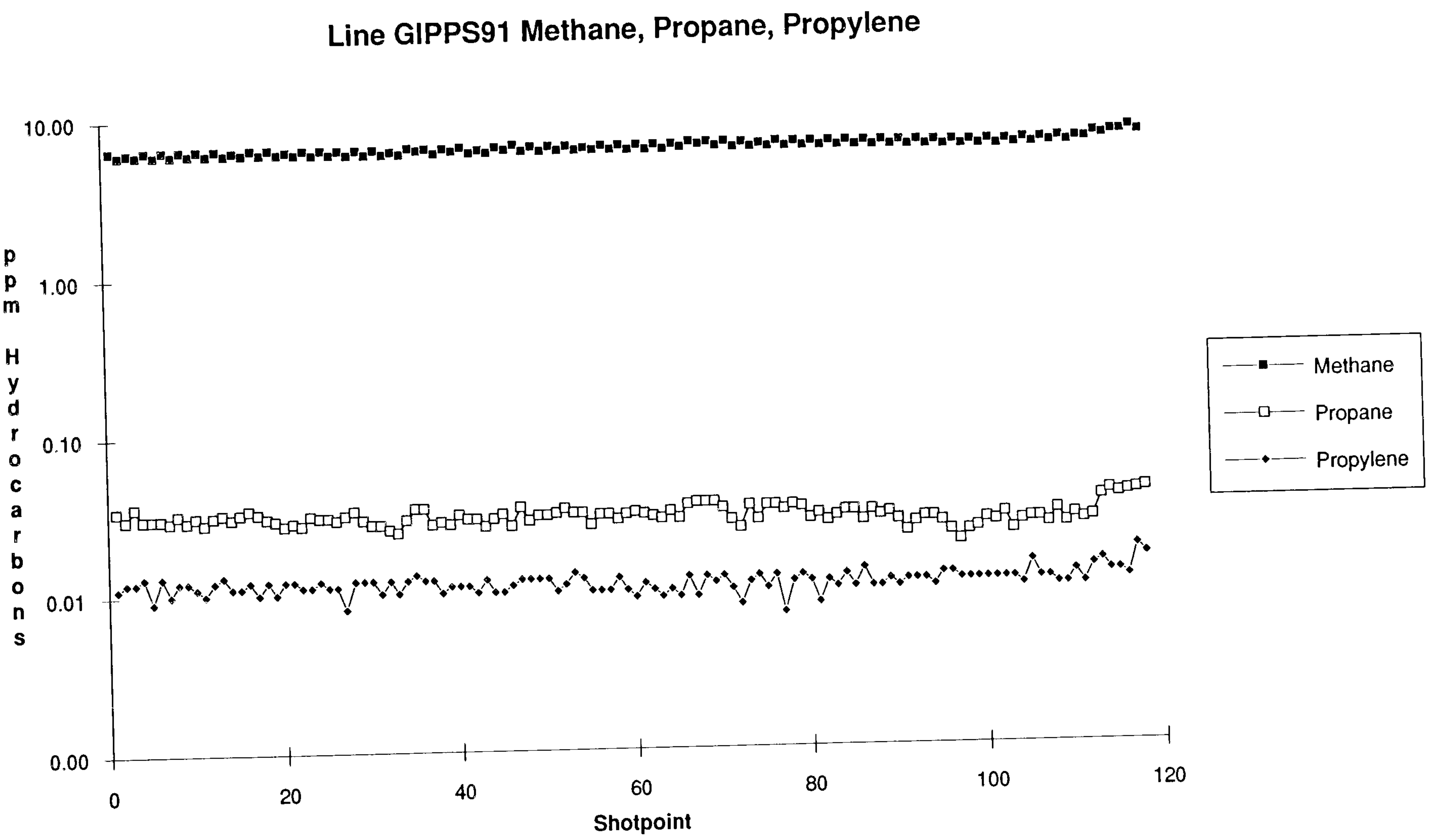
Notes No Anomalies



Line GIPPS91 THC, Methane
ppm Hydrocarbons
20.00
18.00
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
0
20
40
60
80
100
120
Shotpoint
THC
Methane

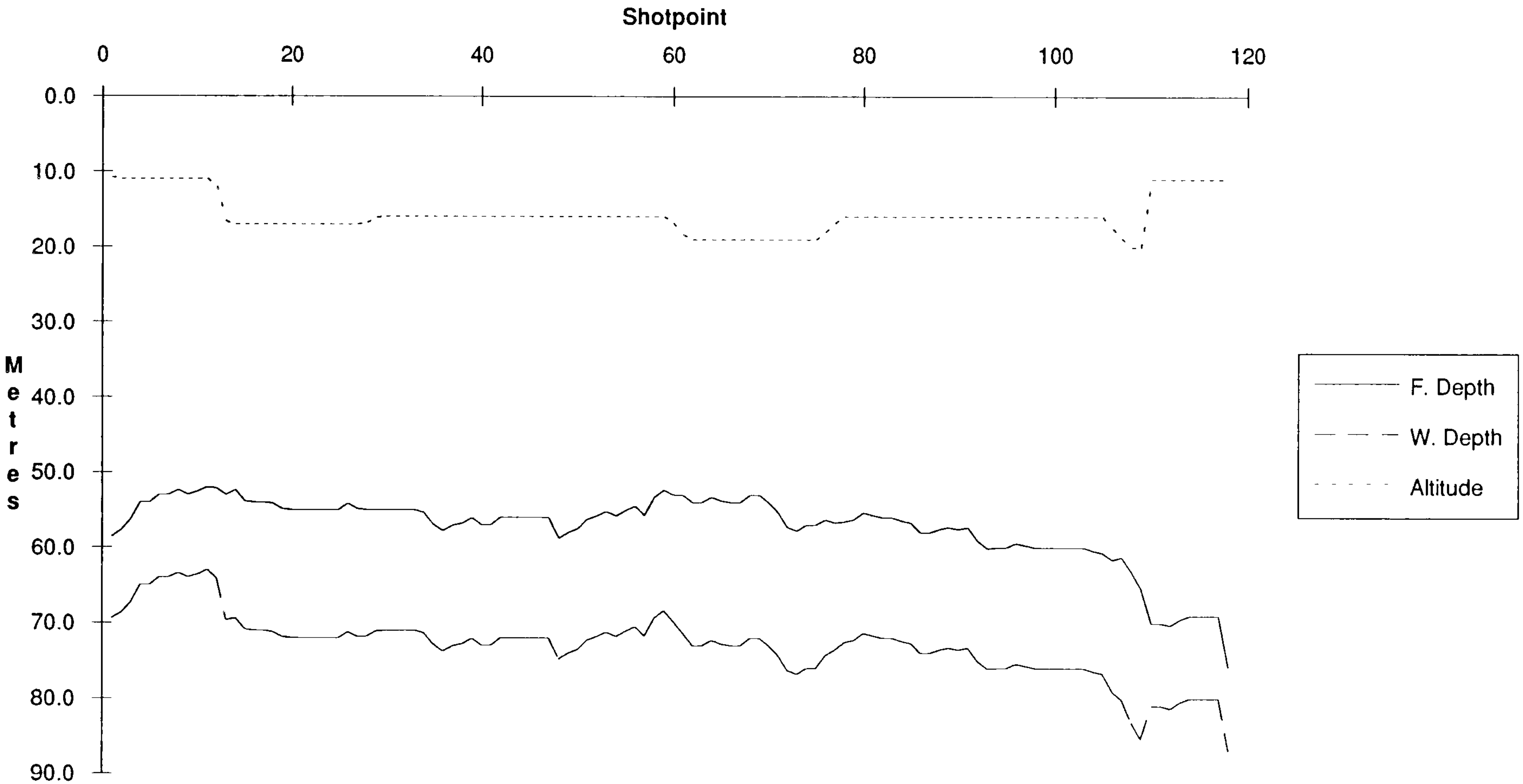
Line GIPPS91 Methane, Ethane, Ethylene





Line GIPPS91 Methane, Propane, Propylene
ppm Hydrocarbons
10.00
1.00
0.10
0.01
0.00
0
20
40
60
80
100
120
Shotpoint
Methane
Propane
Propylene

Line GIPPS91 Depths, Altitude



Line Summary

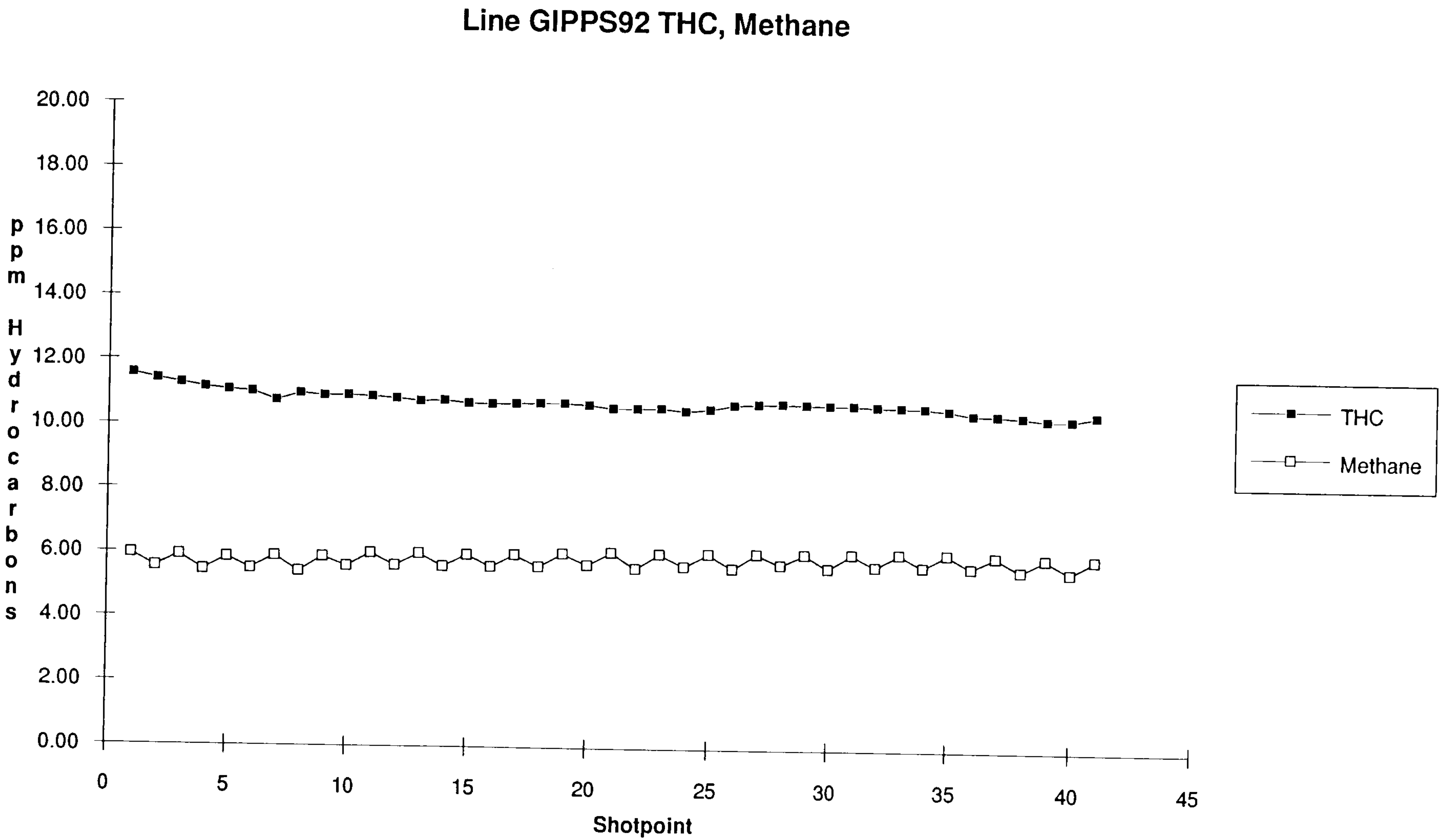
Line Number	gipps92
No. of Shotpoints	41

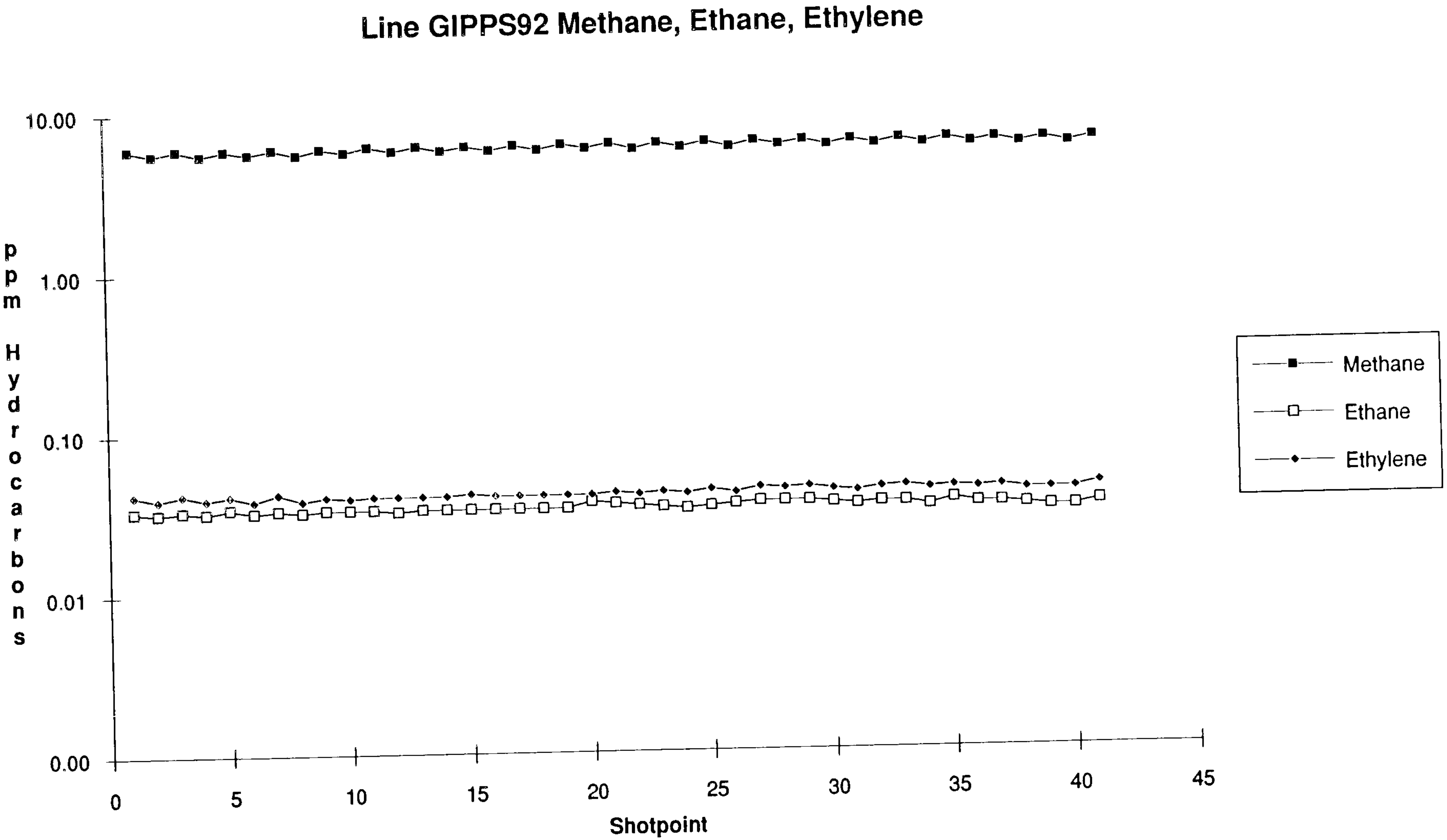
	Shotpoint	Date	Time	Latitude		Longitude	
Start	2	2-Mar-89	17:18:15	37	56.619	149	09.685
End	42	2-Mar-89	18:39:38	38	03.043	149	04.611

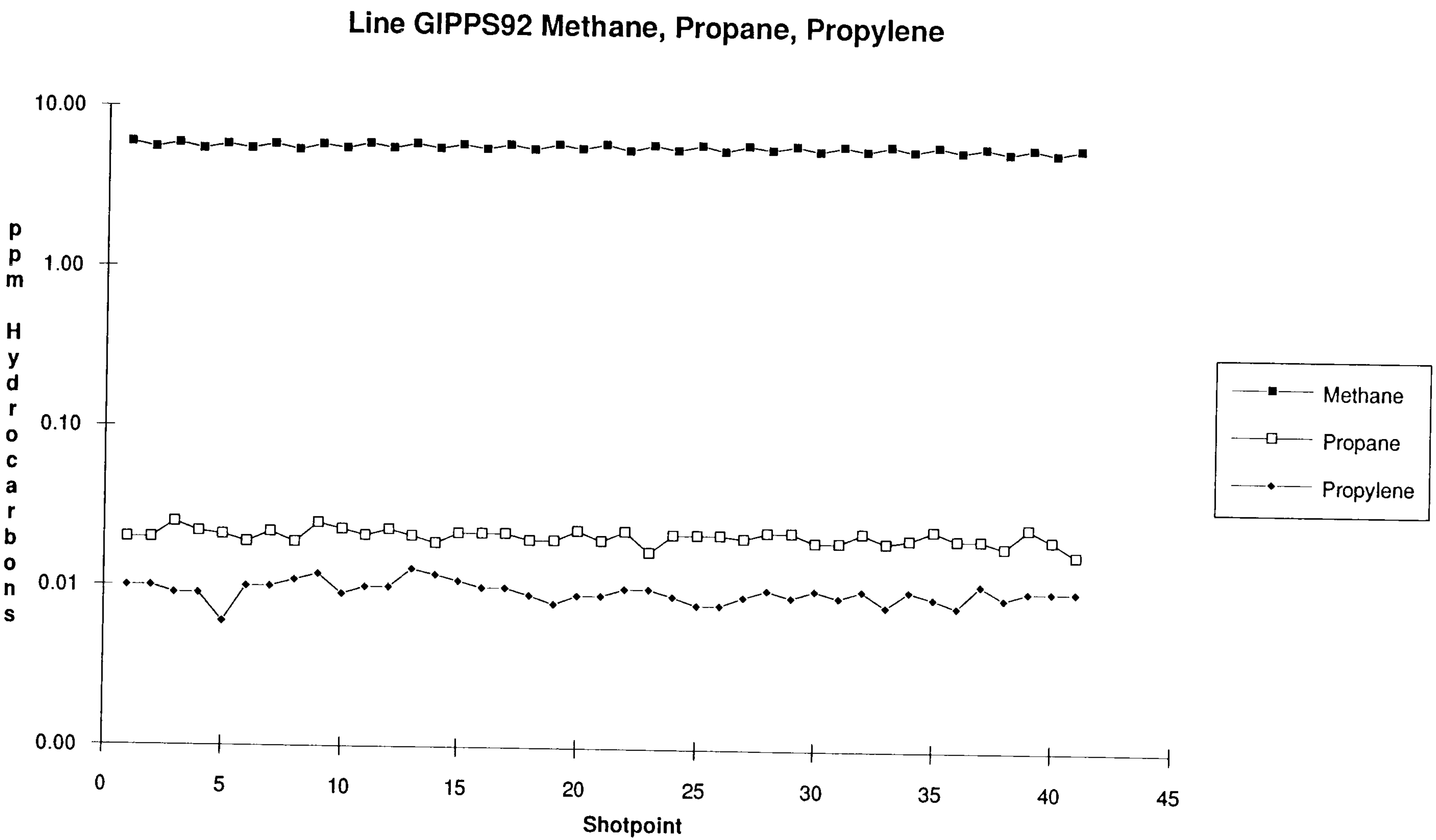
	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	10.771	5.826	0.033	0.041	0.021	0.010	0.000	0.000	N/A	N/A	N/A	N/A	0.935
Std. Dev.	0.255	0.216	0.001	0.001	0.002	0.001	0.001	0.001	N/A	N/A	N/A	N/A	0.056
Minimum	10.353	5.421	0.031	0.038	0.017	0.006	0.000	0.000	N/A	N/A	N/A	N/A	0.819
Maximum	11.559	6.123	0.036	0.043	0.025	0.013	0.005	0.004	N/A	N/A	N/A	N/A	1.071

	Salinity	Temp.	F. Depth	W.Depth	Altitude
Mean	29.326	15.713	94.561	109.949	15.388
Std. Dev.	0.037	0.032	5.580	3.280	3.498
Minimum	29.260	15.610	84.000	104.700	12.000
Maximum	29.400	15.770	107.900	119.900	22.000

Notes — No Anomalies

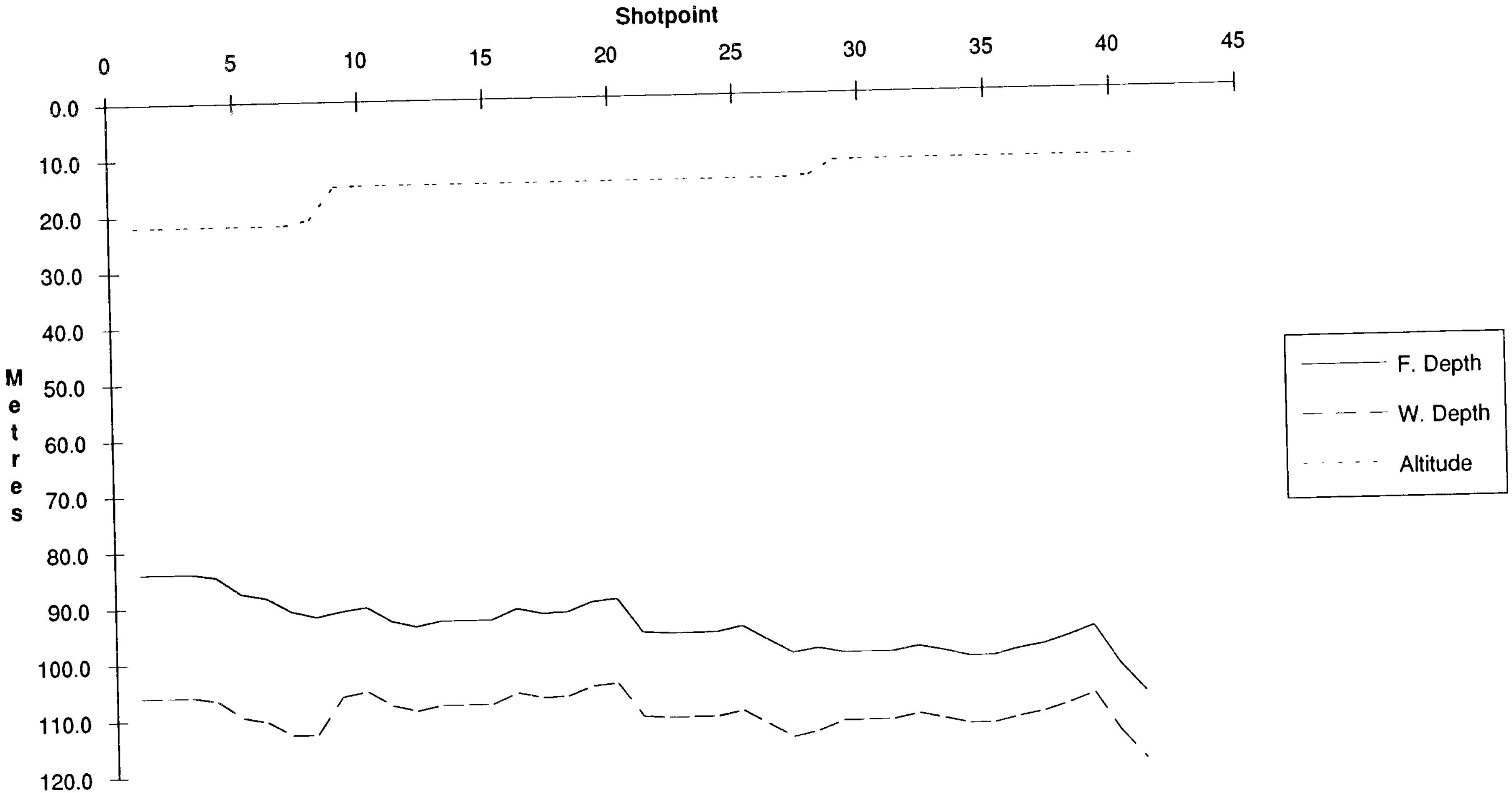

Line GIPPS92 THC, Methane
ppm Hydrocarbons
20.00
18.00
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
0
5
10
15
20
25
30
35
40
45
Shotpoint
THC
Methane


Line GIPPS92 Methane, Ethane, Ethylene
ppm Hydrocarbons
10.00
1.00
0.10
0.01
0.00
0
5
10
15
20
25
30
35
40
45
Shotpoint
Methane
Ethane
Ethylene



Line GIPPS92 Methane, Propane, Propylene
10.00
1.00
0.10
0.01
0.00
ppm Hydrocarbons
0
5
10
15
20
25
30
35
40
45
Shotpoint
Methane
Propane
Propylene

Line GIPPS92 Depths, Altitude



Line Summary

Line Number	gipps93
No. of Shotpoints	48

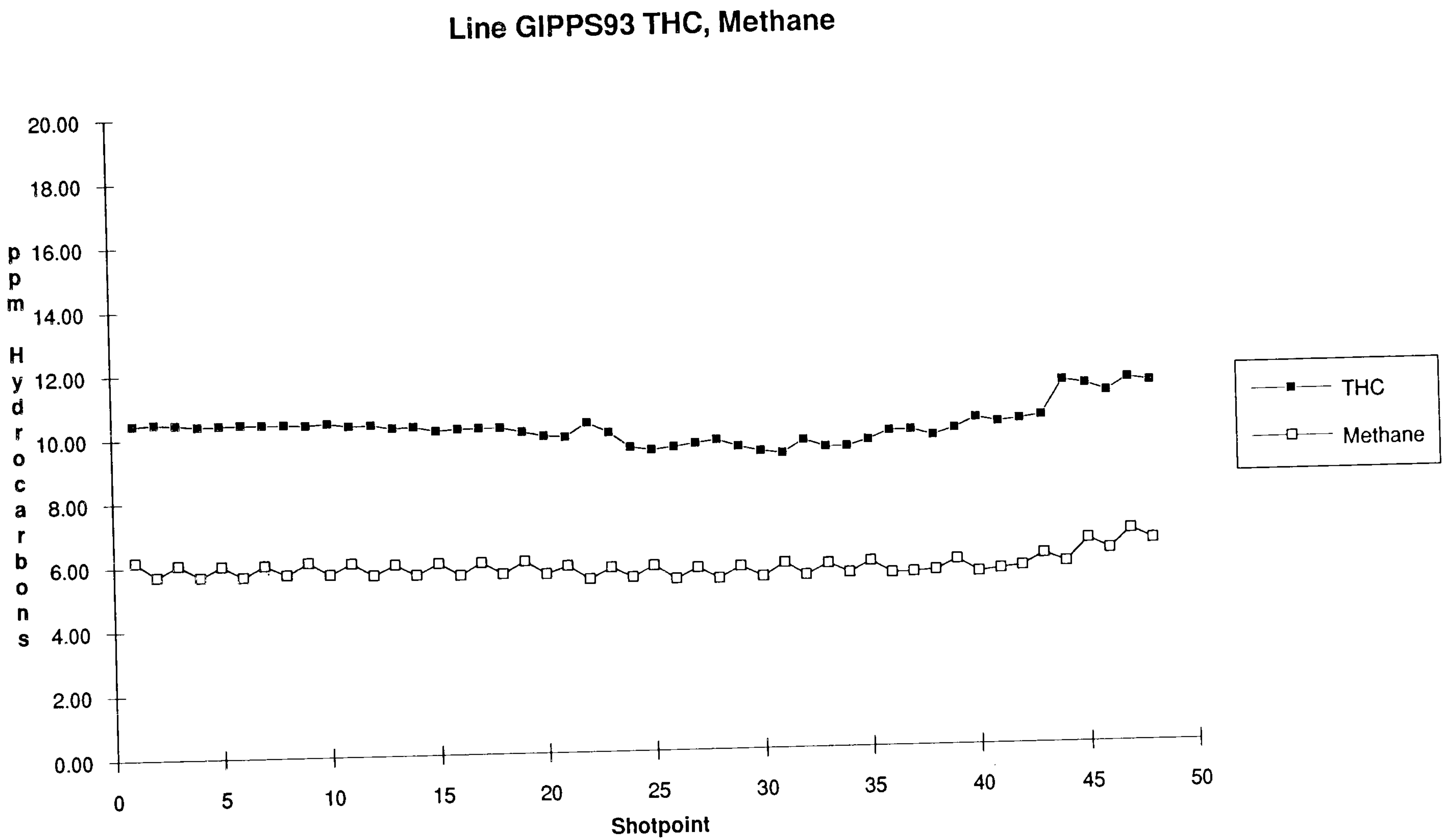
	Shotpoint	Date	Time	Latitude		Longitude	
Start	2	2-Mar-89	18:43:43	38	02.861	149	04.875
End	49	2-Mar-89	20:19:32	37	55.617	148	58.447

	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	10.096	5.730	0.038	0.040	0.024	0.009	0.001	0.002	N/A	N/A	N/A	N/A	1.096
Std. Dev.	0.528	0.291	0.019	0.003	0.011	0.002	0.002	0.006	N/A	N/A	N/A	N/A	0.547
Minimum	9.194	5.322	0.026	0.034	0.016	0.006	0.000	0.000	N/A	N/A	N/A	N/A	0.765
Maximum	11.330	6.603	0.103	0.049	0.062	0.015	0.010	0.023	N/A	N/A	N/A	N/A	2.821

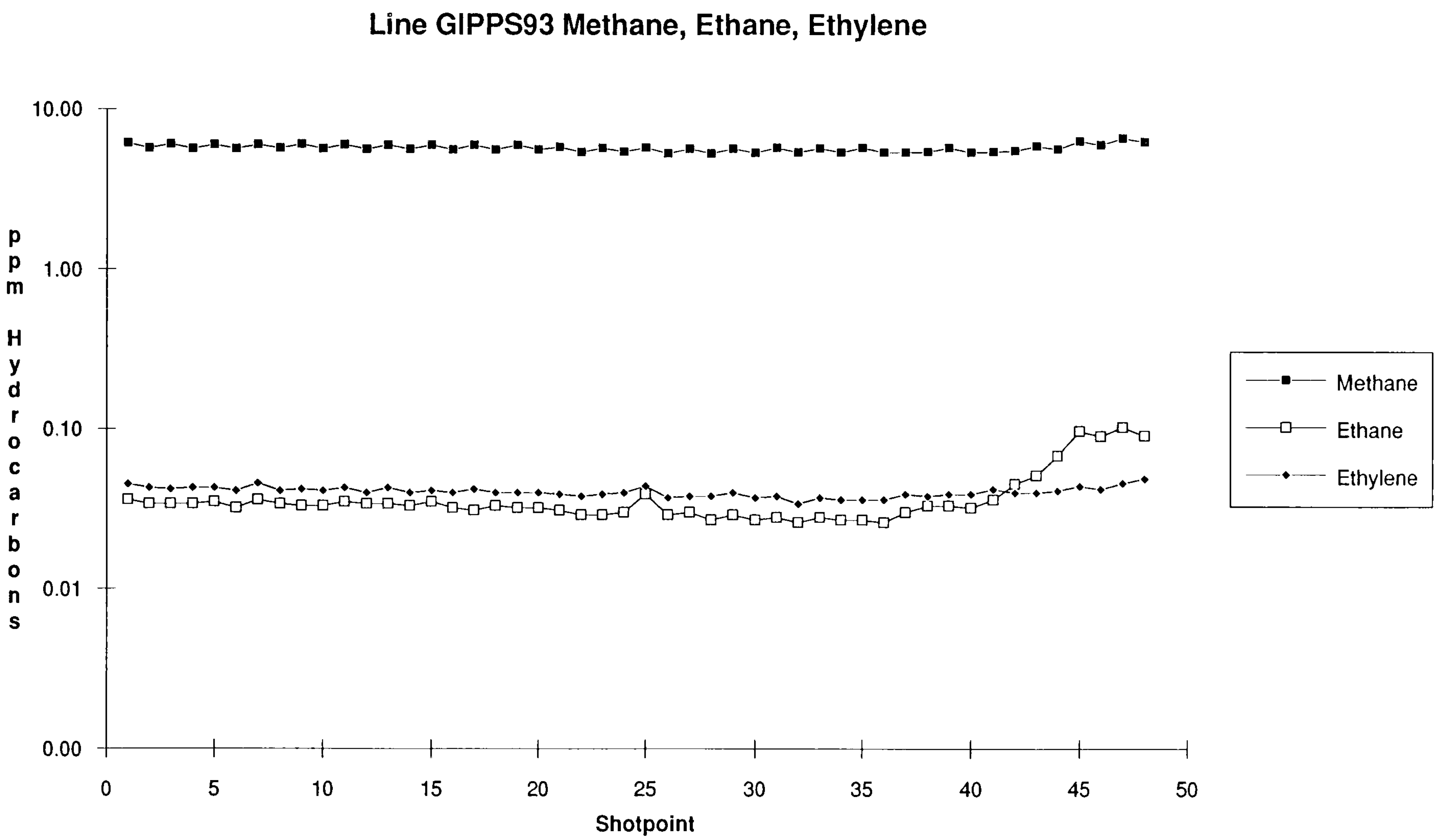
	Salinity	Temp.	F. Depth	W.Depth	Altitude
Mean	29.464	15.891	84.531	99.800	15.267
Std. Dev.	0.244	0.304	11.617	12.805	2.656
Minimum	29.260	15.640	58.000	71.000	12.000
Maximum	30.100	16.670	95.900	112.900	20.000

Notes

Weak anomaly at end of line correlates with marked decrease in fish depth and increase in fish altitude.
Considered to be an artefact of fish depth.

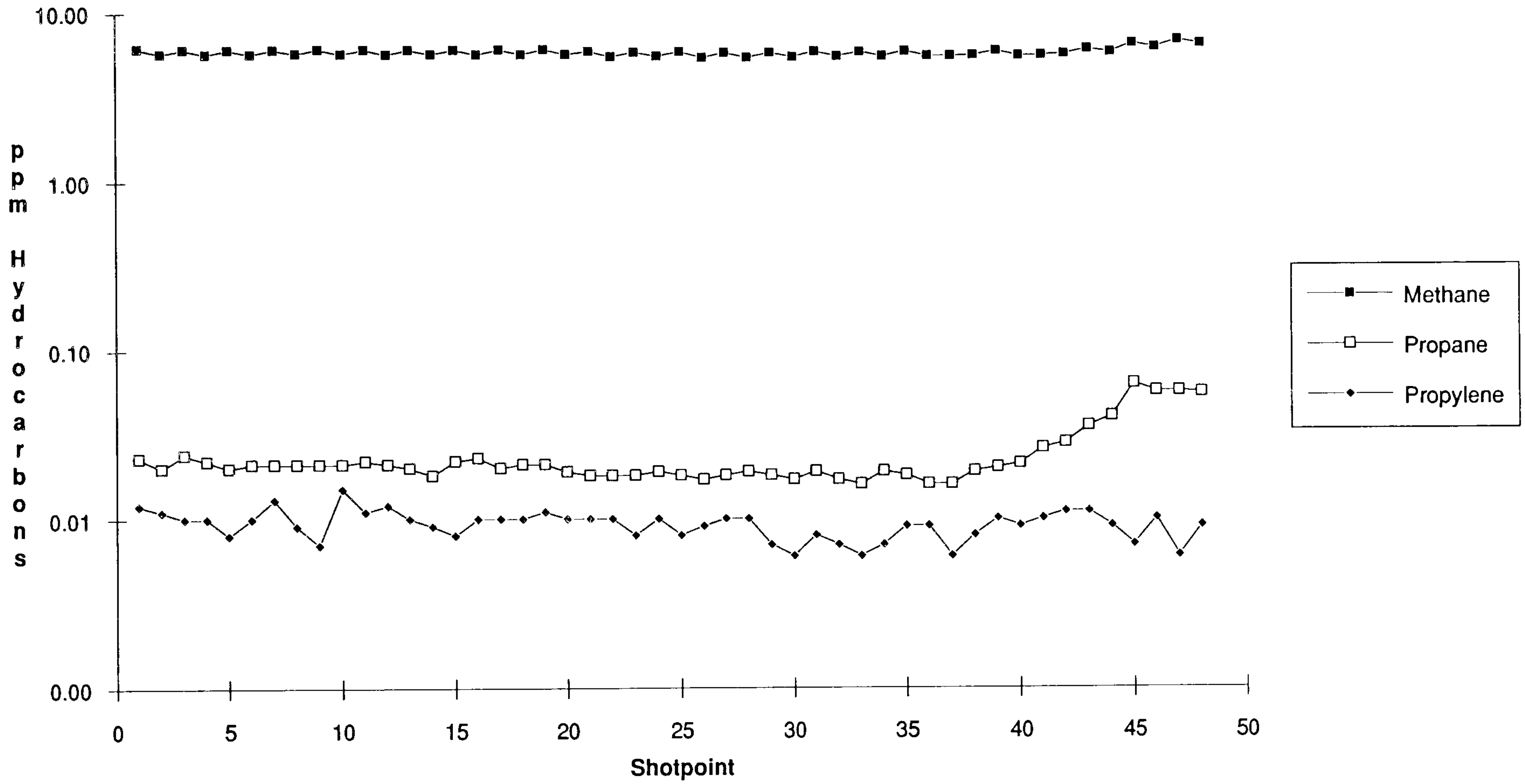


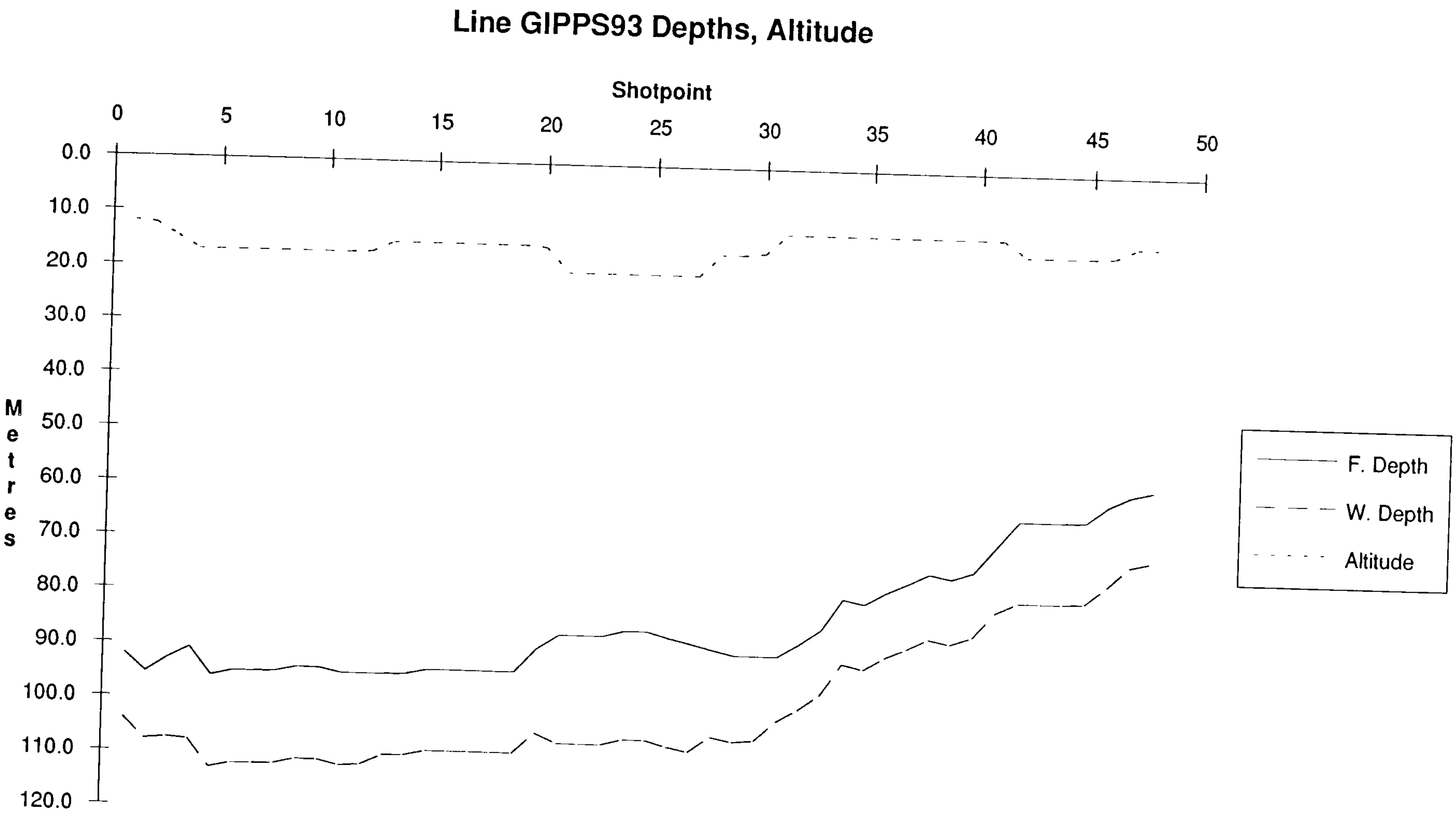
Line GIPPS93 THC, Methane
ppm Hydrocarbons
20.00
18.00
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
0
5
10
15
20
25
30
35
40
45
50
Shotpoint
THC
Methane



Line GIPPS93 Methane, Ethane, Ethylene
ppm Hydrocarbons
10.00
1.00
0.10
0.01
0.00
0
5
10
15
20
25
30
35
40
45
50
Shotpoint
Methane
Ethane
Ethylene

Line GIPPS93 Methane, Propane, Propylene





Line GIPPS93 Depths, Altitude
Shotpoint
0
5
10
15
20
25
30
35
40
45
50
0.0
10.0
20.0
30.0
40.0
50.0
60.0
70.0
80.0
90.0
100.0
110.0
120.0
Metres
F. Depth
W. Depth
Altitude

Line Summary

Line Number	gipps94
No. of Shotpoints	42

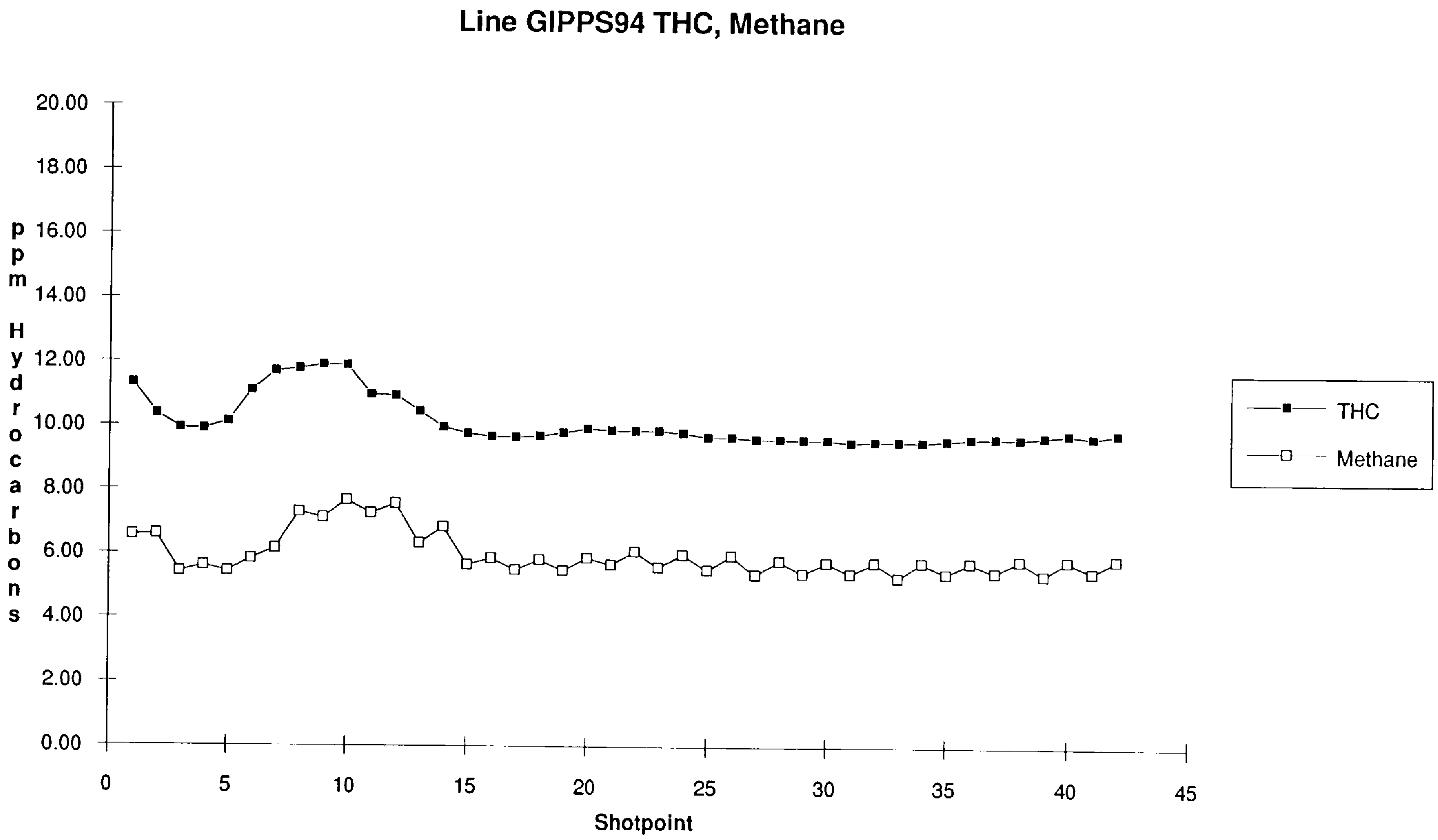
	Shotpoint	Date	Time	Latitude		Longitude	
Start	2	2-Mar-89	20:23:45	37	55.807	148	58.667
End	43	2-Mar-89	21:47:23	38	02.317	148	53.923

