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BMR Record 1992/62
Light hydrocarbon geochemistry of the Vulcan Sub-Basin, Timor Sea: *Rig Seismic* Survey 97

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Project 121.19

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MARINE GEOSCIENCE AND PETROLEUM GEOLOGY PROGRAM

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BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS, AUSTRALIA

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EXECUTIVE SUMMARY

In October/November 1990, the Australian Bureau of Mineral Resources (BMR) carried out an 18 day combined water column geochemical and high resolution seismic survey in the Vulcan Sub-Basin region of the Timor Sea. This report presents the results of the water column geochemical (direct hydrocarbon detection or DHD) aspects of that program.

During the program, 2730km of DHD data were obtained along 44 lines over the Vulcan Sub-Basin, the Ashmore Platform and the Londonderry High. Ten water bottom hydrocarbon anomalies were detected during the program. Seven of these anomalies fell into two distinct groupings, which were associated with:

- the Skua field and surrounding fault blocks
- the intersection of the NE-trending Vulcan Sub-Basin/Londonderry High Boundary Zone with a prominent NW-trending transfer fault zone.

The composition of the hydrocarbon anomalies within the Skua grouping was generally consistent with them having an oil-prone, Late Jurassic source, and is thus compatible with the known composition of the hydrocarbons in the Skua accumulation. The composition of the other grouping was more consistent with a gas/condensate source; they may have originated from more gas-prone Permo-Triassic source rocks on the edge of the Londonderry High.

The remaining three anomalies were all very weak, and may have been due to biogenic activity.

The data indicate that the DHD technique can be useful at a prospect level within the Timor Sea (for example, it did remotely detect the Skua accumulation). The types of accumulations which are most easily detected using DHD are those with a significant gas cap, a relatively shallow (<2000m) reservoir, and faulting which extends from the reservoir horizon to near the seafloor. Furthermore, the data suggest that transfer fault zones provide important pathways for hydrocarbon migration in this region.

INTRODUCTION

Surface geochemistry and offshore exploration for hydrocarbons

The aims of surface geochemical techniques in offshore petroleum exploration are: (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. The 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 remain proprietary and the opinions expressed publicly, about surface 'sniffer' geochemical techniques, by the petroleum exploration community remain divided. Scheiner et al. (1985) have reviewed 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. Consequently, since 1989, the Bureau of Mineral Resources (BMR) has, as part of its Continental Margins Program (and under the auspices of a Joint Agreement with Transglobal Environmental Geoscience (TEG) of Leucadia California (Heggie et al., 1990) been conducting bottom-water DHD programs around the Australian continental margin to better evaluate the usefulness of this technique. Part of this work includes research into:

- ❑ the origins (biogenic or thermogenic?) of bottom-water light hydrocarbons

❑ light hydrocarbon 'sources' (liquids, condensate or gas?)
❑ bottom-water and seafloor expressions of seepage
❑ the relationships of seepage 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-head-space] techniques) to hydrocarbon exploration around the Australian continental margin. Specific objectives include:

❑ To collect, via reconnaissance surveys, new information on the thermal generation of hydrocarbons in under-explored Australian basins.
❑ 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.
❑ To test, develop and refine criteria to recognise thermally-generated migrated hydrocarbons from background biogenic hydrocarbons in both seawater and sediments.
❑ 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.
❑ To relate the chemical and isotopic compositions of seeps to 'source' characteristics, ie. gas, condensate, liquids, and to predictions from geohistory and maturation modelling of different source rock types.
❑ To test bottom-water DHD and sediment geochemistry techniques in the search for hydrocarbons sealed by stratigraphic traps.
❑ To examine the biogenic processes influencing the concentrations, distributions and chemical compositions of hydrocarbon seeps in bottom-waters and the near surface sediments.
❑ 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 been carried out by the BMR's research vessel *Rig Seismic* around the Australian continental margin.

The geochemical analysis system (Direct Hydrocarbon Detection or DHD) that has been installed aboard the *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 are given in Appendices II and III.

This BMR Record provides both the basic data and a preliminary interpretation of the bottom-water hydrocarbon data which were collected by the R.V. *Rig Seismic* in the Vulcan Sub-Basin during Survey 97 in October-November 1990. In addition, sediment geochemical data which were acquired during Survey 98 (November-December, 1990) are also included.

OBJECTIVES AND PREVIOUS WORK

The Vulcan Sub-Basin is located within the Timor Sea on the far north-western Australian margin and lies approximately half-way between the Kimberley Block and Timor (Figure 1). It is presently one of Australia's most active petroleum exploration areas, with a number of significant oil discoveries, including the Jabiru, Challis/Cassini, and Skua fields. It is flanked by two major elevated Permo-Triassic tectonic provinces, the Ashmore Platform to the north-west and the Londonderry High to the south-east. The Vulcan Sub-Basin itself is a Jurassic feature which can be sub-divided into a series of NE- and ENE-trending, asymmetric sub-grabens (Figure 2), which are separated by intra-graben terraces (Patillo and Nicholls, 1990).

The discovery of significant hydrocarbon accumulations in the Jabiru, Challis and Skua fields in the early to mid-1980's substantially upgraded the prospectivity of the Timor Sea region. However, this initial success, which led to a vigorous upsurge in exploration activity in the area, has been followed by period of very low reward for explorers. In order to assist the exploration effort in this region, the Bureau of Mineral Resources carried out in October-November 1990, as part of a much larger research program in the area, an 18 day program of high resolution seismic and water column geochemical (DHD) research (Figure 3; Enclosure 1) in the Vulcan Sub-Basin .

The principal objectives of the program were to:

- ❐ Evaluate the usefulness and applicability of DHD in assessing basin prospectivity within the Vulcan Sub-Basin.

- ❐ Provide new information on source rocks, maturation, and hydrocarbon migration within the Vulcan Sub-Basin.

The Timor Sea appeared to be a good location to test this method's usefulness as a remote sensing tool, as some faults extend all the way from the reservoir/source horizon to the seafloor. Moreover, a limited (~1600 kms) "sniffer" survey conducted in the Vulcan Sub-Basin by BHPP in late 1988 detected some weak geochemical anomalies, thereby providing some encouragement for future work.

During BMR's survey, the DHD data were acquired over the complete range of structural elements within the basin. Lines were run over the commercial and non-commercial hydrocarbon discoveries/accumulations at Skua, Montara, Puffin, Oliver, Talbot, Keeling, and Pengana. This allowed the method to be 'ground-truthed'. Lines were also run over a number of (as yet) undrilled prospects throughout the Vulcan Sub-Basin, in order to test the usefulness of the method as a predictive tool in petroleum exploration in the region. Unfortunately, because of engineering concerns, DHD data were not acquired over the Challis and Jabiru oil fields.

Other specific DHD investigations included:-

- ❐ surveying in the vicinity of the Avocet 1A well in the north-eastern Vulcan Sub Basin/Eider Horst area, where a number of oil fields that were breached during the Late Tertiary reactivation are present;
- ❐ regional lines over the western and central Cartier Trough;
- ❐ regional lines over the Ashmore Platform;
- ❐ regional lines over the Londonderry High.

A total of 2730 km of simultaneously acquired high resolution seismic and water column DHD data were acquired over 44 survey lines during the program within the Vulcan Sub-Basin. The location of the lines acquired during the survey are shown in Figure 3 and Enclosure 1, while positional details for these lines are given in Table 1.

RESULTS

Water Column Geochemistry (DHD)

The water column geochemistry program in the northern Vulcan Sub-Basin consisted of 44 lines with a total survey length of 2730 kilometres (see Table 1). The location of the DHD survey lines are shown in Figure 3 and Enclosure 1. Composite summary plots of the DHD data, showing the distribution of an assortment of hydrocarbon concentrations and parameters along all of the survey lines from the Vulcan Sub-Basin, are presented in Figures 5-22.

The complete set of results for the entire survey (on an individual line-by-line basis) are given in Appendix I, which includes:

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

- Charts showing the distribution along each survey line of:
  - total hydrocarbons (THC) and methane;
  - methane, ethane and ethylene;
  - methane, propane and propylene;
  - DHD fish depth, altitude and water depth.

Full details of the acquisition methods used and the interpretative methodologies employed are given in Appendices II and III. Floppy diskette(s) containing geochemical and navigation data in an ASCII format are included in Enclosure 2.

Vulcan Sub-Basin

Ten hydrocarbon anomalies were discovered during the program (Table 2; Figure 4), and of these, seven appear to be related to thermogenic seepage All of the anomalies were restricted to the southern half of the Vulcan Sub-Basin, with the northernmost anomaly being located near the East Swan 1 well. The westernmost anomaly was very weak and was located on the eastern Ashmore Platform in the vicinity of the Cartier 1 exploration well.

The majority of the anomalies clustered in two discrete areas. The first group was located near, and over, the Skua oil-gas field, and to the north-east Skua in the Swan Graben (the Skua/Swan Graben Group). The second was located at the intersection of a NW-trending reactivated Permo-Carboniferous transfer fault and the Vulcan Sub-Basin/Londonderry High Boundary Zone, south-east of the Montara 1 discovery (Transfer Fault Zone Group). All of the anomalies in both groups were moderately weak and consisted principally of methane and ethane enrichments, though some anomalies in the Skua Group also had moderate propane enrichments. The anomalies were also characterised by a significantly greater ethane enrichment as compared to methane. Specific aspects of these two principal groups of anomalies will be discussed individually below

Skua/Swan Graben Group

The strongest anomalies were located immediately around the Skua Field (Line 29, 31 & 32), as well to the south-east near the Swift 1 and Birch 1 wells (Lines 29 & 31), which is located on the Swift fault blocks, and to the north-east of the Skua Field in the Swan Graben (Line 62). In these anomalies, methane increased by less than two-fold above background (60%: from 3.5 to 5.5 ppm), whereas ethane and propane increased by nearly an order of magnitude and by four-fold respectively [ethane: 960%: to 0.148 ppm; propane: 400% to 0.06 ppm)]. The methane versus % hydrocarbon wetness trend for the Skua data is shown in Figure 23. Two trends appear to be present in these data. The data in the first trend (Line 62 on Figure 23) is characterised by nearly constant, or very slowly increasing, hydrocarbon wetness values with increasing methane concentration, suggesting that the source of this anomaly was principally gas/condensate-prone. In the second trend (Lines 29, 31 & 32), the hydrocarbon wetness increases significantly, from < 1% to about

7%, for a less than two-fold increase in methane. The positive slope of this trend indicates that the source of the anomaly was oil-prone, which is consistent with the known composition of the hydrocarbons in the Skua Field (Osborne, 1990). The differences between these two data groupings is even more evident on Figure 24, which shows the relationships between the ethane and methane concentrations in the anomalies. Clearly the anomaly on Line 62 is "drier" than those on Lines 29, 31 and 32.

Transfer Fault Zone Group

The second major group of anomalies, which was located on the edge of the Vulcan Sub-Basin south-east of Montara 1, occurs in an area with little well control (Figure 3; Enclosure 1). Two of the anomalies in this group (Lines 25 & 64) were directly associated with a major, northwest-trending reactivated Permo-Carboniferous transfer fault (as identified from both seismic and aeromagnetic data: Wellman and O'Brien, 1991; O'Brien et al., 1992), suggesting that transfer faults can act as hydrocarbon migration conduits in the Timor Sea. Another significant anomaly in this group (on Line 63) was closely associated with a large, as yet undrilled, aeromagnetic 'high', as identified by Wellman & O'Brien (1991).

The relationships between the methane concentration and hydrocarbon wetness and the methane and ethane concentrations are provided in Figures 25 and 26 respectively. These plots are significantly different from those for the anomalies spatially associated with the Skua field (i.e. Lines 29, 31 & 32). Hydrocarbon wetness does not increase with increasing methane concentration, indicating that the source of the anomalies is gas/condensate prone. Similarly, the methane/ethane ratio is higher in the anomalies associated with the transfer fault than with those directly associated with the Skua field. The composition of the anomalies along the transfer zone are in fact most similar to the anomaly seen on Line 62 (i.e. in the Swan Graben to the north-east of the Skua structure).

Other Anomalies

There were three other hydrocarbon anomalies detected during the survey (apart from those within the two groups discussed above). A very weak minor ethane anomaly was present near the Cartier 1 well on the Ashmore Platform (Line 28). Another very weak ethane (and THC) anomaly was detected on Line 36 near the East Swan 1 well, on the eastern edge of the Swan Graben. In addition, a very weak ethane (with minor methane) anomaly was encountered on Line 37, between the edge of the Paqualin Graben and the Rainbow 1 well on the Ashmore Platform. The very subdued nature of all of these anomalies prevents us from determining whether they are due to thermogenic seepage from the seafloor, or are related to some other process. However, both of the anomalies on Lines 36 and 37 were accompanied by minor increases in the ethylene concentration, which might indicate that they are of biogenic, rather than thermogenic, origin.

Jabiru And Challis Fields

As a result of concerns about safety (namely tangling the DHD fish with seafloor production installations), no DHD surveying could be carried out over the Jabiru or Challis oil fields, and so we cannot say whether these fields have water bottom hydrocarbon anomalies associated with them. On the lines that crossed these fields (Lines 41, 42 & 45), the DHD fish was raised to within about 5m of the surface when the ship was within 3-4km of the fields. The fish was then lowered back to about 10m above the seafloor when the ship had passed about 3-4km beyond the field. This raising of the DHD fish produced "pseudo-anomalies" on these lines, for the shallow waters on either side of the Jabiru and Challis structures show significant enrichments in ethane and propane. These enrichments probably originate from leakage from the production facilities at Jabiru and Challis.

Vertical Profiles

In order to characterise the vertical structure of the water column within the Vulcan Sub-Basin, two vertical profiles were carried out. These were acquired at the beginning (line 25: 13^{0} 04.2'S;124^{0} 39.5'E) and the end (line 68: 12^{0} 02'S; 124^{0} 27'E) of the survey. Both profiles yielded similar results. Typically, the temperature of the water column decreased slowly from the surface to a depth of 95m (Figure 27a), then decreased sharply, indicating that the water column is somewhat stratified. Similarly, the THC and methane concentrations of the water column are relatively constant until a depth of 95m (Figure 27b). Below 95m, THC decreases sharply in concentration, whereas the methane concentration increases. Both ethane and propane show slowly increasing concentrations with depth (Figure 27c). The concentrations of the biologically-produced hydrocarbons, ethylene and propylene, are almost constant to a depth of about 60m, below which they decrease sharply (Figure 27d).

The results from the vertical profiles suggest that raising and lowering the DHD fish within the depth range of 90 to 120m could cause some variation in the recorded methane concentrations, perhaps thereby producing apparent subtle "anomalies". However, this has not created any significant problems within the Vulcan Sub-Basin data-set, as all of the anomalies identified in this study are characterised by both methane *and* ethane (+/- propane) enrichments. Neither the ethane nor propane concentrations are affected by fish depth.

Implications For Exploration

The following inferences can be drawn from the DHD results which were obtained from the Vulcan Sub-Basin, Timor Sea.

❒ The Vulcan Sub-Basin is not a region of large scale hydrocarbon seepage from the seafloor, though 7 significant, and three very weak, hydrocarbon anomalies were encountered during the program.

❒ One potentially important interpretation can be made of the DHD anomalies around the Skua Field. The majority of the anomalies around the field are located from the north-east to south-east of the field itself. However, it is generally considered that the field was charged from oil generated from Lower Vulcan Formation (Late Jurassic) source rocks within the Swan Graben to the west. This scenario would downgrade the prospectivity of the fault blocks (such as that drilled at Swift 1) positioned to the east of the Skua fault block, because of the difficulty in charging the structures. However, anomalies were consistently obtained in the vicinity of Swift 1 and along the Swift trend to the north-east, towards the Birch 1 well. If these anomalies were not sourced from the graben, then they may have been sourced from either the east (the Montara Terrace of Patillo and Nicholls, 1990) or locally within the Swift fault blocks. This would enhance the prospectivity of the fault blocks along the Swift trend.

❒ The DHD survey has clearly identified the presence of the Skua Field, and therefore indicates that the DHD technique can be useful as an exploration tool at the prospect level in the Timor Sea. In particular, the water column anomaly extends to the south-east of the Skua Field. Why Skua yields a clear anomaly, whereas the other fields surveyed, such as Montara/Bilyara, Puffin and Talbot do not, remains problematical. However, Skua has a significant gas cap, which contrasts it with the Puffin and Talbot accumulations, and may explain the lack of anomalies over those fields. While Montara also has a gas cap, a number of features contrast it with Skua. For example, Skua is a tight, fault-dependent structure, in which the faulting can extend close to the seafloor (Osborne, 1990). The oil column is relatively thick and, because of the tightness of the structure, is distributed over a narrow zone. The field is characterised by a very strong water drive, possibly because of the steep, south-easterly regional dips. Moreover, oil shows were reported in an Eocene sand in Skua 2 between 570 and 600 m depth. All of these features indicate that the potential exists for substantial vertical migration in the Skua field. In contrast, the Montara structure is much less fault-dependent, the oil field is thinner, and is distributed over a much broader area. The gas cap is also thinner than at Skua. These differences may provide insights into the types of trap/accumulation styles that the DHD technique will most readily detect in the Timor Sea, namely highly faulted, relatively shallow reservoirs with a significant gas cap.

❒ Oliver 1 is the other well in the basin which intersected a substantial gas accumulation, and which therefore might be also be expected to possess a water bottom geochemical anomaly. No hydrocarbon anomaly was detected over Oliver 1. However, the well is located in deep water (323 m) on the edge of the Cartier Trough, and because of the deep water, the DHD fish was towed approximately 150 m above the seafloor over this well. Even if a very substantial bottom water anomaly existed over Oliver 1, it would not have been detected because of the dilution effects.

❒ A zone of significant hydrocarbon leakage from the seafloor is present on the far south-eastern part of the Vulcan Sub-Basin. This zone of anomalies corresponds to the intersection of the basin-margin fault system with:

❒❒NW-trending Permo-Carboniferous transfer fault (Lines 25 & 64)

❒❒A prominent aeromagnetic high (Line 63)

These anomalies are moderately "dry", suggesting that they were derived from a gas/condensate source. This source may have been within the Permo-Triassic sequence on the Londonderry High, or perhaps from Late Jurassic, overmature oil-prone or mature gas-prone source rocks in the Montara Terrace or Heywood Graben. Whichever is correct, the results show that transfer faults provide pathways for hydrocarbon migration in the Timor Sea.

- Perhaps surprisingly, no geochemical anomalies were found in the north-eastern part of the Vulcan Sub-Basin survey area, in the vicinity of the Eider Horst and along the margins of the Sahul Syncline. Large, residual oil columns were encountered in drilling a number of wells in this area, such as Avocet 1A & 2 (Whibley & Jacobson, 1990) and it is believed that these traps were breached during the Late Miocene to Recent fault reactivation associated with the collision with Timor. One possible interpretation of the lack of water column anomalies over these wells is that the structures are not presently receiving charge from the Sahul Syncline. This would imply either that the source rock is spent, or that the structures are now cut off from the charge. In either case, the observations support the proposal that the structures were charged prior to the collisional event in the mid-Miocene. If the structures are indeed not being charged at present, then it would be necessary to drill only structures that were charged before the mid-Miocene and that have not been breached since. The probability of a post mid-Miocene charge may be remote in this area.

- In view of the relatively subtle nature of the water bottom geochemical anomalies which have been discovered so far in the Vulcan Sub-Basin, the DHD fish should be towed within about 10m of the seafloor on all future surveys if anomalies are to be reliably detected. Moreover, the fact that methane increases in concentration between water depths of 95m and the seafloor means that care should be taken in the interpretation of subtle methane anomalies. The fact that methane does increase, albeit slightly, in concentration nearer the seafloor, may suggest that there is ubiquitous, though very weak, methane seepage from the seafllor in this region. Since neither ethylene nor propylene increase in concentration near the seafloor indicates that the micro-seepage is not of biologic origin.

Sediment Geochemistry

During Survey 98, 56 vibro-cores and 3 grab samples of surficial and near-surface sediments were taken in the Vulcan Sub-Basin (Table 3). The purpose of this sampling program was to obtain sediment geochemical data (light hydrocarbon head-space analysis) in the vicinity of the water bottom anomalies which were identified during Survey 97. The sampling was concentrated in two areas: in the vicinity of the Skua/Swan Graben and the Transfer Fault Zone anomalies (Enclosure 3). In addition, cores linking these two groups were also taken.

After the vibro-cores were taken, sediment sub-samples were removed and immediately frozen. These sub-samples were then analysed at BMR's Canberra laboratories following completion of Survey 98. The results of these gas chromatographic analyses are given in Table 4.

Almost all of the sediment cores have low hydrocarbon concentrations and have compositions which are typical of "background" values (see Figure 28). One core, however, (vibro-core 98VC 13; see Table 4) was characterised by high hydrocarbon wetness values, as well as high ethane/ethylene and propane/propylene ratios (see Figure 29), and may contain thermogenic hydrocarbons which were produced from an oil-prone source. Core 98VC 13 is located on the edge of the Swan Graben, to the north-east of the Rainier 1 well (i.e. within the Skua/Swan Graben Group of anomalies). It may be that the relatively coarse and porous nature of the surficial sediments within the Vulcan Sub-Basin is not conducive to either the retention or preservation of thermogenic hydrocarbons. In coarse sediments, the sample must be taken almost directly over the seep if thermogenic hydrocarbons are to be detected.

SUMMARY

During the program, 2730km of DHD data were obtained along 44 lines over the Vulcan Sub-Basin, the Ashmore Platform and the Londonderry High. Ten water bottom hydrocarbon anomalies were detected during the program. Seven of these anoamlies fell into two distinct groupings, which were associated with:

- the Skua field and surrounding fault blocks
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them having originated from more gas-prone Permo-Triassic source rocks on the edge of the Londonderry High.

The remaining three anomalies were all very weak, and may have been due to biogenic activity.

The data indicate that the DHD technique can be useful at a prospect level within the Timor Sea (for example it did remotely detect the Skua accumulation). The types of accumulations which are most easily detected using DHD are those with a significant gas cap, a relatively shallow (<2000m) reservoir and faulting which extends from the reservoir horizon to near the seafloor. Furthermore, the data show that transfer fault zones probably provide important pathways for hydrocarbon migration in this region.

In spite of a significant sediment coring and geochemical analysis program in the vicinity of the known water bottom hydrocarbon anomalies, only one core contained significant concentrations of thermogenic hydrocarbons (as identified from empirical ratios). This lack of success may be due to the generally coarse-grained nature of the surficial sediments.

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LIST OF ENCLOSURES

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Table 1. Direct hydrocarbon detection lines, Survey 97, Timor Sea.

Line #	Lat. Start Lat. Finish	Long. Start Long. Finish	J.Day Start J.Day Finish	GMT Start GMT Finish	Line Length (nM/km)
97/025	12 57.74 12 48.28	124 37.84 124 45.82	304 304	0111 0337	12.5 23.16
97/026	12 55.455 12 36.070	124 49.392 124 22.799	304 304	07 02 16 52	46 85.24
97/027	12 35.932 12 29.159	124 22.836 124 18.614	304 304	19 01 20 41	8 14.8
97/028	12 29.683 12 12.006	124 19.482 123 53.128	304 305	22 43 04 59	30.6 56.7
97/029	12 05.538 12 37.514	124 02.130 124 35.731	305 305	07 26 19 17	49.65 92.00
97/030	12 36.449 12 45.601	124 33.887 124 57.826	305 306	20 45 01 42	25.2 46.7
97/031	12 45.700 12 27.563	124 58.970 124 29.594	306 306	02 31 09 14	34.7 64.3
97/032	12 30.639 12 15.931	124 30.807 124 20.384	306 306	11 58 20 14	14.8 27.4
97/033	12 15.090 12 02.598	124 20.699 124 01.085	306 307	21 38 02 50	22.8 42.2
97/034	11 59.979 12 16.357	124 13.891 124 34.648	307 307	06 10 11 18	26.1 48.4
97/035	12 13.862 12 19.496	124 32.577 124 36.293	307 307	12 44 14 05	7.5 13.9
97/036	12 17.112 12 45.018	124 34.545 125 06.740	307 308	16 16 00 31	36.75 68.10
97/037	12 37.718 11 51.472	125 04.769 124 14.967	308 308	02 49 17 45	71.3 132.1
97/038	11 50.303 12 08.485	124 23.349 124 38.441	308 309	20 43 01 21	25.9 48.0
97/039	12 07.761 12 05.005	124 36.95 124 50.614	309 309	0225 0504	13.7 25.4
97/040	12 04.350 12 30.545	124 47.121 125 04.458	309 309	0650 1309	31.9 59.1
97/041	12 22.954 11 54.05	125 11.797 124 57.54	309 310	1700 0356	31.8 58.9
97/042	11 58.892 11 32.807	125 00.05 124 41.661	310 310	0554 1215	32.1 59.5
97/043	11 32.66 11 34.549	124 41.613 124 43.12	310 310	1341 1701	16.5 30.6
97/044	11 32.023 12 03.285	124 26.971 124 55.332	310 311	2258 0725	42.4 78.6
97/045	12 00.842 12 17.207	124 52.384 125 20.001	311 311	0919 1534	37.2 68.9
97/046	12 17.816 11 14.421	125 16.758 124 37.641	311 312	2152 1235	72.1 133.6
97/047	11 11.601 12 15.318	124 47.163 125 18.727	312 313	1550 0555	73.5 136.2
97/048	12 10.952 11 57.473	125 25.635 125 16.482	313 313	0930 1249	18.7 34.7

97/049	12 02.916 11 41.062	125 18.349 125 17.668	313 313	1437 1851	21.8 40.4
97/050	11 46.331 11 33.288	125 19.691 125 07.267	313 314	2146 0108	19.8 36.7
97/051	11 36.917 11 04.772	125 09.375 124 55.866	314 314	0349 1041	34.7 64.3
97/052	11 03.326 11 12.397	124 58.752 125 21.92	314 314	1127 1619	21.3 39.5
97/053	11 09.98 11 17.043	125 17.572 125 27.813	314 314	1827 2051	11.3 20.9
97/054	11 15.296 11 09.31	125 24.645 125 40.00	314 315	2243 0156	13.8 25.6
97/055	11 08.186 11 24.246	125 35.435 125 47.135	315 315	0356 0810	20.3 37.6
97/056	11 19.047 11 56.773	125 44.465 125 57.362	315 315	1000 1841	39.8 73.8
97/057	11 56.500 11 18.527	126 05.69 125 54.115	315 316	2104 0500	36.8 68.2
97/058	11 21.276 11 21.987	125 57.421 125 42.478	316 316	0648 1126	16.1 29.8
97/059	11 20.236 11 46.247	125 47.413 125 15.253	316 316	1405 2215	41.0 76.0
97/060	11 42.698 11 56.084	125 20.244 124 58.249	317 317	0041 0905	31.7 58.8
97/061	11 52.946 12 16.419	125 02.545 124 36.246	317 317	11 31 1823	35.4 65.6
97/062	12 12.216 12 38.807	124 40.414 124 17.638	318 318	2043 0337	34.8 64.5
97/063	12 33.060 13 02.788	124 17.182 124 35.951	318 318	0606 1300	35.8 66.4
97/064	13 02.109 12 10.885	124 30.656 125 15.212	318 319	1436 0350	66.7 123.7
97/065	12 13.788 12 06.834	125 10.472 125 40.731	319 319	0614 1212	30.7 56.9
97/066	12 09.750 11 06.623	125 38.143 125 25.240	319 320	1428 0744	65.0 120.5
97/067	11 08.590 11 39.024	125 22.067 125 00.29	320 320	0853 2346	40.5 75.1
97/068	11 36.921 12 00.982	125 02.955 124 27.063	321 321	0230 1034	42.5 78.8

Table 2. Water column geochemical anomalies detected during Survey 97.

Anomaly Number	Line Number	Location/ Association
1	97/25	**Transfer Fault Zone Group:** Transfer fault on edge of Vulcan Sub-Basin south-east of Montara 1. C1 and C2 enrichment; source probably gas/condensate.
2	97/28	Extremely weak anomaly on the Ashmore Platform near Cartier 1 well. C2 enrichment.
3	97/29	**Skua/Swan Graben Group:** Over and to the SE of the Skua Field towards Taltarni 1 well. C1, C2, C3 enrichment; source probably oil.
4	97/31	**Skua/Swan Graben Group:** Over Skua. C1, C2, C3 enrichment; source probably oil.
5	97/32	**Skua/Swan Graben Group:** Over and to the NW of Skua into the Swan Graben. C1, C2, C3 enrichment; source probably oil.
6	97/36	Near East Swan well. THC and C2 enrichment with accompanying ethylene enrichment. May be of biogenic origin.
7	97/37	Ashmore Platform north-west of Swan 1 (very weak). C1 and C2 enrichment with accompanying ethylene enrichment. May be of biogenic origin.
8	97/62	**Skua/Swan Graben Group:** Within the Swan Graben NE of Skua. C1, C2 and C3 enrichment; source probably gas/condensate

9	97/63	**Transfer Fault Zone Group:** Transfer fault/aeromagnetic high on edge of Vulcan Sub-Basin. C1 and C2 enrichment, possible minor propane increase; source probably gas/condensate
10	97/64	**Transfer Fault Zone Group:** Transfer fault on the edge of the Vulcan Sub-Basin. C1 and C2 enrichment, possible minor propane increase; source probably gas/condensate

Table 3. Sediment sampling sites in the Vulcan Sub-Basin, Timor Sea.

Sample #	Latitude (S)	Longitude (E)
98VC 01	12.53428	124.63587
98VC 02	12.52233	124.62412
98VC 03	12.50912	124.61115
98VC 04	12.50342	124.60413
98VC 05	12.49695	124.59845
98VC 06A	12.48362	124.58585
98VC 06B	12.48360	124.58597
98VC 07	12.46987	124.57165
98VC 08	12.52488	124.45825
98VC 09	12.50603	124.43897
98VC 10	12.49890	124.43237
98VC 11	12.49313	124.42593
98VC 12	12.48553	124.41877
98VC 13	12.48048	124.41370
98VC 14	12.45960	124.39340
98VC 15	12.48703	124.43872
98VC 16	12.50520	124.43277
98VC 17	12.50605	124.41480
98VC 18	12.50988	124.40453
98VC 27	13.02782	124.46030
98VC 28	13.03605	124.50287
98VC 29	13.03732	124.50918
98VC 30	13.03973	124.52530
98VC 31	13.04235	124.53952
98VC 32	13.04792	124.57663
98VC 33	13.05098	124.59342
98VC 34	13.05130	124.60132
98VC 35	13.05465	124.61175
98VC 36	13.05725	124.63073
98VC 40	12.91687	124.53360
98VC 41	12.91972	124.59702
98VC 42	12.92215	124.59765
98VC 43	12.92623	124.59738
98VC 44	12.91467	124.65983
98VC 45	12.91183	124.67017
98VC 46	12.90917	124.67533
98VC 47	12.90633	124.68133
98VC 48	12.90317	124.69317
98VC 49	12.52900	124.43117
98VC 50	12.58267	124.46500
98VC 51	12.63950	124.49917
98VC 52	12.69833	124.53900
98VC 54	12.81317	124.61100
98VC 55	12.86833	124.64583
98VC 56	12.91983	124.67883
98GS 03	12.50902	124.61118

Table 4. Sediment geochemical (head-space) data from the Vulcan Sub-Basin, Timor Sea. Data acquired during Survey 98.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V
1	Sample # *	Latitude	Longitude	Water	Depth in	Mean	C1	C2	C2:1	C3	C3:1	iC4	nC4	iC5	nC5	C1-C4	Wet	C1/	C2/	C3/	iC4/	iC5/
2				Depth (m)	Core (cm)	Depth											Gas %	C2+C3	C2:1	C3:1	nC4	nC5
3						(cm)																
4																						
5																						
6	98VC 01	12.53428	124.63587	86	50-60	55	6.017	0.231	0.419	0.117	0.137	0.030	0.037	0.000	0.000	6.433	6.460	17.282	0.551	0.854	0.804	
7	98VC 01	12.53428	124.63587	86	80-90	85	5.344	0.224	0.261	0.090	0.063	0.030	0.023	0.000	0.000	5.712	6.435	17.011	0.859	1.421	1.286	
8	98VC 01	12.53428	124.63587	86	110-120	115	1.693	0.051	0.143	0.045	0.036	0.013	0.012	0.000	0.006	1.815	6.725	17.503	0.358	1.259	1.111	0.000
9	98VC 01	12.53428	124.63587	86	140-150	145	3.267	0.089	0.090	0.057	0.070	0.048	0.000	0.000	0.000	3.461	5.608	22.365	0.985	0.819		
10																						
11	98VC 02	12.52233	124.62412	87	80-90	85	2.727	0.084	0.277	0.086	0.109	0.023	0.025	0.000	0.000	2.945	7.407	16.031	0.304	0.791	0.895	
12	98VC 02	12.52233	124.62412	87	120-130	125	2.951	0.086	0.183	0.091	0.087	0.032	0.023	0.000	0.000	3.184	7.291	16.698	0.471	1.038	1.371	
13																						
14	98VC 03	12.50912	124.61115	89	10-.20	5	1.393	0.039	0.245	0.047	0.047	0.011	0.017	0.000	0.005	1.506	7.484	16.320	0.158	0.986	0.640	0.000
15																						
16	98VC 04	12.50342	124.60413	91	80-90	85	1.812	0.037	0.271	0.053	0.043	0.011	0.021	0.000	0.040	1.933	6.280	20.119	0.135	1.231	0.516	0.000
17	98VC 04	12.50342	124.60413	91	120-130	125	1.018	0.026	0.190	0.036	0.034	0.009	0.013	0.003	0.003	1.102	7.627	16.409	0.137	1.059	0.650	1.000
18	98VC 04	12.50342	124.60413	91	190-200	195	2.580	0.089	0.115	0.083	0.019	0.019	0.021	0.000	0.000	2.791	7.575	14.992	0.779	4.276	0.903	
19																						
20	98VC 05	12.49695	124.59845	89	80-90	85	1.171	0.033	0.185	0.045	0.047	0.013	0.013	0.013	0.015	1.275	8.159	14.881	0.181	0.971	1.000	0.909
21																						
22	98VC 06A	12.48362	124.58585	90	50-60	55	6.430	0.295	0.358	0.105	0.080	0.055	0.028	0.000	0.003	6.913	6.995	16.040	0.825	1.317	1.952	0.000
23																						
24	98VC 06B	12.48360	124.58597	91	80-90	85	1.391	0.042	0.152	0.055	0.050	0.017	0.000	0.000	0.009	1.505	7.580	14.379	0.276	1.093		0.000
25																						
26	98VC 07	12.46987	124.57165	89	30-40	35	0.690	0.021	0.057	0.000	0.000	0.000	0.000	0.000	0.050	0.710	2.911	33.355	0.365			0.000
27	98VC 07	12.46987	124.57165	89	80-90	85	2.405	0.063	0.155	0.045	0.039	0.025	0.013	0.107	0.015	2.549	5.678	22.391	0.405	1.155	1.947	6.957
28																						
29	98VC 08	12.52488	124.45825	79	54-64	59	2.925	0.067	0.088	0.046	0.053	0.012	0.015	0.000	0.099	3.064	4.549	25.947	0.758	0.873	0.818	0.000
30																						
31	98VC 09	12.50603	124.43897	75	80-90	85	1.011	0.019	0.053	0.013	0.009	0.004	0.000	0.000	0.000	1.047	3.439	31.583	0.363	1.357		
32	98VC 09	12.50603	124.43897	75	110-120	115	4.997	0.066	0.070	0.051	0.045	0.007	0.009	0.000	0.083	5.130	2.587	42.568	0.943	1.149	0.769	0.000
33																						
34	98VC 11	12.49313	124.42593	77	25-35	30	1.433	0.023	0.196	0.047	0.059	0.004	0.008	0.000	0.000	1.515	5.372	20.663	0.116	0.795	0.500	
35	98VC 11	12.49313	124.42593	77	65-75	70	4.016	0.107	0.189	0.081	0.089	0.024	0.000	0.000	0.000	4.229	5.032	21.276	0.569	0.910		
36																						
37	98VC 12	12.48553	124.41877	79	80-90	85	1.048	0.015	0.107	0.030	0.003	0.000	0.000	0.000	0.000	1.093	4.090	23.448	0.137	9.000		

Table 4. Sediment geochemical (head-space) data from the Vulcan Sub-Basin, Timor Sea. Data acquired during Survey 98.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V
38																						
39	Sample #*	Latitude	Longitude	Water	Depth in	Mean	C1	C2	C2:1	C3	C3:1	iC4	nC4	iC5	nC5	C1-C4	Wet	C1/	C2/	C3/	iC4/	iC5/
40				Depth (m)	Core (cm)	Depth											Gas %	C2+C3	C2:1	C3:1	nC4	nC5
41						(cm)																
42																						
43																						
44	**98VC 13**	12.48048	124.41370	82	80-90	85	1.294	0.023	0.013	0.021	0.005	0.003	0.000	0.000	0.000	1.341	3.531	29.394	1.842	4.429		
45	**98VC 13**	12.48048	124.41370	82	130-140	135	1.996	0.206	0.025	0.083	0.011	0.025	0.000	0.000	0.000	2.310	13.572	6.912	8.132	7.750		
46	**98VC 13**	12.48048	124.41370	82	150-160	155	2.928	0.236	0.070	0.106	0.020	0.033	0.000	0.000	0.000	3.303	11.363	8.561	3.371	5.297		
47																						
48	**98VC 14**	12.45960	124.39340	83	80-90	85	1.054	0.021	0.032	0.022	0.000	0.000	0.000	0.000	0.000	1.097	3.893	24.688	0.646			
49	**98VC 14**	12.45960	124.39340	83	110-120	115	1.674	0.053	0.128	0.057	0.021	0.007	0.000	0.011	0.008	1.790	6.520	15.206	0.417	2.656		1.417
50	**98VC 14**	12.45960	124.39340	83	130-140	135	1.172	0.039	0.029	0.024	0.007	0.005	0.000	0.000	0.053	1.240	5.487	18.691	1.349	3.600		0.000
51																						
52	**98VC 15**	12.48703	124.43872	77	50-60	55	1.435	0.035	0.120	0.055	0.090	0.017	0.017	0.000	0.000	1.560	7.995	15.941	0.289	0.615	1.000	
53	**98VC 15**	12.48703	124.43872	77	80-90	85	1.382	0.012	0.189	0.053	0.041	0.007	0.013	0.000	0.000	1.467	5.818	21.361	0.064	1.274	0.550	
54																						
55	**98VC 16**	12.50520	124.43277	77	80-90	85	1.886	0.056	0.128	0.031	0.027	0.014	0.018	0.000	0.000	2.004	5.923	21.746	0.438	1.122	0.778	
56	**98VC 16**	12.50520	124.43277	77	120-130	125	1.487	0.031	0.131	0.055	0.029	0.008	0.013	0.000	0.000	1.594	6.736	17.279	0.235	1.886	0.600	
57																						
58	**98VC 17**	12.50605	124.41480	76	80-90	85	1.091	0.022	0.165	0.025	0.031	0.004	0.004	0.000	0.000	1.145	4.776	23.357	0.134	0.804	1.000	
59	**98VC 17**	12.50605	124.41480	76	130-140	135	1.239	0.028	0.101	0.021	0.038	0.004	0.000	0.000	0.000	1.293	4.128	25.108	0.278	0.561		
60																						
61	**98VC 18**	12.50988	124.40453	75	80-90	85	1.353	0.026	0.099	0.044	0.051	0.011	0.013	0.000	0.000	1.447	6.501	19.314	0.264	0.857	0.800	
62	**98VC 18**	12.50988	124.40453	75	140-150	145	0.936	0.013	0.023	0.021	0.005	0.000	0.000	0.000	0.119	0.969	3.441	28.060	0.543	4.429		0.000
63	**98VC 18**	12.50988	124.40453	75	160-170	165	2.836	0.071	0.063	0.053	0.003	0.000	0.000	0.000	0.003	2.960	4.191	22.860	1.128	20.000		0.000
64																						
65	**98VC 27**	13.02782	124.46030	171	80-90	85	1.203	0.077	0.156	0.101	0.048	0.027	0.000	0.005	0.014	1.408	14.543	6.782	0.491	2.097		0.381
66	**98VC 27**	13.02782	124.46030	171	130-140	135	1.657	0.142	0.345	0.124	0.085	0.029	0.041	0.000	0.000	1.992	16.840	6.226	0.412	1.465	0.705	
67	**98VC 27**	13.02782	124.46030	171	170-180	175	3.278	0.165	0.323	0.123	0.089	0.025	0.041	0.000	0.000	3.632	9.734	11.377	0.509	1.381	0.607	
68	**98VC 27**	13.02782	124.46030	171	215-225	220	1.960	0.083	0.131	0.056	0.071	0.018	0.019	0.000	0.000	2.136	8.245	14.057	0.638	0.785	0.964	
69																						
70	**98VC 28**	13.03605	124.50287	157	130-140	135	2.515	0.106	0.322	0.070	0.101	0.013	0.000	0.000	0.000	2.703	6.982	14.280	0.329	0.695		
71	**98VC 28**	13.03605	124.50287	157	180-190	185	2.515	0.106	0.322	0.070	0.101	0.013	0.000	0.000	0.000	2.703	6.982	14.280	0.329	0.695		
72	**98VC 28**	13.03605	124.50287	157	215-225	220	2.874	0.096	0.151	0.051	0.039	0.003	0.000	0.000	0.000	3.024	4.942	19.586	0.637	1.288		
73																						
74	**98VC 29**	13.03732	124.50918	153	68-78	73	1.759	0.082	0.239	0.093	0.059	0.011	0.025	0.000	0.000	1.970	10.701	10.065	0.343	1.580	0.459	
75																						
76	**98VC 30**	13.03973	124.52530	138	160-170	165	2.365	0.093	0.135	0.075	0.046	0.021	0.000	0.000	0.000	2.555	7.415	14.071	0.688	1.638		
77																						
78																						

Table 4. Sediment geochemical (head-space) data from the Vulcan Sub-Basin, Timor Sea. Data acquired during Survey 98.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V
79	Sample #*	Latitude	Longitude	Water	Depth in	Mean	C1	C2	C2:1	C3	C3:1	iC4	nC4	iC5	nC5	C1-C4	Wet	C1/	C2/	C3/	iC4/	iC5/
80				Depth (m)	Core (cm)	Depth											Gas %	C2+C3	C2:1	C3:1	nC4	nC5
81						(cm)																
82																						
83																						
84	98VC 31	13.04235	124.53952	142	30-40	35	2.645	0.079	0.124	0.062	0.067	0.009	0.023	0.000	0.000	2.819	6.152	18.708	0.640	0.921	0.371	
85	98VC 31	13.04235	124.53952	142	60-70	65	1.427	0.073	0.203	0.089	0.103	0.017	0.025	0.000	0.000	1.631	12.515	8.802	0.361	0.858	0.658	
86																						
87	98VC 32	13.04792	124.57663	139	140-150	145	1.725	0.086	0.356	0.089	0.071	0.006	0.017	0.000	0.000	1.924	10.333	9.833	0.242	1.264	0.346	
88																						
89	98VC 33	13.05098	124.59342	147	20-30	25	1.846	0.103	0.393	0.103	0.049	0.008	0.023	0.000	0.000	2.082	11.371	8.984	0.261	2.081	0.343	
90	98VC 33	13.05098	124.59342	147	60-70	65	2.047	0.095	0.322	0.087	0.056	0.003	0.014	0.000	0.000	2.246	8.878	11.242	0.296	1.548	0.238	
91	98VC 33	13.05098	124.59342	147	80-90	85	1.387	0.072	0.359	0.083	0.051	0.006	0.017	0.000	0.000	1.564	11.343	8.961	0.201	1.610	0.360	
92	98VC 33	13.05098	124.59342	147	180-190	185	1.914	0.083	0.223	0.074	0.037	0.006	0.016	0.000	0.000	2.092	8.543	12.209	0.370	2.018	0.375	
93																						
94	98VC 34	13.05130	124.60132	150	80-90	85	1.279	0.059	0.350	0.089	0.033	0.008	0.016	0.000	0.000	1.451	11.862	8.635	0.170	2.714	0.500	
95	98VC 34	13.05130	124.60132	150	150-160	155	1.778	0.118	0.386	0.144	0.056	0.009	0.016	0.000	0.000	2.064	13.893	6.781	0.306	2.571	0.542	
96	98VC 34	13.05130	124.60132	150	180-190	185	2.367	0.116	0.265	0.105	0.042	0.017	0.000	0.000	0.000	2.605	9.142	10.719	0.438	2.492		
97																						
98	98VC 35	13.05465	124.61175	146	150-160	155	1.321	0.095	0.428	0.102	0.087	0.016	0.000	0.000	0.000	1.533	13.876	6.712	0.221	1.177		
99	98VC 35	13.05465	124.61175	146	180-190	185	2.081	0.120	0.319	0.101	0.071	0.017	0.000	0.000	0.000	2.318	10.242	9.426	0.377	1.425		
100	98VC 35	13.05465	124.61175	146	210-220	215	3.089	0.163	0.407	0.131	0.054	0.012	0.031	0.000	0.000	3.427	9.868	10.477	0.402	2.432	0.383	
101																						
102	98VC 36	13.05725	124.63073	131	150-160	155	2.173	0.109	0.651	0.101	0.047	0.009	0.023	0.000	0.017	2.417	10.075	10.310	0.168	2.141	0.400	0.000
103	98VC 36	13.05725	124.63073	131	180-190	185	2.175	0.119	0.362	0.103	0.068	0.005	0.013	0.000	0.000	2.416	9.967	9.763	0.330	1.520	0.421	
104	98VC 36	13.05725	124.63073	131	210-220	215	1.644	0.059	0.181	0.070	0.029	0.005	0.016	0.000	0.000	1.794	8.364	12.772	0.325	2.442	0.333	
105																						
106	98VC 40	12.91687	124.53360	104	80-90	85	2.881	0.078	0.277	0.072	0.091	0.011	0.024	0.000	0.000	3.066	6.027	19.196	0.282	0.794	0.444	
107	98VC 40	12.91687	124.53360	104	120-130	125	1.950	0.072	0.215	0.072	0.115	0.019	0.023	0.000	0.000	2.136	8.711	13.537	0.334	0.628	0.853	
108	98VC 40	12.91687	124.53360	104	150-160	155	6.258	0.221	0.165	0.058	0.028	0.007	0.019	0.000	0.000	6.564	4.664	22.391	1.339	2.071	0.379	0.000
109																						
110	98VC 41	12.91972	124.59702	89	80-90	85	4.163	0.120	0.147	0.049	0.025	0.000	0.000	0.000	0.000	4.332	3.895	24.672	0.818	1.921		
111																						
112	98VC 42	12.92215	124.59765	91	80-90	85	4.710	0.129	0.254	0.085	0.091	0.019	0.000	0.000	0.000	4.943	4.709	22.000	0.509	0.927		
113	98VC 42	12.92215	124.59765	91	120-130	125	1.393	0.035	0.171	0.050	0.047	0.000	0.000	0.000	0.000	1.478	5.776	16.313	0.207	1.056		
114	98VC 42	12.92215	124.59765	91	160-170	165	3.913	0.122	0.159	0.043	0.026	0.009	0.017	0.000	0.005	4.104	4.648	23.657	0.766	1.667	0.520	0.000
115																						
116	98VC 43	12.92623	124.59738	92	120-130	125	1.908	0.045	0.163	0.061	0.033	0.003	0.007	0.000	0.008	2.024	5.766	17.987	0.278	1.857	0.455	0.000
117	98VC 43	12.92623	124.59738	92	170-180	175	2.585	0.145	0.289	0.101	0.080	0.013	0.019	0.000	0.000	2.864	9.735	10.476	0.502	1.267	0.714	
118																						
119																						

Table 4. Sediment geochemical (head-space) data from the Vulcan Sub-Basin, Timor Sea. Data acquired during Survey 98.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V
120	Sample #*	Latitude	Longitude	Water	Depth in	Mean	C1	C2	C2:1	C3	C3:1	iC4	nC4	iC5	nC5	C1-C4	Wet	C1/	C2/	C3/	iC4/	iC5/
121				Depth (m)	Core (cm)	Depth											Gas %	C2+C3	C2:1	C3:1	nC4	nC5
122						(cm)																
123																						
124																						
125	98VC 45	12.91183	124.67017	84	120-130	125	1.341	0.045	0.165	0.053	0.065	0.008	0.017	0.000	0.000	1.465	8.424	13.680	0.275	0.806	0.462	
126	98VC 45	12.91183	124.67017	84	170-180	175	1.138	0.021	0.020	0.031	0.020	0.018	0.000	0.000	0.000	1.209	5.850	21.595	1.067	1.567		
127																						
128	98VC 46	12.90917	124.67533	82	180-190	185	2.339	0.052	0.075	0.011	0.011	0.000	0.000	0.000	0.000	2.402	2.610	37.309	0.690	0.941		
129																						
130	98VC 47	12.90633	124.68133	78	55-65	60	1.354	0.039	0.310	0.046	0.047	0.007	0.013	0.011	0.000	1.459	7.221	15.859	0.127	0.972	0.500	
131																						
132	98VC 50	12.58267	124.46500	79	60-70	65	5.460	0.121	0.215	0.083	0.080	0.013	0.040	0.000	0.000	5.718	4.503	26.752	0.565	1.033	0.333	
133	98VC 51	12.63950	124.49917	79	56-66	61	3.755	0.056	0.194	0.055	0.061	0.006	0.019	0.000	0.000	3.891	3.514	33.707	0.289	0.902	0.310	
134																						
135	98VC 52	12.69833	124.53900	81	80-90	85	3.174	0.053	0.241	0.061	0.079	0.008	0.023	0.000	0.000	3.320	4.400	27.663	0.221	0.773	0.343	
136	98VC 52	12.69833	124.53900	81	120-130	125	1.403	0.023	0.105	0.033	0.028	0.007	0.007	0.000	0.000	1.474	4.796	24.753	0.222	1.190	0.909	
137							0.000															
138	98VC 54	12.81317	124.61100	80	40-50	45	1.323	0.023	0.151	0.063	0.055	0.007	0.009	0.000	0.000	1.425	7.163	15.492	0.150	1.133	0.786	
139																						
140	98VC 55	12.86833	124.64583	80	80-90	85	3.049	0.071	0.253	0.070	0.095	0.011	0.026	0.000	0.000	3.228	5.538	21.561	0.282	0.734	0.436	
141																						
142	98VC 56	12.91983	124.67883	82	80-90	85	3.049	0.071	0.253	0.070	0.095	0.011	0.026	0.000	0.000	3.228	5.538	21.561	0.282	0.734	0.436	
143	98VC 56	12.91983	124.67883	82	120-130	125	2.124	0.058	0.109	0.059	0.043	0.005	0.003	0.000	0.000	2.250	5.574	18.097	0.534	1.391	1.400	
144																						
145							0.019	0.084	0.026	0.000	0.000	0.000	0.000	0.000	0.000	0.103	81.290	0.230	3.231			
146	98GS 03	12.50902	124.61118	89	1.504	0.016																
147																						
148																						
149		These samples were analysed using a 35ml bottle with a 15ml sample and 10ml headspace. The sample was shaken for 45 minutes.																				
150	* VC = vibro-cores; GS = grabs																					

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Figure 24. Methane versus ethane for the Skua/Swan Graben Group of anomalies.
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Appendix I

Hydrocarbon compositions on individual survey lines

The following charts were prepared for all of the survey lines. They are in Appendix I.

- THC and methane concentration versus shot-point number.
- Methane, ethane and ethylene concentration versus shot-point number.
- Methane, propane and propylene concentration versus shot-point number.
- DHD fish depth and altitude versus shot-point number.

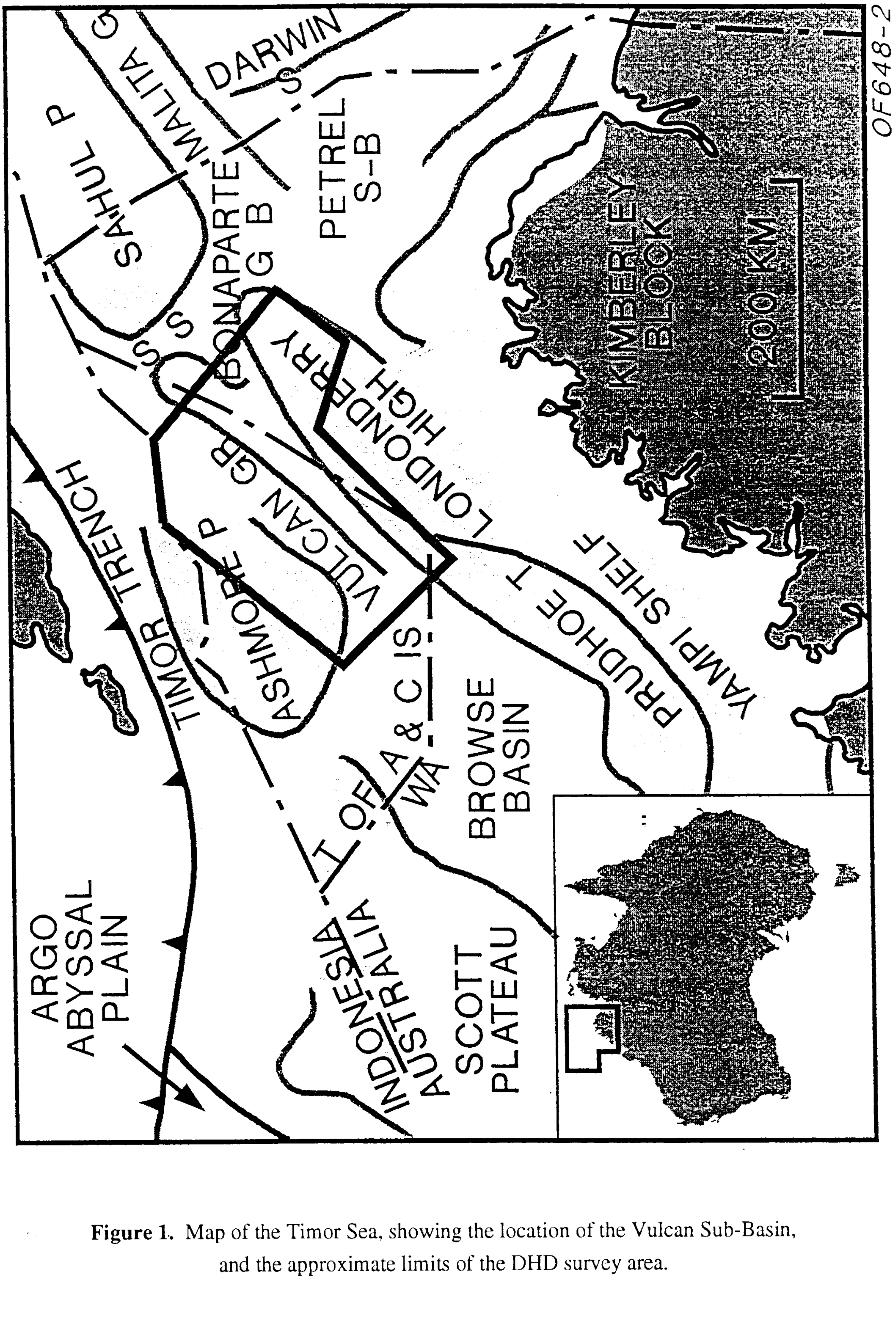


Figure 1. Map of the Timor Sea, showing the location of the Vulcan Sub-Basin, and the approximate limits of the DHD survey area.

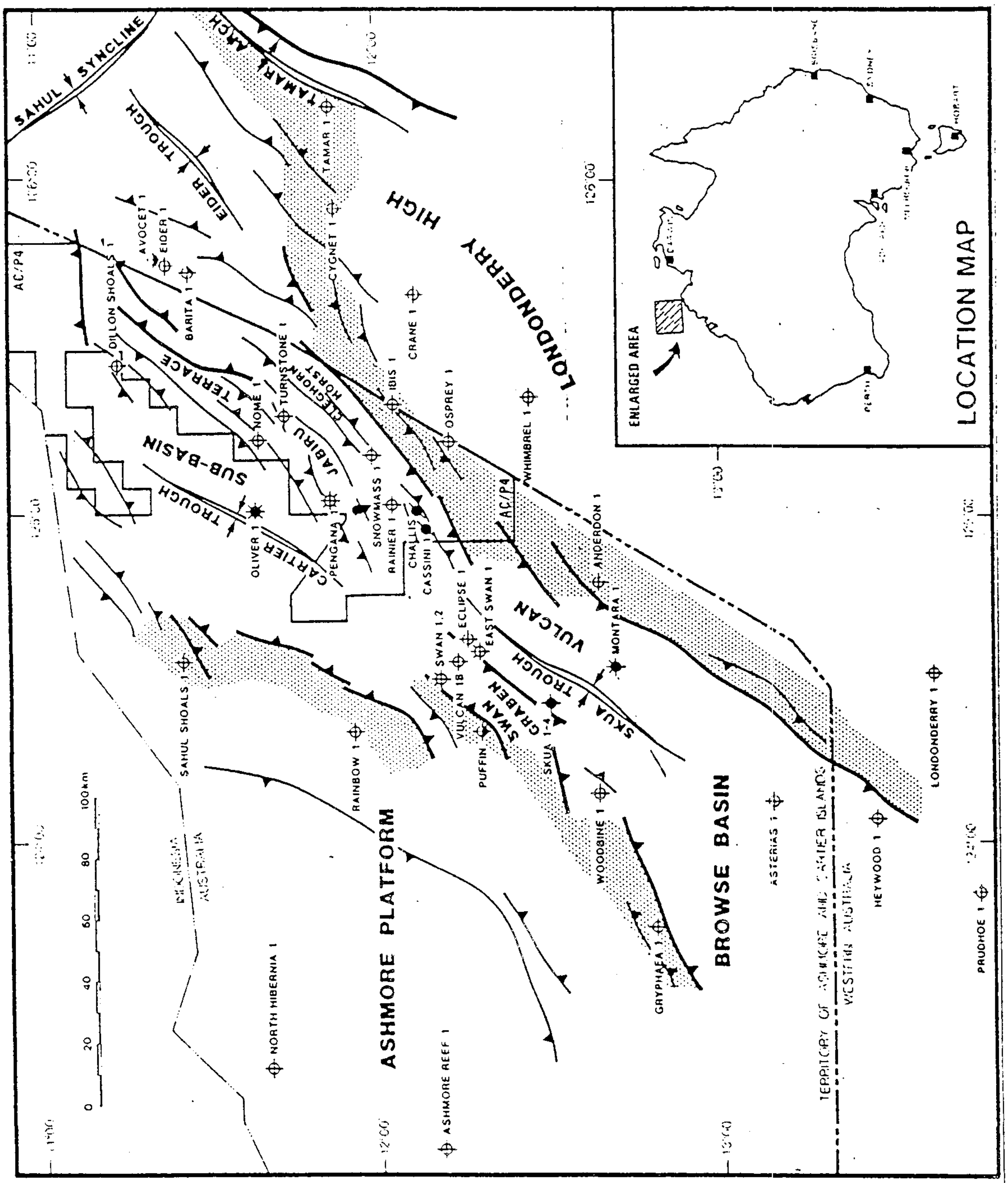


Figure 2. Location map and tectonic elements of the Vulcan Sub-Basin, Timor Sea (after MacDaniel, 1988).

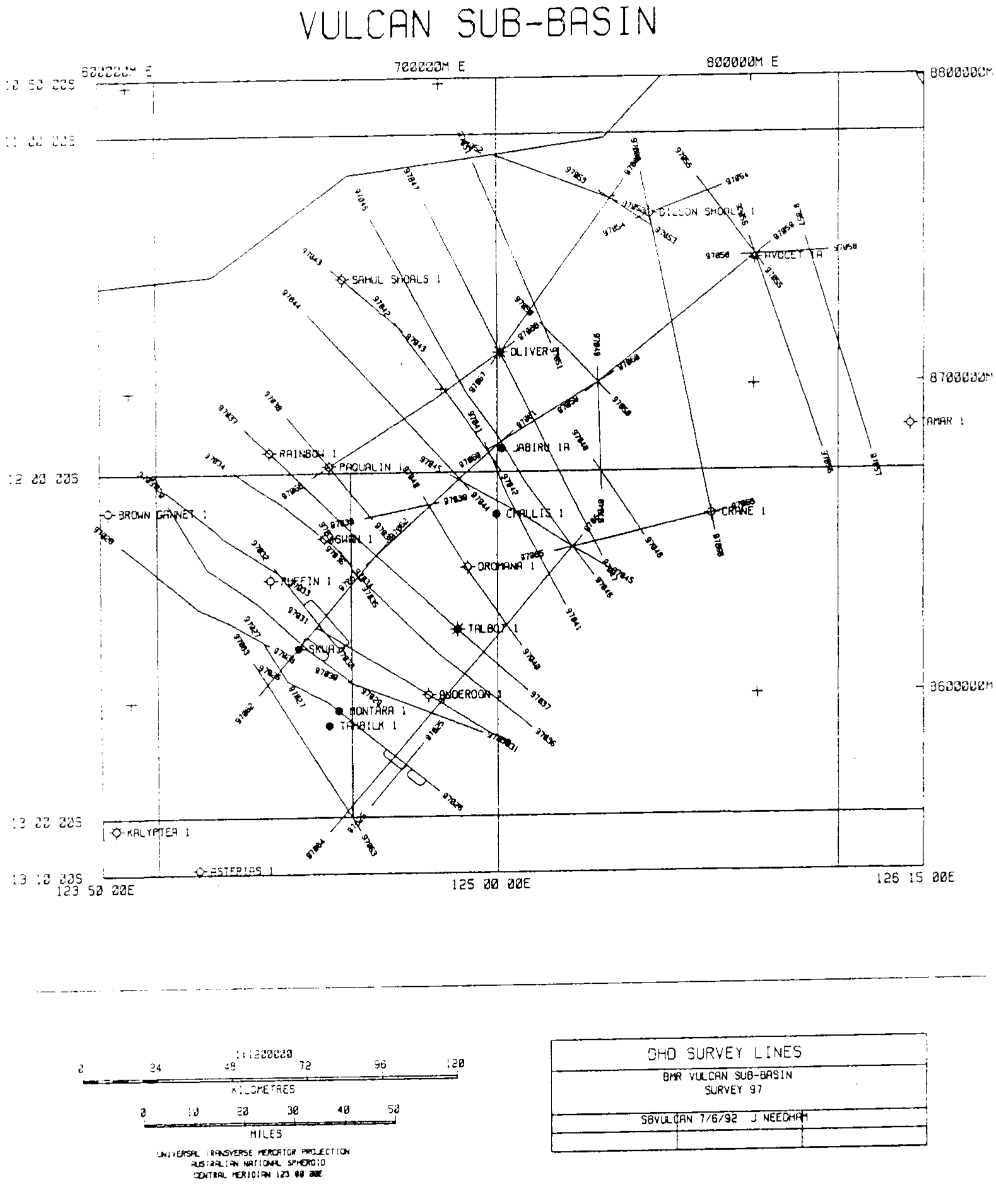


Figure 3. Map of the Vulcan Sub-Basin showing the geochemical survey lines in relation to the principal well locations.

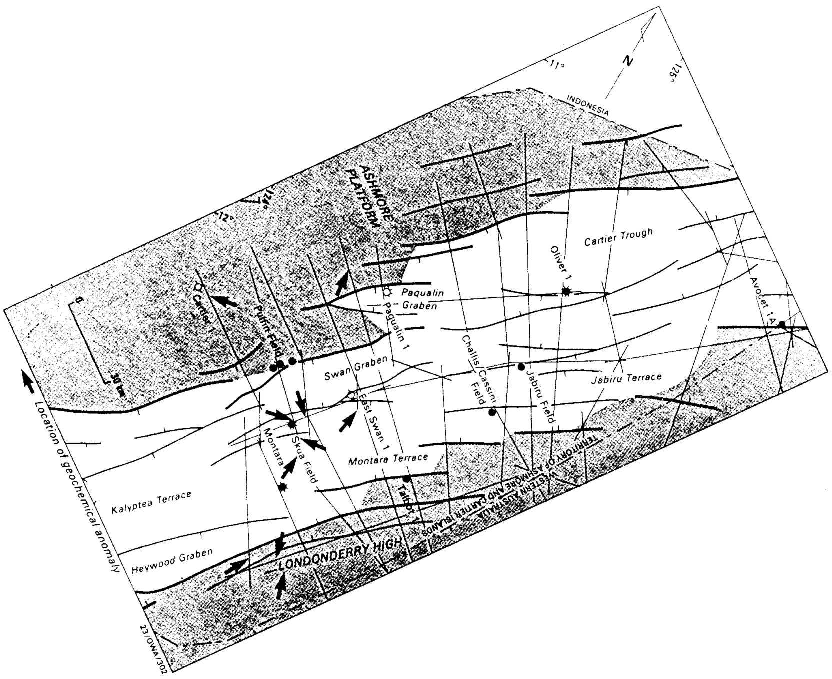


Figure 4. Map of the Vulcan Sub-Basin showing the geochemical anomalies detected during the survey.