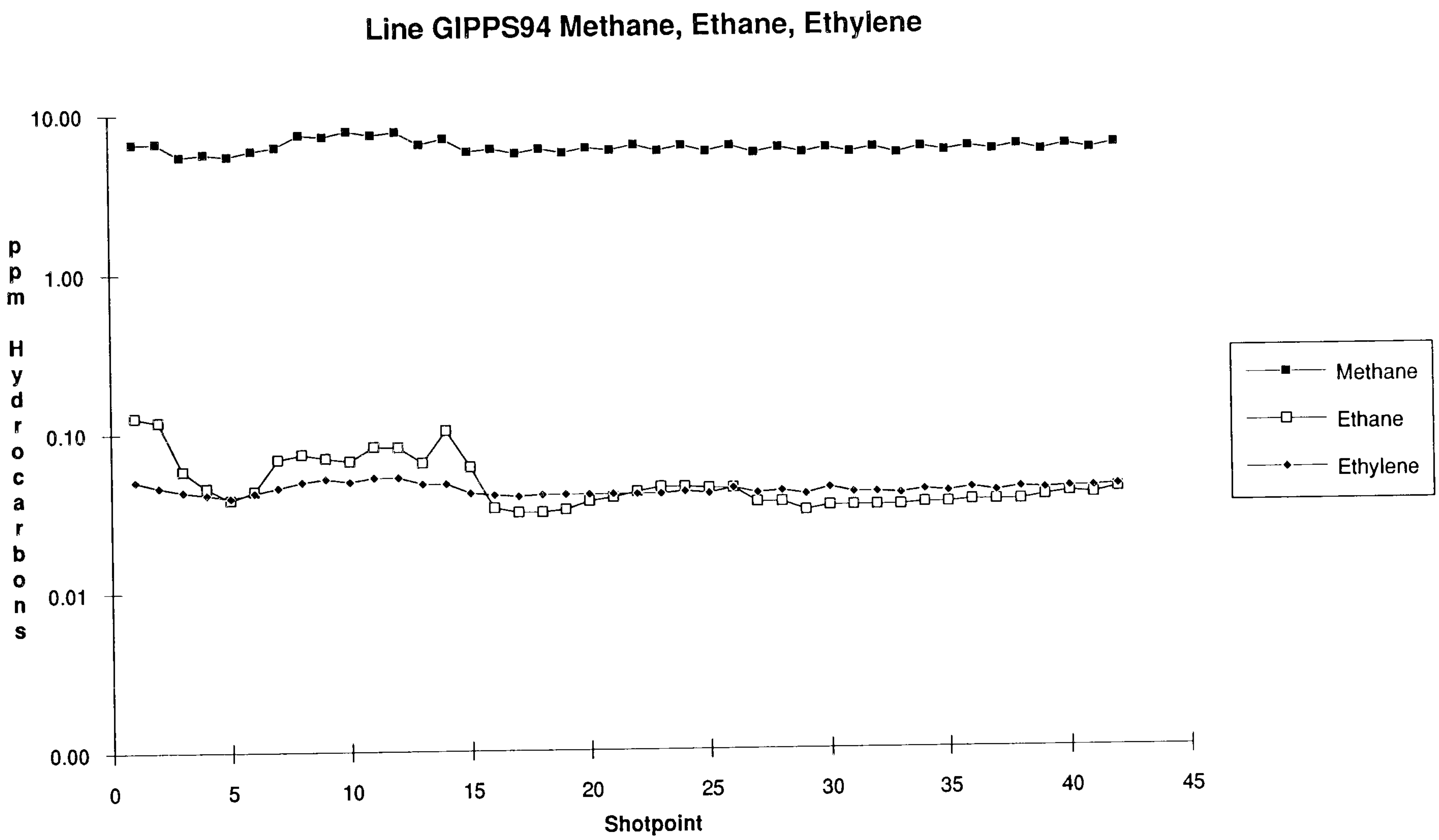
	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	10.093	5.963	0.049	0.043	0.031	0.009	0.003	0.004	N/A	N/A	N/A	N/A	1.395
Std. Dev.	0.716	0.632	0.023	0.004	0.015	0.003	0.004	0.007	N/A	N/A	N/A	N/A	0.622
Minimum	9.526	5.287	0.031	0.039	0.017	0.000	0.000	0.000	N/A	N/A	N/A	N/A	0.851
Maximum	11.903	7.671	0.126	0.052	0.077	0.012	0.013	0.020	N/A	N/A	N/A	N/A	3.472

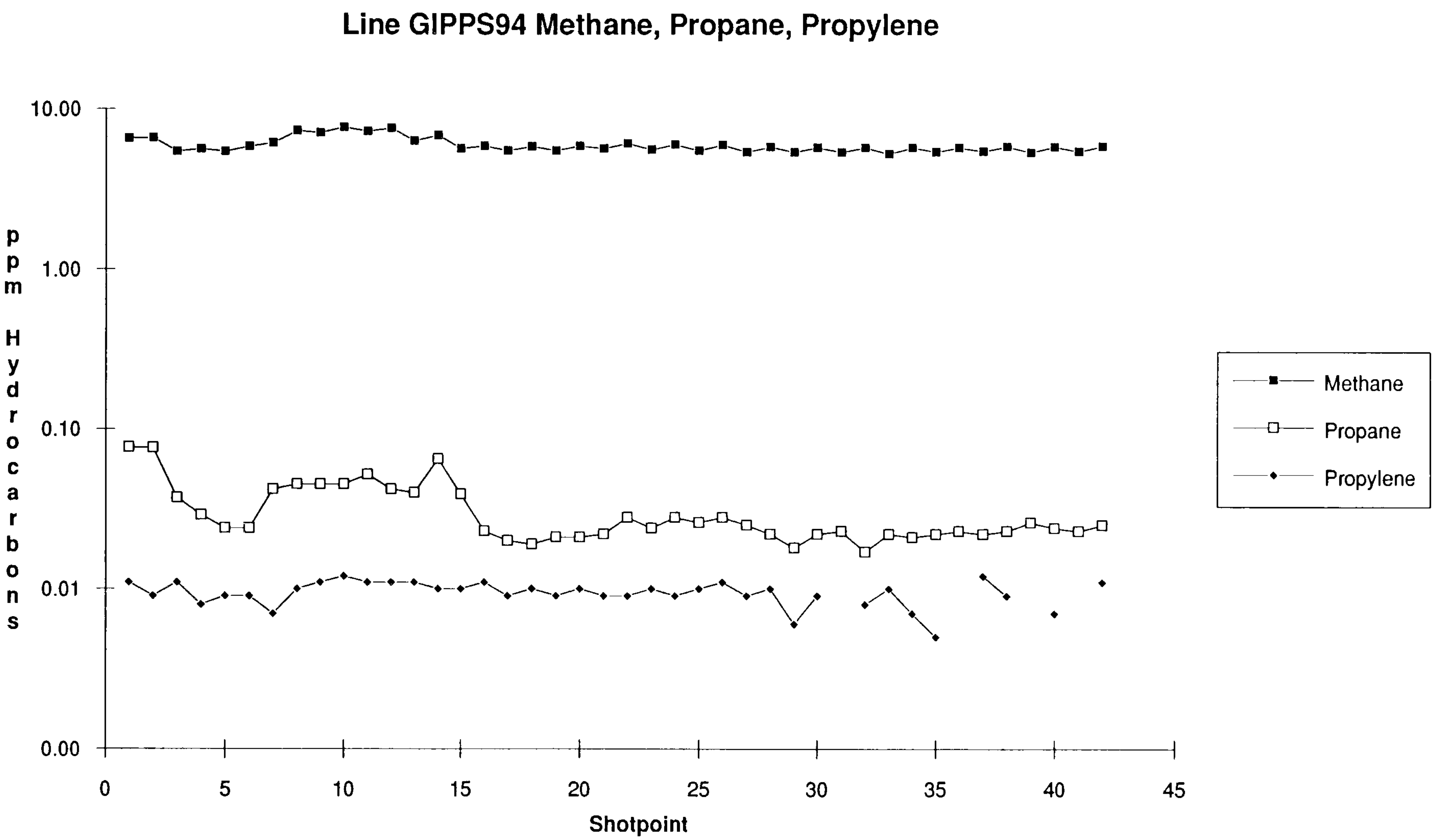
	Salinity	Temp.	F. Depth	W.Depth	Altitude
Mean	29.637	16.110	77.671	91.681	14.010
Std. Dev.	0.196	0.230	11.777	12.765	1.321
Minimum	29.470	15.850	59.300	73.300	12.000
Maximum	30.100	16.680	94.800	108.800	15.000

Notes

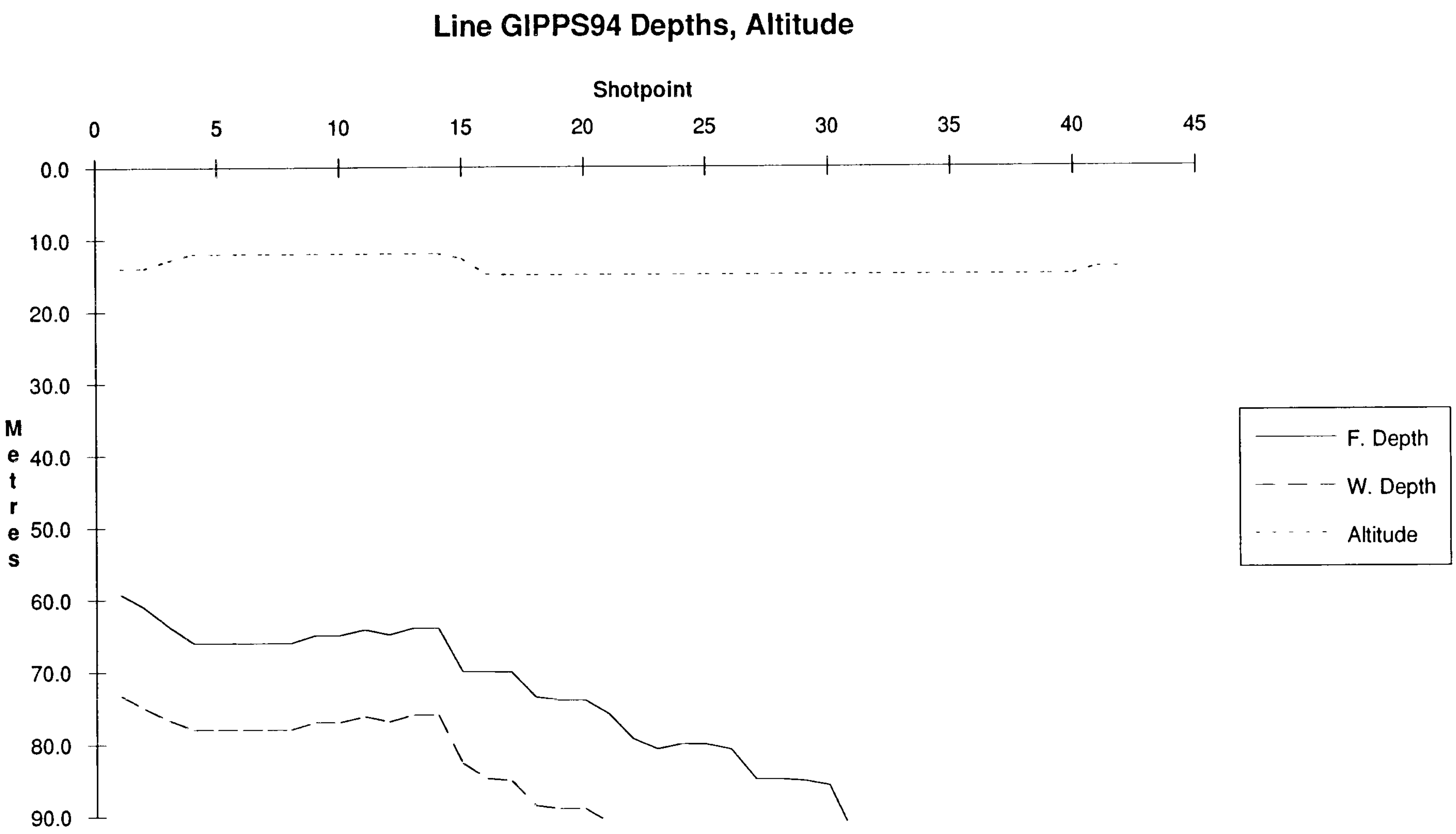
Weak anomaly at beginning of line is a continuation of the anomaly present at end of line Gipps93, and is related to fish depth and fish altitude.


Line GIPPS94 THC, Methane
ppm Hydrocarbons
20.00
18.00
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
0
5
10
15
20
25
30
35
40
45
Shotpoint
THC
Methane


Line GIPPS94 Methane, Ethane, Ethylene
10.00
1.00
0.10
0.01
0.00
ppm Hydrocarbons
0
5
10
15
20
25
30
35
40
45
Shotpoint
Methane
Ethane
Ethylene



Line GIPPS94 Methane, Propane, Propylene
ppm Hydrocarbons
10.00
1.00
0.10
0.01
0.00
0
5
10
15
20
25
30
35
40
45
Shotpoint
Methane
Propane
Propylene


Line GIPPS94 Depths, Altitude
Shotpoint
0
5
10
15
20
25
30
35
40
45
0.0
10.0
20.0
30.0
40.0
50.0
60.0
70.0
80.0
90.0
Metres
F. Depth
W. Depth
Altitude

Line Summary

Line Number	gipps95
No. of Shotpoints	67

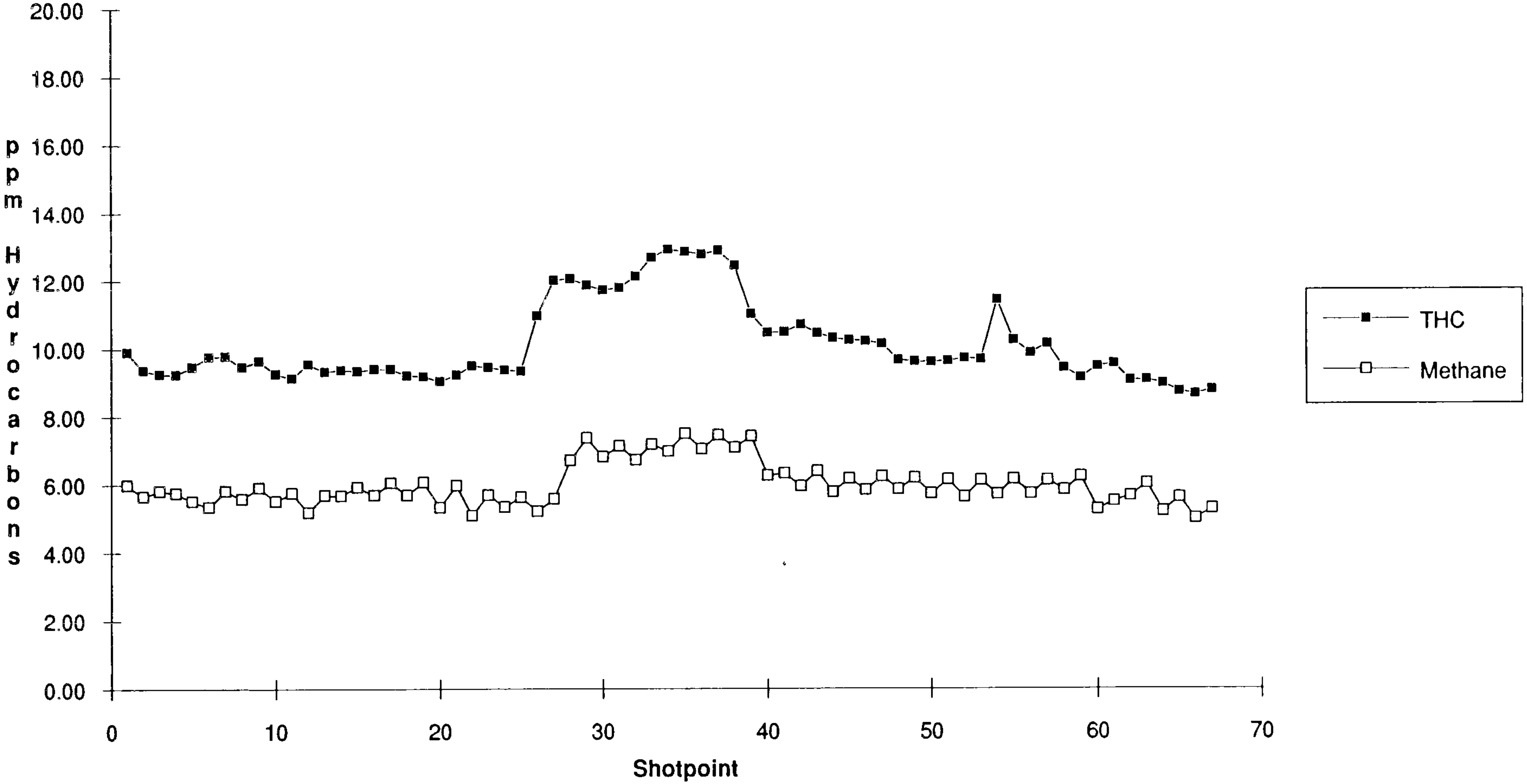
	Shotpoint	Date	Time	Latitude		Longitude	
Start	2	2-Mar-89	21:51:40	38	02.619	148	53.690
End	68	3-Mar-89	00:06:23	37	57.924	148	48.038

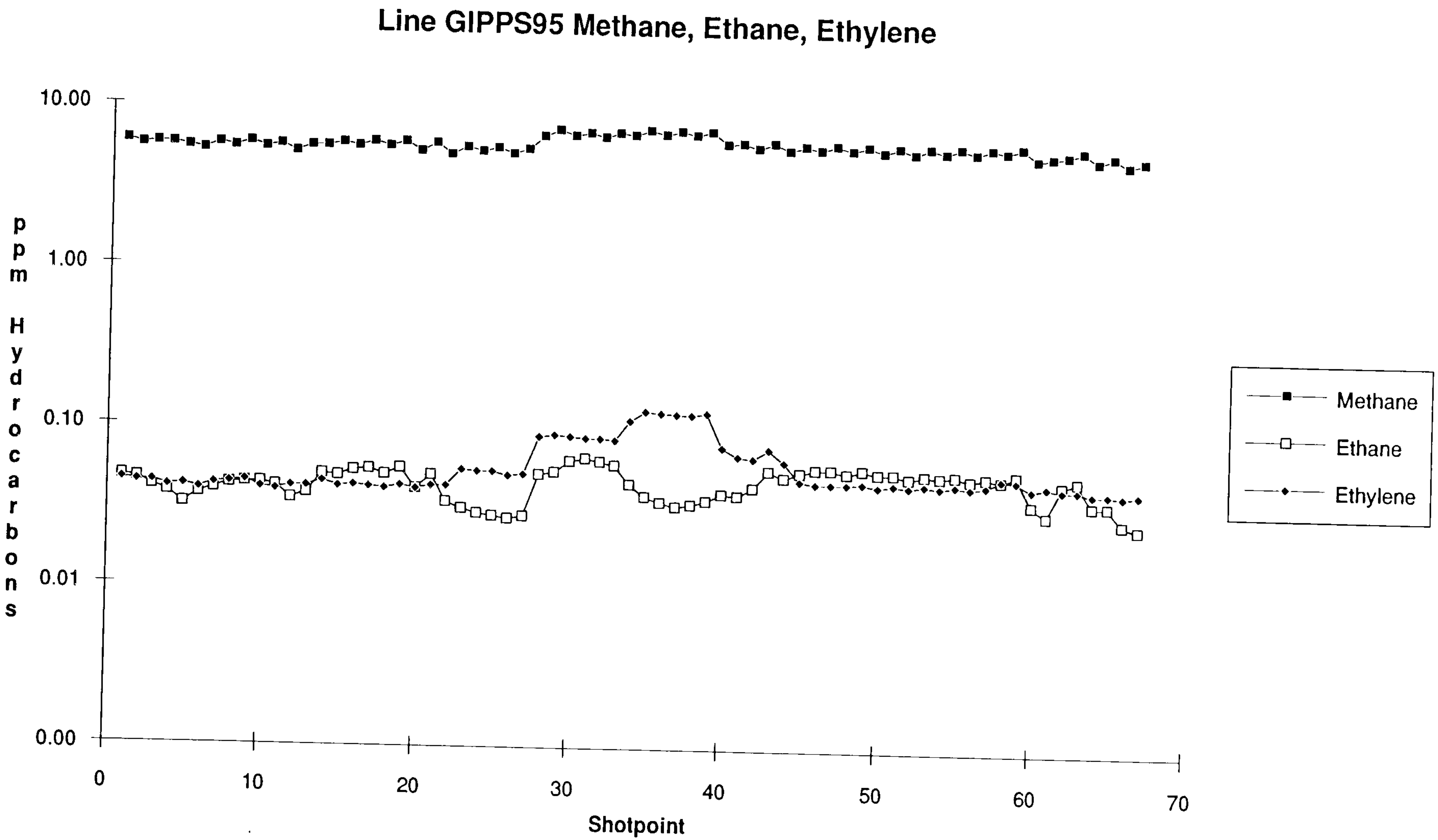
	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	10.117	5.986	0.045	0.058	0.029	0.012	0.002	0.001	N/A	N/A	N/A	N/A	1.265
Std. Dev.	1.186	0.618	0.010	0.025	0.006	0.006	0.003	0.003	N/A	N/A	N/A	N/A	0.264
Minimum	8.636	4.984	0.026	0.040	0.018	0.006	0.000	0.000	N/A	N/A	N/A	N/A	0.785
Maximum	12.906	7.486	0.065	0.130	0.046	0.032	0.008	0.013	N/A	N/A	N/A	N/A	1.910

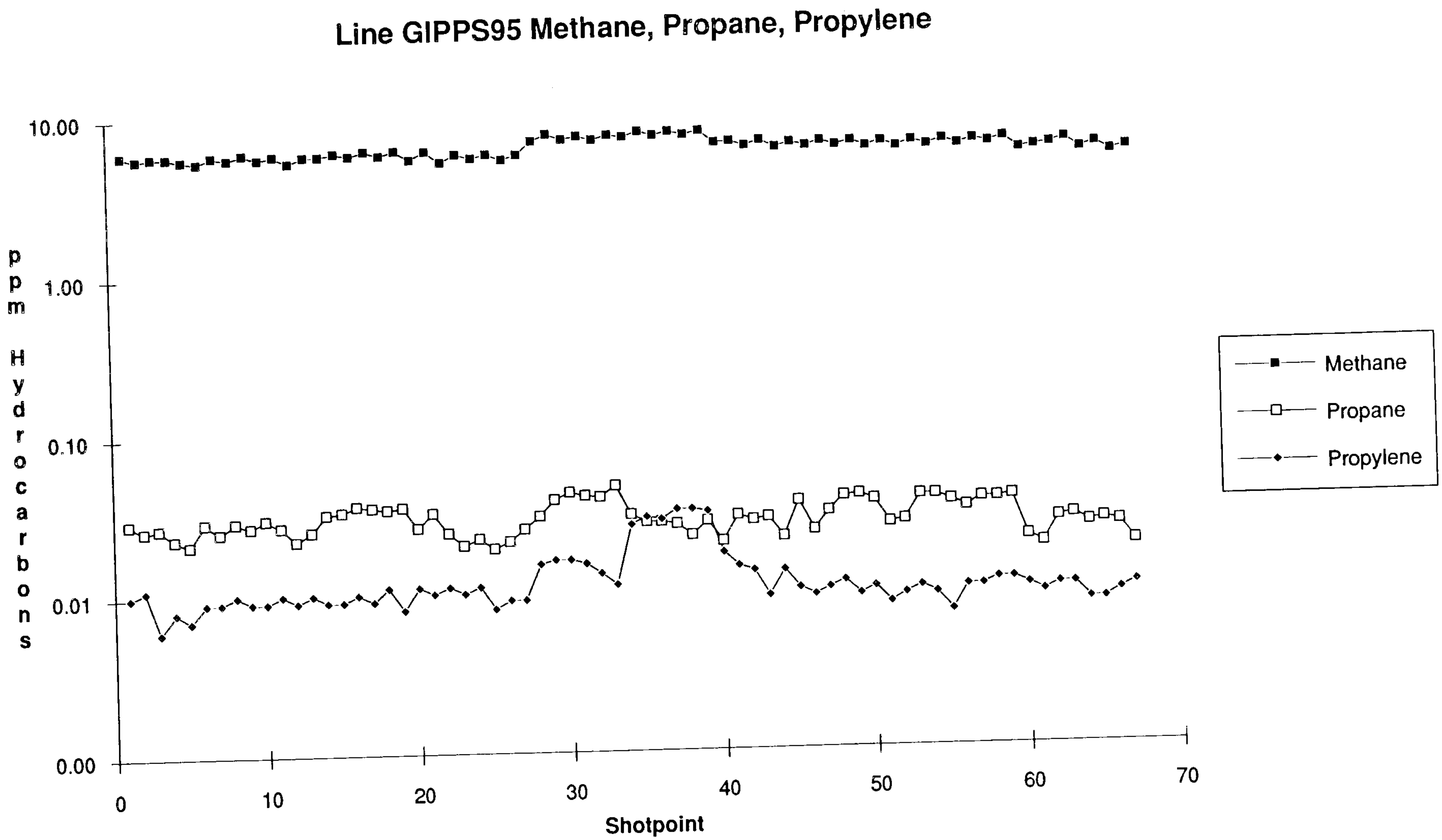
	Salinity	Temp.	F. Depth	W.Depth	Altitude
Mean	30.585	17.278	51.943	87.354	35.410
Std. Dev.	1.288	1.598	24.875	15.661	24.307
Minimum	29.590	16.010	5.000	61.200	10.000
Maximum	34.070	21.620	94.000	112.900	85.000

Notes Vertical profile carried out whilst underway. C1, C2 & C2:1 highest in 'surface' layer, with a mid-water minimum in C2 suggesting two possible 'sources'.

Line GIPPS95 THC, Methane

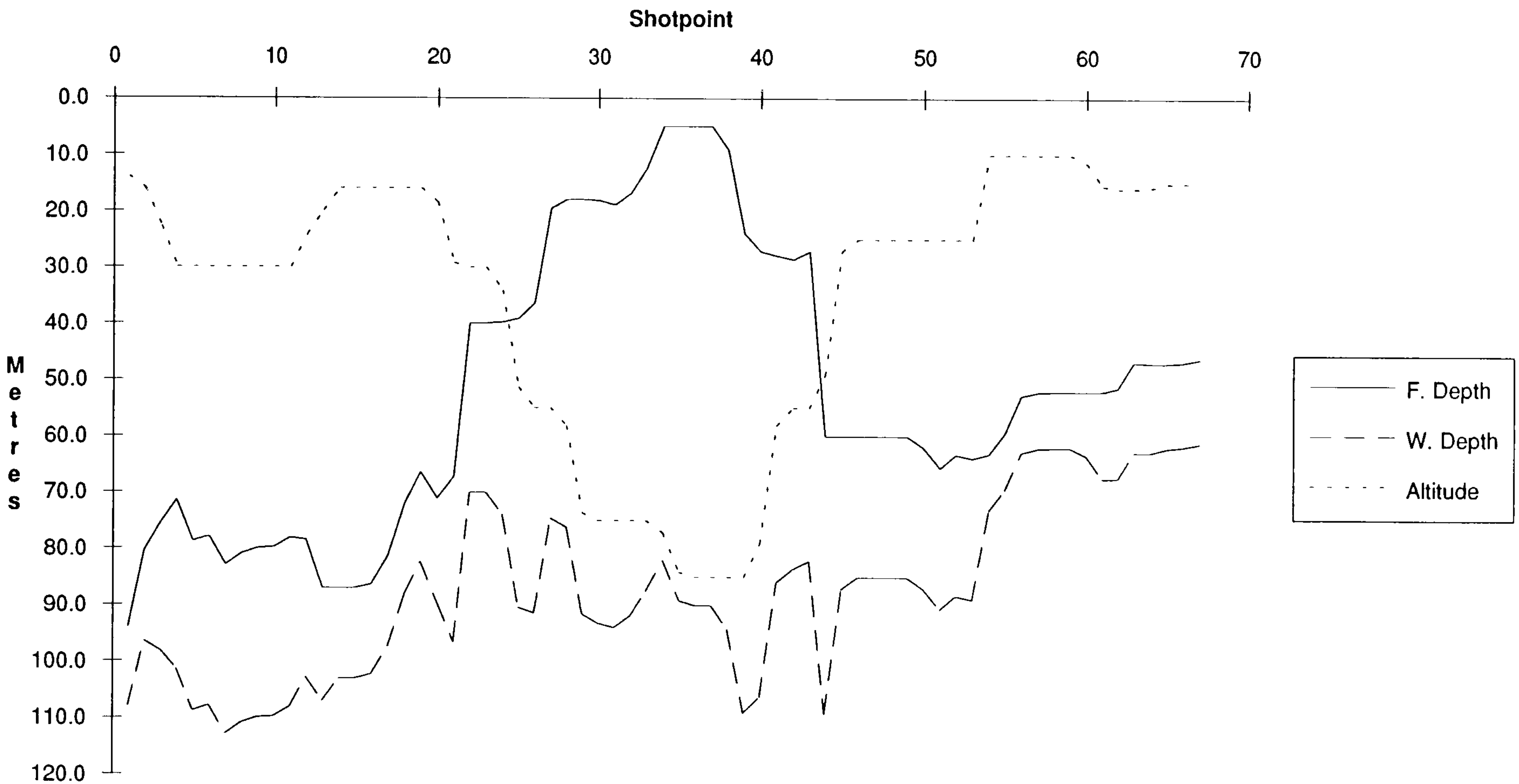



Line GIPPS95 Methane, Ethane, Ethylene
10.00
1.00
0.10
0.01
0.00
ppm Hydrocarbons
0
10
20
30
40
50
60
70
Shotpoint
Methane
Ethane
Ethylene



Line GIPPS95 Methane, Propane, Propylene
ppm Hydrocarbons
10.00
1.00
0.10
0.01
0.00
0
10
20
30
40
50
60
70
Shotpoint
Methane
Propane
Propylene

Line GIPPS95 Depths, Altitude



Line Summary

Line Number	gipps96
No. of Shotpoints	54

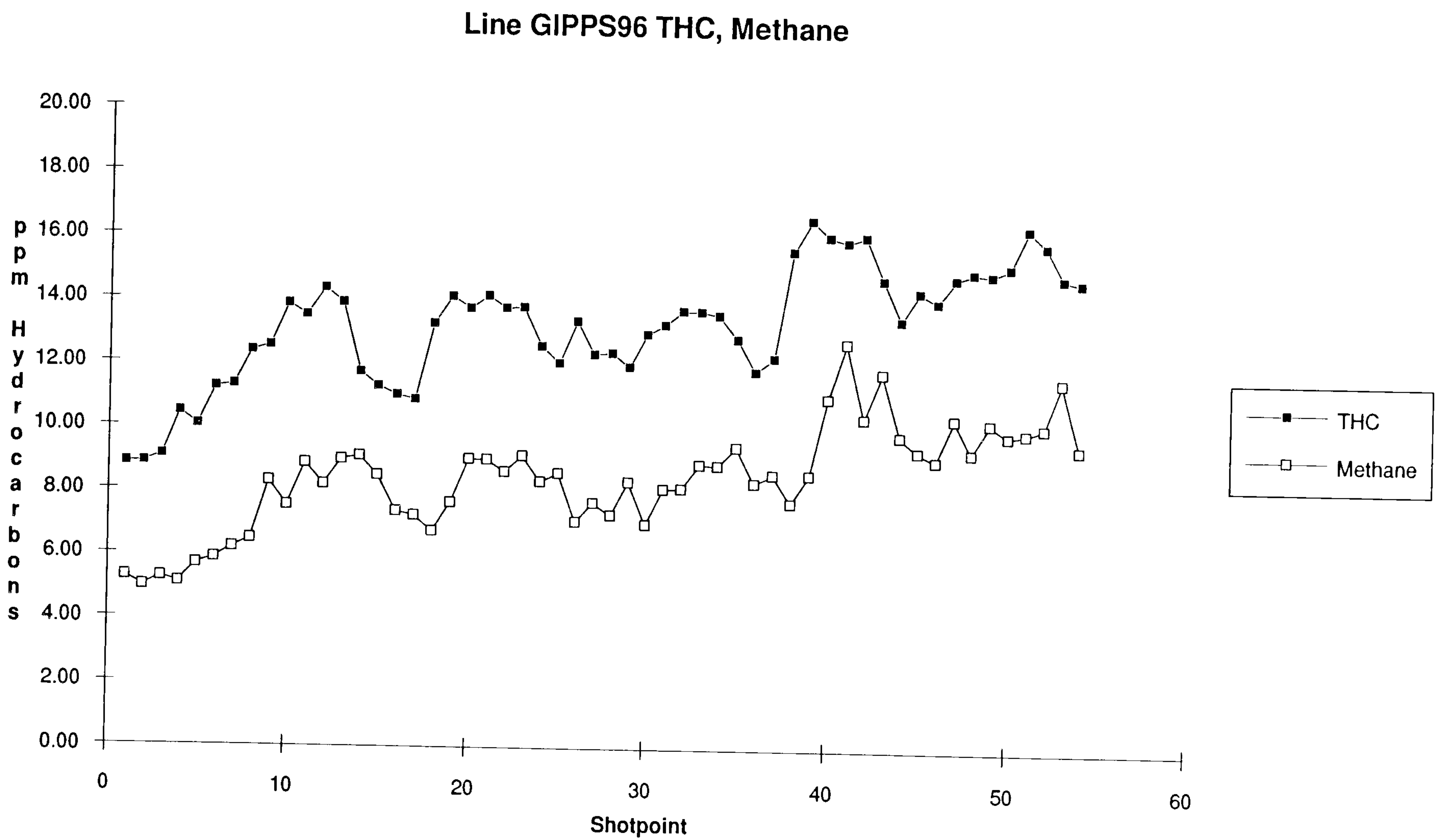
	Shotpoint	Date	Time	Latitude		Longitude	
Start	2	3-Mar-89	00:10:39	37	57.636	148	47.704
End	55	3-Mar-89	02:00:28	37	56.192	148	45.765

	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	13.262	8.444	0.130	0.084	0.071	0.015	0.009	0.012	N/A	N/A	N/A	N/A	2.455
Std. Dev.	1.901	1.705	0.056	0.023	0.028	0.005	0.005	0.010	N/A	N/A	N/A	N/A	0.778
Minimum	8.846	4.969	0.027	0.044	0.014	0.006	0.000	0.000	N/A	N/A	N/A	N/A	0.888
Maximum	16.613	12.766	0.213	0.140	0.113	0.031	0.018	0.028	N/A	N/A	N/A	N/A	3.620

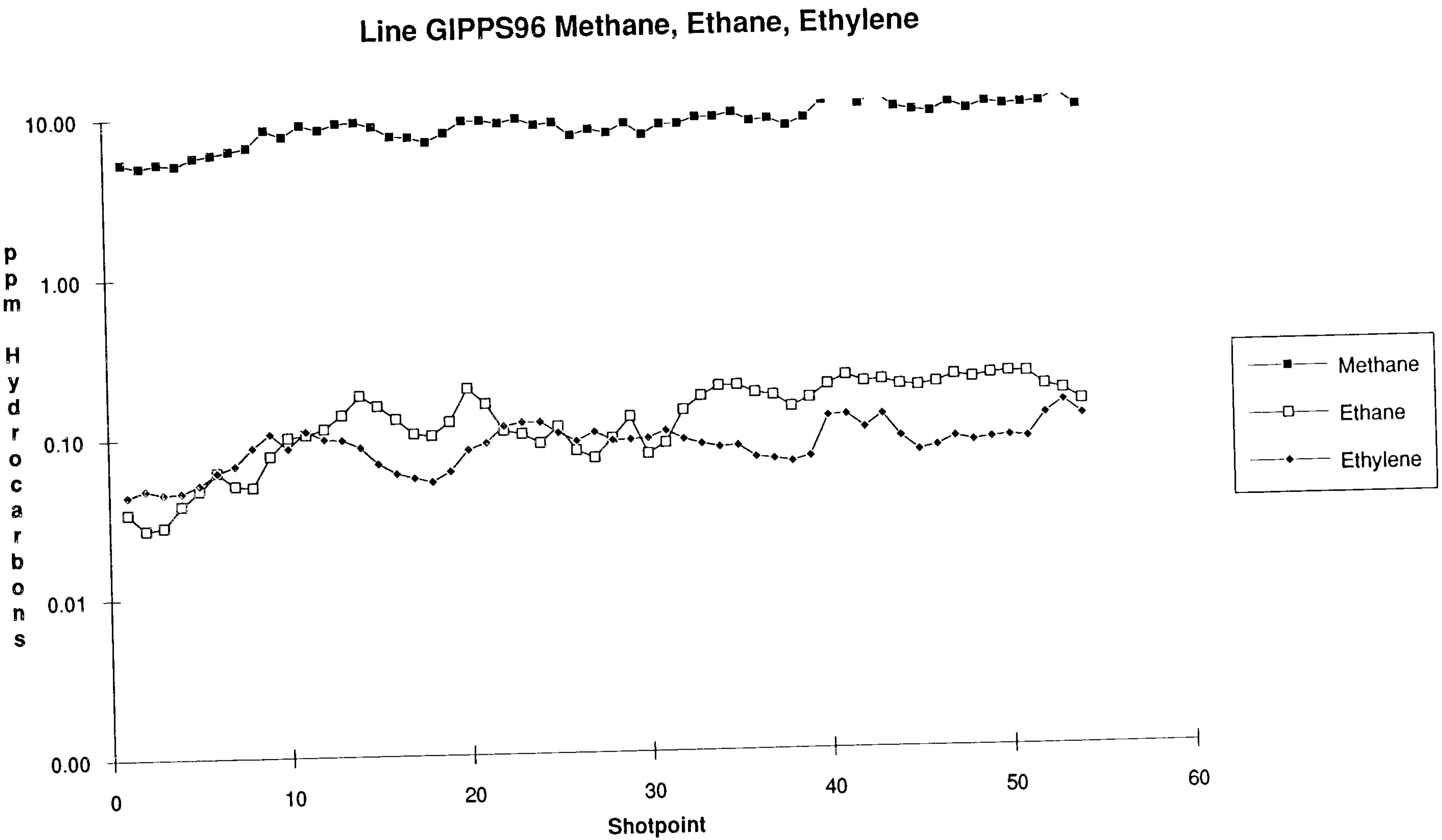
	Salinity	Temp.	F. Depth	W.Depth	Altitude
Mean	31.499	18.375	28.165	44.924	16.759
Std. Dev.	0.849	1.061	5.670	5.755	3.118
Minimum	30.120	16.670	20.000	33.600	10.900
Maximum	33.030	20.290	38.800	56.600	24.500

Notes

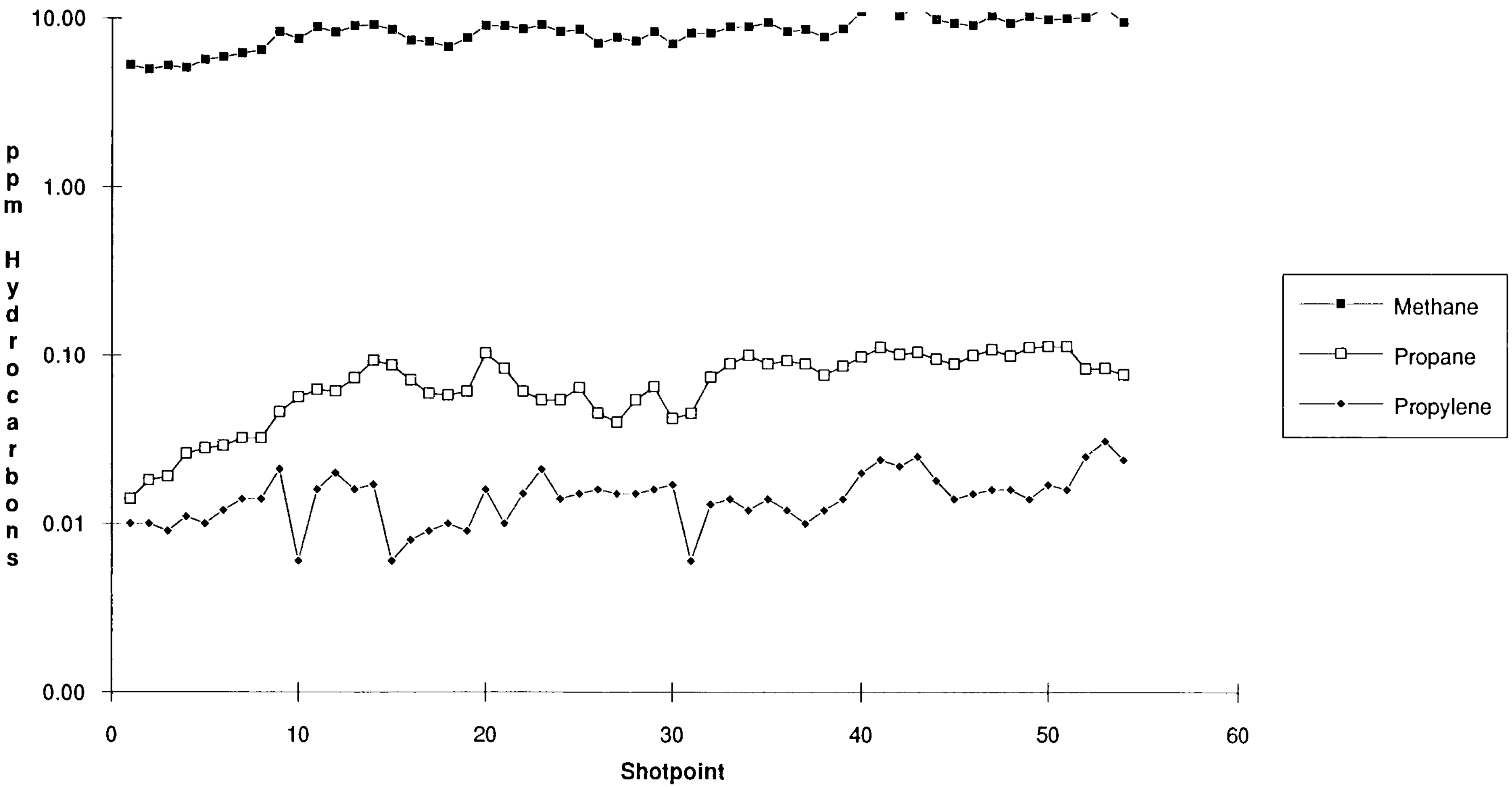
Anomaly at end of line maybe due to decreasing fish depth. The tow-fish is near the base of the thermocline and water depths decrease slightly toward the end of this line. There maybe more than one 'source' of hydrocarbons contributing to these variations.