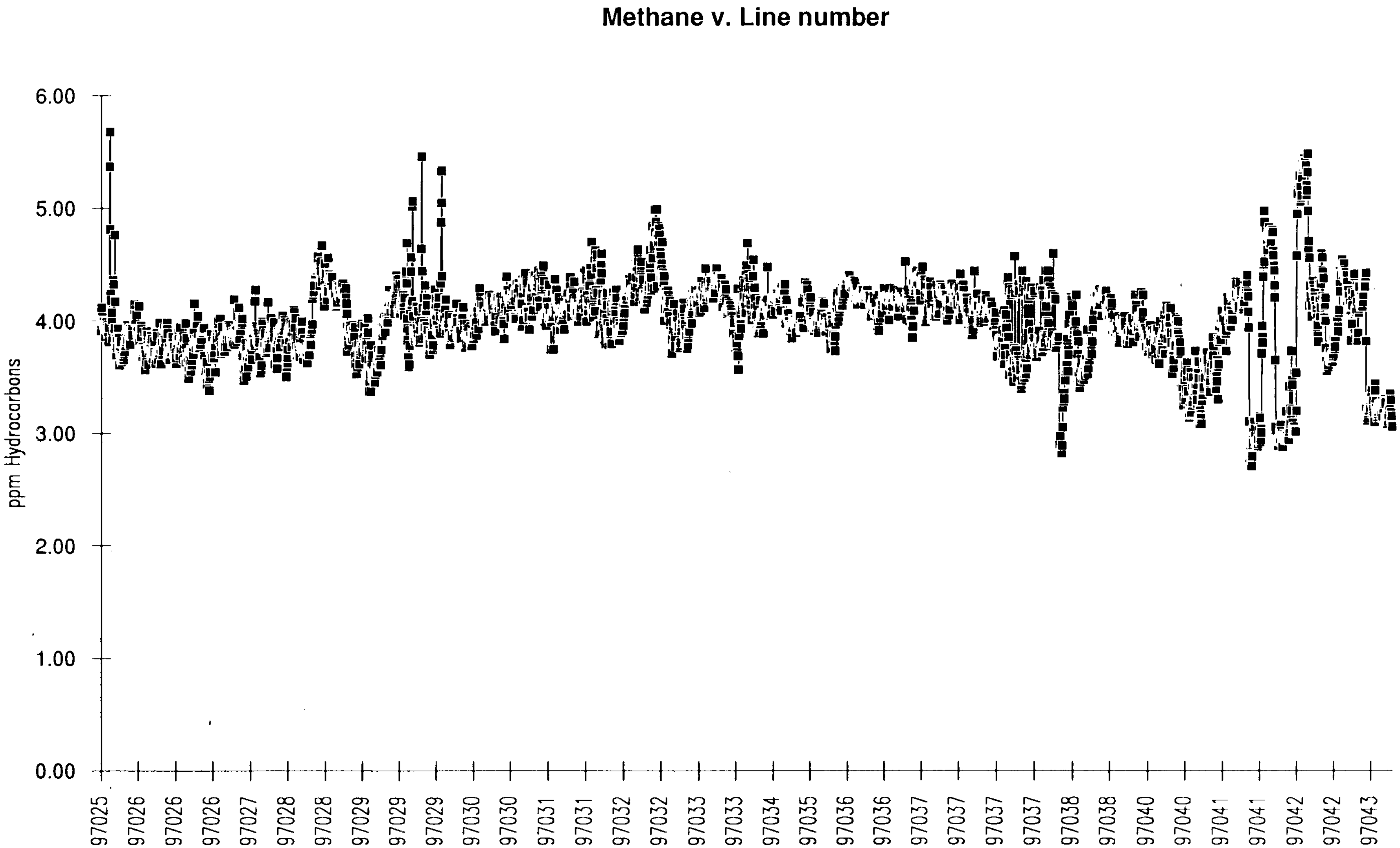


Figure 5a. Methane versus line number for Lines 25-43 (Vulcan Sub-Basin).

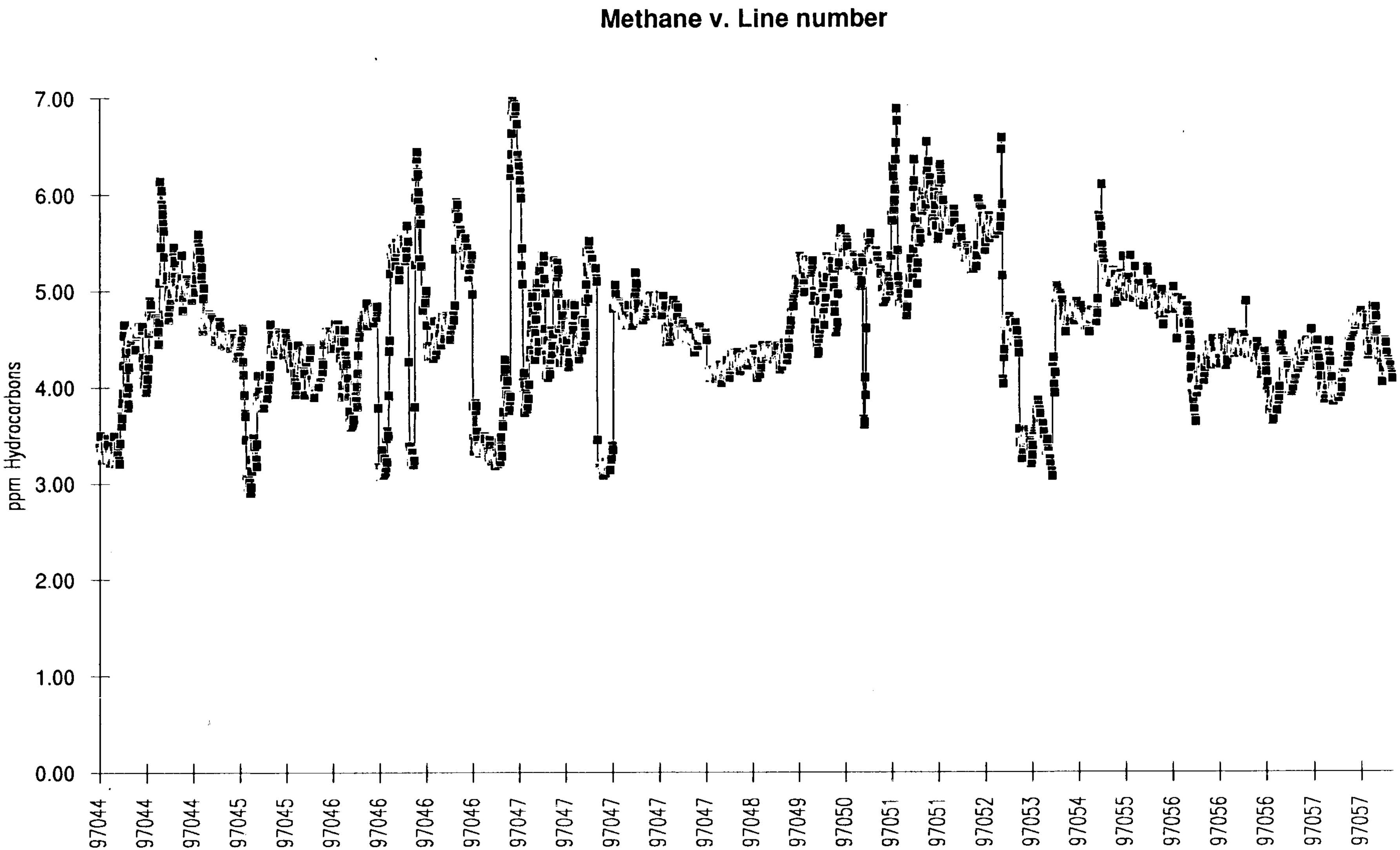


Figure 5b. Methane versus line number for Lines 44-57 (Vulcan Sub-Basin).

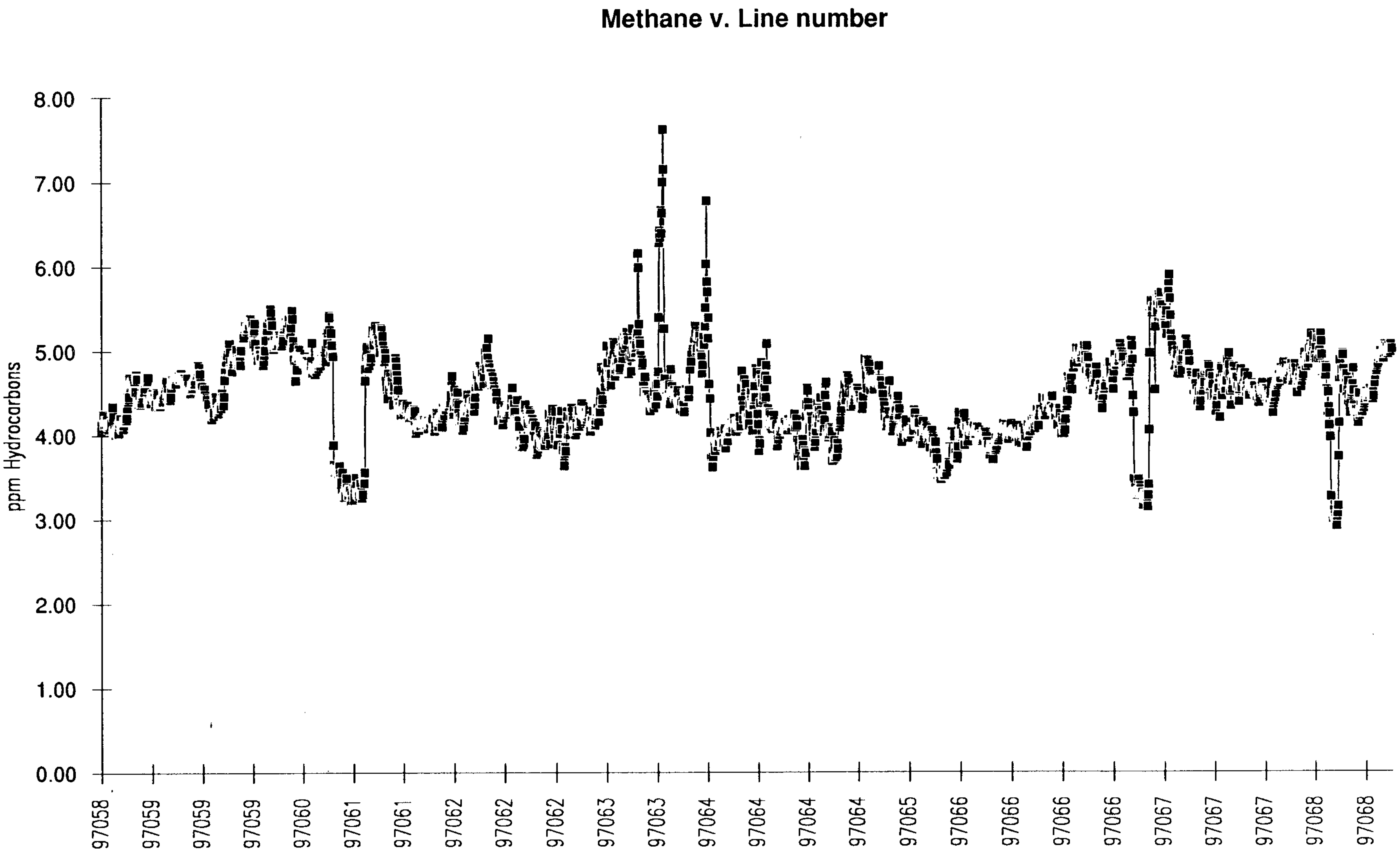


Figure 5c. Methane versus line number for Lines 58-68 (Vulcan Sub-Basin).

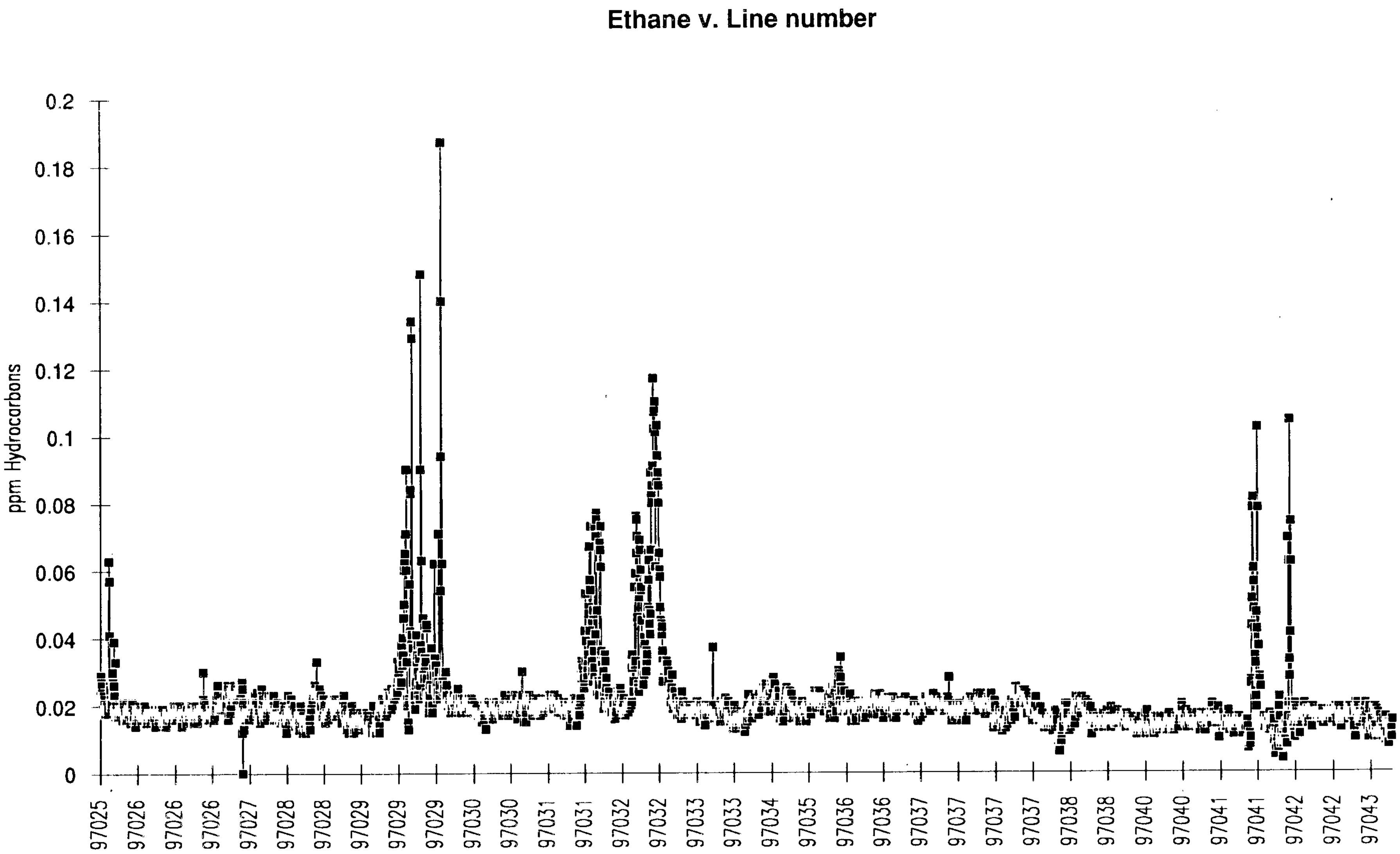


Figure 6a. Ethane versus line number for Lines 25-43 (Vulcan Sub-Basin).

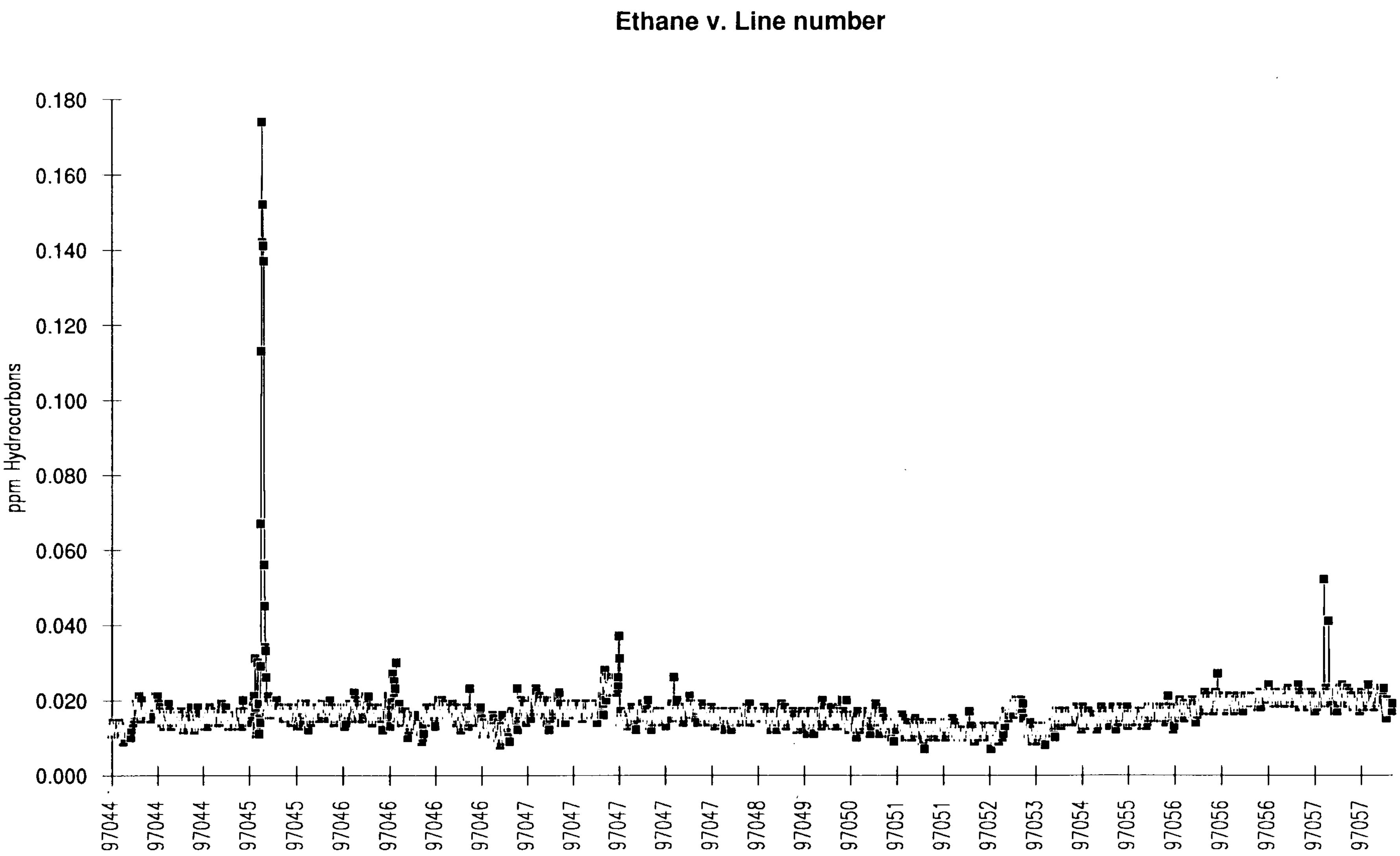


Figure 6b. Ethane versus line number for Lines 44-57 (Vulcan Sub-Basin).

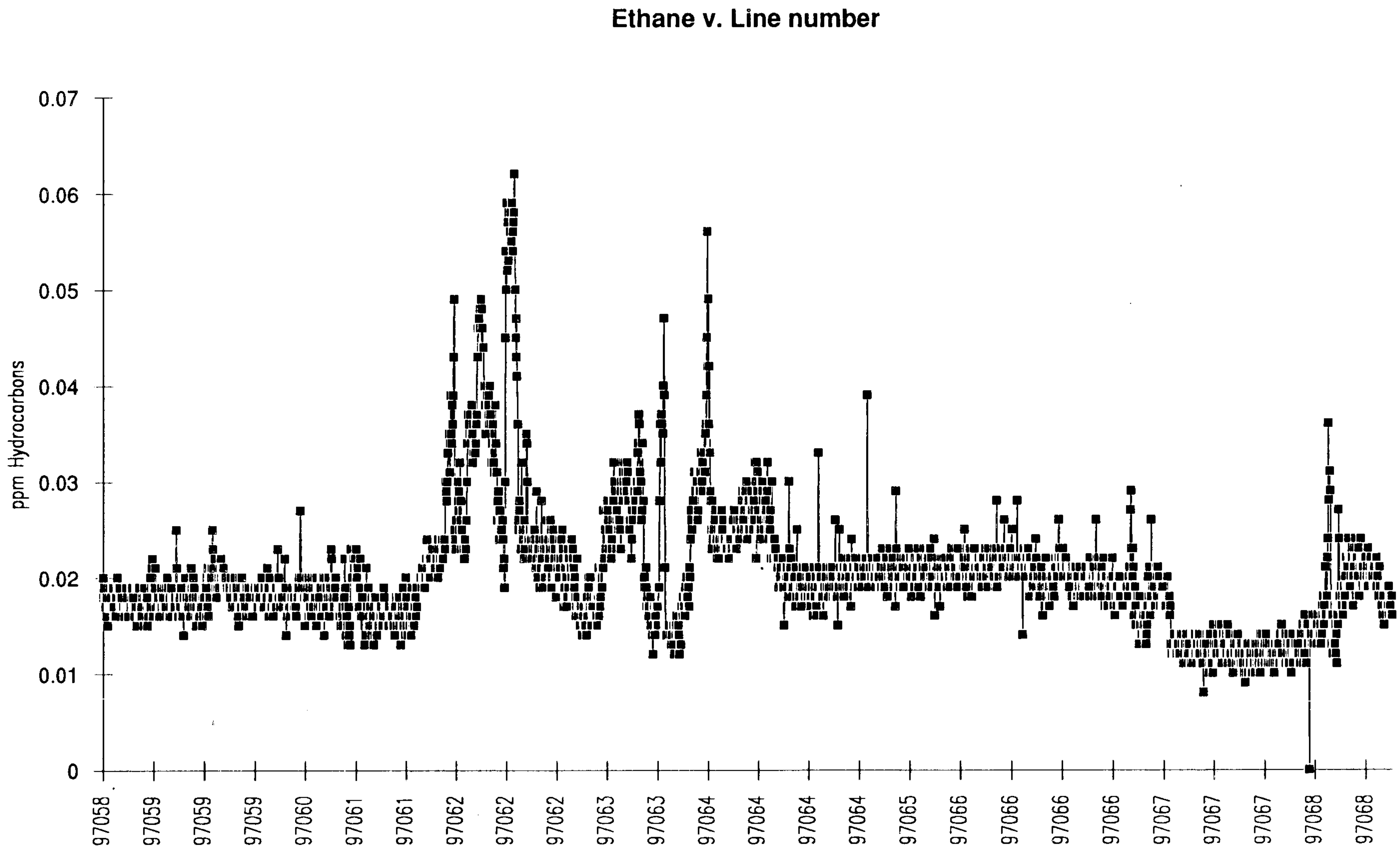


Figure 6c. Ethane versus line number for Lines 58-68 (Vulcan Sub-Basin).

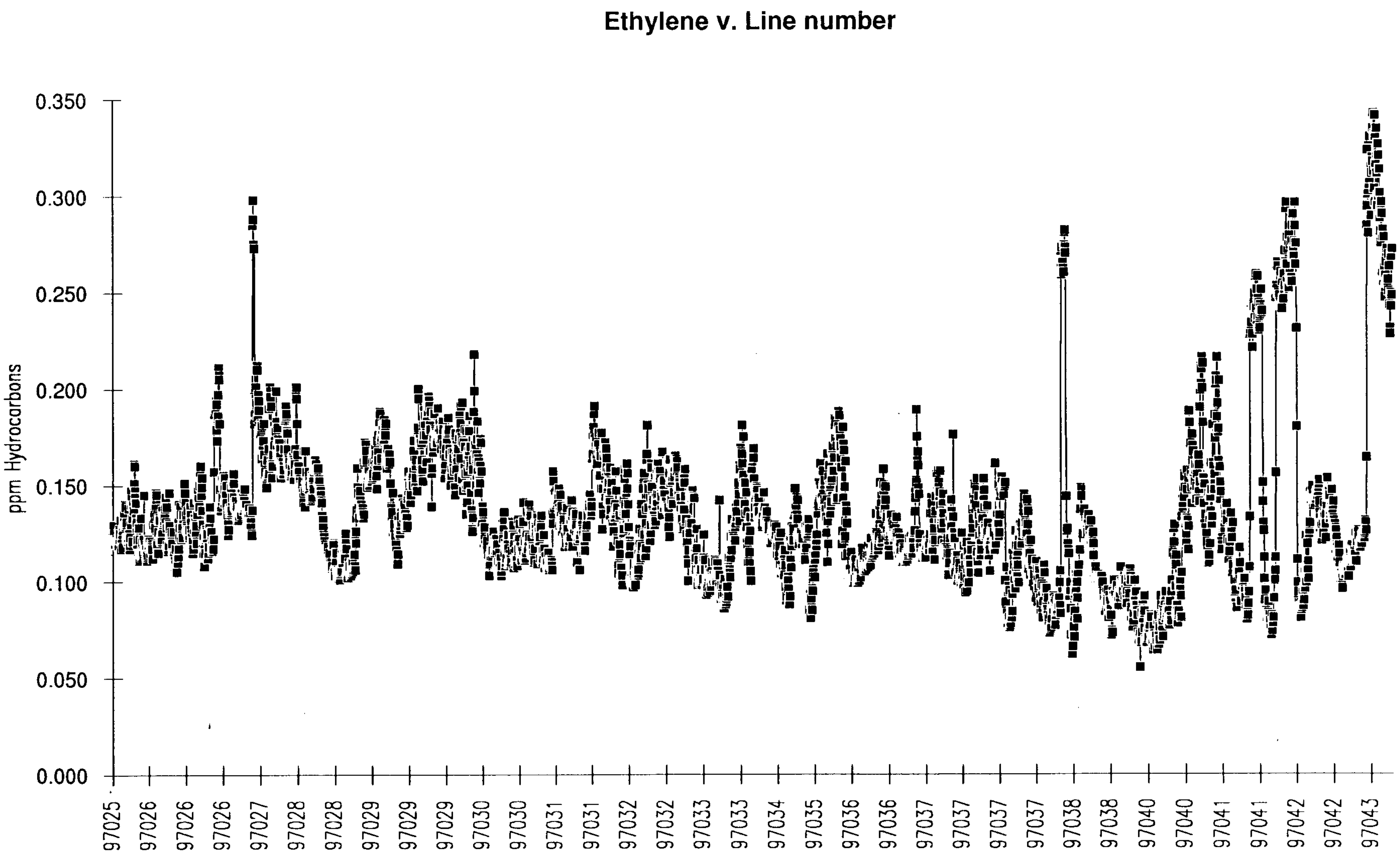


Figure 7a. Ethylene versus line number for Lines 25-43 (Vulcan Sub-Basin).

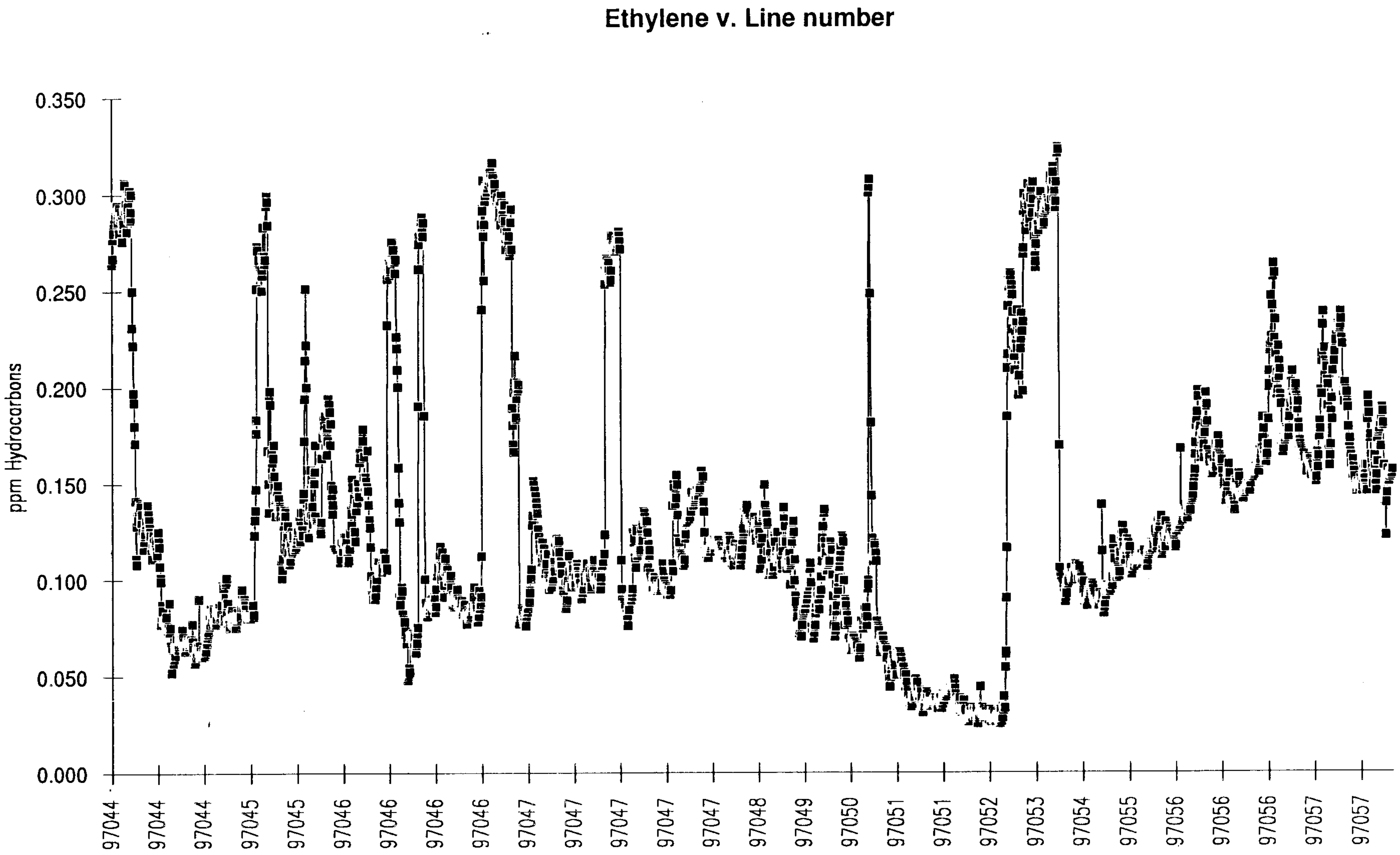


Figure 7b. Ethylene versus line number for Lines 44-57 (Vulcan Sub-Basin).

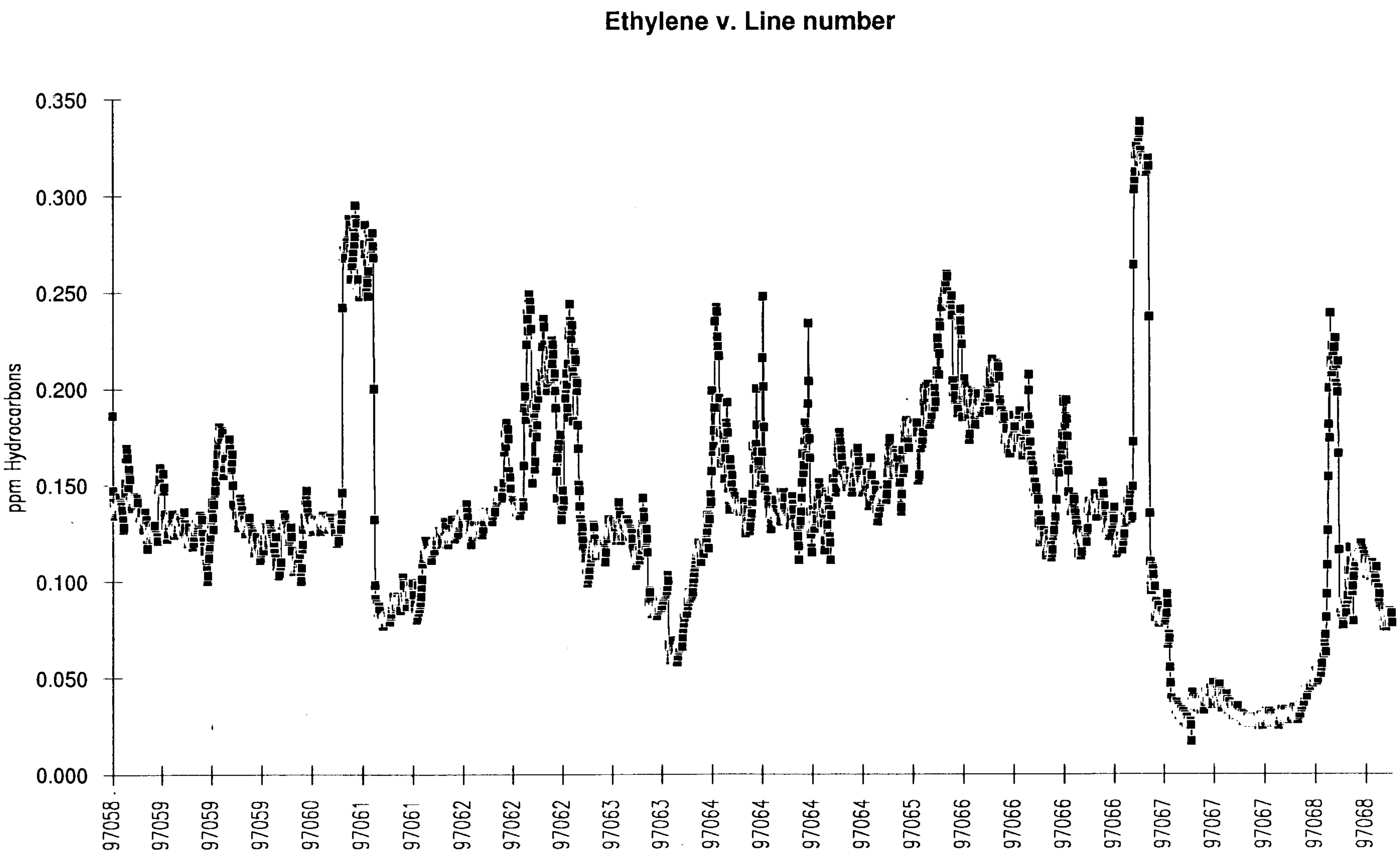


Figure 7c. Ethylene versus line number for Lines 58-68 (Vulcan Sub-Basin).

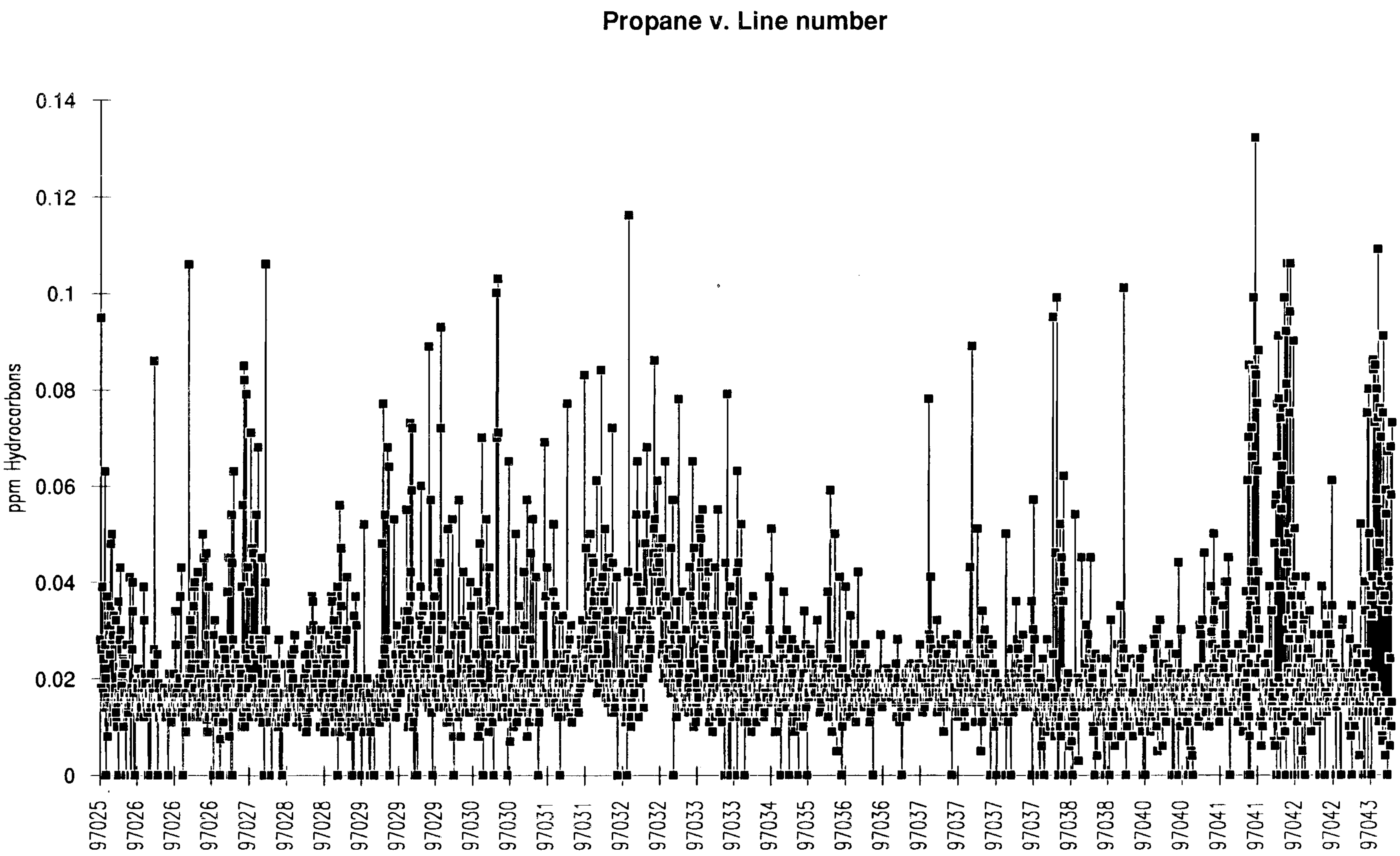


Figure 8a. Propane versus line number for Lines 25-43 (Vulcan Sub-Basin).

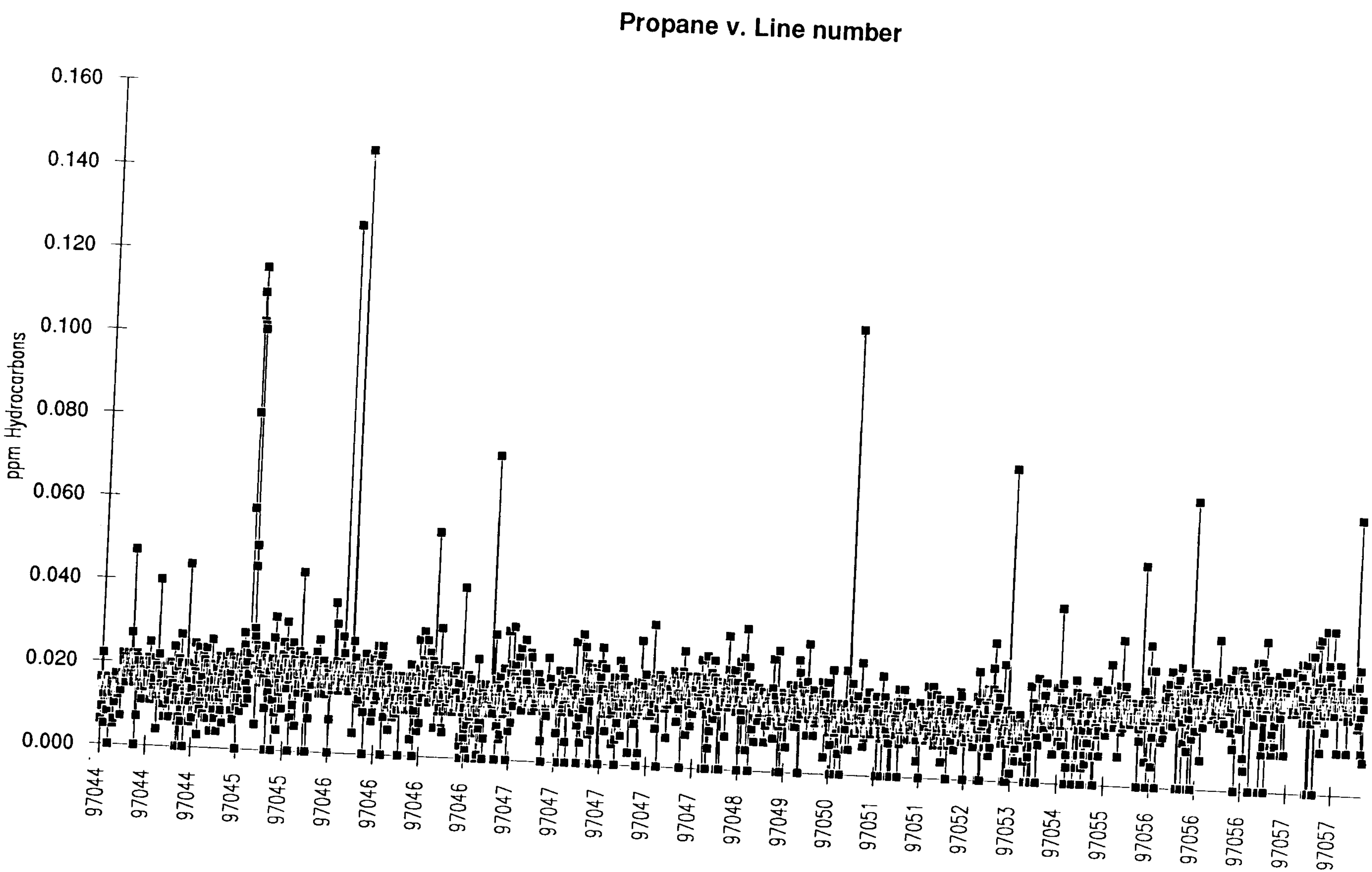


Figure 8b. Propane versus line number for Lines 44-57 (Vulcan Sub-Basin).

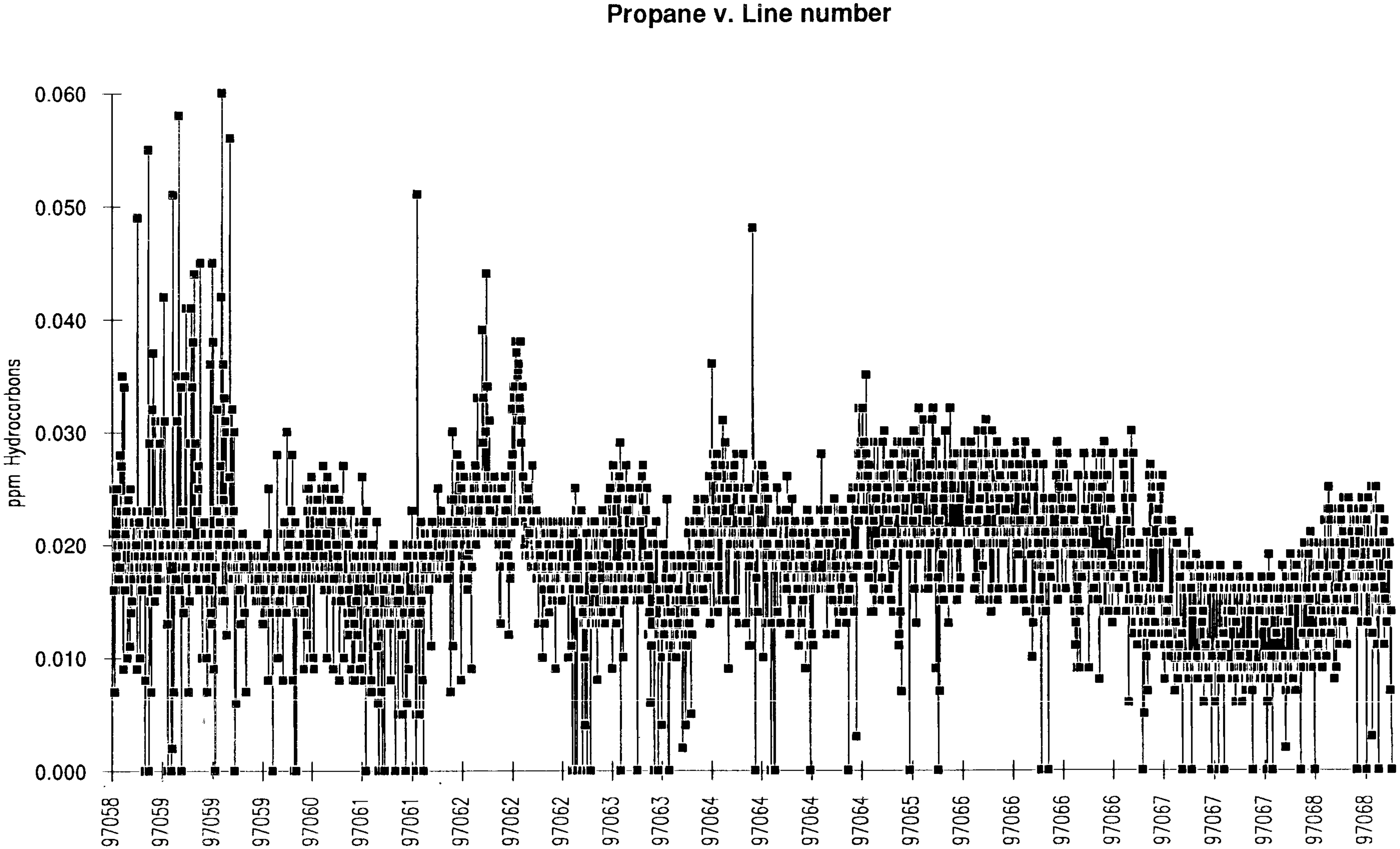


Figure 8c. Propane versus line number for Lines 58-68 (Vulcan Sub-Basin).

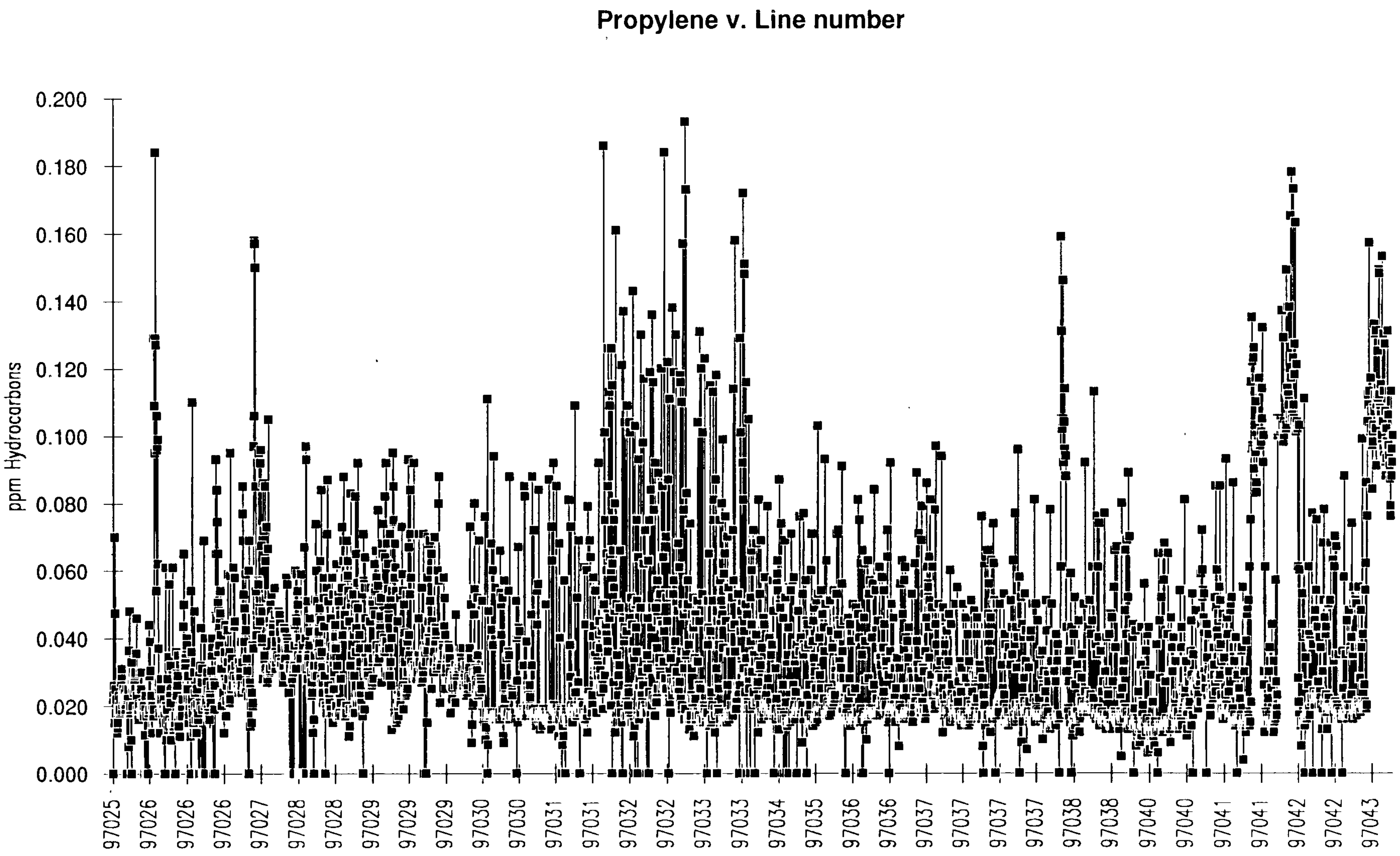


Figure 9a . Propylene versus line number for Lines 25-43 (Vulcan Sub-Basin).

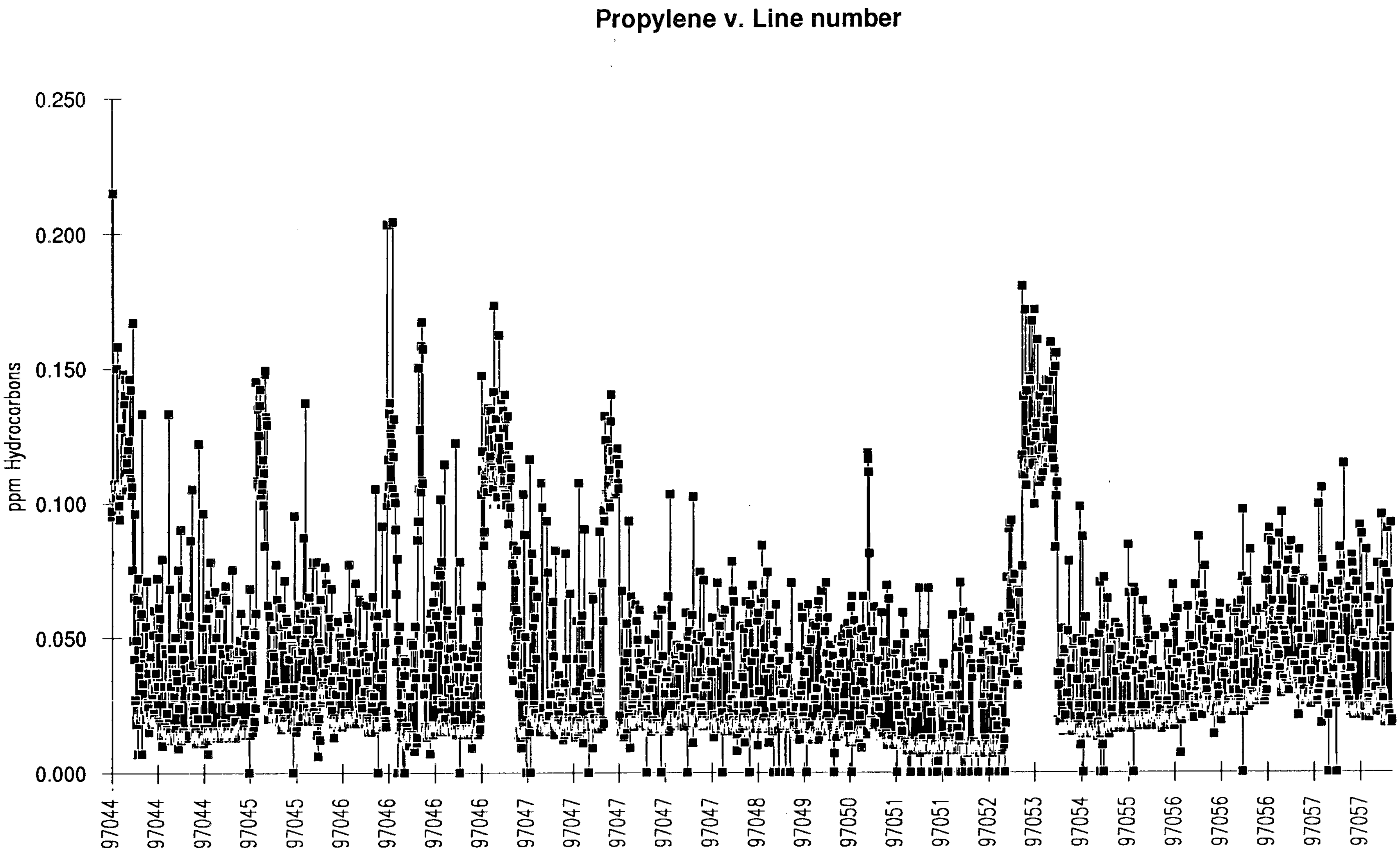


Figure 9b. Propylene versus line number for Lines 44-57 (Vulcan Sub-Basin).

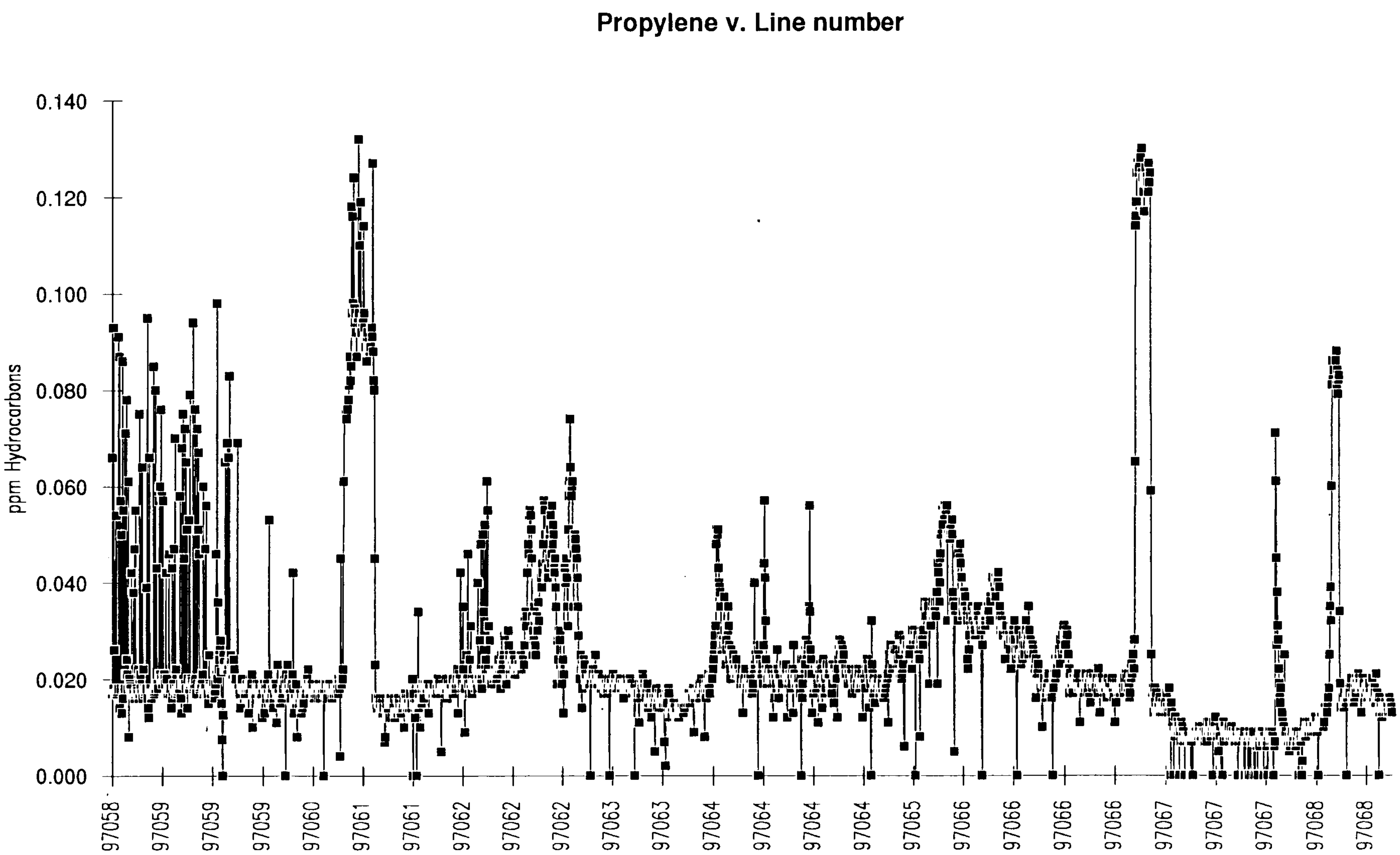


Figure 9c. Propylene versus line number for Lines 58-68 (Vulcan Sub-Basin).

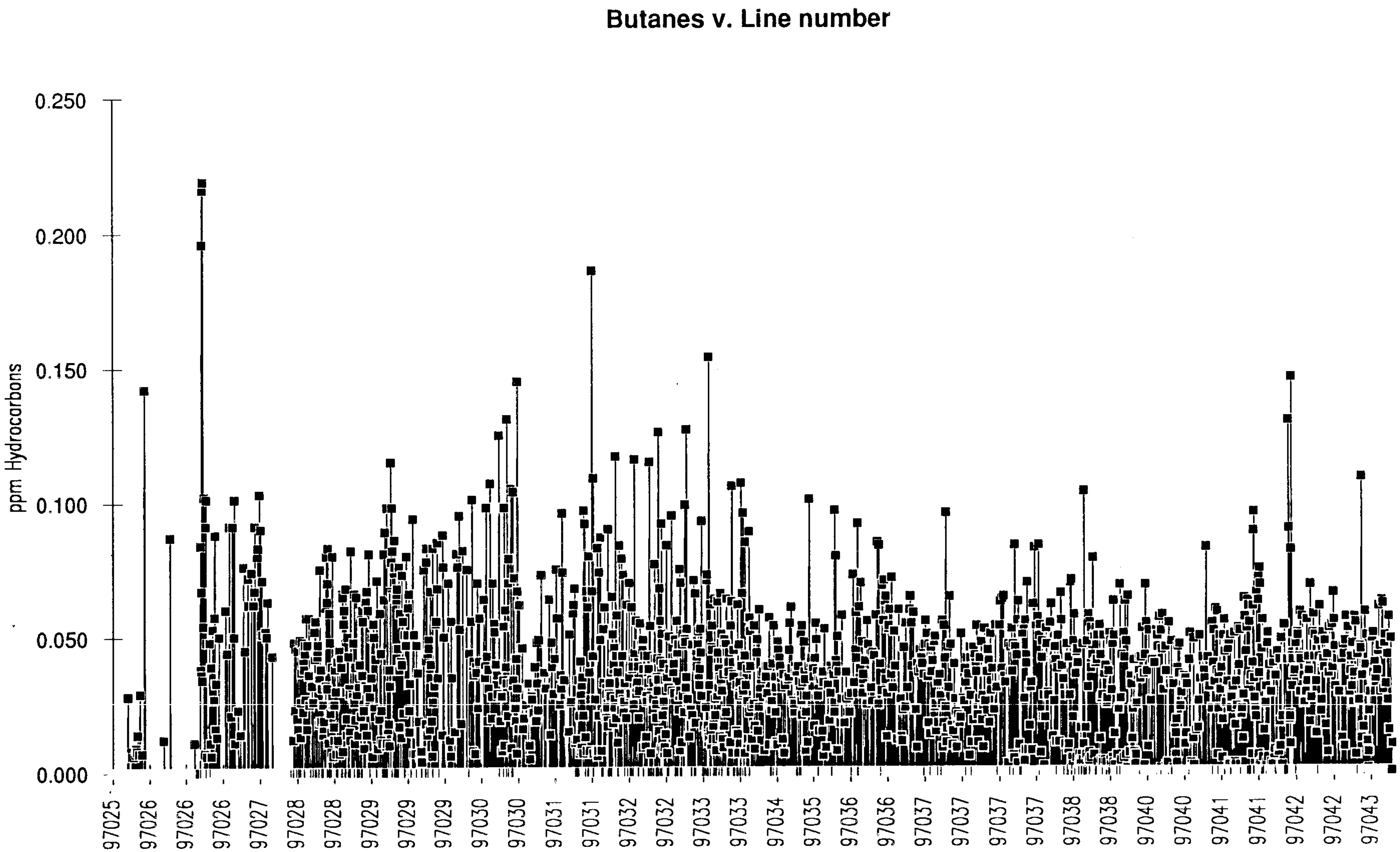


Figure 10a. Butane versus line number for Lines 25-43 (Vulcan Sub-Basin).

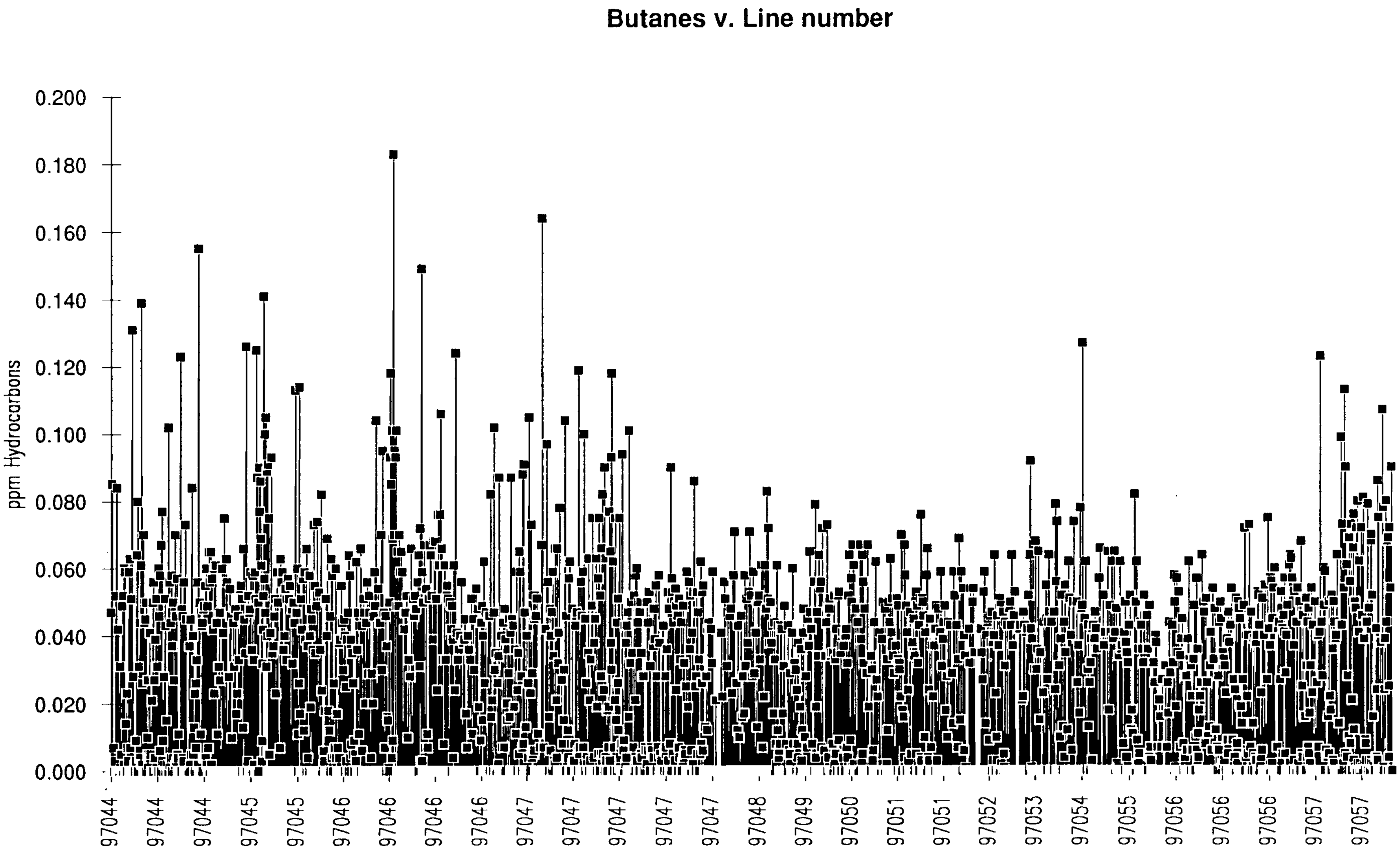


Figure 10b. Butane versus line number for Lines 44-57 (Vulcan Sub-Basin).

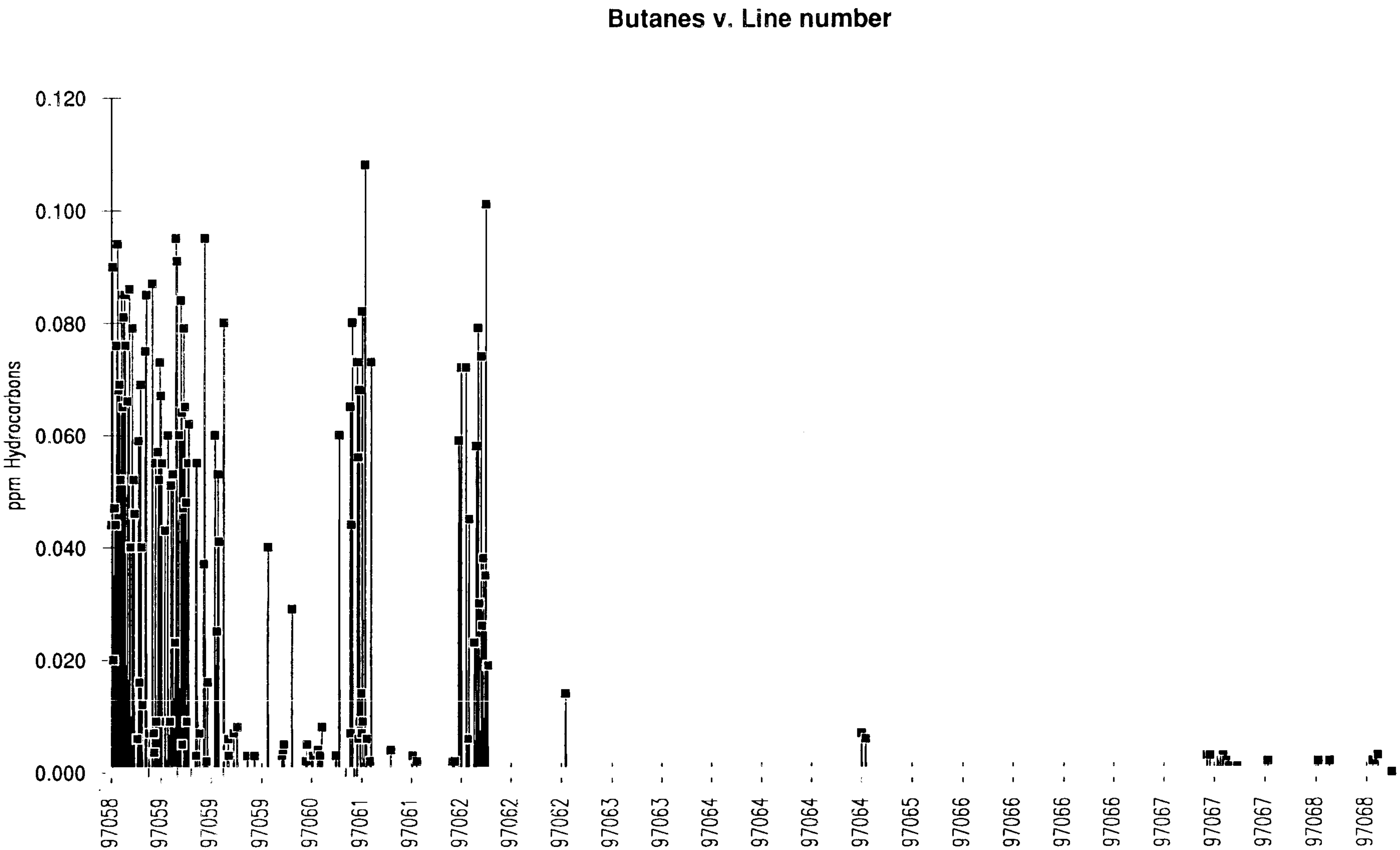


Figure 10c. Butane versus line number for Lines 58-68 (Vulcan Sub-Basin).