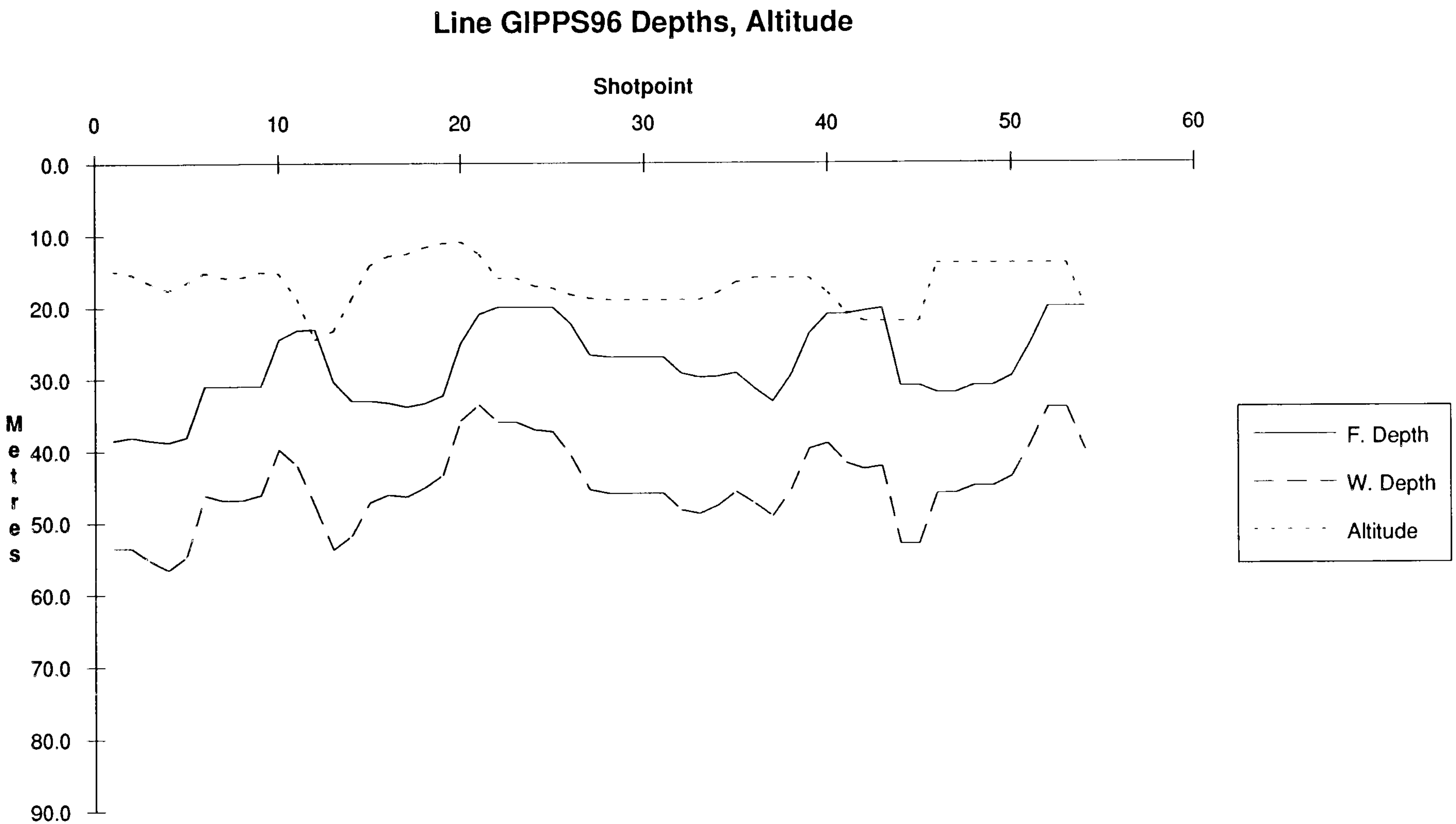


Line GIPPS96 THC, Methane
ppm Hydrocarbons
20.00
18.00
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
0
10
20
30
40
50
60
Shotpoint
THC
Methane


Line GIPPS96 Methane, Ethane, Ethylene
ppm Hydrocarbons
10.00
1.00
0.10
0.01
0.00
0
10
20
30
40
50
60
Shotpoint
Methane
Ethane
Ethylene

Line GIPPS96 Methane, Propane, Propylene




Line GIPPS96 Depths, Altitude
Shotpoint
0
10
20
30
40
50
60
0.0
10.0
20.0
30.0
40.0
50.0
60.0
70.0
80.0
90.0
Metres
F. Depth
W. Depth
Altitude

Line Summary

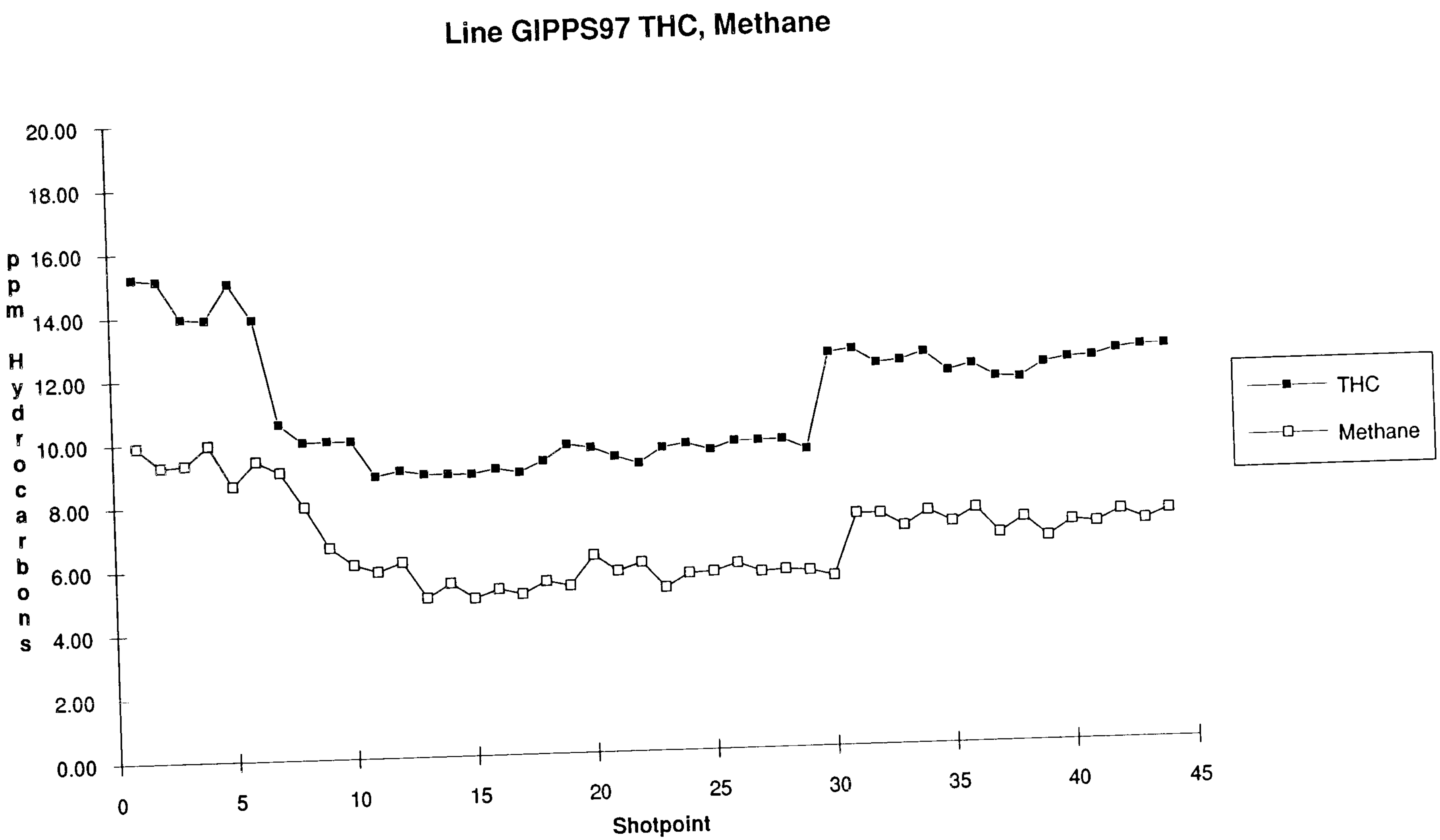
Line Number	gipps97
No. of Shotpoints	44

	Shotpoint	Date	Time	Latitude		Longitude	
Start	1	3-Mar-89	02:29:28	37	56.445	148	47.265
End	45	3-Mar-89	04:05:43	38	01.882	148	44.318

	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	10.972	6.661	0.070	0.071	0.041	0.014	0.003	0.006	N/A	N/A	N/A	N/A	1.651
Std. Dev.	1.905	1.413	0.050	0.022	0.024	0.005	0.005	0.008	N/A	N/A	N/A	N/A	0.782
Minimum	8.830	4.928	0.031	0.042	0.019	0.007	0.000	0.000	N/A	N/A	N/A	N/A	0.914
Maximum	15.201	9.916	0.196	0.105	0.100	0.024	0.019	0.029	N/A	N/A	N/A	N/A	3.571

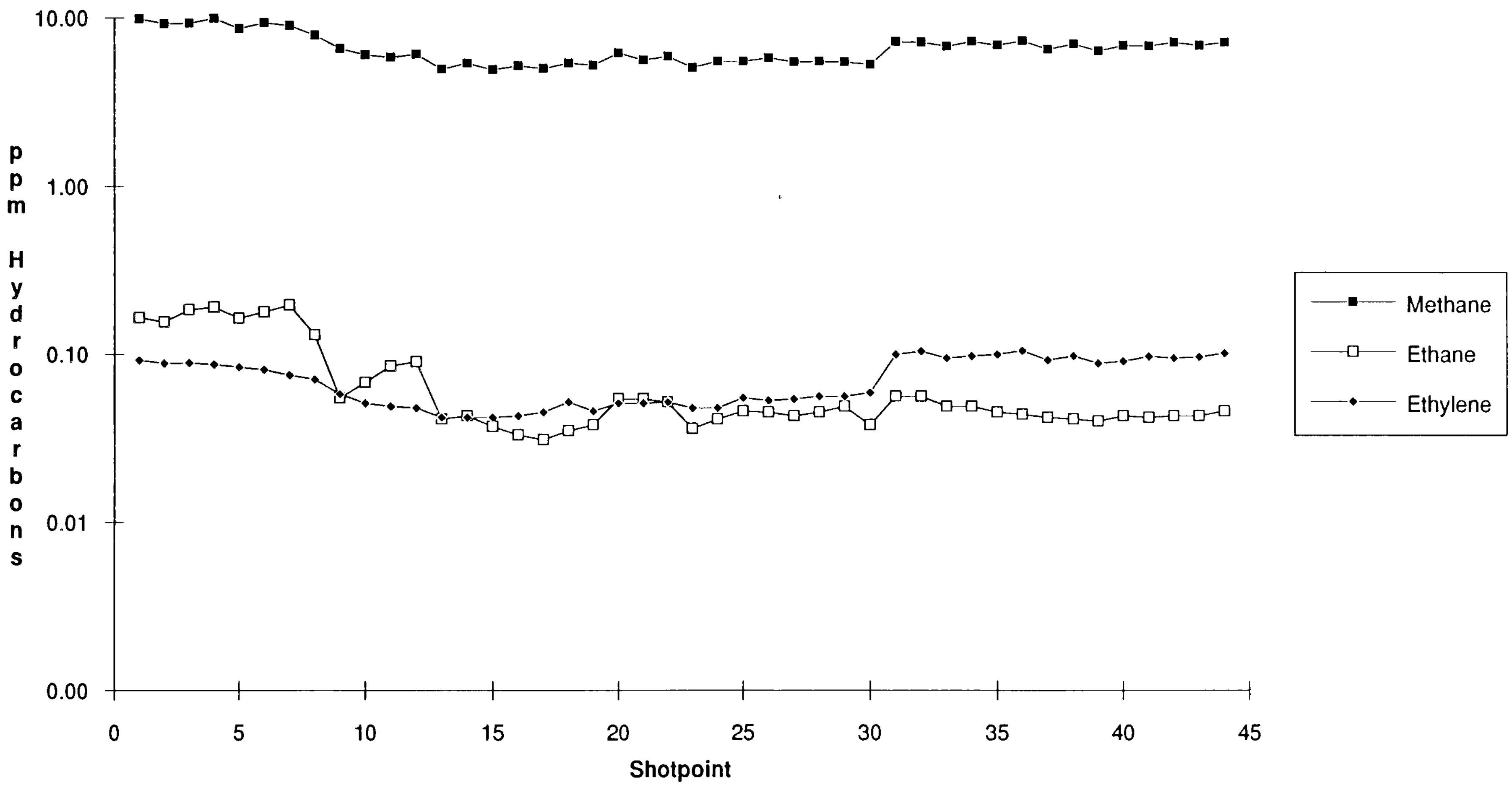
	Salinity	Temp.	F. Depth	W.Depth	Altitude
Mean	31.380	15.385	33.023	47.625	14.611
Std. Dev.	1.083	1.144	15.590	14.114	2.003
Minimum	30.200	14.140	15.500	32.500	12.000
Maximum	33.560	17.450	50.600	66.400	17.000

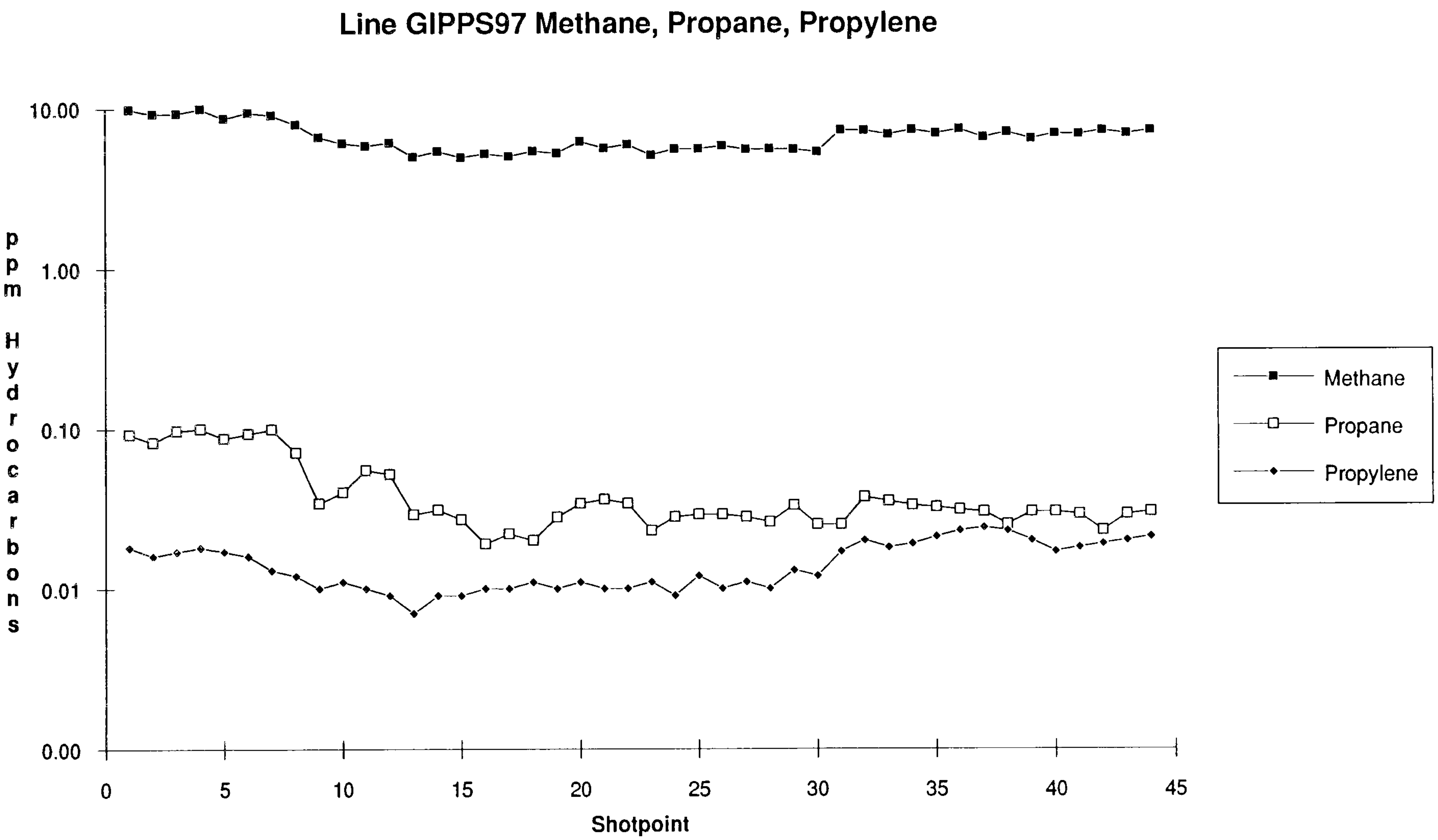
Notes Anomaly at beginning of line is continuation of anomaly at end of line Gipps96. Probably due to decreasing fish depth.

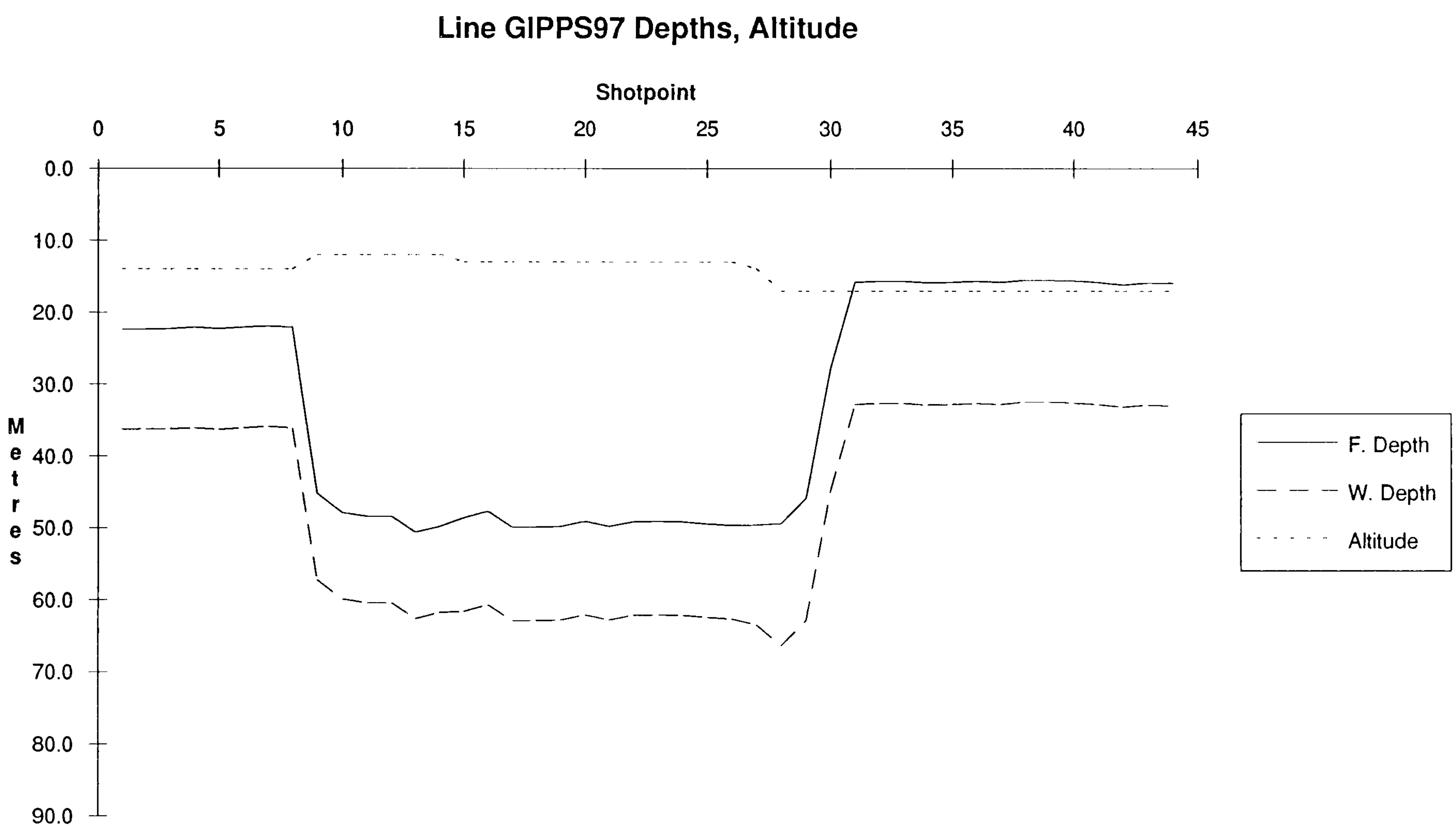


Line GIPPS97 THC, Methane
ppm Hydrocarbons
20.00
18.00
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
0
5
10
15
20
25
30
35
40
45
Shotpoint
THC
Methane

Line GIPPS97 Methane, Ethane, Ethylene




Line GIPPS97 Methane, Propane, Propylene
ppm Hydrocarbons
10.00
1.00
0.10
0.01
0.00
0
5
10
15
20
25
30
35
40
45
Shotpoint
Methane
Propane
Propylene


Line GIPPS97 Depths, Altitude
Shotpoint
0
5
10
15
20
25
30
35
40
45
0.0
10.0
20.0
30.0
40.0
50.0
60.0
70.0
80.0
90.0
Metres
F. Depth
W. Depth
Altitude

NORTH BASS BASIN DHD LINE SUMMARY SHEETS AND PLOTS

Line Summary

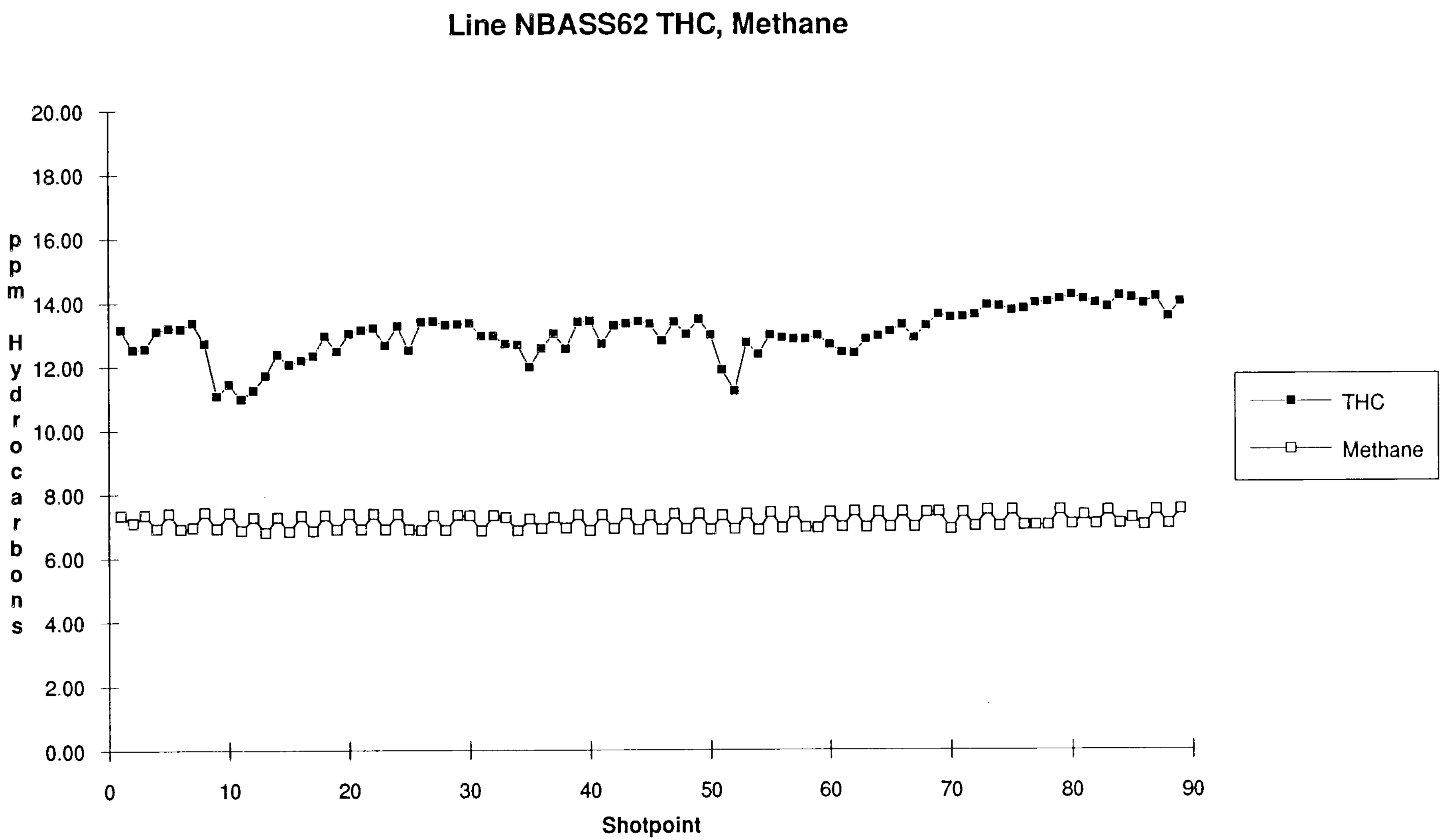
Line Number	nbass62
No. of Shotpoints	89

	Shotpoint	Date	Time	Latitude		Longitude	
Start	1	15-Feb-89	13:08:30	39	22.652	145	20.793
End	89	15-Feb-89	16:25:44	39	11.924	145	02.883

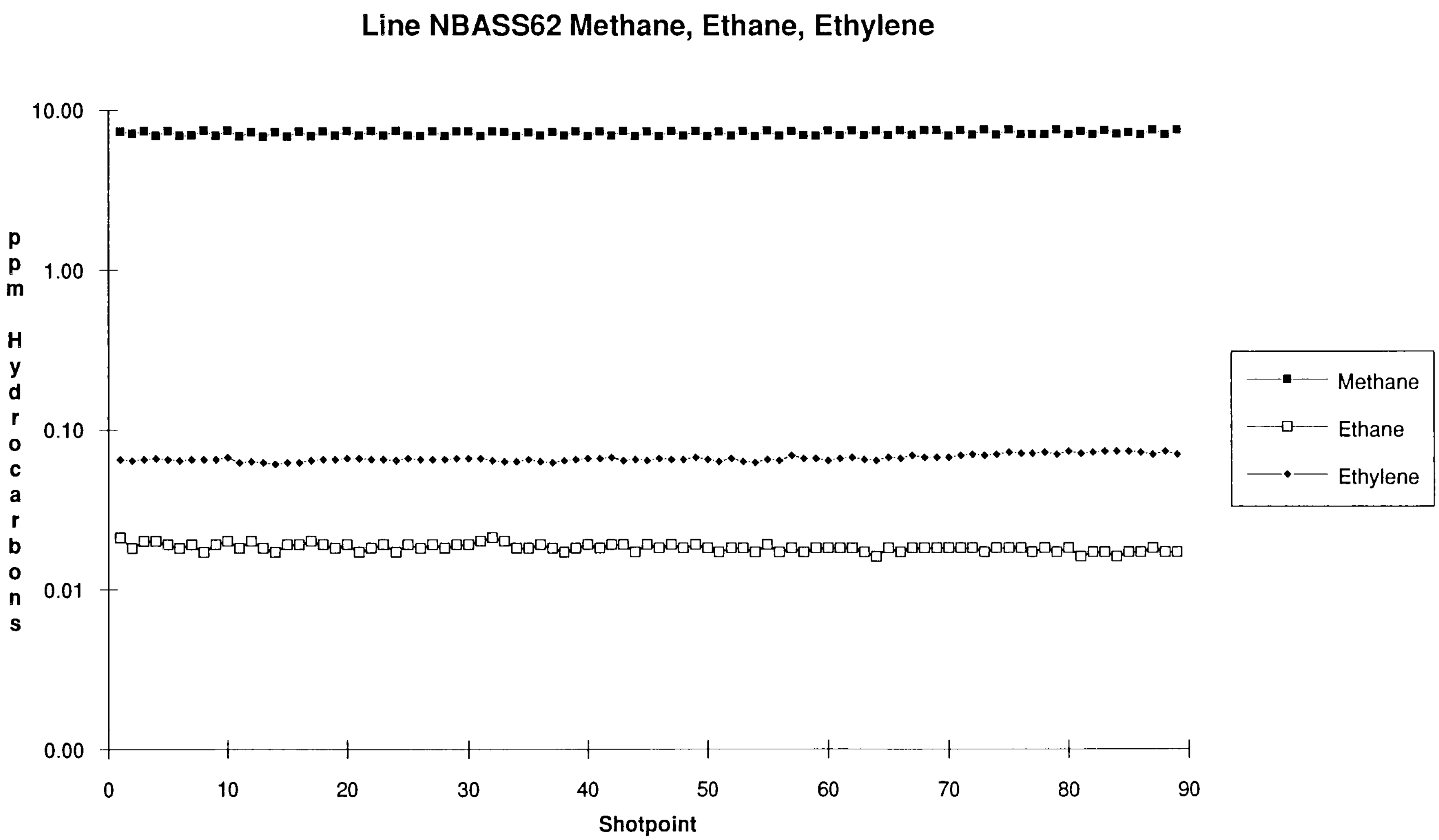
	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	13.006	7.134	0.018	0.066	0.017	0.010	0.000	0.005	N/A	N/A	N/A	N/A	0.570
Std. Dev.	0.716	0.234	0.001	0.003	0.002	0.002	0.001	0.006	N/A	N/A	N/A	N/A	0.085
Minimum	10.970	6.790	0.016	0.061	0.013	0.007	0.000	0.000	N/A	N/A	N/A	N/A	0.439
Maximum	14.190	7.480	0.021	0.073	0.022	0.014	0.006	0.017	N/A	N/A	N/A	N/A	0.763

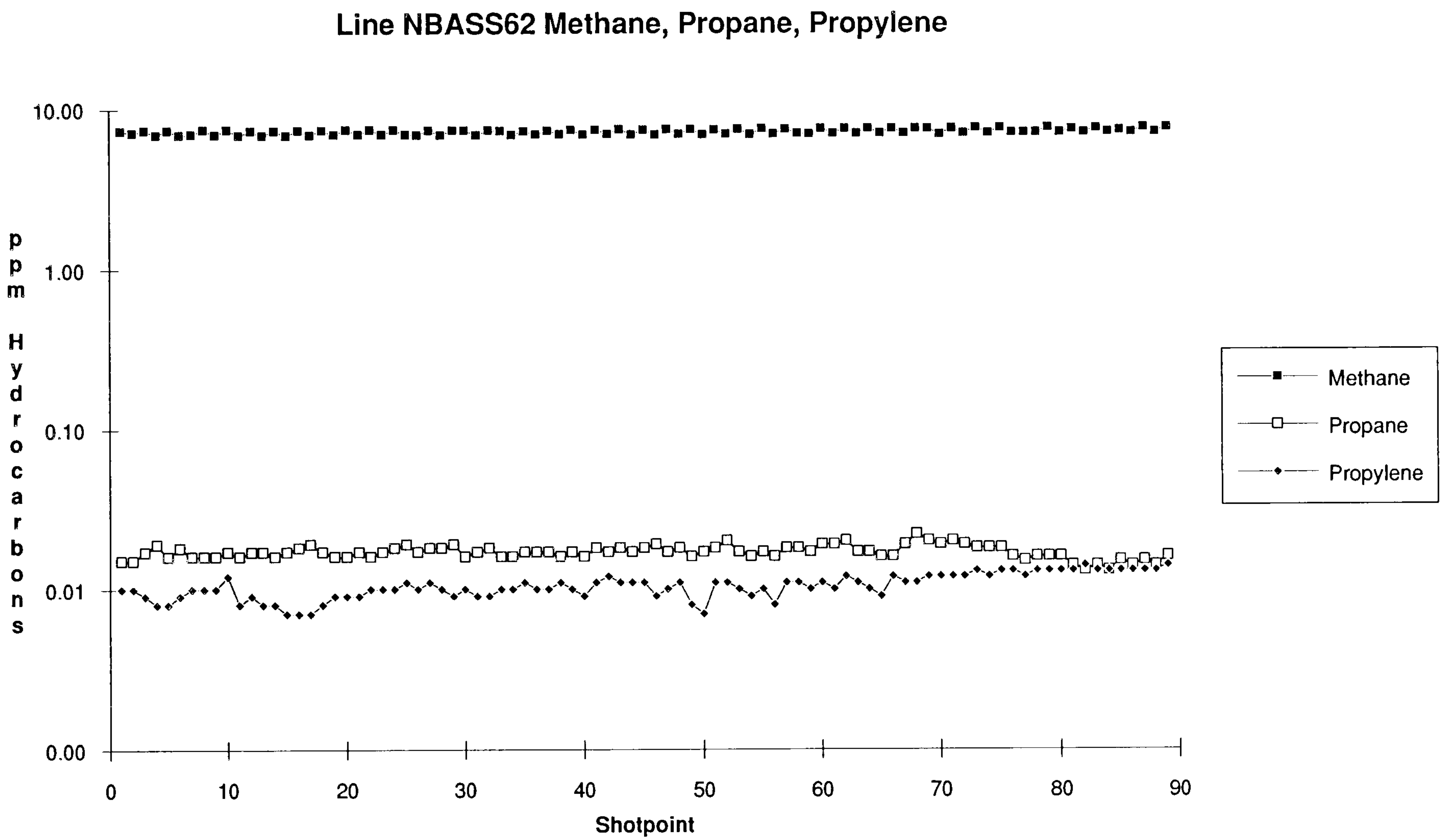
	Salinity	Temp.	F. Depth	W.Depth	Altitude
Mean	31.276	17.939	52.407	64.352	11.947
Std. Dev.	0.295	0.362	2.906	3.998	1.544
Minimum	31.010	17.600	47.900	57.900	10.000
Maximum	32.220	19.120	56.400	69.600	15.000

Notes No anomalies.

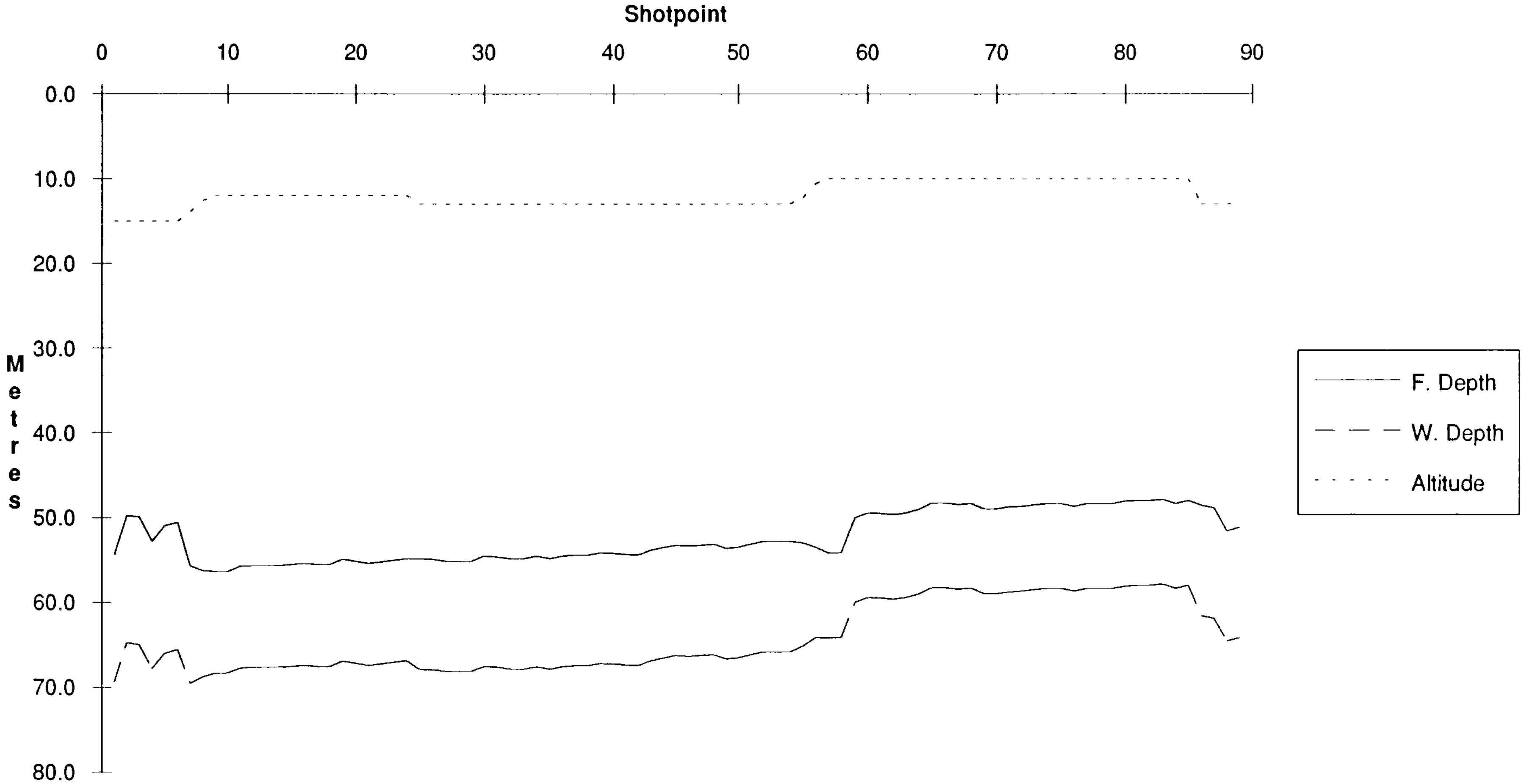


Line NBASS62 THC, Methane
ppm Hydrocarbons
20.00
18.00
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
0
10
20
30
40
50
60
70
80
90
Shotpoint
THC
Methane


Line NBASS62 Methane, Ethane, Ethylene
10.00
1.00
0.10
0.01
0.00
ppm Hydrocarbons
0
10
20
30
40
50
60
70
80
90
Shotpoint
Methane
Ethane
Ethylene


Line NBASS62 Methane, Propane, Propylene
ppm Hydrocarbons
10.00
1.00
0.10
0.01
0.00
0
10
20
30
40
50
60
70
80
90
Shotpoint
Methane
Propane
Propylene

Line NBASS62 Depths, Altitude



Line Summary

Line Number	nbass63
No. of Shotpoints	194

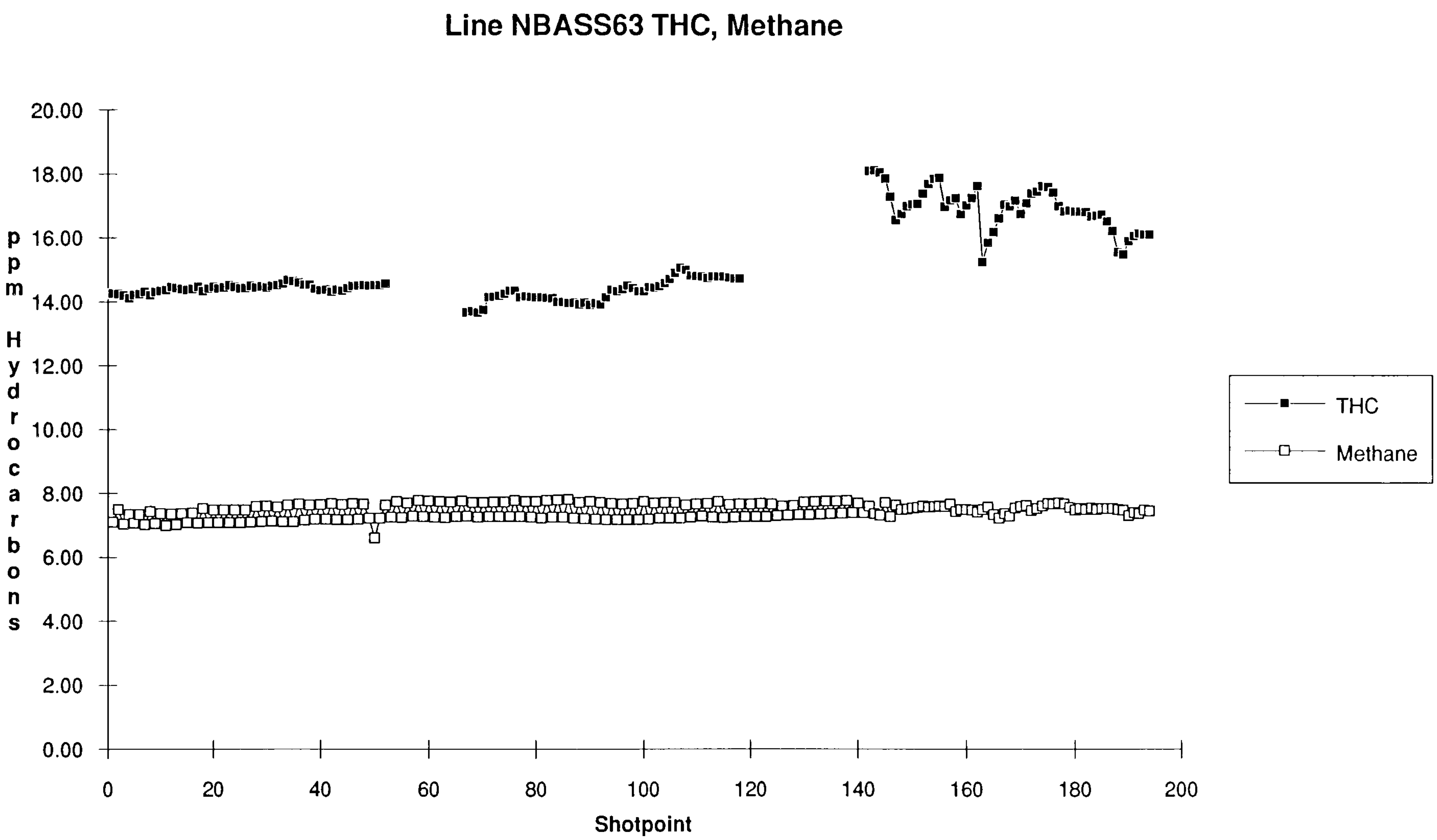
	Shotpoint	Date	Time	Latitude		Longitude	
Start	1	15-Feb-89	16:28:55	39	12.155	145	02.837
End	194	15-Feb-89	23:24:03	38	54.341	145	42.005

	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	15.224	7.434	0.016	0.072	0.015	0.013	0.000	0.000	N/A	N/A	N/A	N/A	0.426
Std. Dev.	1.283	0.229	0.003	0.003	0.002	0.003	0.001	0.000	N/A	N/A	N/A	N/A	0.065
Minimum	13.670	6.590	0.011	0.062	0.011	0.007	0.000	0.000	N/A	N/A	N/A	N/A	0.290
Maximum	18.100	7.800	0.021	0.079	0.020	0.020	0.013	0.000	N/A	N/A	N/A	N/A	0.661

	Salinity	Temp.	F. Depth	W.Depth	Altitude
Mean	32.253	19.204	52.089	65.829	13.739
Std. Dev.	0.768	0.978	2.213	2.919	1.558
Minimum	31.360	18.100	47.300	57.200	8.000
Maximum	33.380	20.500	55.400	70.400	16.000

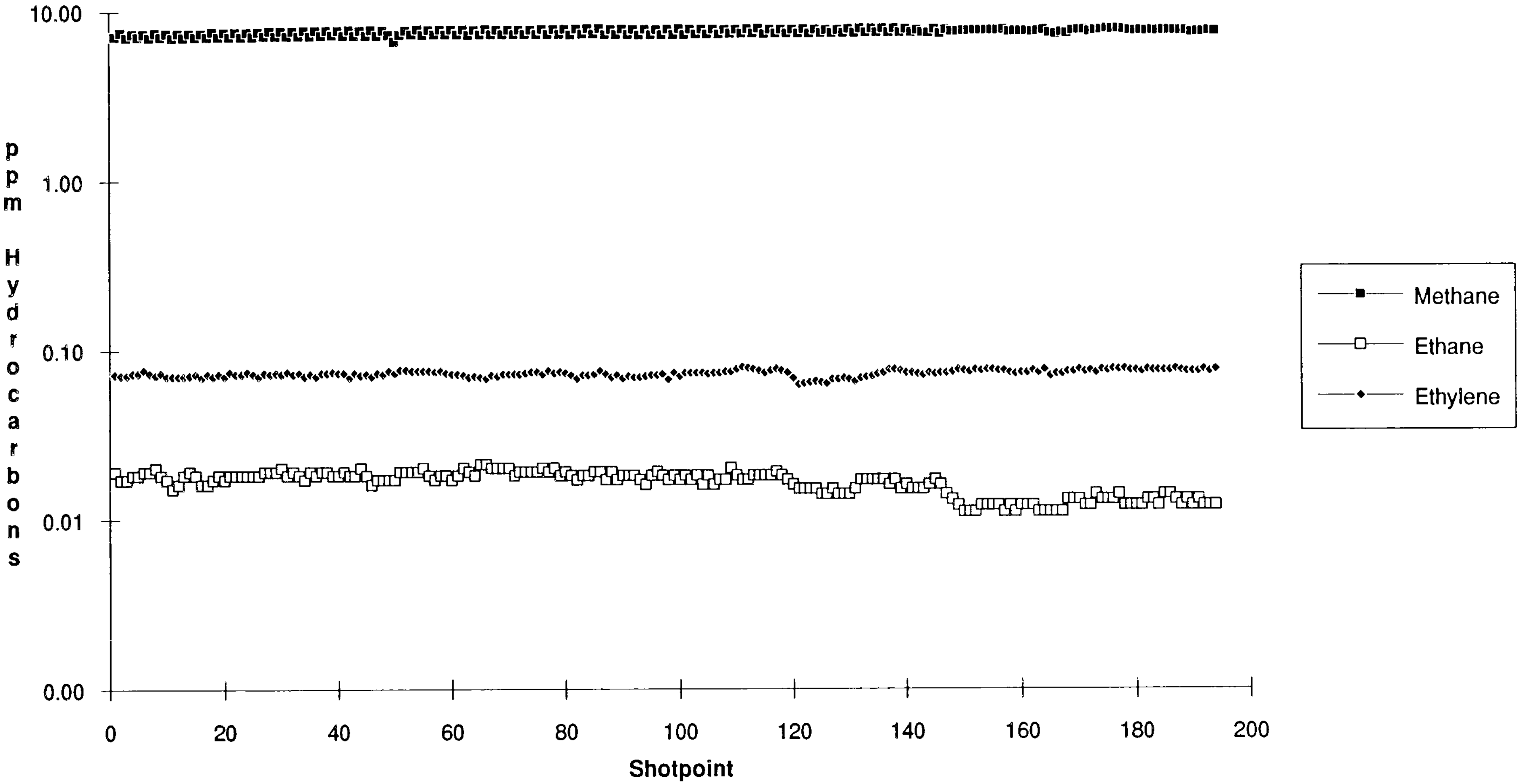
Notes

No anomalies.
Shotpoint 120 - vacuum pump replaced, THC contamination shotpoints 120-142.