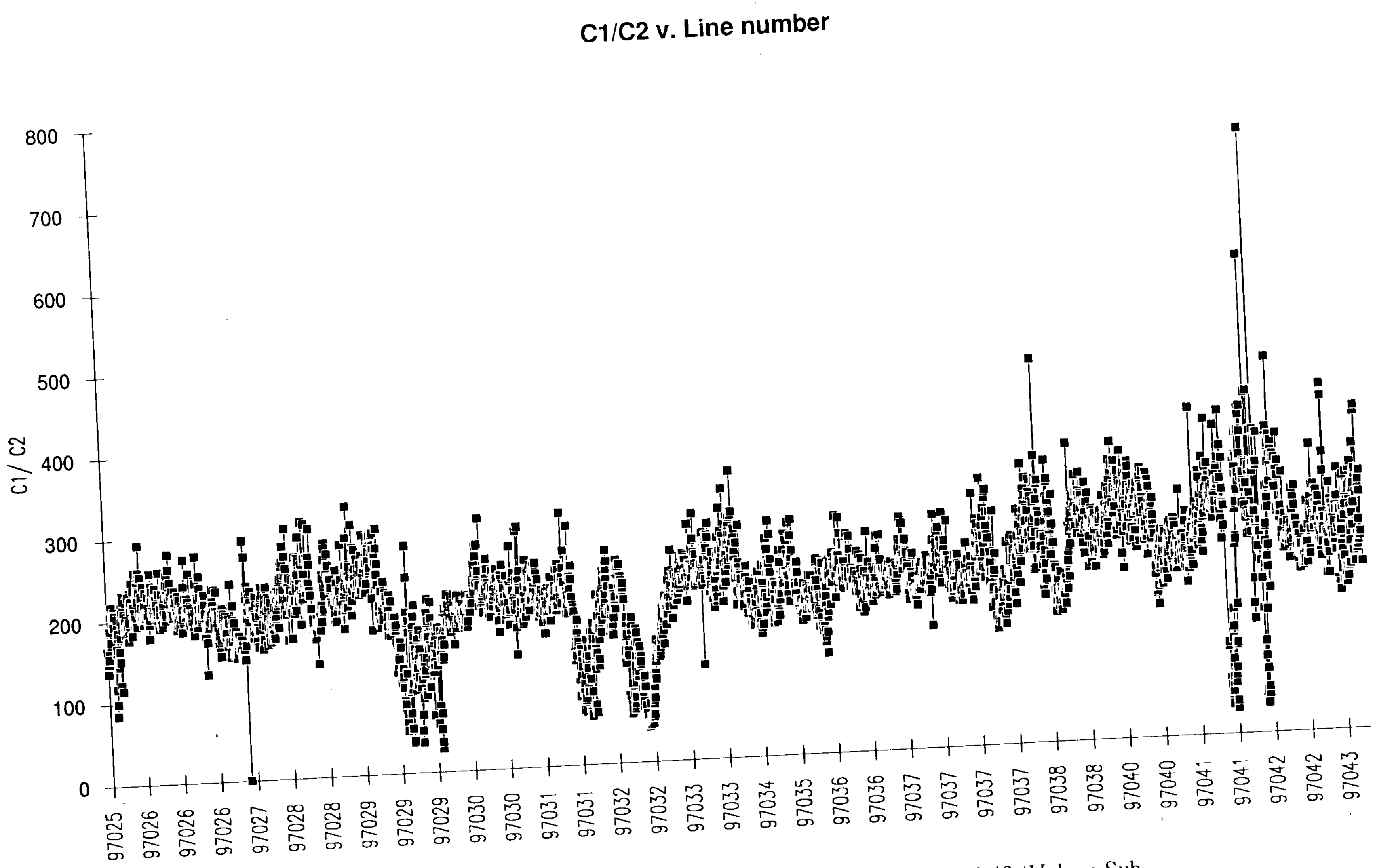


Figure 11a. Ratio of C1/C2 versus line number for Lines 25-43 (Vulcan Sub-Basin).

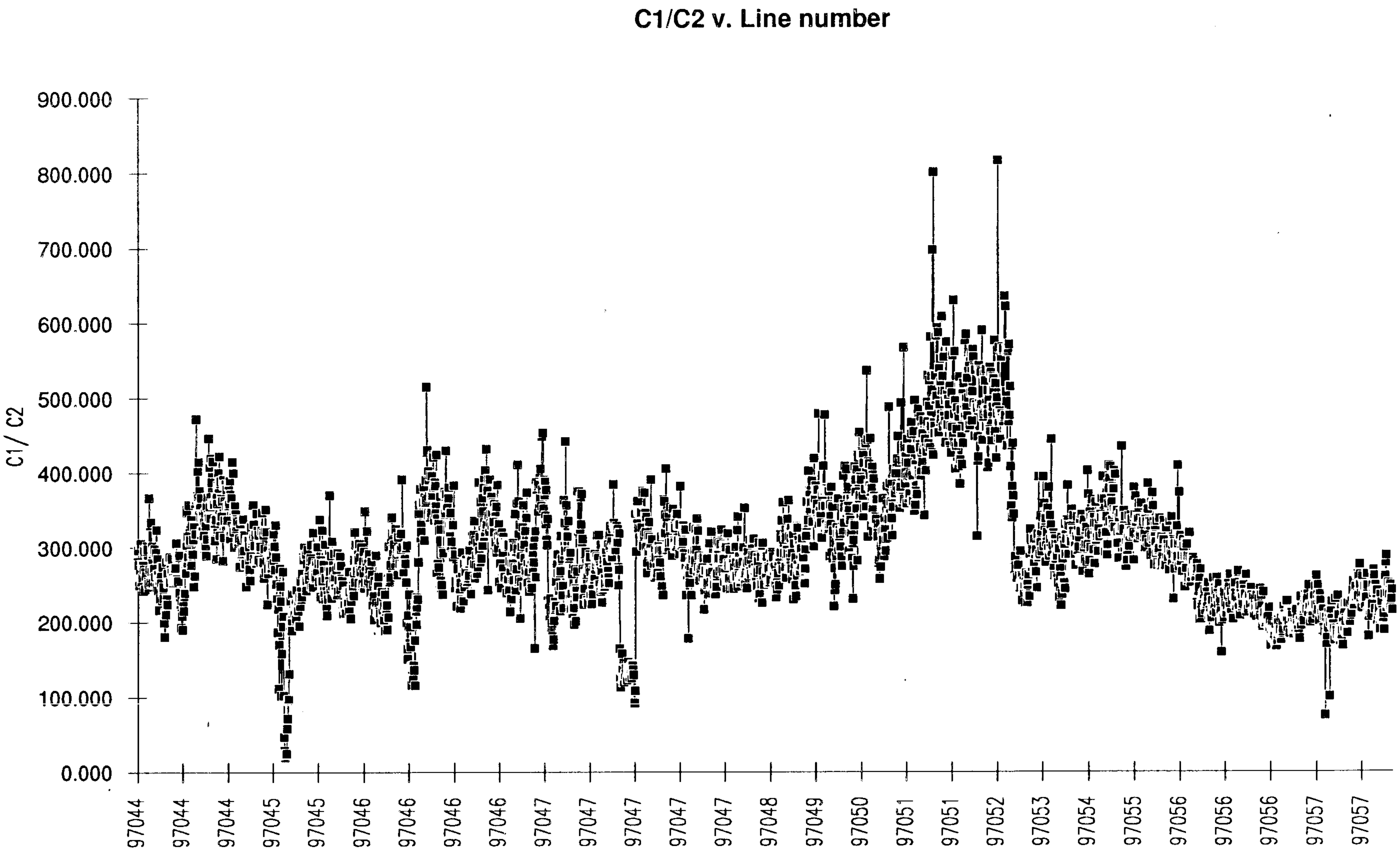


Figure 11b. Ratio of C1/C2 versus line number for Lines 44-57 (Vulcan Sub-Basin).

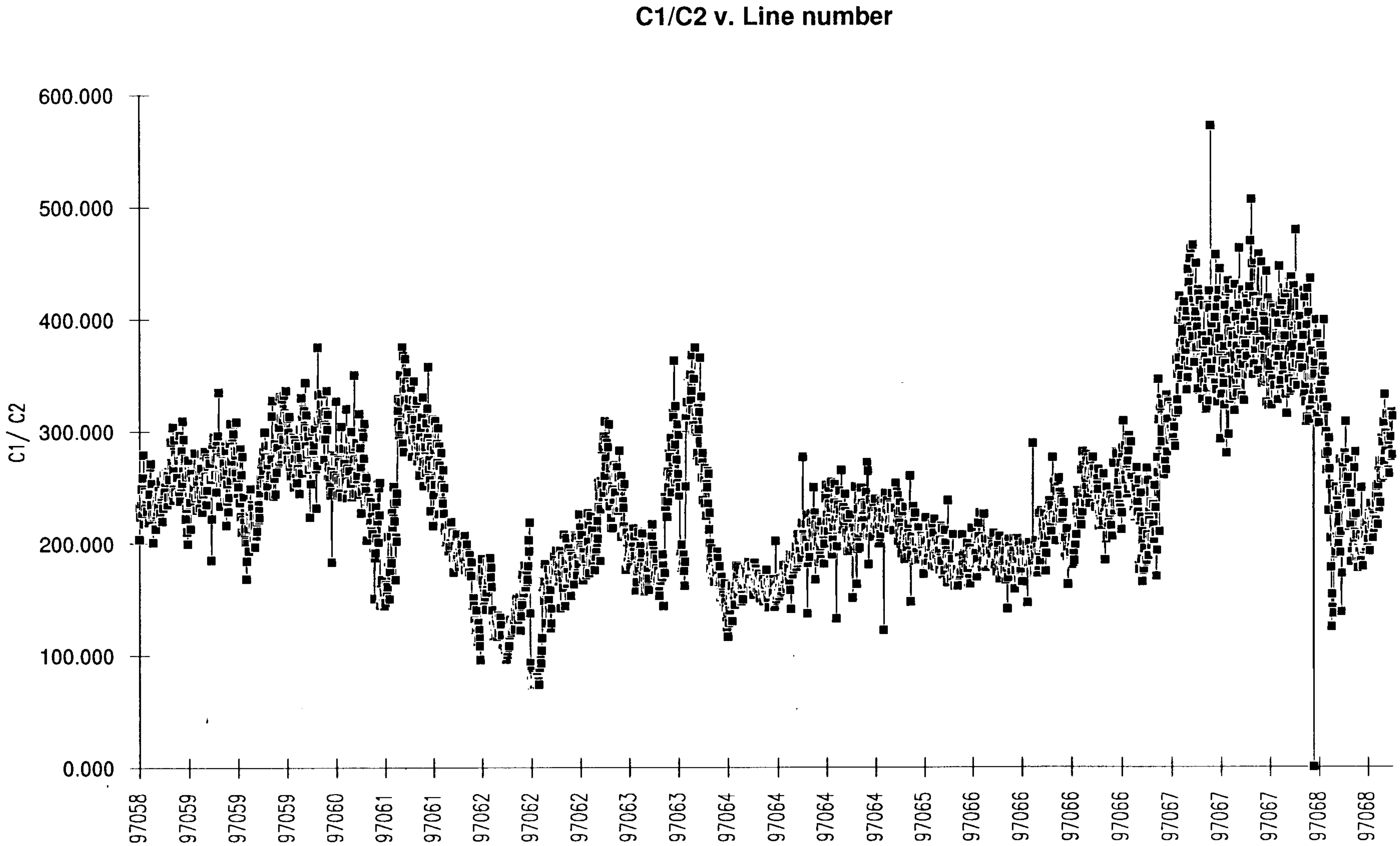


Figure 11c. Ratio of C1/C2 versus line number for Lines 58-68 (Vulcan Sub-Basin).

C2/C3 v. Line number

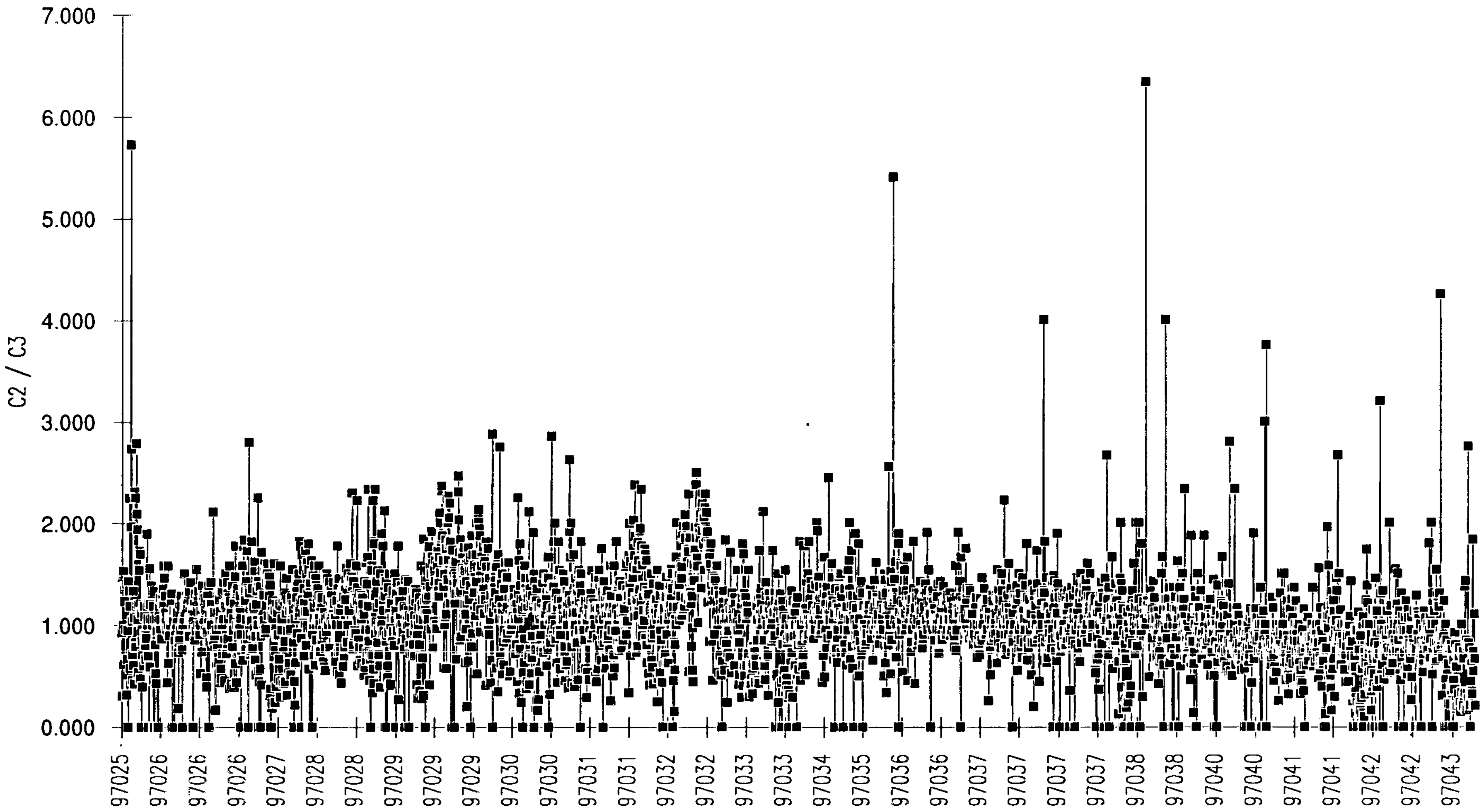


Figure 12a. Ratio of C2/C3 versus line number for Lines 25-43 (Vulcan Sub-Basin).

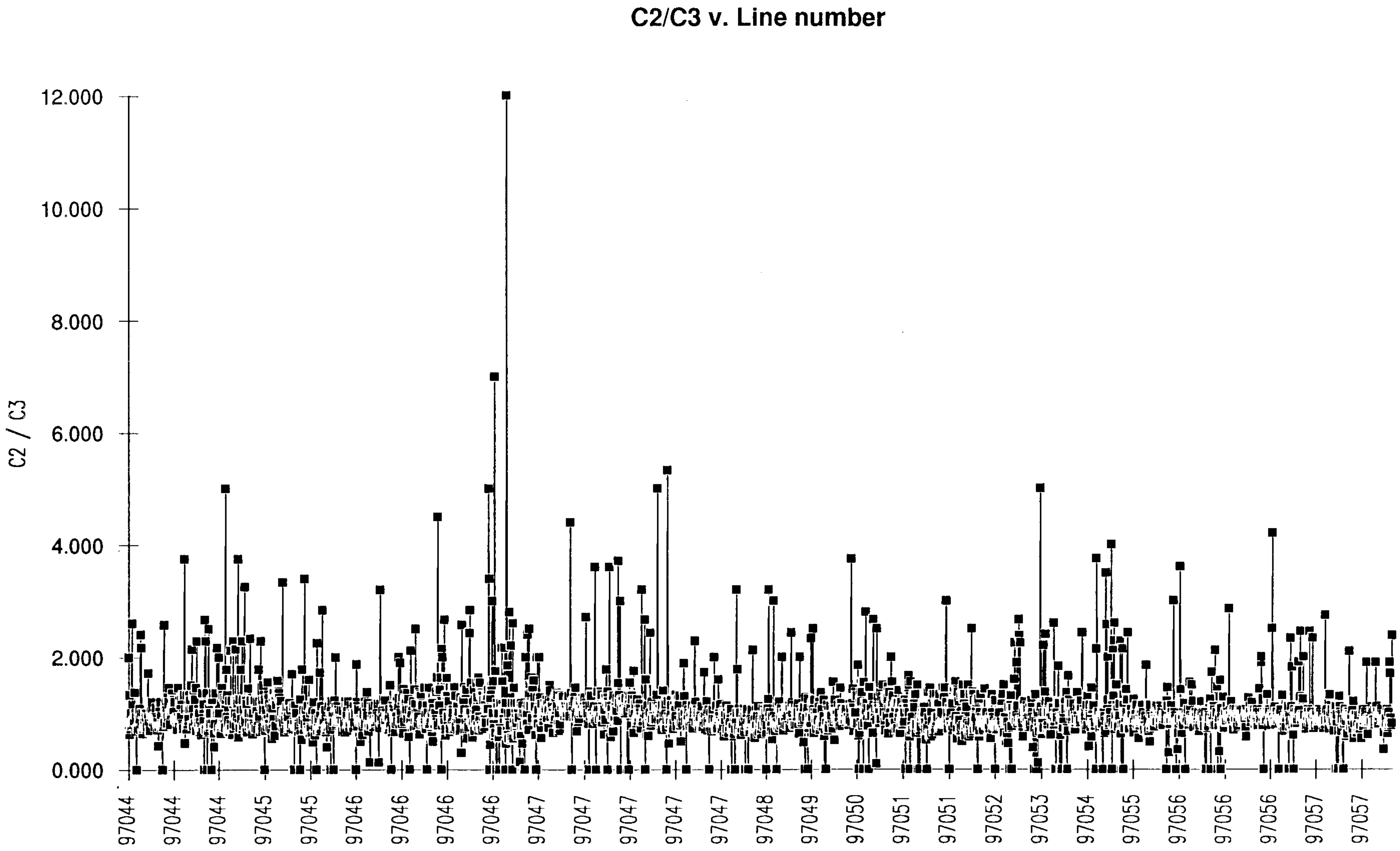


Figure 12b. Ratio of C2/C3 versus line number for Lines 44-57 (Vulcan Sub-Basin).

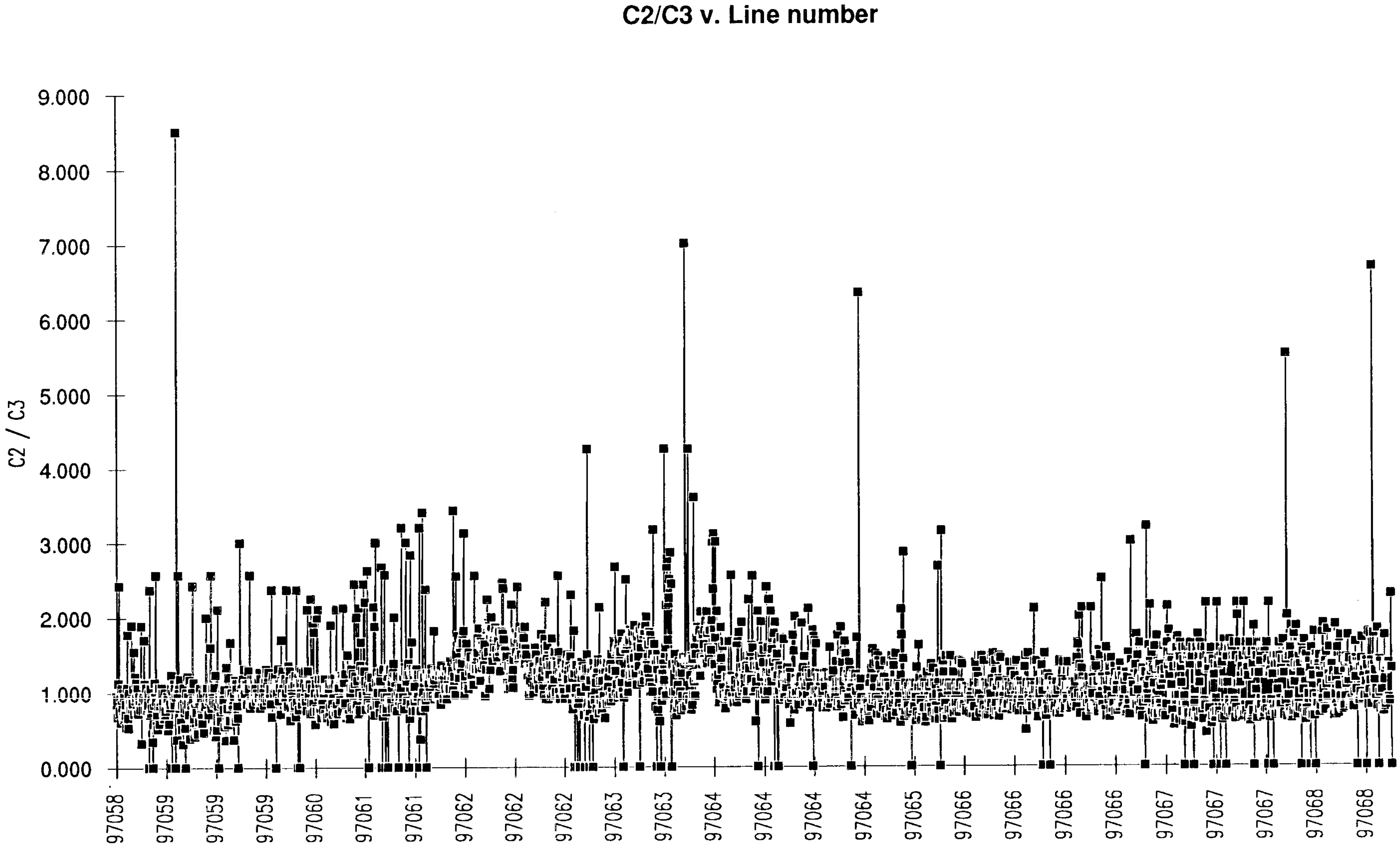


Figure 12c. Ratio of C2/C3 versus line number for Lines 58-68 (Vulcan Sub-Basin).

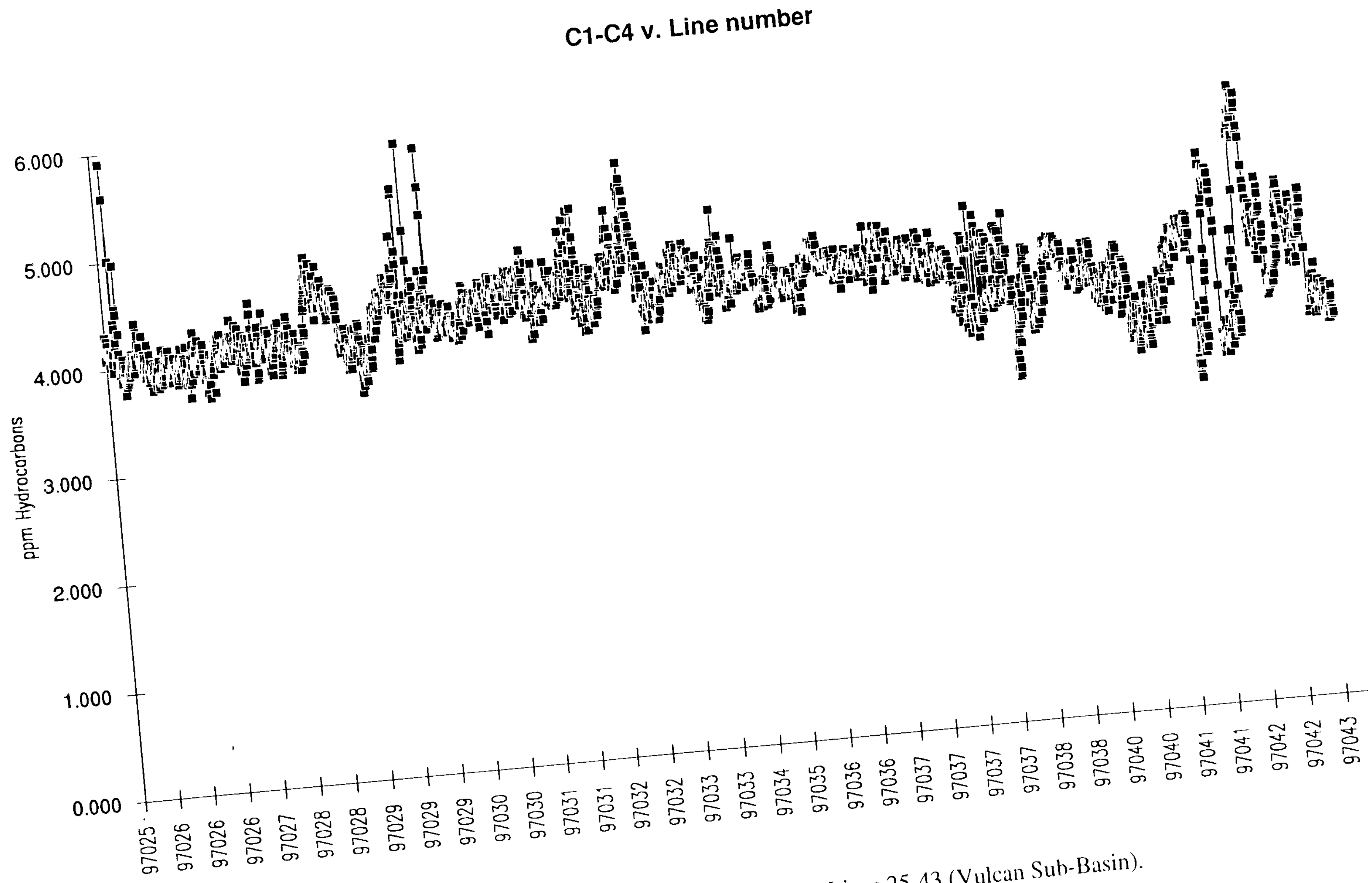


Figure 13a. Sum of C1-C4 hydrocarbons Lines 25-43 (Vulcan Sub-Basin).

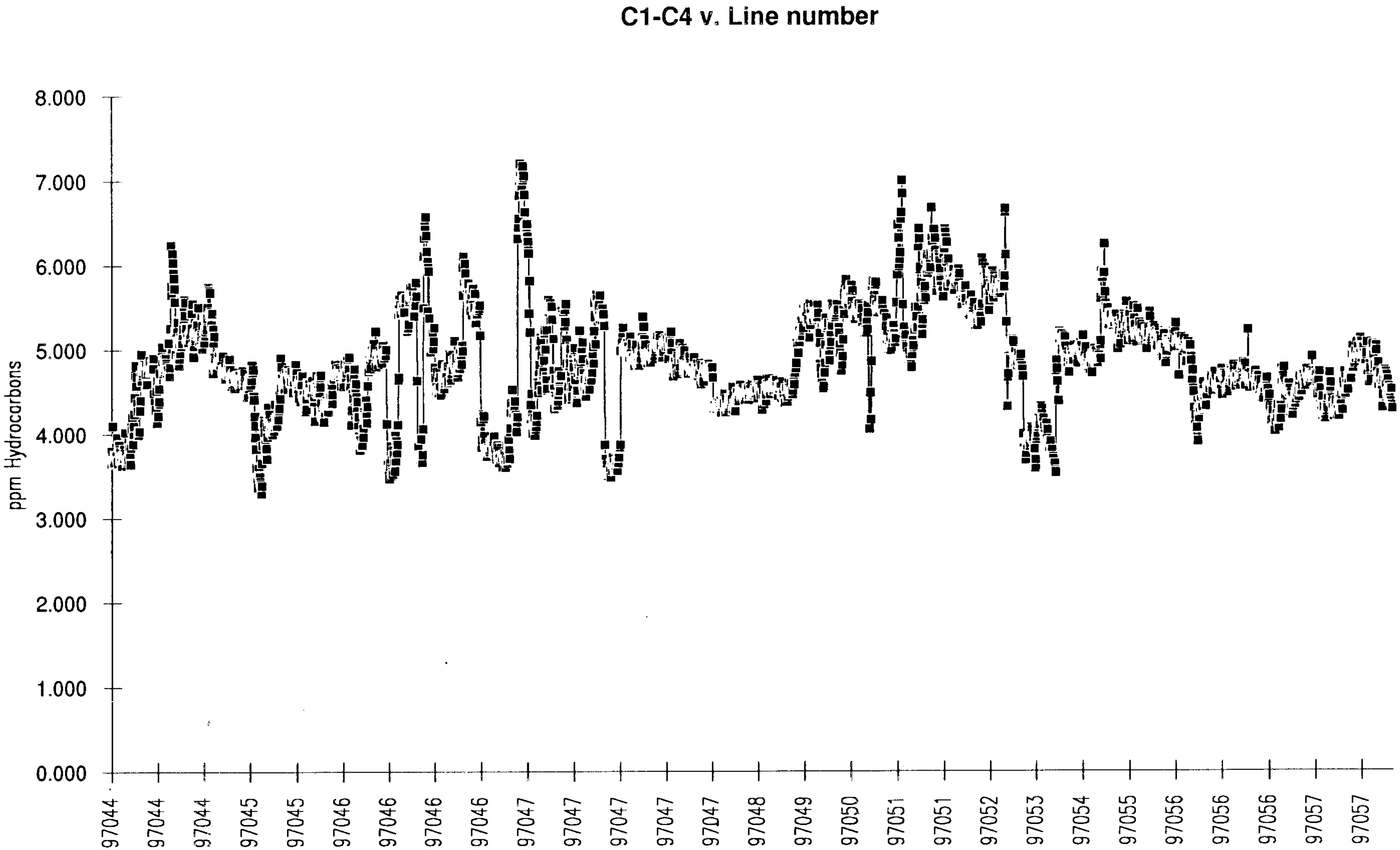


Figure 13b. Sum of C1-C4 hydrocarbons Lines 44-57 (Vulcan Sub-Basin).

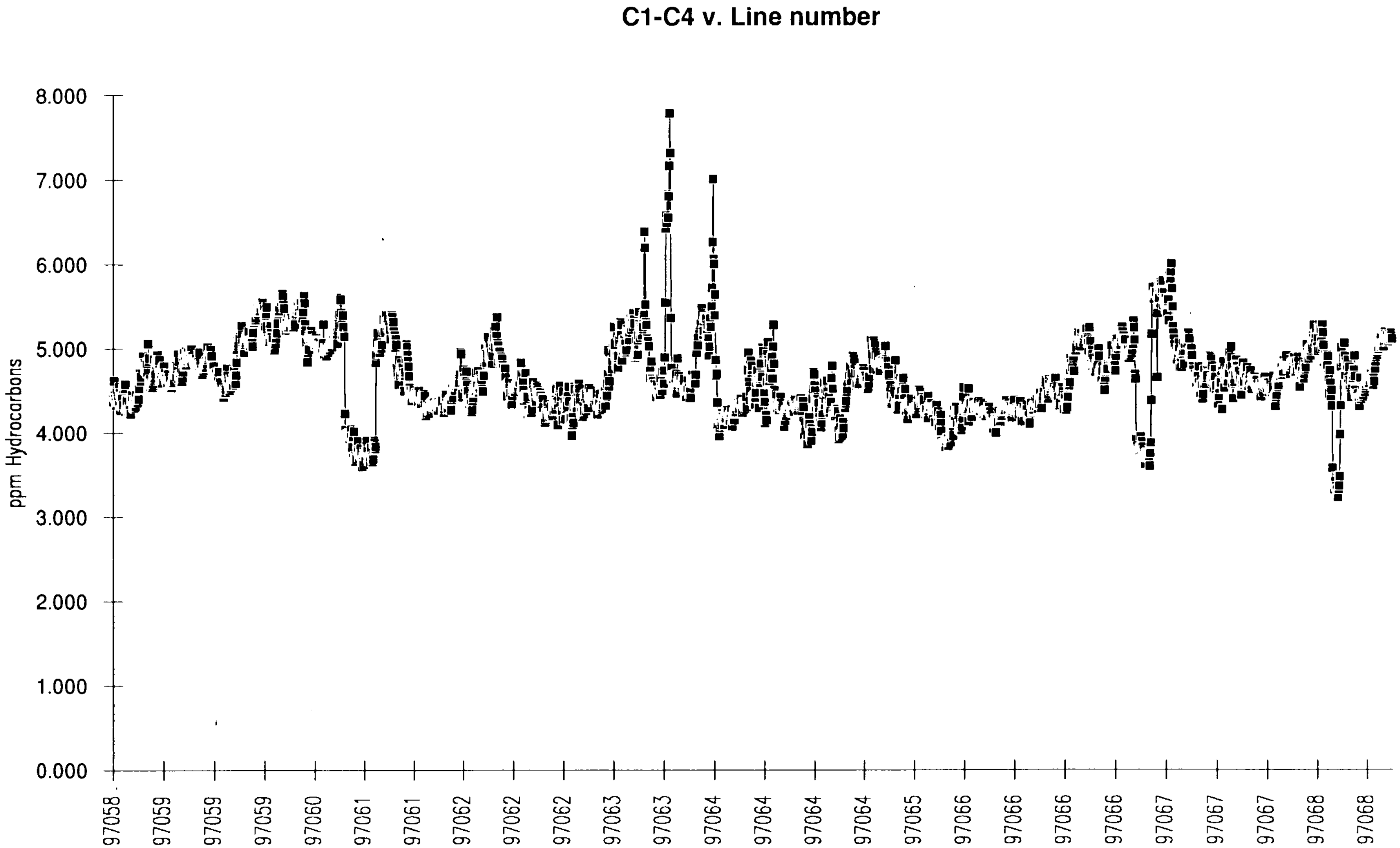


Figure 13c. Sum of C1-C4 hydrocarbons Lines 58-68 (Vulcan Sub-Basin).

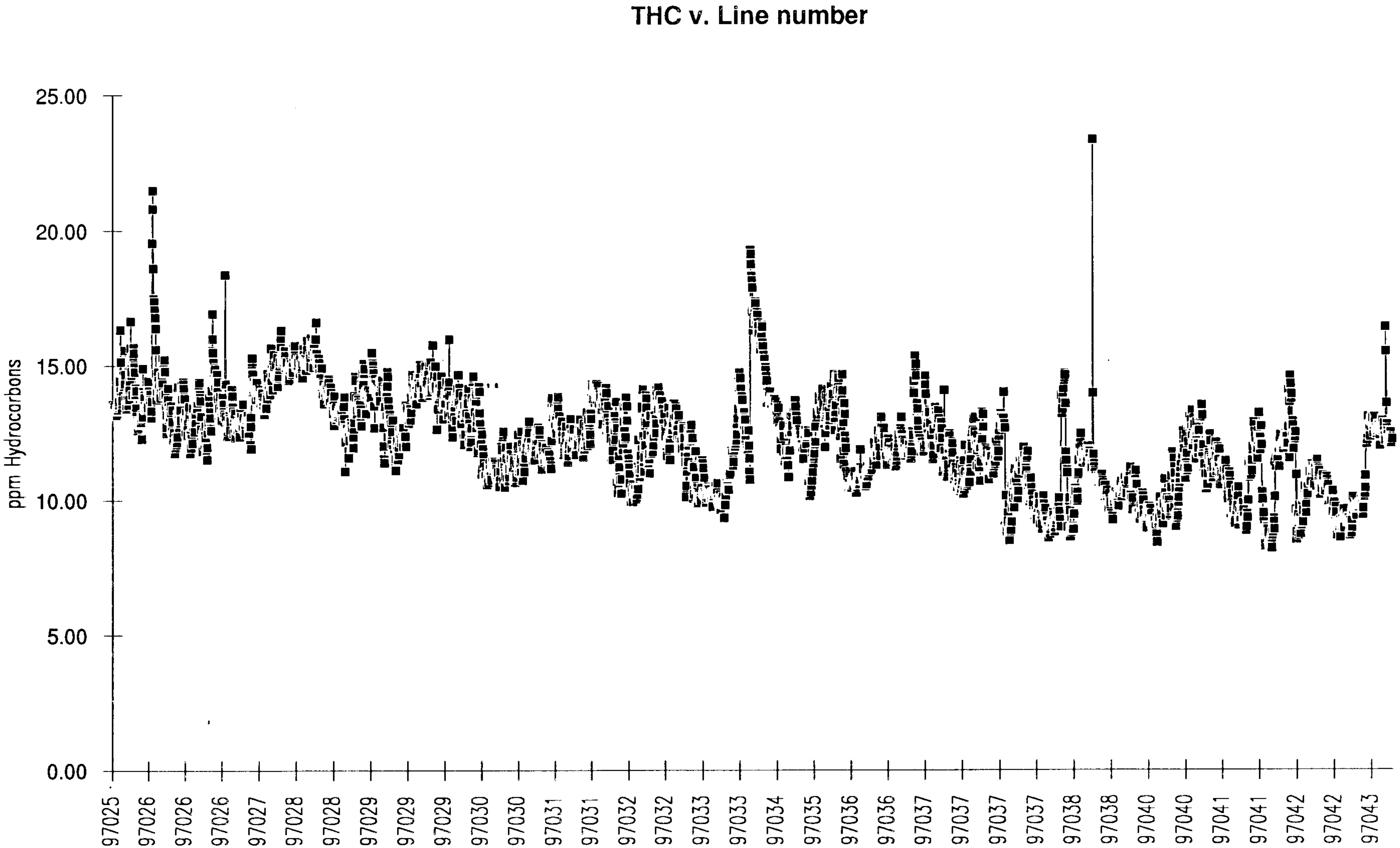


Figure 14a. Total hydrocarbons (THC) versus line number for Lines 25-43 (Vulcan Sub-Basin).

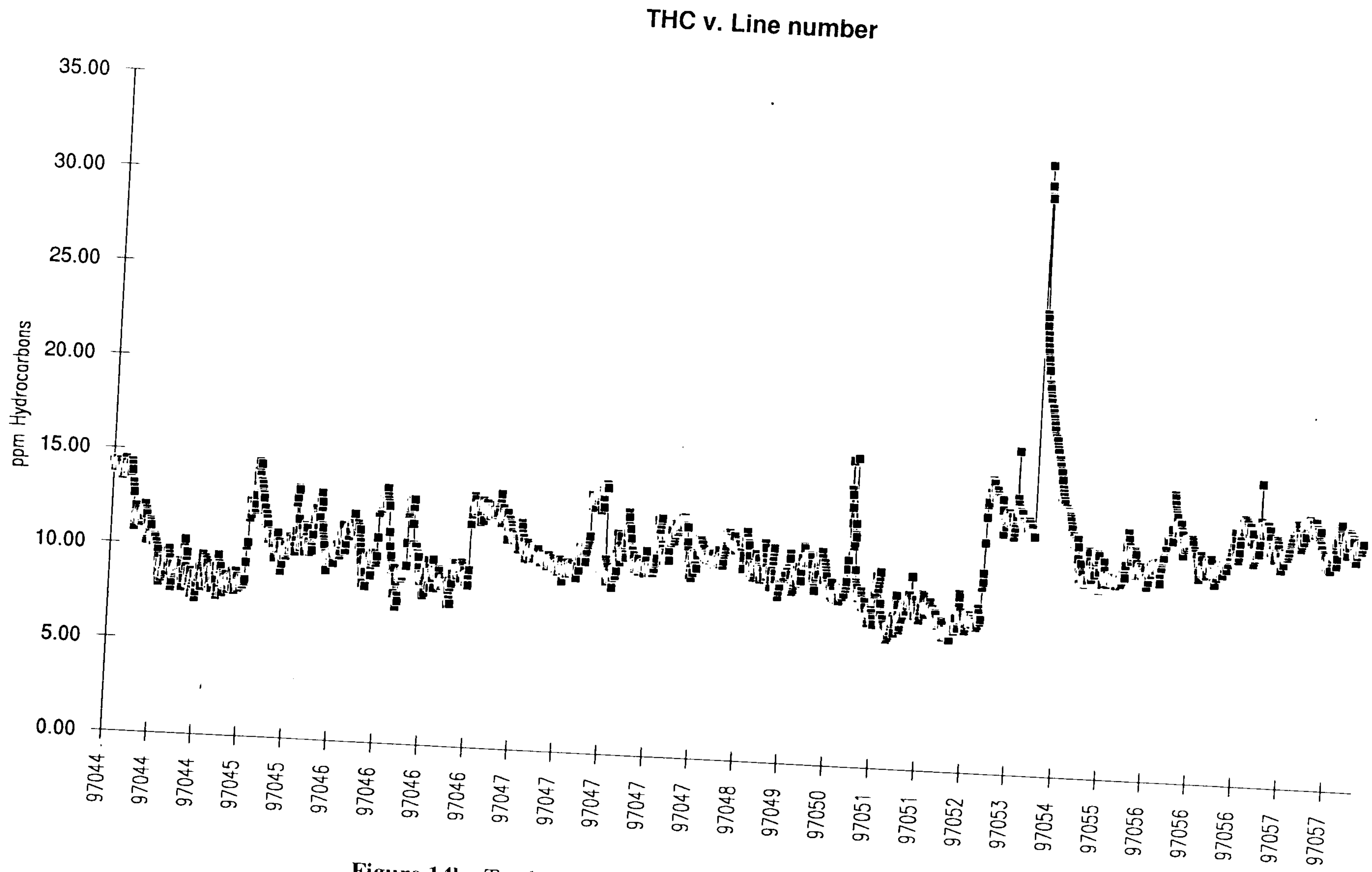


Figure 14b. Total hydrocarbons (THC) versus line number for Lines 44-57 (Vulcan Sub-Basin).

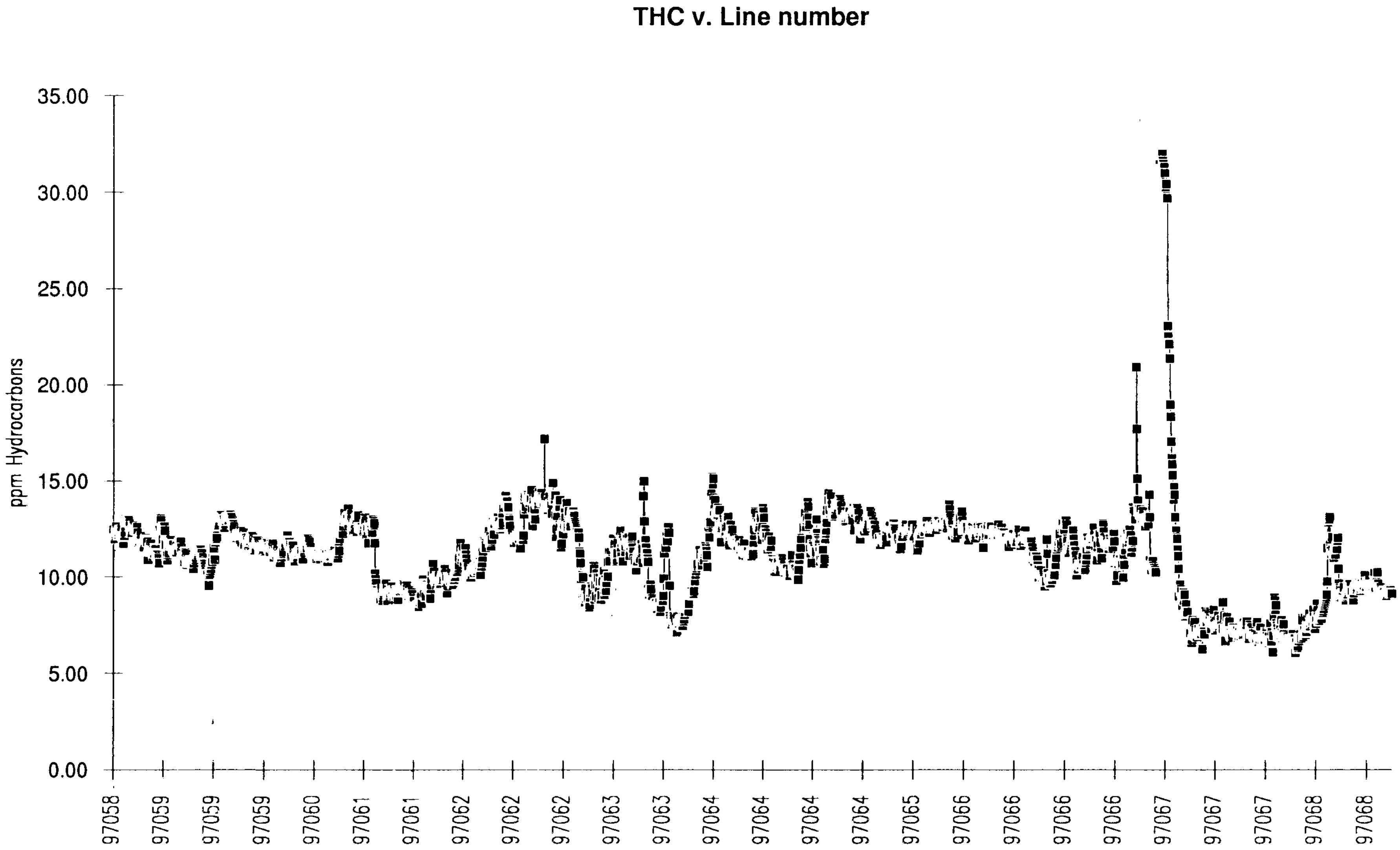


Figure 14c. Total hydrocarbons (THC) versus line number for Lines 58-68 (Vulcan Sub-Basin).

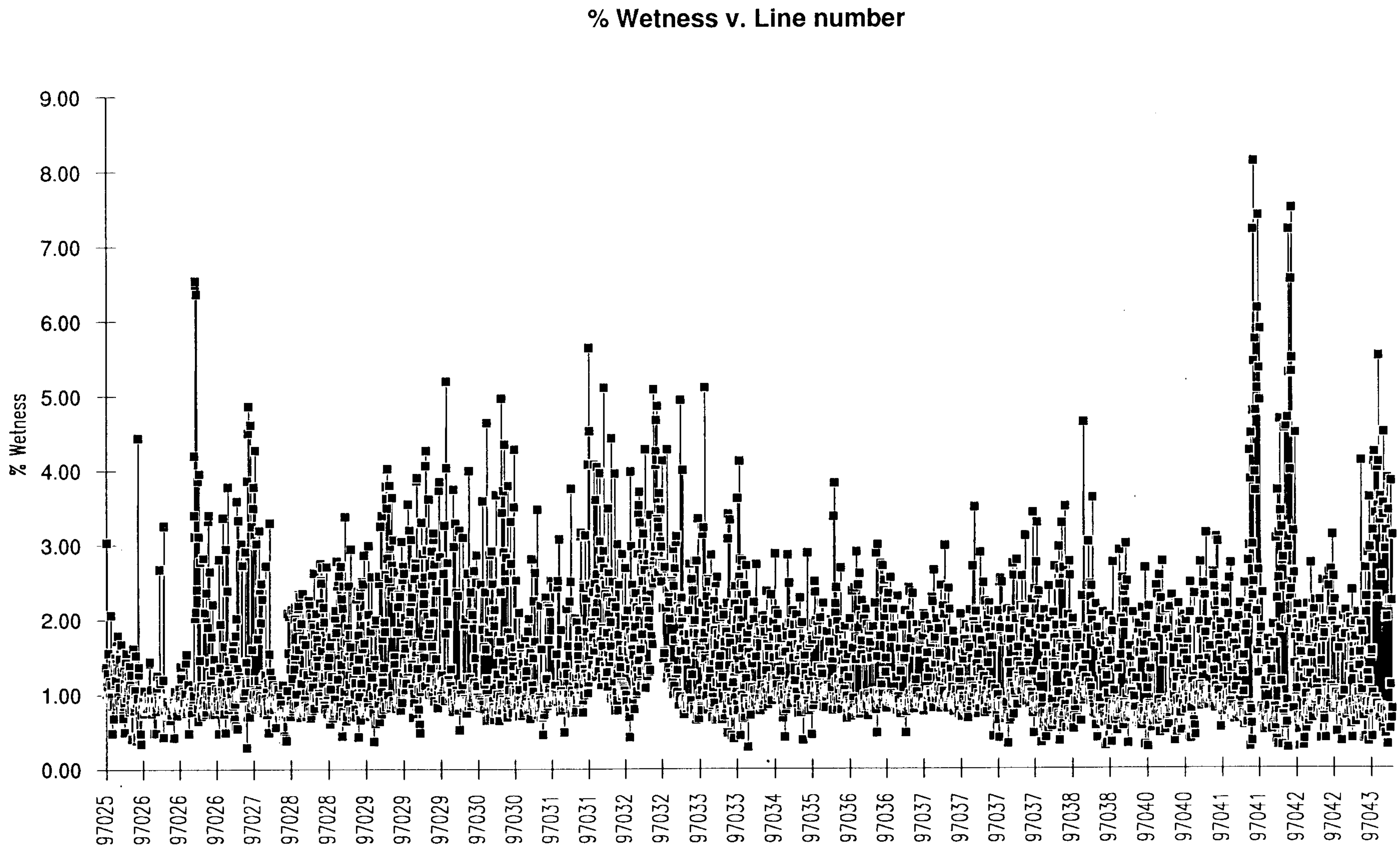


Figure 15a. Percent hydrocarbon wetness versus line number for Lines 25-43 (Vulcan Sub-Basin).

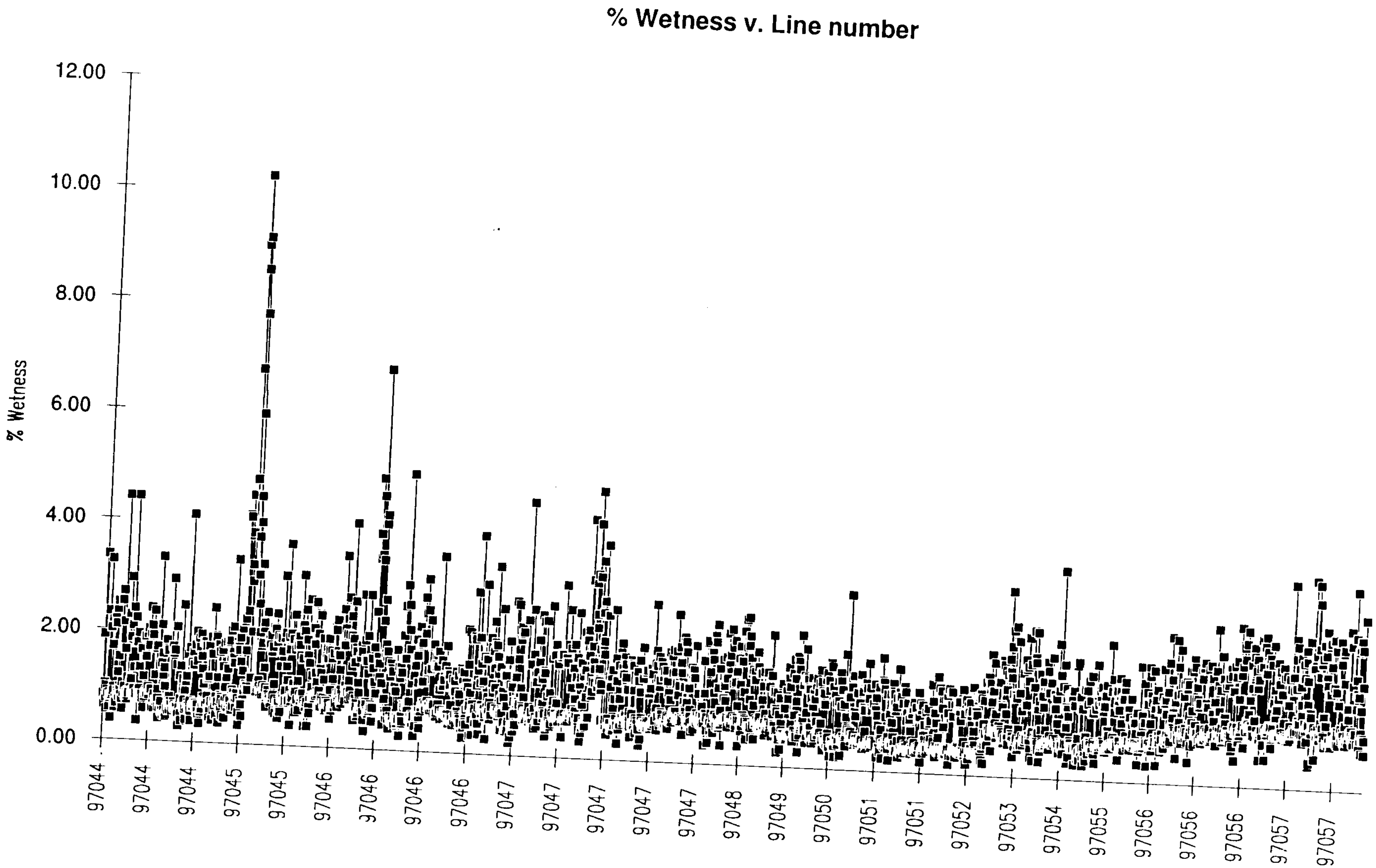


Figure 15b. Percent hydrocarbon wetness versus line number for Lines 44-57 (Vulcan Sub-Basin).

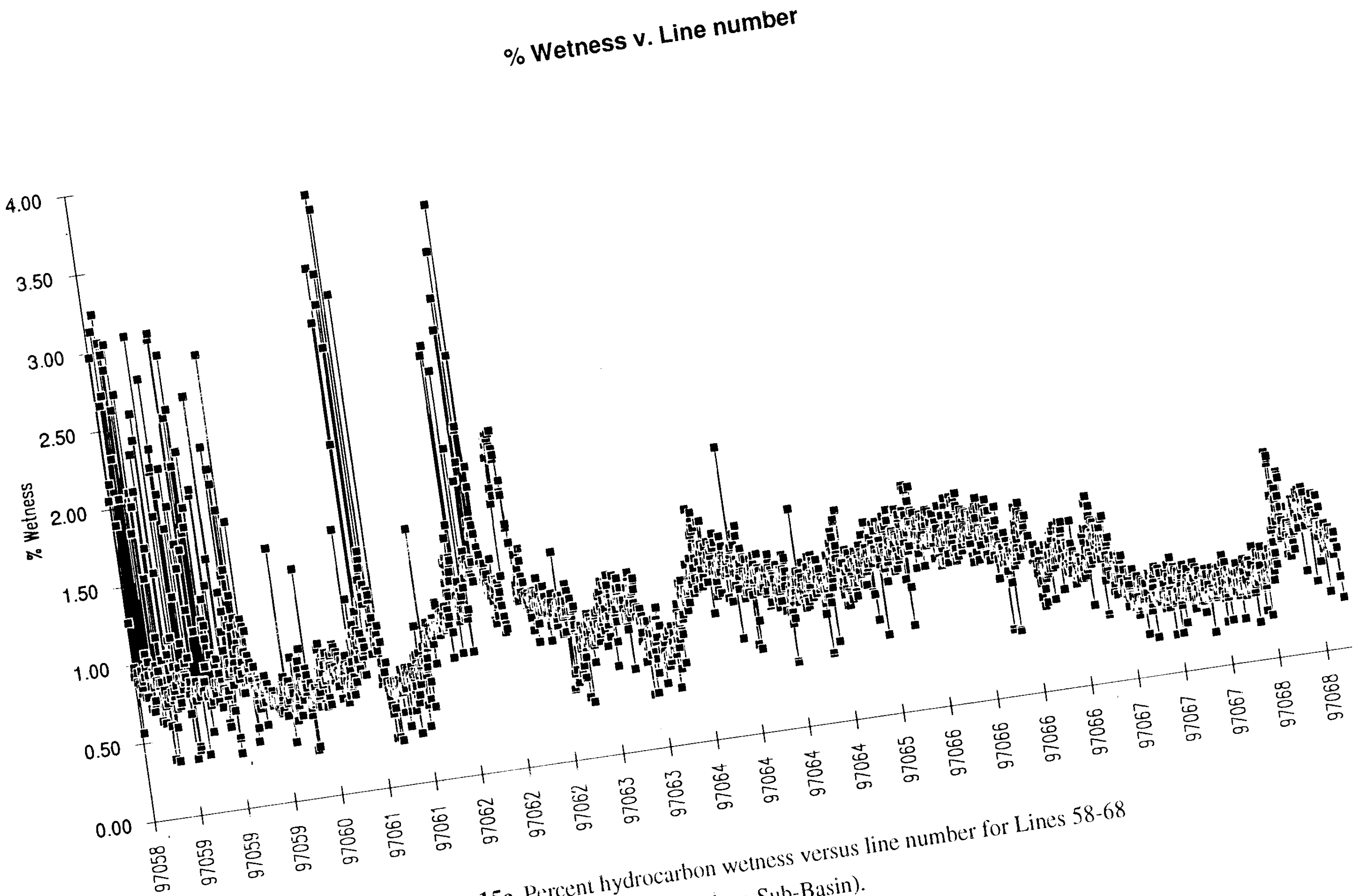


Figure 15c. Percent hydrocarbon wetness versus line number for Lines 58-68 (Vulcan Sub-Basin).

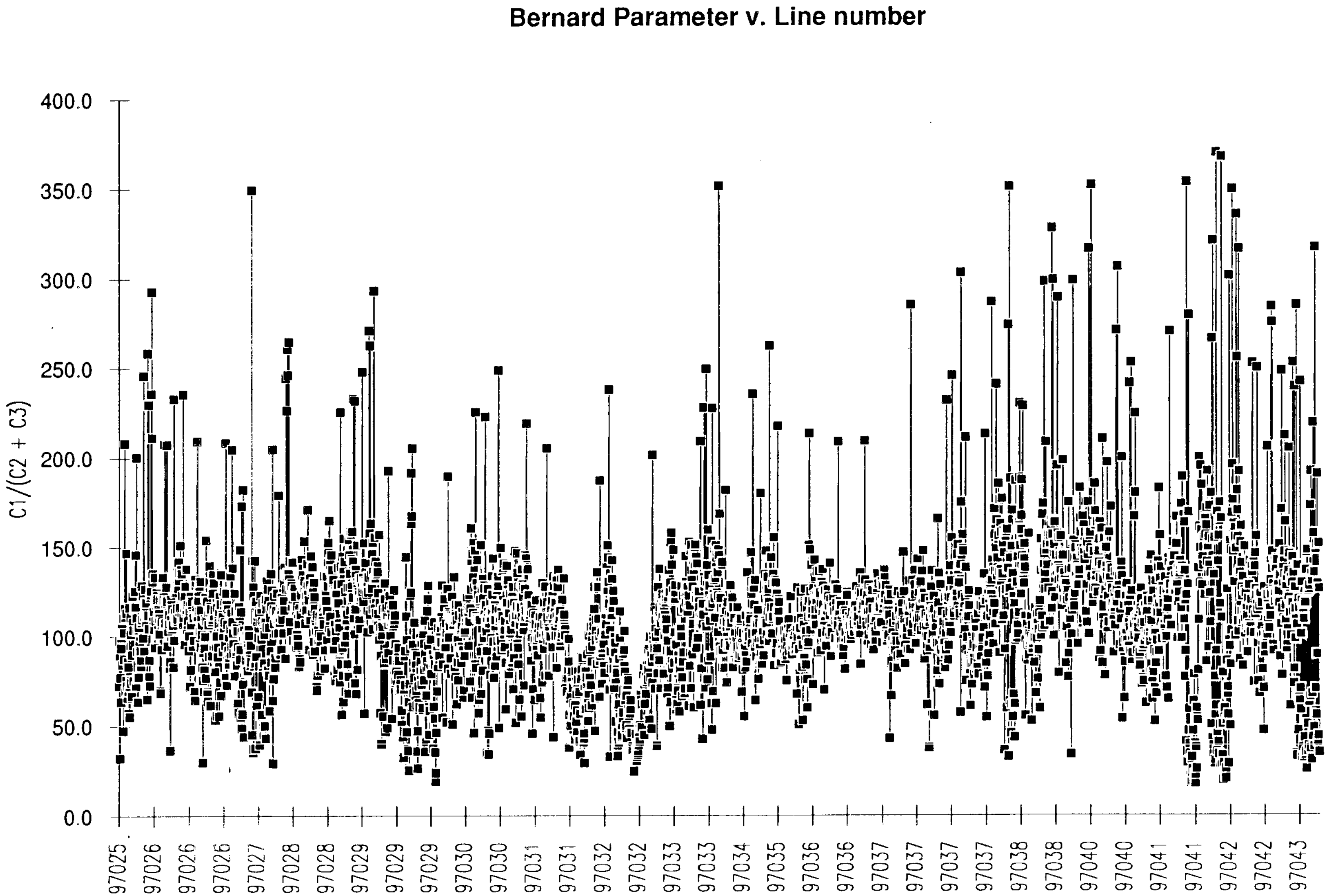


Figure 16a. Bernard parameter versus line number for Lines 25-43 (Vulcan Sub-Basin).

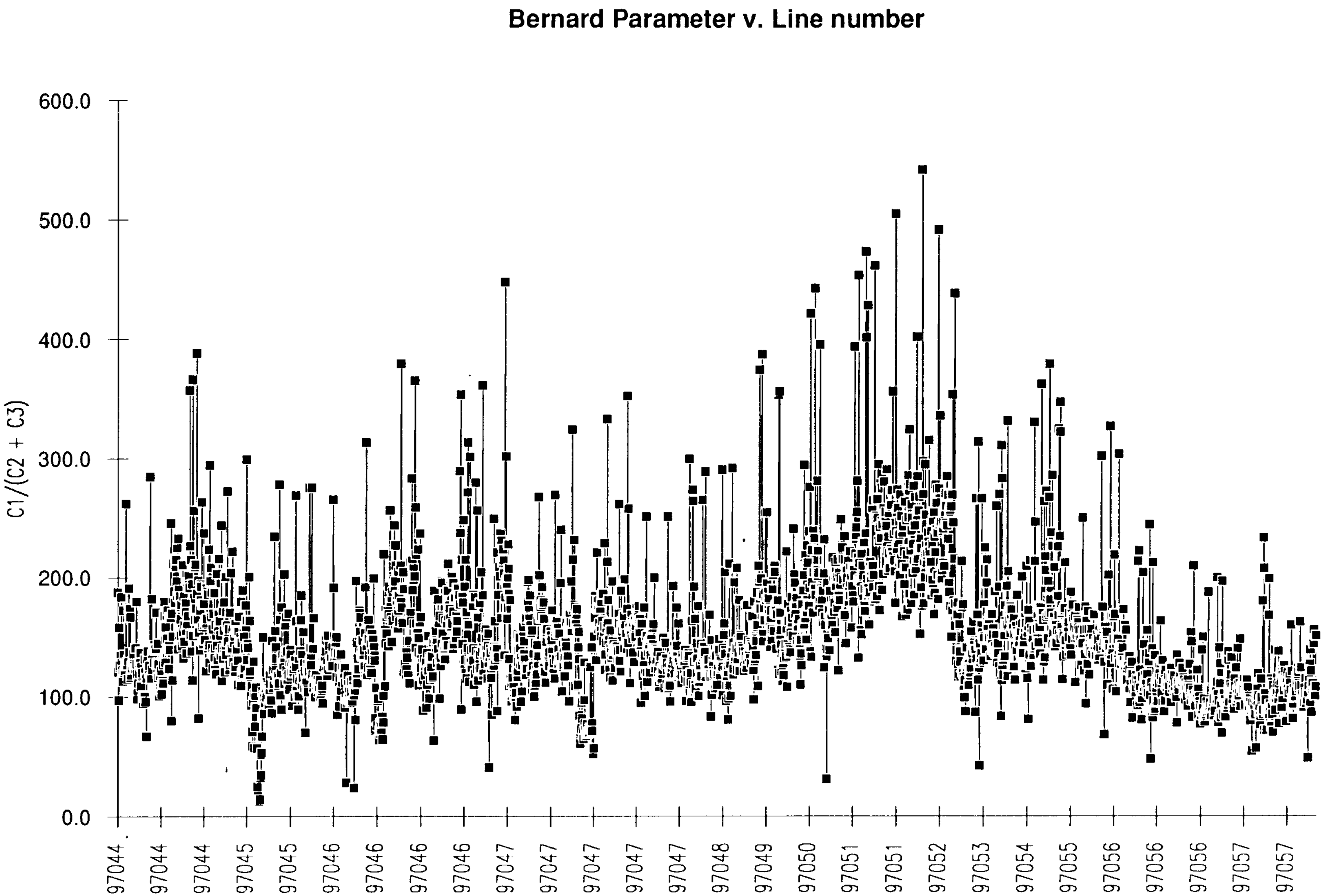


Figure 16b. Bernard parameter versus line number for Lines 44-57 (Vulcan Sub-Basin).