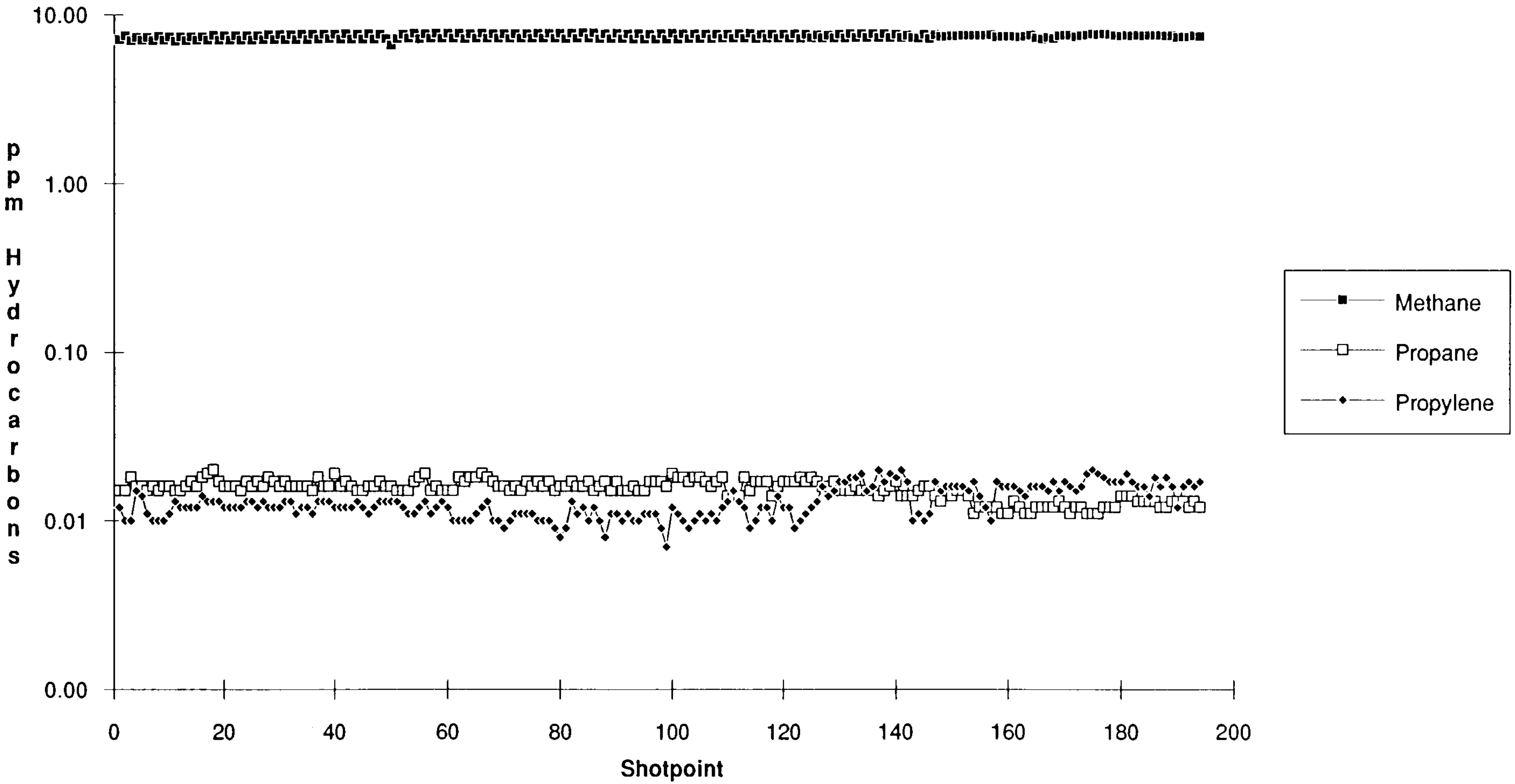


Line NBASS63 THC, Methane
ppm Hydrocarbons
20.00
18.00
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
0
20
40
60
80
100
120
140
160
180
200
Shotpoint
THC
Methane

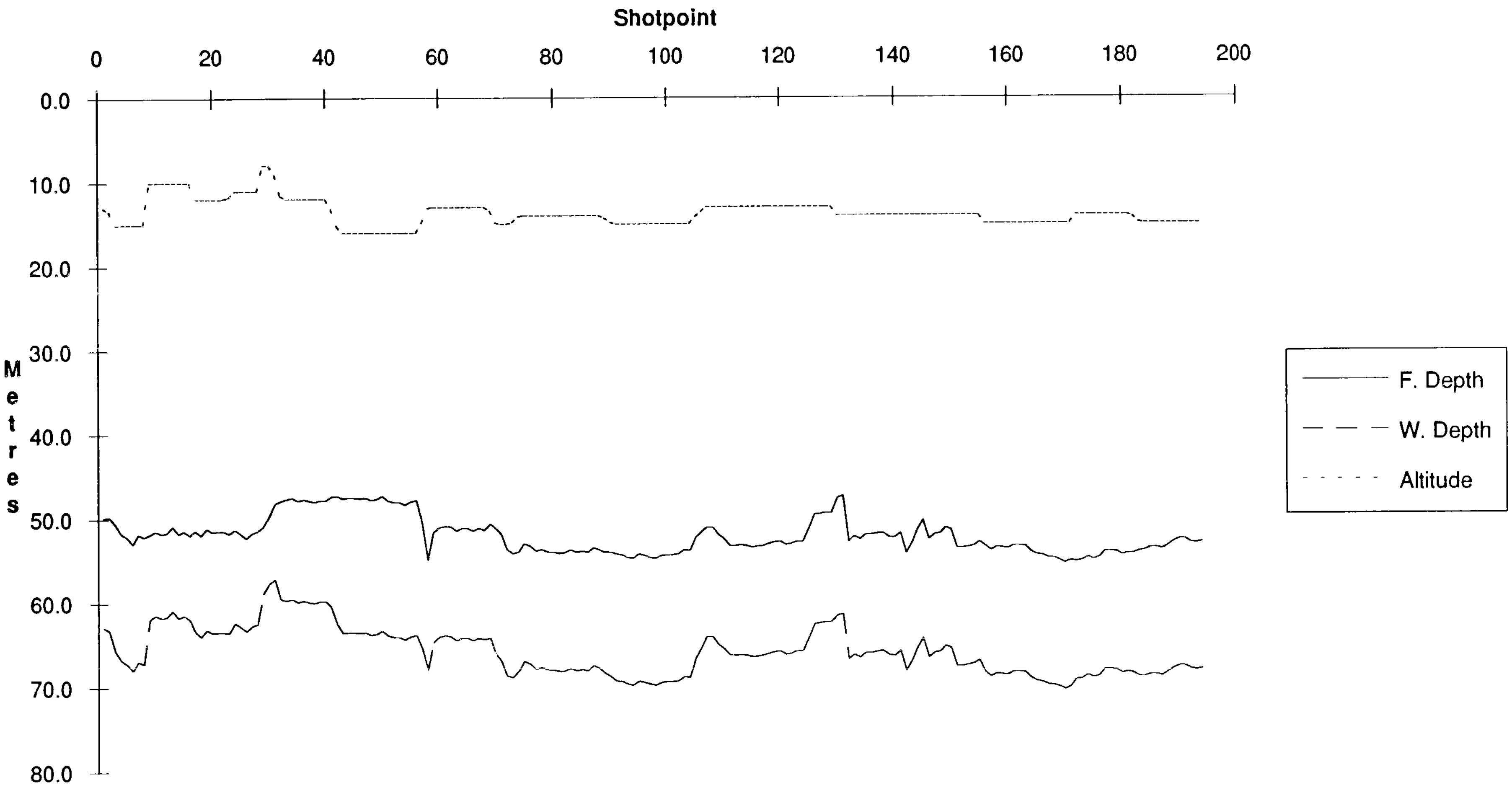
Line NBASS63 Methane, Ethane, Ethylene



Line NBASS63 Methane, Propane, Propylene



Line NBASS63 Depths, Altitude



Line Summary

Line Number	nbass64
No. of Shotpoints	87

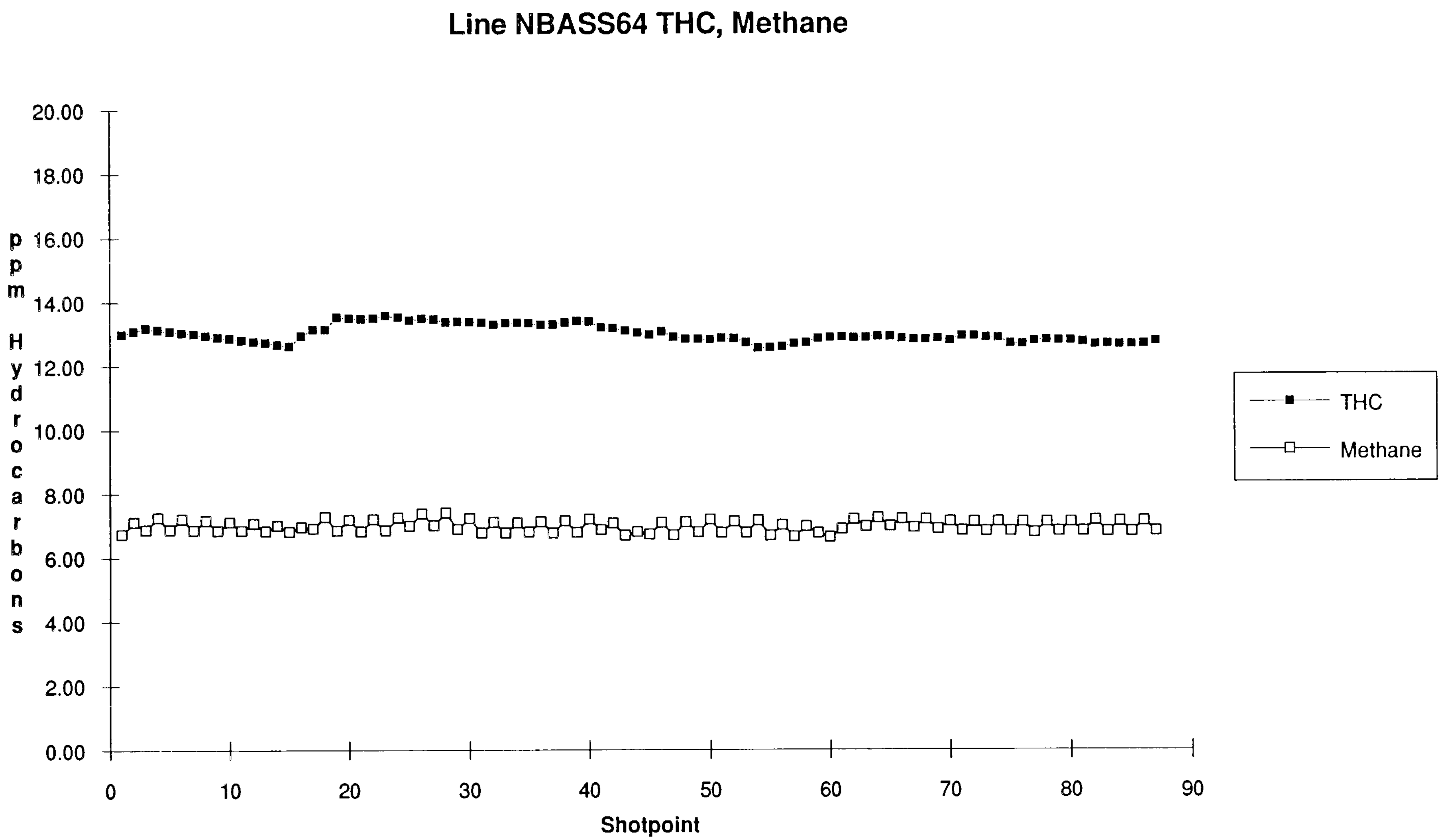
	Shotpoint	Date	Time	Latitude		Longitude	
Start	1	25-Feb-89	03:35:06	38	41.901	145	27.614
End	87	25-Feb-89	06:30:21	38	53.598	145	41.797

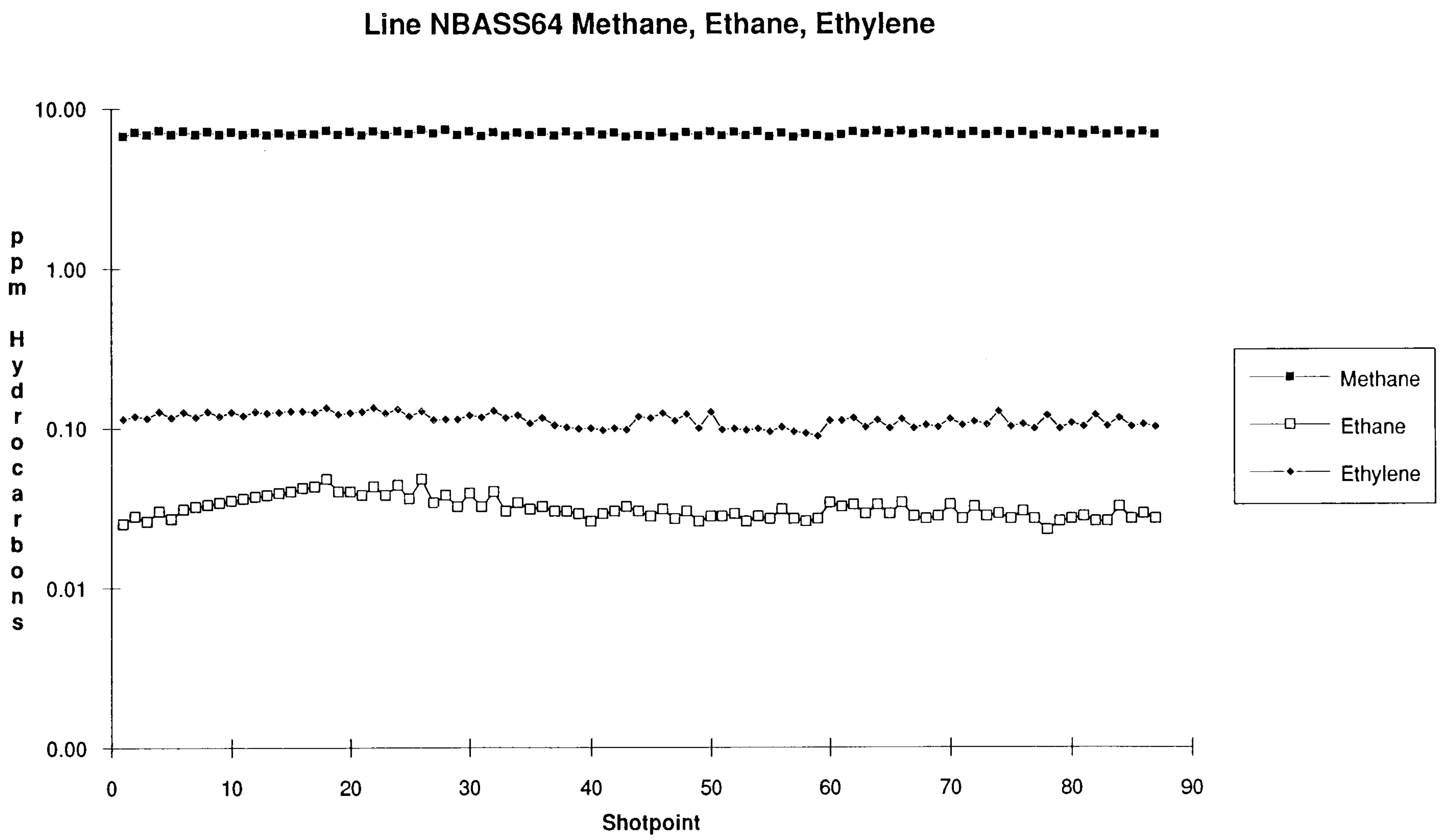
	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	12.977	6.958	0.032	0.113	0.021	0.025	0.000	0.001	N/A	N/A	N/A	N/A	0.776
Std. Dev.	0.281	0.186	0.005	0.011	0.002	0.010	0.001	0.002	N/A	N/A	N/A	N/A	0.093
Minimum	12.530	6.610	0.023	0.089	0.015	0.010	0.000	0.000	N/A	N/A	N/A	N/A	0.593
Maximum	13.550	7.380	0.048	0.135	0.027	0.046	0.004	0.008	N/A	N/A	N/A	N/A	1.013

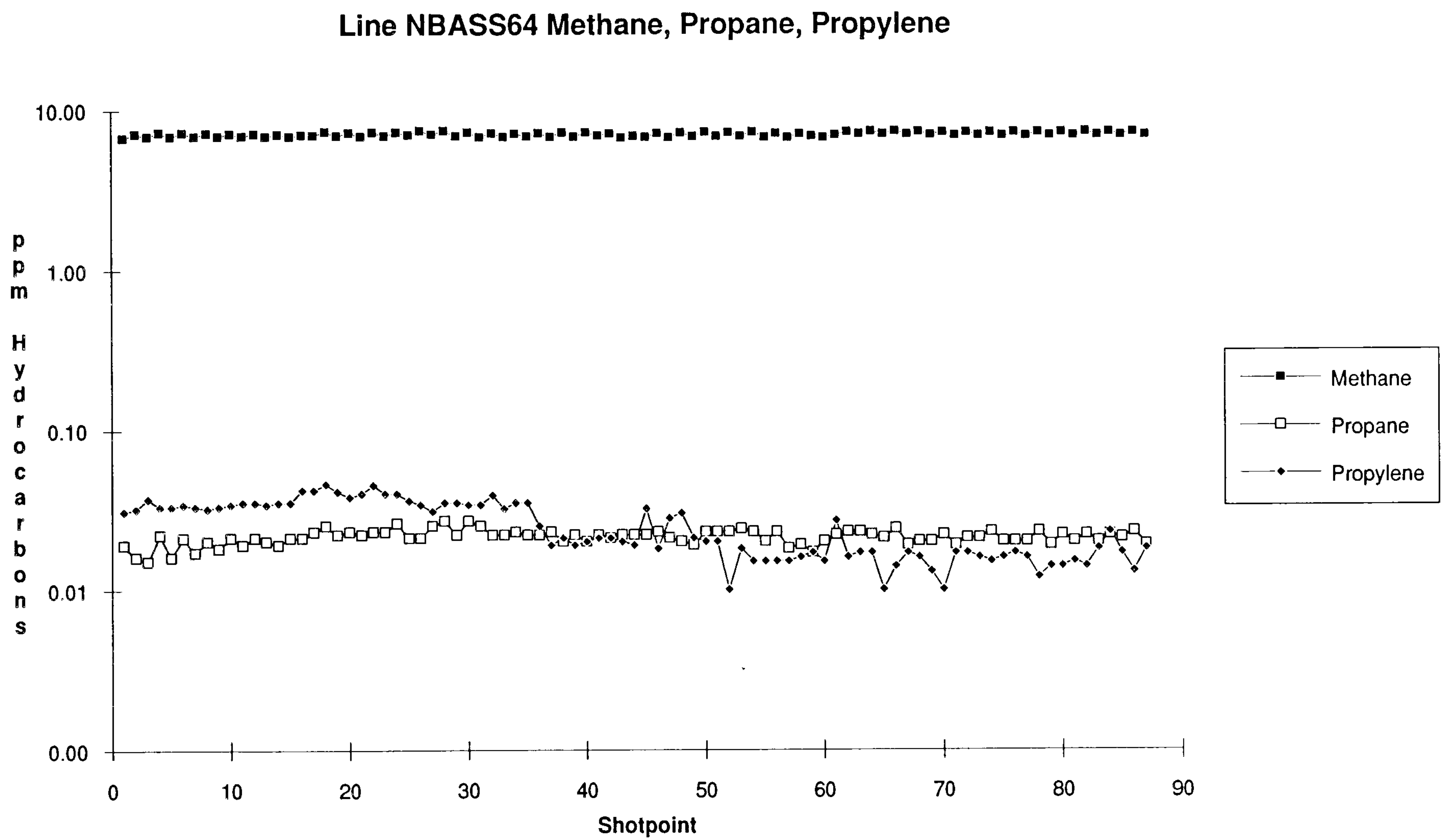
	Salinity	Temp.	F. Depth	W.Depth	Altitude
Mean	33.848	21.152	34.995	53.307	18.311
Std. Dev.	0.396	0.463	7.421	11.542	4.896
Minimum	33.130	20.330	23.300	33.300	5.600
Maximum	34.440	21.900	43.300	71.700	30.000

Notes

No anomalies.
Gas extractor problem, shotpoints 4-14, values interpolated.

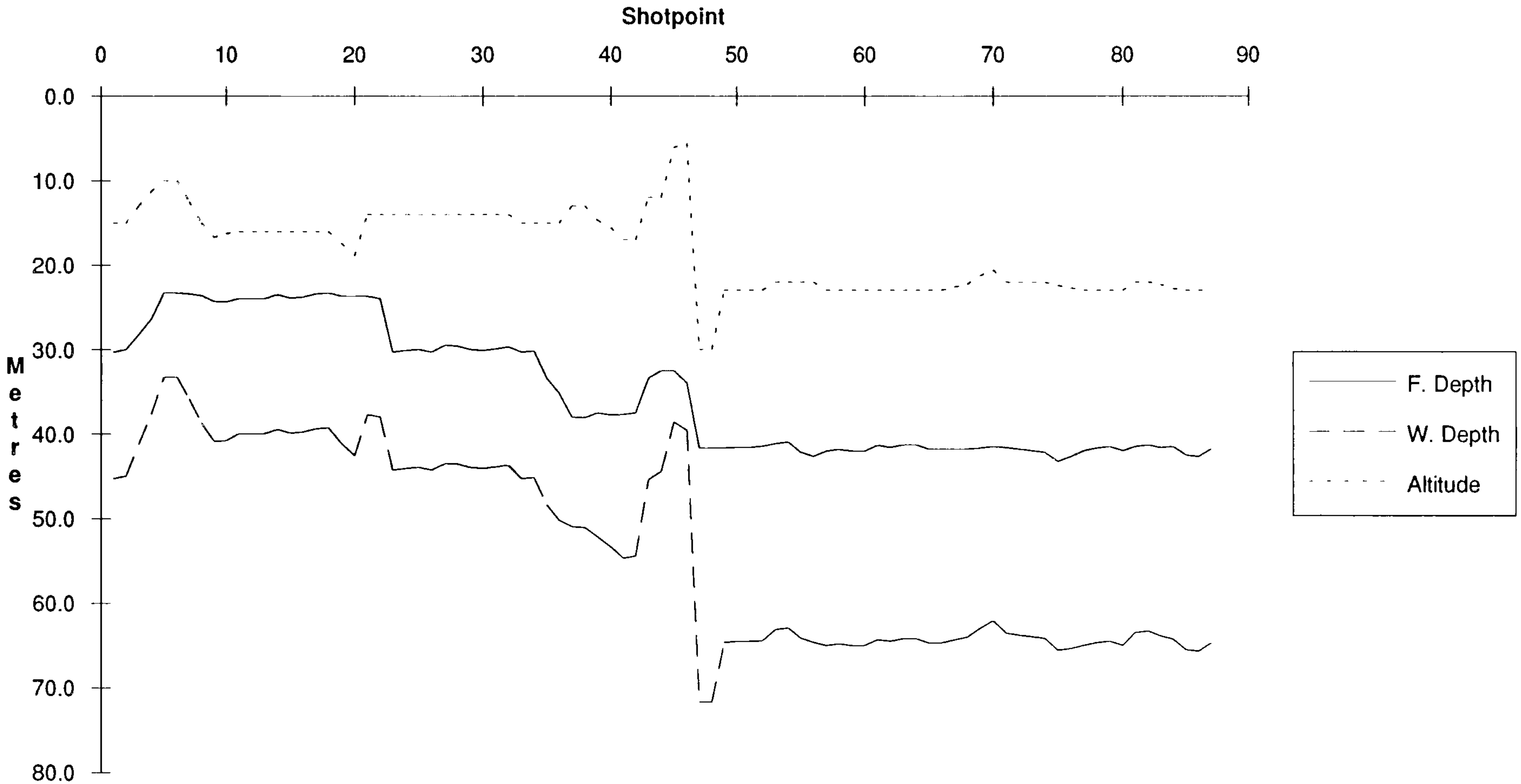

Line NBASS64 THC, Methane
ppm Hydrocarbons
20.00
18.00
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
0
10
20
30
40
50
60
70
80
90
Shotpoint
THC
Methane


Line NBASS64 Methane, Ethane, Ethylene
ppm Hydrocarbons
10.00
1.00
0.10
0.01
0.00
0
10
20
30
40
50
60
70
80
90
Shotpoint
Methane
Ethane
Ethylene



Line NBASS64 Methane, Propane, Propylene
ppm Hydrocarbons
10.00
1.00
0.10
0.01
0.00
0
10
20
30
40
50
60
70
80
90
Shotpoint
Methane
Propane
Propylene

Line NBASS64 Depths, Altitude



Line Summary

Line Number	nbass65
No. of Shotpoints	164

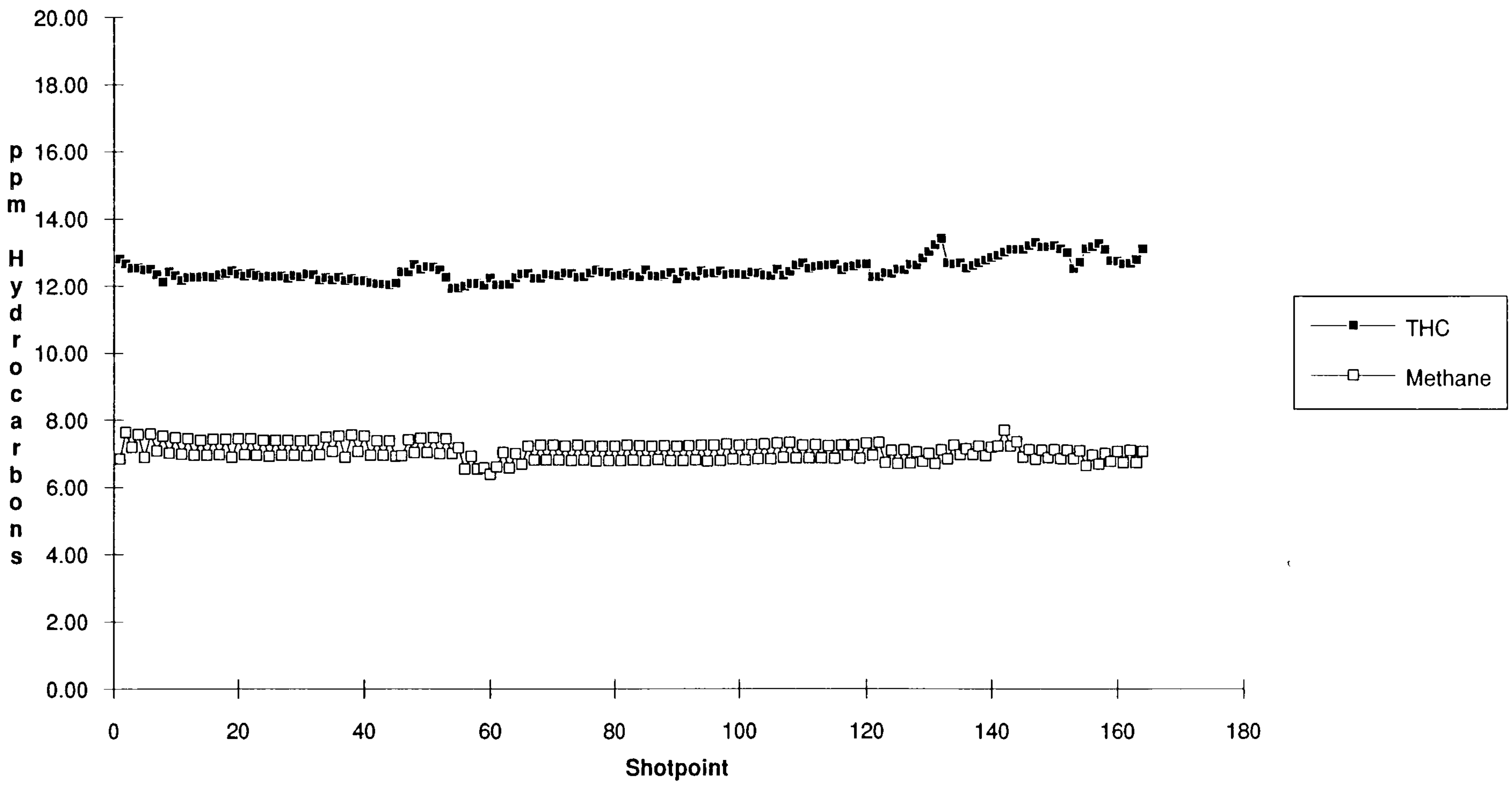
	Shotpoint	Date	Time	Latitude		Longitude	
Start	1	24-Feb-89	21:51:55	39	09.765	144	59.468
End	165	25-Feb-89	03:32:00	38	42.188	145	27.307

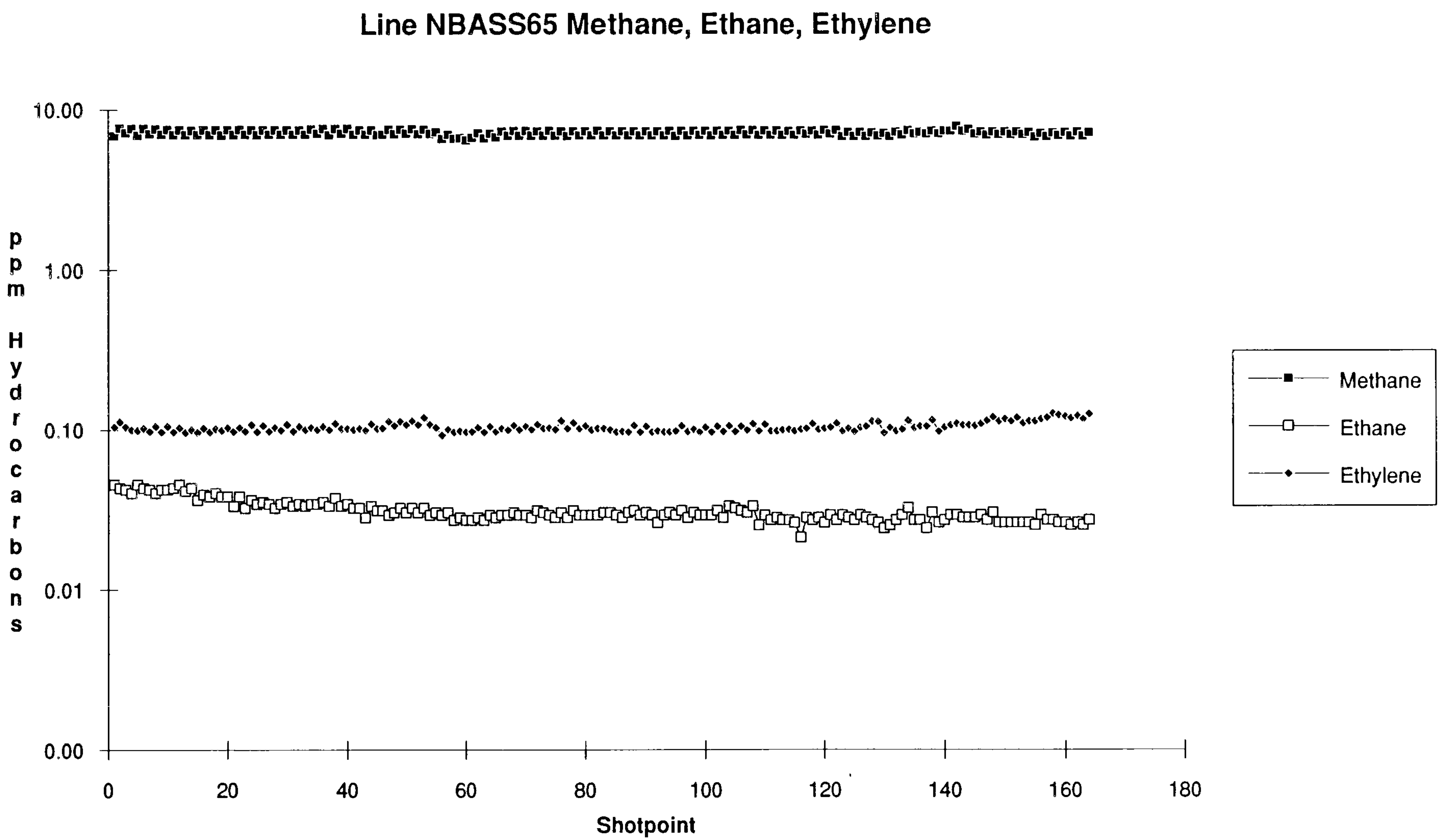
	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	12.469	7.056	0.031	0.104	0.022	0.017	0.000	0.001	N/A	N/A	N/A	N/A	0.761
Std. Dev.	0.309	0.263	0.005	0.007	0.004	0.005	0.000	0.003	N/A	N/A	N/A	N/A	0.125
Minimum	11.930	6.380	0.021	0.092	0.013	0.010	0.000	0.000	N/A	N/A	N/A	N/A	0.549
Maximum	13.410	7.690	0.045	0.125	0.041	0.036	0.000	0.009	N/A	N/A	N/A	N/A	1.272

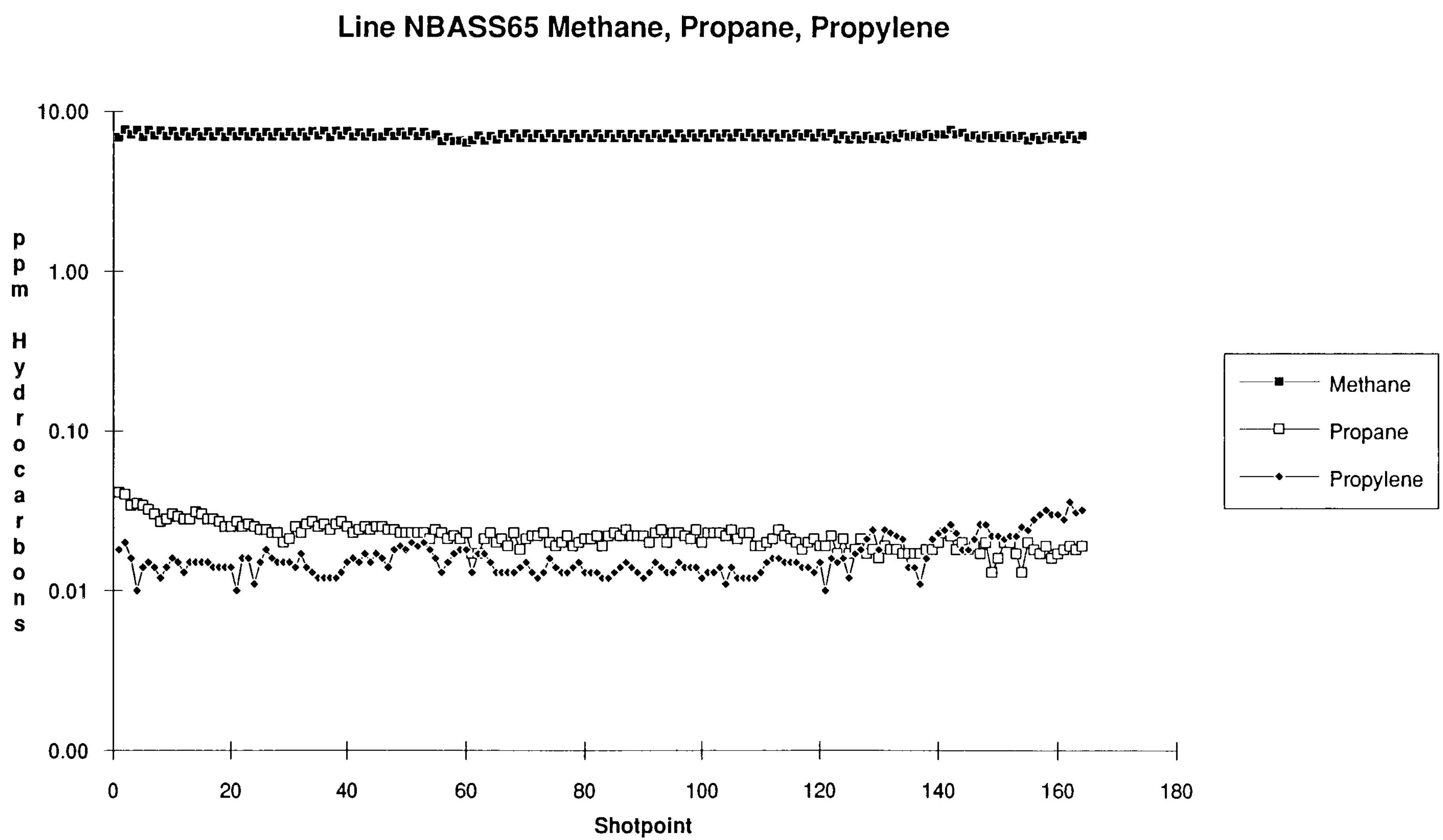
	Salinity	Temp.	F. Depth	W.Depth	Altitude
Mean	32.815	19.930	48.226	62.527	14.302
Std. Dev.	0.648	0.756	8.964	8.516	3.883
Minimum	32.060	19.020	29.300	40.600	10.000
Maximum	34.300	21.600	55.000	78.900	25.000

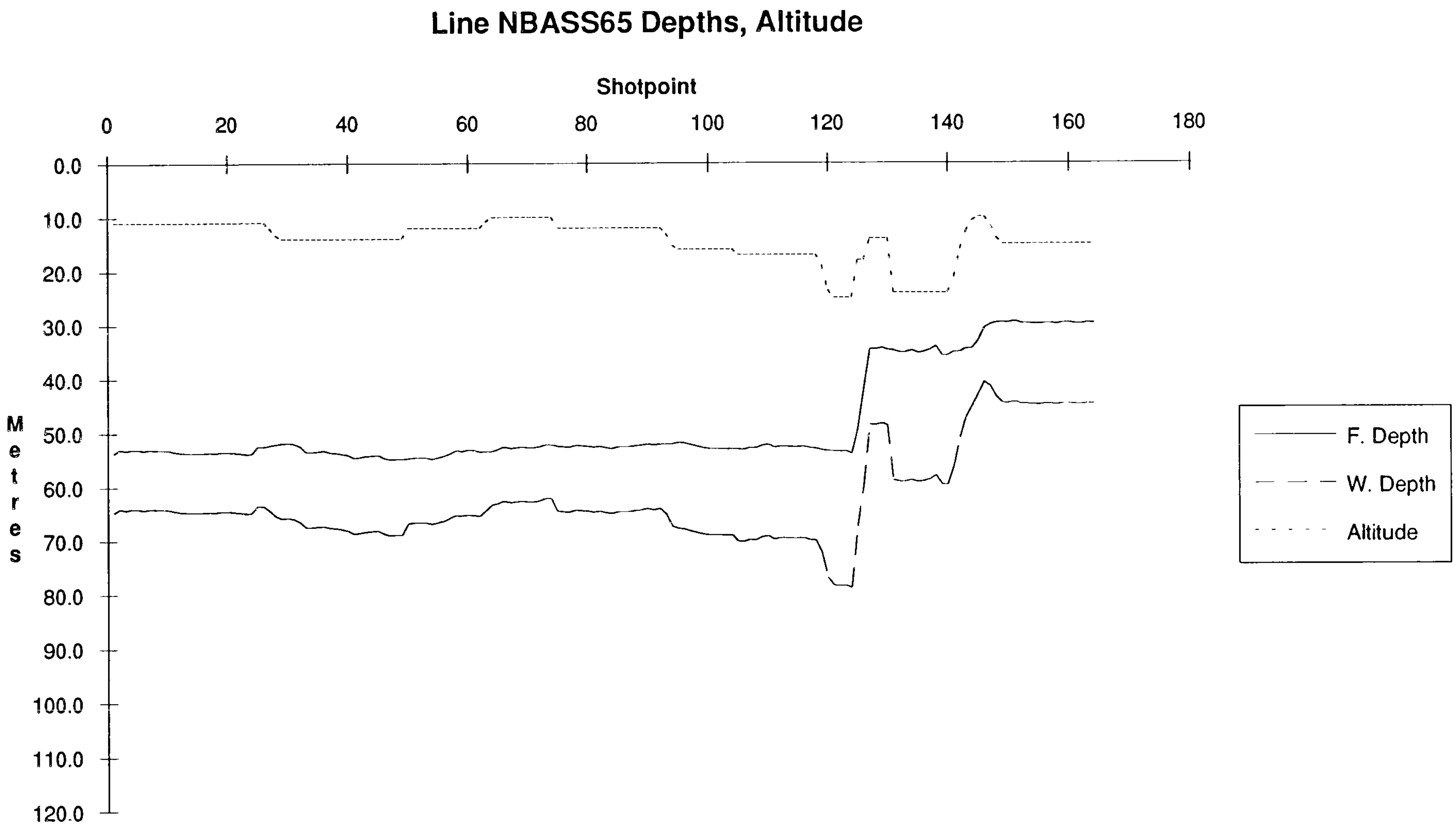
Notes No anomalies.