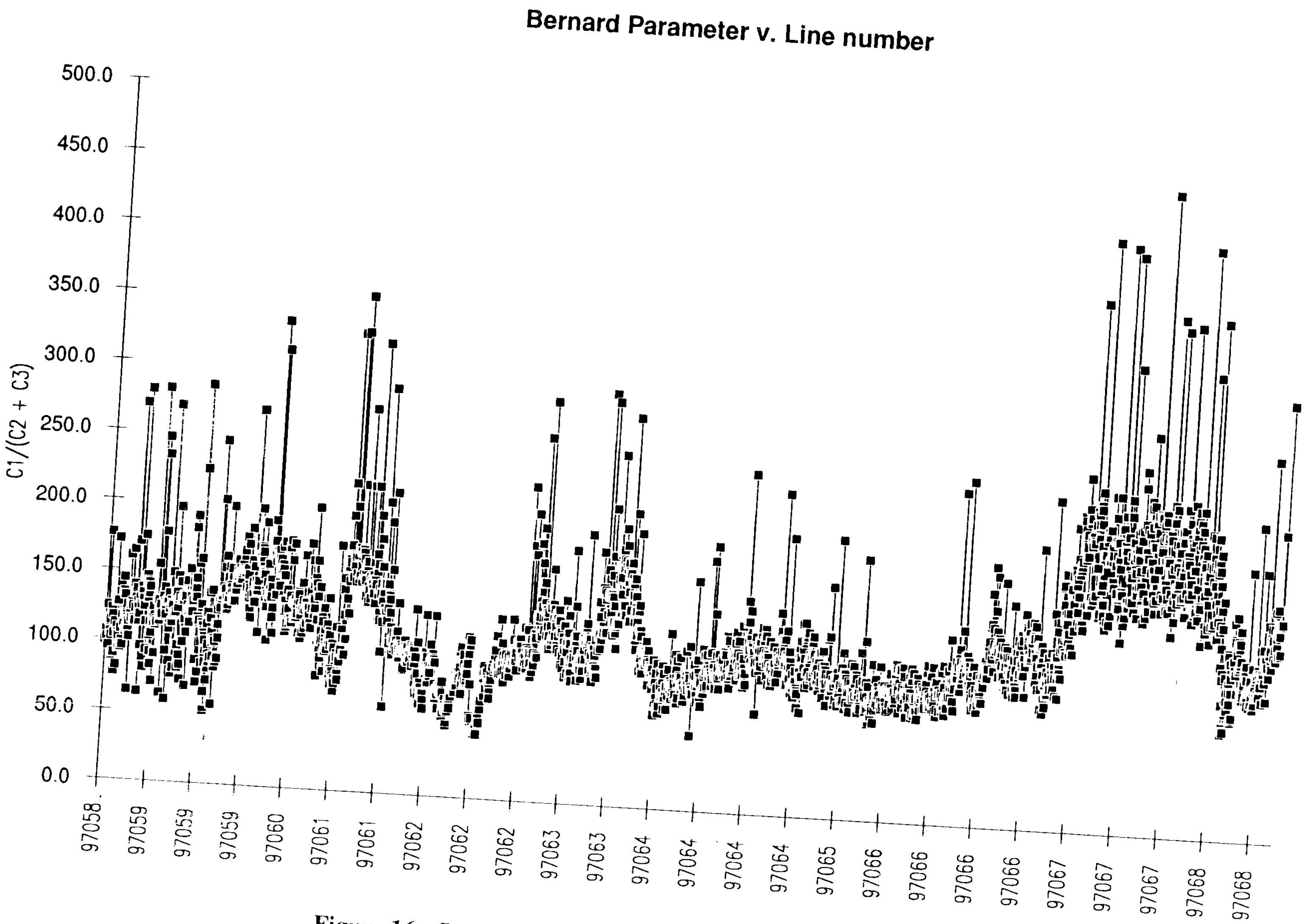


Figure 16c. Bernard parameter versus line number for Lines 58-68 (Vulcan Sub-Basin).

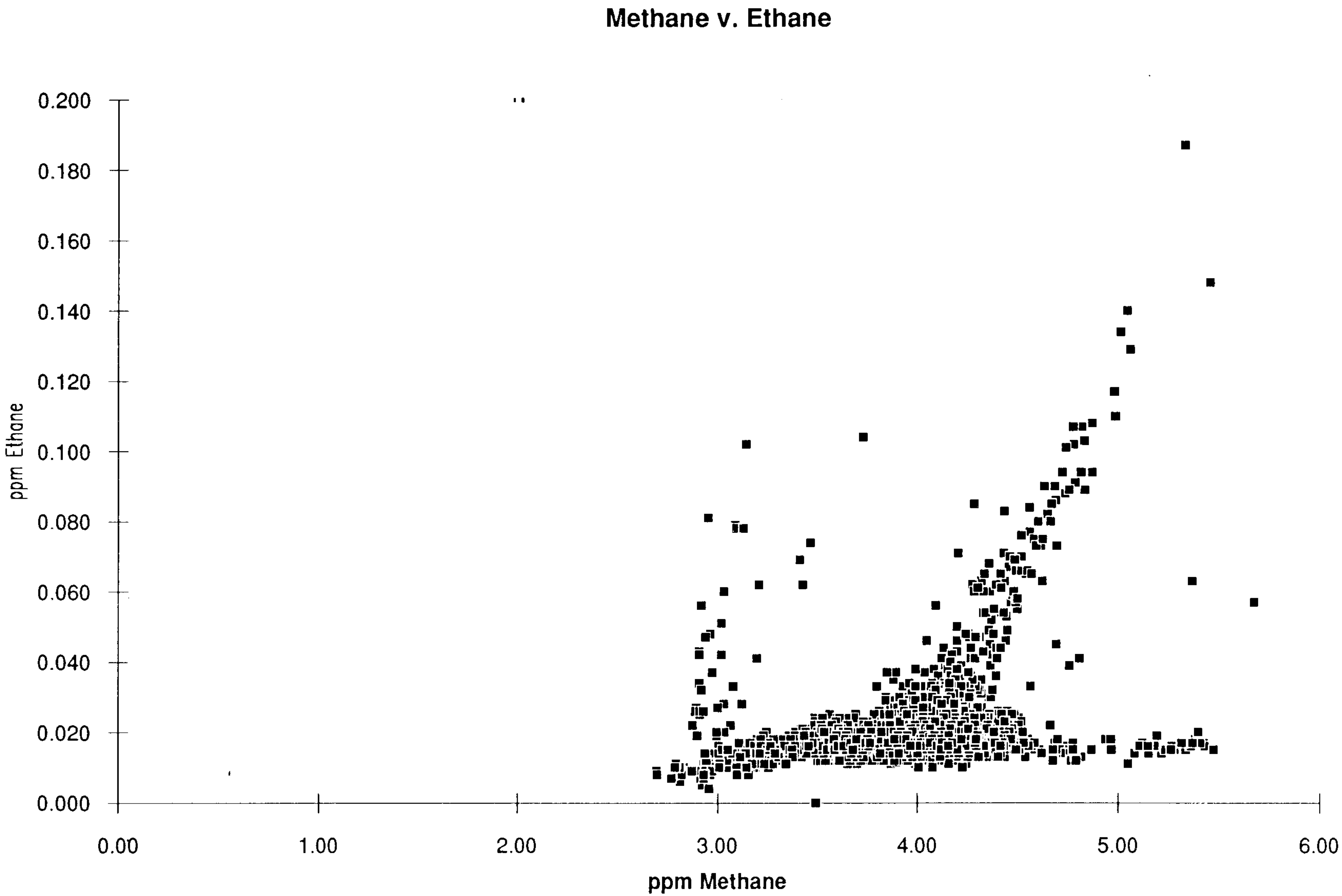


Figure 17a. Methane versus ethane Lines 25-43 (Vulcan Sub-Basin).

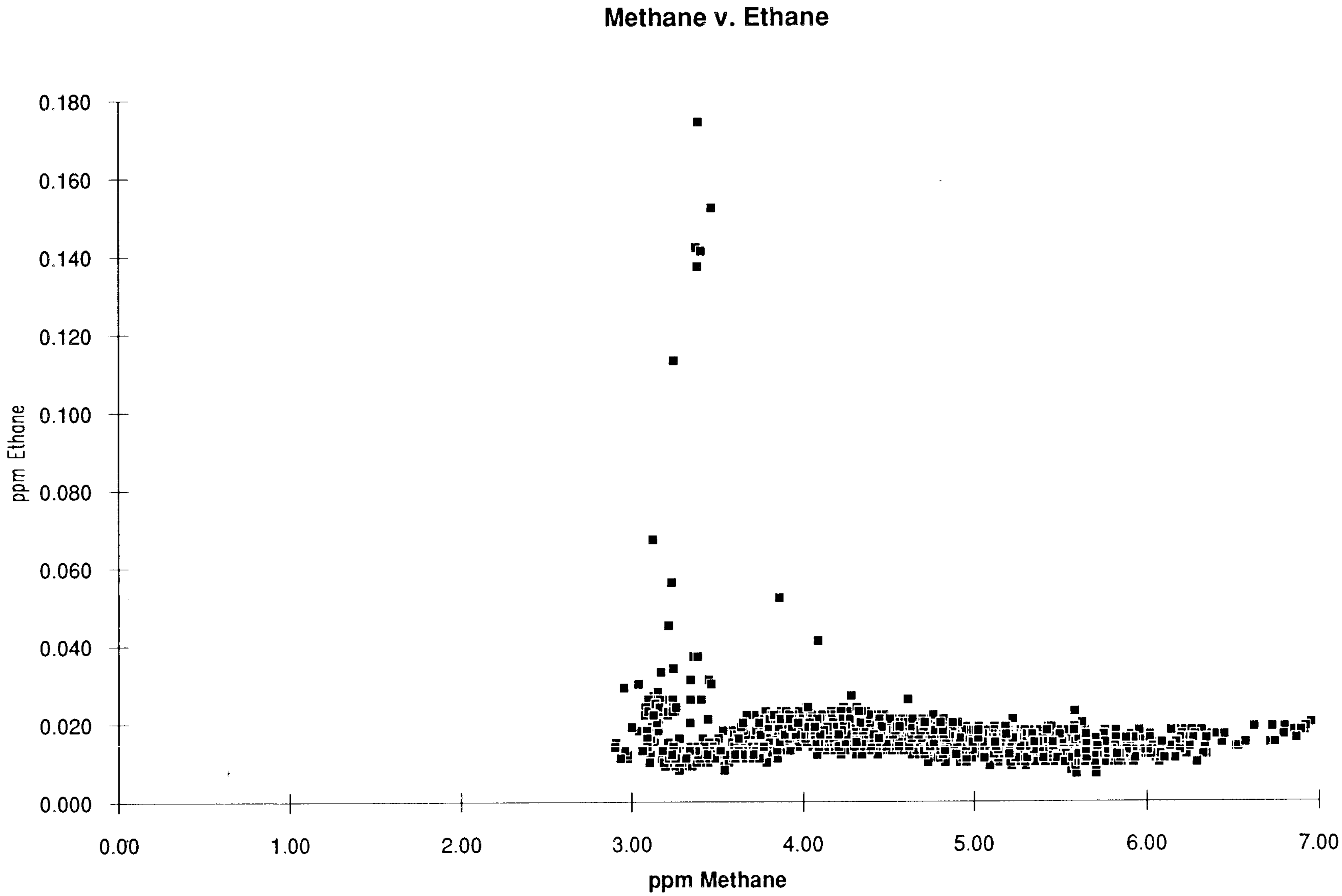


Figure 17b. Methane versus ethane Lines 44-57 (Vulcan Sub-Basin).

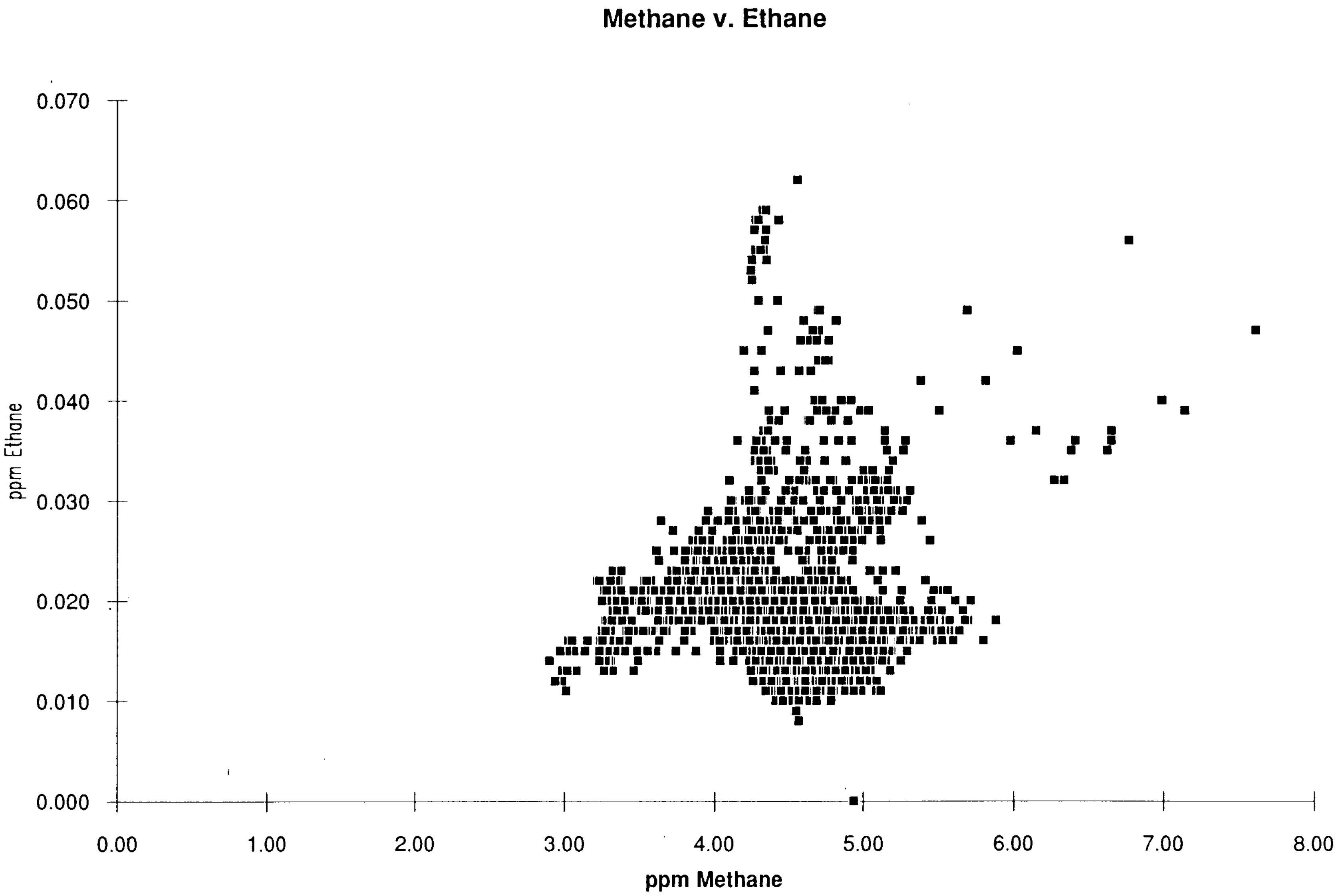


Figure 17c. Methane versus ethane Lines 58-68 (Vulcan Sub-Basin).

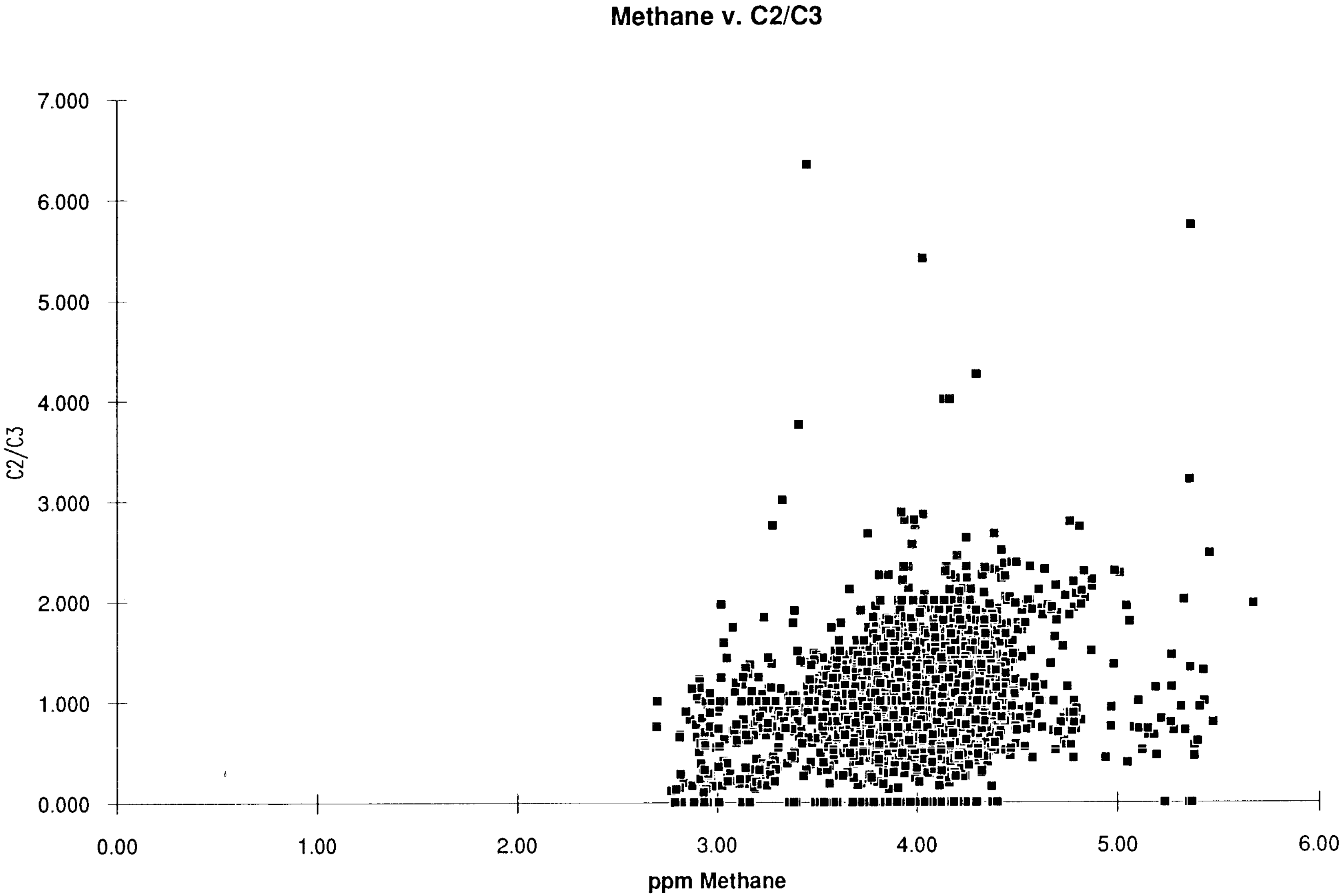


Figure 18a. Methane versus C2/C3 Lines 25-43 (Vulcan Sub-Basin).

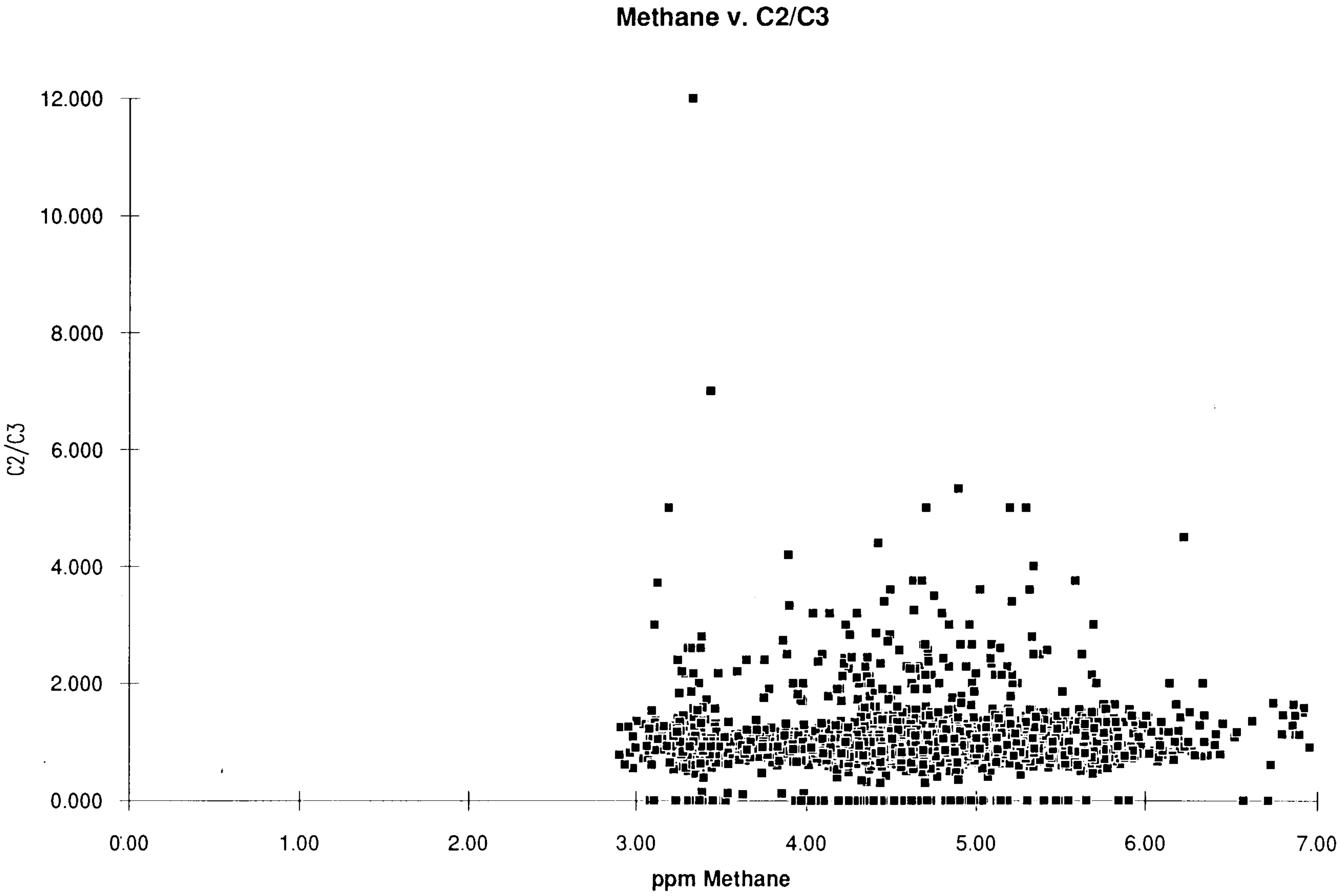


Figure 18b. Methane versus C2/C3 Lines 44-57 (Vulcan Sub-Basin).

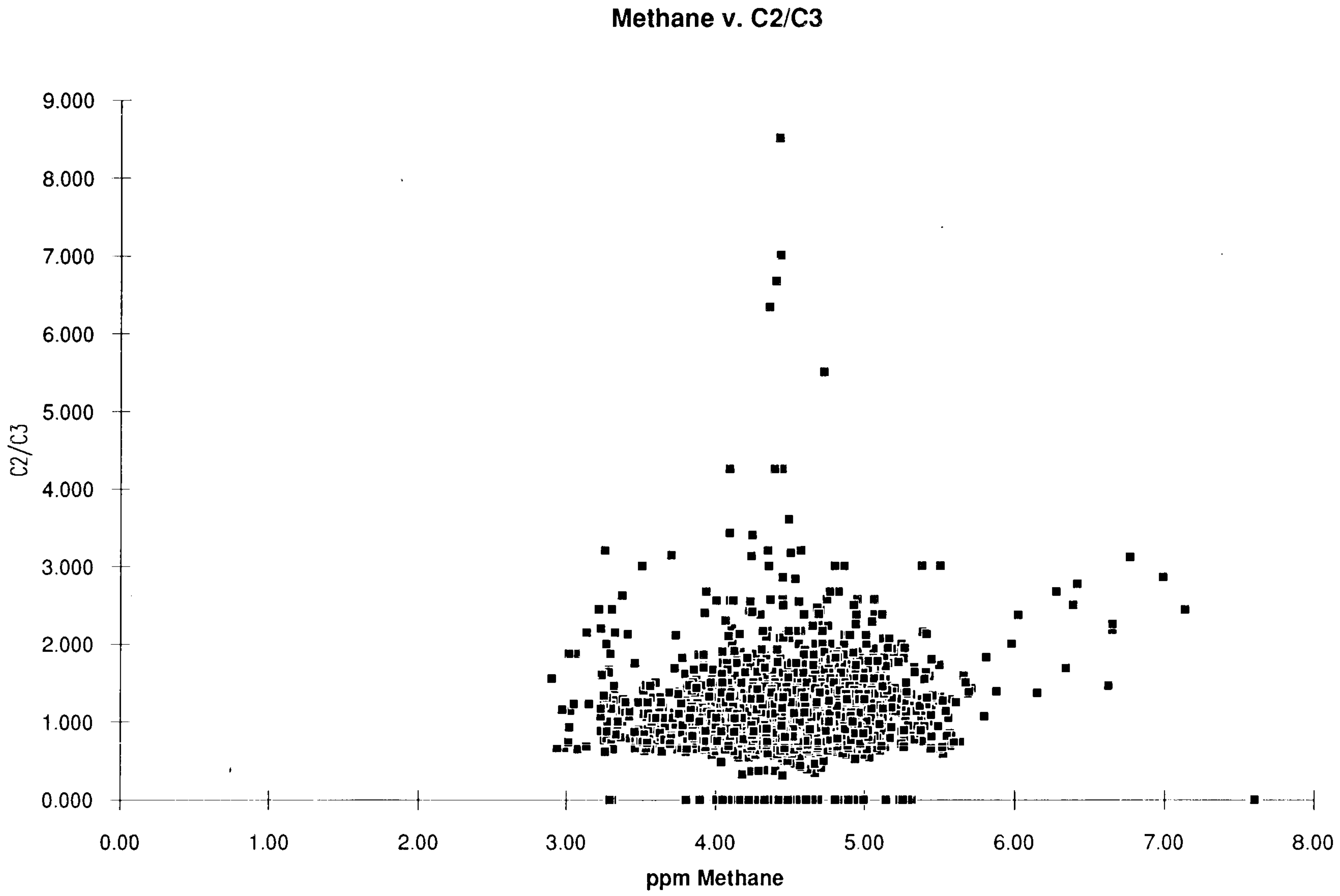


Figure 18c. Methane versus C2/C3 Lines 58-68 (Vulcan Sub-Basin).

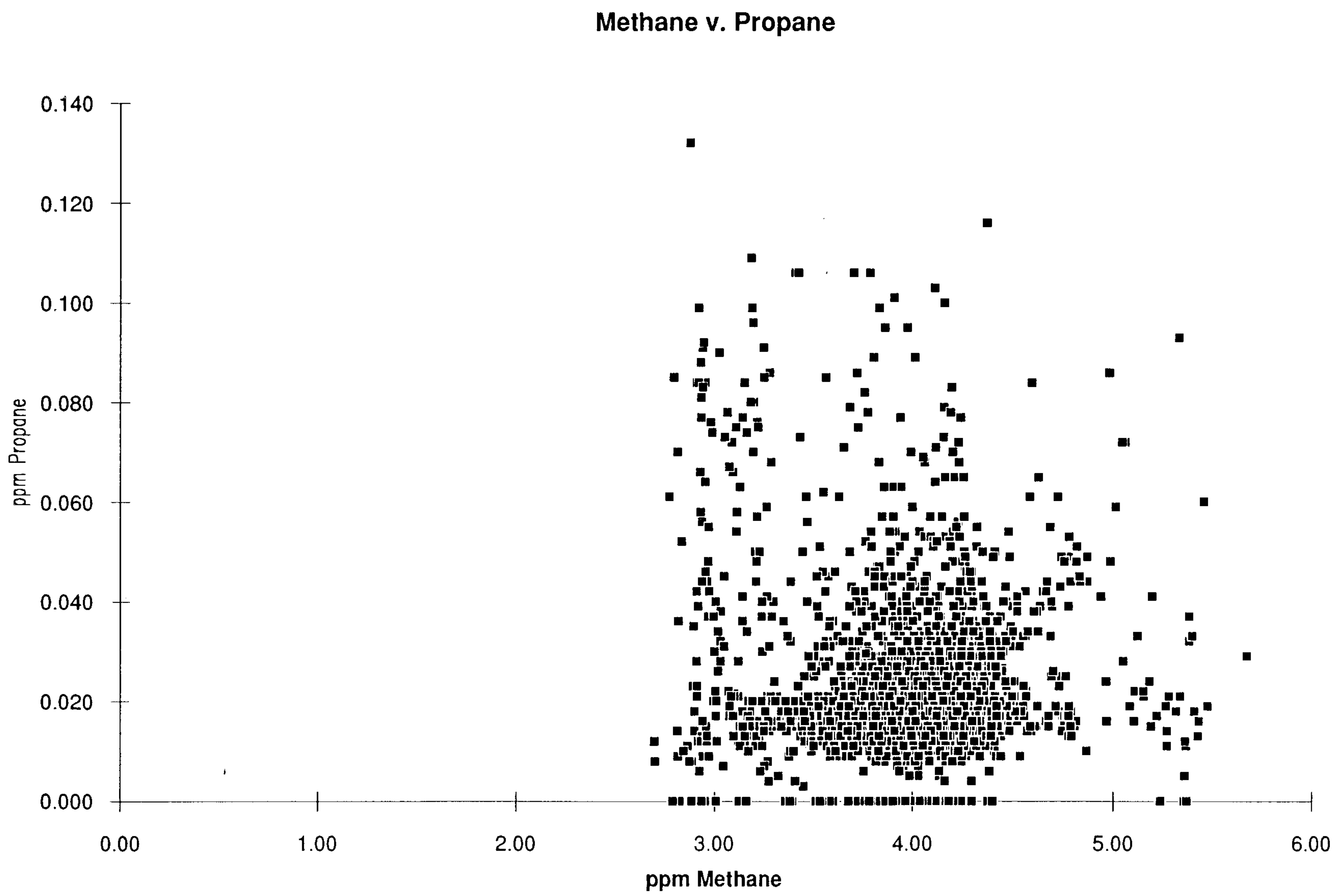


Figure 19a. Methane versus propane Lines 25-43 (Vulcan Sub-Basin).

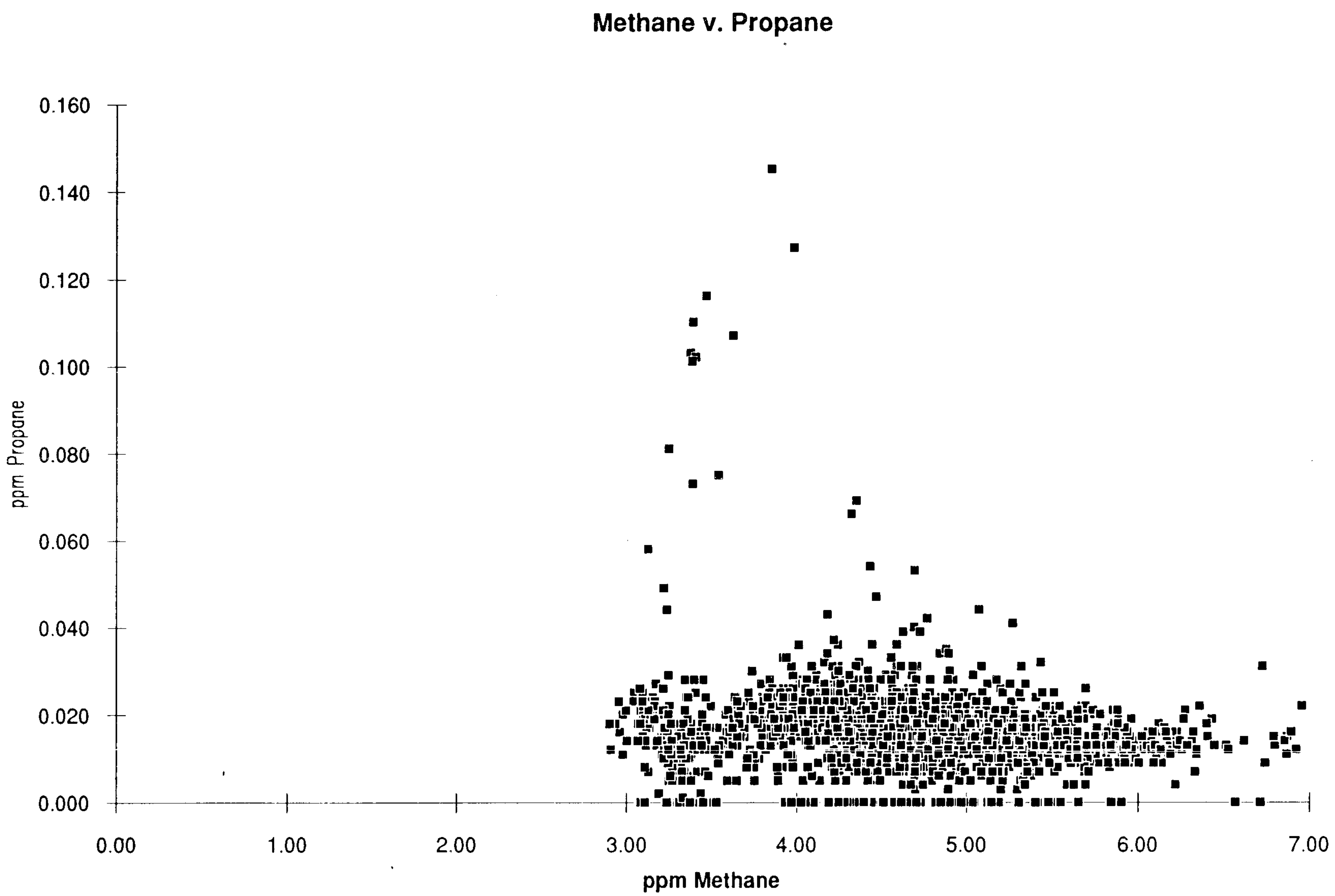


Figure 19b. Methane versus propane Lines 44-57 (Vulcan Sub-Basin).

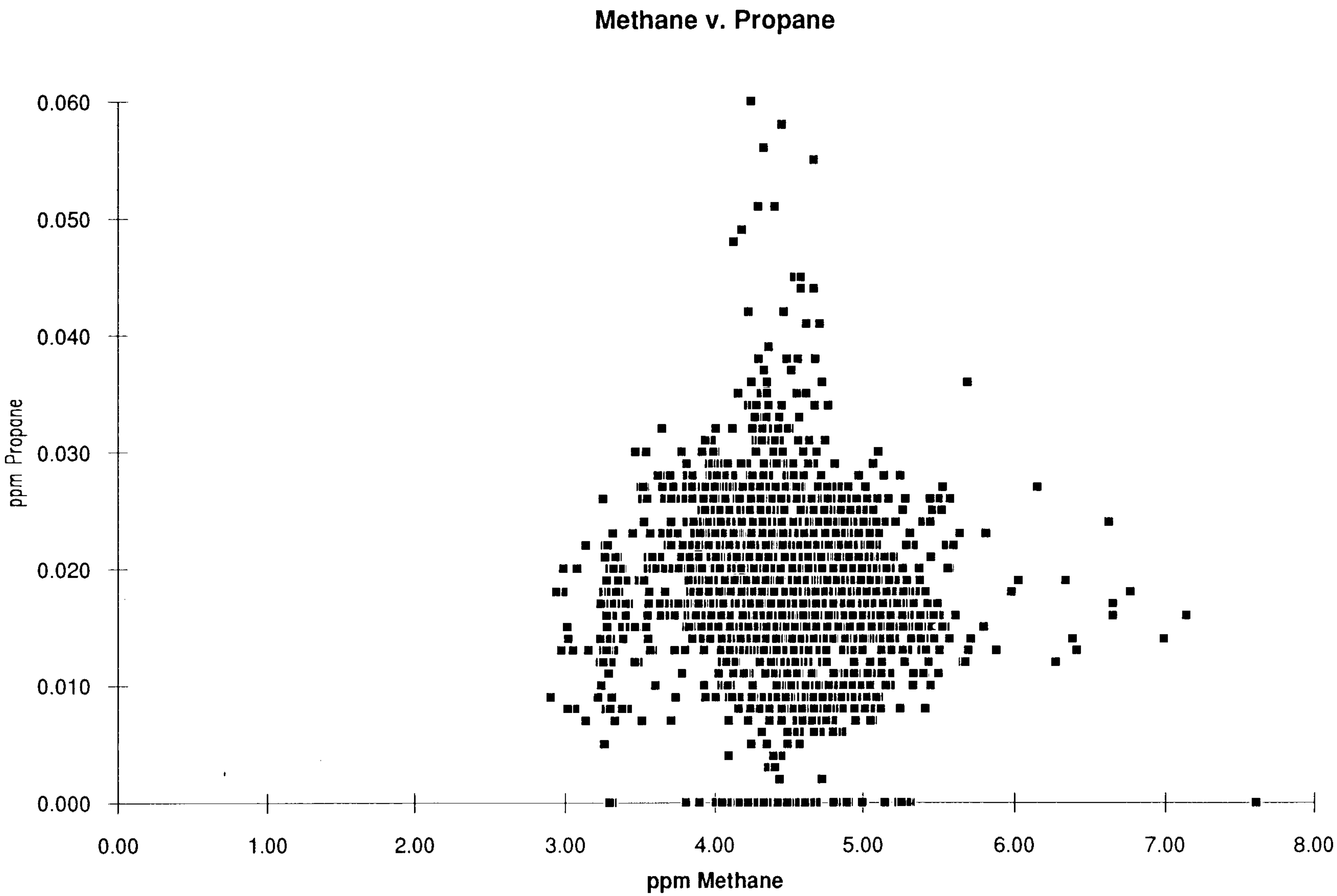


Figure 19c. Methane versus propane Lines 58-68 (Vulcan Sub-Basin).

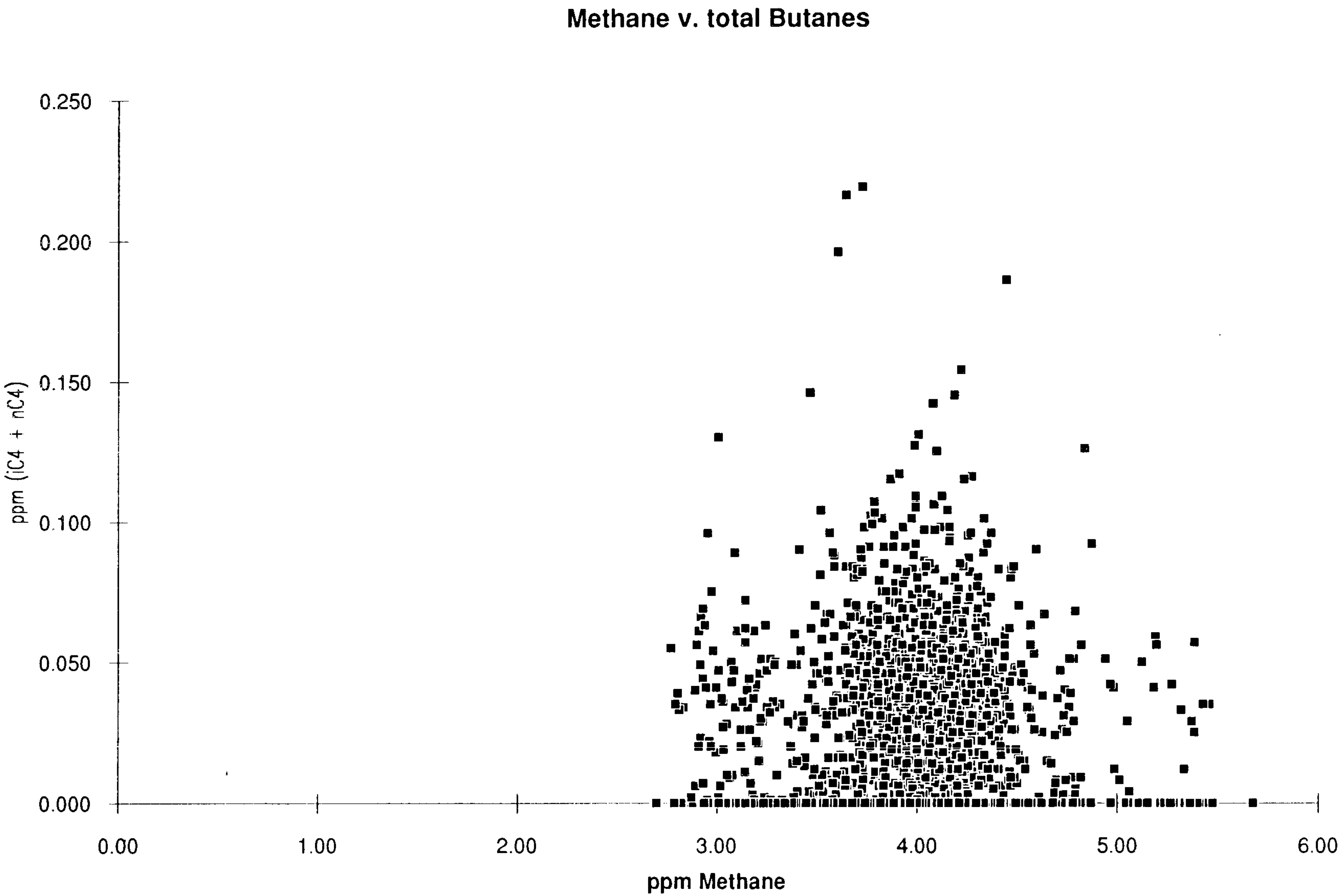


Figure 20a. Methane versus total butanes Lines 25-43 (Vulcan Sub-Basin).

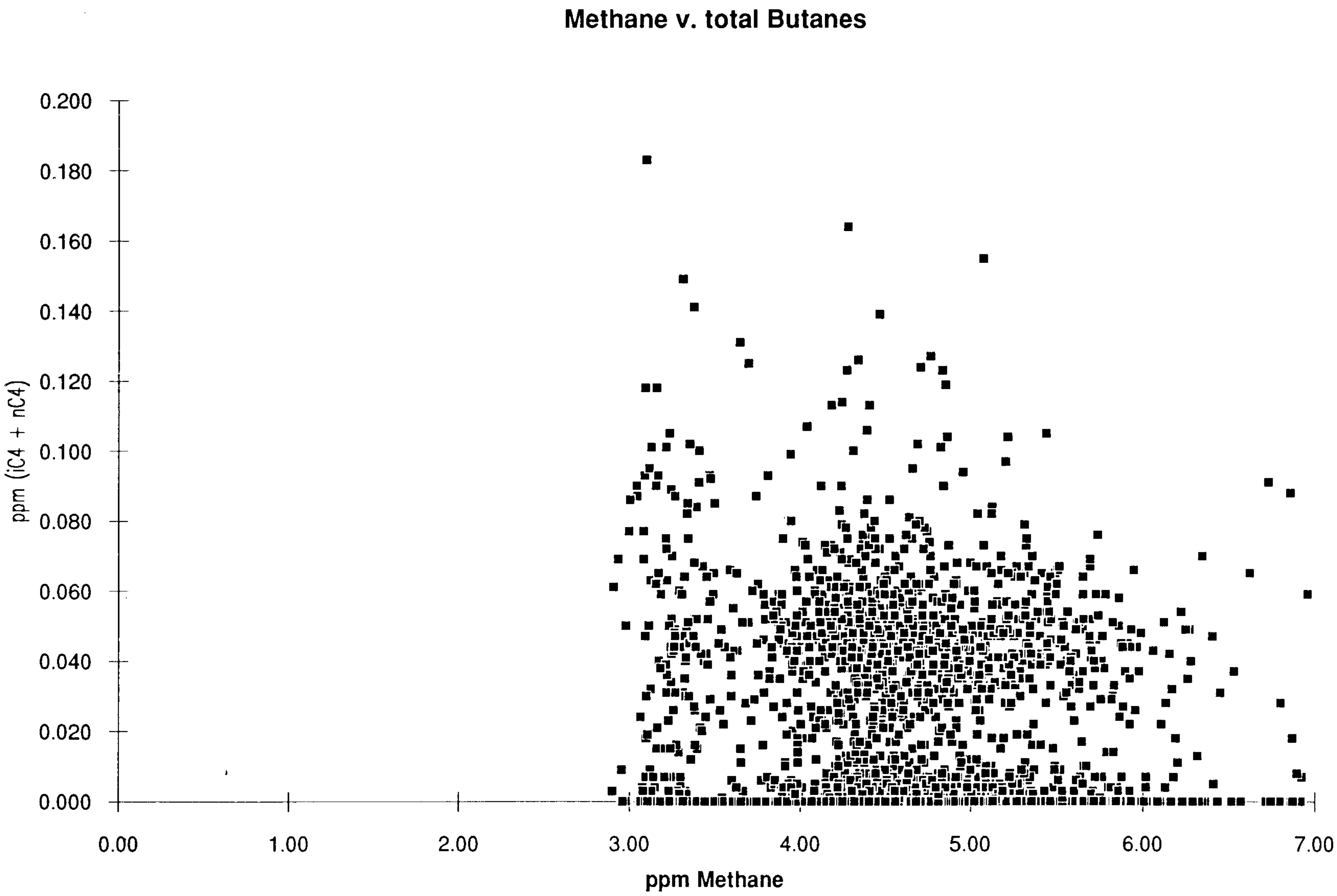


Figure 20b. Methane versus total butanes Lines 44-57 (Vulcan Sub-Basin).

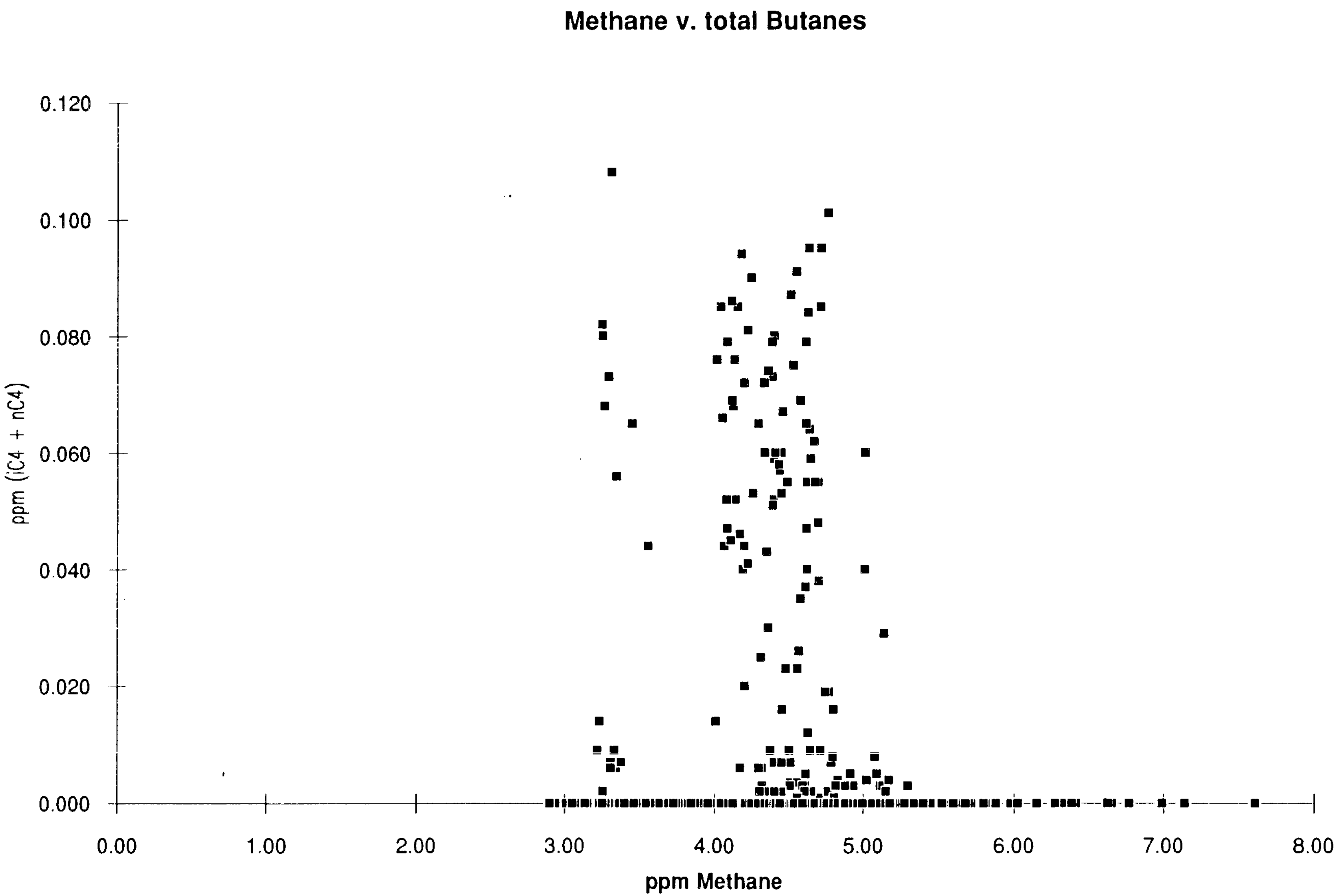


Figure 20c. Methane versus total butanes Lines 58-68 (Vulcan Sub-Basin).

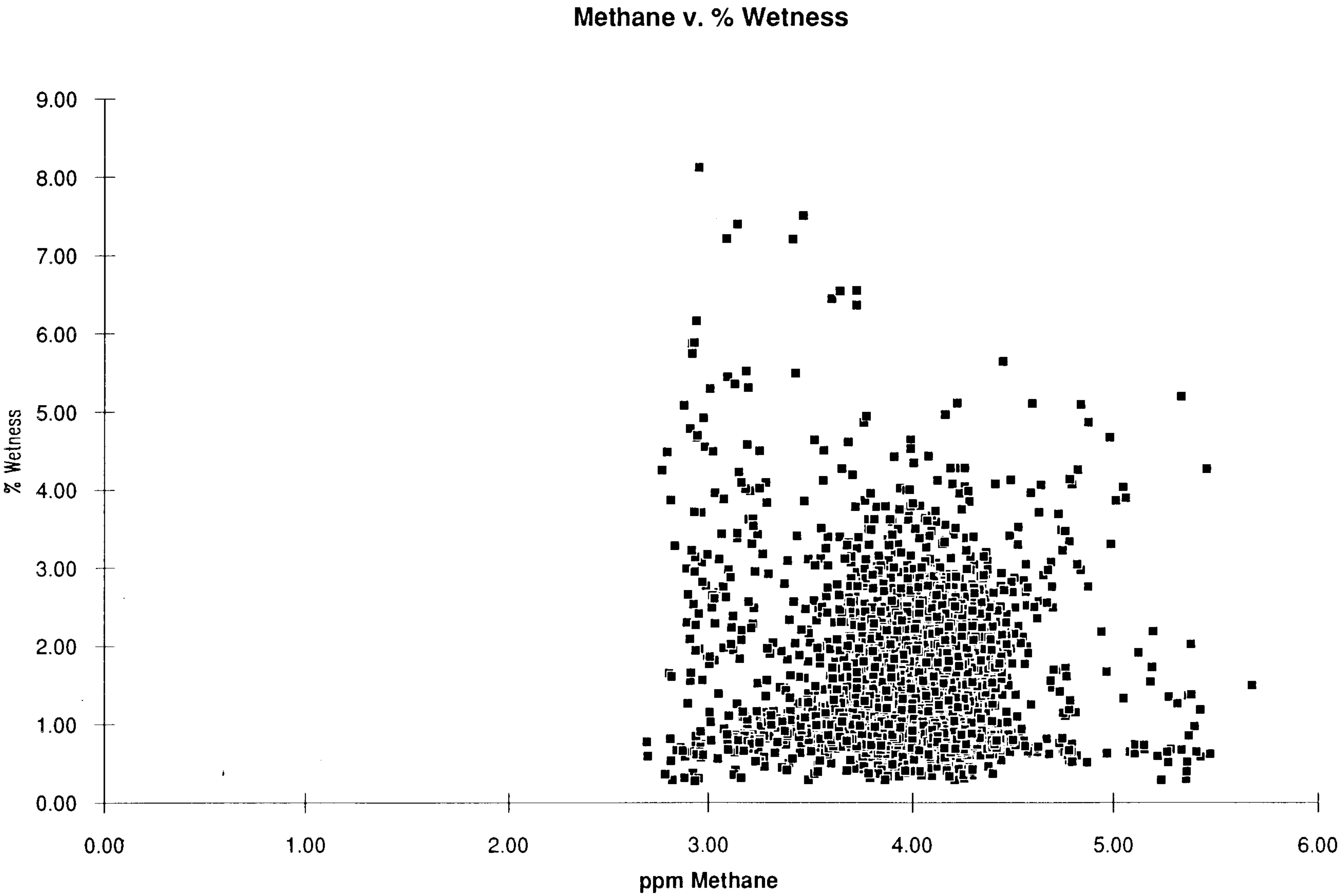


Figure 21a. Methane versus % hydrocarbon wetness Lines 25-43 (Vulcan Sub-Basin).

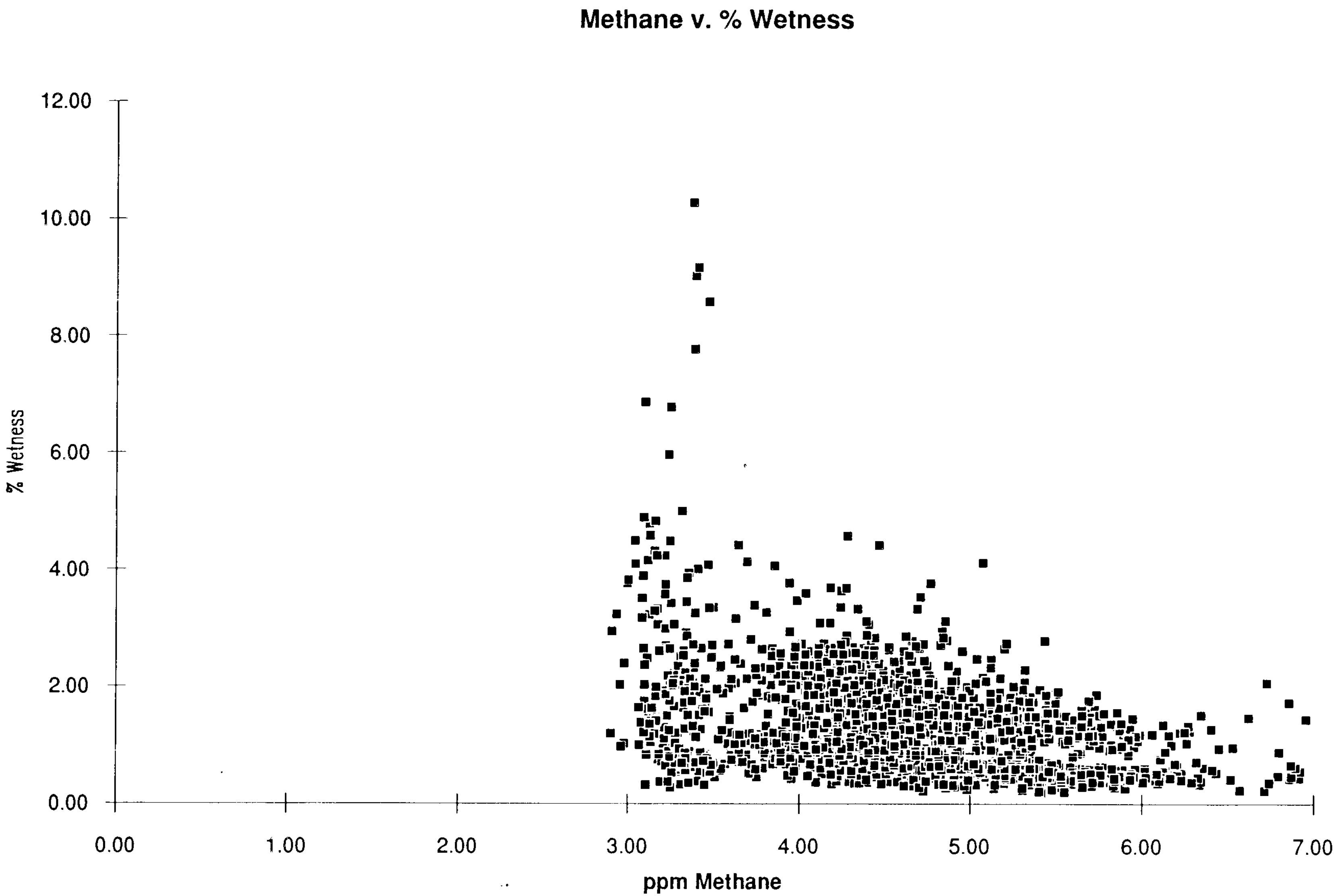


Figure 21b. Methane versus % hydrocarbon wetness Lines 44-57 (Vulcan Sub-Basin).

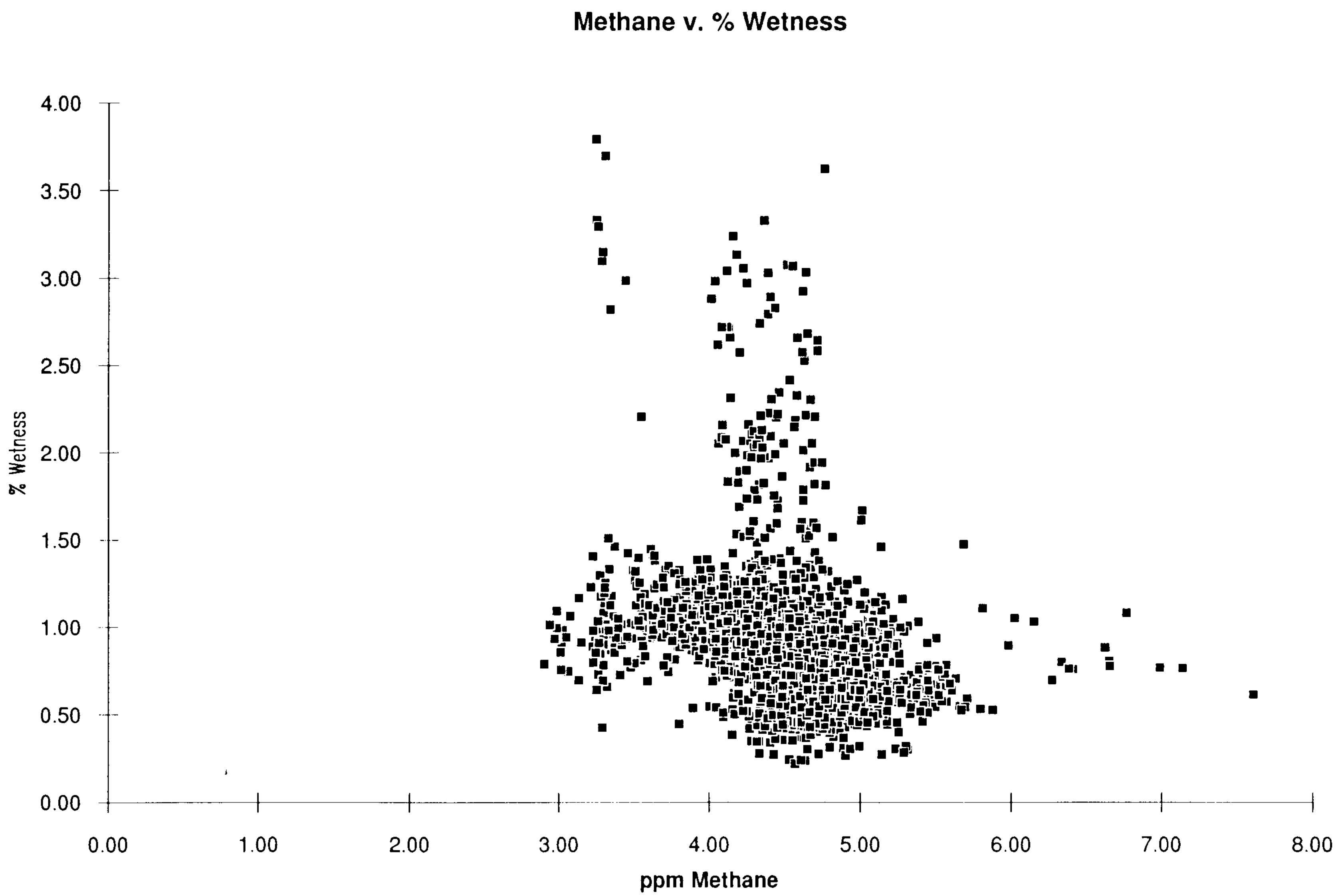


Figure 21c. Methane versus % hydrocarbon wetness Lines 58-68 (Vulcan Sub-Basin).

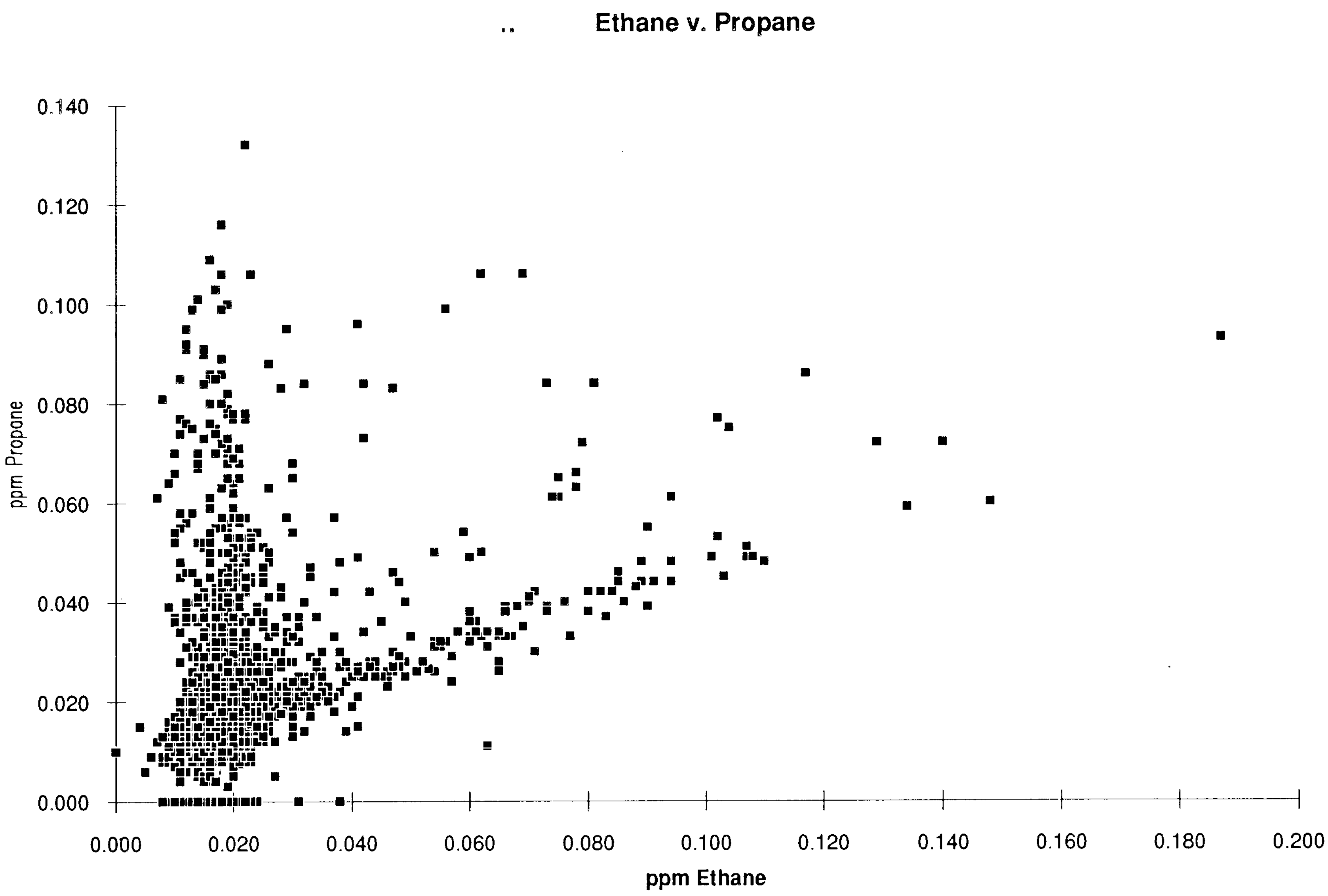


Figure 22a. Ethane versus propane Lines 25-43 (Vulcan Sub-Basin).