Line NBASS65 THC, Methane




Line NBASS65 Methane, Ethane, Ethylene
ppm Hydrocarbons
10.00
1.00
0.10
0.01
0.00
0
20
40
60
80
100
120
140
160
180
Shotpoint
Methane
Ethane
Ethylene


Line NBASS65 Methane, Propane, Propylene
10.00
1.00
0.10
0.01
0.00
ppm Hydrocarbons
0
20
40
60
80
100
120
140
160
180
Shotpoint
Methane
Propane
Propylene



Line NBASS65 Depths, Altitude
Shotpoint
0
20
40
60
80
100
120
140
160
180
0.0
10.0
20.0
30.0
40.0
50.0
60.0
70.0
80.0
90.0
100.0
110.0
120.0
Metres
F. Depth
W. Depth
Altitude

Line Summary

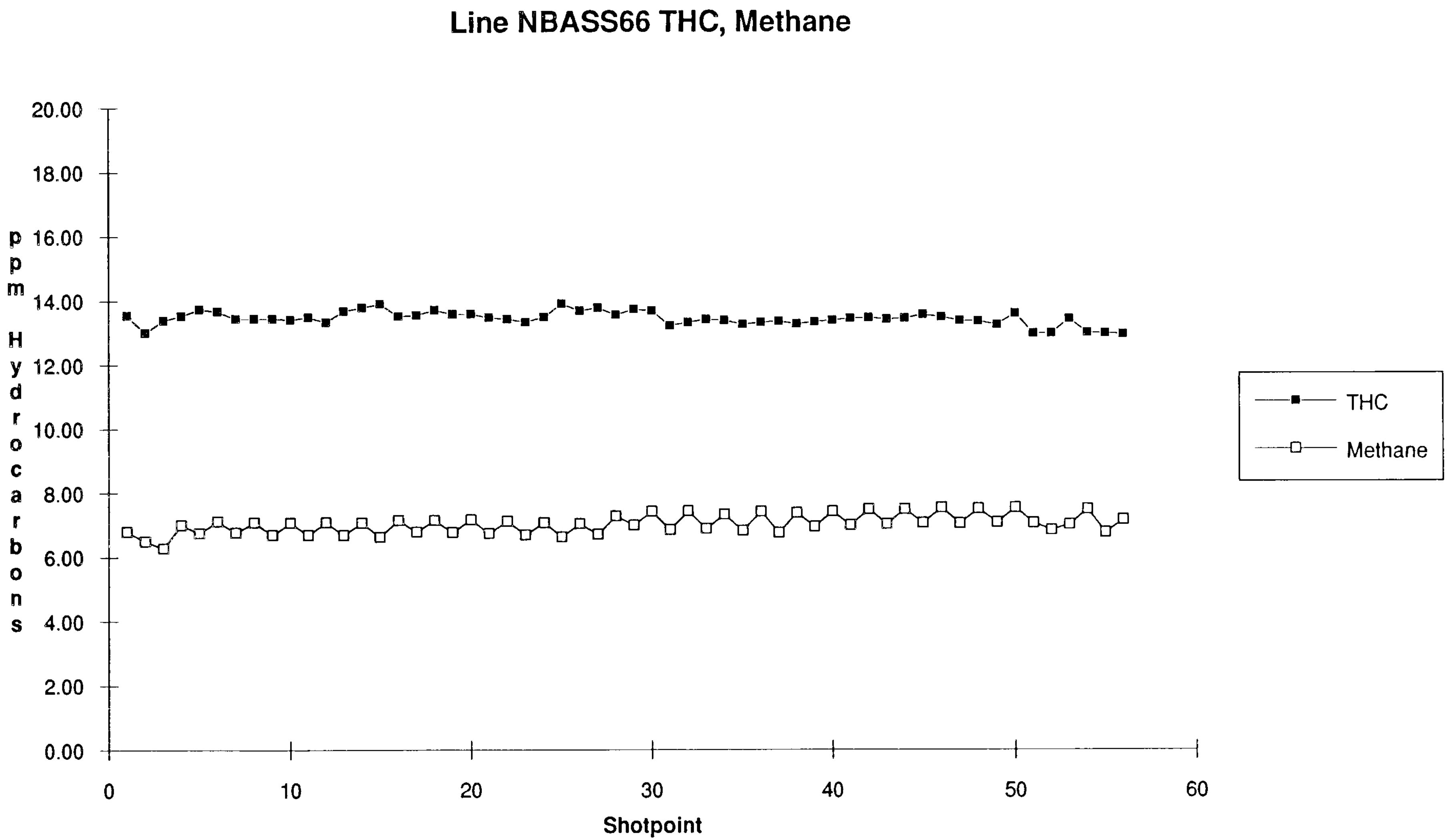
Line Number	nbass66
No. of Shotpoints	56

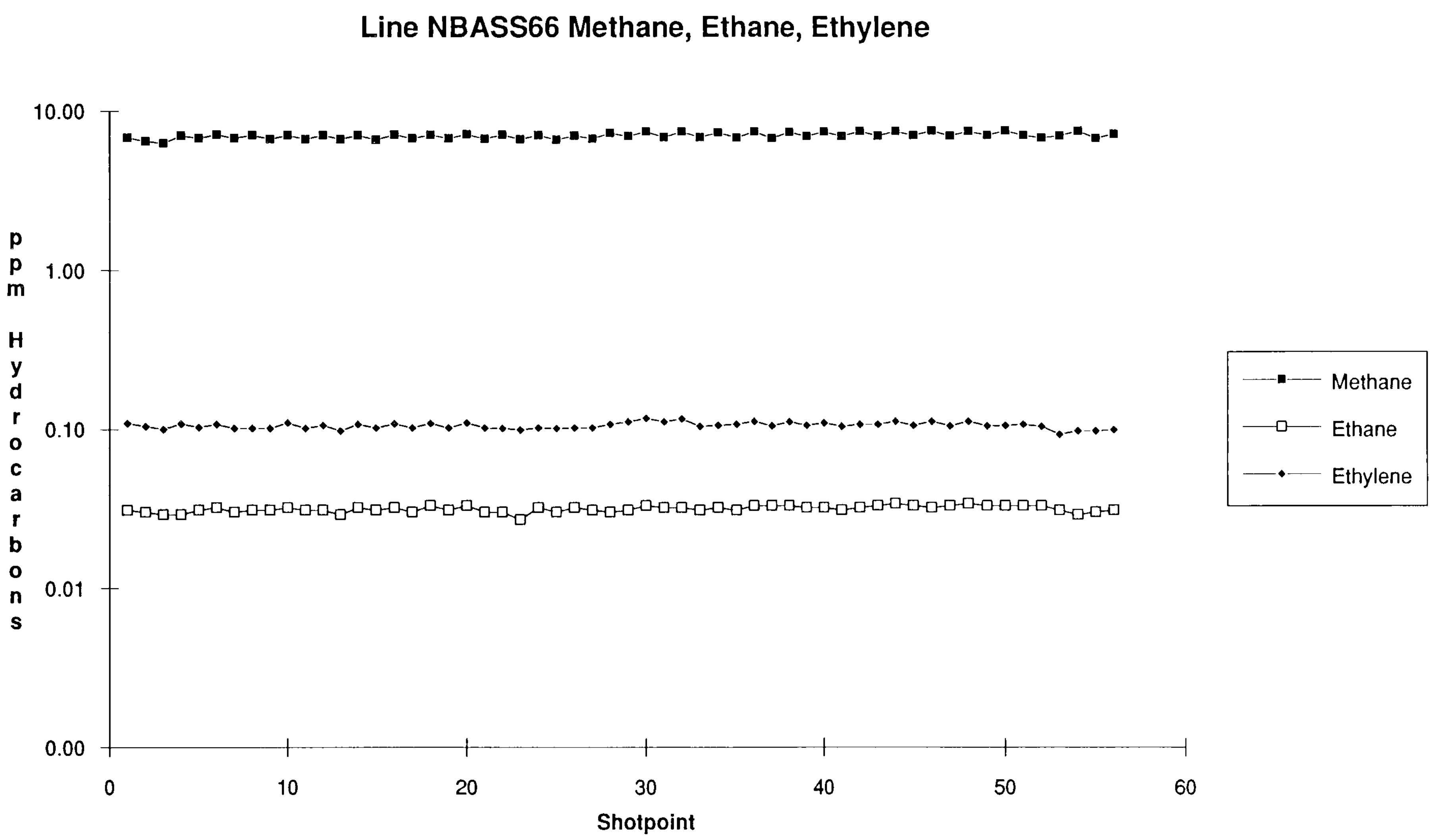
	Shotpoint	Date	Time	Latitude		Longitude	
Start	1	24-Feb-89	19:15:38	38	57.824	144	57.228
End	56	24-Feb-89	21:07:12	39	08.987	144	59.846

	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	13.424	7.006	0.031	0.105	0.021	0.020	0.000	0.001	N/A	N/A	N/A	N/A	0.762
Std. Dev.	0.227	0.295	0.001	0.005	0.002	0.003	0.000	0.003	N/A	N/A	N/A	N/A	0.067
Minimum	12.920	6.260	0.027	0.093	0.016	0.011	0.000	0.000	N/A	N/A	N/A	N/A	0.652
Maximum	13.890	7.520	0.034	0.117	0.024	0.024	0.000	0.009	N/A	N/A	N/A	N/A	0.915

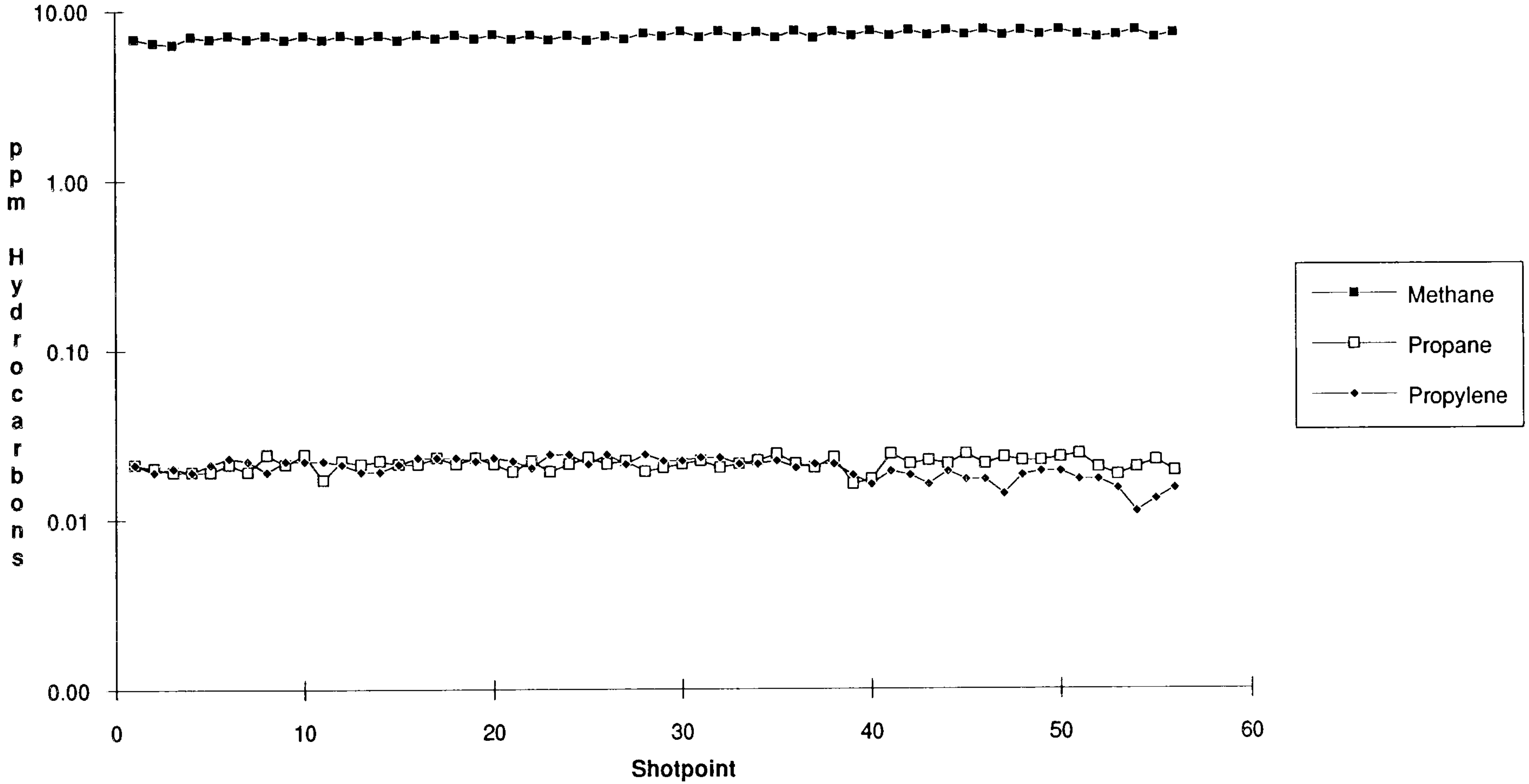
	Salinity	Temp.	F. Depth	W.Depth	Altitude
Mean	32.778	20.090	49.120	63.646	14.525
Std. Dev.	0.291	0.233	0.524	0.368	0.493
Minimum	32.200	19.600	47.400	62.400	14.000
Maximum	33.110	20.380	49.900	64.300	15.000

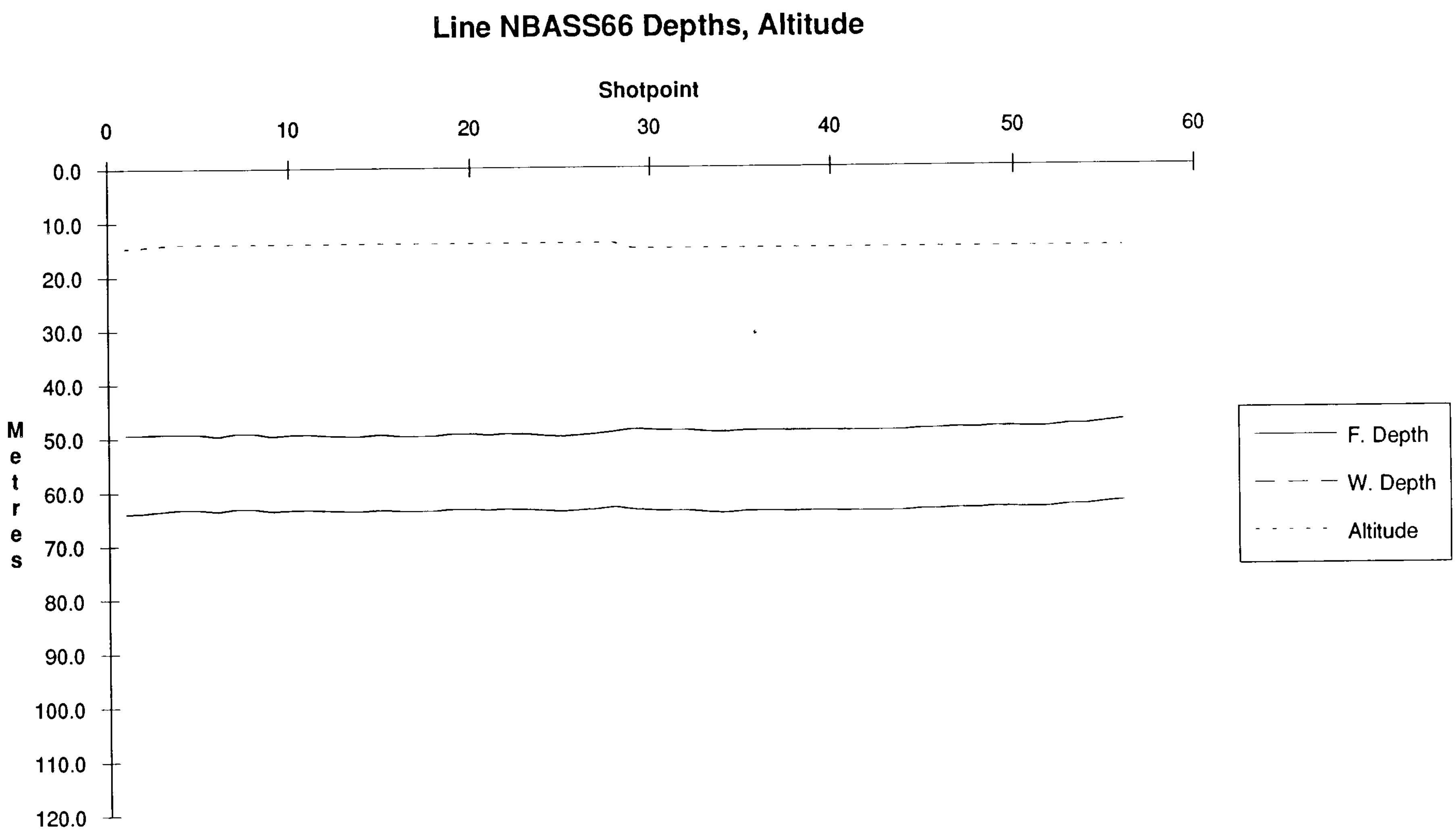
Notes No anomalies.


Line NBASS66 THC, Methane
20.00
18.00
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
ppm Hydrocarbons
0
10
20
30
40
50
60
Shotpoint
THC
Methane


Line NBASS66 Methane, Ethane, Ethylene
ppm Hydrocarbons
10.00
1.00
0.10
0.01
0.00
0
10
20
30
40
50
60
Shotpoint
Methane
Ethane
Ethylene

Line NBASS66 Methane, Propane, Propylene




Line NBASS66 Depths, Altitude
Shotpoint
0
10
20
30
40
50
60
0.0
10.0
20.0
30.0
40.0
50.0
60.0
70.0
80.0
90.0
100.0
110.0
120.0
Metres
F. Depth
W. Depth
Altitude

Line Summary

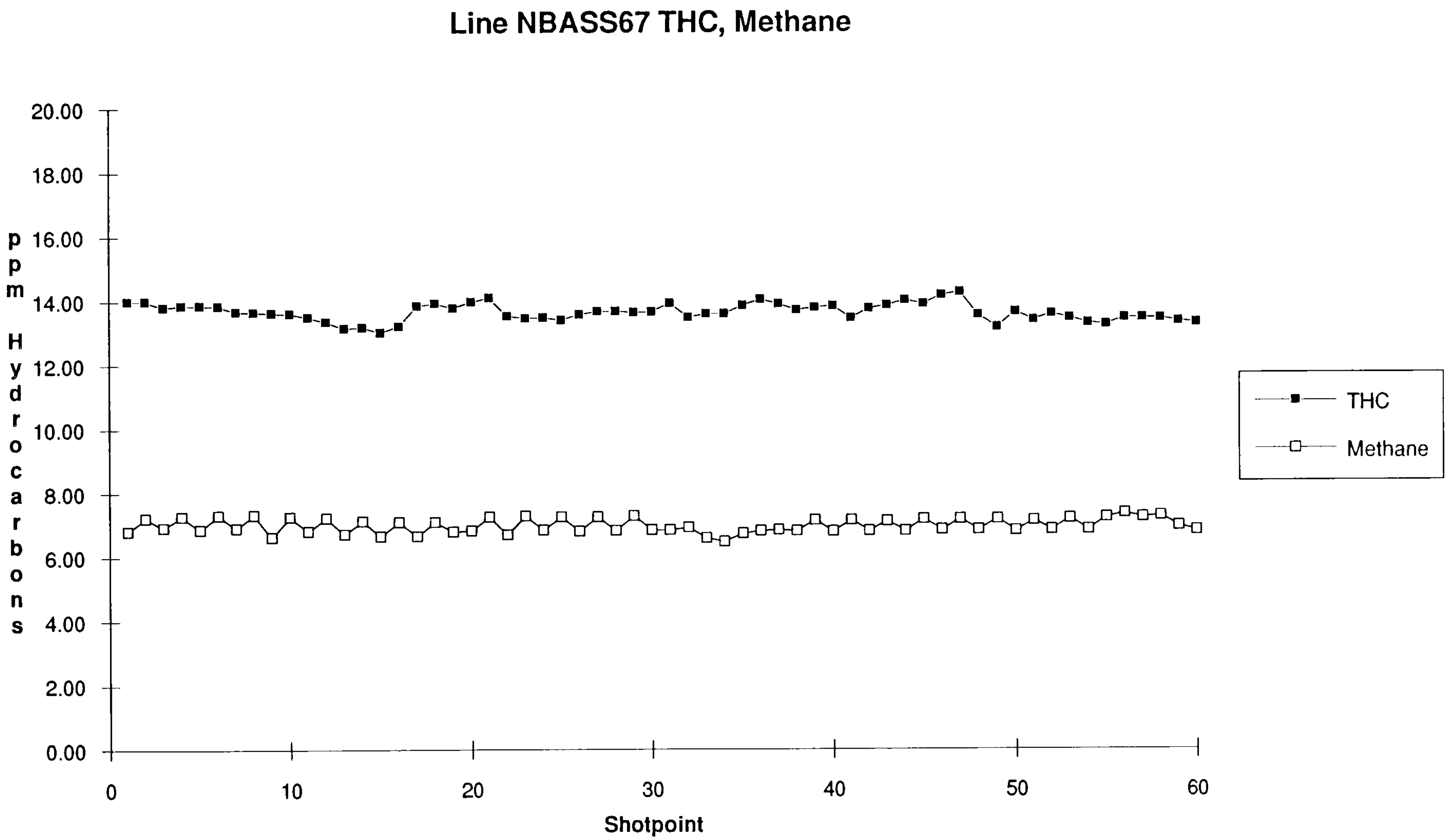
Line Number	nbass67
No. of Shotpoints	60

	Shotpoint	Date	Time	Latitude		Longitude	
Start	1	24-Feb-89	16:47:27	39	10.409	144	51.855
End	60	24-Feb-89	19:07:08	38	57.418	144	57.331

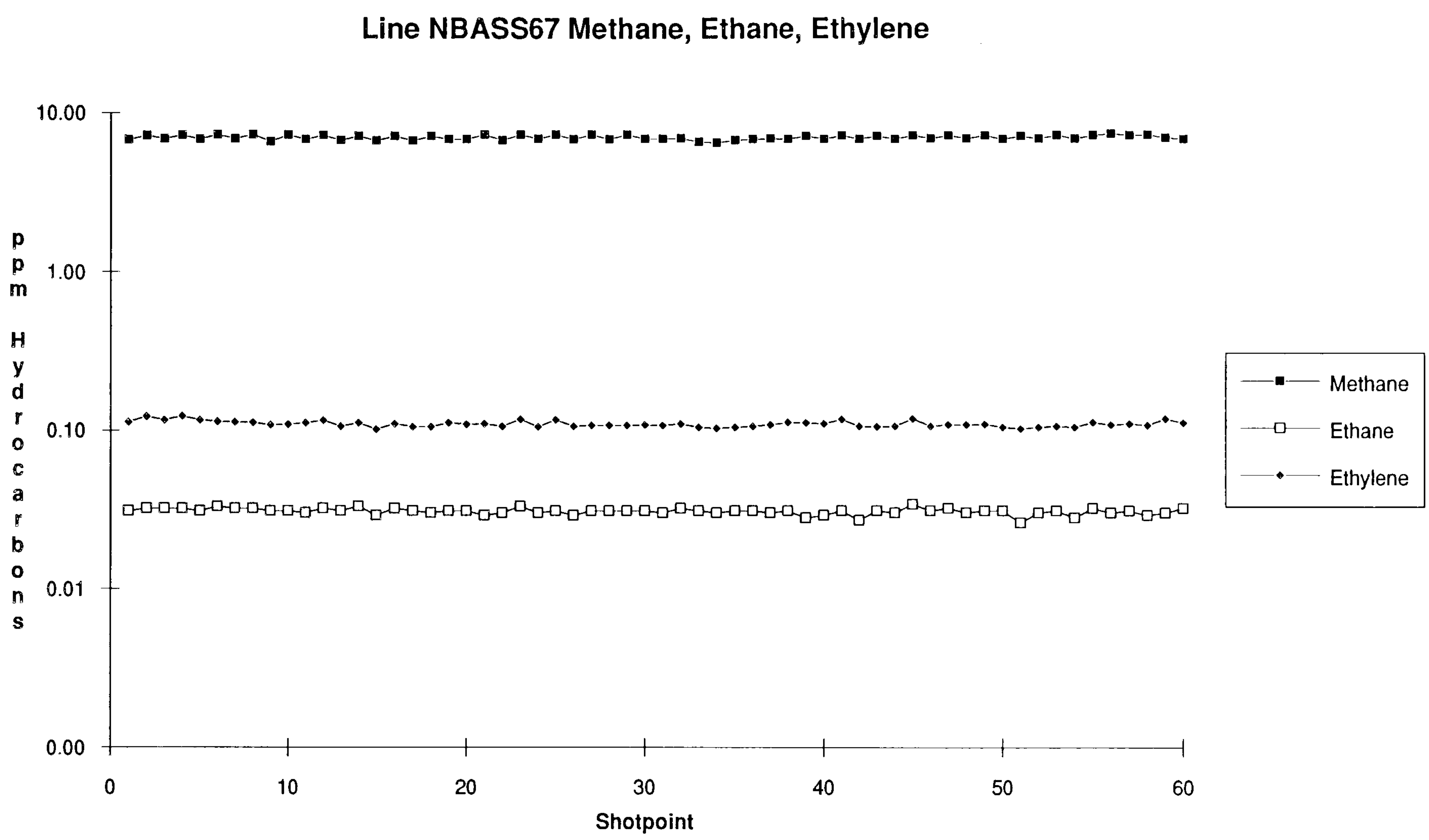
	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	13.633	6.969	0.031	0.109	0.021	0.025	0.000	0.004	N/A	N/A	N/A	N/A	0.798
Std. Dev.	0.275	0.227	0.001	0.005	0.002	0.003	0.001	0.004	N/A	N/A	N/A	N/A	0.082
Minimum	13.010	6.470	0.026	0.101	0.010	0.016	0.000	0.000	N/A	N/A	N/A	N/A	0.668
Maximum	14.250	7.340	0.034	0.123	0.025	0.031	0.008	0.012	N/A	N/A	N/A	N/A	0.995

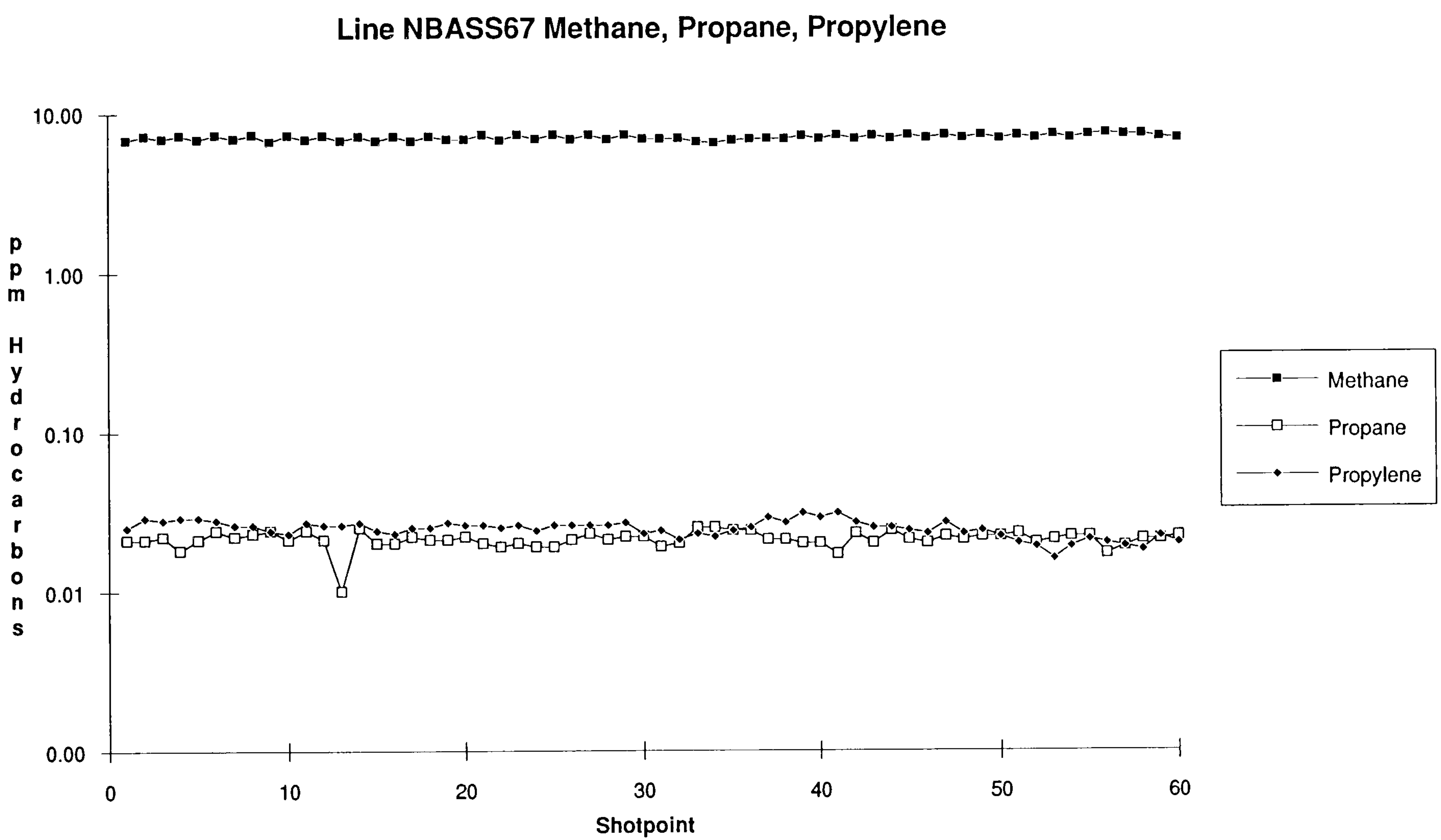
	Salinity	Temp.	F. Depth	W.Depth	Altitude
Mean	33.025	20.287	48.538	61.688	13.150
Std. Dev.	0.088	0.090	1.127	1.691	1.071
Minimum	32.900	20.100	46.300	59.100	12.000
Maximum	33.220	20.470	50.000	65.000	15.000

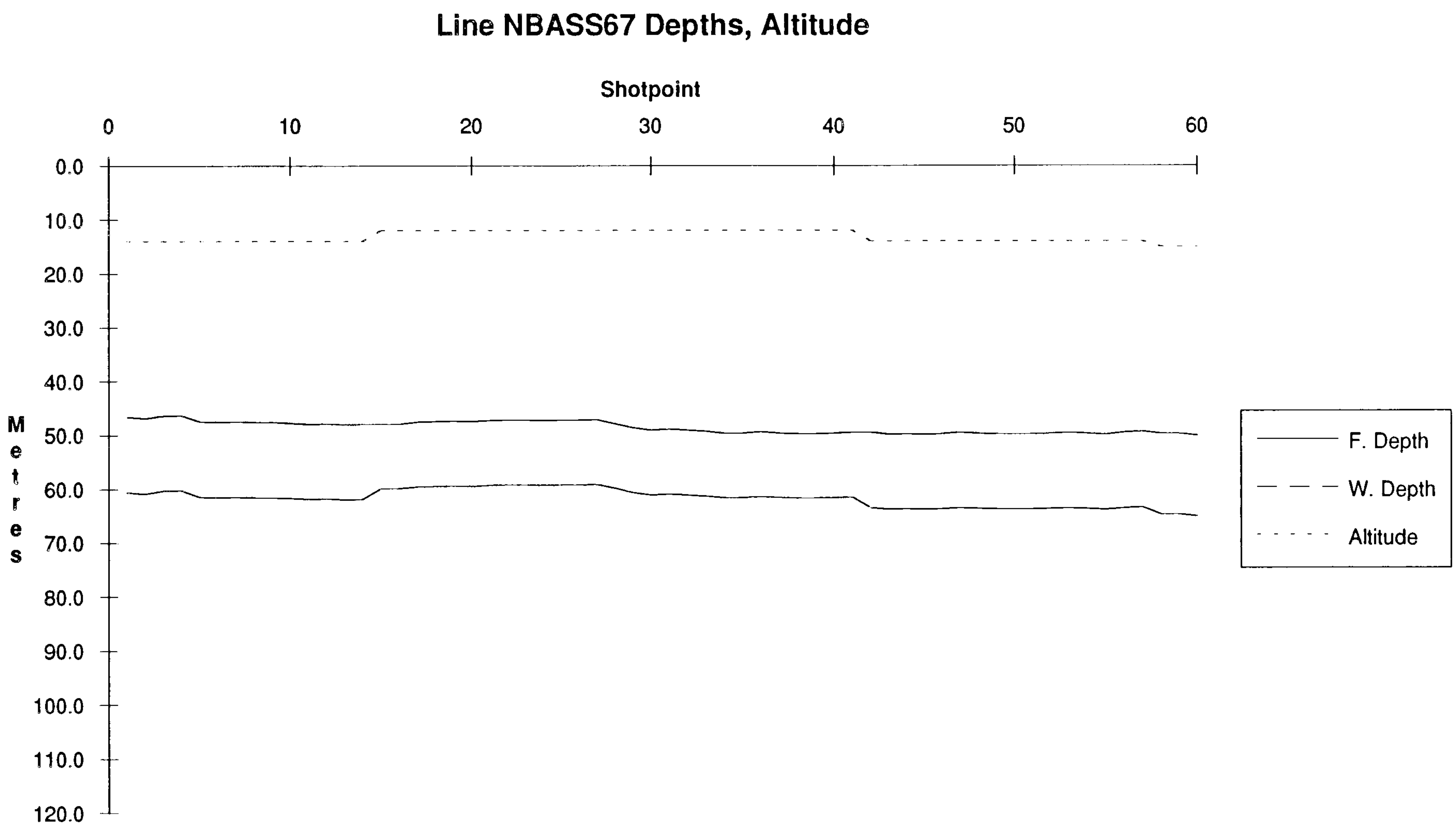
Notes No anomalies.



Line NBASS67 THC, Methane
ppm Hydrocarbons
20.00
18.00
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
0
10
20
30
40
50
60
Shotpoint
THC
Methane


Line NBASS67 Methane, Ethane, Ethylene
10.00
1.00
0.10
0.01
0.00
ppm Hydrocarbons
0
10
20
30
40
50
60
Shotpoint
Methane
Ethane
Ethylene


Line NBASS67 Methane, Propane, Propylene
ppm Hydrocarbons
10.00
1.00
0.10
0.01
0.00
0
10
20
30
40
50
60
Shotpoint
Methane
Propane
Propylene


Line NBASS67 Depths, Altitude
Shotpoint
0
10
20
30
40
50
60
0.0
10.0
20.0
30.0
40.0
50.0
60.0
70.0
80.0
90.0
100.0
110.0
120.0
Metres
F. Depth
W. Depth
Altitude

Line Summary

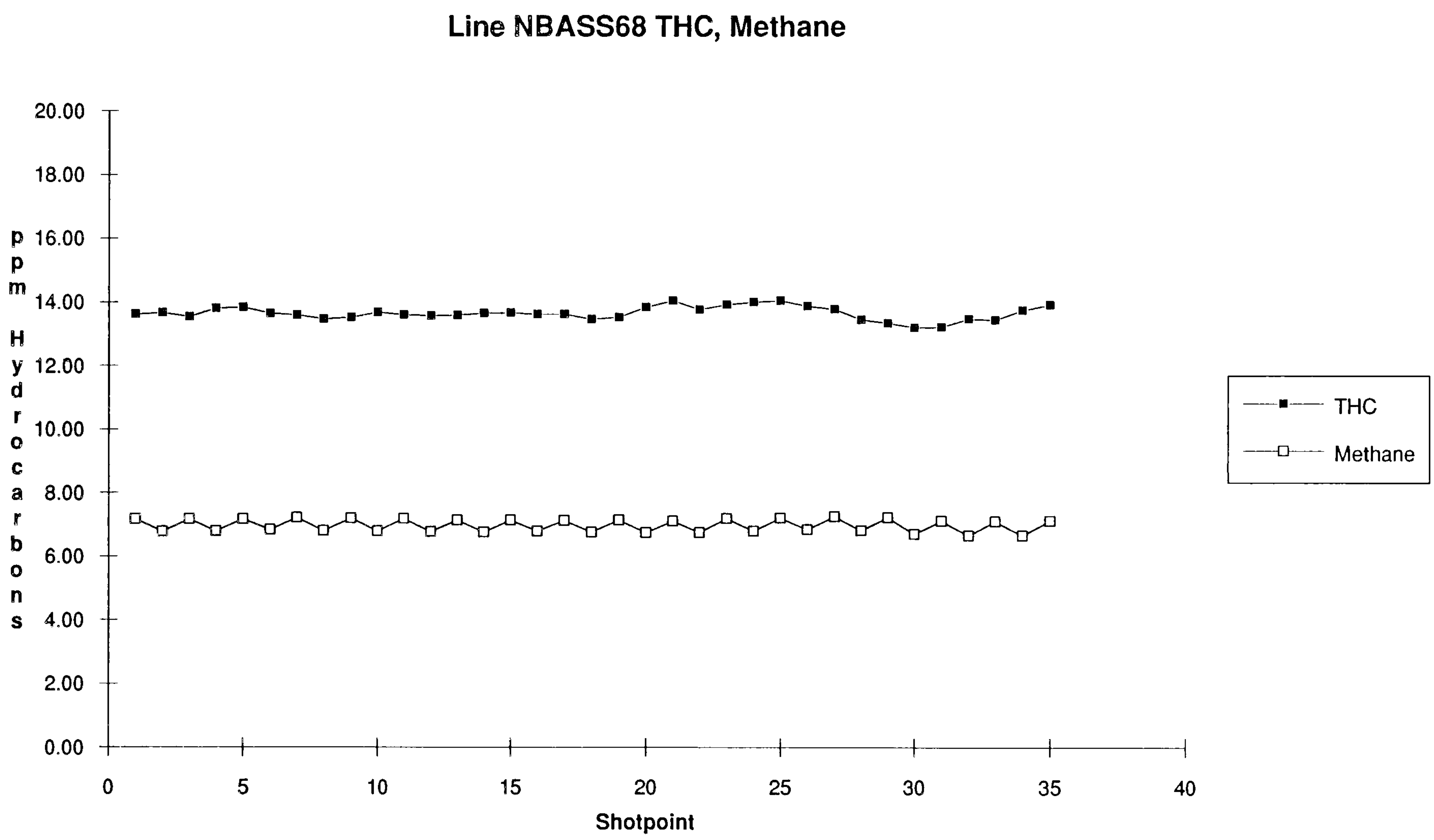
Line Number	nbass68
No. of Shotpoints	35

	Shotpoint	Date	Time	Latitude		Longitude	
Start	1	24-Feb-89	15:35:22	39	09.671	144	43.629
End	35	24-Feb-89	16:44:41	39	10.402	144	51.403

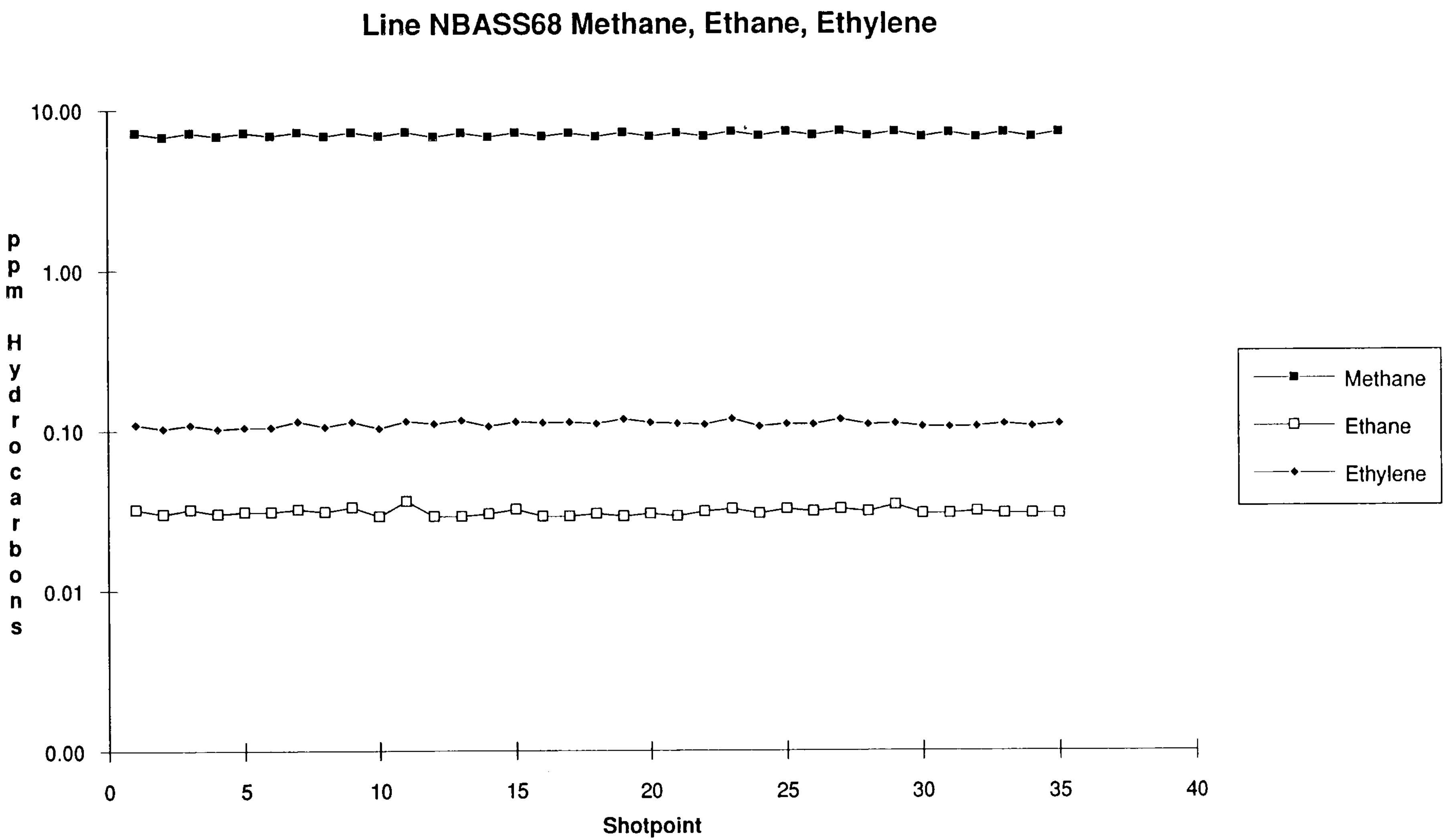
	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	13.645	6.966	0.031	0.109	0.021	0.027	0.000	0.002	N/A	N/A	N/A	N/A	0.765
Std. Dev.	0.211	0.209	0.002	0.004	0.002	0.004	0.000	0.003	N/A	N/A	N/A	N/A	0.066
Minimum	13.190	6.640	0.029	0.102	0.017	0.018	0.000	0.000	N/A	N/A	N/A	N/A	0.658
Maximum	14.050	7.240	0.036	0.117	0.025	0.035	0.000	0.008	N/A	N/A	N/A	N/A	0.910

	Salinity	Temp.	F. Depth	W.Depth	Altitude
Mean	33.105	20.387	48.740	60.423	11.680
Std. Dev.	0.150	0.187	2.960	3.391	1.119
Minimum	32.780	19.990	45.900	55.900	10.000
Maximum	33.310	20.690	53.500	65.500	14.000

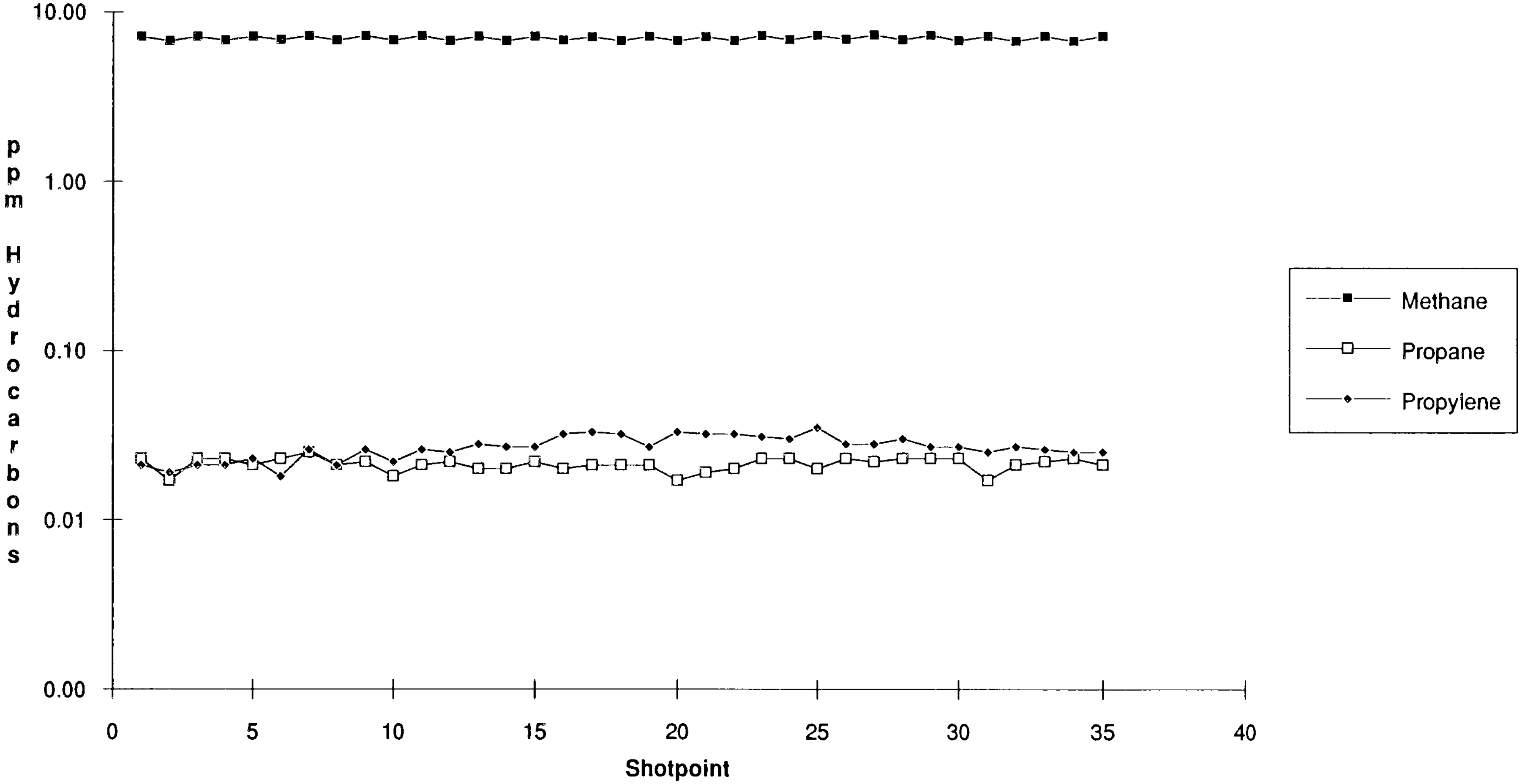
Notes No anomalies.