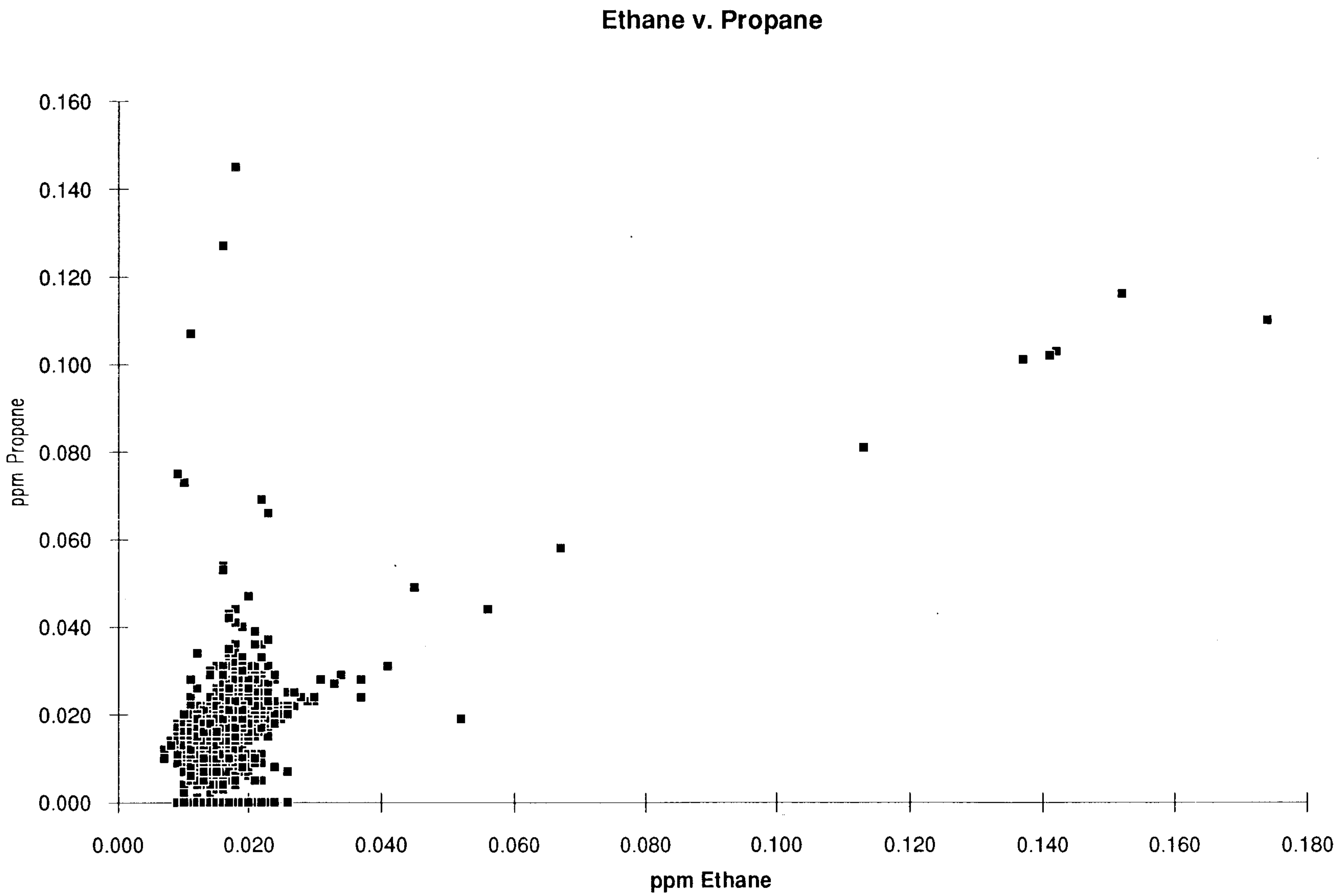


Figure 22b. Ethane versus propane Lines 44-57 (Vulcan Sub-Basin).

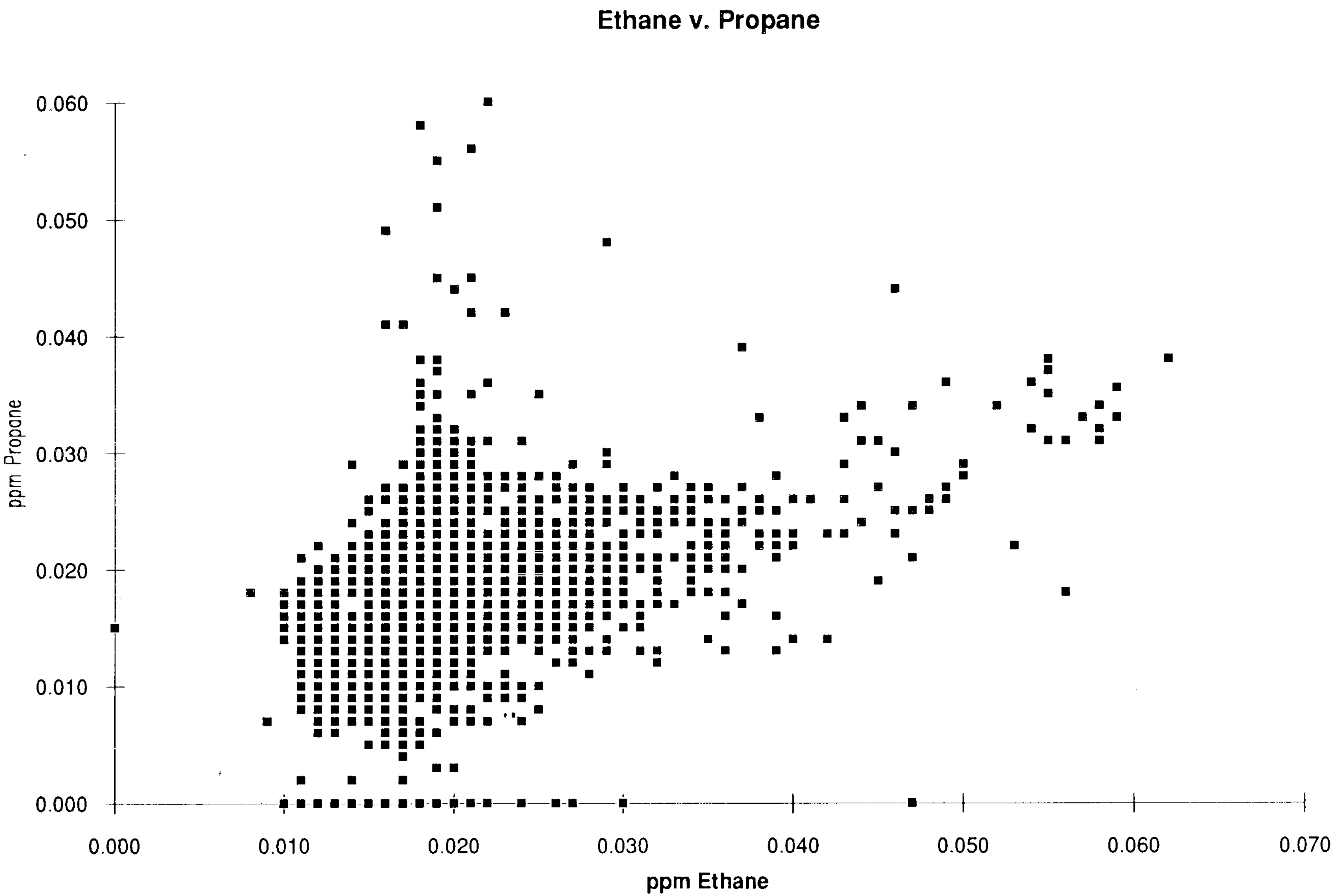


Figure 22c. Ethane versus propane Lines 58-68 (Vulcan Sub-Basin).

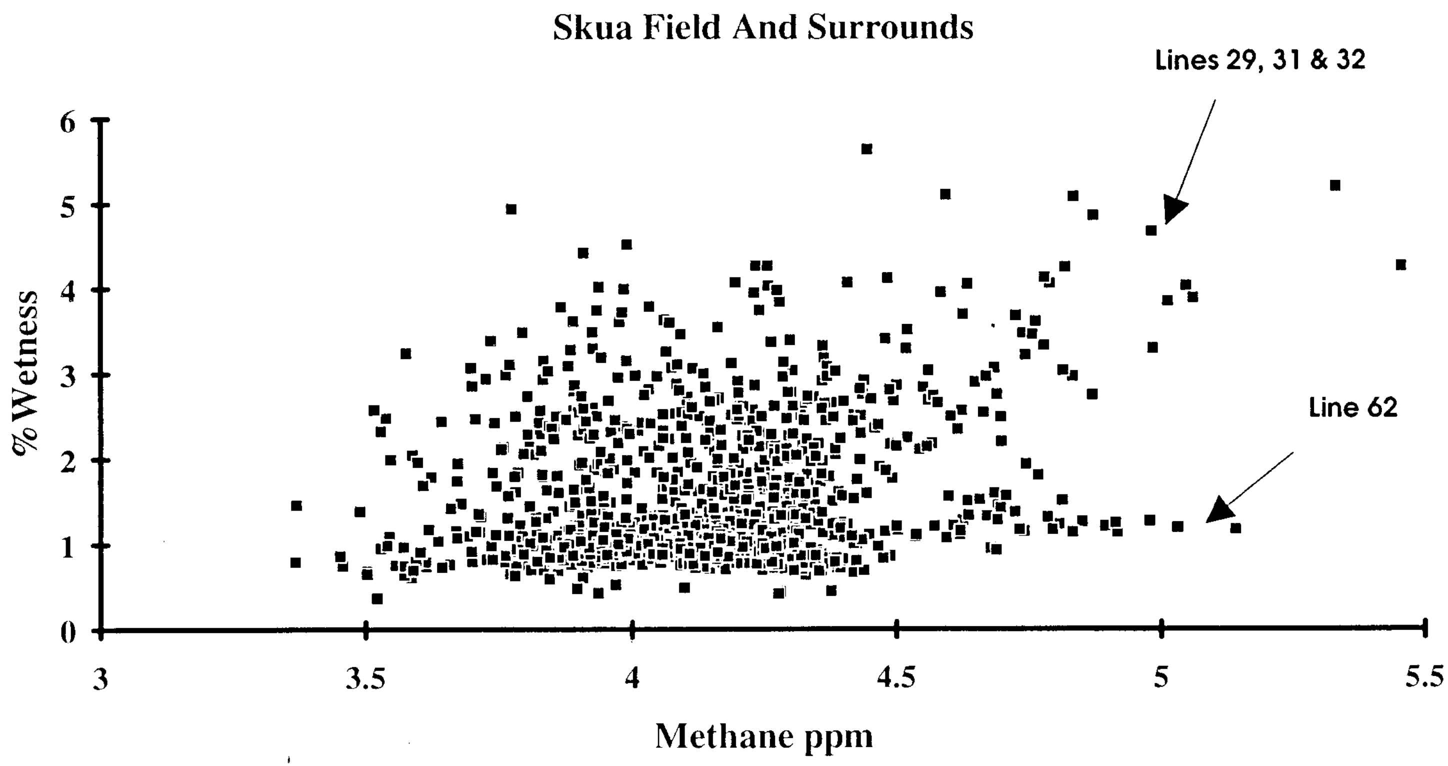


Figure 23. Methane versus % hydrocarbon wetness for the Skua/Swan Graben Group of anomalies. The trend of increasing hydrocarbon wetness values with increasing methane concentrations are consistent with an oil (liquid) source for the light hydrocarbon gases.

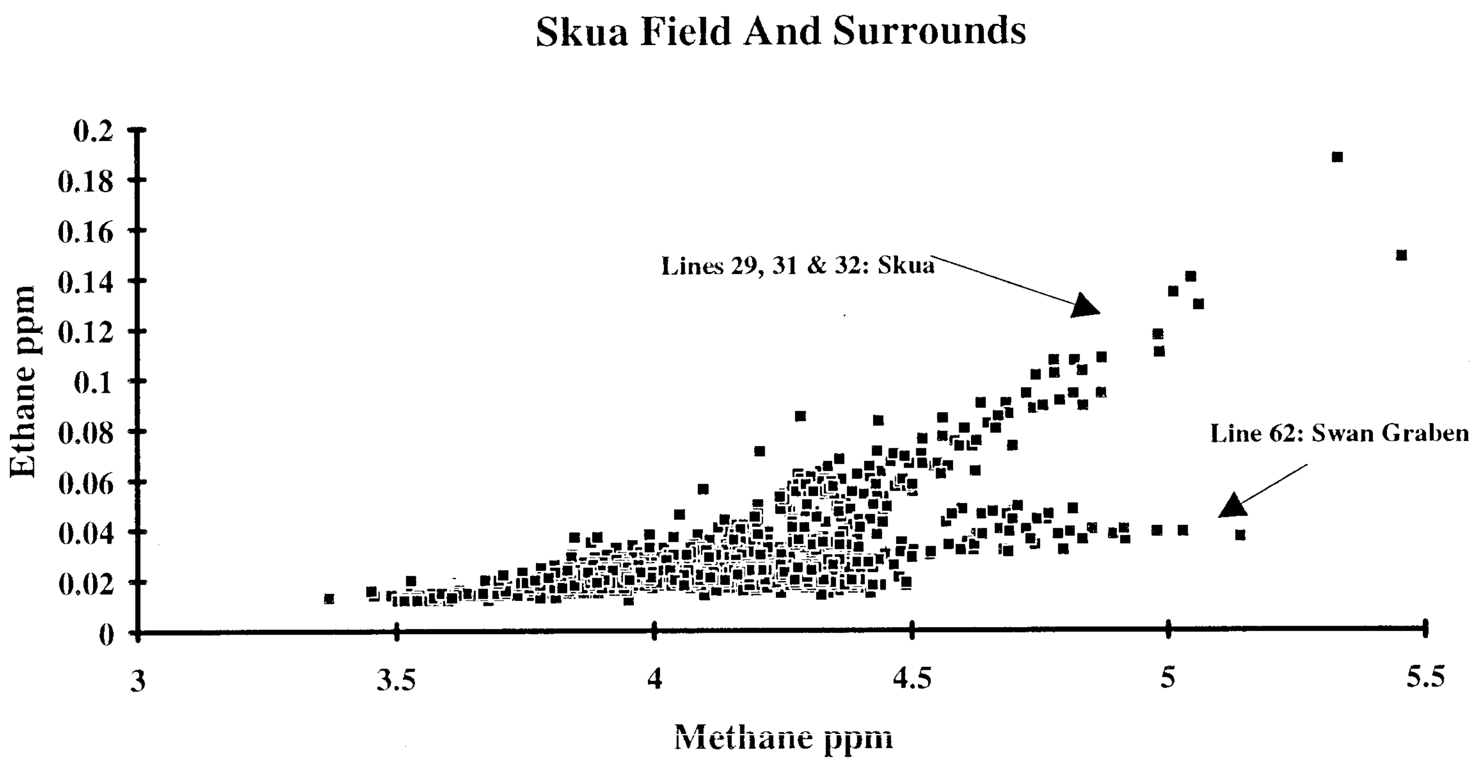


Figure 24. Methane versus ethane for the Skua/Swan Graben Group of anomalies.

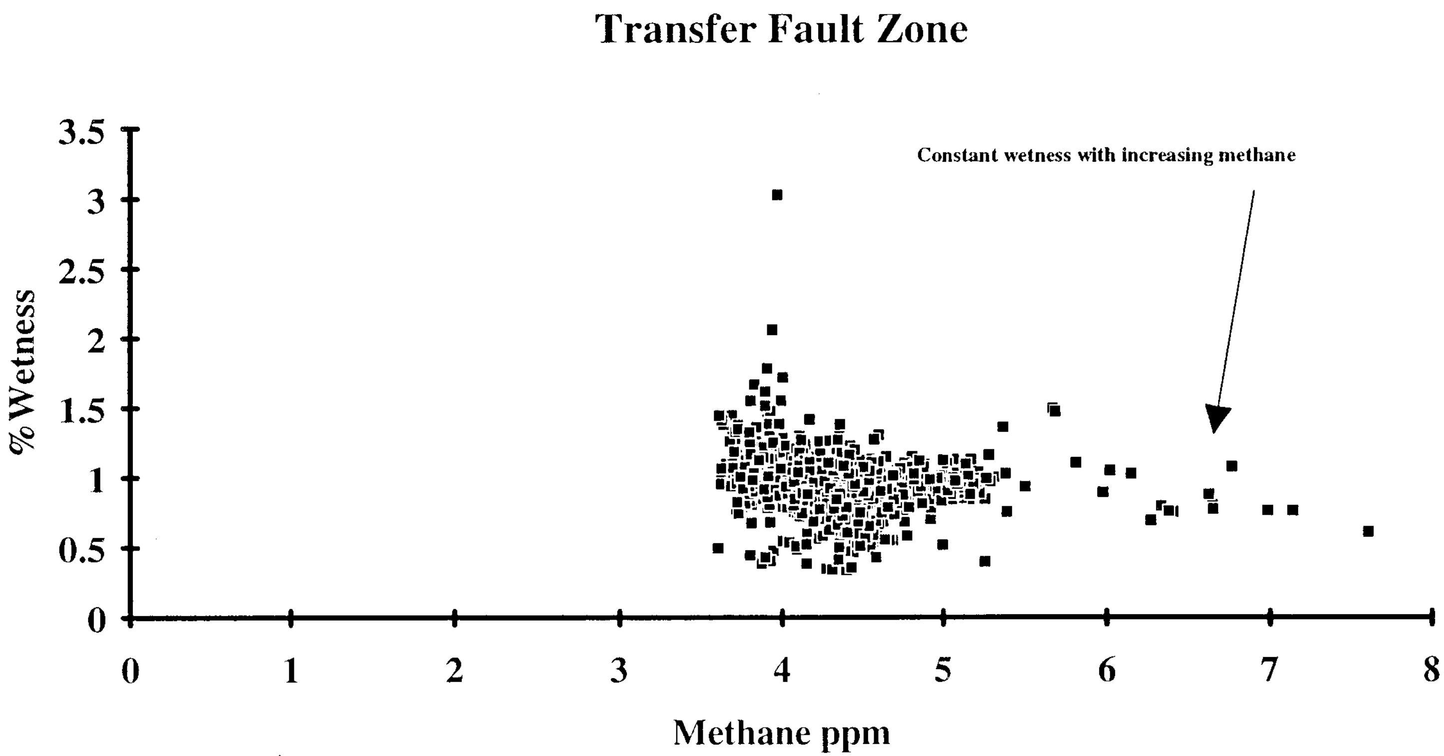


Figure 25. Methane versus % hydrocarbon wetness for the Transfer Fault Zone Group of anomalies. The trend of nearly constant hydrocarbon wetness values with increasing methane concentrations are consistent with a gas/condensate source for the light hydrocarbon gases.

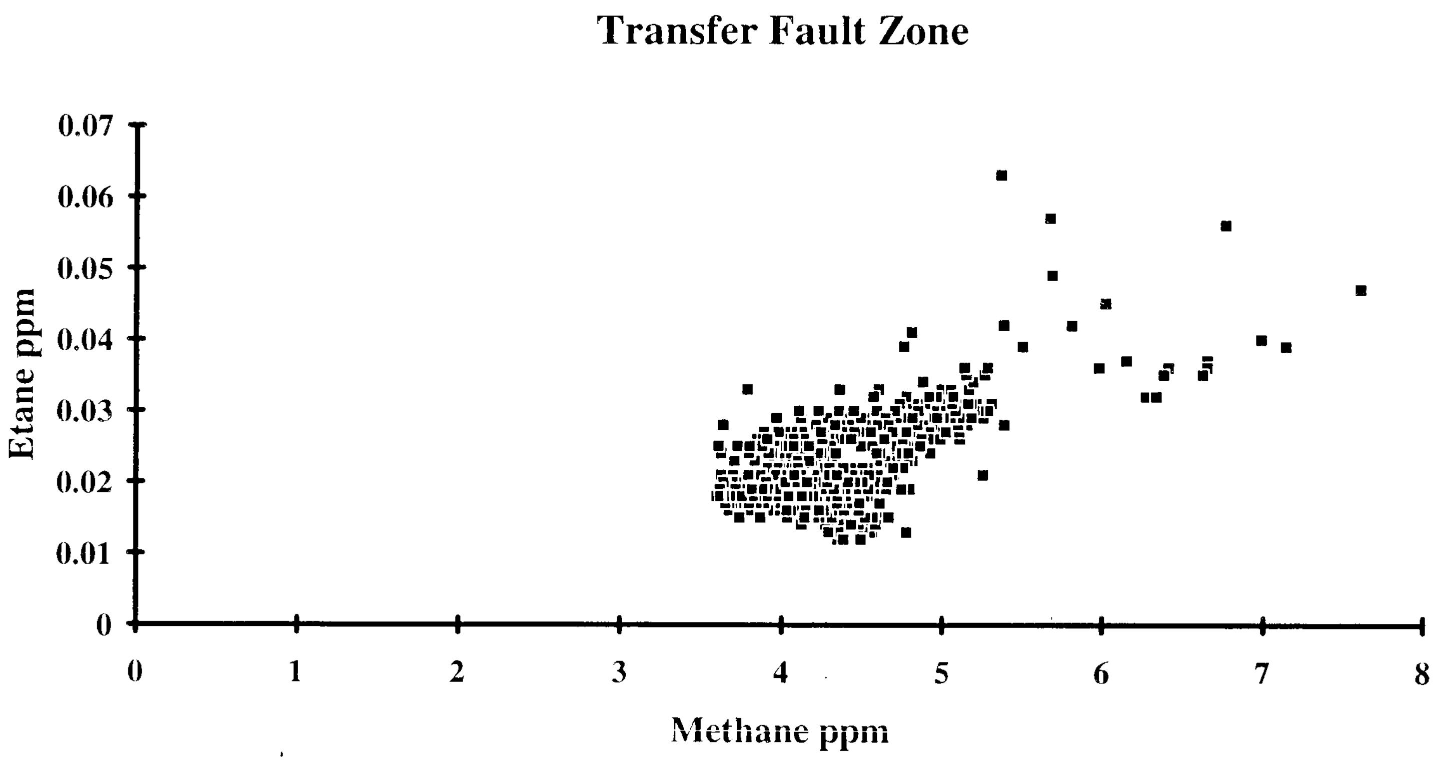


Figure 26. Methane versus ethane for the Transfer Fault Zone Group of anomalies.

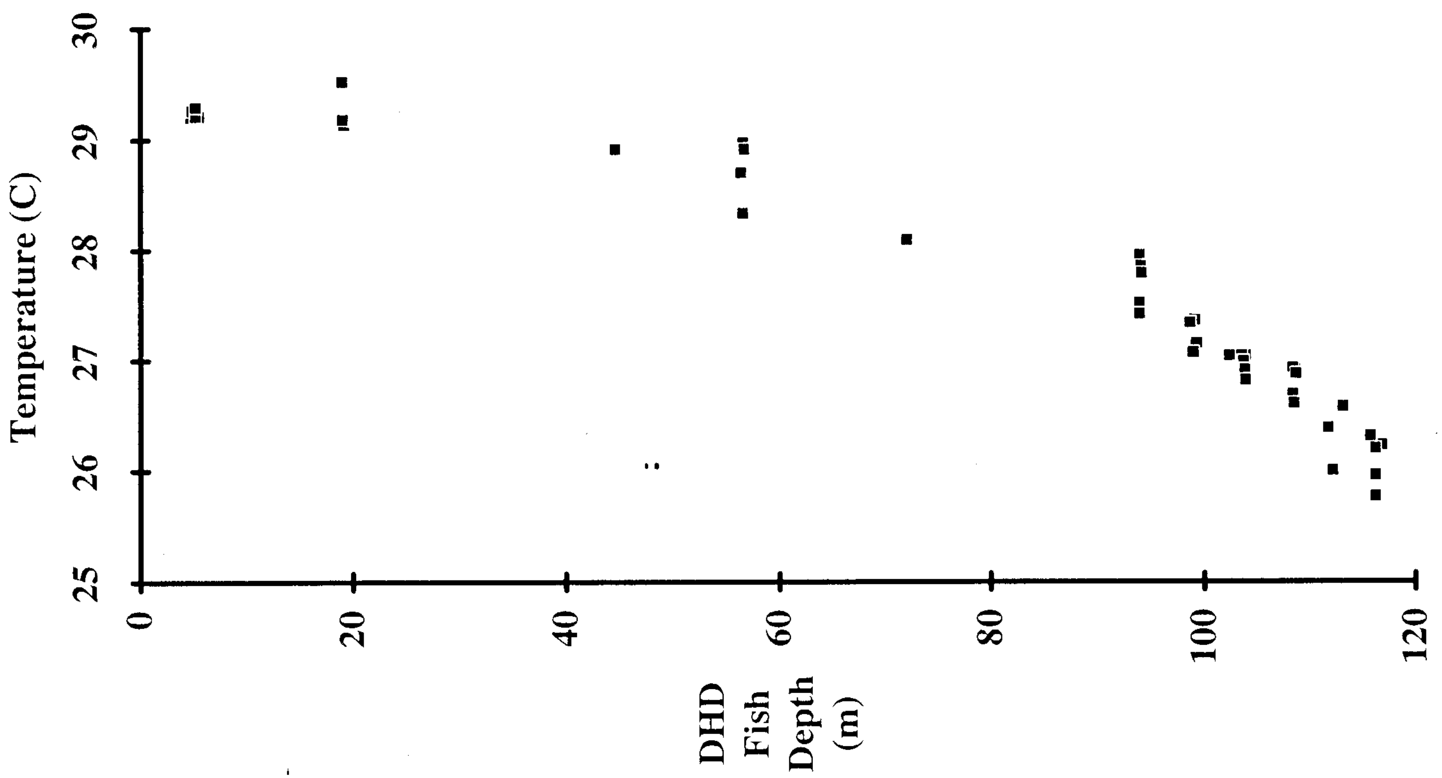


Figure 27a. Vertical profile on line 97/068, showing the relationship between depth and the water column's temperature (Vulcan Sub-Basin).

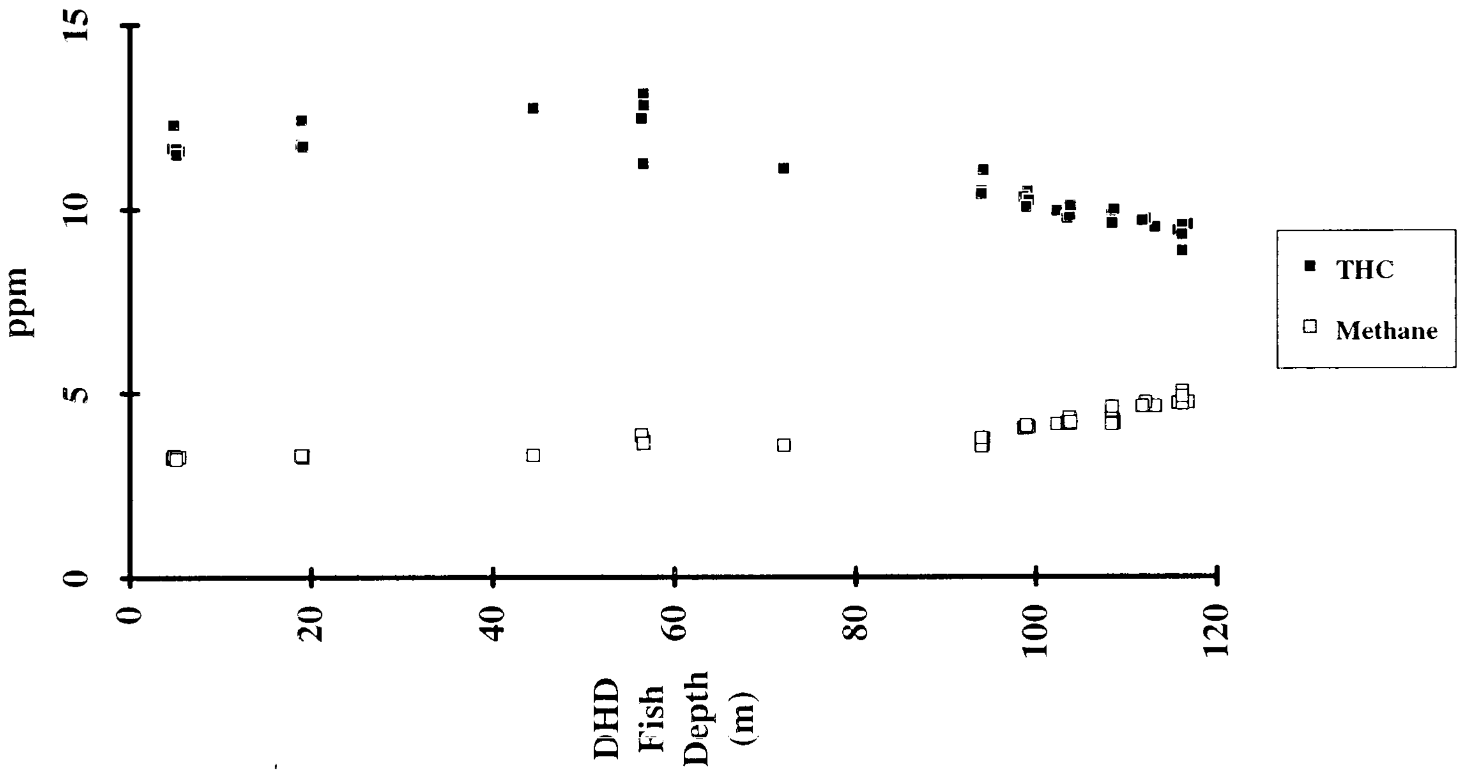


Figure 27b. Vertical profile on line 97/068, showing the relationship between depth and the water column's THC and methane concentrations (Vulcan Sub-Basin).

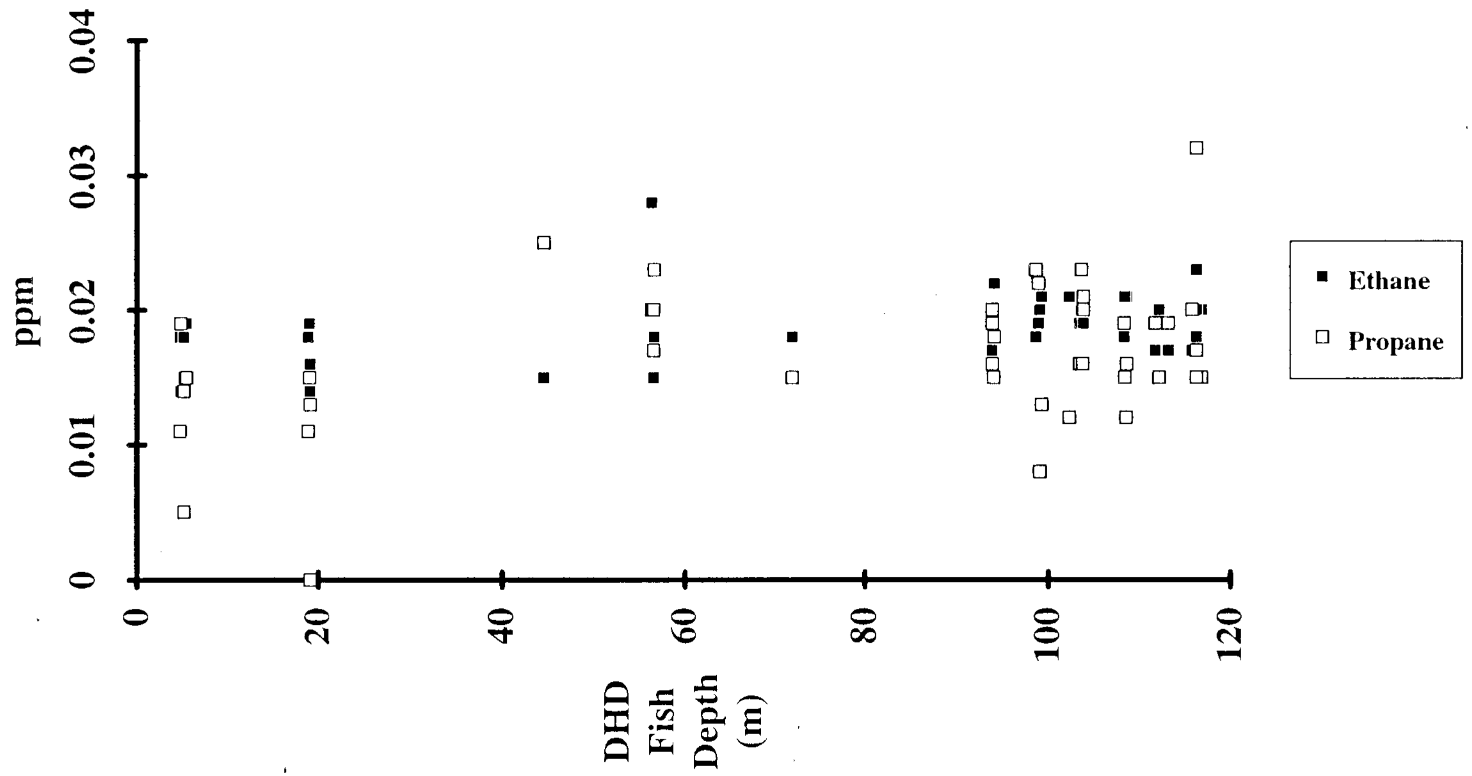


Figure 27c. Vertical profile on line 97/068, showing the relationship between depth and the water column's ethane and propane concentrations (Vulcan Sub-Basin).

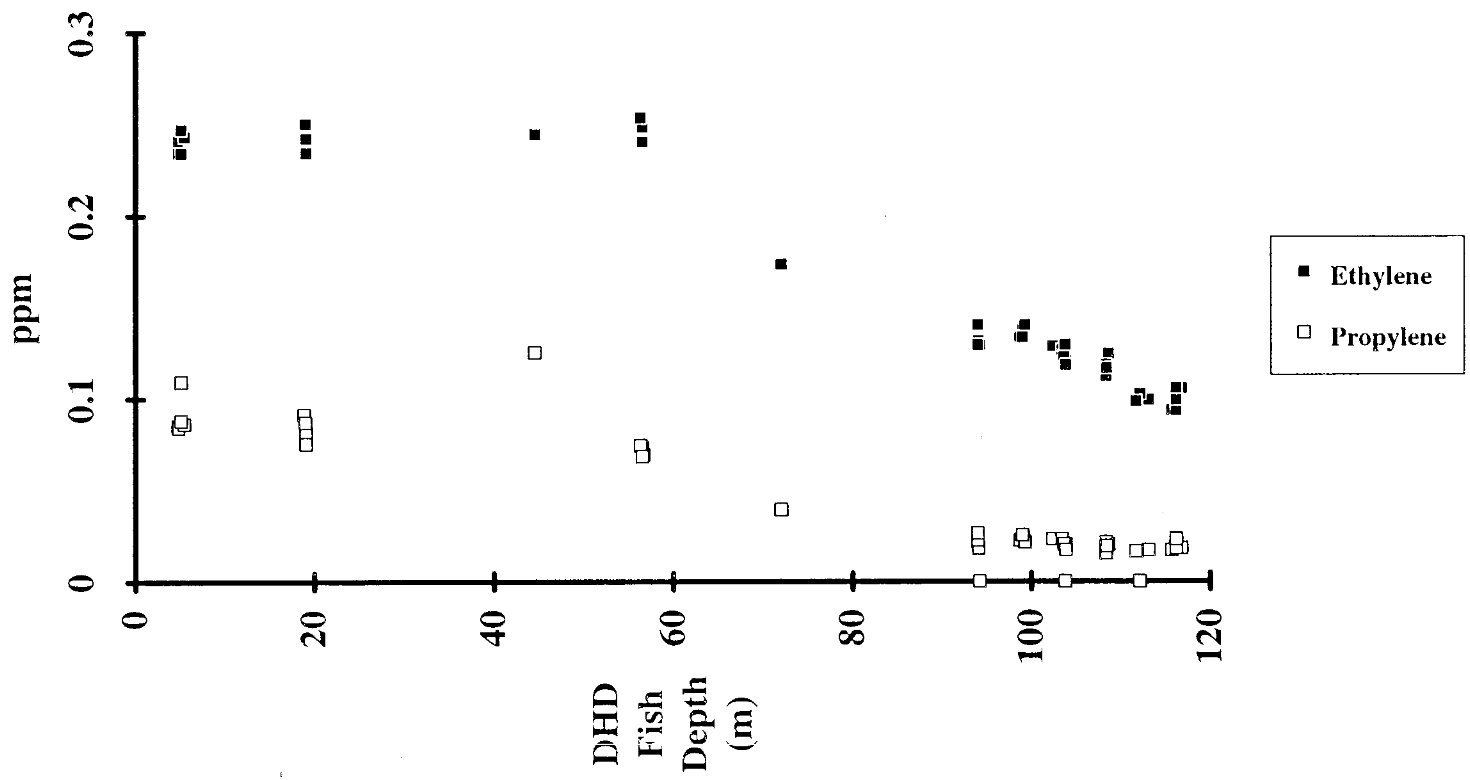


Figure 27d. Vertical profile on line 97/068, showing the relationship between depth and the water column's ethylene and propylene concentrations (Vulcan Sub-Basin).

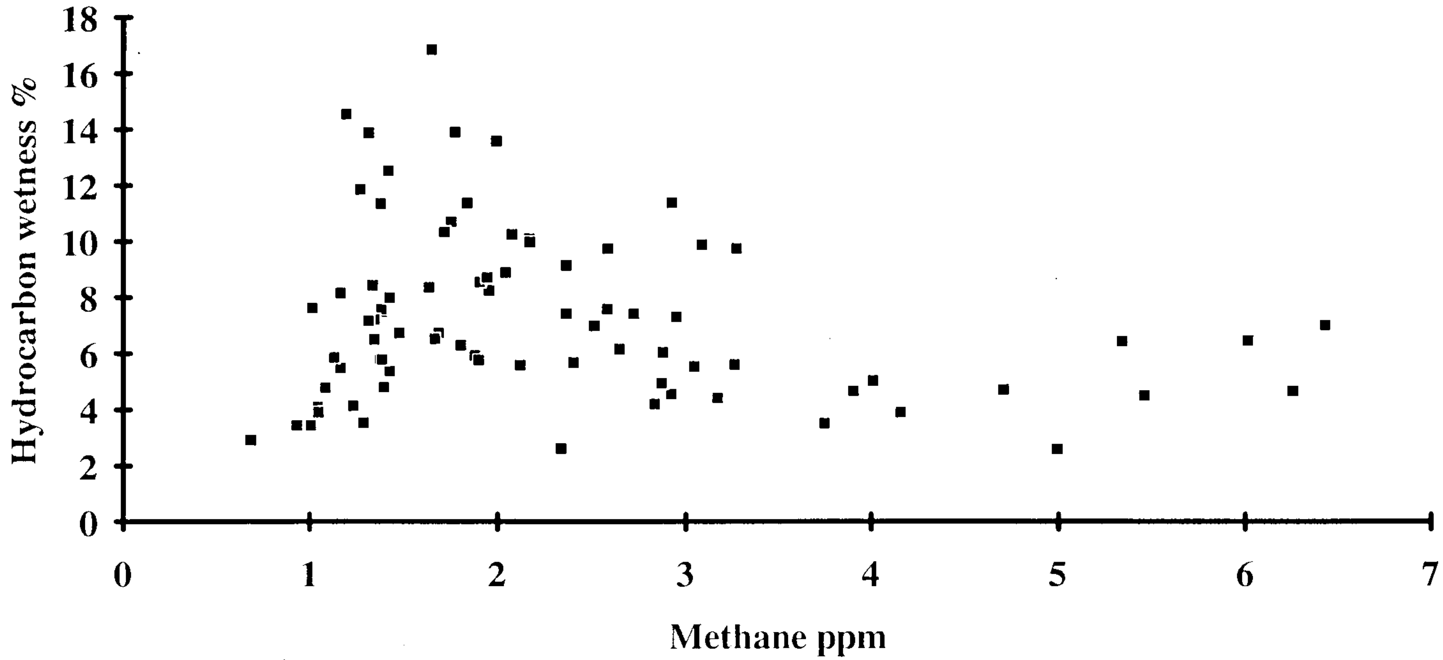


Figure 28. Methane versus % hydrocarbon wetness in sediments from the Vulcan Sub-Basin, Timor Sea. The trend of decreasing hydrocarbon wetness values with increasing methane concentrations are consistent with a predominantly biogenic origin for the light hydrocarbon gases.

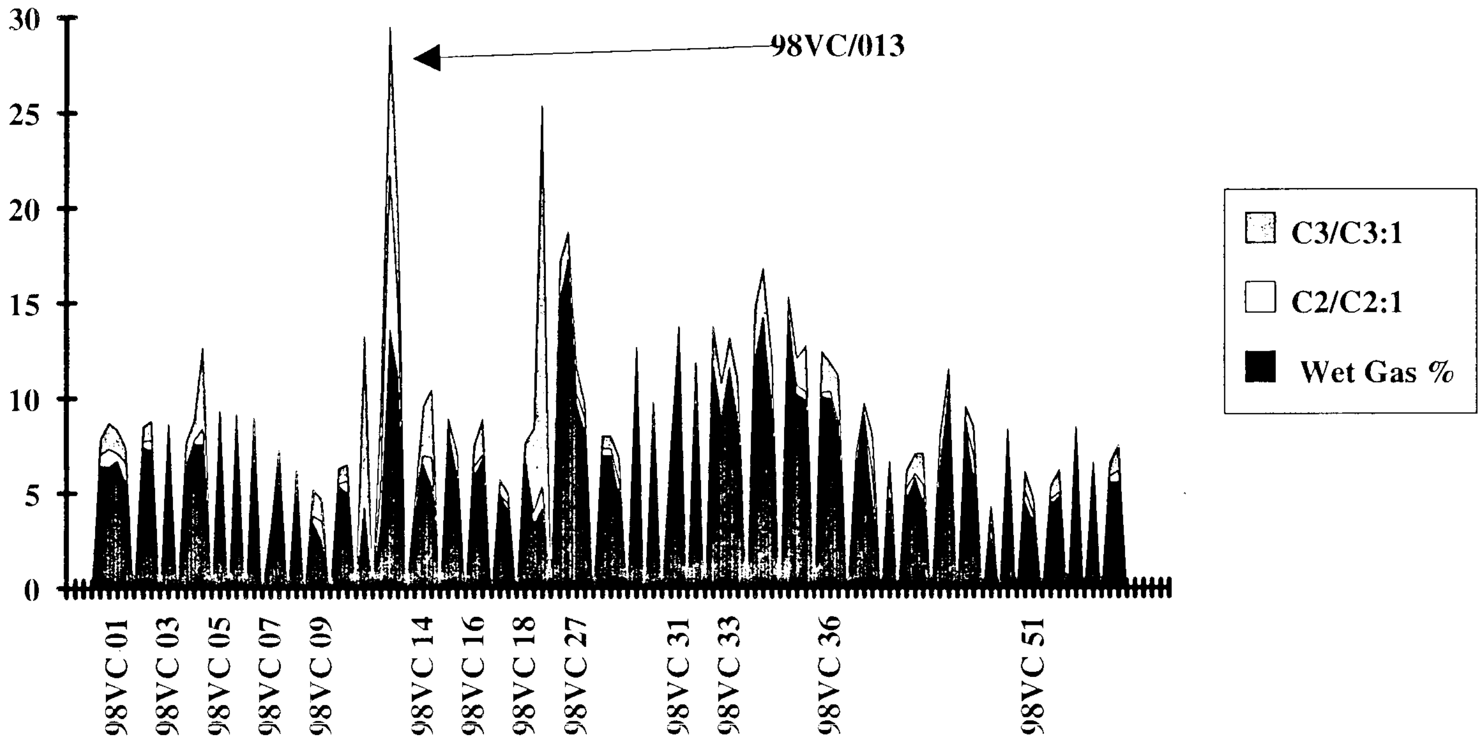


Figure 29. % hydrocarbon wetness, ethane/ethylene and propane/propylene ratios for sediments from the Vulcan Sub-Basin, Timor Sea. Only core 98VC 13 (arrowed) has a composition which is consistent with the presence of significant thermogenic hydrocarbons. Refer to Table 4 for complete analytical results.

APPENDIX I

DATA SUMMARY SHEETS

GRAPHS OF HYDROCARBON CONCENTRATIONS VERSUS SHOTPOINT

Line Summary

Line Number	97025
No. of Shotpoints	85

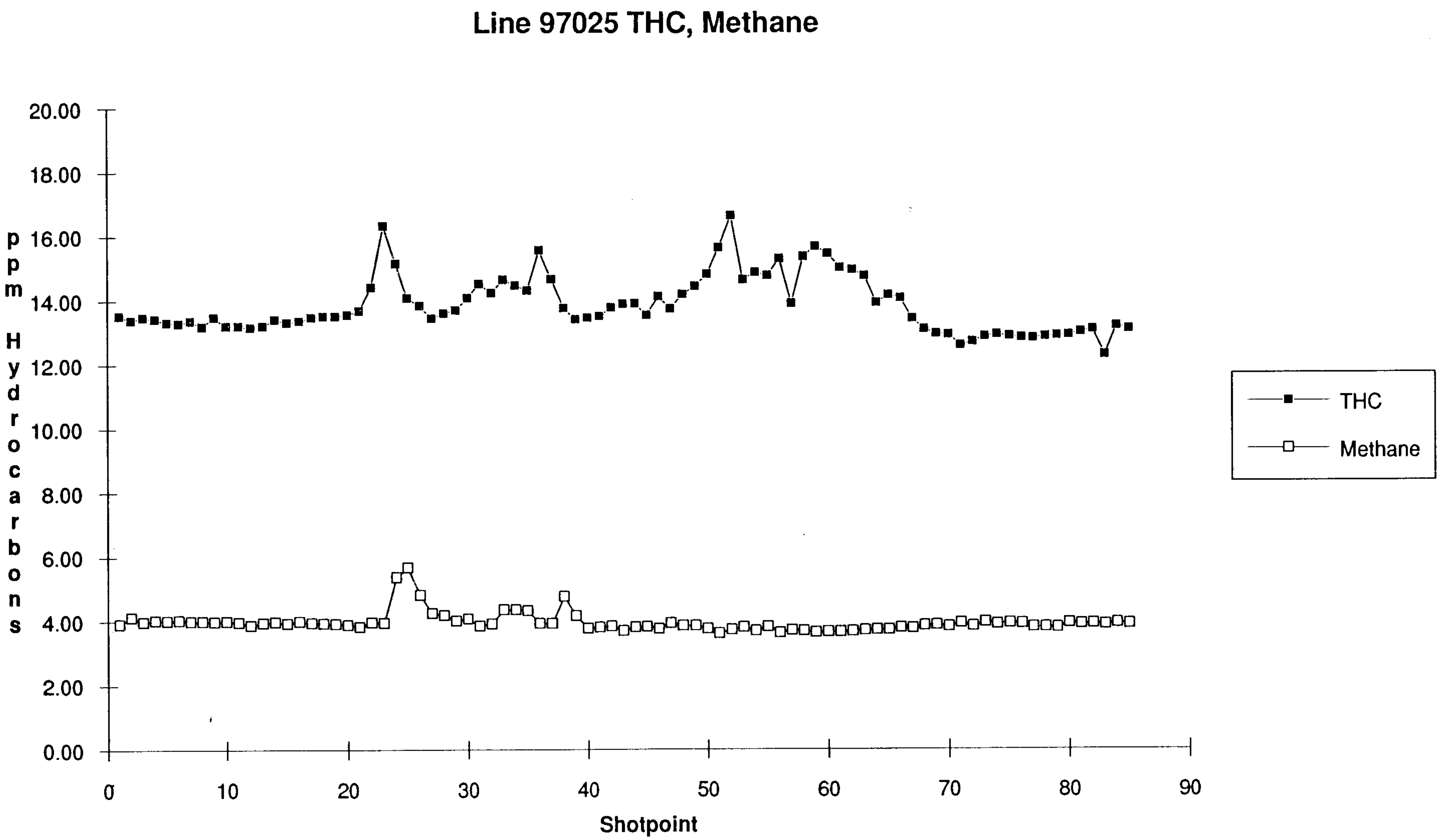
	Shotpoint	Date	Time	Latitude		Longitude	
Start	2	31-Oct-90	01:13:41	12	56.810	124	38.621
End	86	31-Oct-90	04:01:37	12	46.753	124	47.133

	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	13.845	3.949	0.022	0.127	0.021	0.023	0.000	0.002	0.000	0.093	0.007	0.000	1.109
Std. Dev.	0.886	0.320	0.008	0.010	0.014	0.010	0.000	0.005	0.003	0.035	0.012	0.000	0.379
Minimum	12.281	3.604	0.015	0.111	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.386
Maximum	16.635	5.673	0.063	0.161	0.095	0.070	0.000	0.029	0.024	0.171	0.059	0.000	3.027

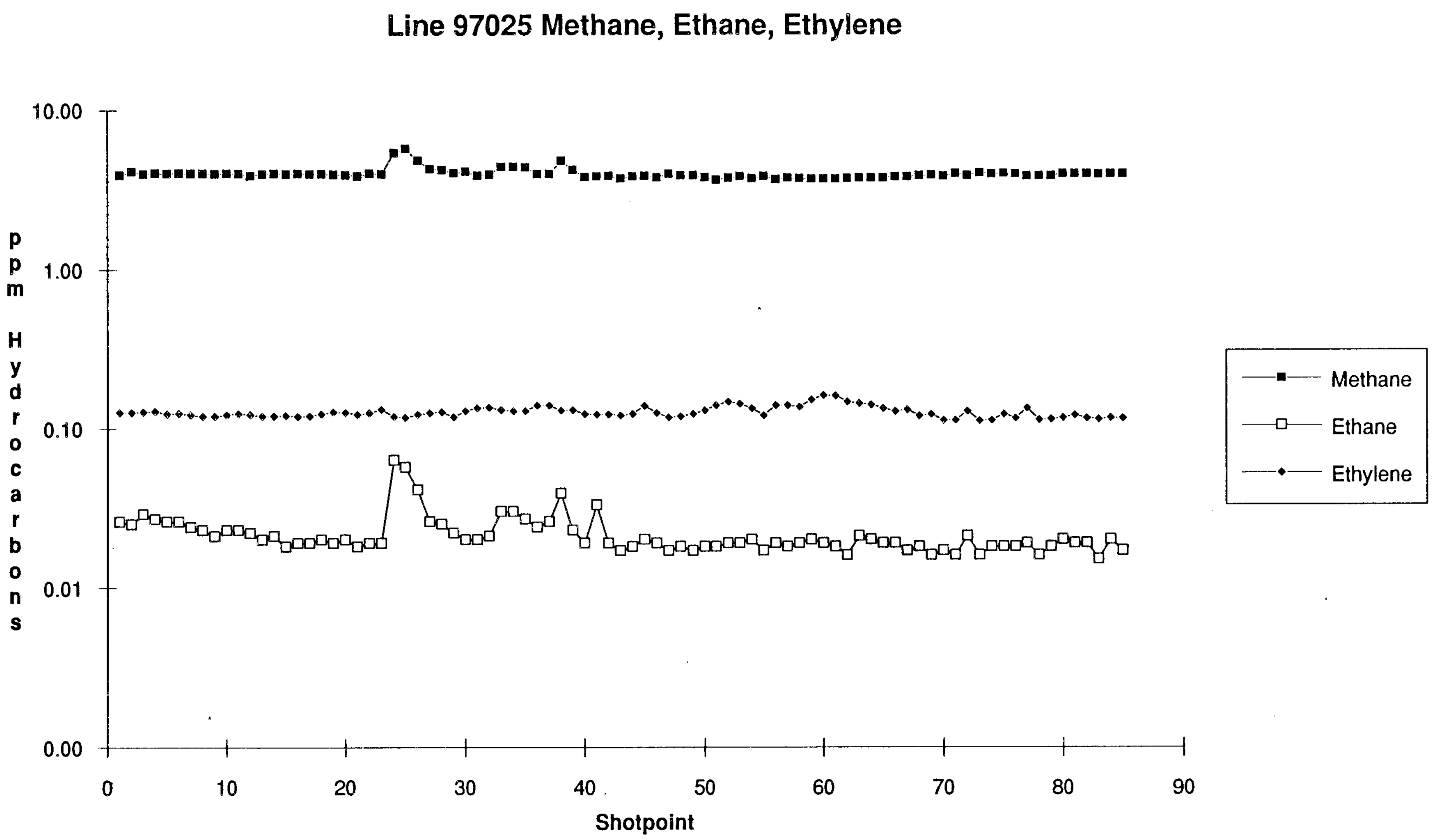
	Cond.	Temp.	F. Depth	W.Depth	Altitude
Mean	57.005	29.277	63.592	81.968	18.376
Std. Dev.	0.354	0.353	7.001	5.689	2.029
Minimum	56.400	28.550	52.734	71.244	14.000
Maximum	57.690	29.950	78.540	95.540	23.000

Notes

Weak methane and ethane anomaly associated wirh northwest - trending transfer fault on the edge of the Vulcan Graben. Extends approximately SP25-40



Line 97025 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 97025 Methane, Ethane, Ethylene
ppm Hydrocarbons
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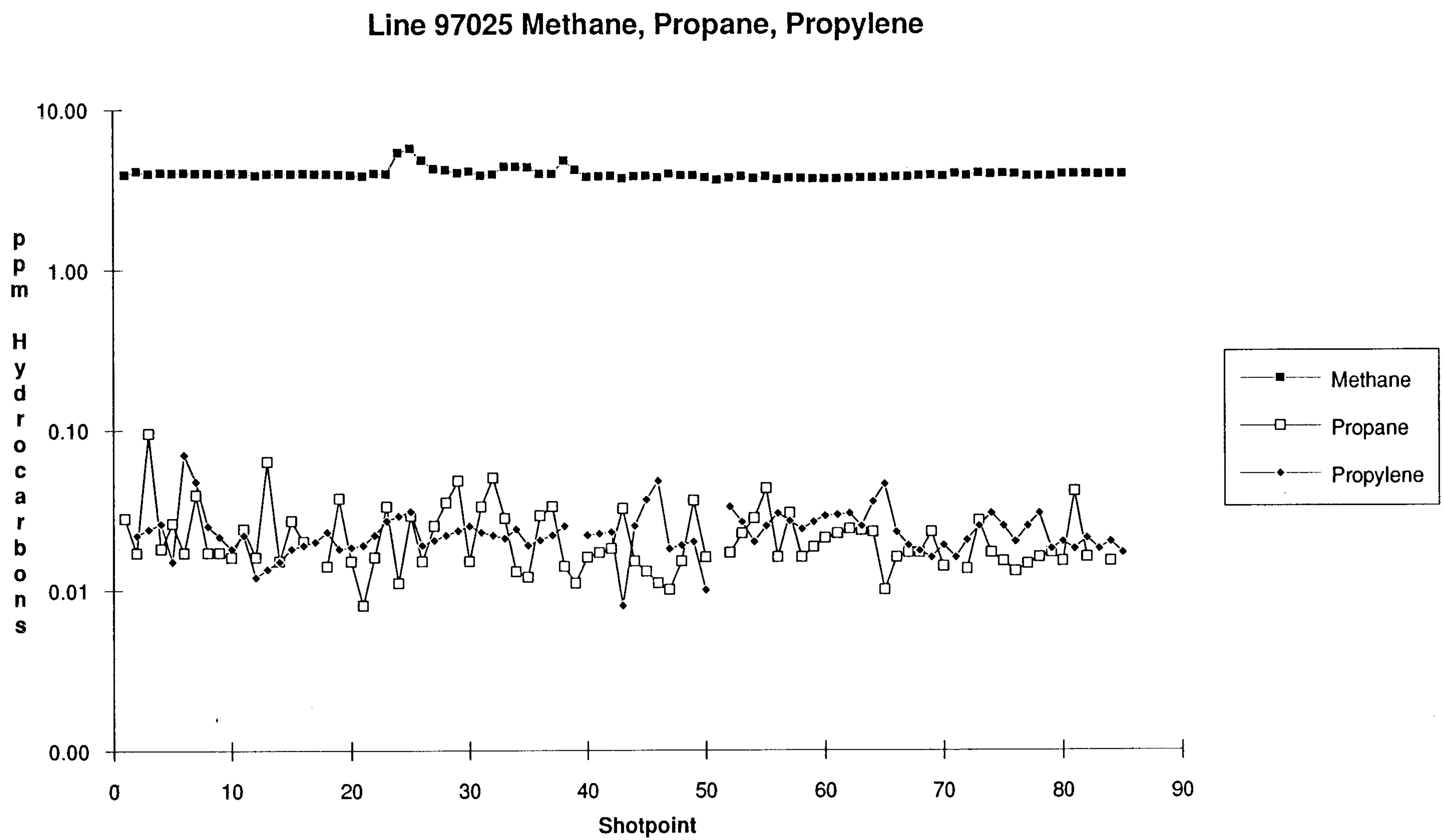
1.00
0.10
0.01
0.00
0
10
20
30
40
50
60
70
80
90
Shotpoint
Methane
Ethane
Ethylene


Line 97025 Methane, Propane, Propylene
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1.00
0.10
0.01
0.00
ppm Hydrocarbons
0
10
20
30
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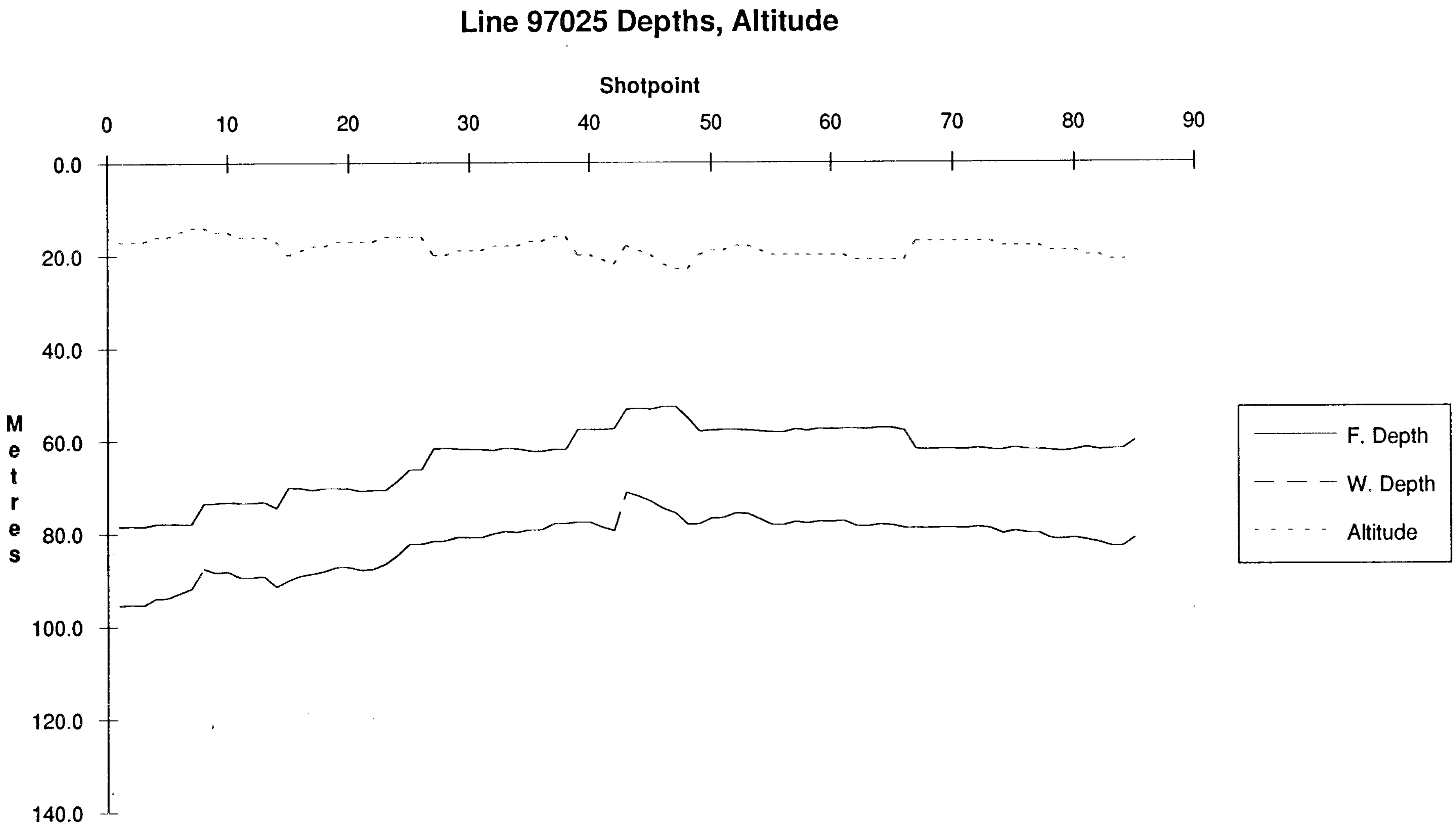
80
90
Shotpoint
Methane
Propane
Propylene



Line 97025 Depths, Altitude
Shotpoint
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10
20
30
40
50
60
70
80
90
0.0
20.0
40.0
60.0
80.0
100.0
120.0
140.0
Metres
F. Depth
W. Depth
Altitude

Line Summary

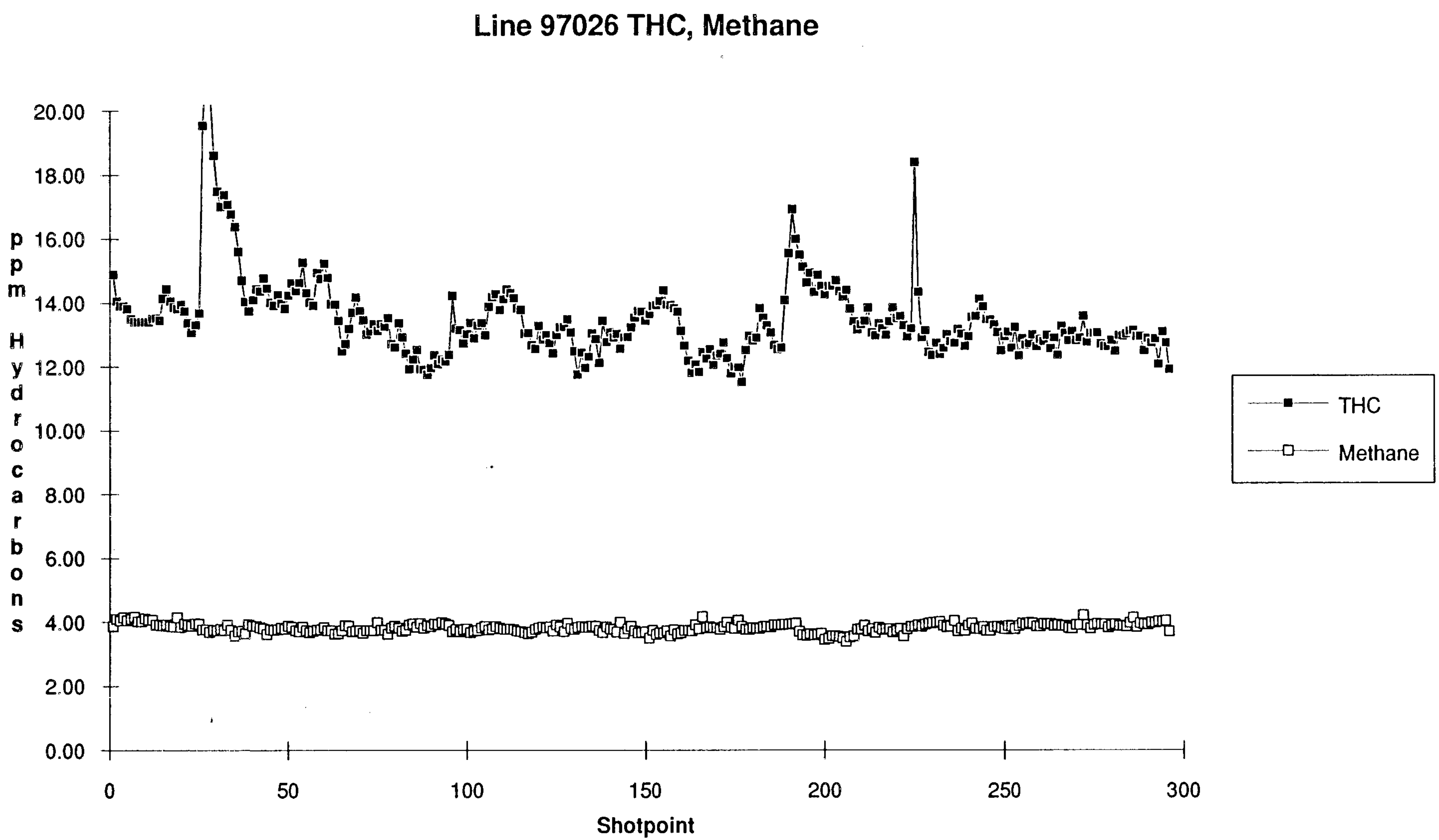
Line Number	97026
No. of Shotpoints	296

	Shotpoint	Date	Time	Latitude		Longitude	
Start	1	31-Oct-90	07:00:21	12	55.455	124	49.392
End	297	31-Oct-90	16:52:03	12	36.070	124	22.799

	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	13.472	3.804	0.019	0.134	0.019	0.030	0.008	0.001	0.000	0.112	0.007	0.000	1.217
Std. Dev.	1.285	0.132	0.003	0.018	0.011	0.024	0.027	0.007	0.000	0.036	0.009	0.000	0.877
Minimum	11.494	3.380	0.014	0.105	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.341
Maximum	21.482	4.189	0.030	0.211	0.106	0.184	0.219	0.084	0.000	0.196	0.029	0.000	6.538

	Cond.	Temp.	F. Depth	W.Depth	Altitude
Mean	55.449	28.048	57.564	75.182	17.618
Std. Dev.	0.565	0.457	6.262	6.904	2.480
Minimum	54.650	27.400	21.828	36.828	13.000
Maximum	56.960	29.420	66.198	86.586	26.000

Notes No anomalies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ppm Hydrocarbons
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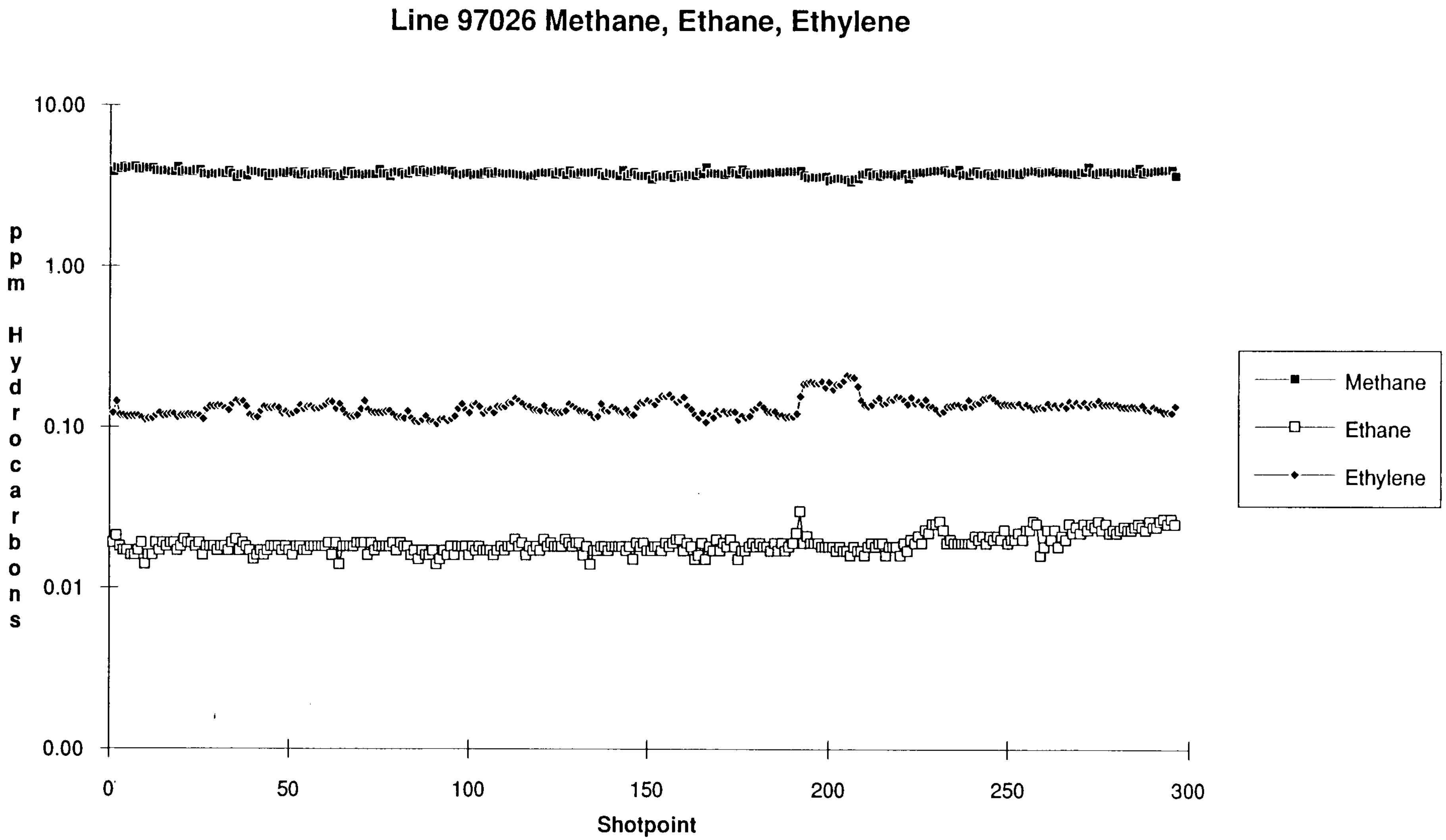
18.00
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
0
50
100
150
200
250
300
Shotpoint
THC
Methane


Line 97026 Methane, Ethane, Ethylene
ppm Hydrocarbons
10.00
1.00
0.10
0.01
0.00
0
50
100
150
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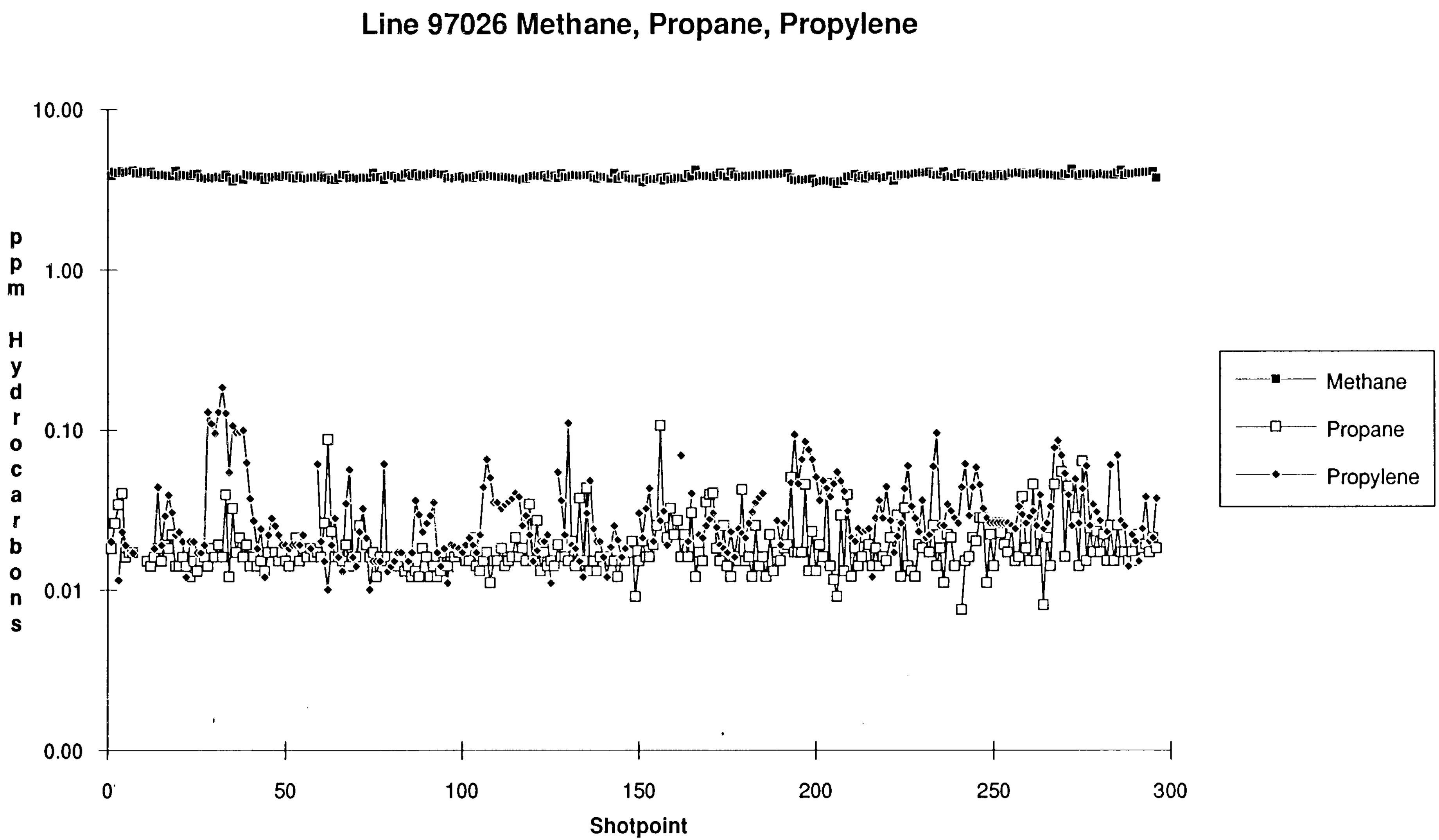
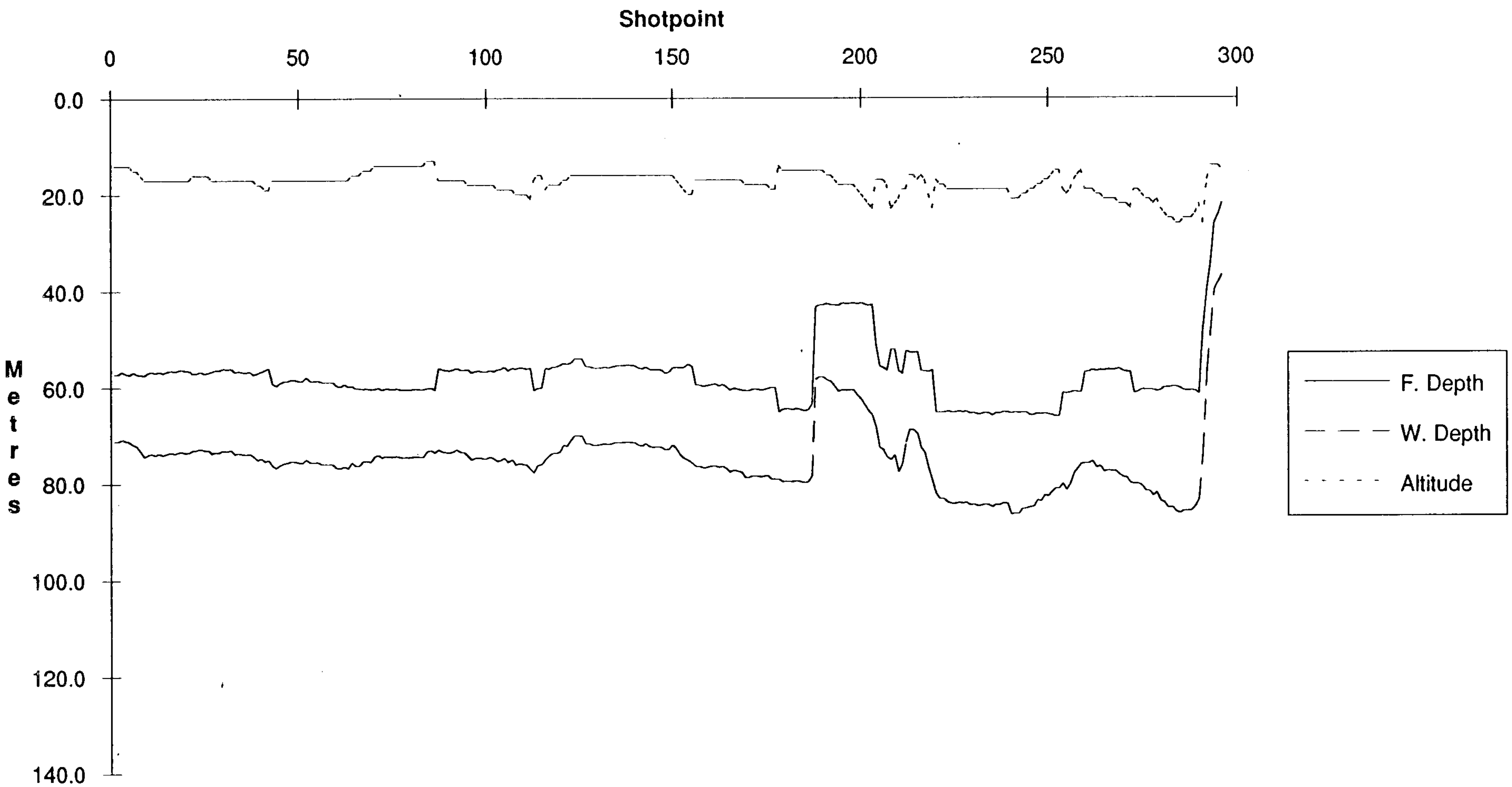
Shotpoint
Methane
Ethane
Ethylene



Line 97026 Methane, Propane, Propylene
10.00
1.00
0.10
0.01
0.00
ppm Hydrocarbons
0
50
100
150
200
250
300
Shotpoint
Methane
Propane
Propylene

Line 97026 Depths, Altitude



Line Summary

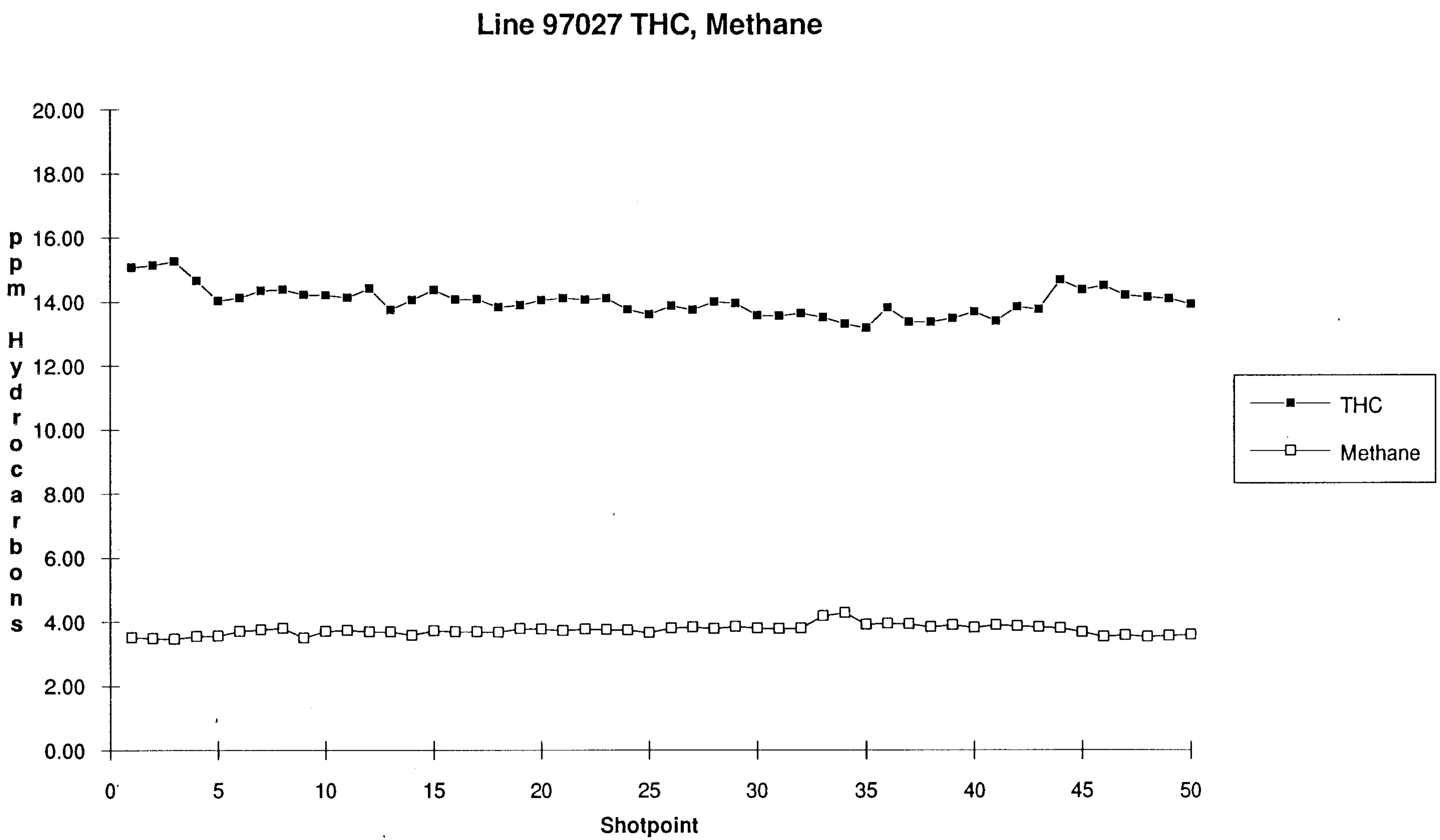
Line Number	97027
No. of Shotpoints	50

	Shotpoint	Date	Time	Latitude		Longitude	
Start	1	31-Oct-90	19:01:01	12	35.932	124	22.836
End	50	31-Oct-90	20:39:05	12	29.159	124	18.614

	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	14.008	3.740	0.018	0.189	0.028	0.061	0.017	0.000	0.000	0.138	0.001	0.000	1.648
Std. Dev.	0.453	0.158	0.004	0.036	0.021	0.033	0.032	0.000	0.000	0.037	0.004	0.000	1.237
Minimum	13.180	3.469	0.000	0.149	0.010	0.027	0.000	0.000	0.000	0.000	0.000	0.000	0.285
Maximum	15.256	4.271	0.024	0.298	0.085	0.158	0.103	0.000	0.000	0.170	0.016	0.000	4.858

	Cond.	Temp.	F. Depth	W.Depth	Altitude
Mean	55.687	28.340	45.465	61.065	15.600
Std. Dev.	0.413	0.356	6.669	6.429	1.979
Minimum	55.220	27.850	25.296	42.296	12.000
Maximum	57.000	29.420	52.632	67.816	20.000

Notes	No anomalies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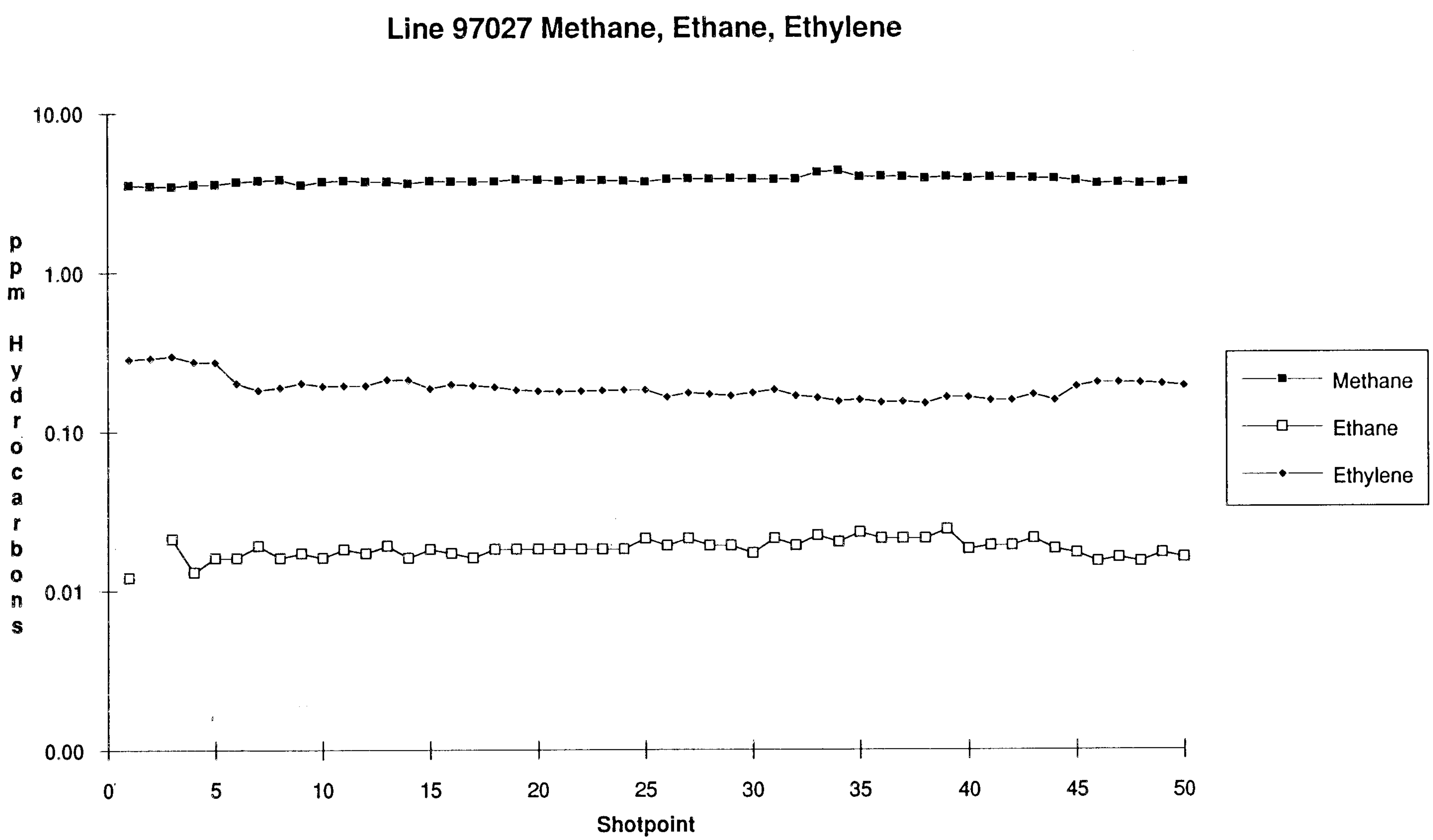
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
0
5
10
15
20
25
30
35
40
45
50
Shotpoint
THC
Methane


Line 97027 Methane, Ethane, Ethylene
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0.01
0.00
0
5
10
15
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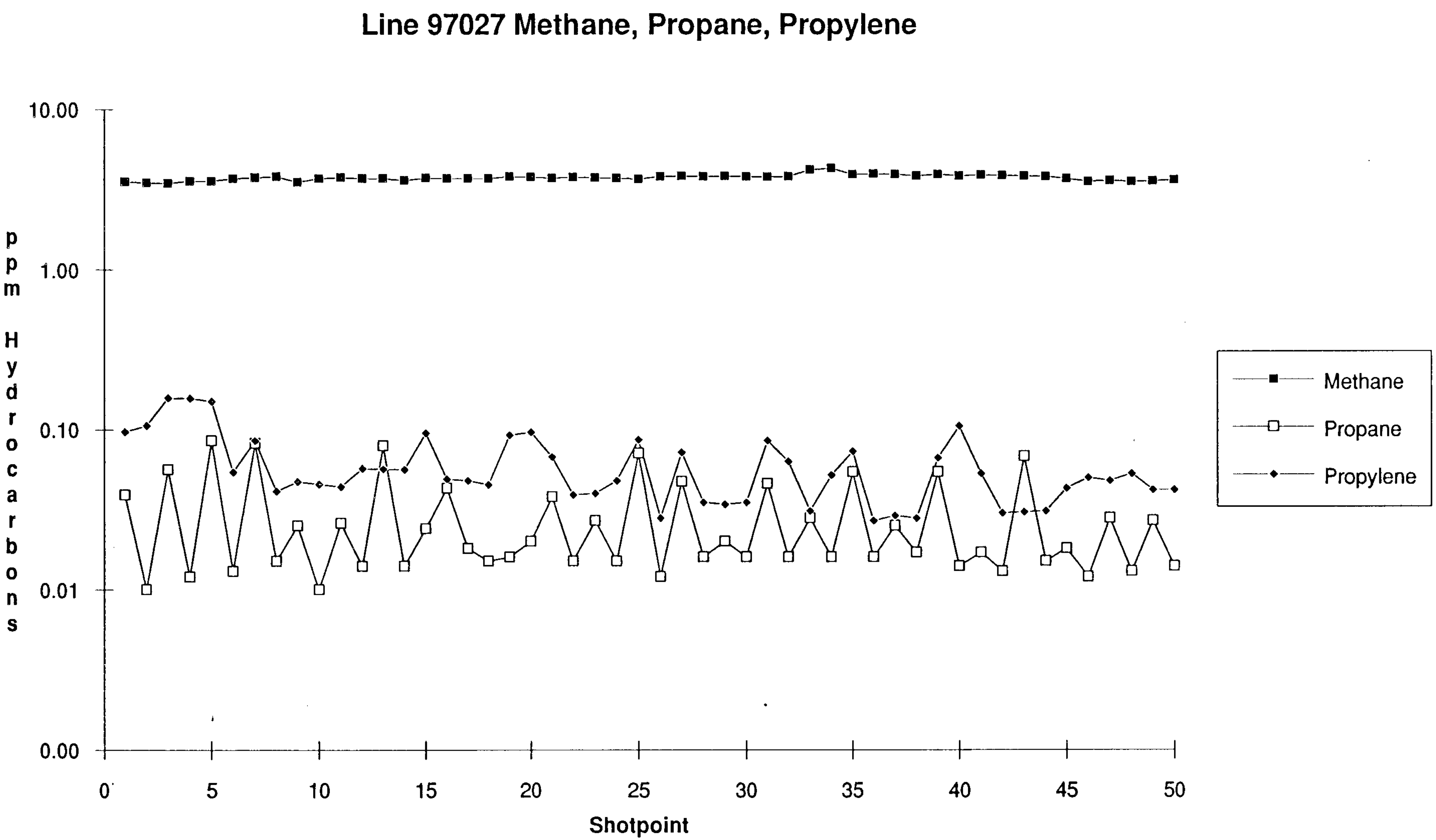
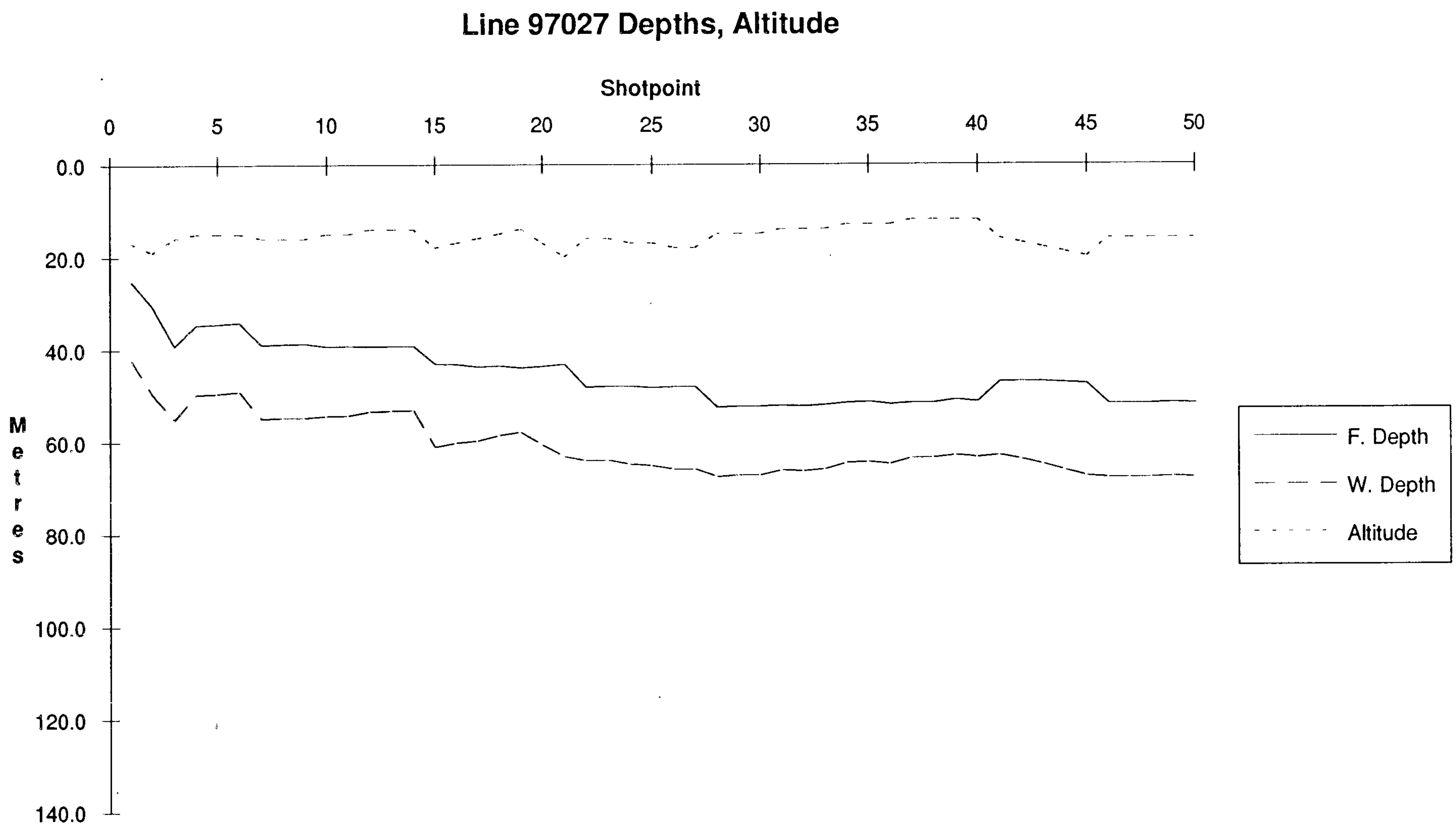
25
30
35
40
45
50
Shotpoint
Methane
Ethane
Ethylene


Line 97027 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
50
Shotpoint
Methane
Propane
Propylene



Line 97027 Depths, Altitude
Shotpoint
0
5
10
15
20
25
30
35
40
45
50
0.0
20.0
40.0
60.0
80.0
100.0
120.0
140.0
Metres
F. Depth
W. Depth
Altitude

Line Summary

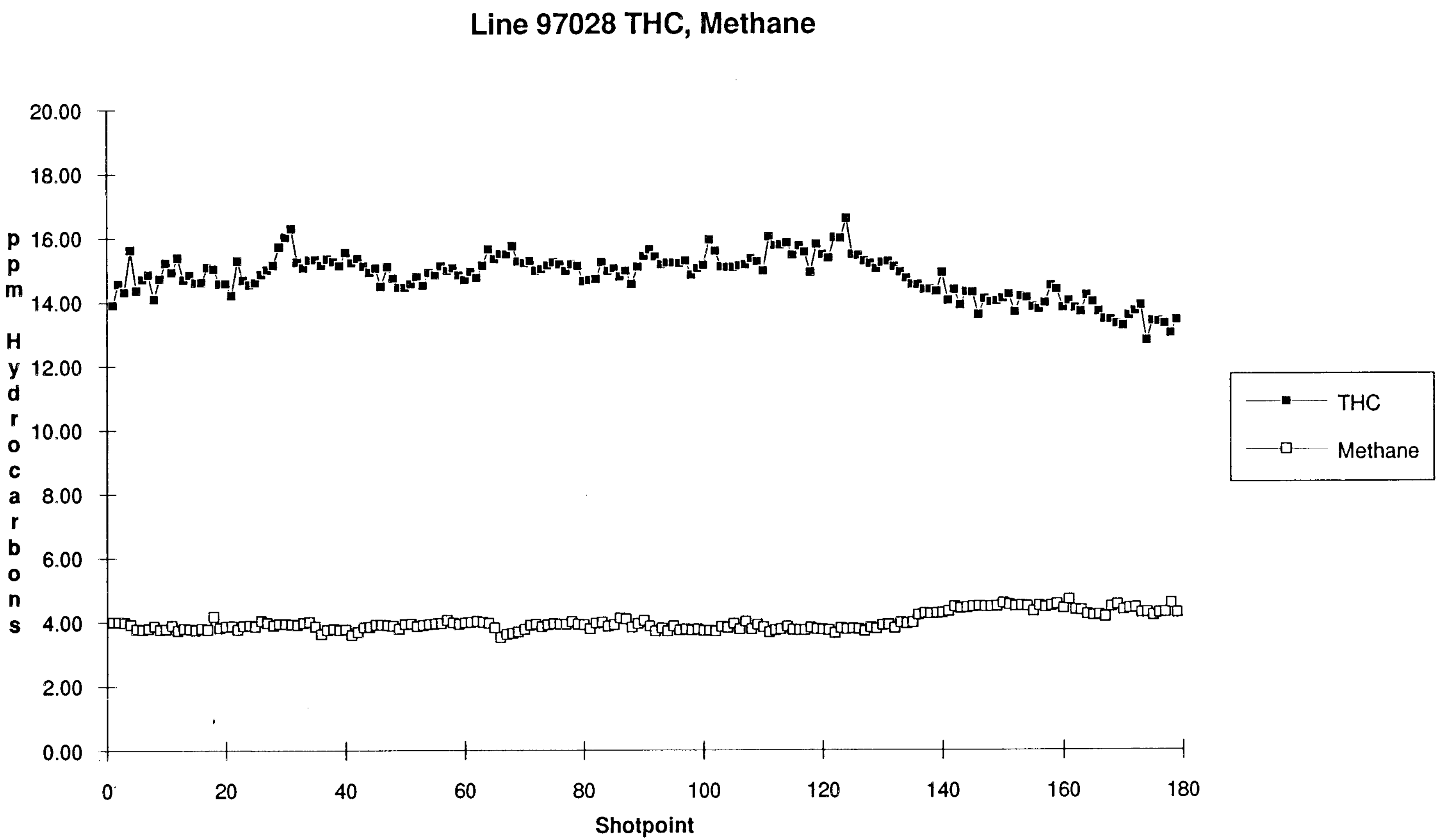
Line Number	97028
No. of Shotpoints	179

	Shotpoint	Date	Time	Latitude		Longitude	
Start	1	31-Oct-90	22:43:25	12	29.683	124	19.482
End	182	1-Nov-90	04:54:40	12	12.111	123	53.257

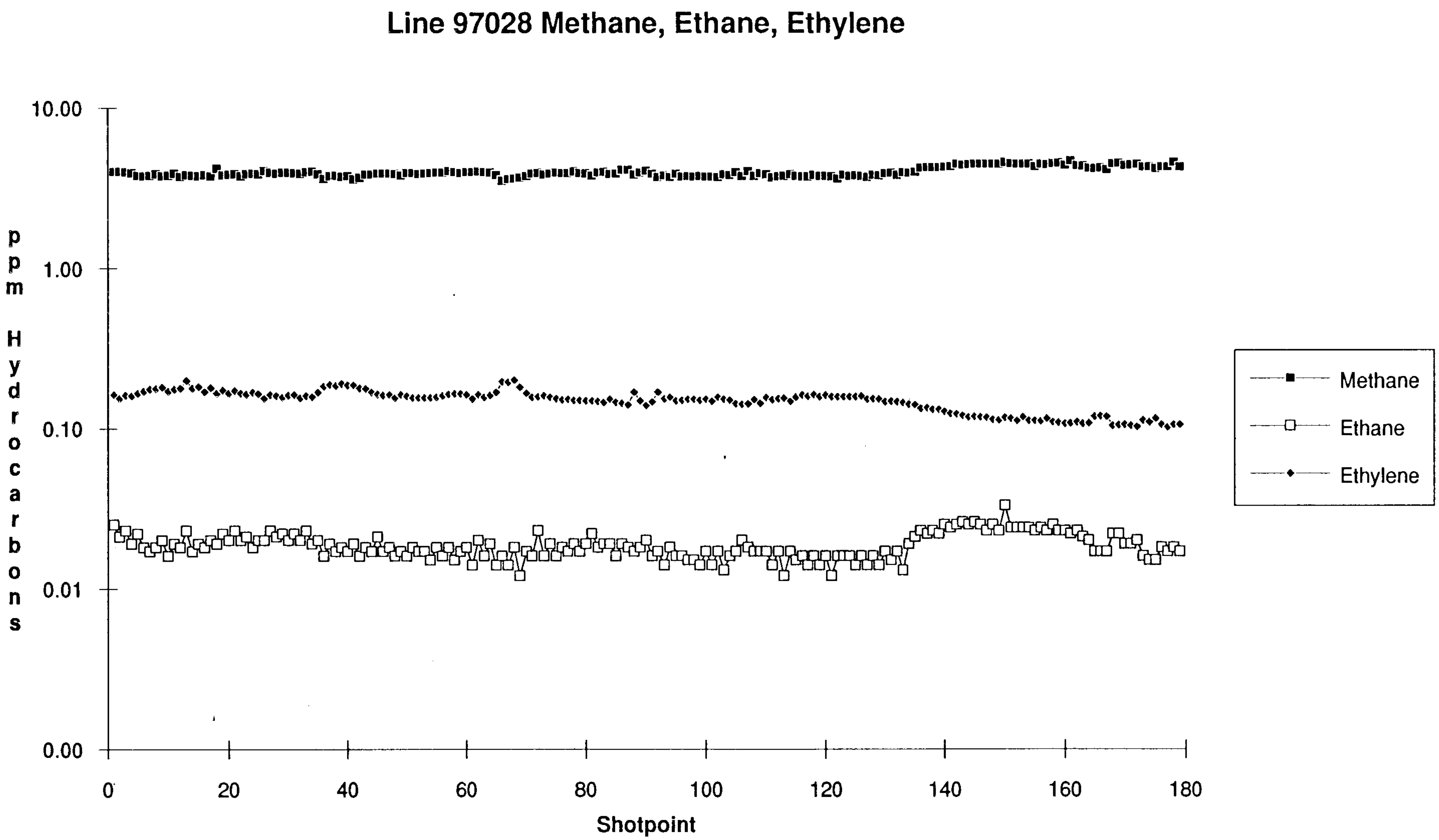
	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	14.790	3.968	0.019	0.149	0.017	0.033	0.014	0.000	0.000	0.143	0.014	0.108	1.228
Std. Dev.	0.687	0.260	0.003	0.023	0.009	0.019	0.021	0.000	0.000	0.044	0.017	0.066	0.588
Minimum	12.767	3.499	0.012	0.102	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.377
Maximum	16.578	4.667	0.033	0.201	0.106	0.097	0.083	0.000	0.000	0.217	0.056	0.268	3.295

	Cond.	Temp.	F. Depth	W.Depth	Altitude
Mean	57.054	29.582	61.453	80.984	19.531
Std. Dev.	0.350	0.347	13.257	16.658	11.653
Minimum	56.070	28.520	38.556	53.658	10.000
Maximum	57.810	30.400	88.944	124.304	68.000

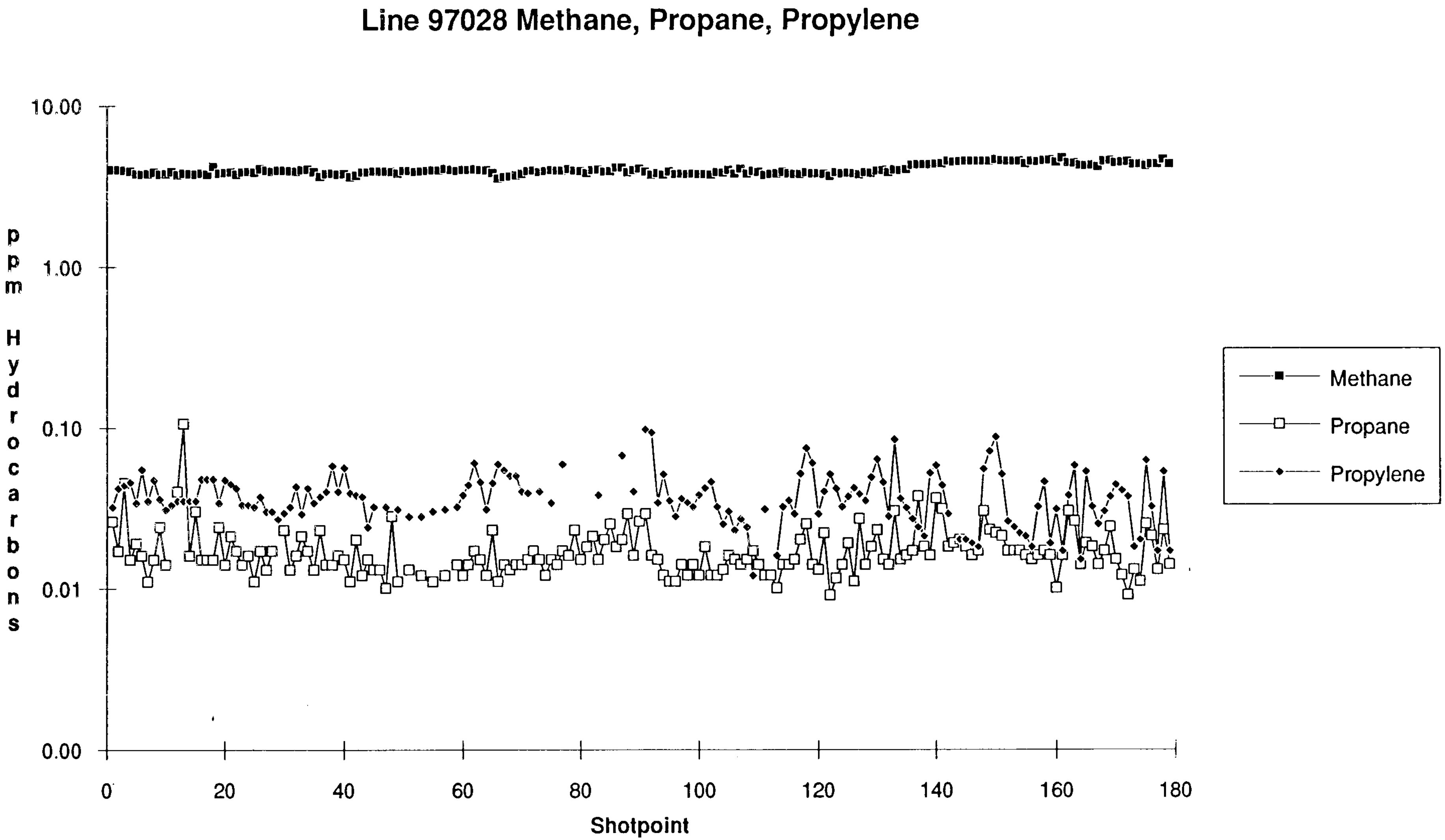
Notes — Very weak methane and propane anomaly towards the end of the line; on the Ashmore Platform near the Cartier 1 well.



Line 97028 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
Shotpoint
THC
Methane

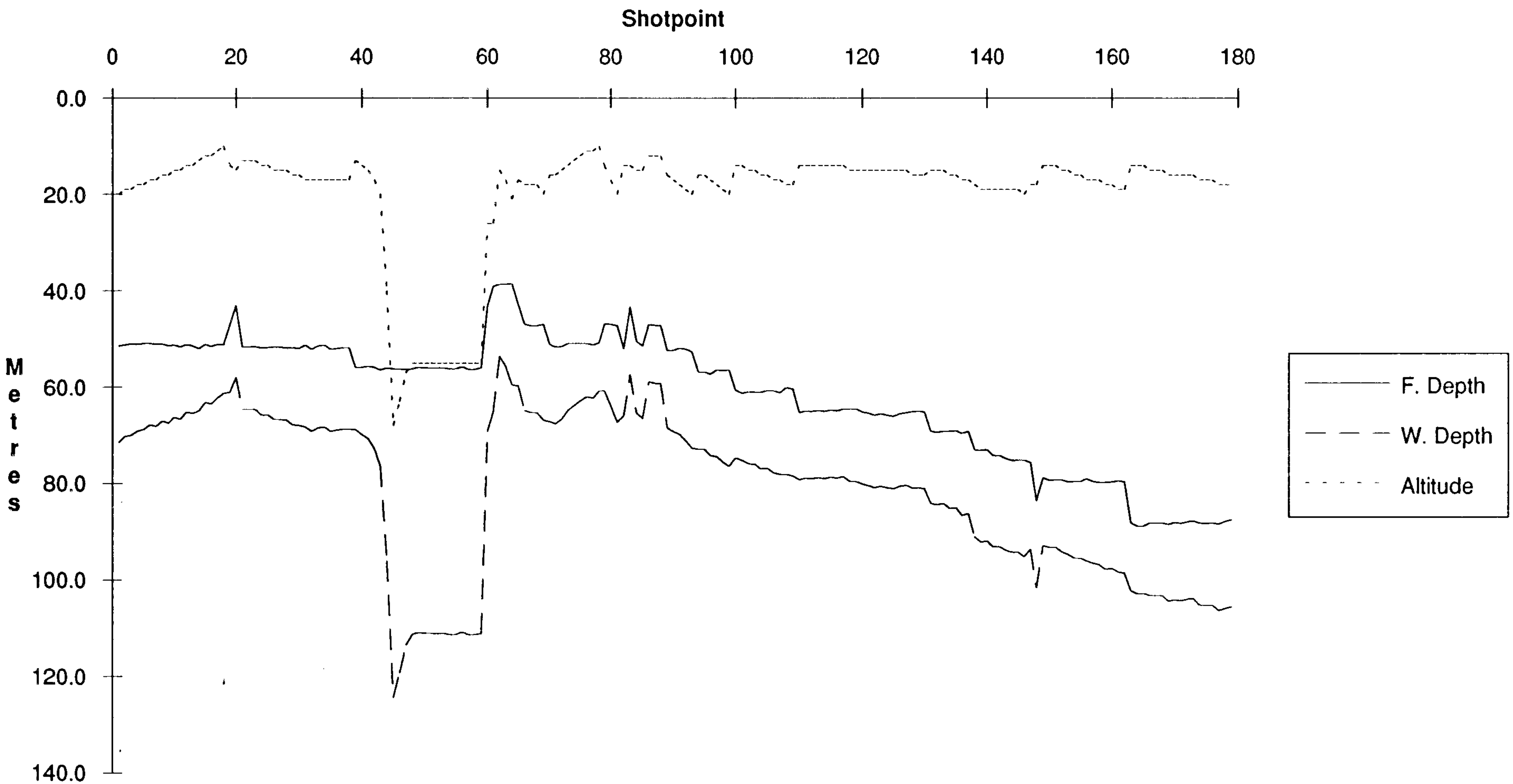


Line 97028 Methane, Ethane, Ethylene
10.00
1.00
0.10
0.01
0.00
ppm Hydrocarbons
0
20
40
60
80
100
120
140
160
180
Shotpoint
Methane
Ethane
Ethylene



Line 97028 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 97028 Depths, Altitude



Line Summary

Line Number	97029
No. of Shotpoints	356

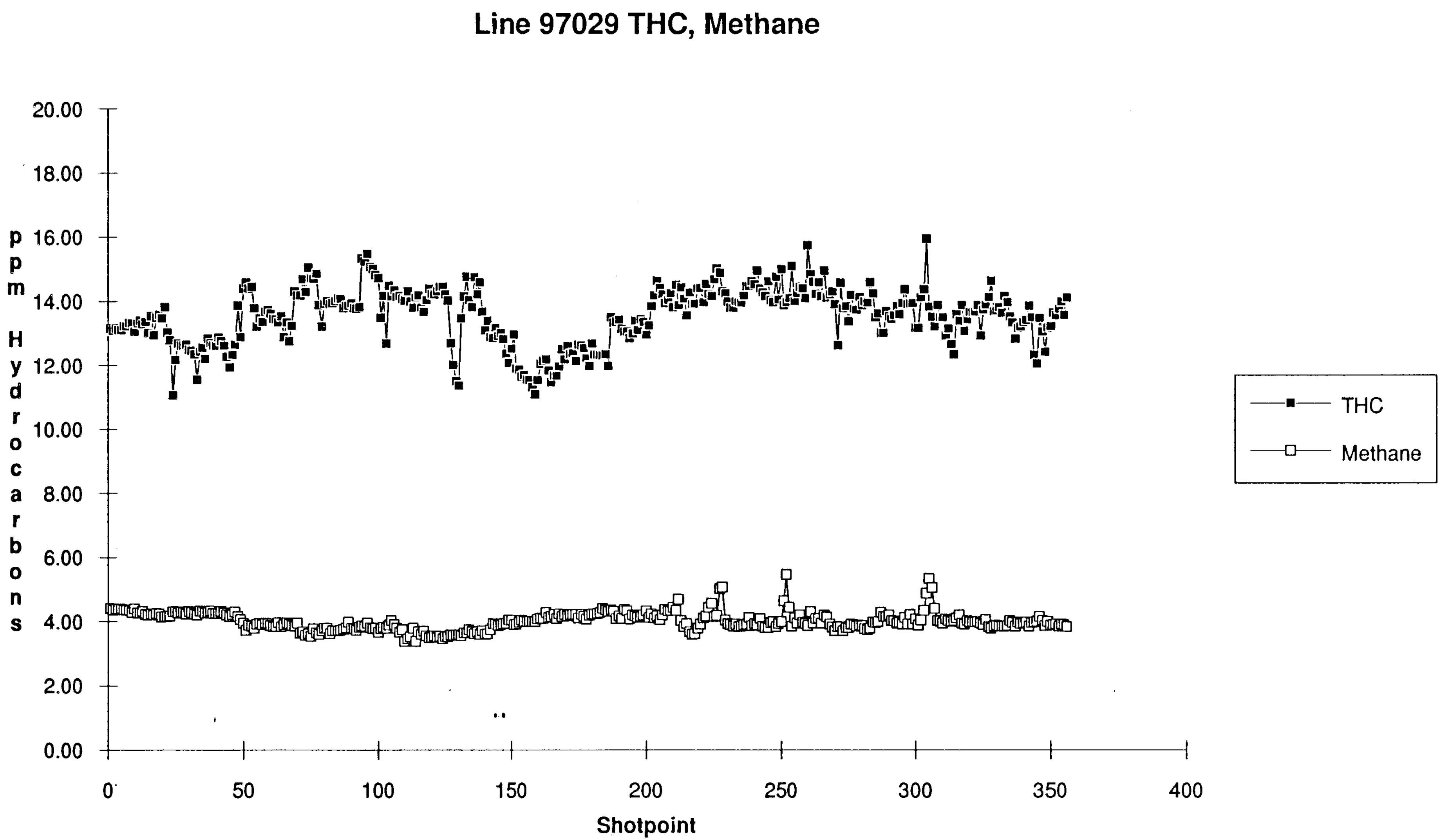
	Shotpoint	Date	Time	Latitude		Longitude	
Start	1	1-Nov-90	07:26:32	12	05.538	124	02.130
End	356	1-Nov-90	19:17:02	12	37.514	124	35.731

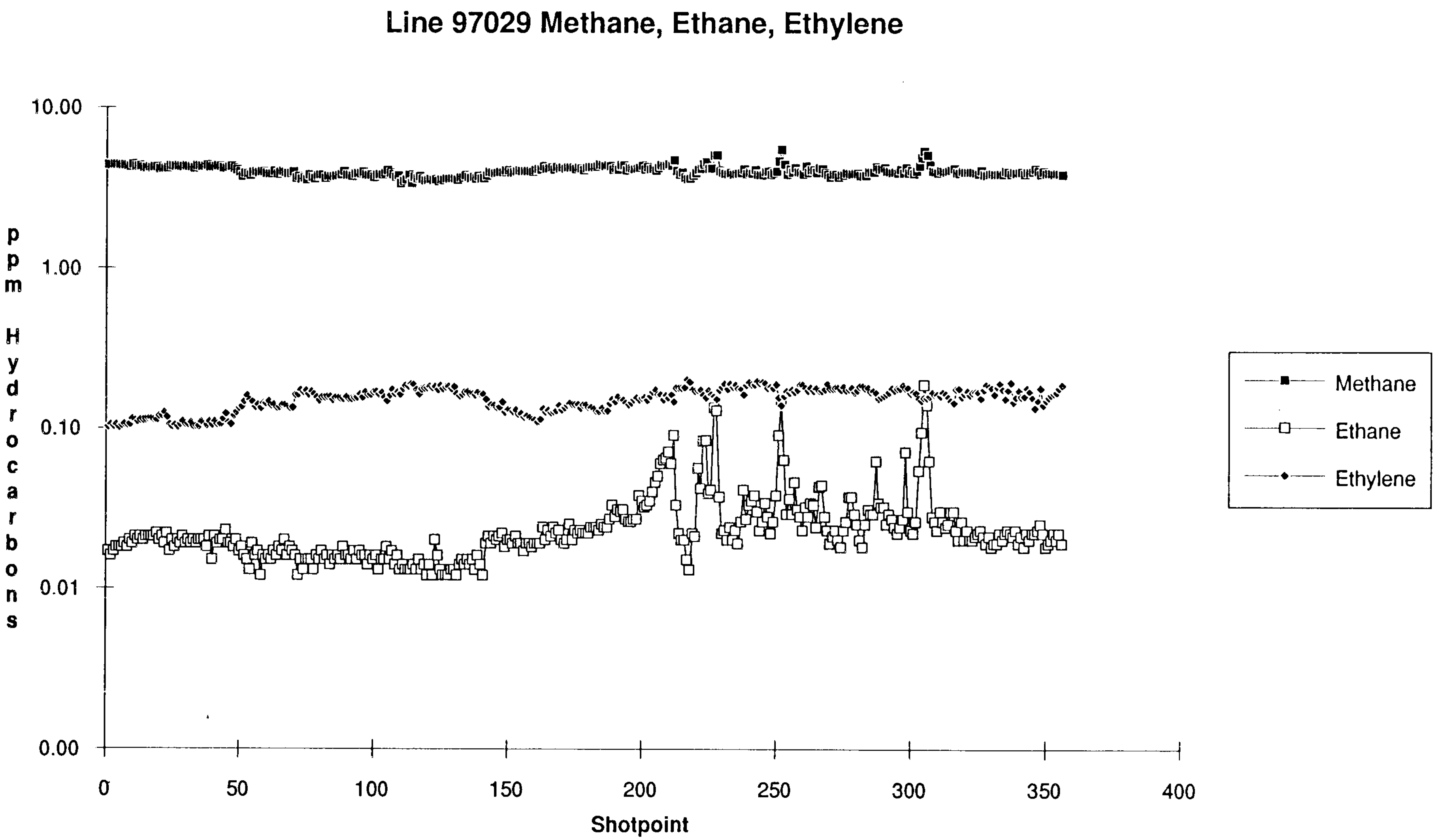
	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	13.523	4.000	0.026	0.153	0.021	0.039	0.016	0.004	0.000	0.140	0.016	0.100	1.620
Std. Dev.	0.873	0.281	0.019	0.025	0.013	0.018	0.025	0.015	0.000	0.049	0.017	0.052	0.897
Minimum	11.057	3.368	0.012	0.101	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.368
Maximum	15.933	5.456	0.187	0.200	0.093	0.095	0.098	0.095	0.000	0.229	0.063	0.235	5.193

	Cond.	Temp.	F. Depth	W.Depth	Altitude
Mean	55.403	28.498	67.749	82.474	14.725
Std. Dev.	0.328	0.330	8.077	9.257	5.676
Minimum	54.440	27.640	44.574	55.574	6.000
Maximum	56.140	29.180	87.312	143.342	80.000

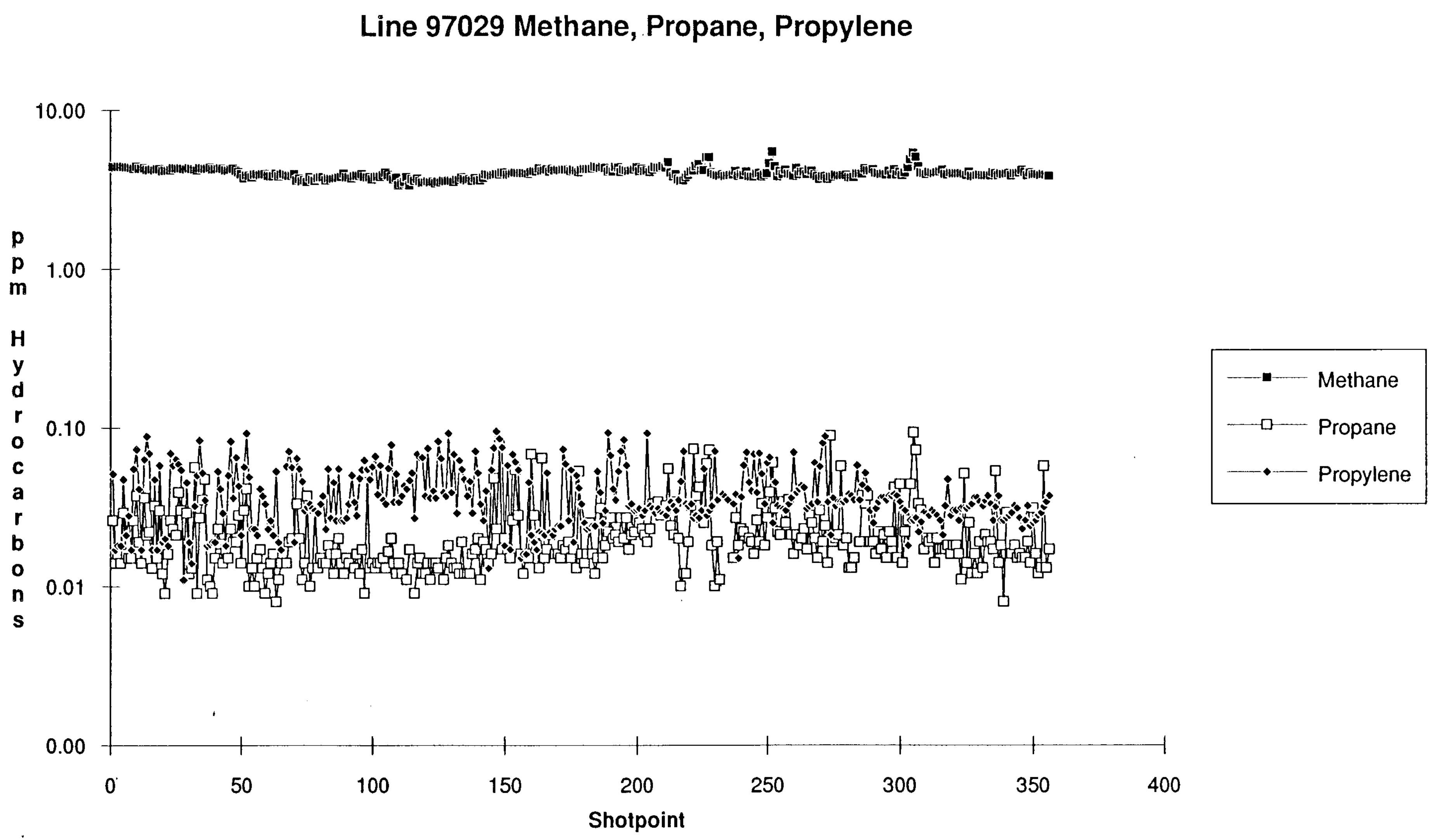
Notes

Weak to moderate anomaly with increased methane and ethane concentrations over, and to the southeast of, the Skua field.
Anomaly betwwen approximately SP 205-320.