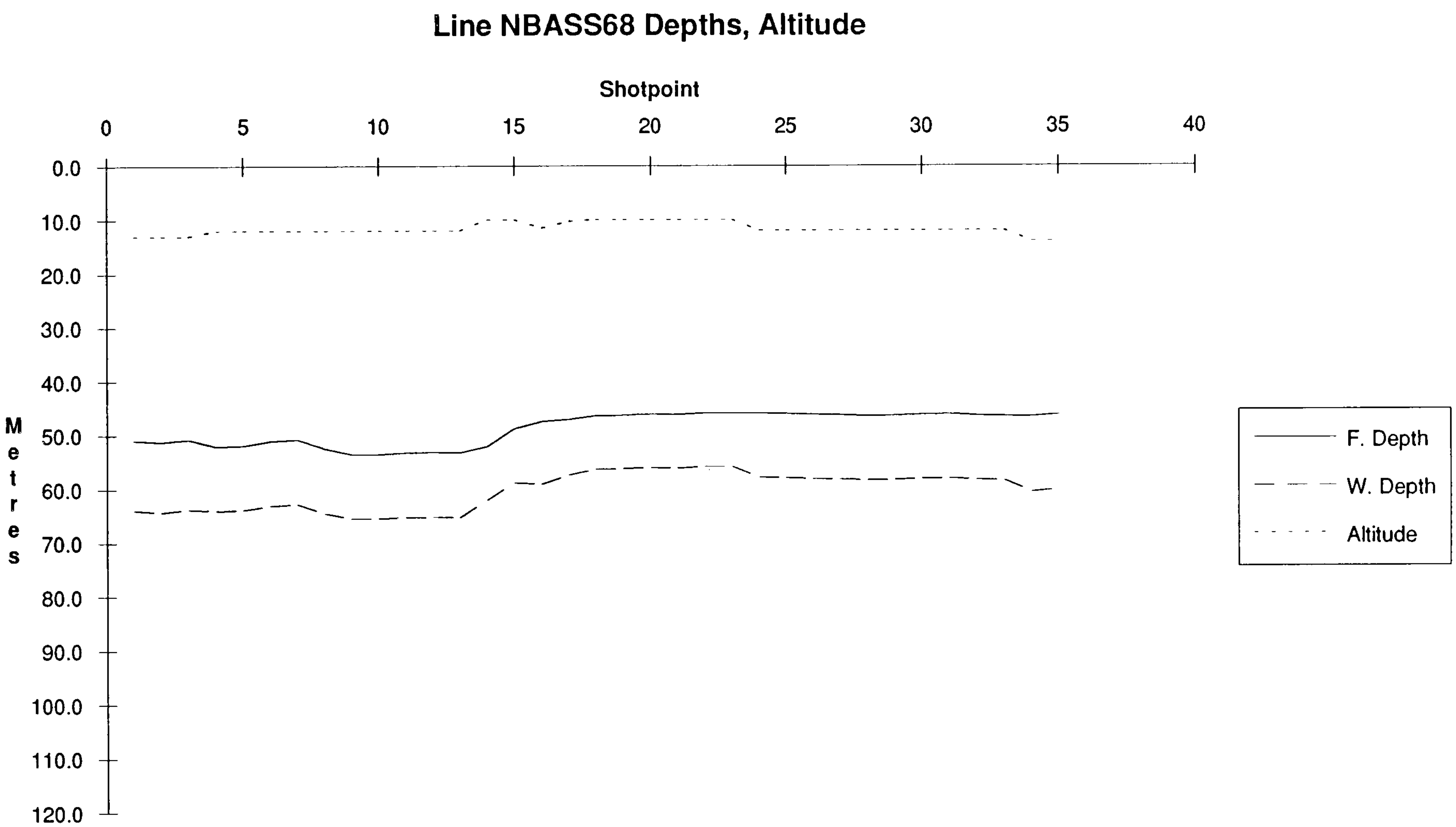


Line NBASS68 THC, Methane
ppm Hydrocarbons
20.00
18.00
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
0
5
10
15
20
25
30
35
40
Shotpoint
THC
Methane


Line NBASS68 Methane, Ethane, Ethylene
10.00
1.00
0.10
0.01
0.00
ppm Hydrocarbons
0
5
10
15
20
25
30
35
40
Shotpoint
Methane
Ethane
Ethylene

Line NBASS68 Methane, Propane, Propylene





Line NBASS68 Depths, Altitude
Shotpoint
0
5
10
15
20
25
30
35
40
0.0
10.0
20.0
30.0
40.0
50.0
60.0
70.0
80.0
90.0
100.0
110.0
120.0
Metres
F. Depth
W. Depth
Altitude

Line Summary

Line Number	nbass69
No. of Shotpoints	174

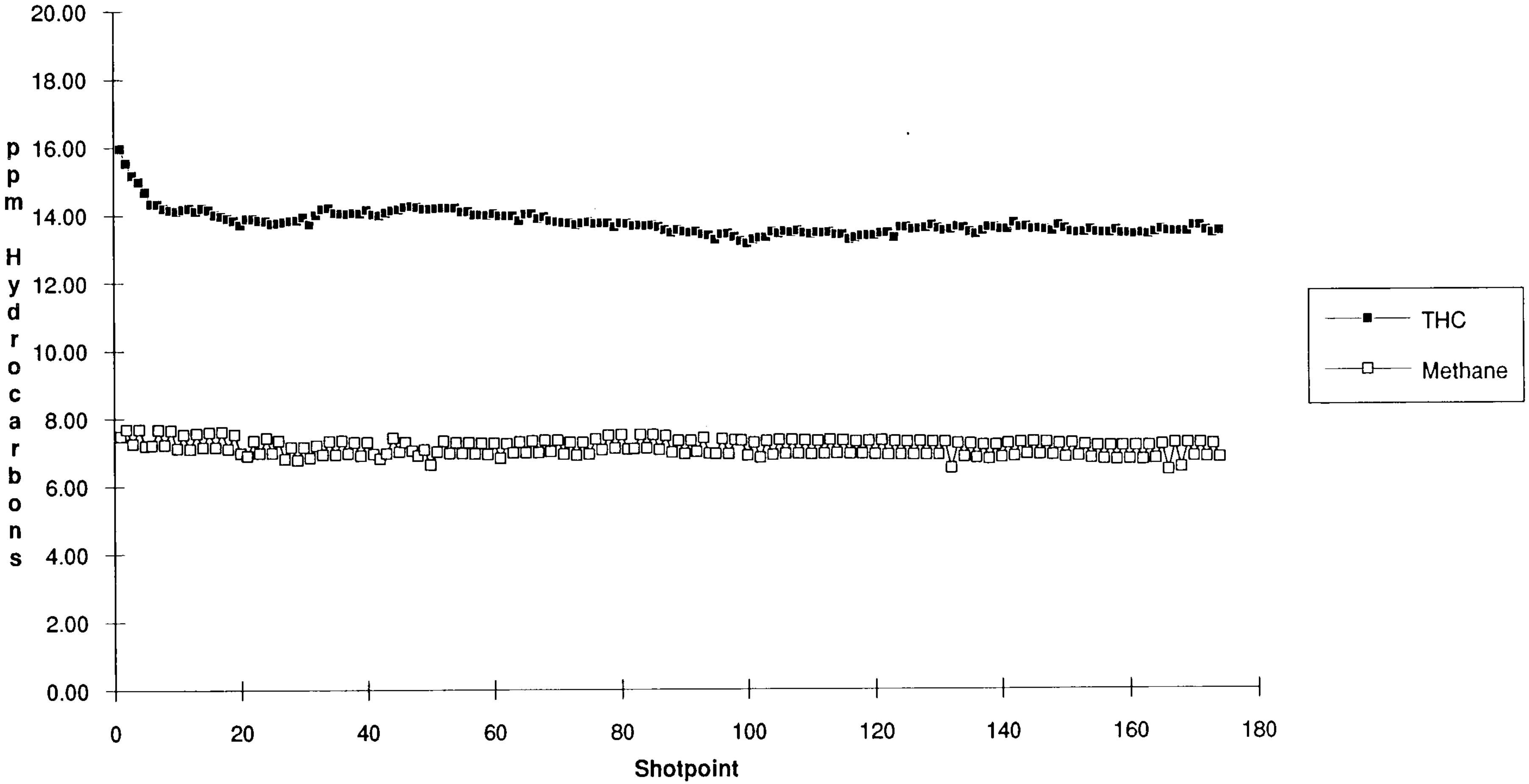
	Shotpoint	Date	Time	Latitude		Longitude	
Start	1	24-Feb-89	09:29:22	38	35.476	144	59.634
End	174	24-Feb-89	15:33:42	39	09.559	144	43.680

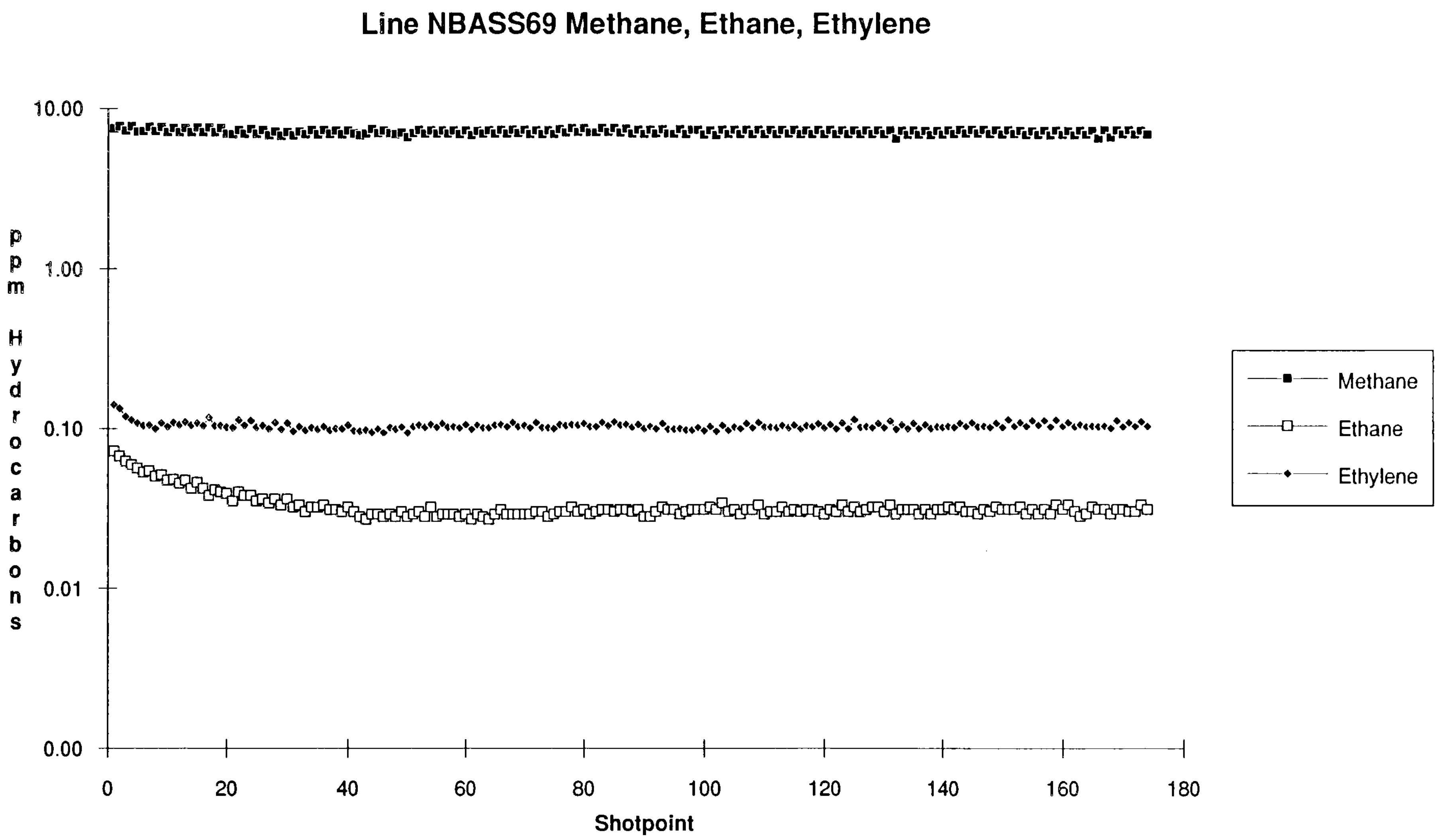
	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	13.732	7.099	0.033	0.104	0.025	0.018	0.000	0.006	N/A	N/A	N/A	N/A	0.893
Std. Dev.	0.398	0.245	0.007	0.006	0.007	0.004	0.001	0.006	N/A	N/A	N/A	N/A	0.231
Minimum	13.130	6.430	0.027	0.094	0.015	0.004	0.000	0.000	N/A	N/A	N/A	N/A	0.612
Maximum	15.960	7.680	0.072	0.141	0.056	0.052	0.008	0.022	N/A	N/A	N/A	N/A	2.074

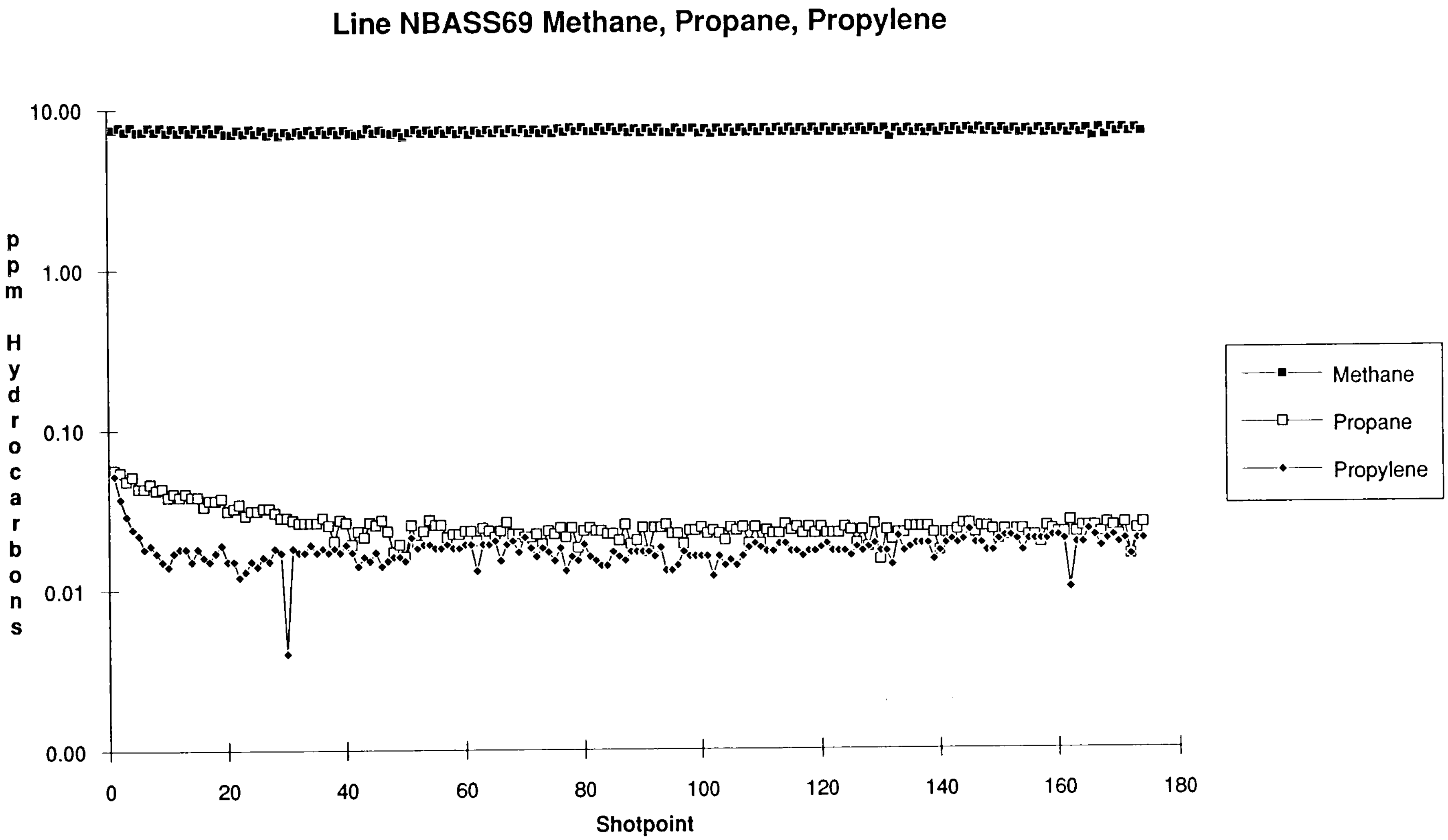
	Salinity	Temp.	F. Depth	W.Depth	Altitude
Mean	32.749	19.886	54.309	67.981	13.657
Std. Dev.	0.247	0.304	2.214	2.315	2.622
Minimum	32.220	19.200	50.500	61.000	9.000
Maximum	33.300	20.550	60.300	72.500	20.000

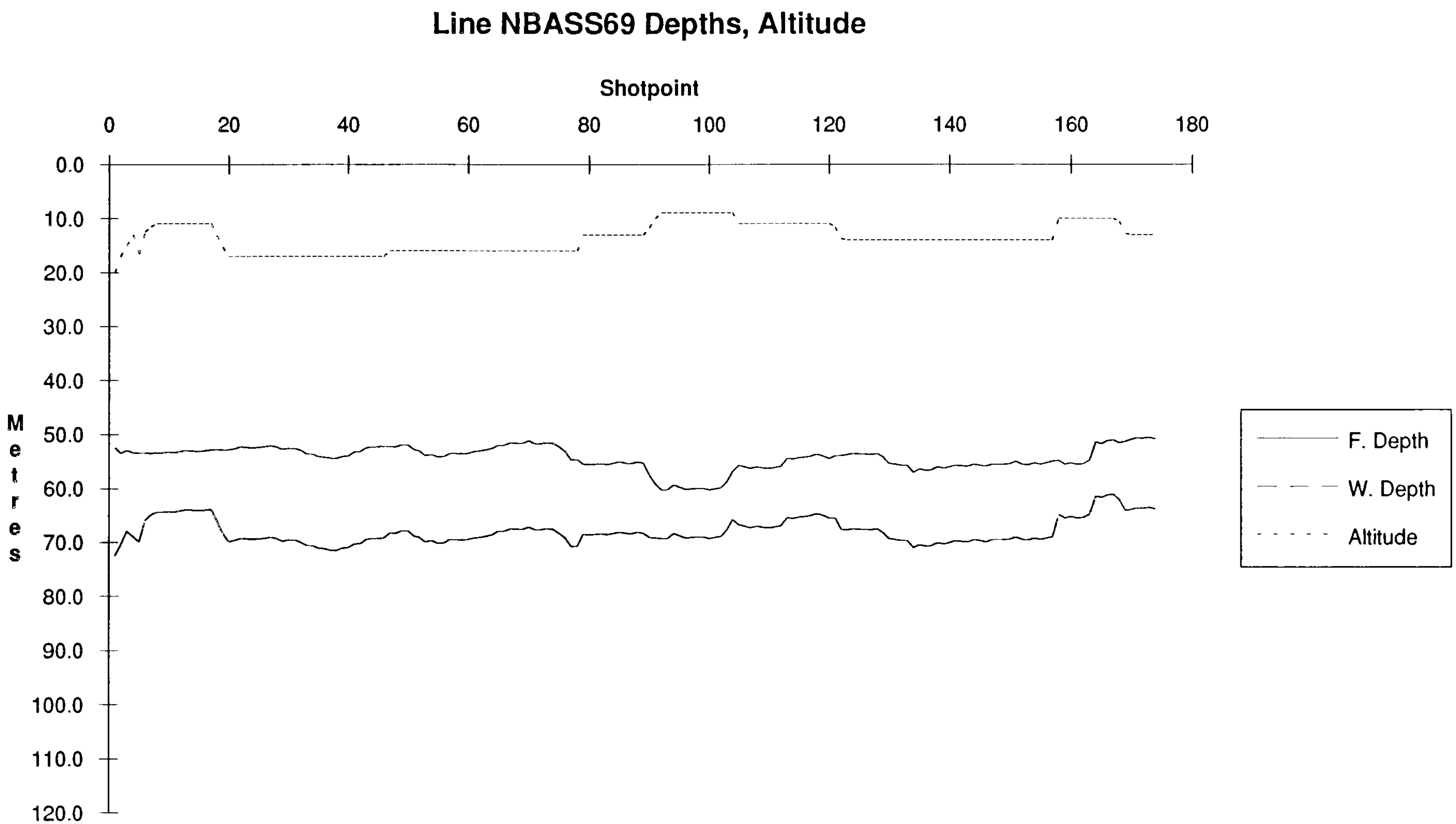
Notes: No anomalies, although high values at start of line.

Line NBASS69 THC, Methane




Line NBASS69 Methane, Ethane, Ethylene
ppm Hydrocarbons
10.00
1.00
0.10
0.01
0.00
0
20
40
60
80
100
120
140
160
180
Shotpoint
Methane
Ethane
Ethylene


Line NBASS69 Methane, Propane, Propylene
ppm Hydrocarbons
10.00
1.00
0.10
0.01
0.00
0
20
40
60
80
100
120
140
160
180
Shotpoint
Methane
Propane
Propylene



Line NBASS69 Depths, Altitude
Shotpoint
0
20
40
60
80
100
120
140
160
180
0.0
10.0
20.0
30.0
40.0
50.0
60.0
70.0
80.0
90.0
100.0
110.0
120.0
Metres
F. Depth
W. Depth
Altitude

BASS BASIN DHD LINE SUMMARY SHEETS AND PLOTS

Line Summary

Line Number	bass1
No. of Shotpoints	88

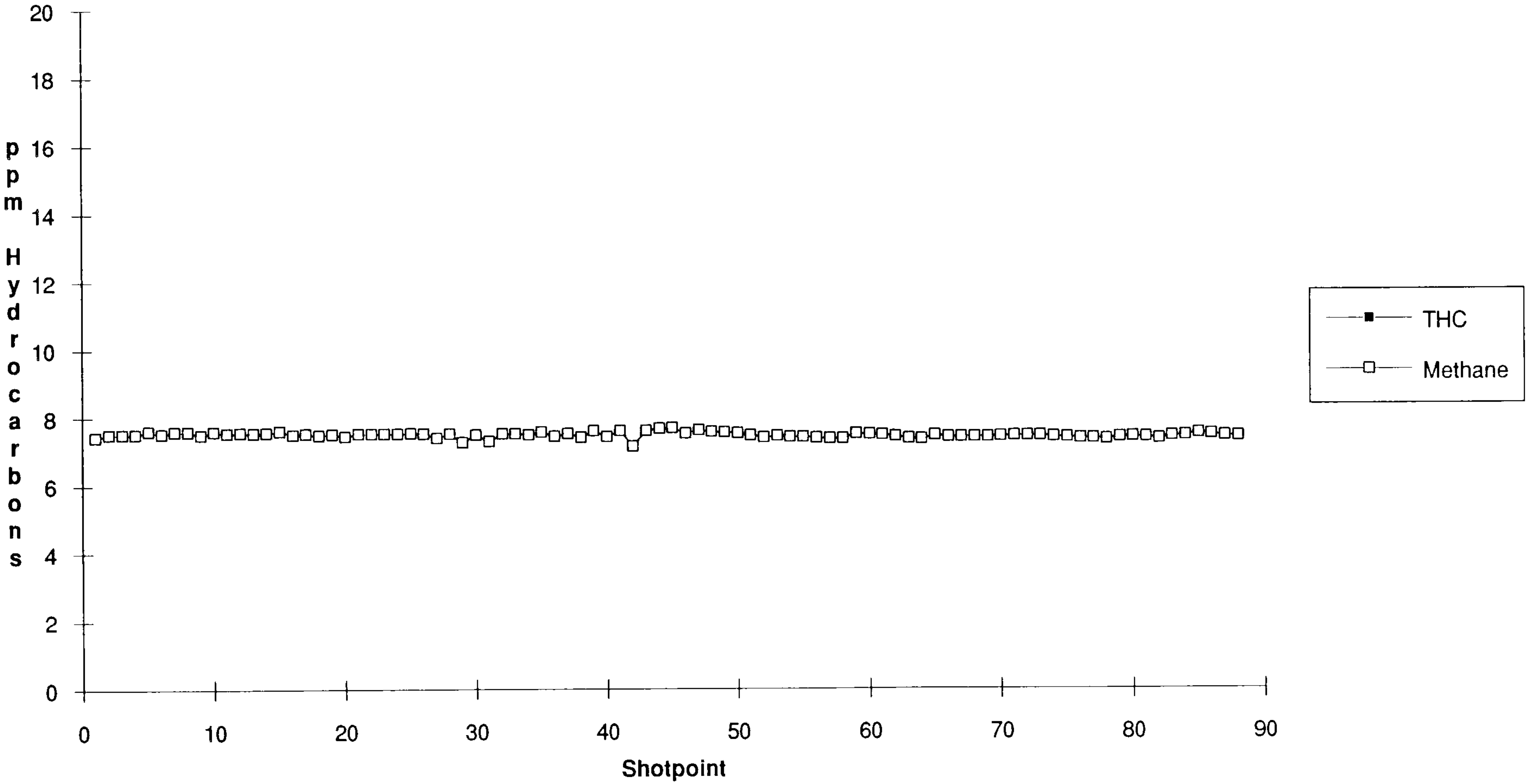
	Shotpoint	Date	Time	Latitude		Longitude	
Start	1	3-Feb-89	20:39:16	40	27.597	147	22.098
End	90	3-Feb-89	23:52:47	40	39.318	146	59.208

	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	N/A	7.463	0.018	0.122	0.021	0.039	0.000	0.000	N/A	N/A	N/A	N/A	0.522
Std. Dev.	N/A	0.090	0.004	0.014	0.006	0.010	0.000	0.001	N/A	N/A	N/A	N/A	0.085
Minimum	N/A	7.130	0.012	0.102	0.011	0.021	0.000	0.000	N/A	N/A	N/A	N/A	0.362
Maximum	N/A	7.680	0.027	0.156	0.039	0.076	0.002	0.006	N/A	N/A	N/A	N/A	0.696

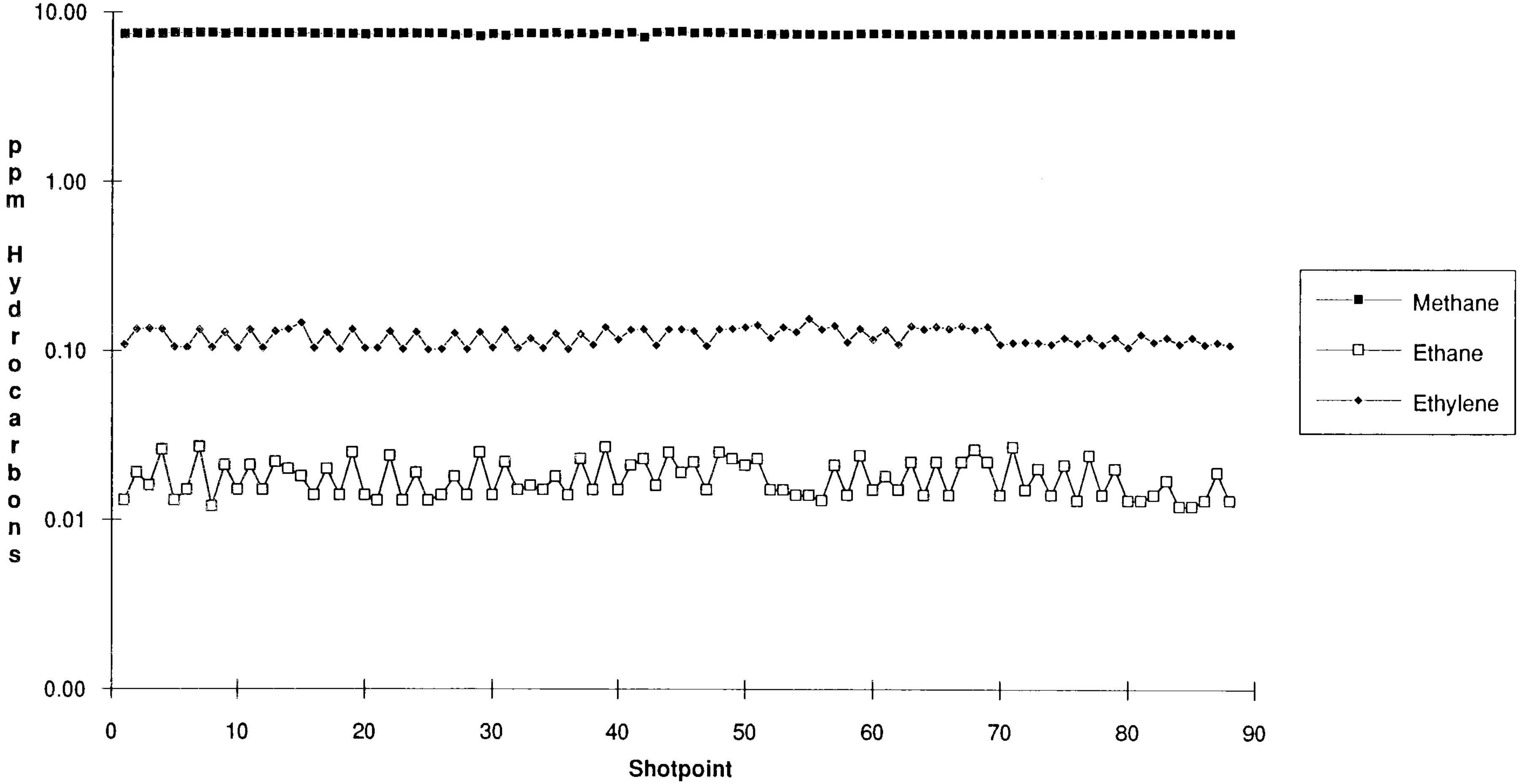
	Salinity	Temp.	F. Depth	W.Depth	Altitude
Mean	33.544	17.776	50.347	64.918	14.572
Std. Dev.	0.159	0.212	2.250	4.905	3.757
Minimum	33.250	17.420	45.100	55.400	9.000
Maximum	33.880	18.100	54.800	72.700	20.000

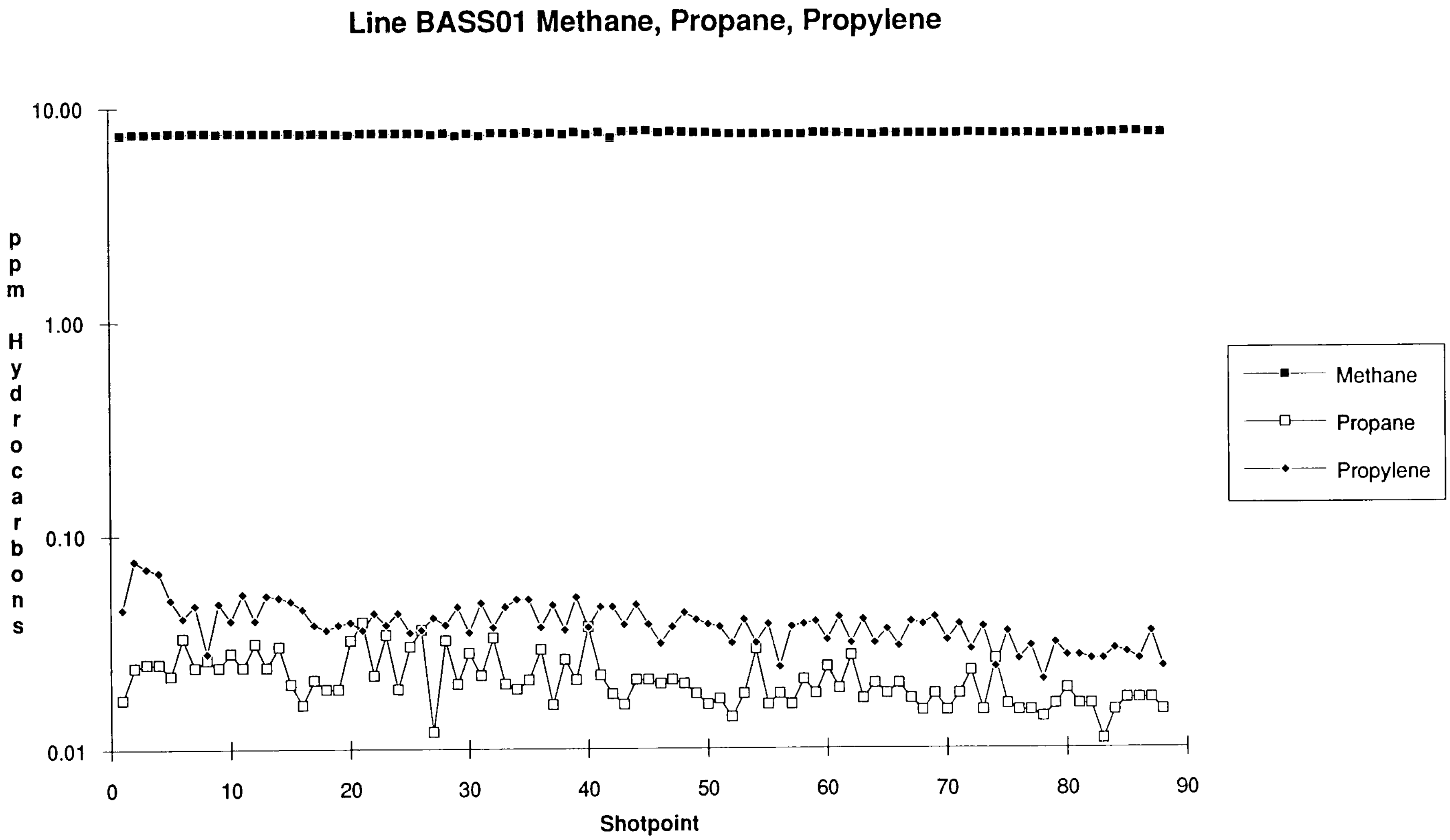
Notes No anomalies.

Line BASS01 THC, Methane



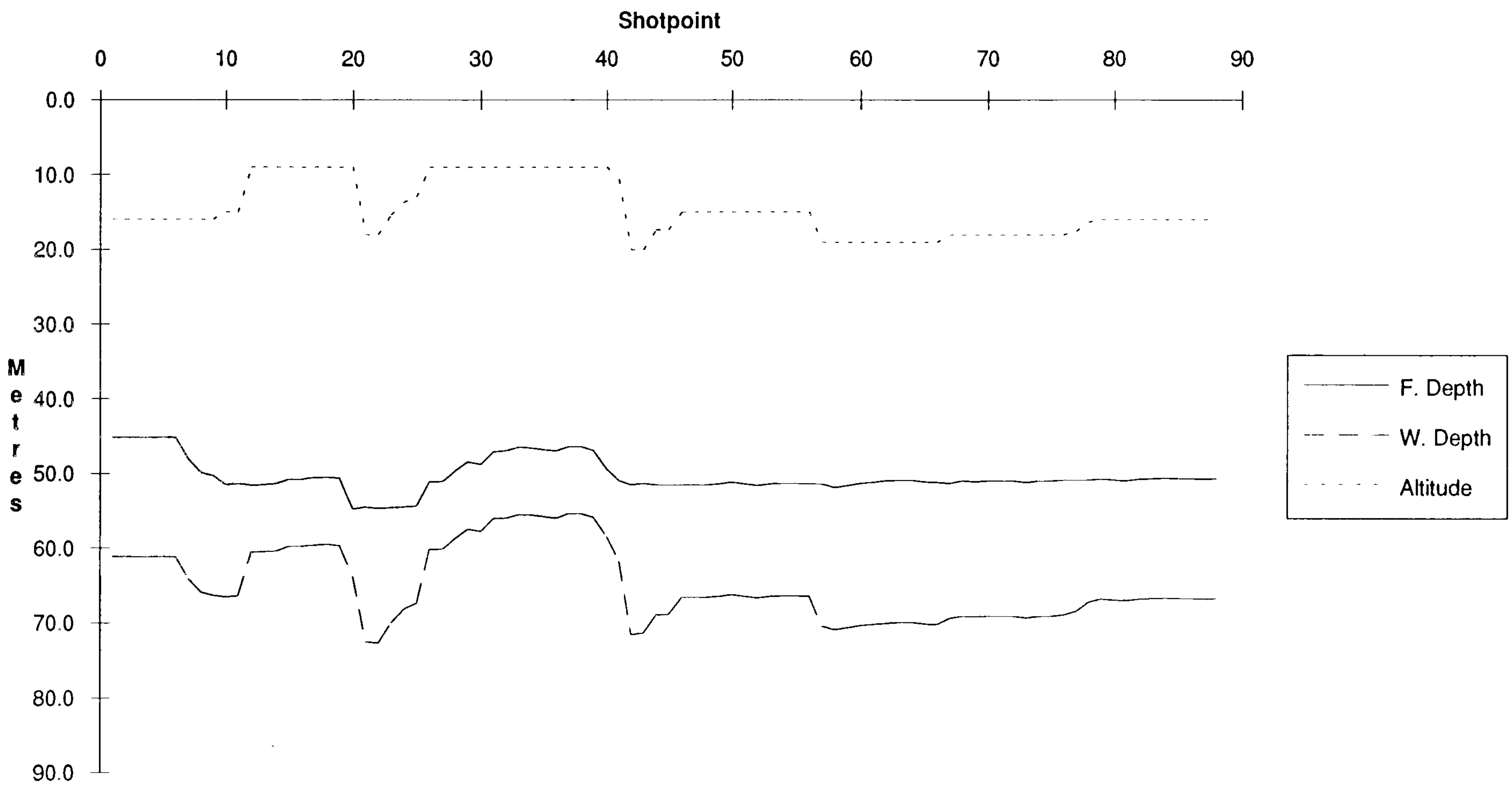
Line BASS01 Methane, Ethane, Ethylene





Line BASS01 Methane, Propane, Propylene
ppm Hydrocarbons
10.00
1.00
0.10
0.01
0
10
20
30
40
50
60
70
80
90
Shotpoint
Methane
Propane
Propylene

Line BASS01 Depths, Altitude



Line Summary

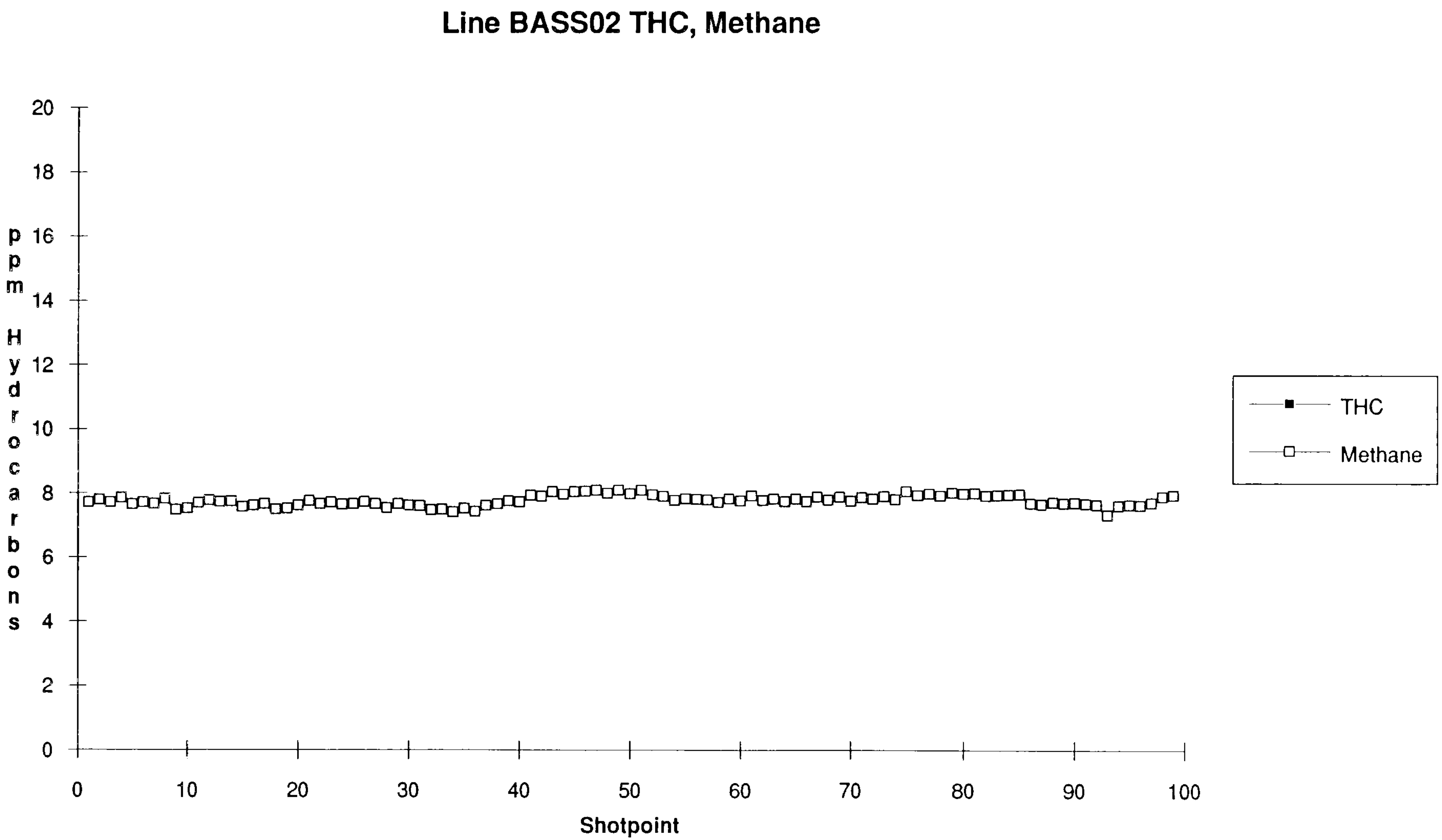
Line Number	bass2
No. of Shotpoints	99

	Shotpoint	Date	Time	Latitude		Longitude	
Start	1	4-Feb-89	00:42:23	40	41.379	146	58.151
End	102	4-Feb-89	04:37:12	40	18.364	147	02.680

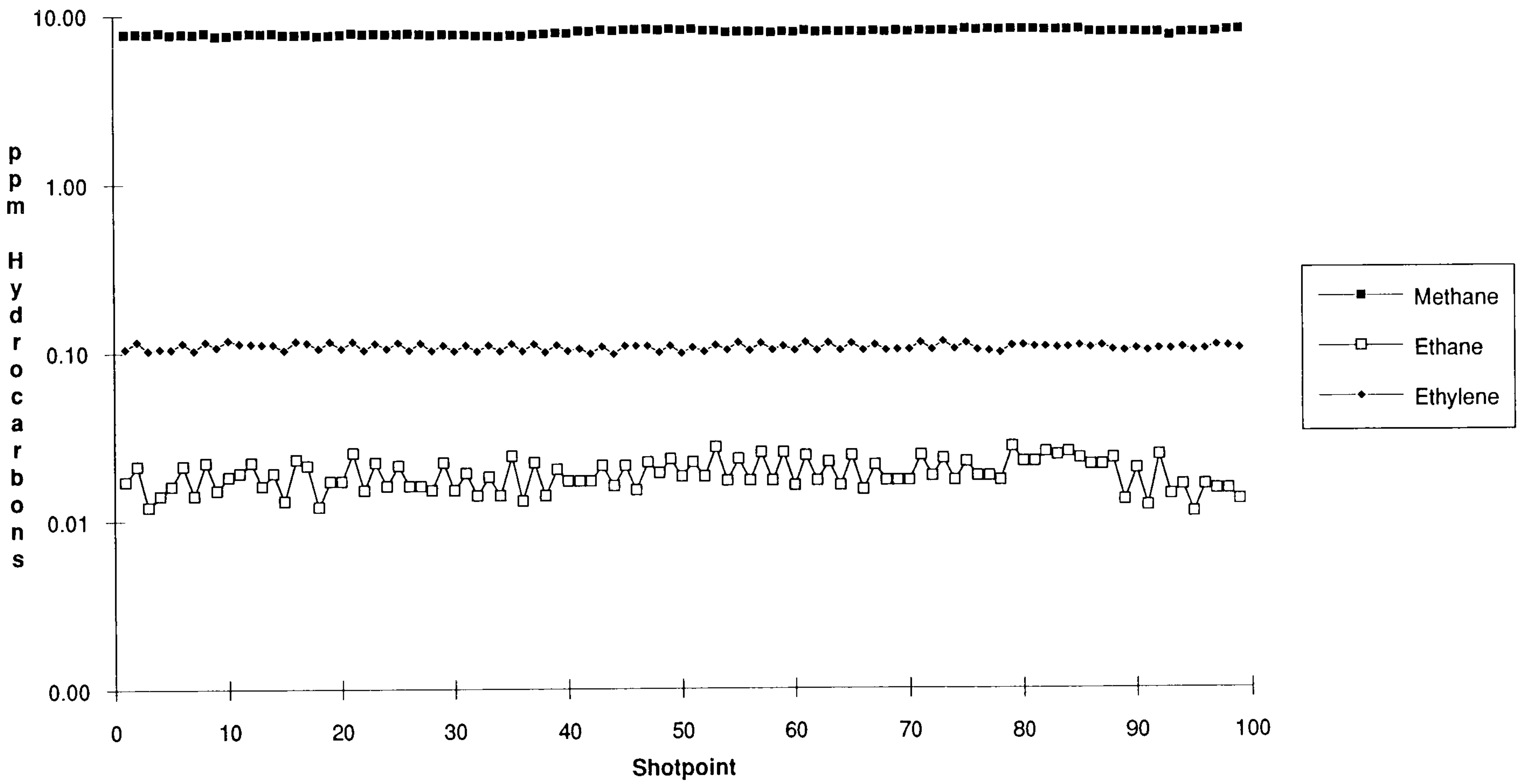
	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	N/A	7.758	0.019	0.106	0.019	0.018	0.000	0.000	N/A	N/A	N/A	N/A	0.482
Std. Dev.	N/A	0.171	0.004	0.005	0.005	0.004	0.000	0.000	N/A	N/A	N/A	N/A	0.057
Minimum	N/A	7.300	0.011	0.097	0.013	0.008	0.000	0.000	N/A	N/A	N/A	N/A	0.338
Maximum	N/A	8.090	0.027	0.118	0.030	0.032	0.002	0.002	N/A	N/A	N/A	N/A	0.670

	Salinity	Temp.	F. Depth	W.Depth	Altitude
Mean	32.923	16.854	53.239	67.409	14.170
Std. Dev.	0.187	0.277	0.775	2.528	2.609
Minimum	32.560	16.400	51.300	62.300	11.000
Maximum	33.350	17.400	56.200	70.700	17.000

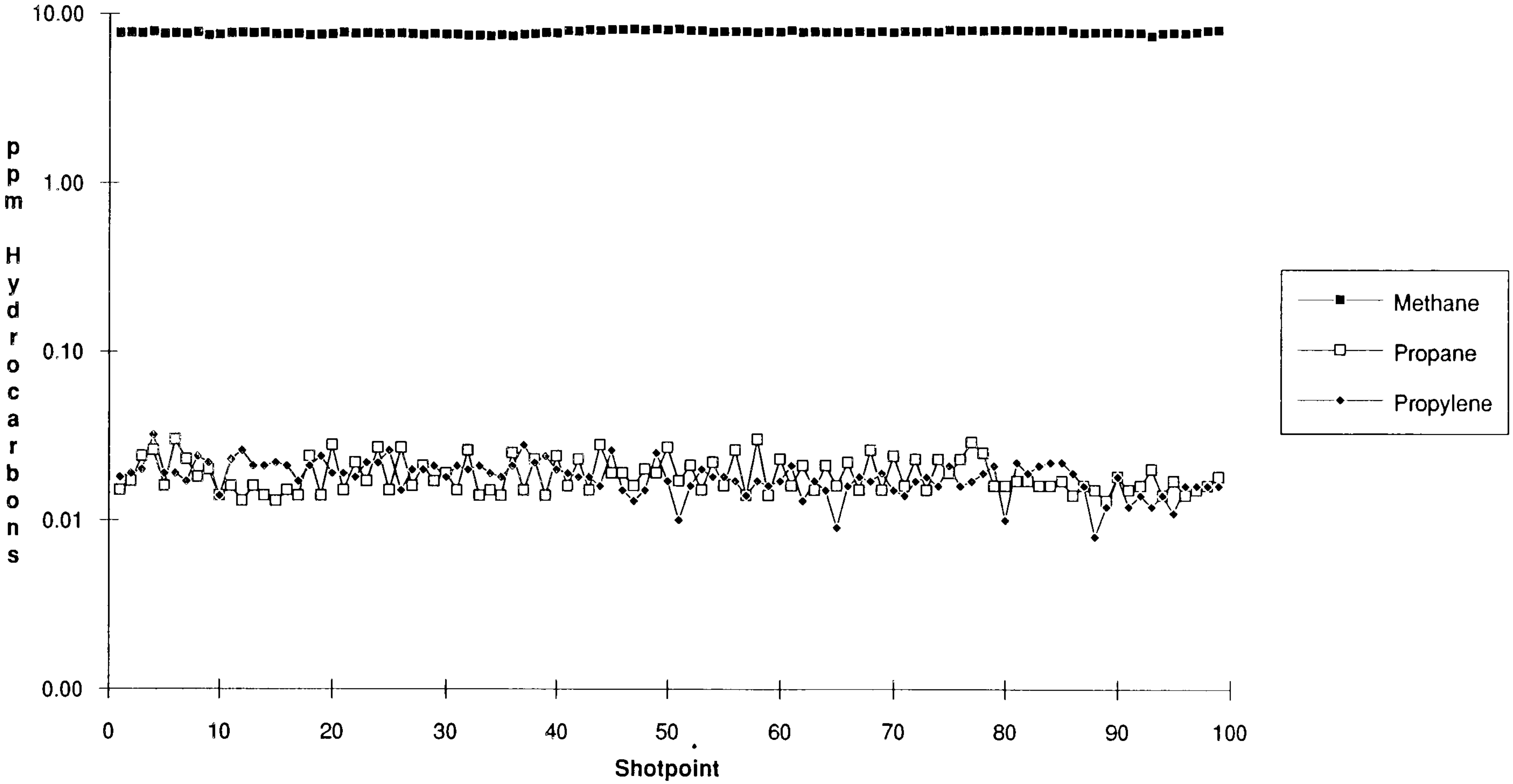
Notes	No anomalies.


Line BASS02 THC, Methane
ppm Hydrocarbons
20
18
16
14
12
10
8
6
4
2
0
0
10
20
30
40
50
60
70
80
90
100
Shotpoint
THC
Methane

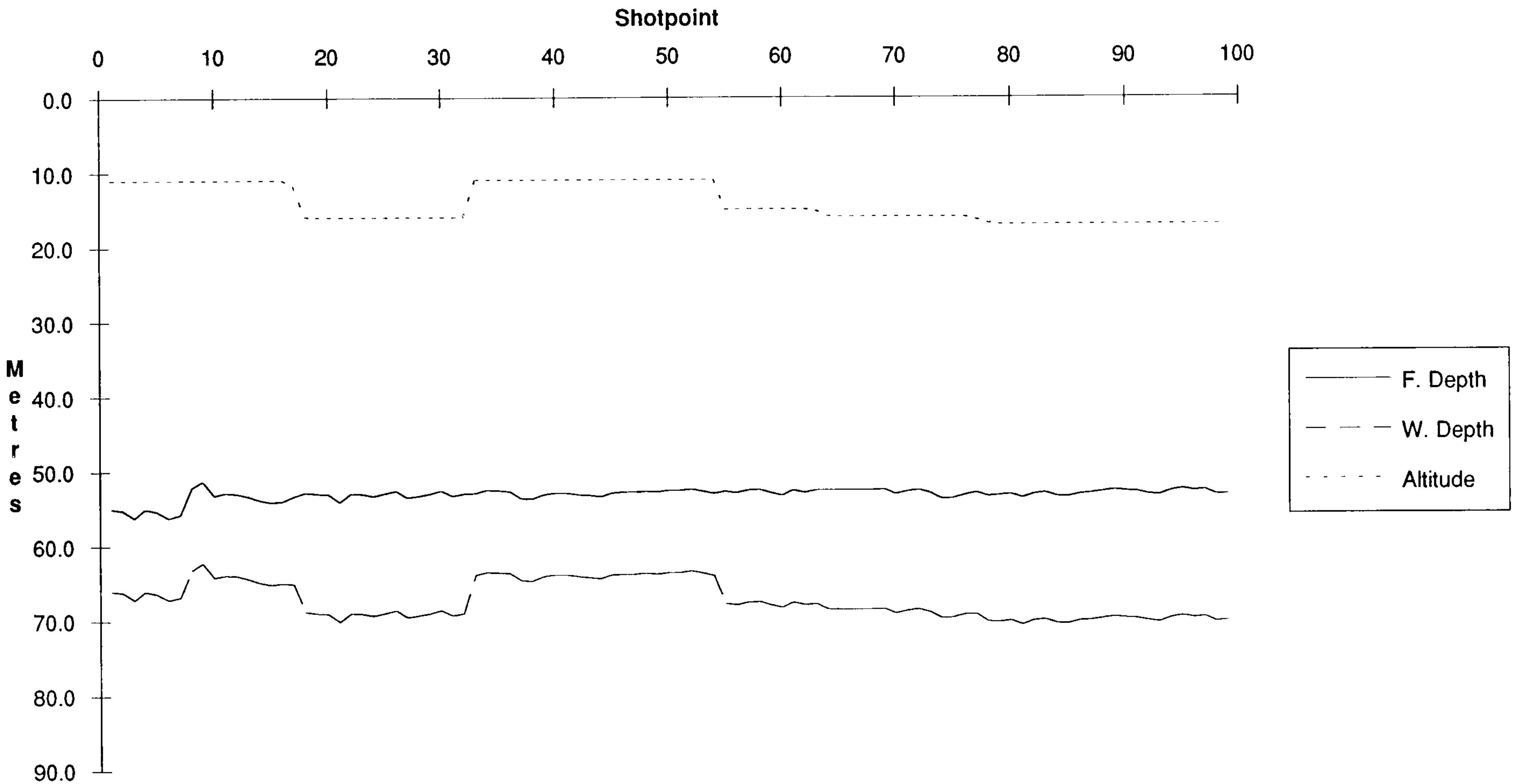
Line BASS02 Methane, Ethane, Ethylene



Line BASS02 Methane, Propane, Propylene



Line BASS02 Depths, Altitude



Line Summary

Line Number	bass3
No. of Shotpoints	60

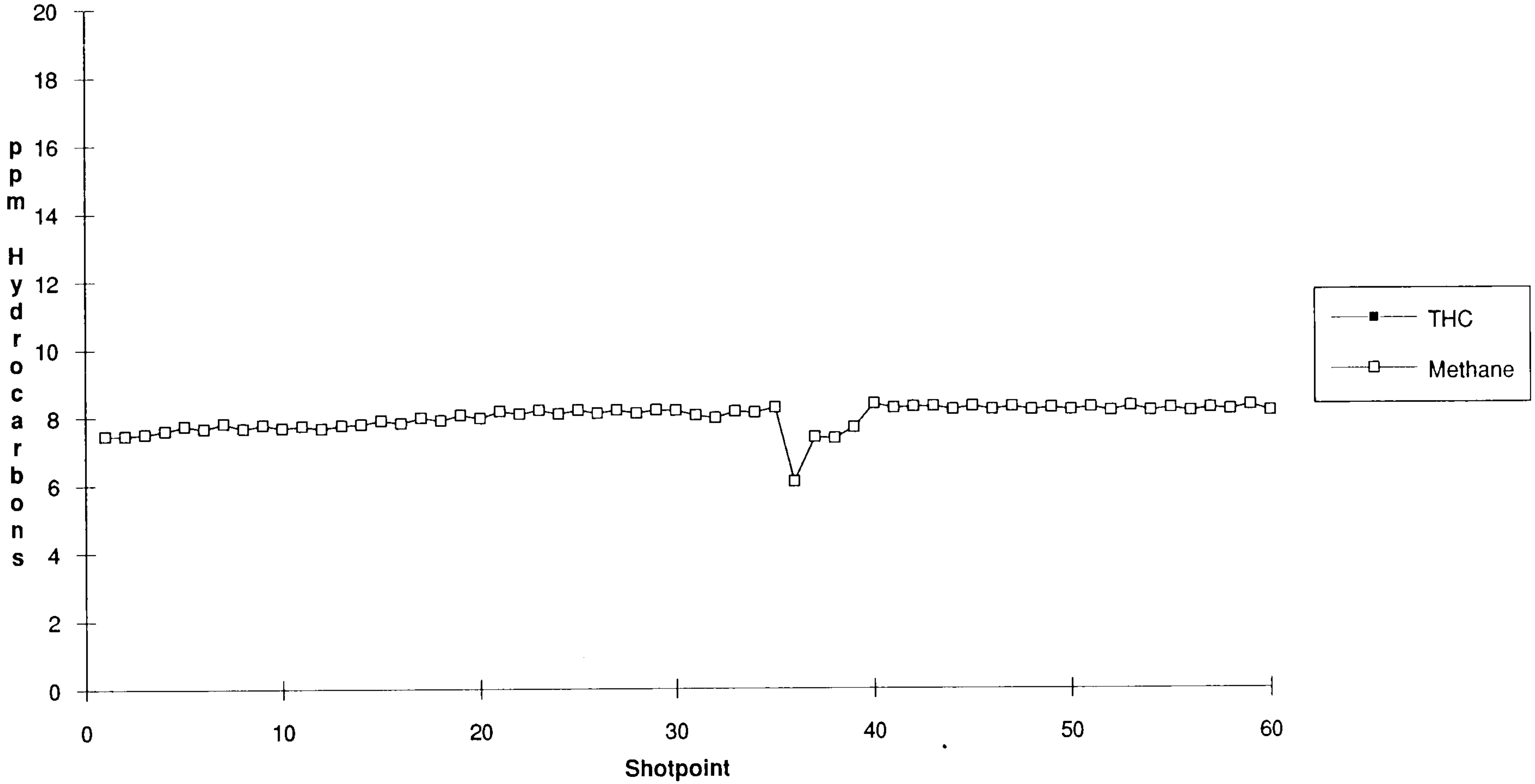
	Shotpoint	Date	Time	Latitude		Longitude	
Start	1	4-Feb-89	05:00:36	40	15.441	147	04.272
End	60	4-Feb-89	07:08:22	40	23.065	146	51.140

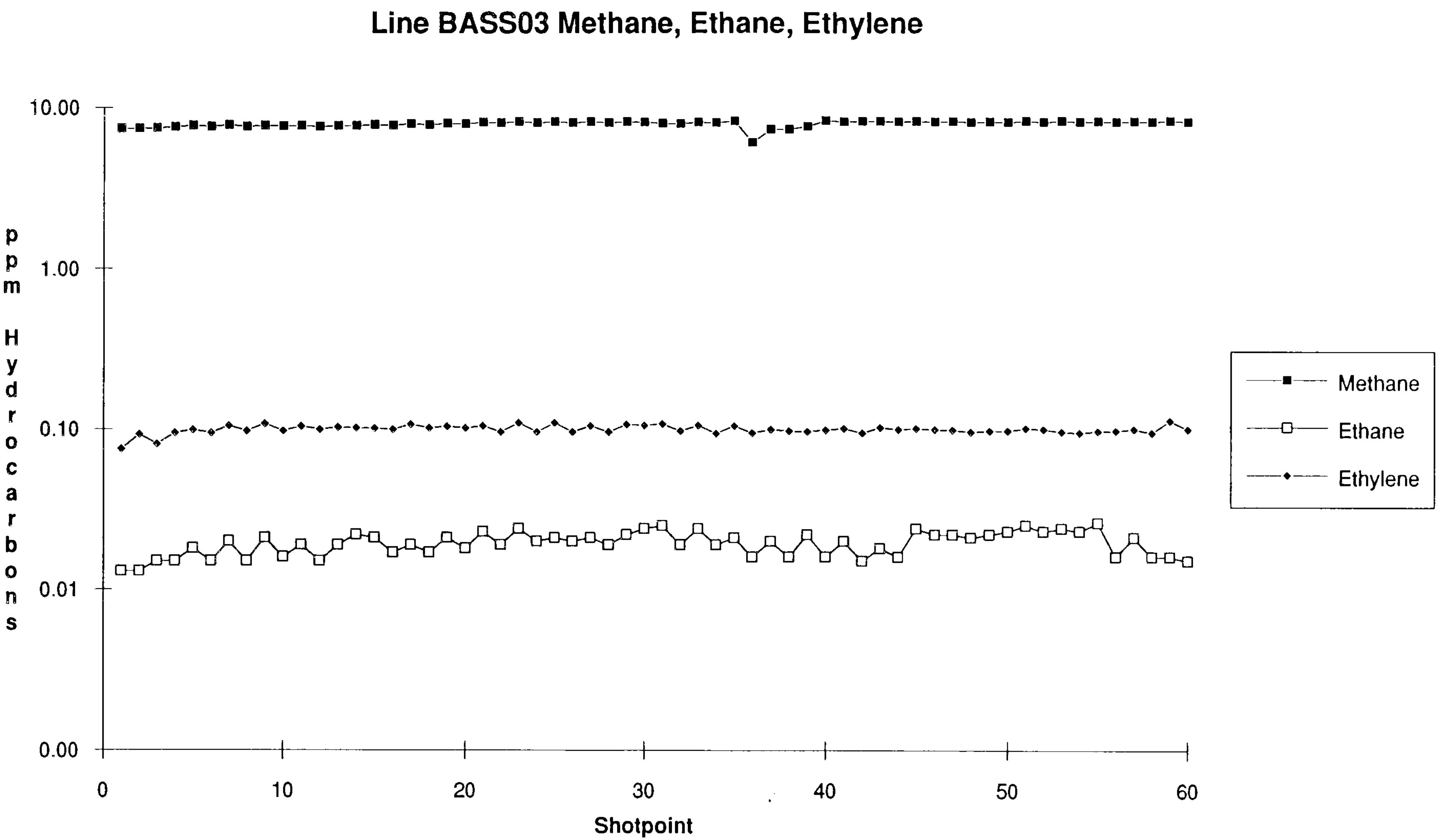
	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	N/A	7.968	0.019	0.100	0.019	0.015	0.000	0.000	N/A	N/A	N/A	N/A	0.479
Std. Dev.	N/A	0.366	0.003	0.006	0.004	0.004	0.001	0.001	N/A	N/A	N/A	N/A	0.051
Minimum	N/A	6.080	0.013	0.075	0.010	0.009	0.000	0.000	N/A	N/A	N/A	N/A	0.308
Maximum	N/A	8.370	0.026	0.113	0.027	0.024	0.002	0.003	N/A	N/A	N/A	N/A	0.565

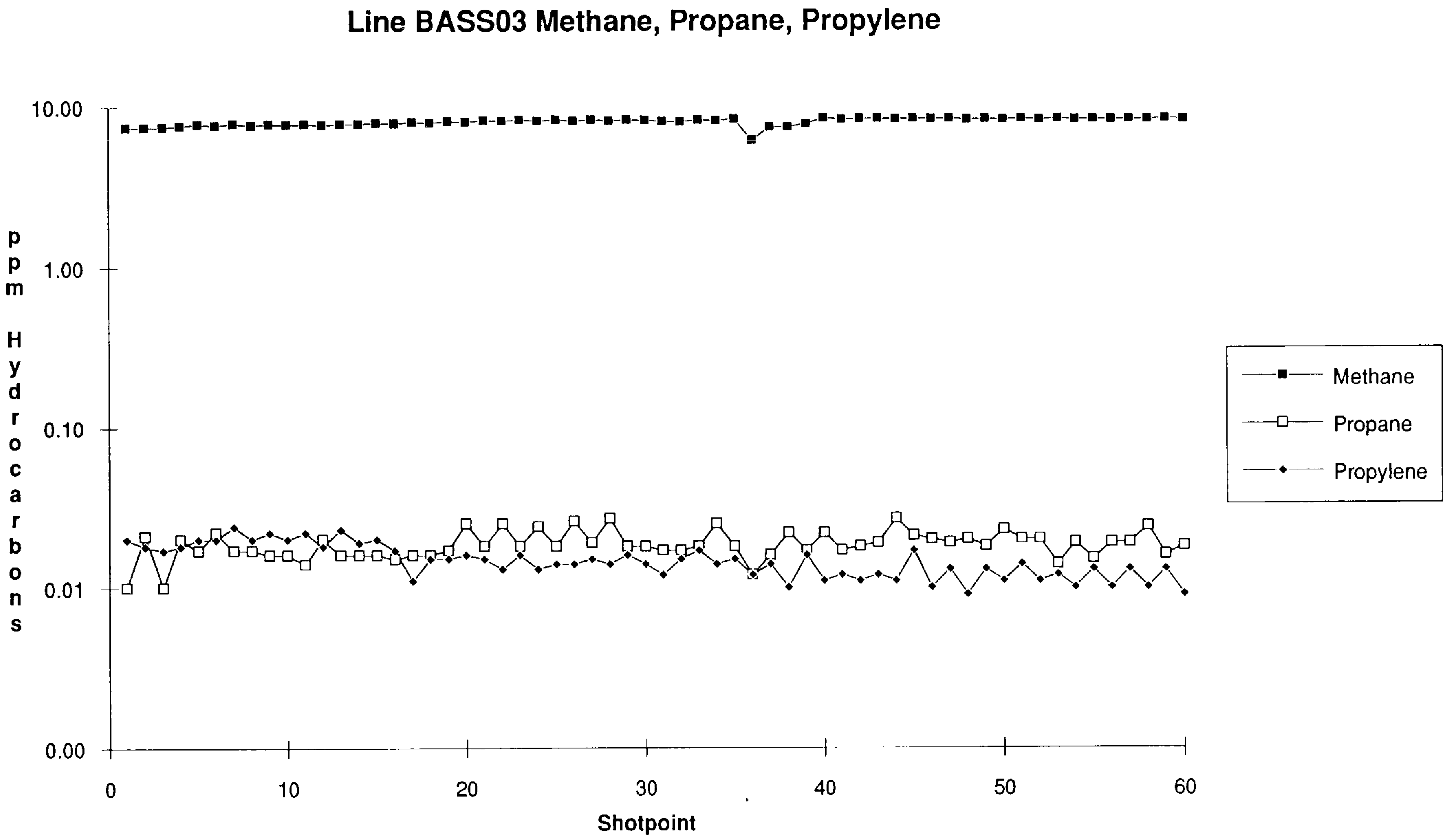
	Salinity	Temp.	F. Depth	W.Depth	Altitude
Mean	32.535	15.992	54.475	69.712	15.237
Std. Dev.	0.578	0.511	0.502	2.890	2.589
Minimum	31.940	15.190	52.800	64.800	12.000
Maximum	33.970	16.970	55.200	73.200	18.000

Notes No anomalies.

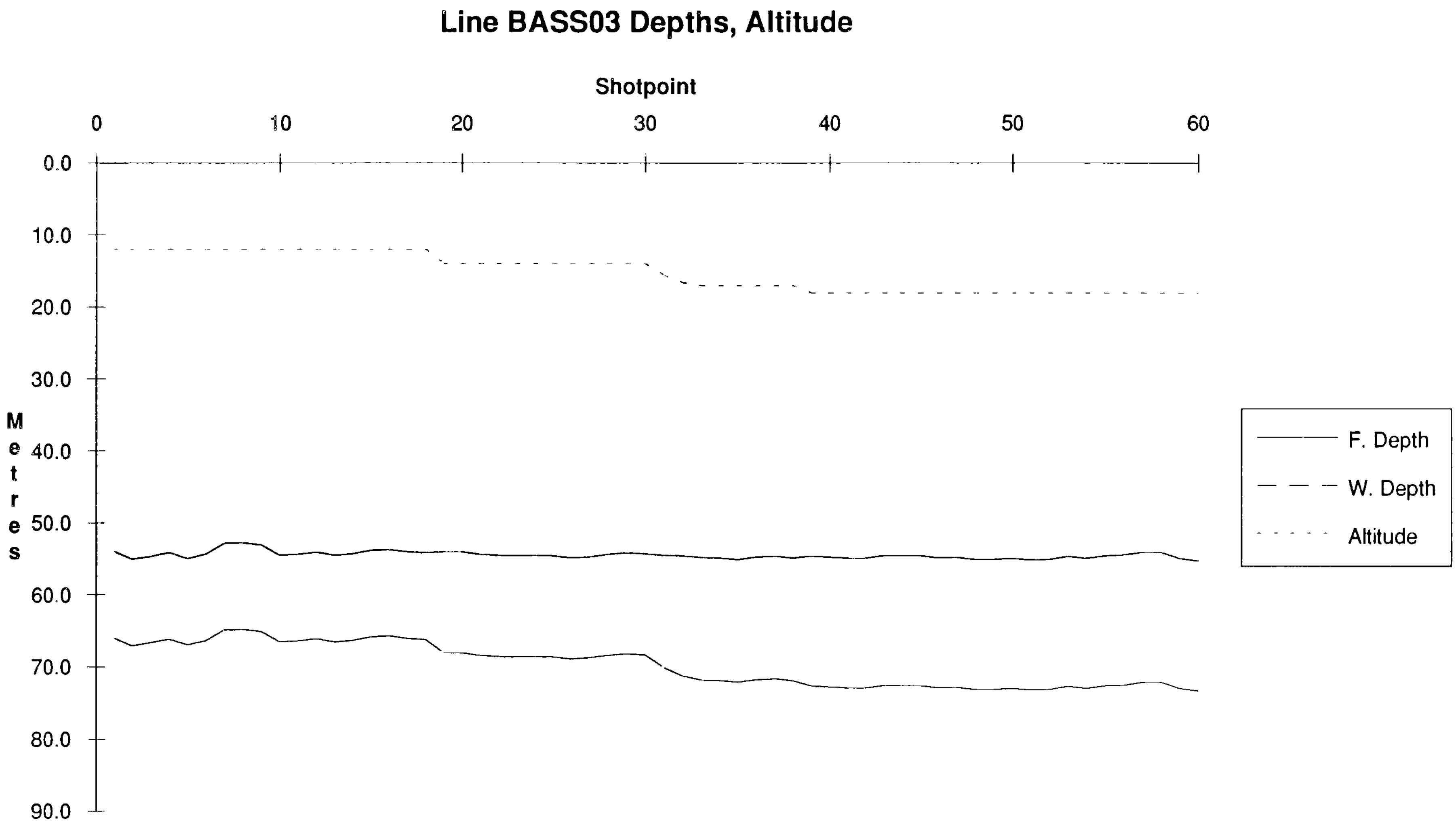
Line BASS03 THC, Methane




Line BASS03 Methane, Ethane, Ethylene
ppm Hydrocarbons
10.00
1.00
0.10
0.01
0.00
0
10
20
30
40
50
60
Shotpoint
Methane
Ethane
Ethylene



Line BASS03 Methane, Propane, Propylene
10.00
1.00
0.10
0.01
0.00
ppm Hydrocarbons
0
10
20
30
40
50
60
Shotpoint
Methane
Propane
Propylene


Line BASS03 Depths, Altitude
Shotpoint
0
10
20
30
40
50
60
0.0
10.0
20.0
30.0
40.0
50.0
60.0
70.0
80.0
90.0
Metres
F. Depth
W. Depth
Altitude

Line Summary

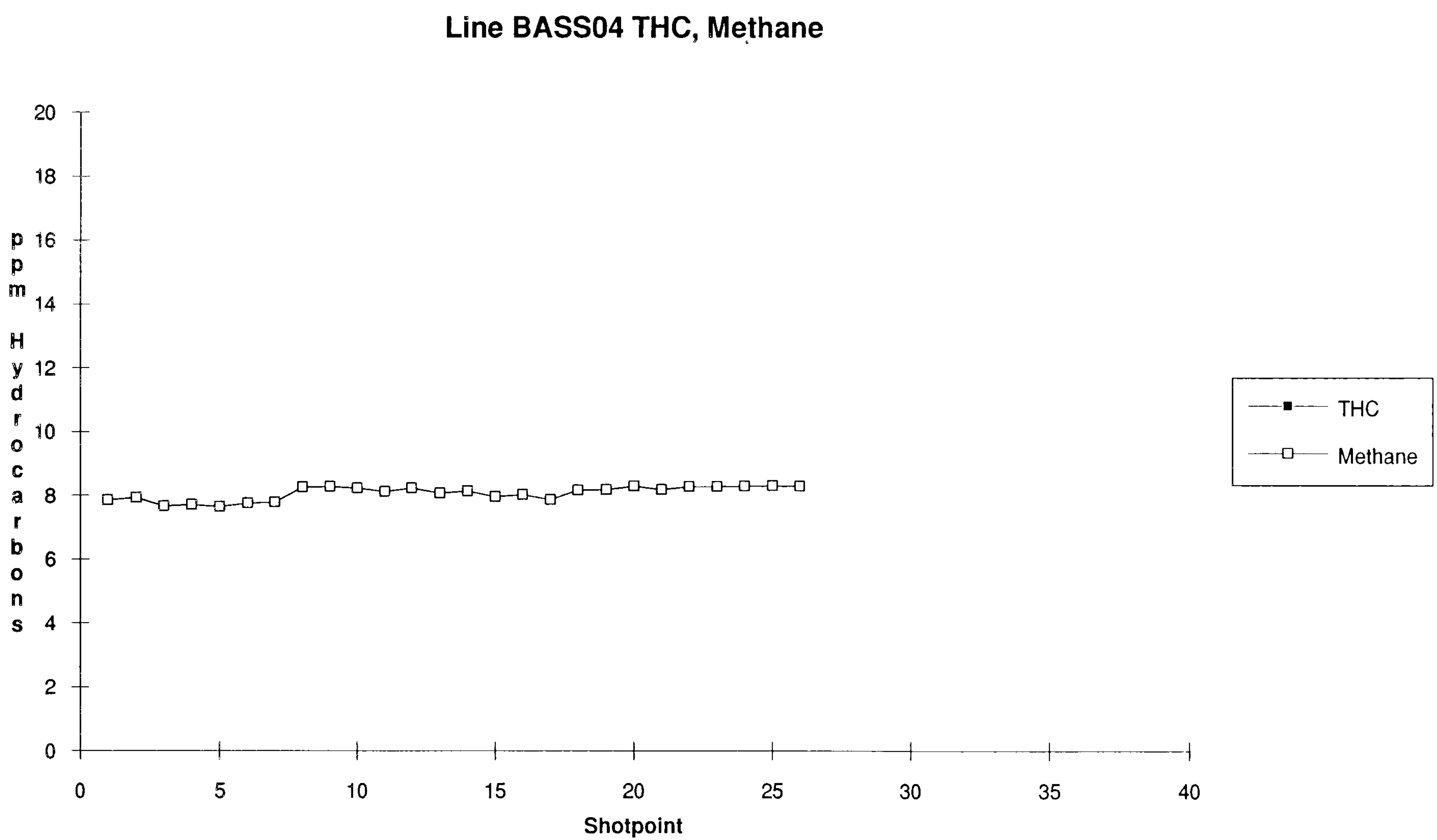
Line Number	bass4
No. of Shotpoints	26

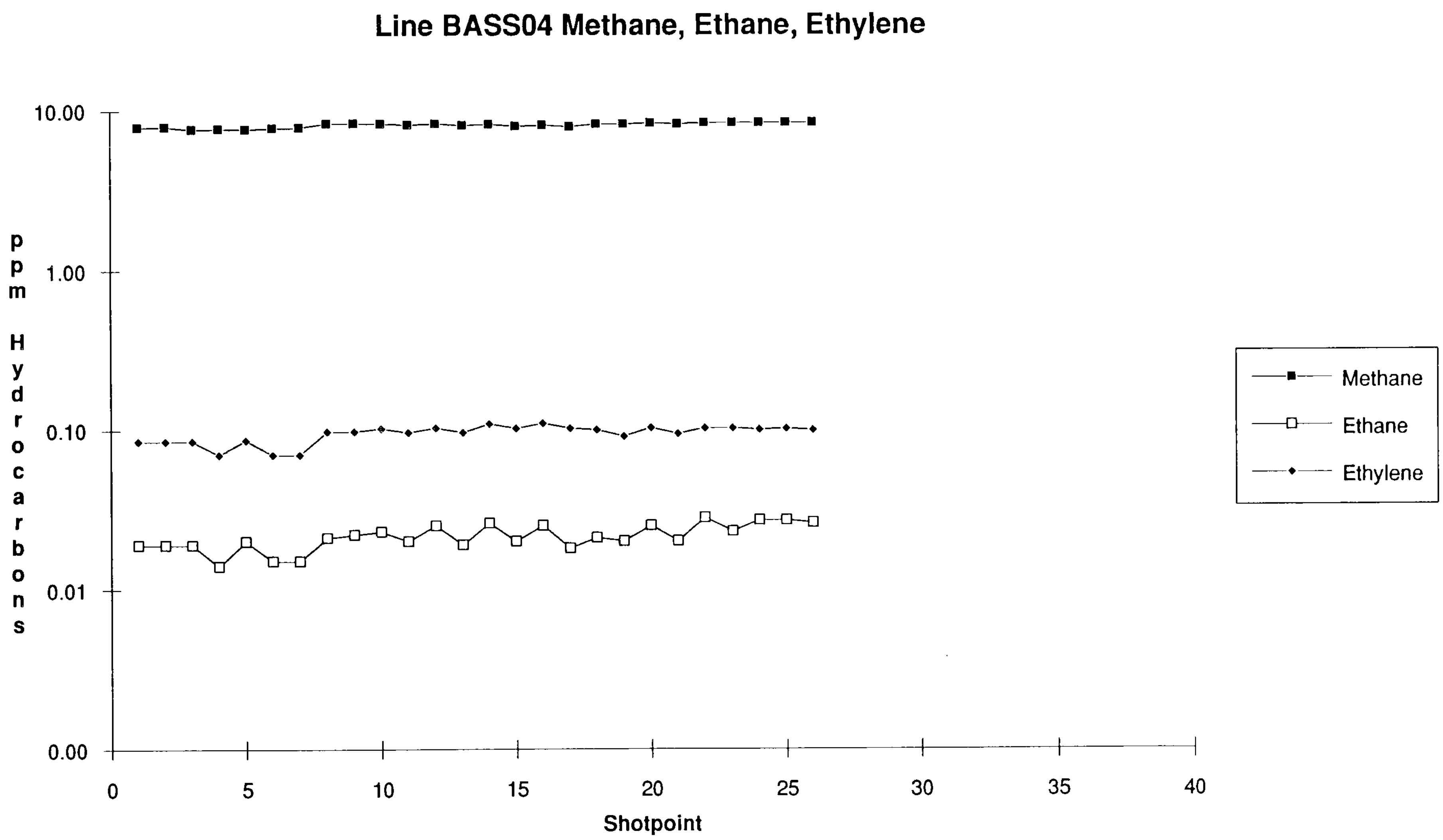
	Shotpoint	Date	Time	Latitude		Longitude	
Start	1	4-Feb-89	07:36:41	40	25.019	146	49.228
End	28	4-Feb-89	08:43:37	40	18.758	146	52.657

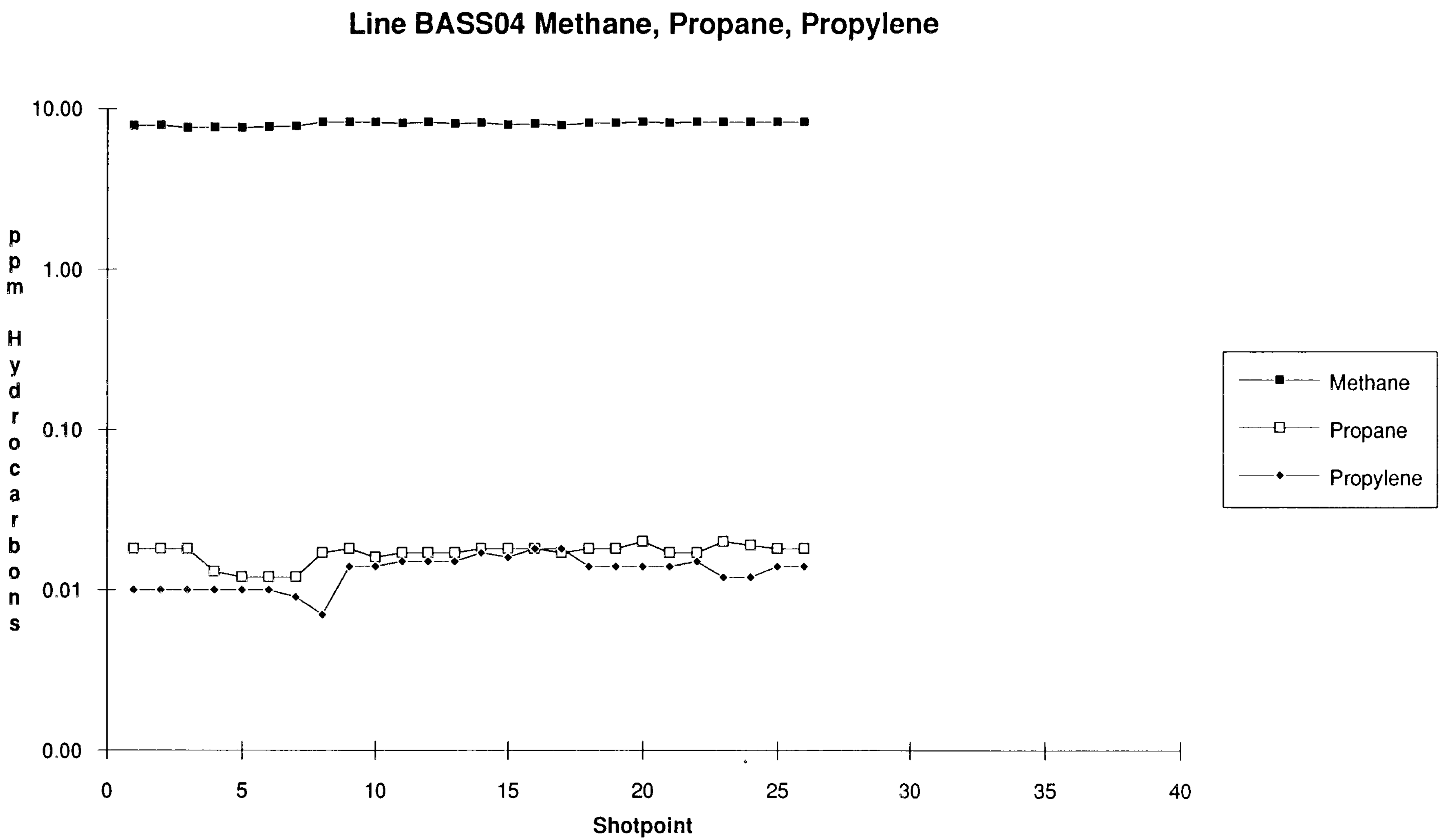
	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	N/A	8.065	0.021	0.095	0.017	0.013	0.000	0.000	N/A	N/A	N/A	N/A	0.473
Std. Dev.	N/A	0.222	0.004	0.011	0.002	0.003	0.000	0.000	N/A	N/A	N/A	N/A	0.058
Minimum	N/A	7.640	0.014	0.070	0.012	0.007	0.000	0.000	N/A	N/A	N/A	N/A	0.345
Maximum	N/A	8.300	0.028	0.110	0.020	0.018	0.000	0.001	N/A	N/A	N/A	N/A	0.552

	Salinity	Temp.	F. Depth	W.Depth	Altitude
Mean	32.098	15.628	52.312	65.350	13.035
Std. Dev.	0.188	0.244	1.313	1.857	0.713
Minimum	31.790	15.300	50.400	63.400	12.000
Maximum	32.540	16.170	54.400	68.400	14.000

No anomalies.