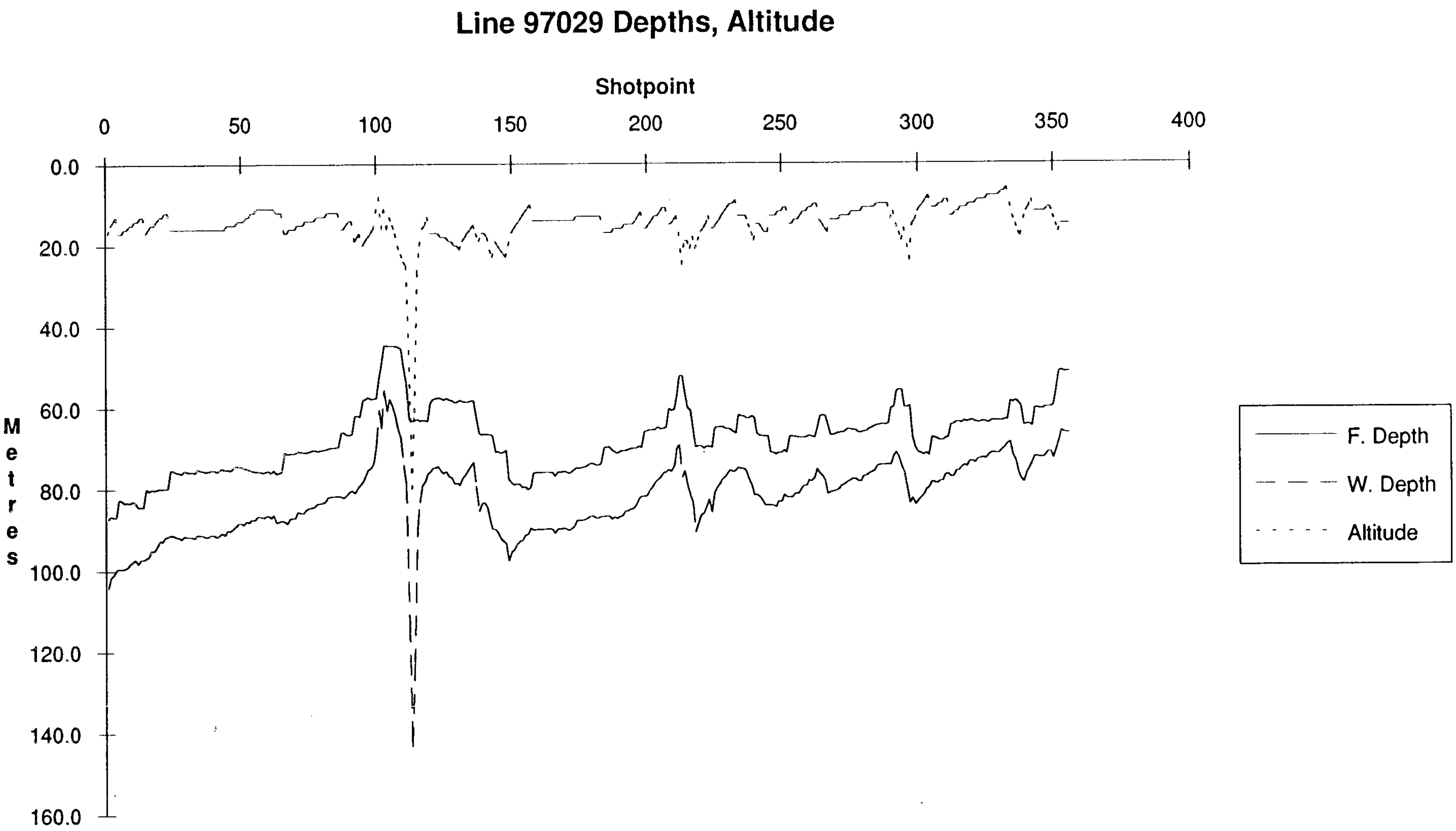

Line 97029 THC, Methane
ppm Hydrocarbons
20.00
18.00
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
0
50
100
150
200
250
300
350
400
Shotpoint
THC
Methane



Line 97029 Methane, Ethane, Ethylene
ppm Hydrocarbons
10.00
1.00
0.10
0.01
0.00
0
50
100
150
200
250
300
350
400
Shotpoint
Methane
Ethane
Ethylene



Line 97029 Methane, Propane, Propylene
10.00
1.00
0.10
0.01
0.00
ppm Hydrocarbons
0
50
100
150
200
250
300
350
400
Shotpoint
Methane
Propane
Propylene


Line 97029 Depths, Altitude
Shotpoint
0
50
100
150
200
250
300
350
400
0.0
20.0
40.0
60.0
80.0
100.0
120.0
140.0
160.0
Metres
F. Depth
W. Depth
Altitude

Line Summary

Line Number	97030
No. of Shotpoints	147

	Shotpoint	Date	Time	Latitude		Longitude	
Start	1	1-Nov-90	20:45:11	12	36.449	124	33.887
End	148	2-Nov-90	01:41:55	12	45.601	124	57.826

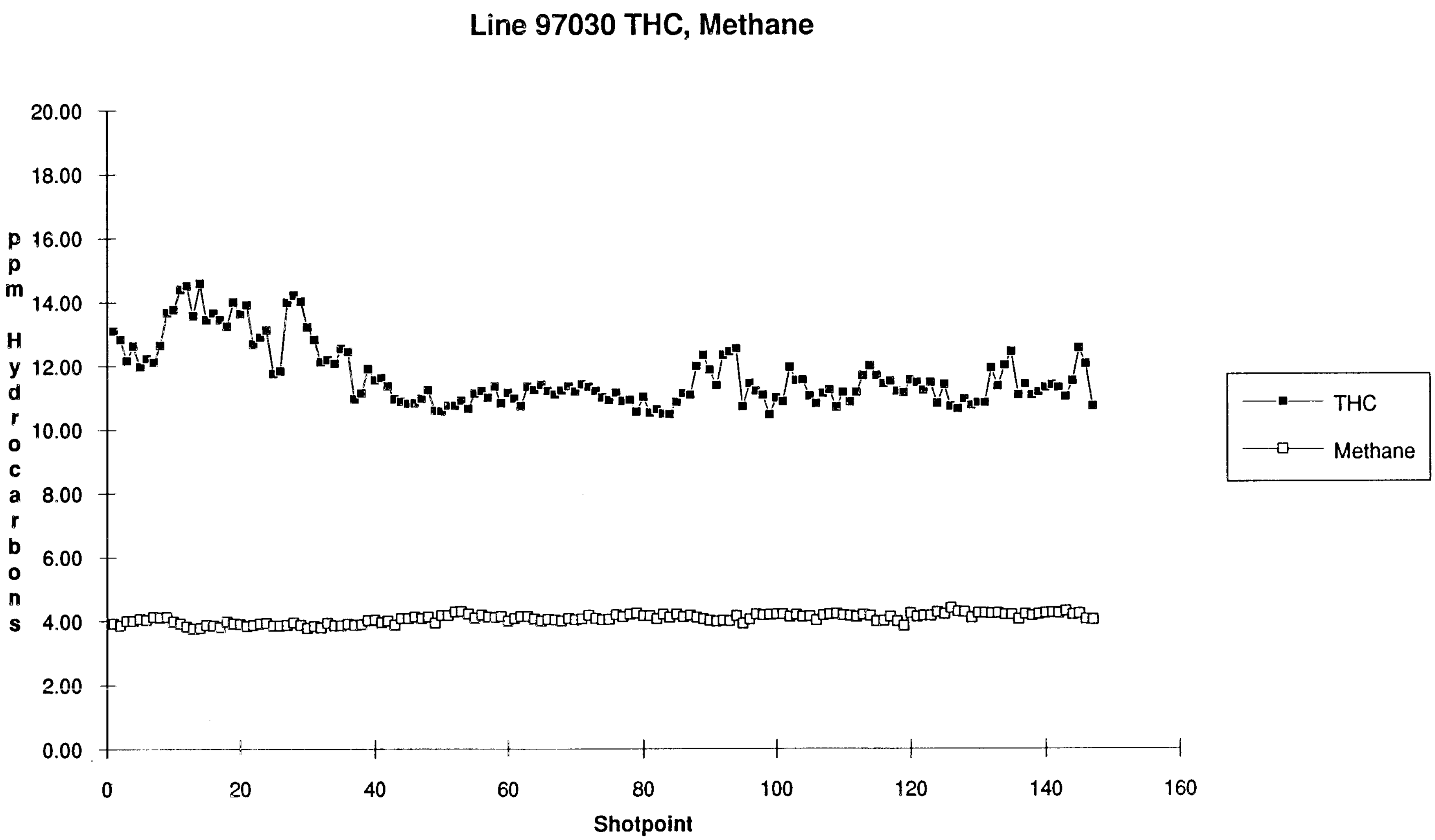
	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	11.665	4.062	0.019	0.127	0.021	0.028	0.021	0.000	0.000	0.089	0.005	0.052	1.471
Std. Dev.	0.994	0.136	0.002	0.021	0.015	0.019	0.032	0.000	0.000	0.037	0.007	0.019	0.960
Minimum	10.458	3.753	0.013	0.103	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.644
Maximum	14.572	4.392	0.023	0.218	0.103	0.111	0.145	0.000	0.000	0.184	0.019	0.088	4.958

	Cond.	Temp.	F. Depth	W.Depth	Altitude
Mean	55.475	28.652	72.378	86.480	14.102
Std. Dev.	0.609	0.545	7.693	7.586	2.266
Minimum	54.570	27.690	52.224	67.632	8.000
Maximum	57.030	30.110	84.252	97.356	20.000

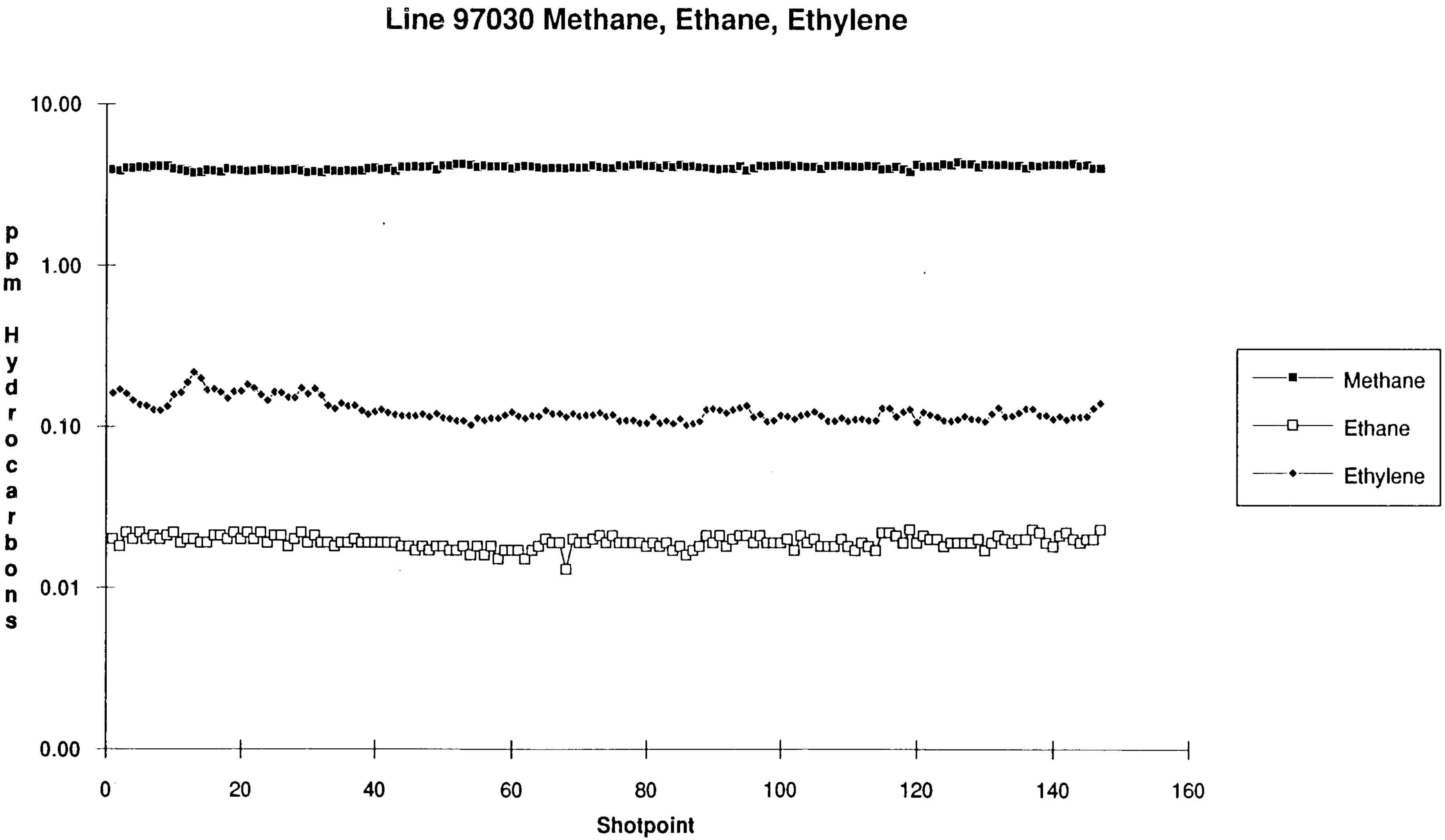
Notes

NO NAVIGATION from shot 5 to shot 98

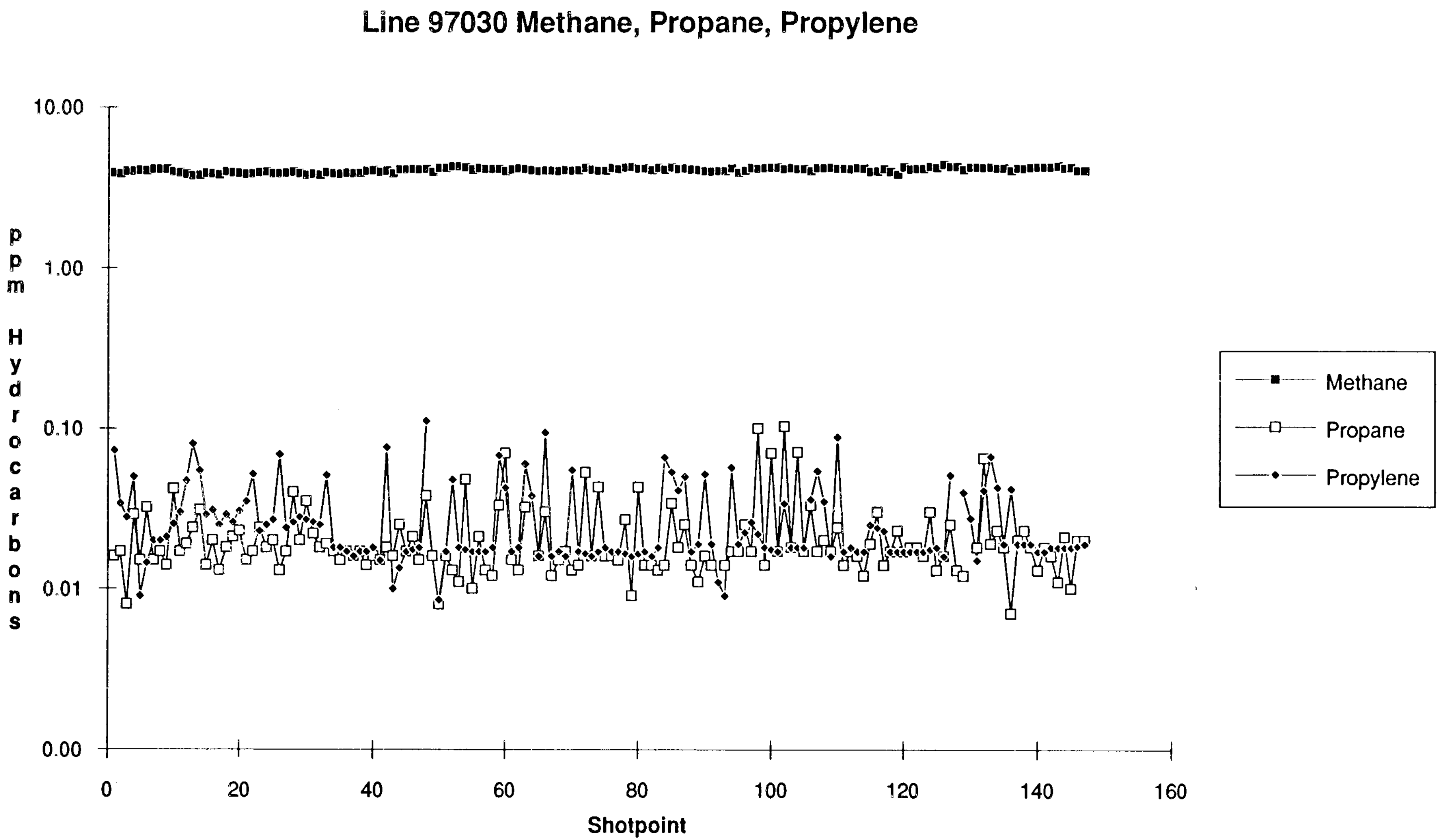
No anomalies



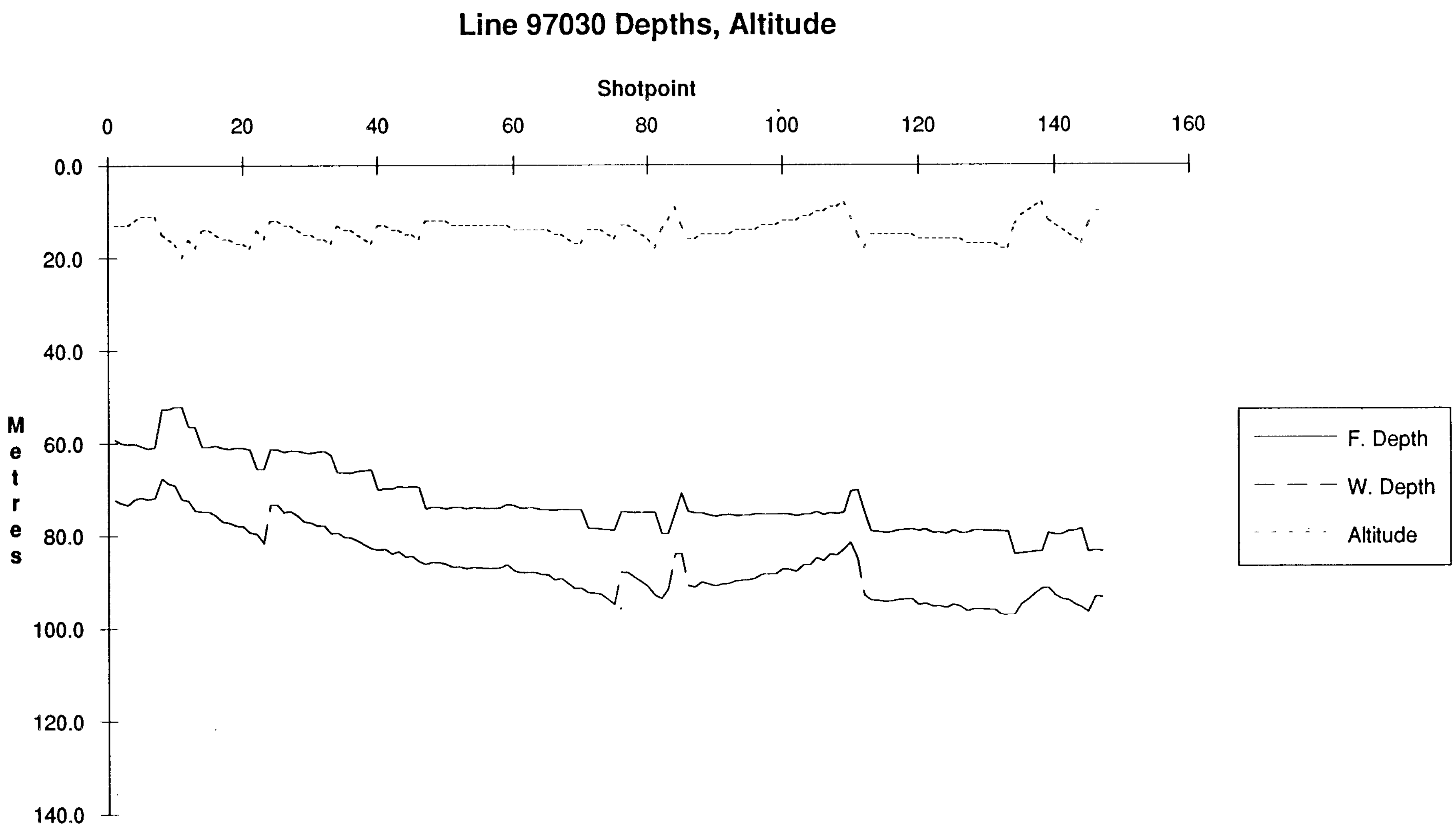
Line 97030 THC, Methane
ppm Hydrocarbons
20.00
18.00
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
0
20
40
60
80
100
120
140
160
Shotpoint
THC
Methane



Line 97030 Methane, Ethane, Ethylene
10.00
1.00
0.10
0.01
0.00
ppm Hydrocarbons
0
20
40
60
80
100
120
140
160
Shotpoint
Methane
Ethane
Ethylene



Line 97030 Methane, Propane, Propylene
ppm Hydrocarbons
10.00
1.00
0.10
0.01
0.00
0
20
40
60
80
100
120
140
160
Shotpoint
Methane
Propane
Propylene



Line 97030 Depths, Altitude
Shotpoint
0
20
40
60
80
100
120
140
160
0.0
20.0
40.0
60.0
80.0
100.0
120.0
140.0
Metres
F. Depth
W. Depth
Altitude

Line Summary

Line Number	97031
No. of Shotpoints	214

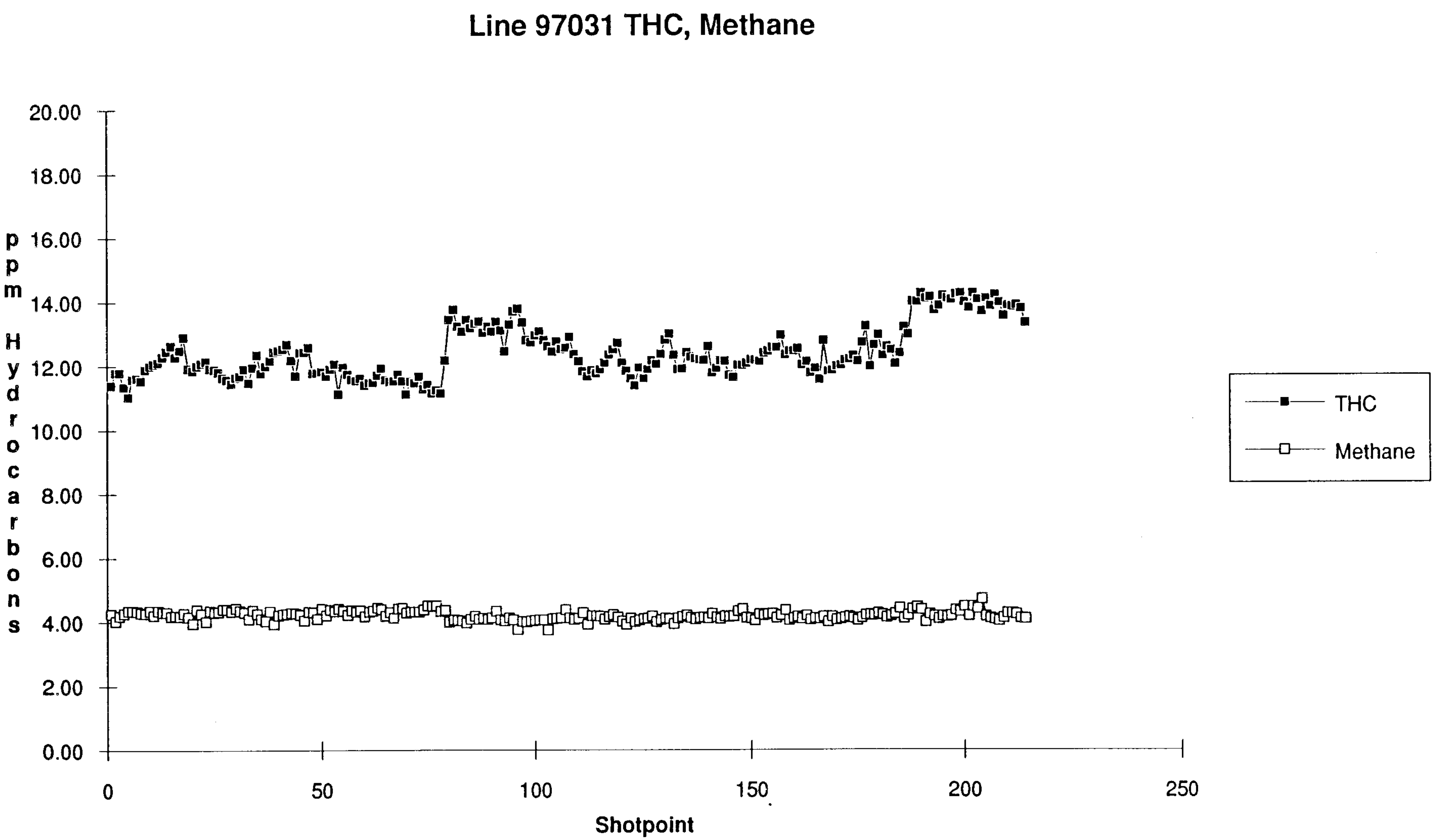
	Shotpoint	Date	Time	Latitude		Longitude	
Start	2	2-Nov-90	02:33:27	12	45.700	124	58.970
End	215	2-Nov-90	09:40:06	12	26.436	124	27.727

	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	12.412	4.187	0.023	0.131	0.022	0.027	0.005	0.010	0.000	0.104	0.022	0.083	1.393
Std. Dev.	0.811	0.142	0.008	0.019	0.011	0.020	0.012	0.024	0.000	0.048	0.015	0.043	0.807
Minimum	11.026	3.743	0.014	0.106	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.455
Maximum	14.268	4.699	0.073	0.191	0.083	0.109	0.073	0.186	0.000	0.192	0.043	0.162	5.635

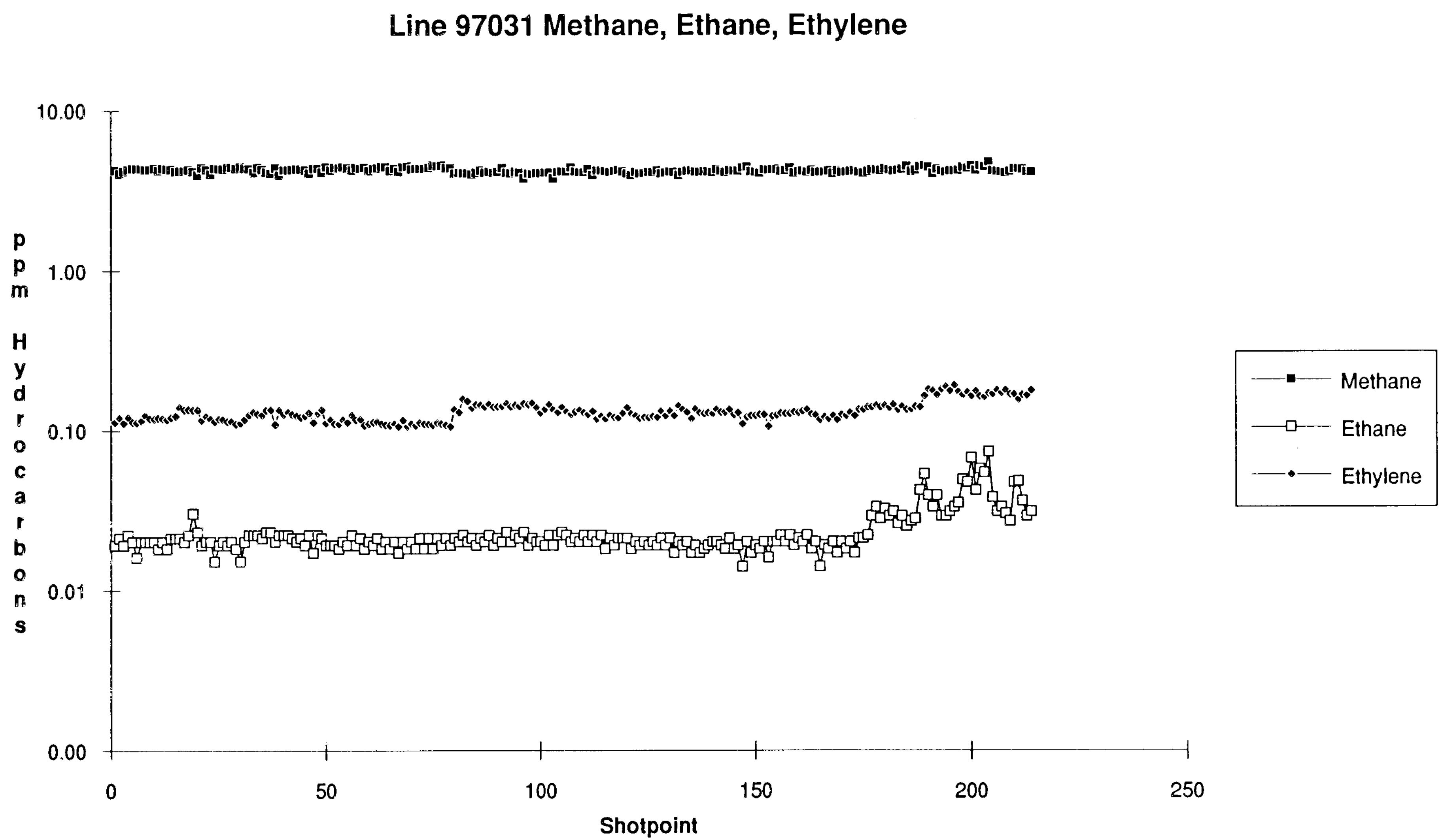
	Cond.	Temp.	F. Depth	W.Depth	Altitude
Mean	57.019	29.938	72.596	89.063	16.467
Std. Dev.	0.529	0.480	2.746	2.996	3.261
Minimum	55.840	28.860	64.872	82.382	8.000
Maximum	57.930	30.810	78.948	98.278	28.000

Notes

Weak anomaly between approximately SP 175 to end of line, characterised principally by ethane enrichment.
Located southeast of and over the Skua field.

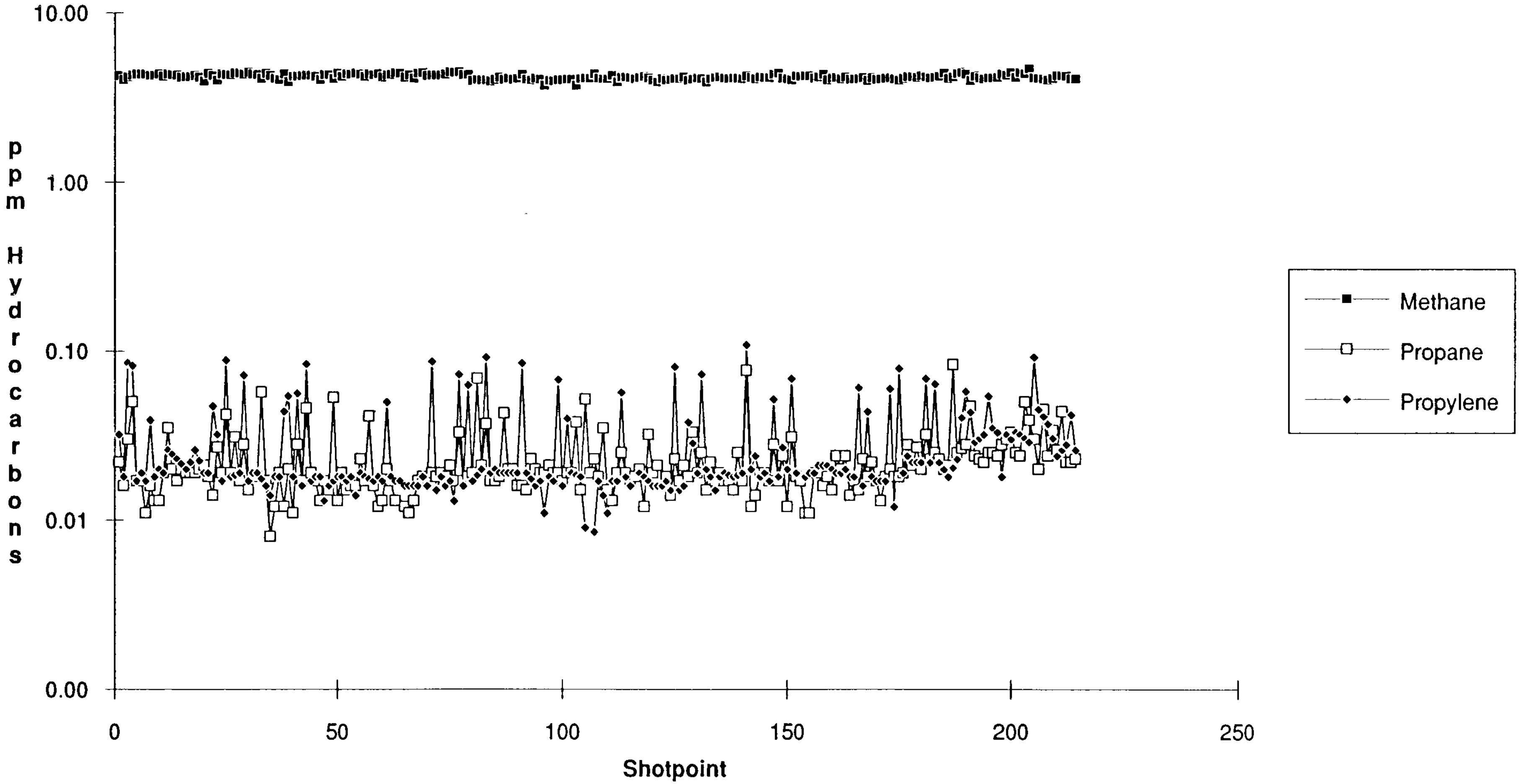


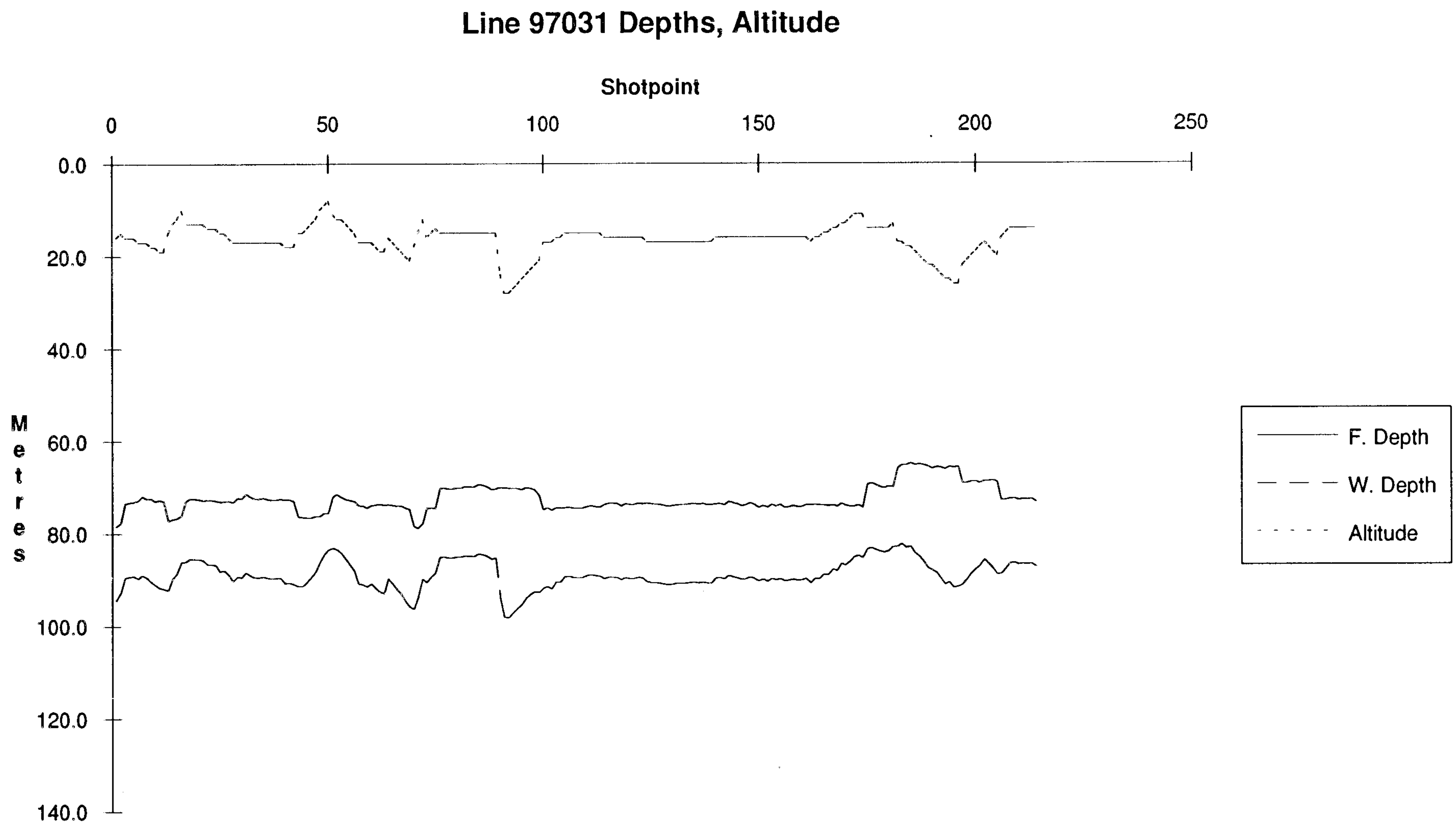
Line 97031 THC, Methane
ppm Hydrocarbons
20.00
18.00
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
0
50
100
150
200
250
Shotpoint
THC
Methane



Line 97031 Methane, Ethane, Ethylene
10.00
1.00
0.10
0.01
0.00
ppm Hydrocarbons
0
50
100
150
200
250
Shotpoint
Methane
Ethane
Ethylene

Line 97031 Methane, Propane, Propylene





Line 97031 Depths, Altitude
Shotpoint
0
50
100
150
200
250
0.0
20.0
40.0
60.0
80.0
100.0
120.0
140.0
Metres
F. Depth
W. Depth
Altitude

Line Summary

Line Number	97032
No. of Shotpoints	249

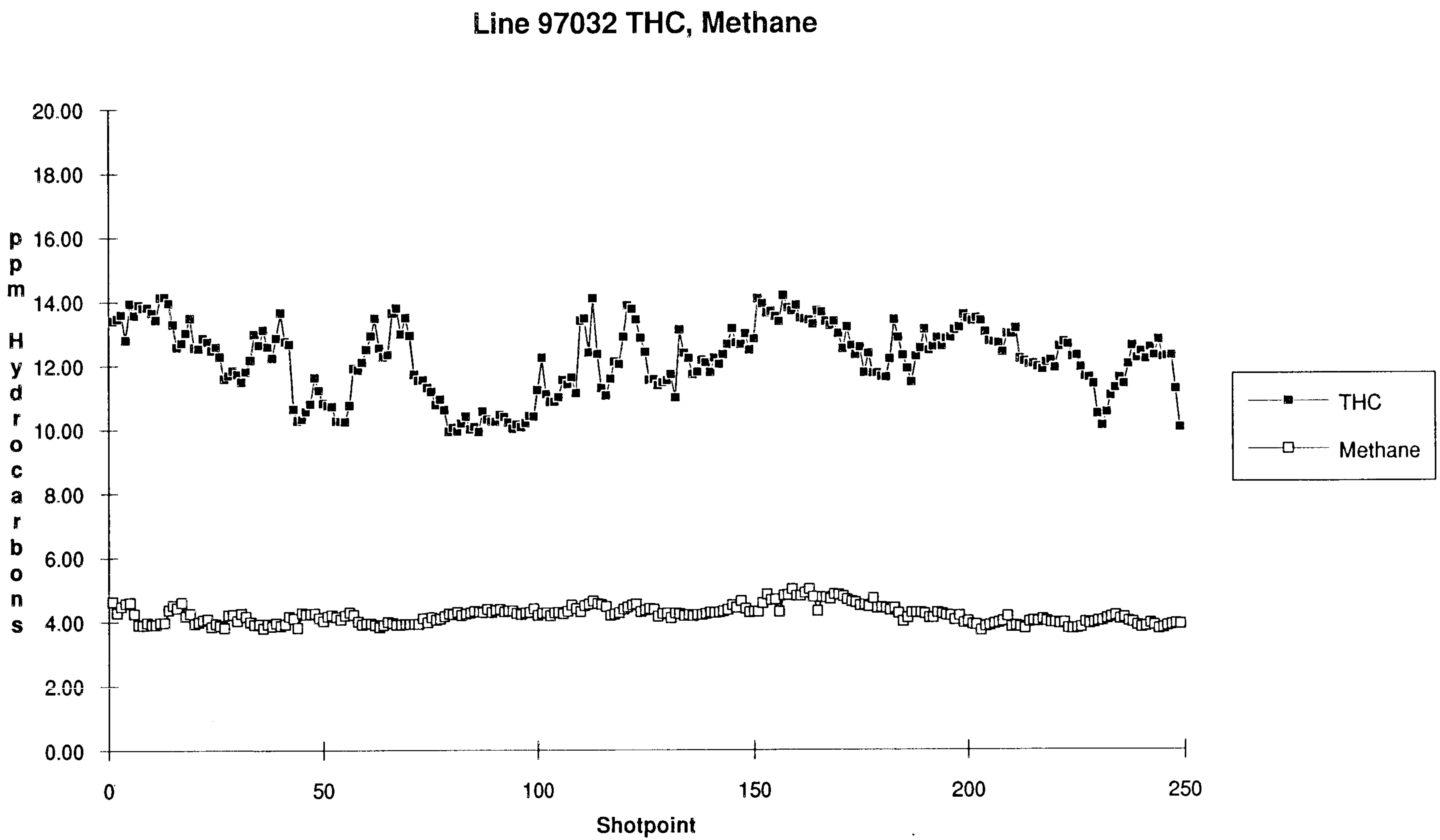
	Shotpoint	Date	Time	Latitude		Longitude	
Start	1	2-Nov-90	11:58:01	12	29.373	124	31.099
End	249	2-Nov-90	20:14:12	12	15.806	124	20.288

	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	12.173	4.187	0.035	0.136	0.028	0.048	0.010	0.015	0.000	0.102	0.003	0.019	2.005
Std. Dev.	1.100	0.274	0.023	0.019	0.015	0.039	0.018	0.026	0.000	0.034	0.007	0.020	0.978
Minimum	9.913	3.708	0.016	0.097	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.419
Maximum	14.152	4.986	0.117	0.181	0.116	0.193	0.127	0.126	0.000	0.179	0.025	0.074	5.101

	Cond.	Temp.	F. Depth	W.Depth	Altitude
Mean	54.837	28.041	77.189	91.571	14.382
Std. Dev.	0.324	0.308	2.704	2.538	2.021
Minimum	54.130	27.290	70.380	82.890	8.000
Maximum	55.550	28.860	84.354	97.152	21.000

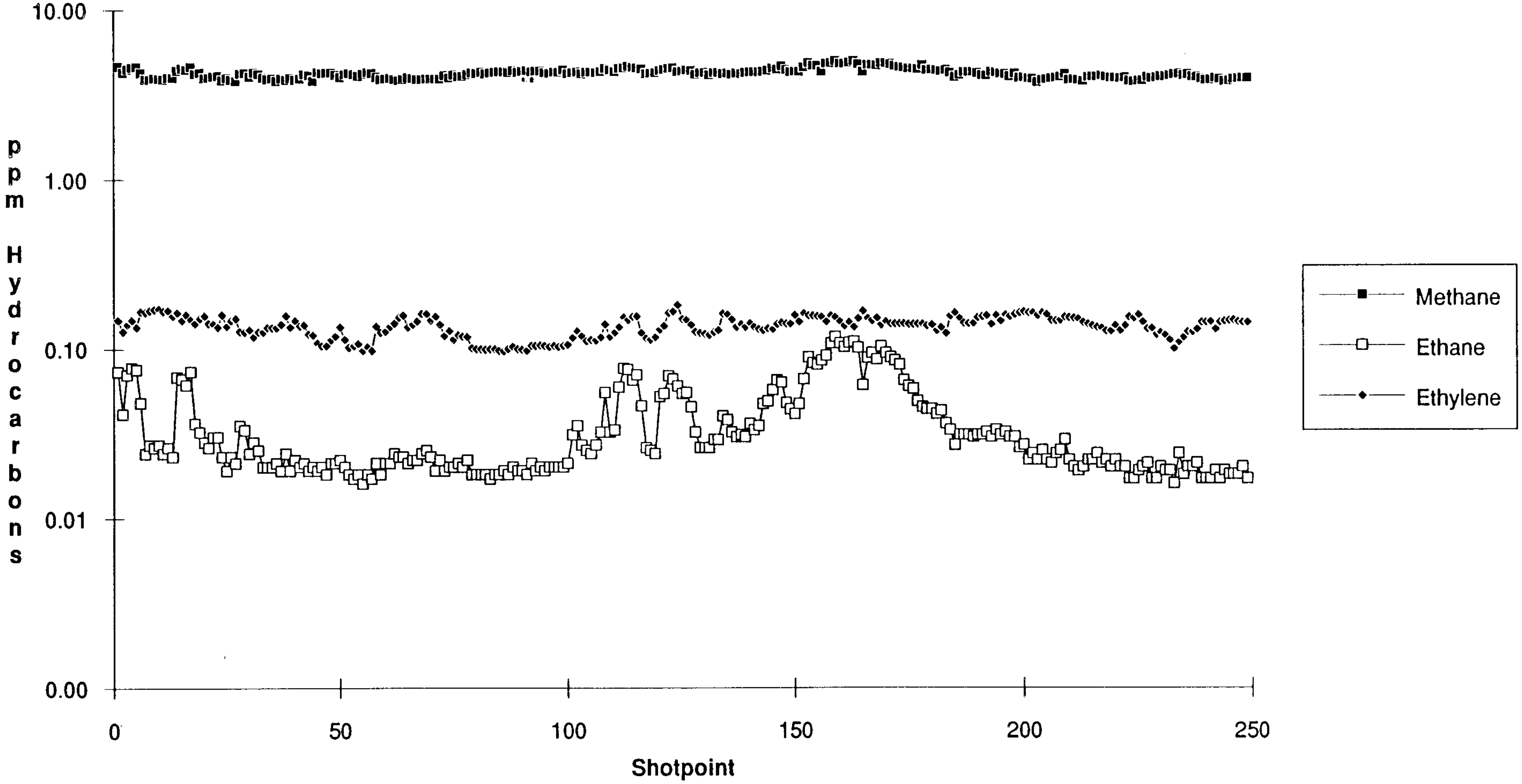
Notes

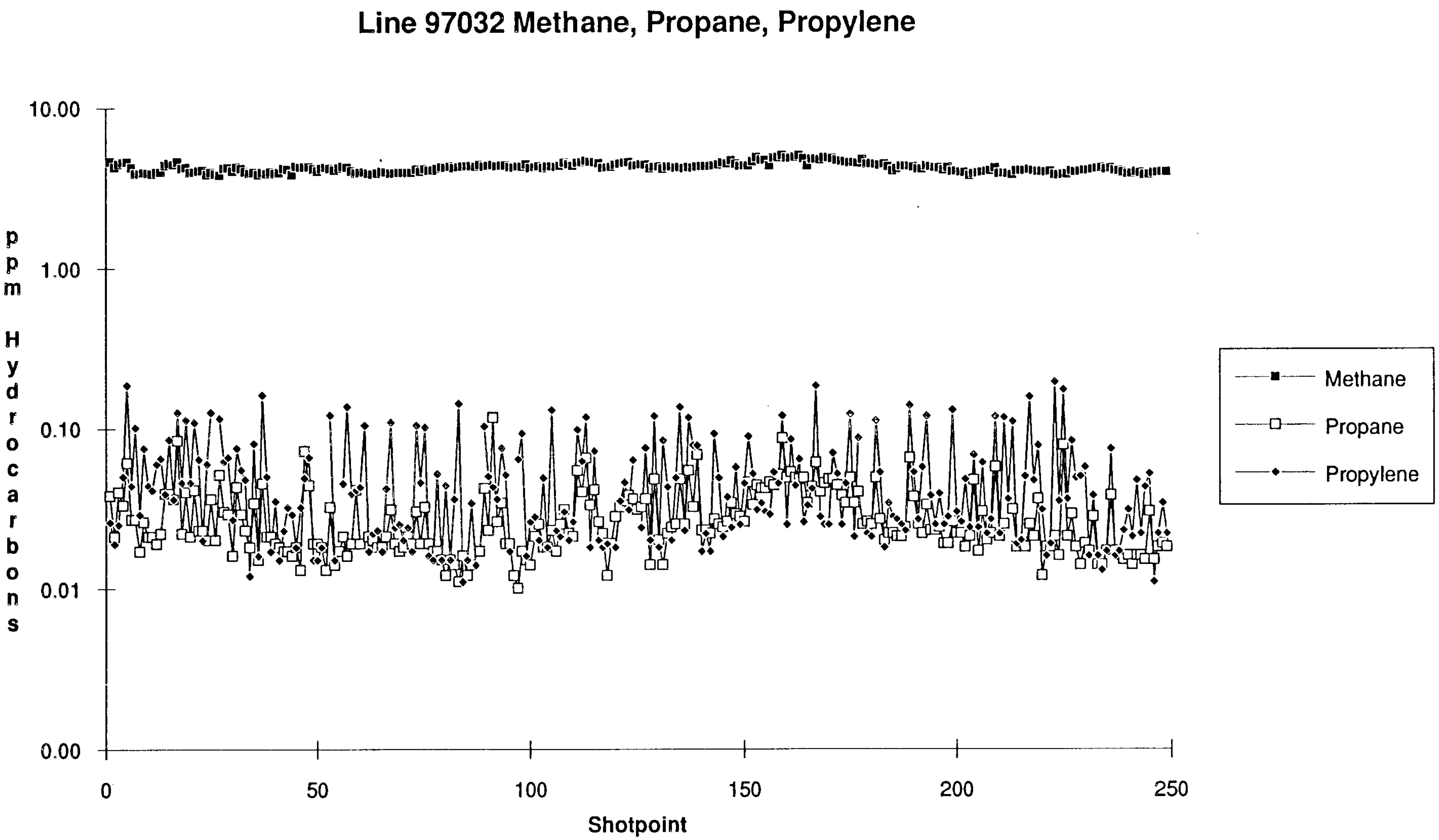
Weak to moderate anomaly characterised by significant ethane and slight methane enrichments.
Located over, and to the northwest of the Skua field between approximately SP 100-200.



Line 97032 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
50
100
150
200
250
Shotpoint
THC
Methane

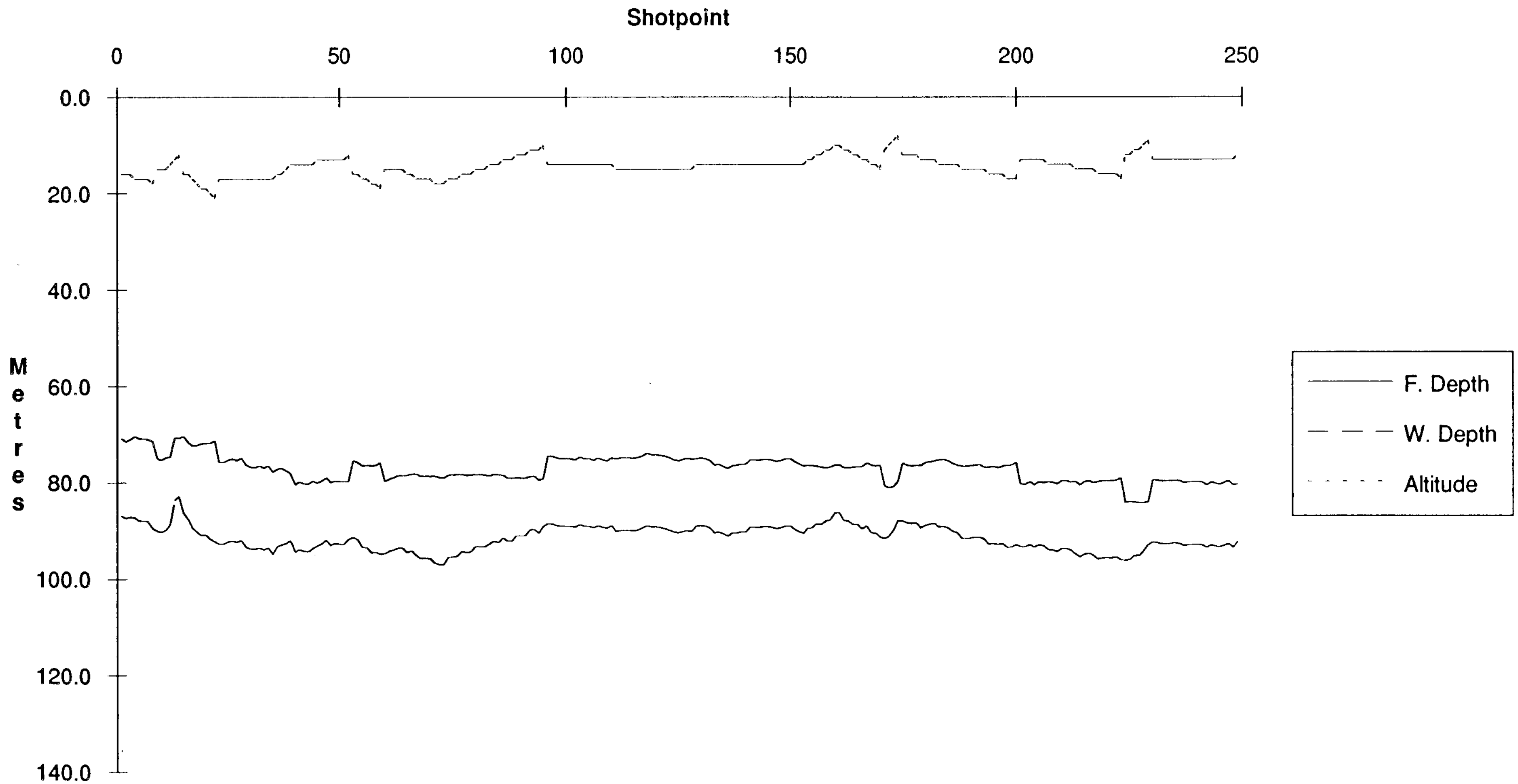
Line 97032 Methane, Ethane, Ethylene





Line 97032 Methane, Propane, Propylene
10.00
1.00
0.10
0.01
0.00
ppm Hydrocarbons
0
50
100
150
200
250
Shotpoint
Methane
Propane
Propylene

Line 97032 Depths, Altitude



Line Summary

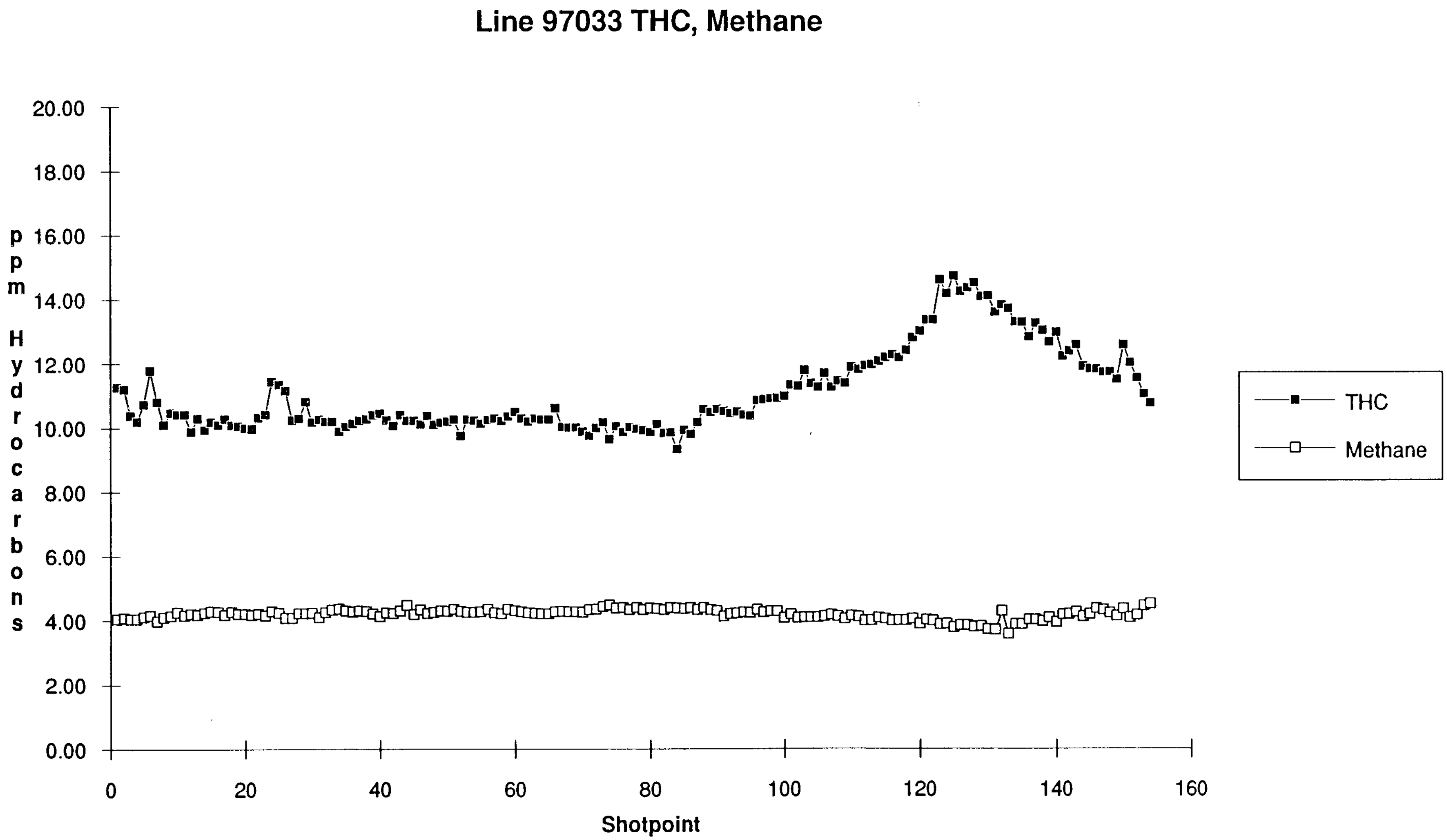
Line Number	97033
No. of Shotpoints	154

	Shotpoint	Date	Time	Latitude		Longitude	
Start	1	2-Nov-90	21:38:23	12	17.973	124	22.308
End	154	3-Nov-90	02:46:14	12	02.705	124	01.224

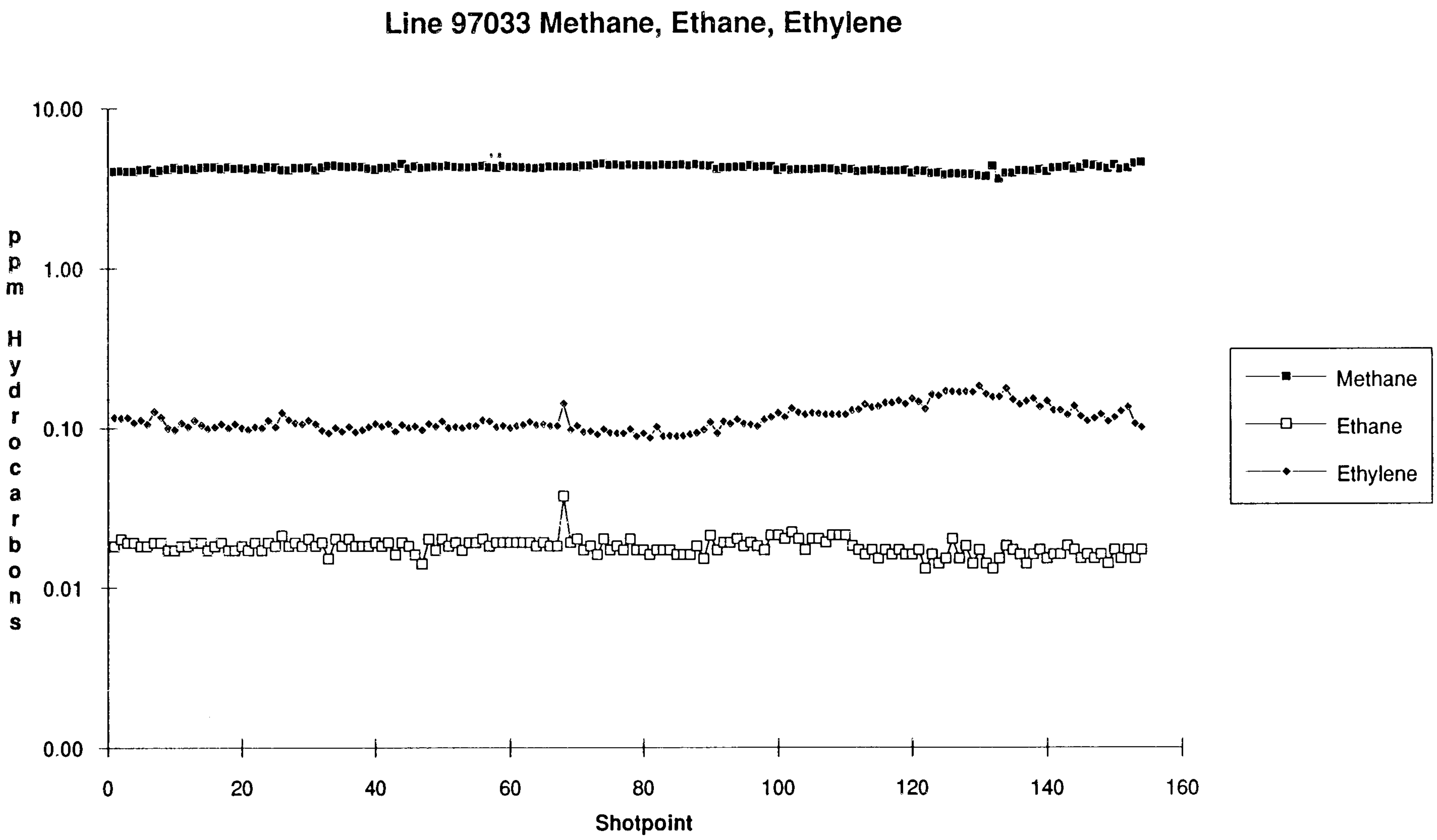
	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	11.070	4.172	0.018	0.115	0.023	0.043	0.020	0.005	0.000	0.070	0.006	0.027	1.554
Std. Dev.	1.279	0.167	0.002	0.021	0.013	0.036	0.025	0.016	0.000	0.034	0.009	0.026	0.828
Minimum	9.319	3.562	0.013	0.086	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.400
Maximum	14.702	4.489	0.037	0.181	0.079	0.172	0.107	0.123	0.000	0.179	0.029	0.100	5.106

	Cond.	Temp.	F Depth	W.Depth	Altitude
Mean	55.506	28.642	86.232	99.966	13.734
Std. Dev.	1.090	0.966	4.351	4.639	1.309
Minimum	54.160	27.290	77.214	91.784	11.000
Maximum	57.620	30.710	96.900	110.900	18.000

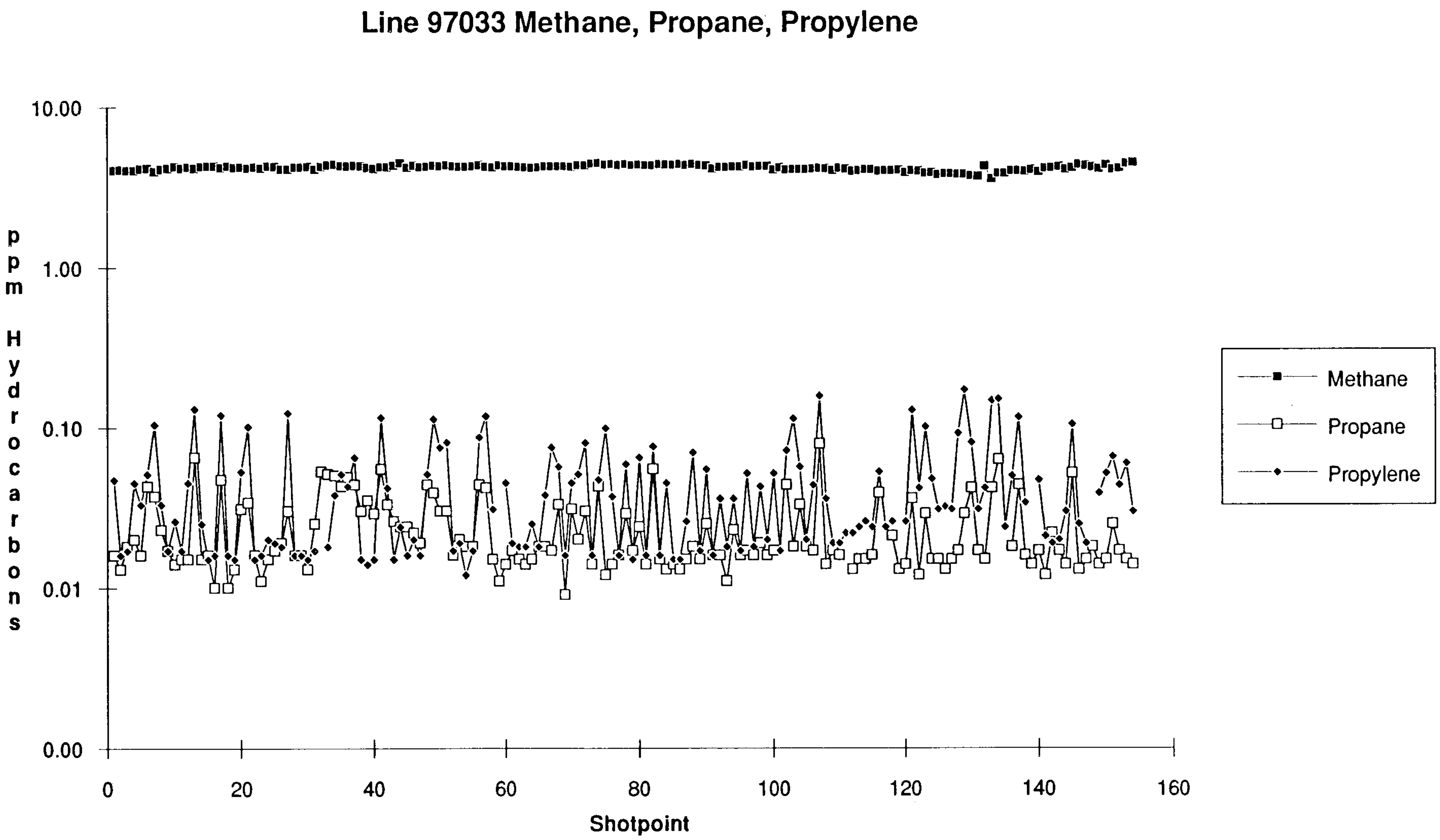
Notes: No anomalies. THC and methane increase towards end of line.



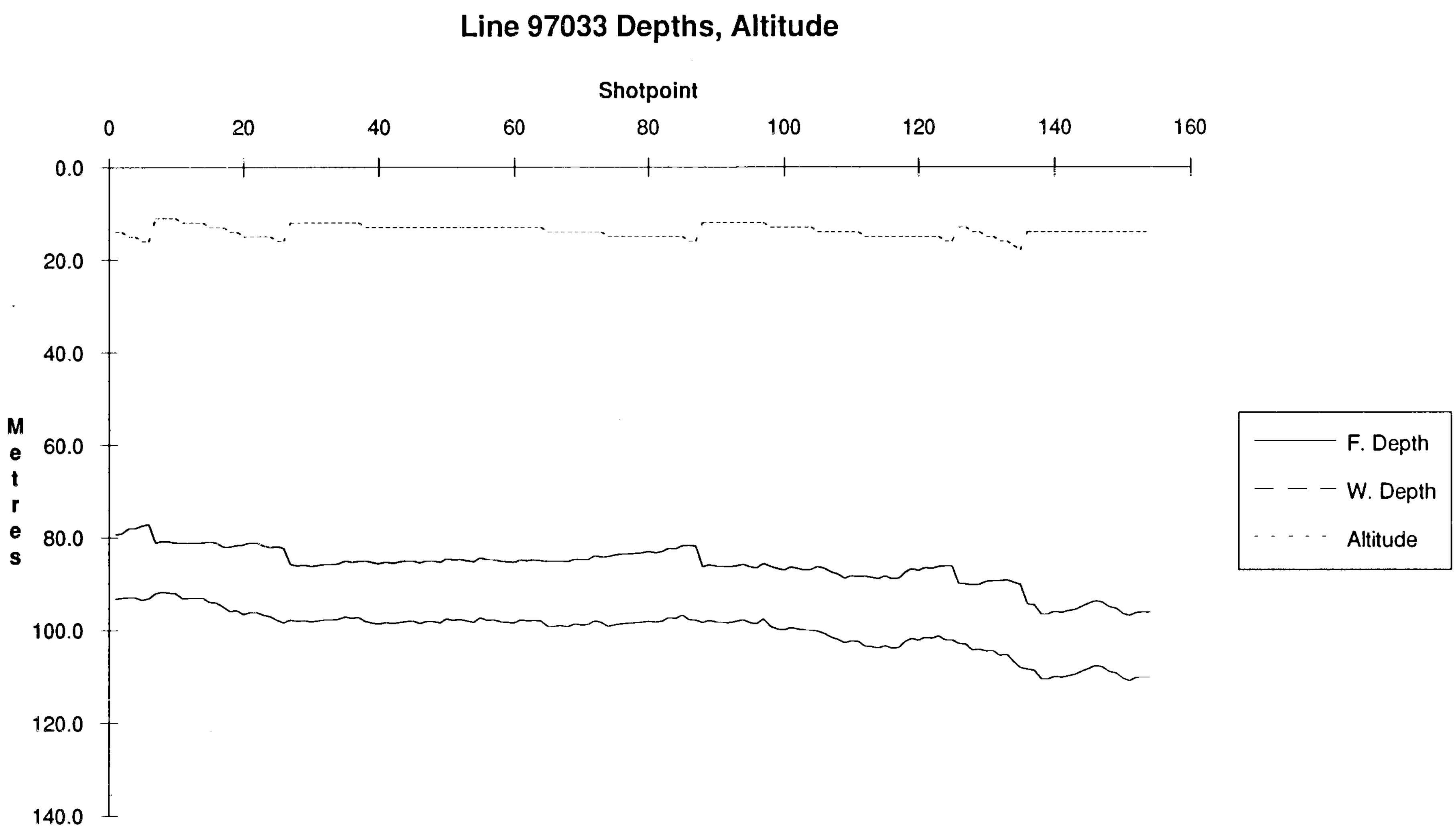
Line 97033 THC, Methane
ppm Hydrocarbons
20.00
18.00
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
0
20
40
60
80
100
120
140
160
Shotpoint
THC
Methane



Line 97033 Methane, Ethane, Ethylene
10.00
1.00
0.10
0.01
0.00
ppm Hydrocarbons
0
20
40
60
80
100
120
140
160
Shotpoint
Methane
Ethane
Ethylene



Line 97033 Methane, Propane, Propylene
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 97033 Depths, Altitude
Shotpoint
0
20
40
60
80
100
120
140
160
Metres
0.0
20.0
40.0
60.0
80.0
100.0
120.0
140.0
F. Depth
W. Depth
Altitude

Line Summary

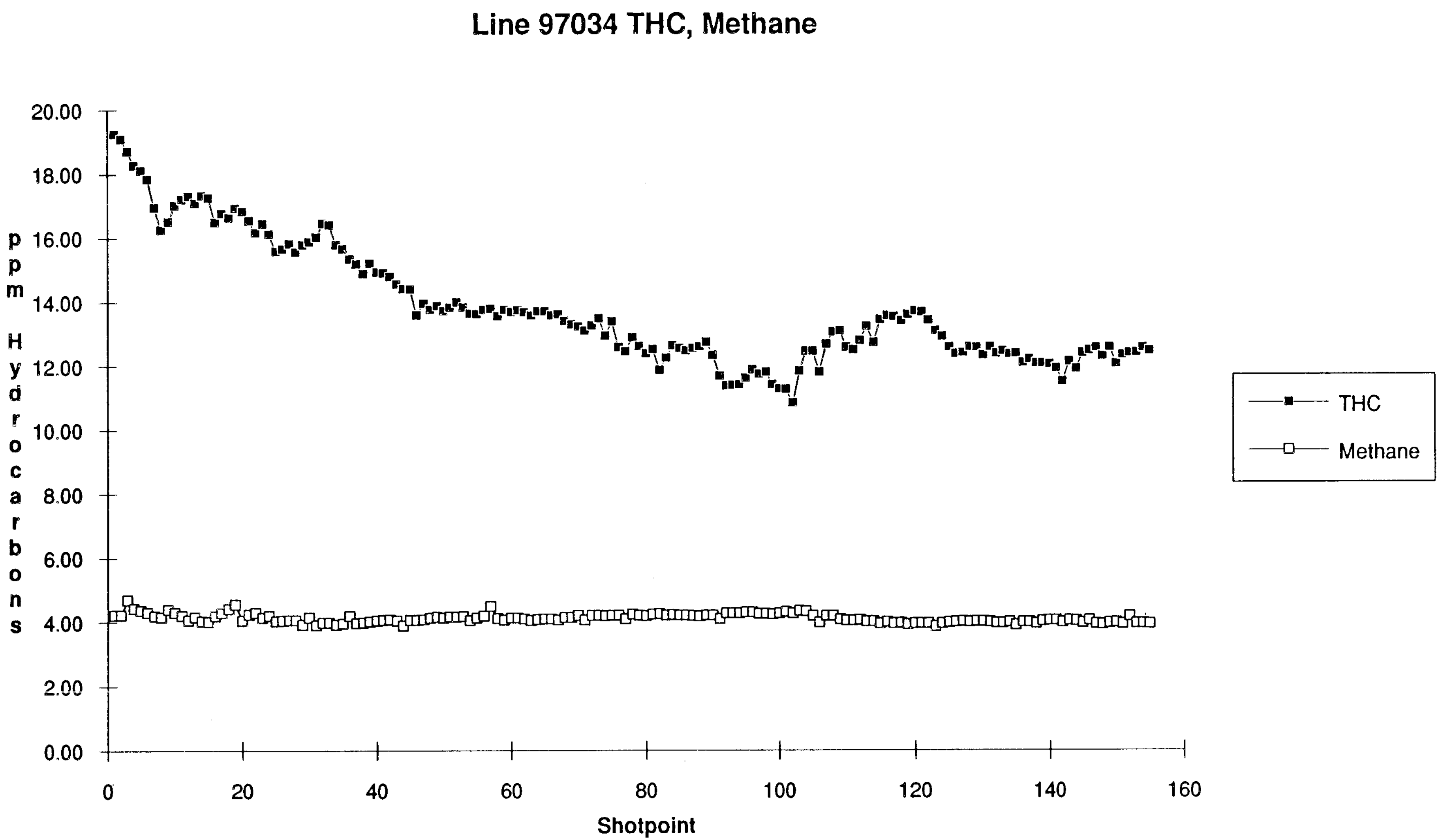
Line Number	97034
No. of Shotpoints	155

	Shotpoint	Date	Time	Latitude		Longitude	
Start	2	3-Nov-90	06:10:19	11	59.979	124	13.891
End	156	3-Nov-90	11:18:19	12	16.480	124	34.759

	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	13.775	4.103	0.020	0.125	0.019	0.030	0.014	0.001	0.000	0.124	0.091	0.111	1.306
Std. Dev.	1.884	0.140	0.003	0.016	0.007	0.019	0.018	0.005	0.000	0.043	0.064	0.046	0.505
Minimum	10.831	3.842	0.012	0.088	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.284
Maximum	19.235	4.689	0.028	0.169	0.051	0.087	0.061	0.051	0.000	0.183	0.260	0.204	2.874

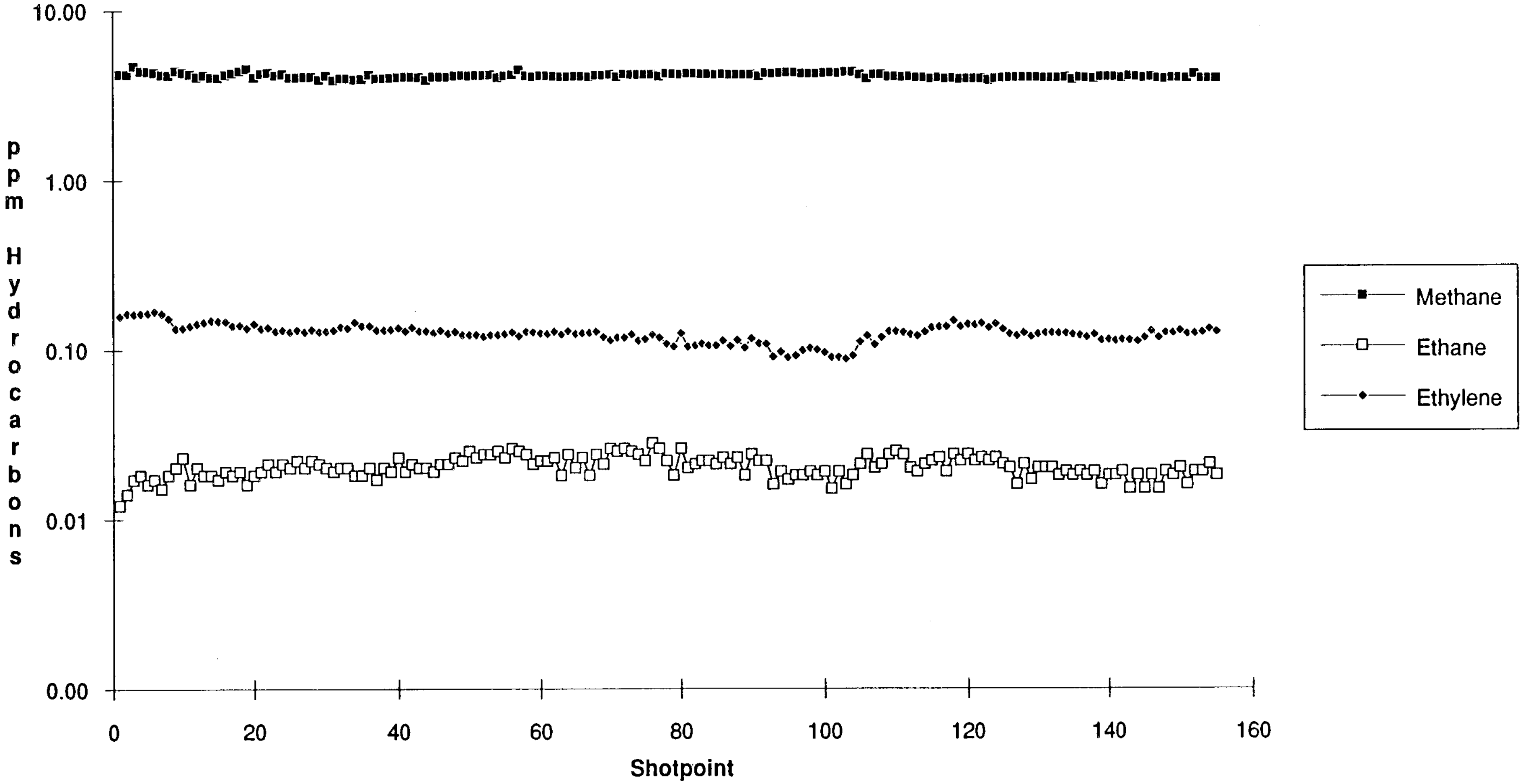
	Cond.	Temp.	F. Depth	W.Depth	Altitude
Mean	55.648	21.550	86.496	102.715	16.219
Std. Dev.	0.895	3.167	6.287	6.152	2.039
Minimum	54.240	17.870	71.502	89.012	10.000
Maximum	57.920	29.480	95.370	111.066	22.000

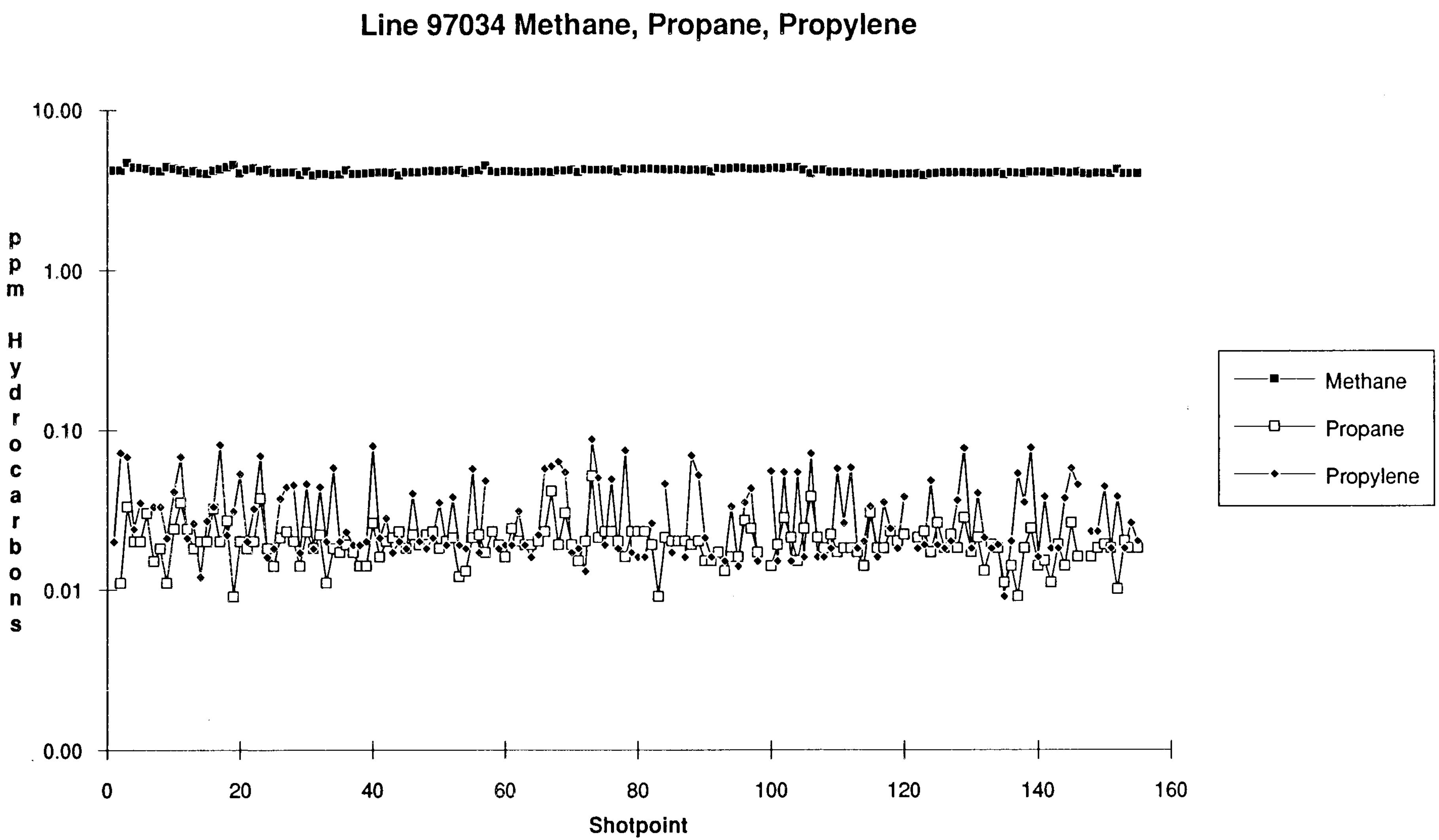
Notes: No anomalies. THC and methane decrease from the beginning of line.