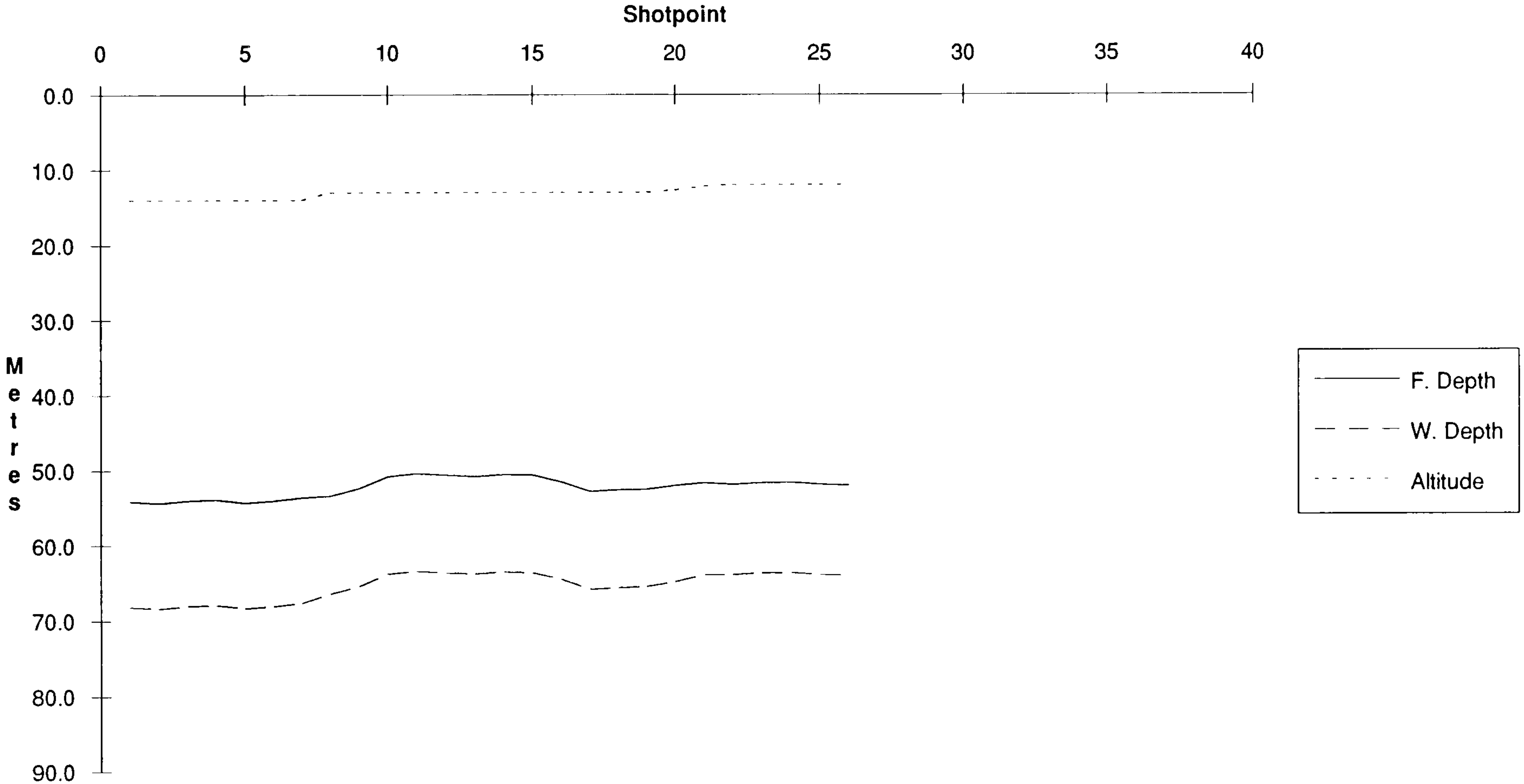

Line BASS04 THC, Methane
ppm Hydrocarbons
0
2
4
6
8
10
12
14
16
18
20
0
5
10
15
20
25
30
35
40
Shotpoint
THC
Methane


Line BASS04 Methane, Ethane, Ethylene
ppm Hydrocarbons
10.00
1.00
0.10
0.01
0.00
0
5
10
15
20
25
30
35
40
Shotpoint
Methane
Ethane
Ethylene



Line BASS04 Methane, Propane, Propylene
ppm Hydrocarbons
10.00
1.00
0.10
0.01
0.00
0
5
10
15
20
25
30
35
40
Shotpoint
Methane
Propane
Propylene

Line BASS04 Depths, Altitude



Line Summary

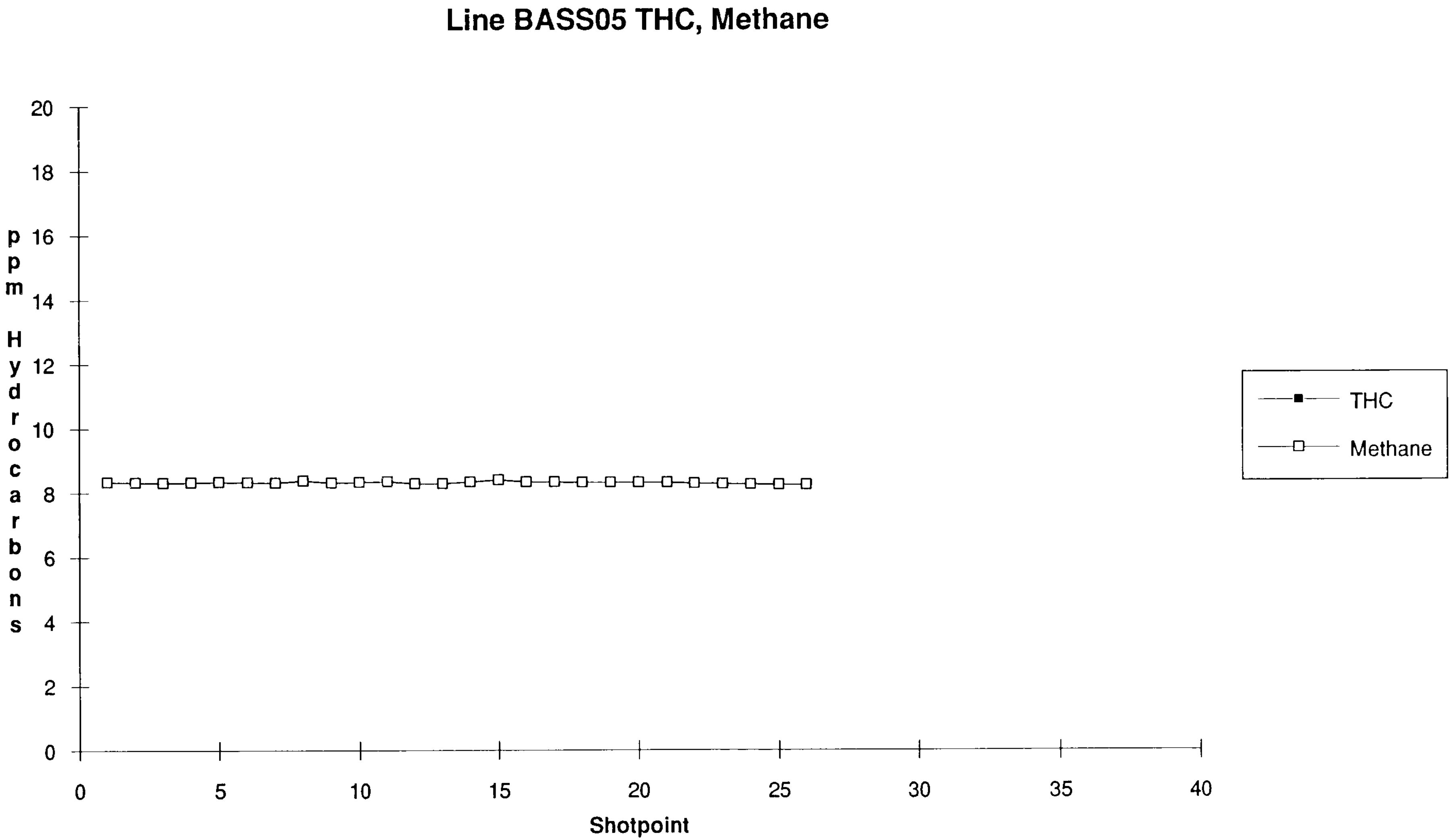
Line Number	bass5
No. of Shotpoints	26

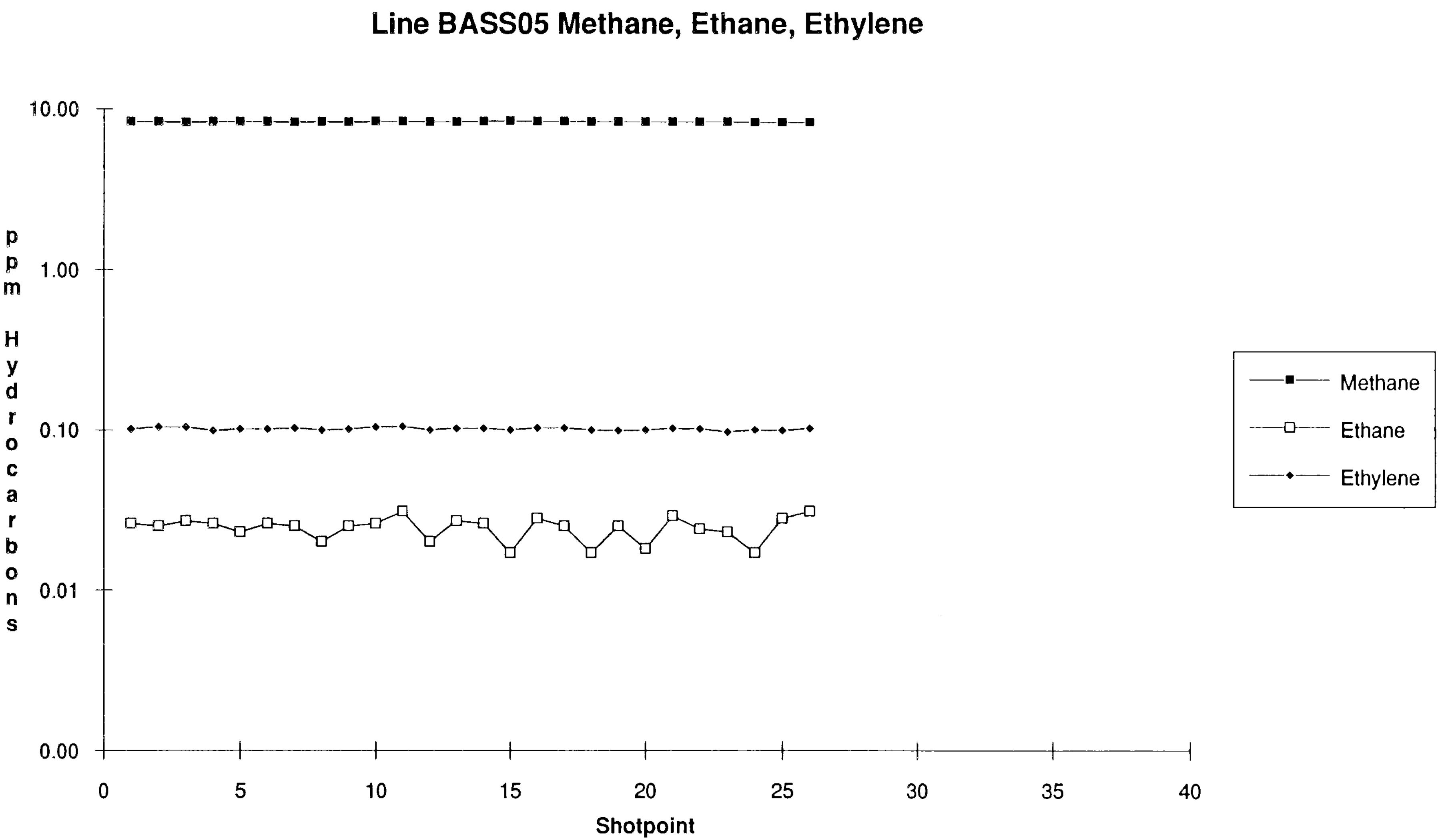
	Shotpoint	Date	Time	Latitude		Longitude	
Start	1	4-Feb-89	08:47:41	40	18.383	146	52.876
End	26	4-Feb-89	10:06:01	40	22.688	146	45.198

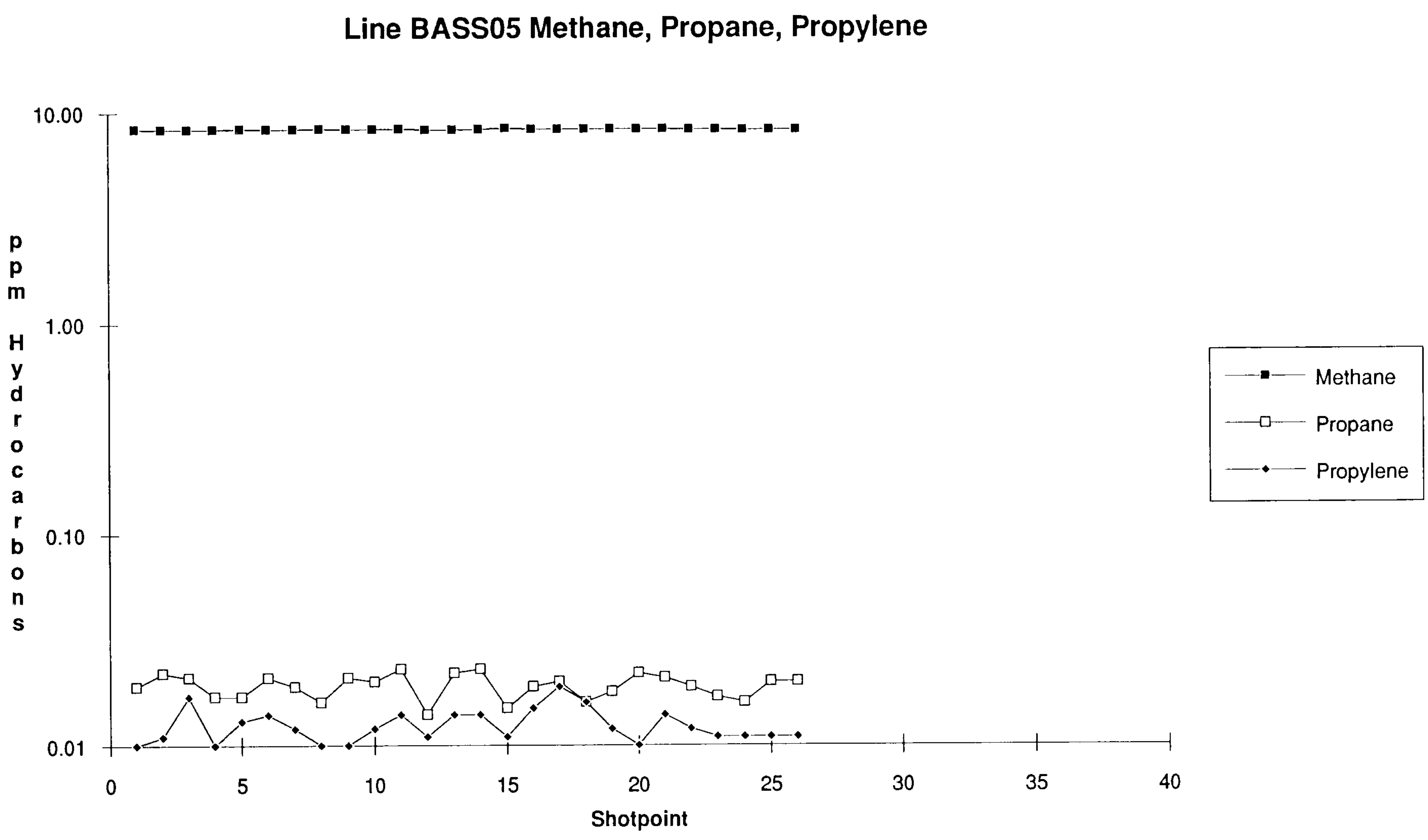
	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	N/A	8.304	0.024	0.101	0.019	0.013	0.001	0.001	N/A	N/A	N/A	N/A	0.535
Std. Dev.	N/A	0.038	0.004	0.002	0.003	0.002	0.001	0.001	N/A	N/A	N/A	N/A	0.077
Minimum	N/A	8.220	0.017	0.097	0.014	0.010	0.000	0.000	N/A	N/A	N/A	N/A	0.380
Maximum	N/A	8.380	0.031	0.105	0.023	0.019	0.002	0.006	N/A	N/A	N/A	N/A	0.644

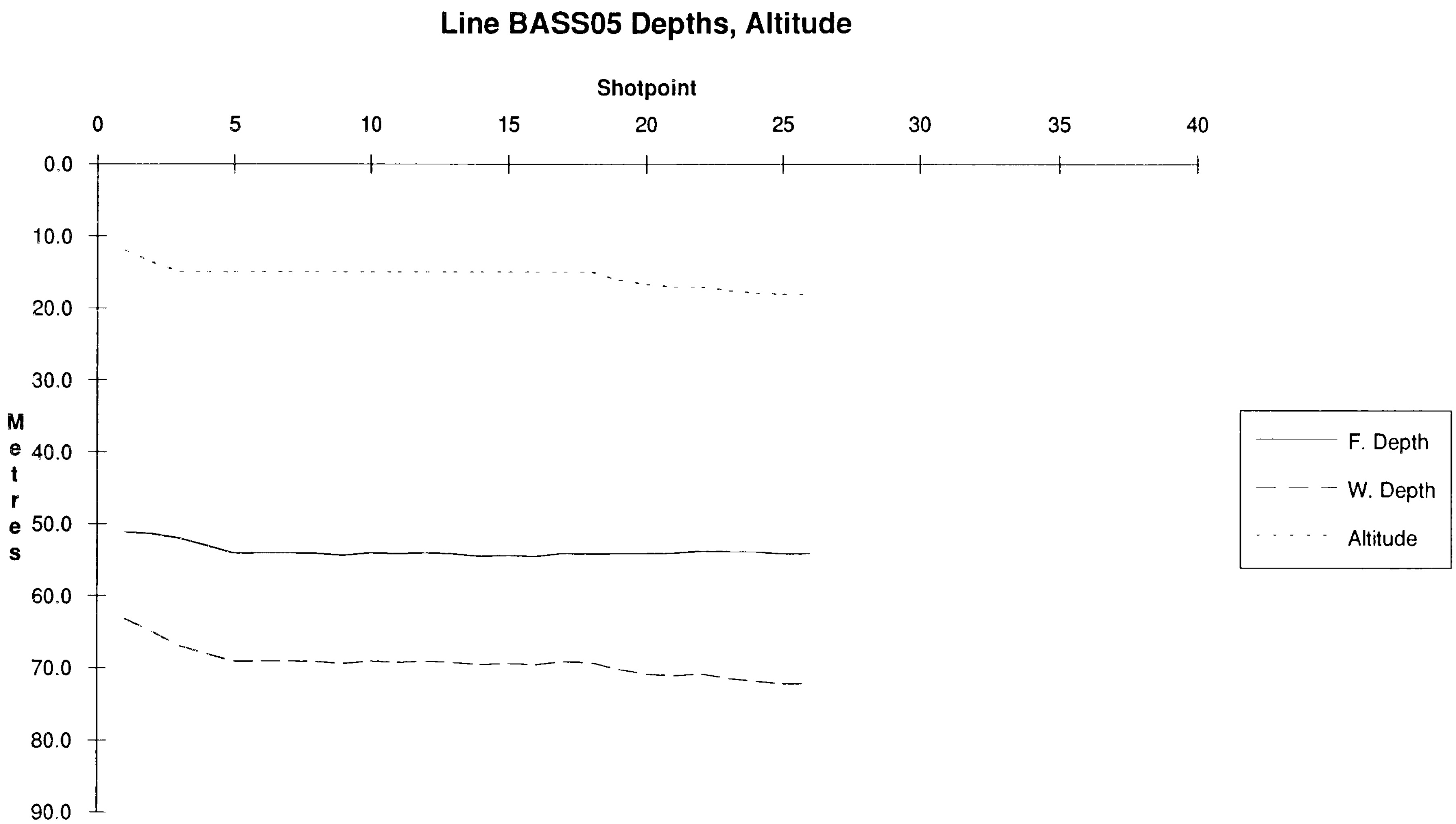
	Salinity	Temp.	F. Depth	W.Depth	Altitude
Mean	32.010	15.420	53.765	69.300	15.531
Std. Dev.	0.062	0.082	0.880	1.965	1.391
Minimum	31.900	15.300	51.200	63.200	12.000
Maximum	32.100	15.600	54.500	72.100	18.000

No anomalies.


Line BASS05 THC, Methane
ppm Hydrocarbons
20
18
16
14
12
10
8
6
4
2
0
0
5
10
15
20
25
30
35
40
Shotpoint
THC
Methane


Line BASS05 Methane, Ethane, Ethylene
ppm Hydrocarbons
10.00
1.00
0.10
0.01
0.00
0
5
10
15
20
25
30
35
40
Shotpoint
Methane
Ethane
Ethylene


Line BASS05 Methane, Propane, Propylene
10.00
1.00
0.10
0.01
ppm Hydrocarbons
0
5
10
15
20
25
30
35
40
Shotpoint
Methane
Propane
Propylene


Line BASS05 Depths, Altitude
Shotpoint
0
5
10
15
20
25
30
35
40
0.0
10.0
20.0
30.0
40.0
50.0
60.0
70.0
80.0
90.0
Metres
F. Depth
W. Depth
Altitude

Line Summary

Line Number	bass6
No. of Shotpoints	89

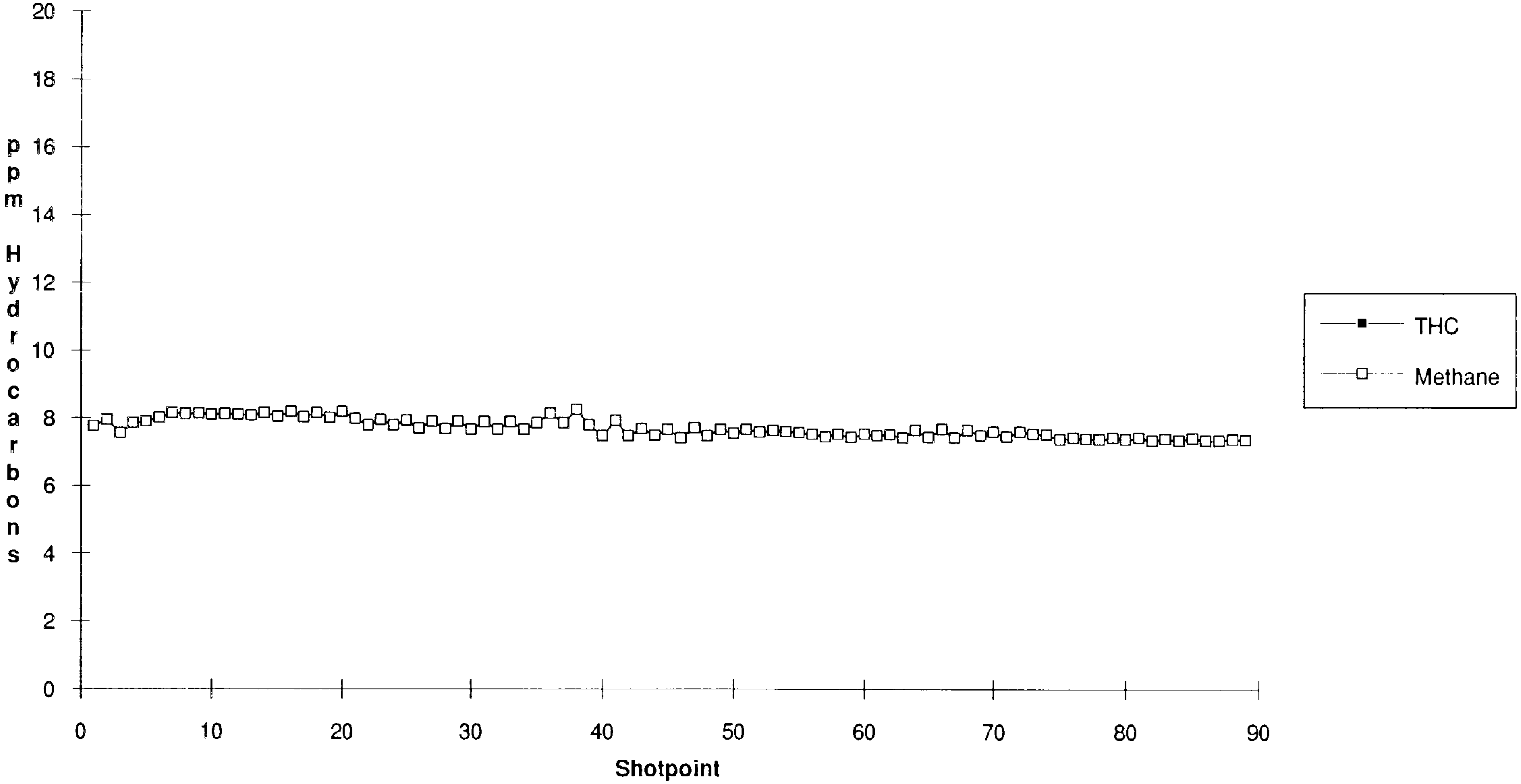
	Shotpoint	Date	Time	Latitude		Longitude	
Start	1	4-Feb-89	10:33:12	40	23.374	146	44.004
End	92	4-Feb-89	13:59:35	40	24.416	146	16.376

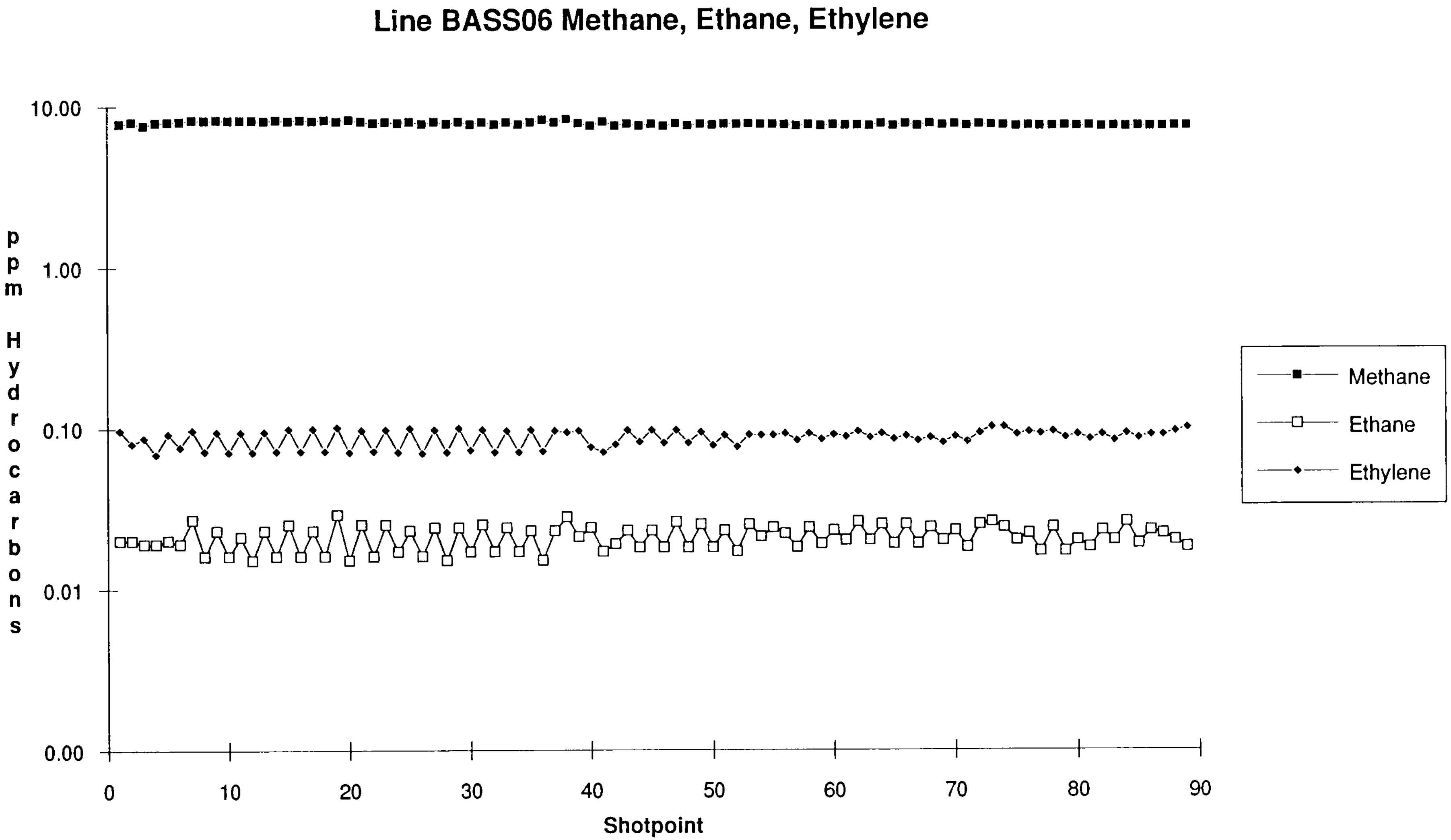
	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	N/A	7.686	0.021	0.087	0.019	0.012	0.000	0.000	N/A	N/A	N/A	N/A	0.521
Std. Dev.	N/A	0.271	0.004	0.010	0.003	0.003	0.000	0.000	N/A	N/A	N/A	N/A	0.054
Minimum	N/A	7.320	0.015	0.069	0.012	0.005	0.000	0.000	N/A	N/A	N/A	N/A	0.357
Maximum	N/A	8.240	0.029	0.101	0.026	0.019	0.000	0.002	N/A	N/A	N/A	N/A	0.621

	Salinity	Temp.	F. Depth	W.Depth	Altitude
Mean	31.769	14.991	54.097	73.772	19.674
Std. Dev.	0.203	0.172	1.334	2.657	1.917
Minimum	31.360	14.600	51.000	68.100	15.000
Maximum	32.410	15.200	55.800	76.900	22.000

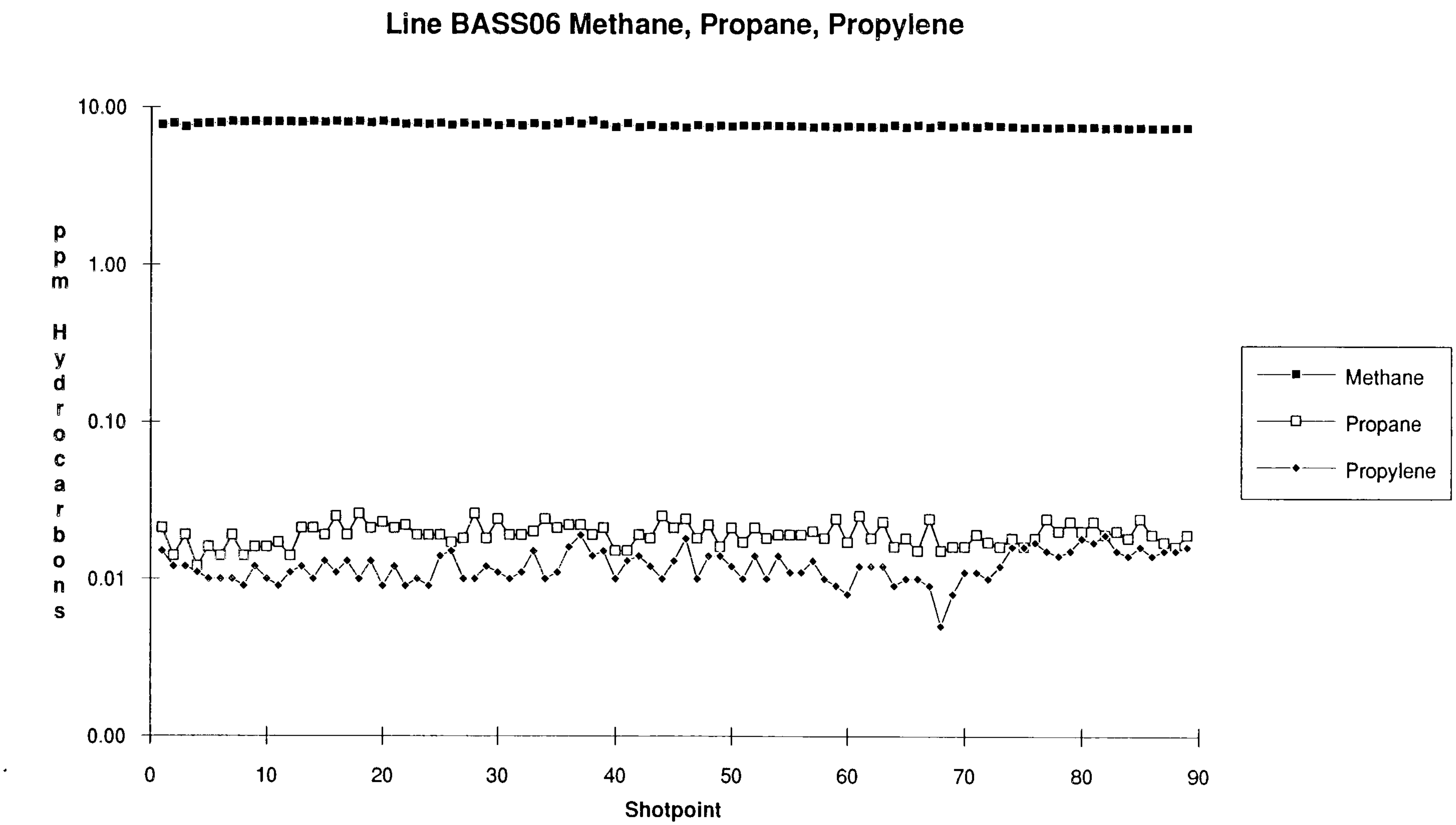
Notes No anomalies.

Line BASS06 THC, Methane



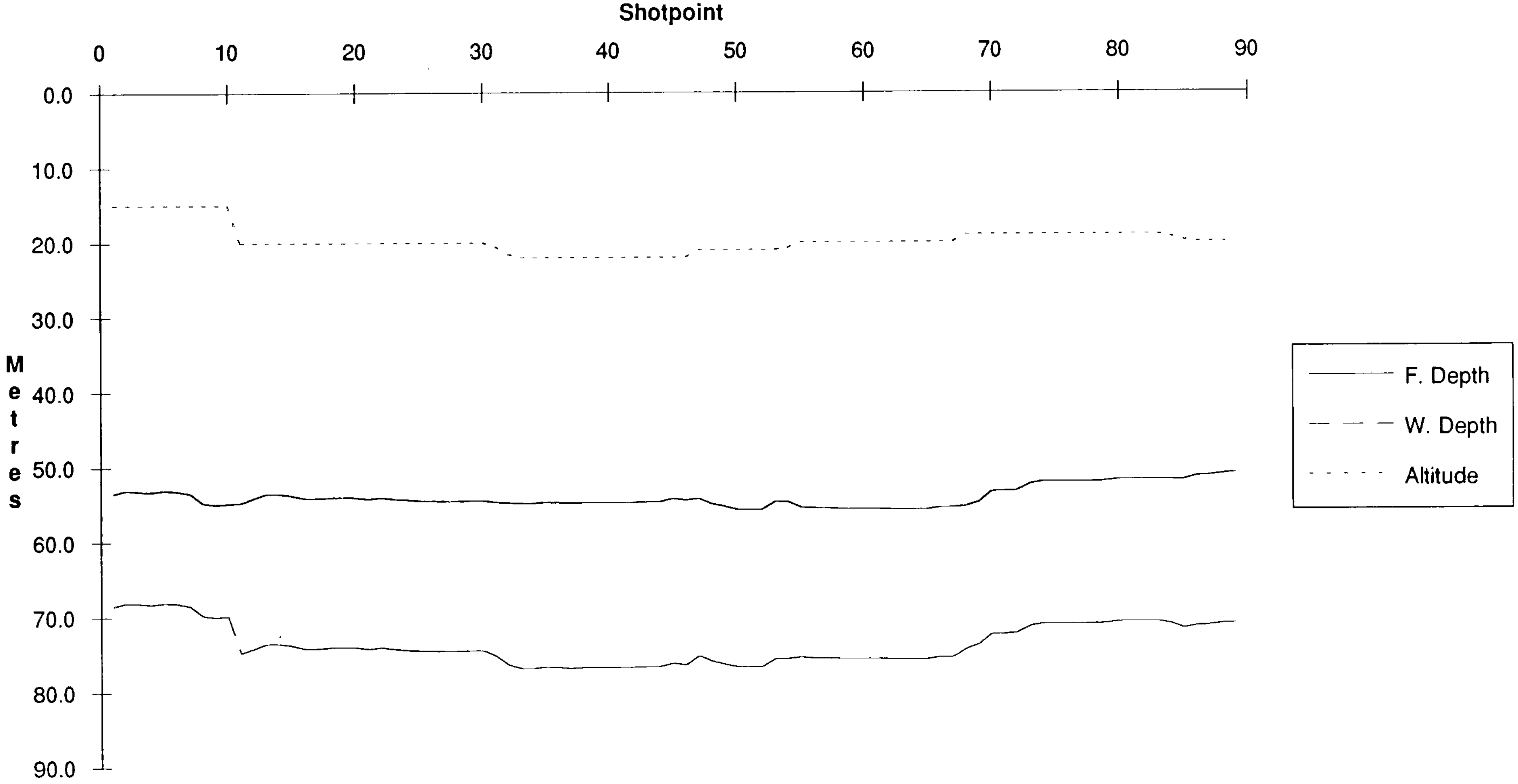


Line BASS06 Methane, Ethane, Ethylene
10.00
1.00
0.10
0.01
0.00
ppm Hydrocarbons
0
10
20
30
40
50
60
70
80
90
Shotpoint
Methane
Ethane
Ethylene



Line BASS06 Methane, Propane, Propylene
ppm Hydrocarbons
10.00
1.00
0.10
0.01
0.00
0
10
20
30
40
50
60
70
80
90
Shotpoint
Methane
Propane
Propylene

Line BASS06 Depths, Altitude



Line Summary

Line Number	bass7
No. of Shotpoints	82

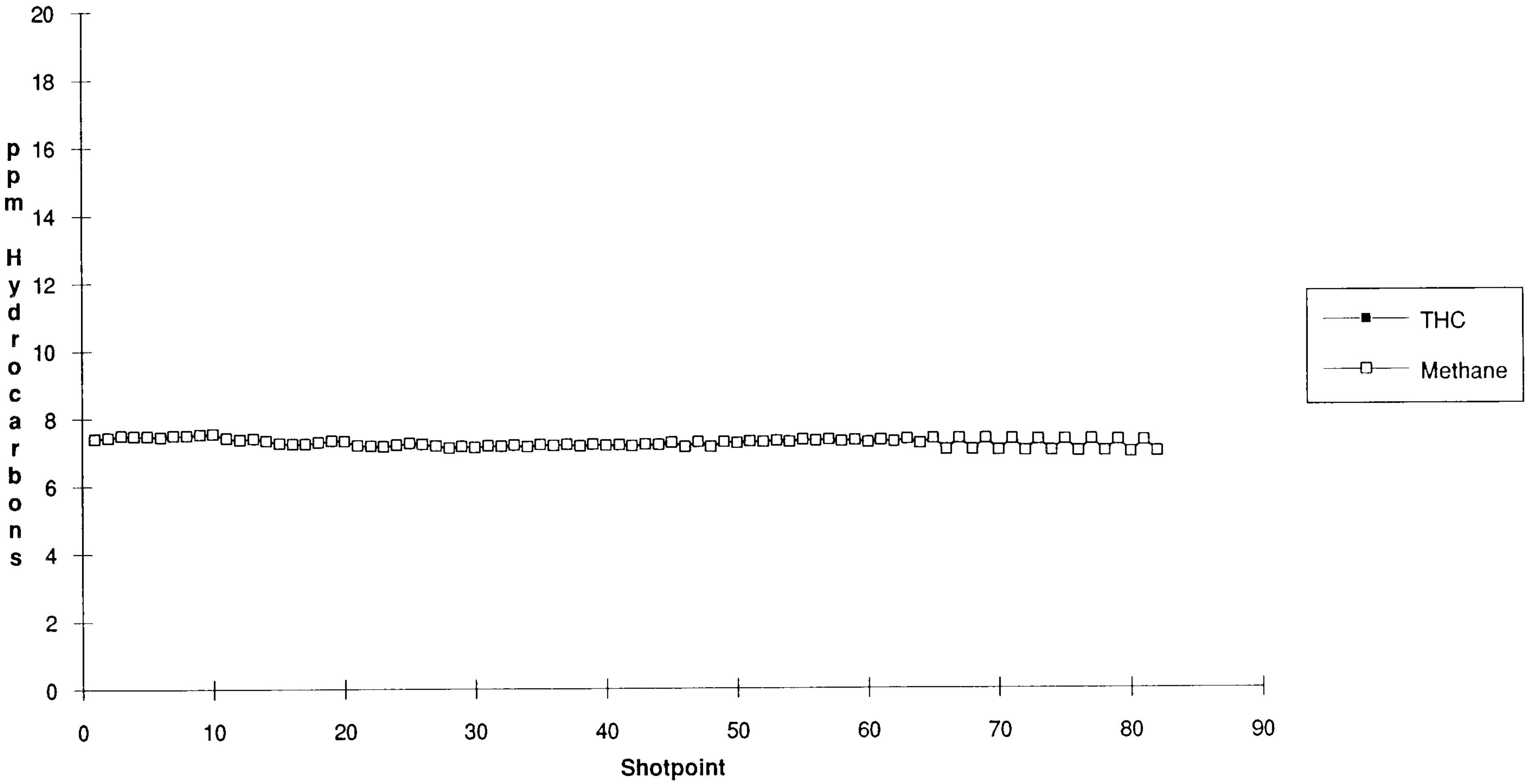
	Shotpoint	Date	Time	Latitude		Longitude	
Start	1	4-Feb-89	14:02:15	40	24.423	146	16.018
End	83	4-Feb-89	16:56:18	40	28.877	145	51.369

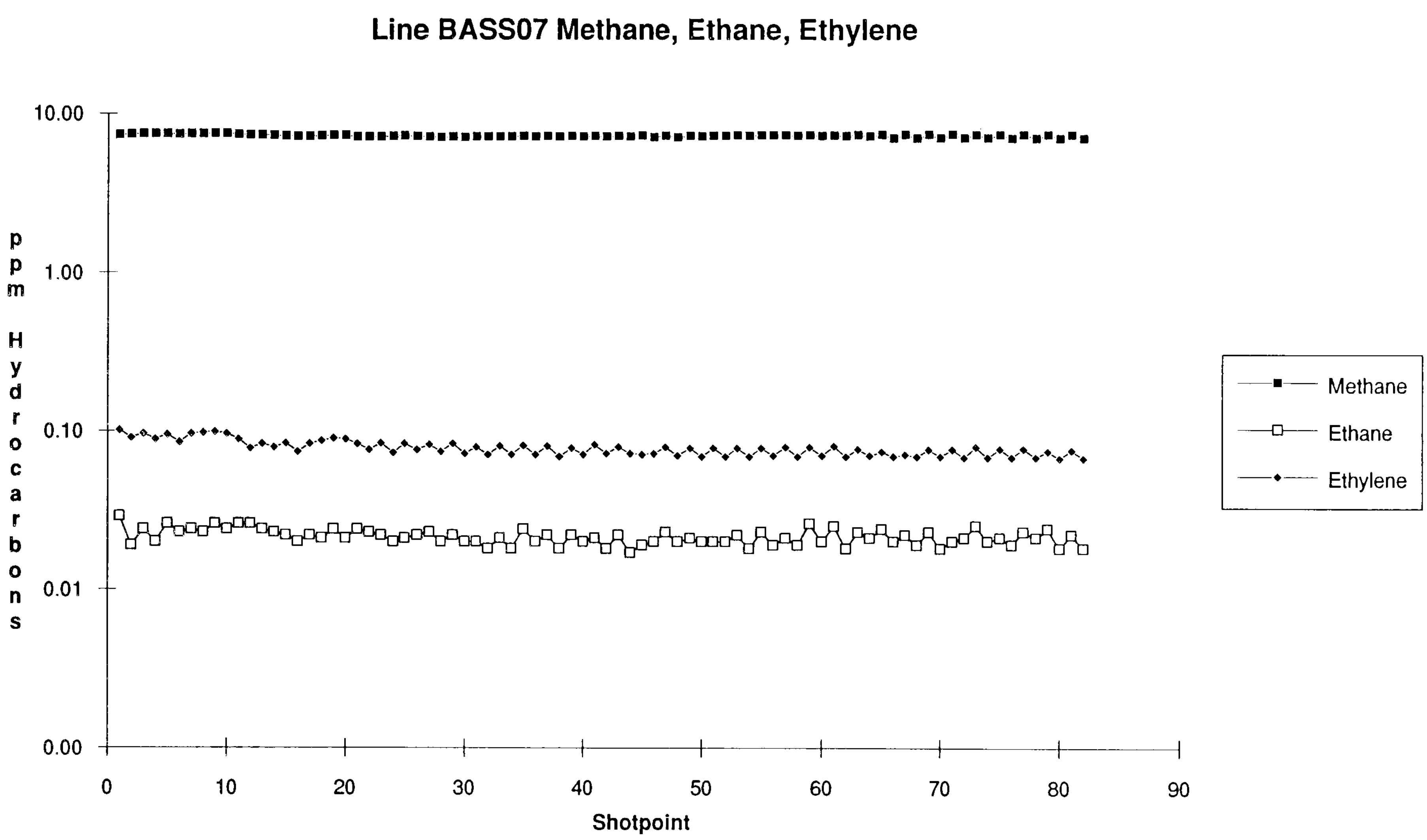
	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	N/A	7.244	0.021	0.078	0.016	0.012	0.000	0.000	N/A	N/A	N/A	N/A	0.518
Std. Dev.	N/A	0.135	0.002	0.009	0.002	0.002	0.000	0.000	N/A	N/A	N/A	N/A	0.038
Minimum	N/A	6.950	0.017	0.067	0.011	0.006	0.000	0.000	N/A	N/A	N/A	N/A	0.415
Maximum	N/A	7.530	0.029	0.101	0.022	0.017	0.000	0.000	N/A	N/A	N/A	N/A	0.619

	Salinity	Temp.	F. Depth	W.Depth	Altitude
Mean	31.422	14.494	55.243	71.815	16.573
Std. Dev.	0.171	0.235	1.827	2.267	3.107
Minimum	31.150	14.030	51.100	66.100	8.000
Maximum	31.940	14.900	58.300	77.200	22.000

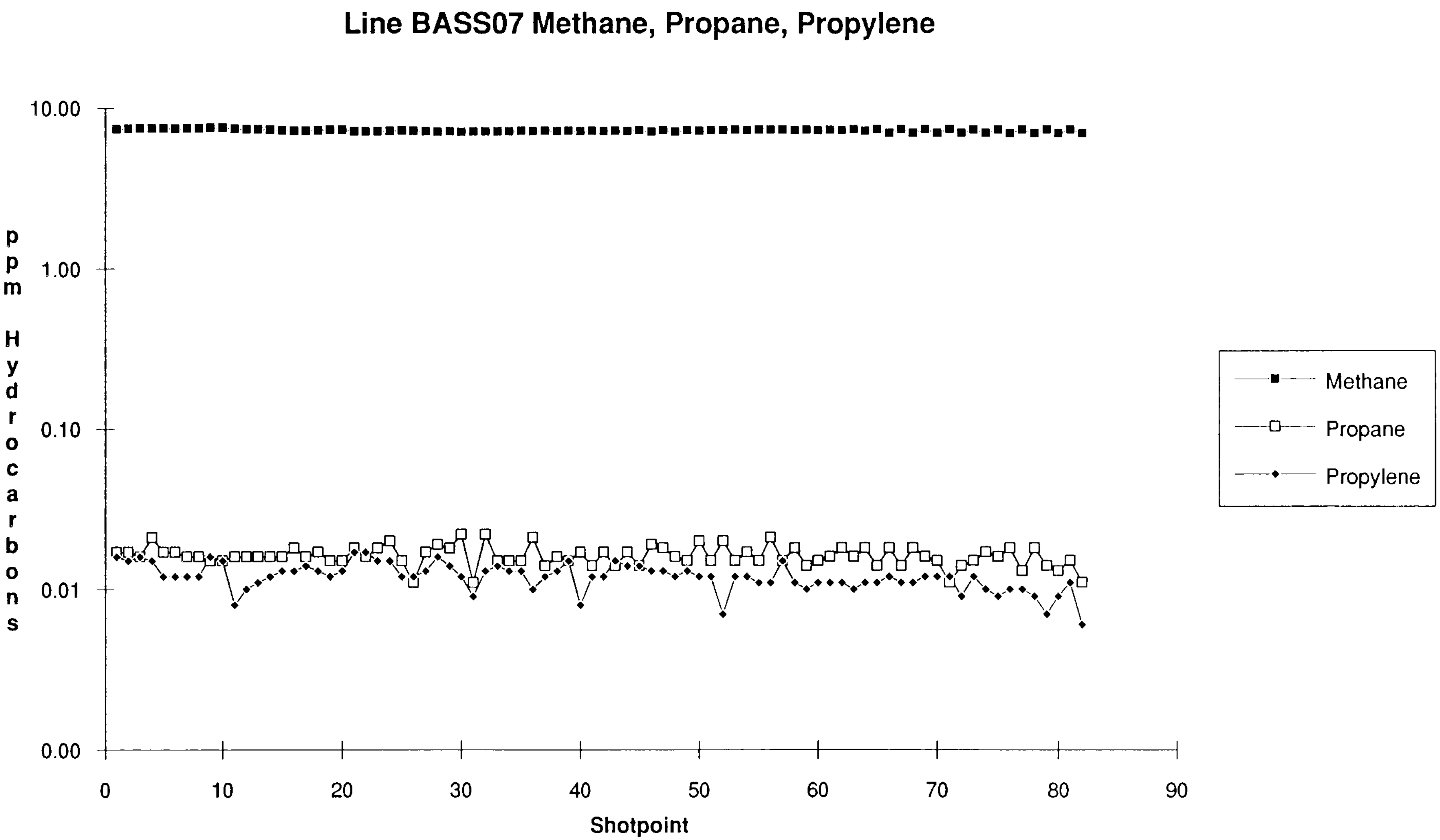
Notes No anomalies.

Line BASS07 THC, Methane





Line BASS07 Methane, Ethane, Ethylene
10.00
1.00
0.10
0.01
0.00
ppm Hydrocarbons
0
10
20
30
40
50
60
70
80
90
Shotpoint
Methane
Ethane
Ethylene


Line BASS07 Methane, Propane, Propylene
ppm Hydrocarbons
10.00
1.00
0.10
0.01
0.00
0
10
20
30
40
50
60
70
80
90
Shotpoint
Methane
Propane
Propylene

Line BASS07 Depths, Altitude