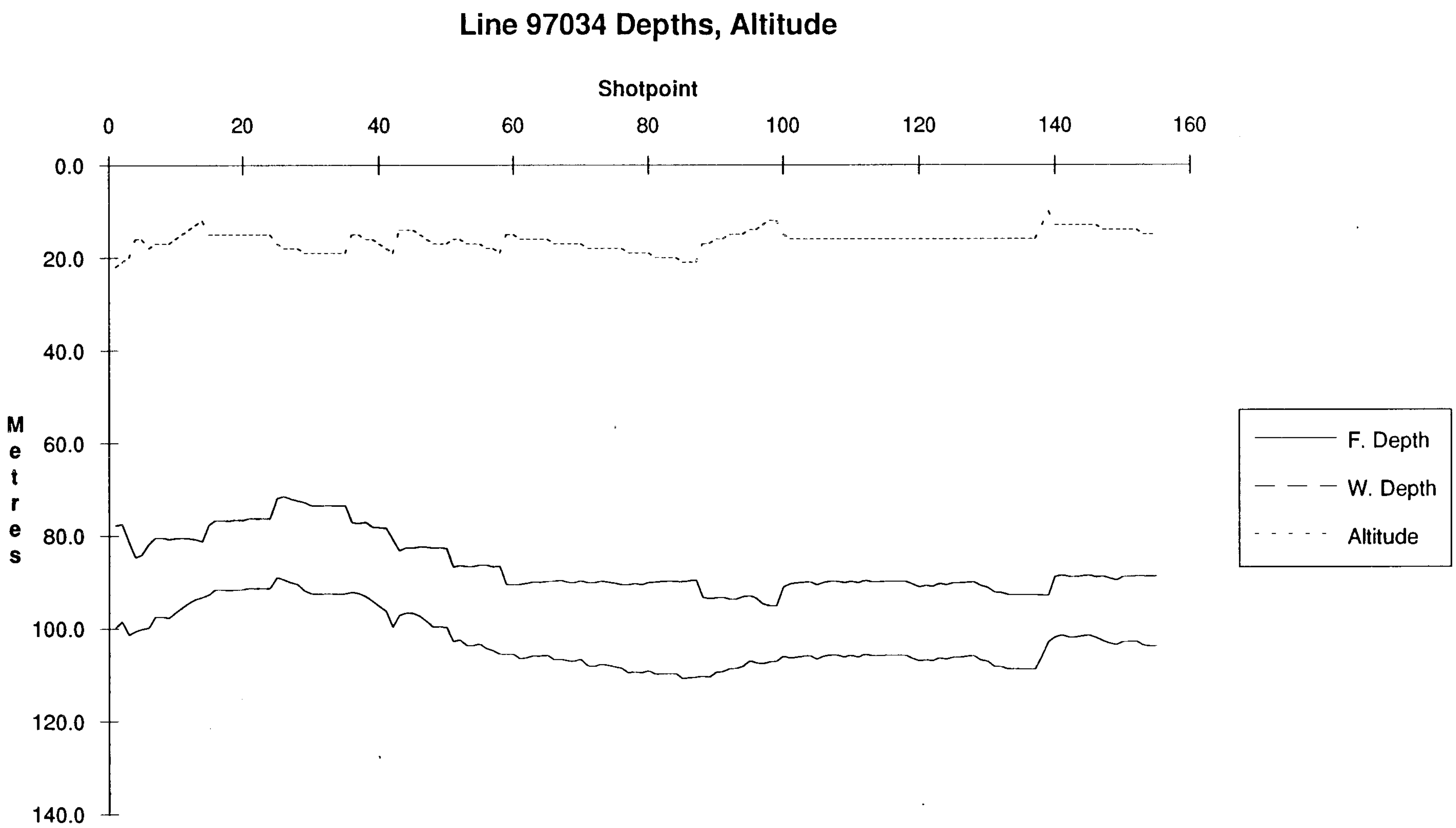
Line 97034 THC, Methane
ppm Hydrocarbons
20.00
18.00
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
0
20
40
60
80
100
120
140
160
Shotpoint
THC
Methane

Line 97034 Methane, Ethane, Ethylene





Line 97034 Methane, Propane, Propylene
ppm Hydrocarbons
10.00
1.00
0.10
0.01
0.00
0
20
40
60
80
100
120
140
160
Shotpoint
Methane
Propane
Propylene


Line 97034 Depths, Altitude
Shotpoint
0
20
40
60
80
100
120
140
160
0.0
20.0
40.0
60.0
80.0
100.0
120.0
140.0
Metres
F. Depth
W. Depth
Altitude

Line Summary

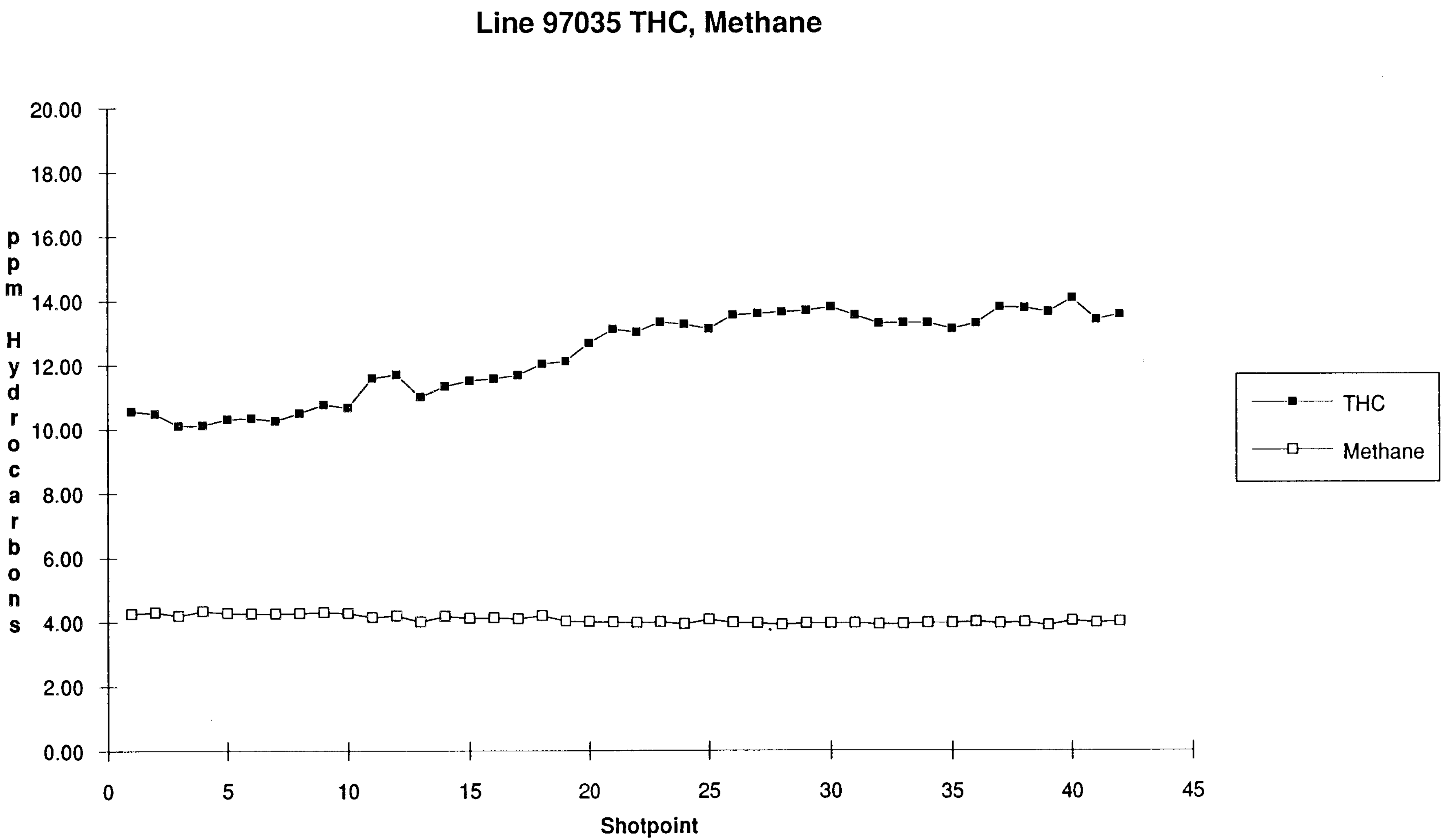
Line Number	97035
No. of Shotpoints	42

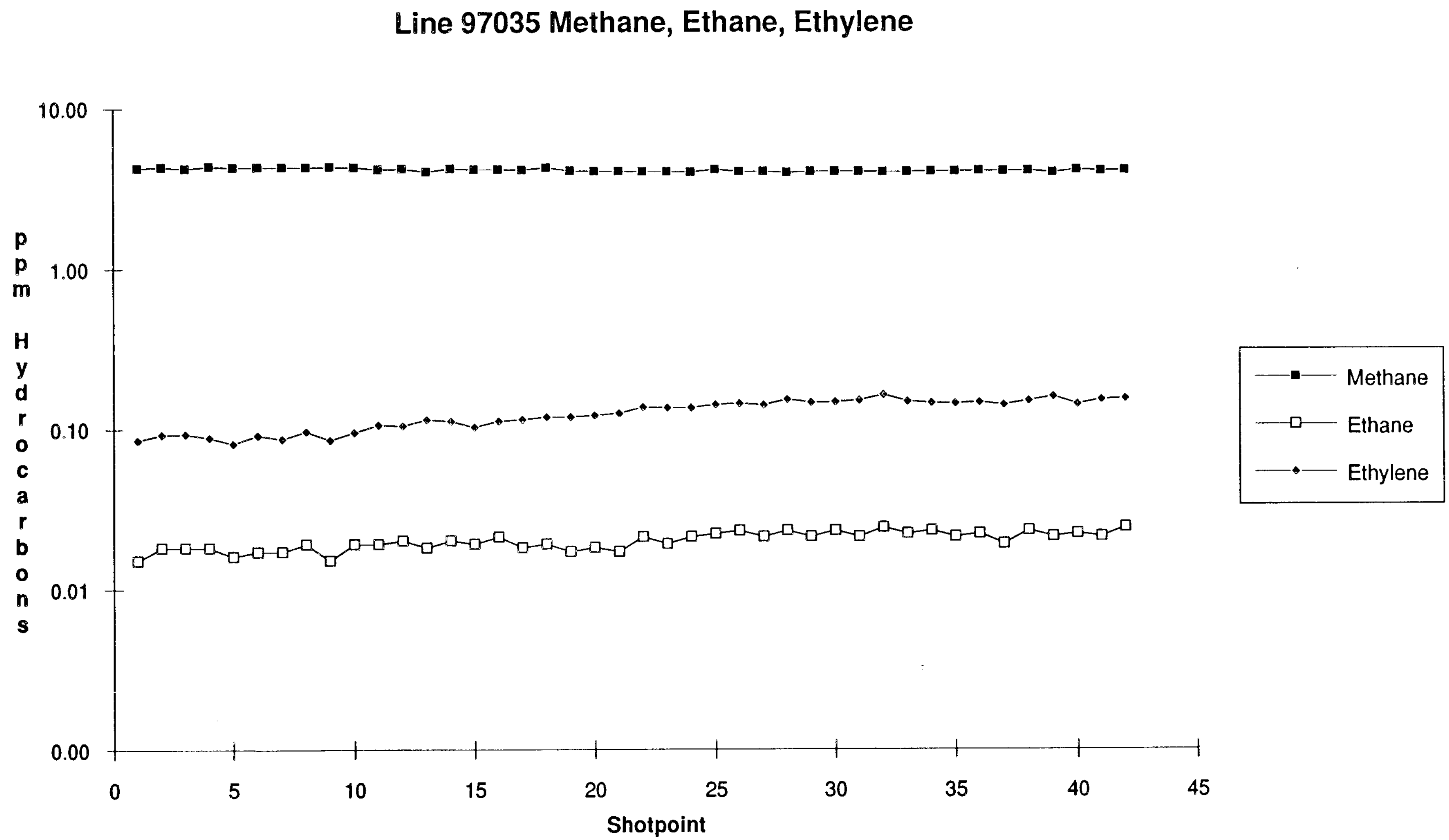
	Shotpoint	Date	Time	Latitude		Longitude	
Start	1	3-Nov-90	12:43:42	12	13.727	124	32.467
End	42	3-Nov-90	14:05:51	12	19.364	124	36.207

	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	12.327	4.077	0.020	0.123	0.020	0.032	0.016	0.001	0.000	0.115	0.027	0.057	1.357
Std. Dev.	1.334	0.134	0.002	0.024	0.006	0.021	0.023	0.003	0.000	0.050	0.011	0.029	0.545
Minimum	10.102	3.892	0.015	0.081	0.000	0.014	0.000	0.000	0.000	0.000	0.000	0.000	0.458
Maximum	14.081	4.335	0.024	0.161	0.034	0.103	0.101	0.017	0.000	0.185	0.042	0.096	2.890

	Cond.	Temp.	F. Depth	W.Depth	Altitude
Mean	54.523	29.421	87.150	102.674	15.524
Std. Dev.	0.590	0.320	4.081	3.582	1.642
Minimum	53.460	28.760	79.458	97.172	11.000
Maximum	55.110	29.900	93.738	109.738	19.000

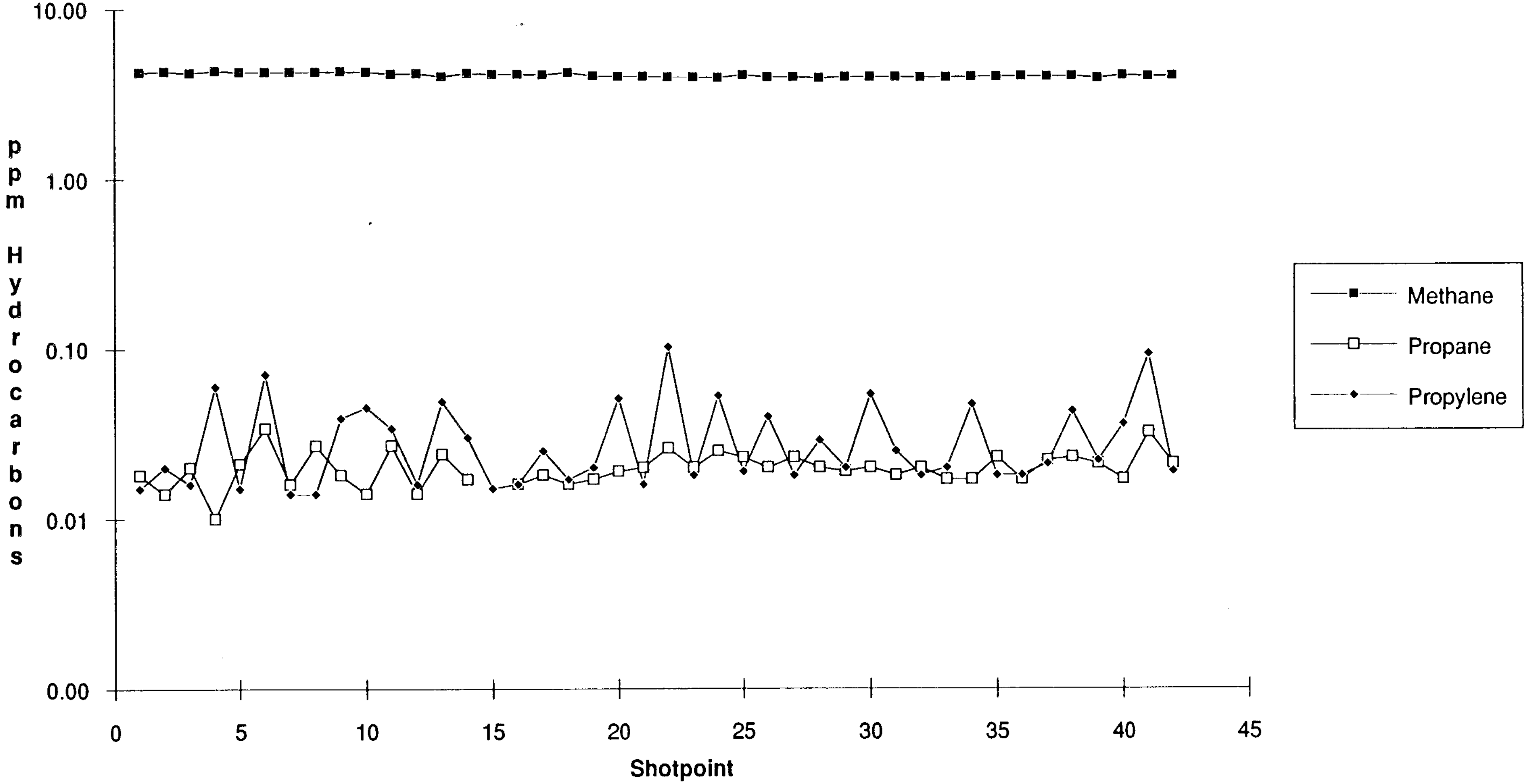
Notes No anomalies

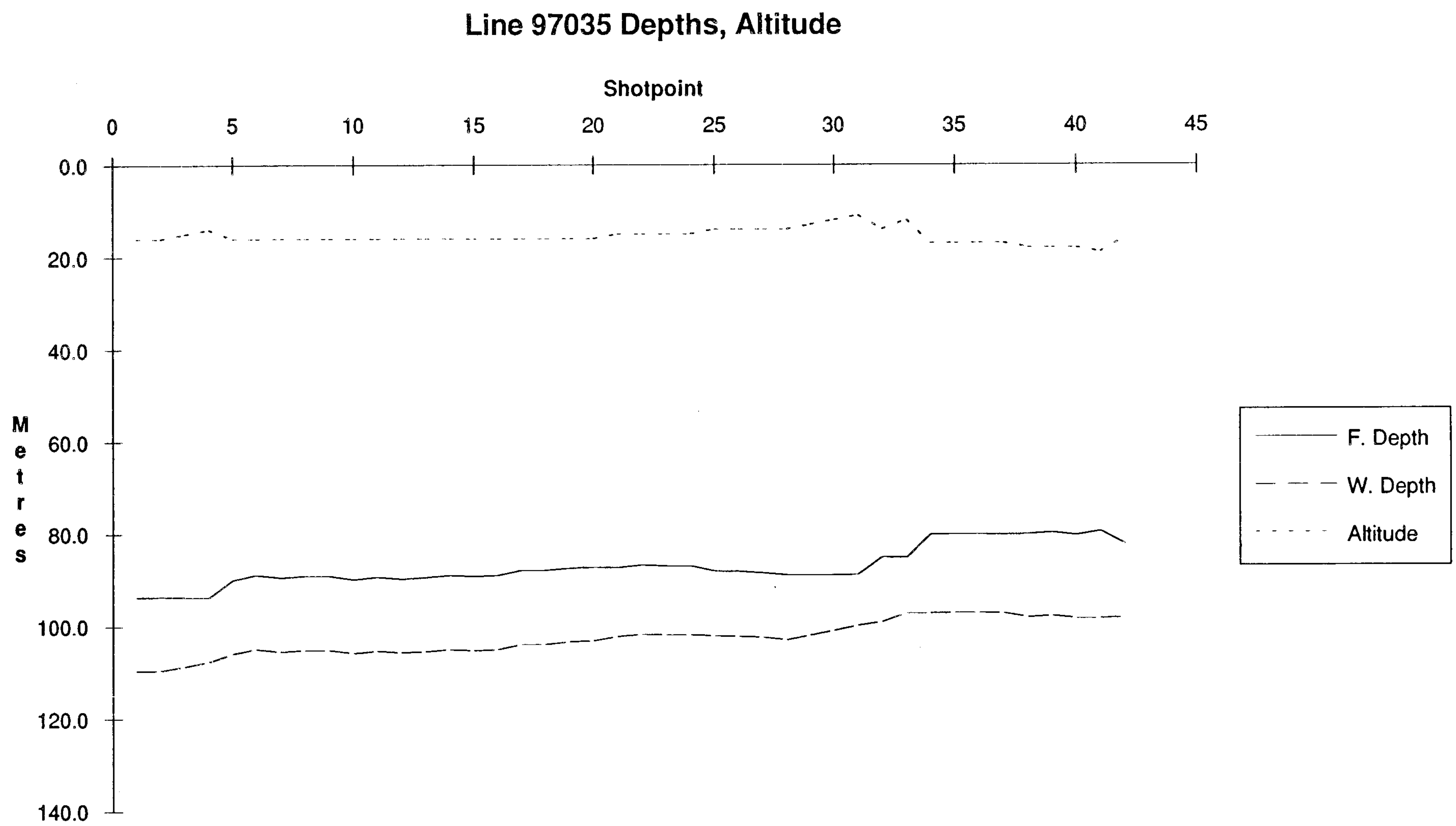

Line 97035 THC, Methane
ppm Hydrocarbons
20.00
18.00
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
0
5
10
15
20
25
30
35
40
45
Shotpoint
THC
Methane



Line 97035 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 97035 Methane, Propane, Propylene




Line 97035 Depths, Altitude
Shotpoint
0
5
10
15
20
25
30
35
40
45
0.0
20.0
40.0
60.0
80.0
100.0
120.0
140.0
Metres
F. Depth
W. Depth
Altitude

Line Summary

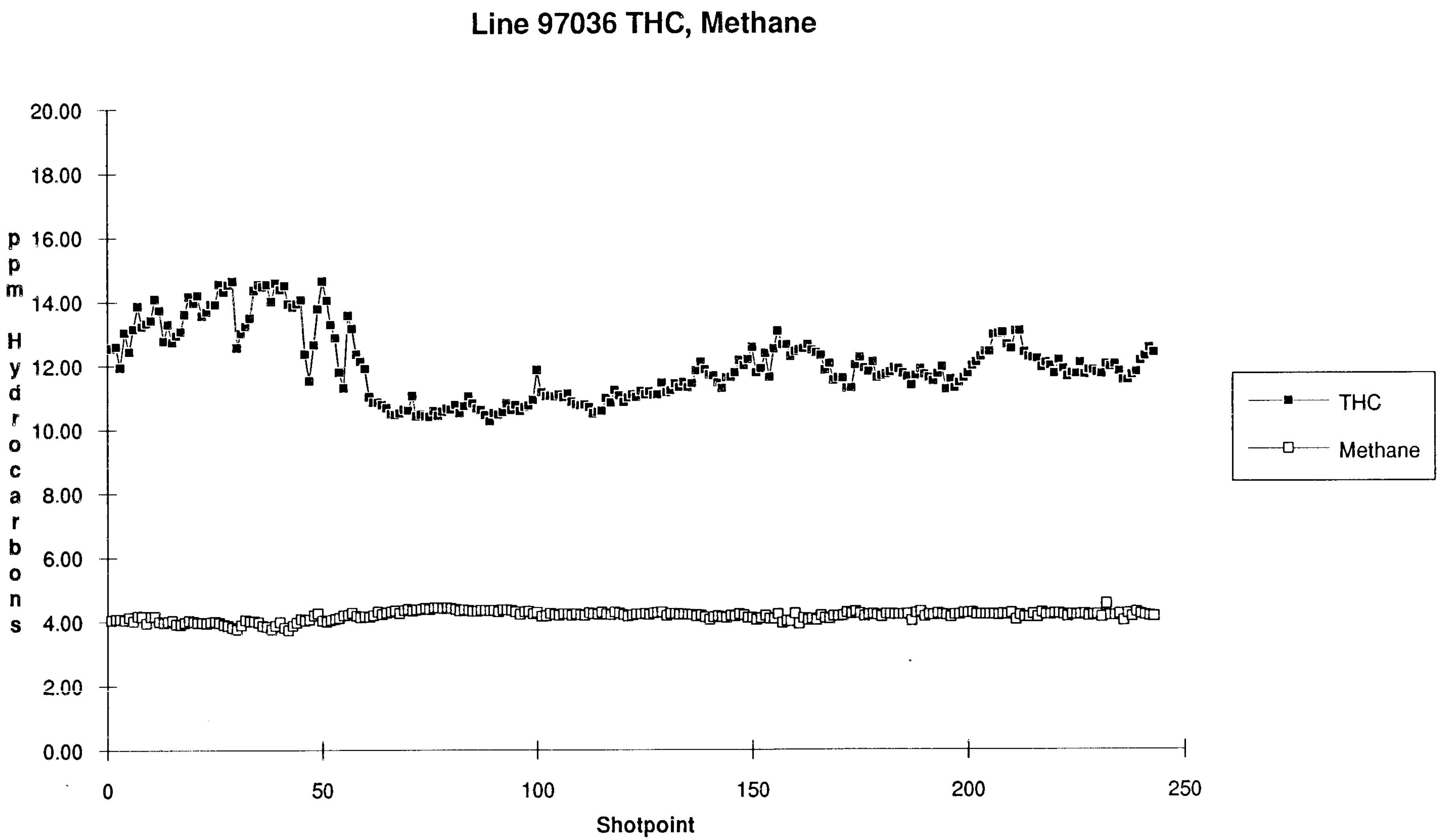
Line Number	97036
No. of Shotpoints	243

	Shotpoint	Date	Time	Latitude		Longitude	
Start	1	3-Nov-90	16:17:49	12	17.112	124	34.545
End	245	4-Nov-90	00:27:15	12	44.952	125	06.459

	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	11.974	4.156	0.020	0.126	0.018	0.029	0.015	0.000	0.000	0.091	0.014	0.024	1.283
Std. Dev.	1.105	0.134	0.002	0.022	0.006	0.017	0.023	0.006	0.000	0.042	0.010	0.021	0.604
Minimum	10.245	3.730	0.015	0.099	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.476
Maximum	14.626	4.528	0.034	0.188	0.059	0.092	0.092	0.097	0.000	0.198	0.029	0.073	3.823

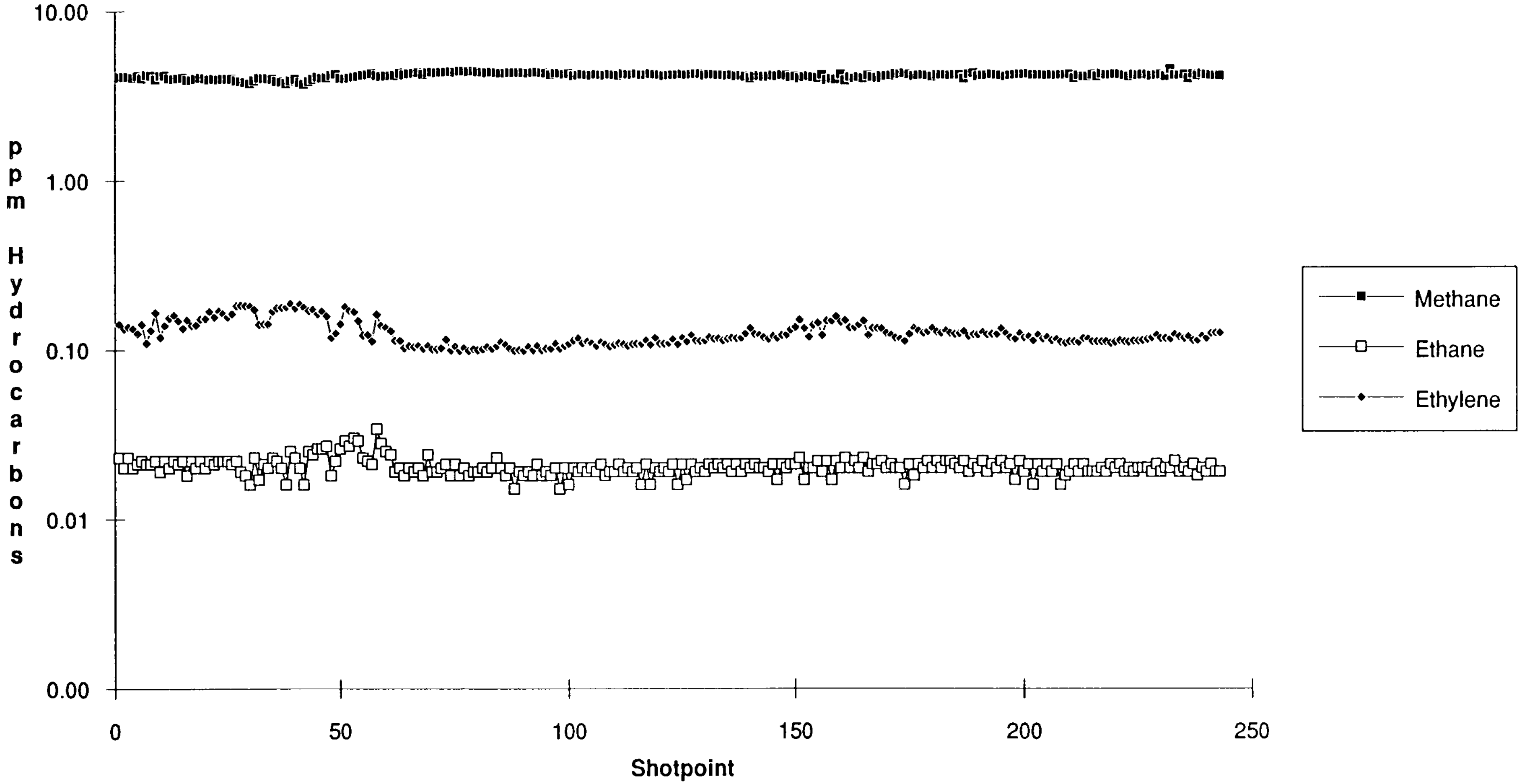
	Cond.	Temp.	F. Depth	W.Depth	Altitude
Mean	54.657	28.064	84.833	99.524	14.691
Std. Dev.	0.674	0.534	4.190	5.008	2.691
Minimum	53.610	27.150	75.072	87.050	8.000
Maximum	56.390	29.240	94.860	111.576	23.000

Notes Weak THC and ethane anomaly between approximately SP 0-70, near the East Swan 1 well.

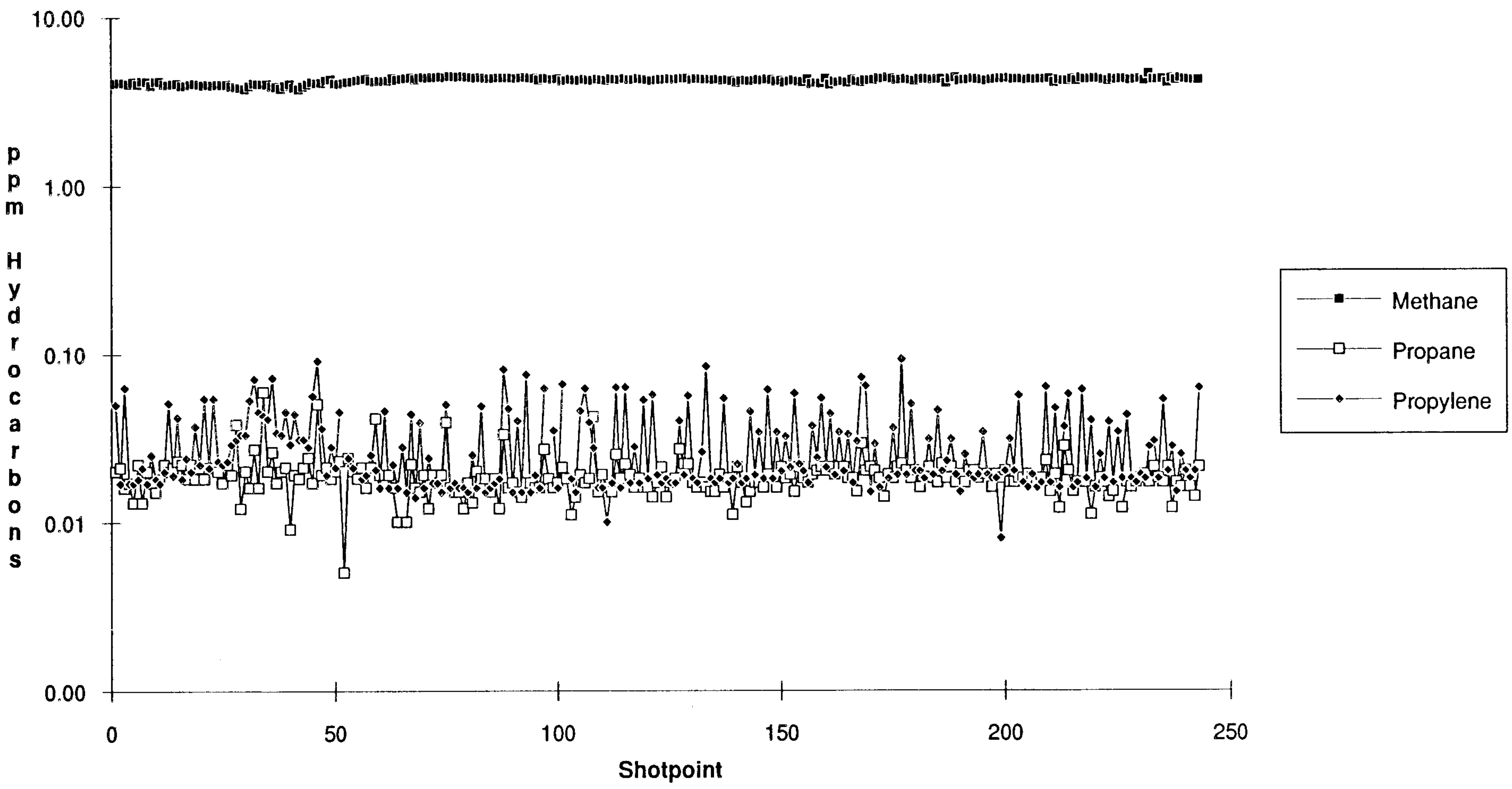


Line 97036 THC, Methane
ppm Hydrocarbons
20.00
18.00
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
0
50
100
150
200
250
Shotpoint
THC
Methane

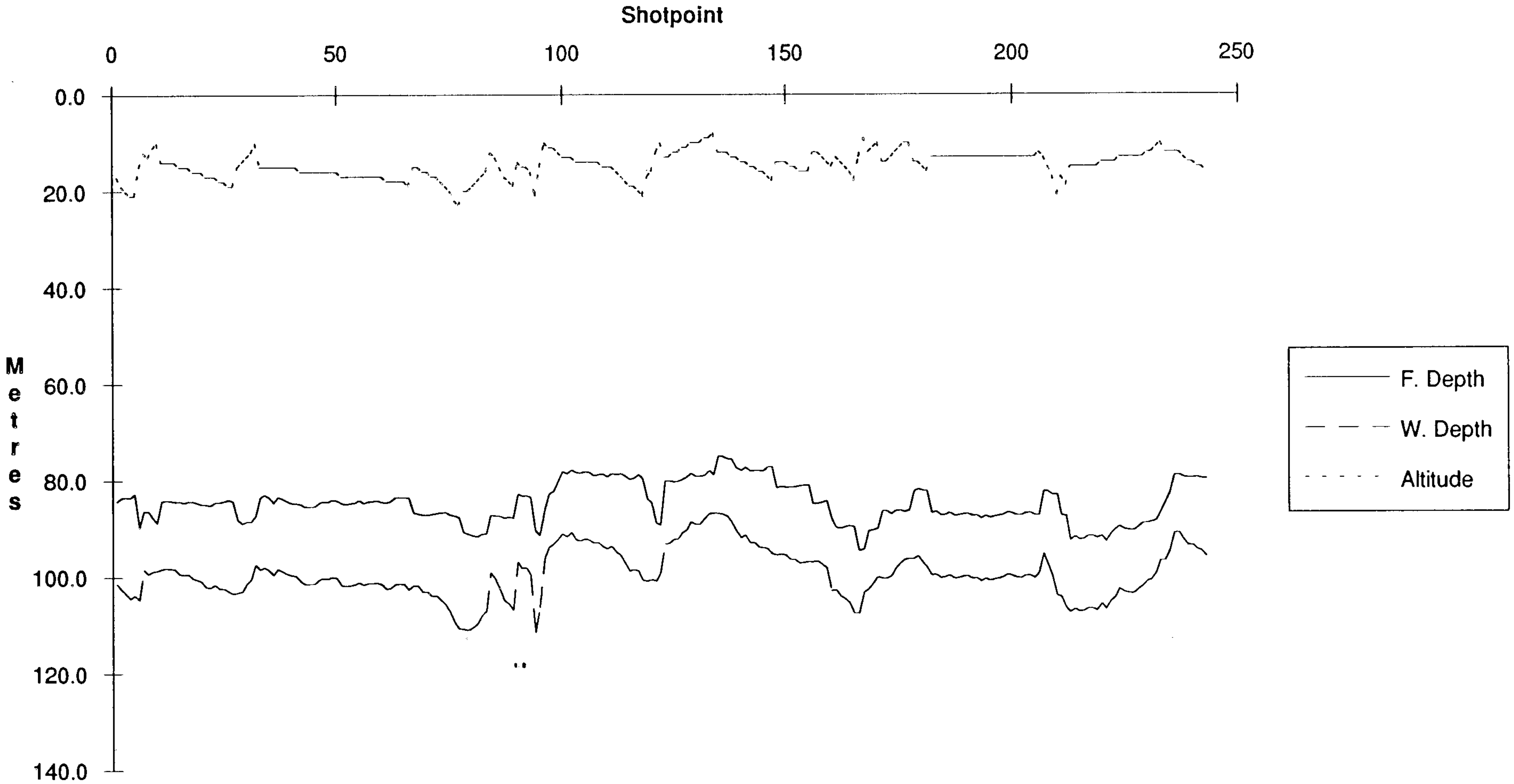
Line 97036 Methane, Ethane, Ethylene



Line 97036 Methane, Propane, Propylene



Line 97036 Depths, Altitude



Line Summary

Line Number	97037
No. of Shotpoints	397

	Shotpoint	Date	Time	Latitude		Longitude	
Start	1	4-Nov-90	02:49:06	12	37.918	125	04.994
End	446	4-Nov-90	17:43:51	11	51.595	124	15.090

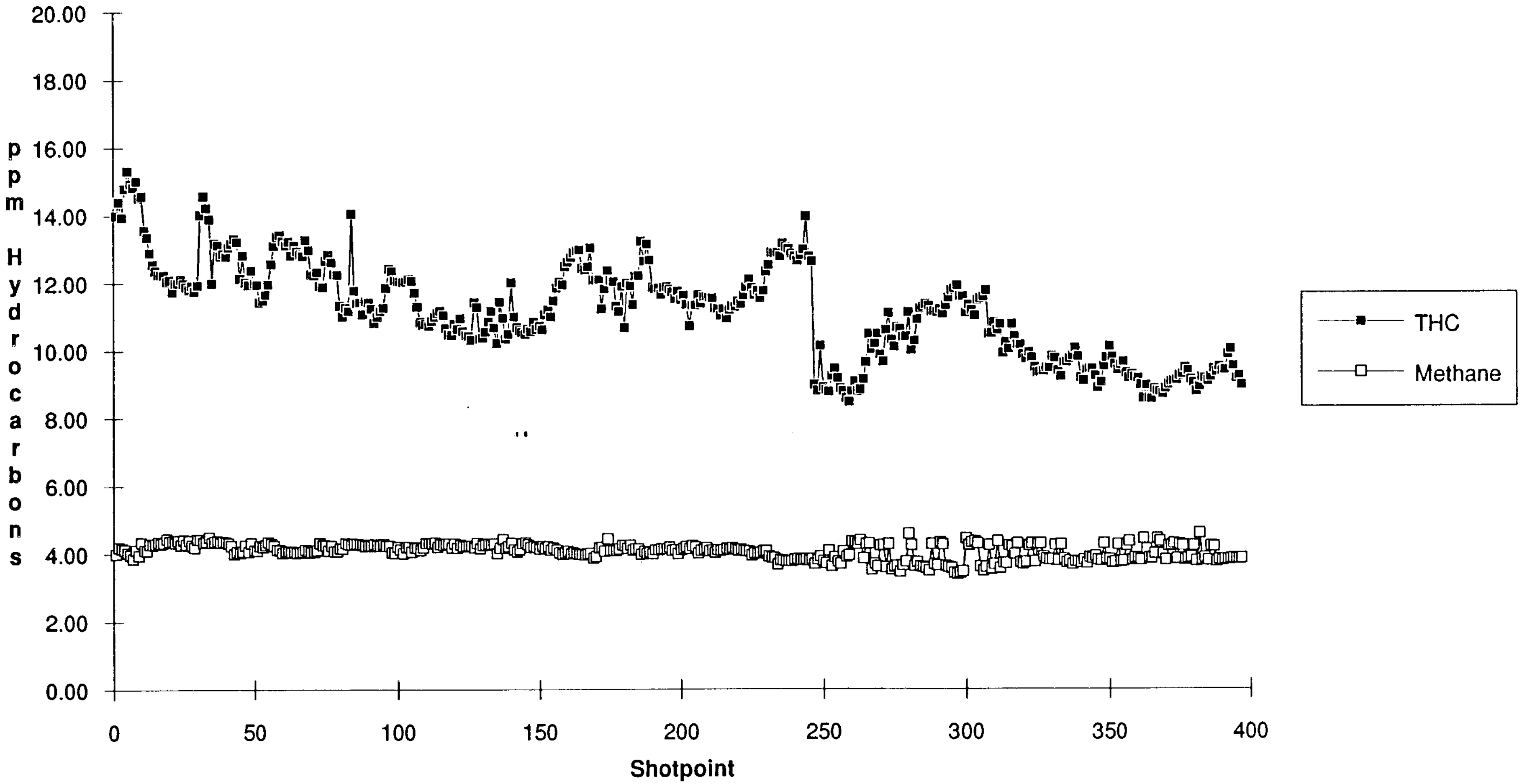
	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	11.181	4.055	0.019	0.116	0.019	0.028	0.013	0.001	0.000	0.119	0.049	0.041	1.266
Std. Dev.	1.438	0.238	0.003	0.021	0.010	0.017	0.020	0.007	0.000	0.062	0.040	0.058	0.589
Minimum	8.478	3.391	0.012	0.073	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.329
Maximum	15.301	4.592	0.028	0.189	0.099	0.097	0.084	0.096	0.000	0.610	0.237	0.209	3.499

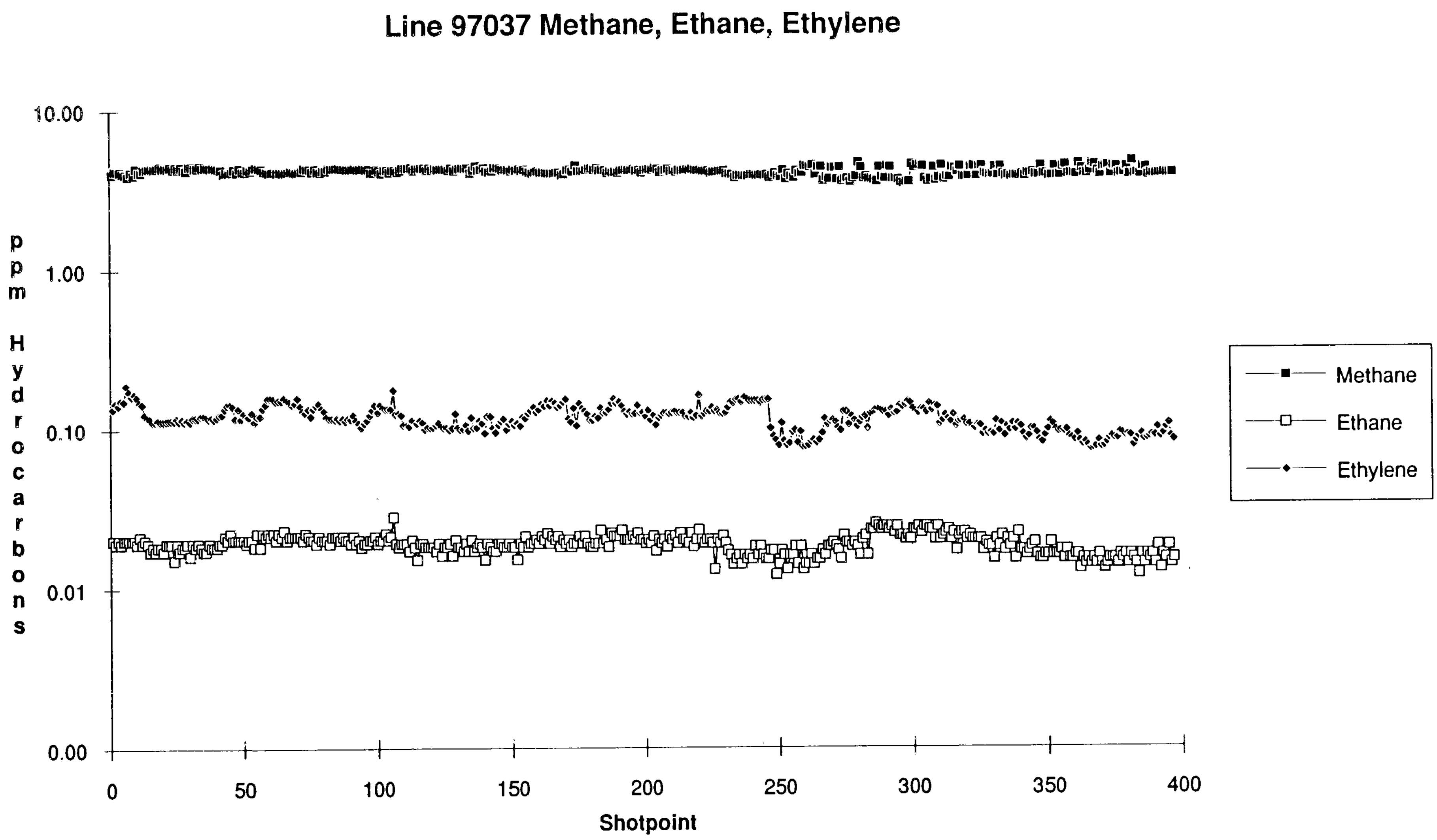
	Cond.	Temp.	F. Depth	W.Depth	Altitude
Mean	55.558	27.524	95.389	112.447	17.058
Std. Dev.	1.561	1.488	15.116	14.252	3.072
Minimum	52.910	24.950	73.032	91.338	10.000
Maximum	58.610	30.530	137.190	159.374	30.000

Notes

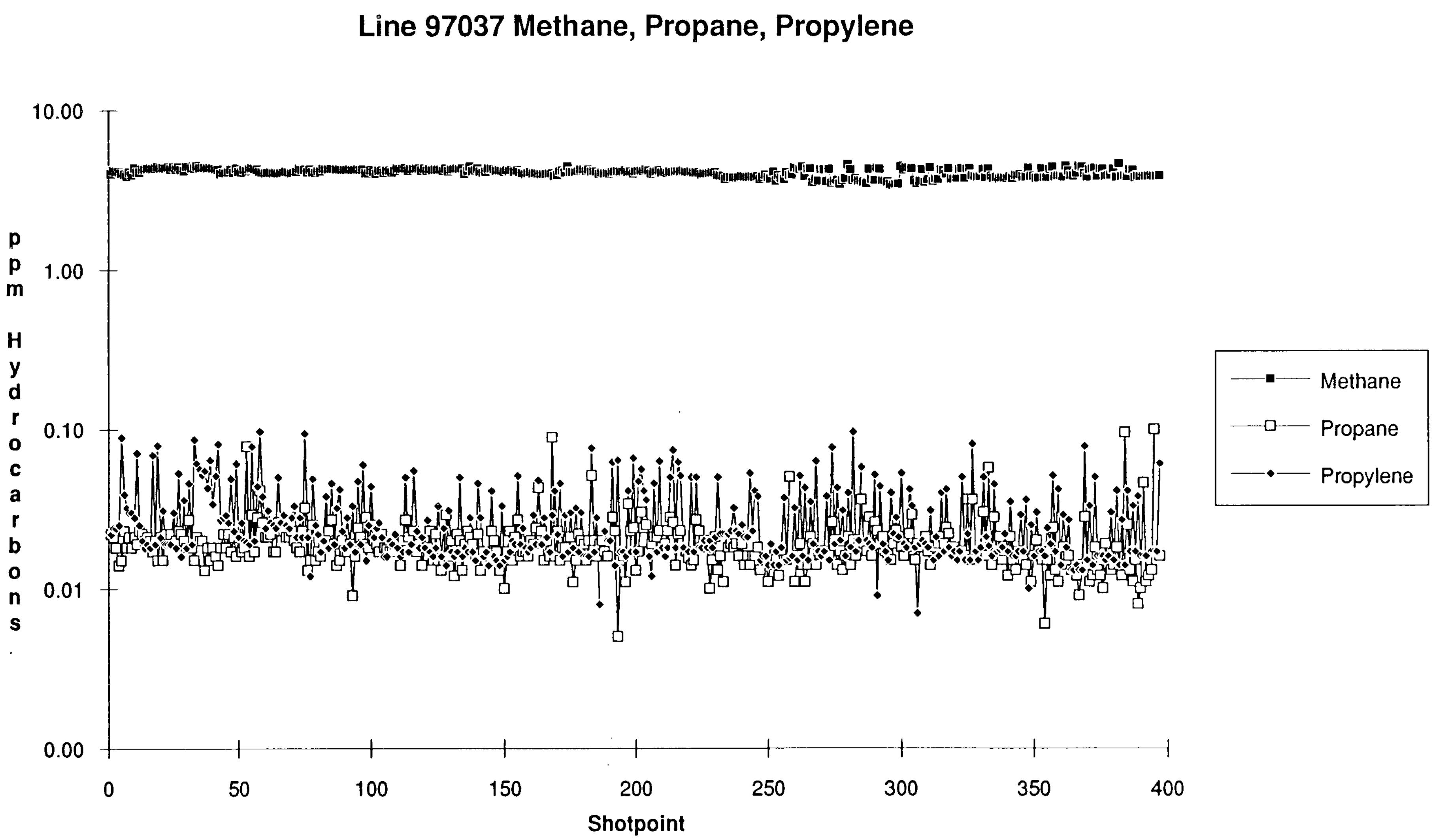
Weak methane and ethane anomaly from approximately SP 250 to end of line.
Located northwest of the Swan 1 well.

Line 97037 THC, Methane



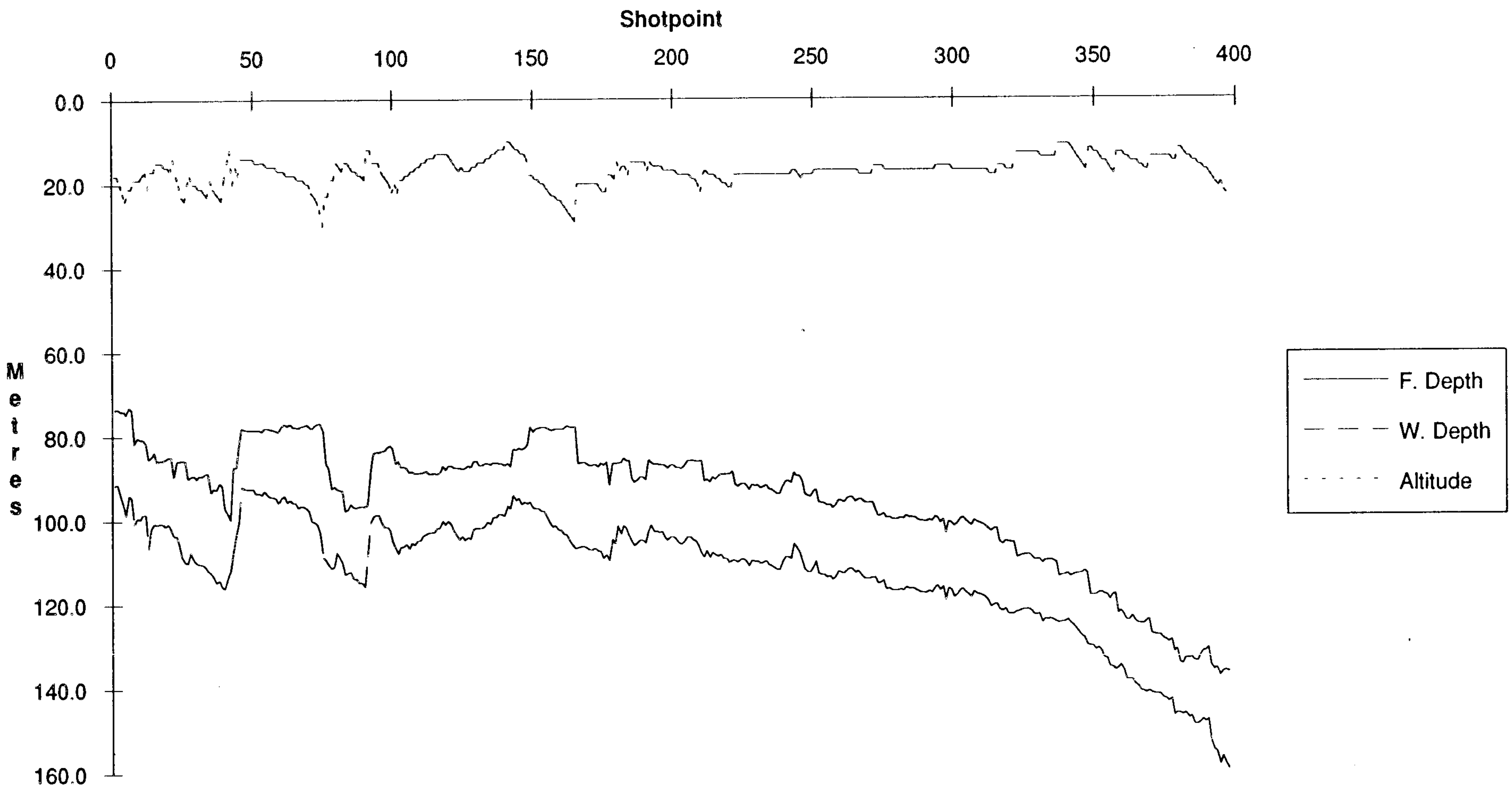


Line 97037 Methane, Ethane, Ethylene
10.00
1.00
0.10
0.01
0.00
ppm Hydrocarbons
0
50
100
150
200
250
300
350
400
Shotpoint
Methane
Ethane
Ethylene



Line 97037 Methane, Propane, Propylene
10.00
1.00
0.10
0.01
0.00
ppm Hydrocarbons
0
50
100
150
200
250
300
350
400
Shotpoint
Methane
Propane
Propylene

Line 97037 Depths, Altitude



Line Summary

Line Number	97038
No. of Shotpoints	139

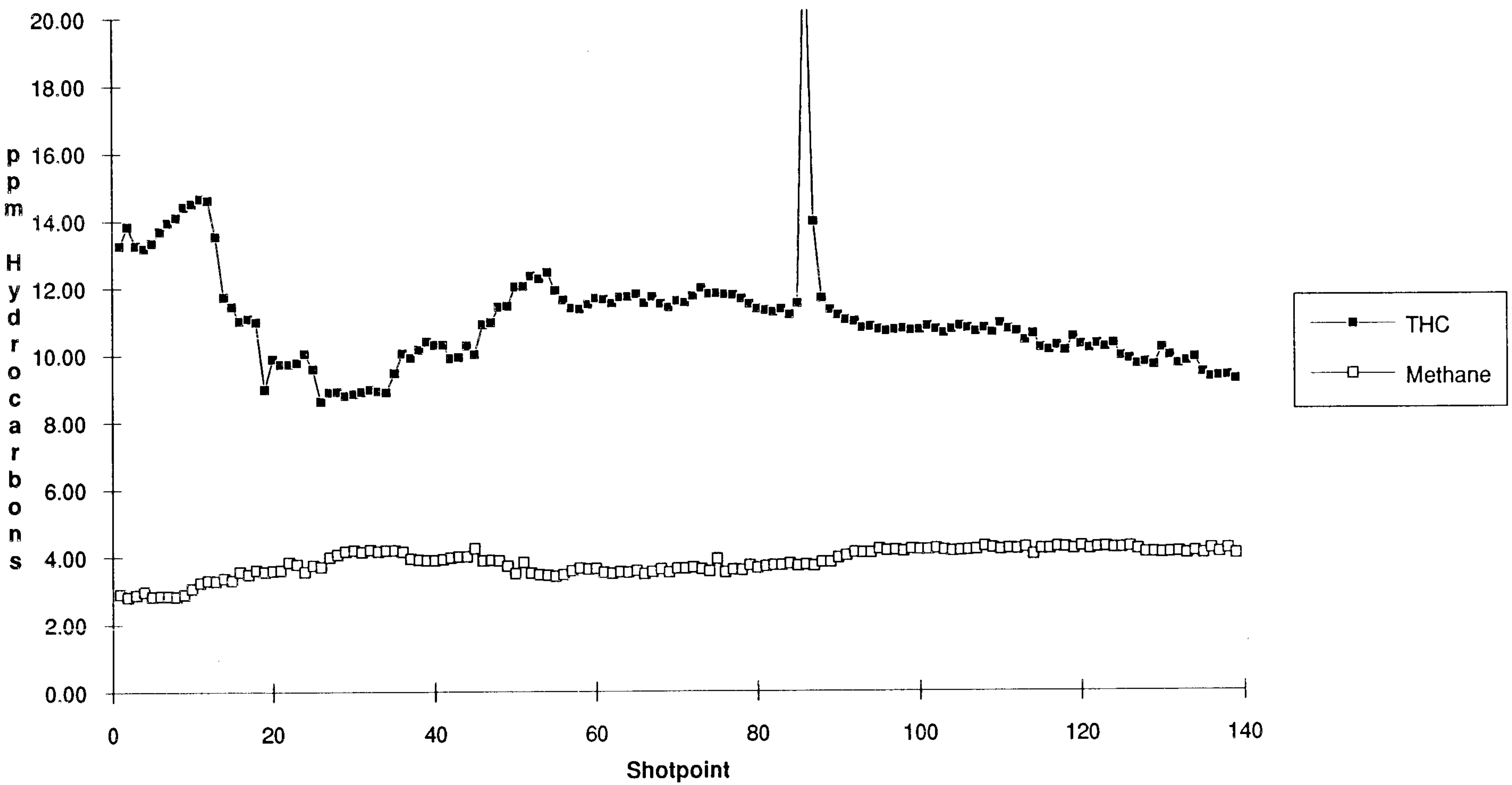
	Shotpoint	Date	Time	Latitude		Longitude	
Start	1	4-Nov-90	20:43:57	11	50.301	124	23.349
End	139	5-Nov-90	01:20:16	12	08.485	124	38.441

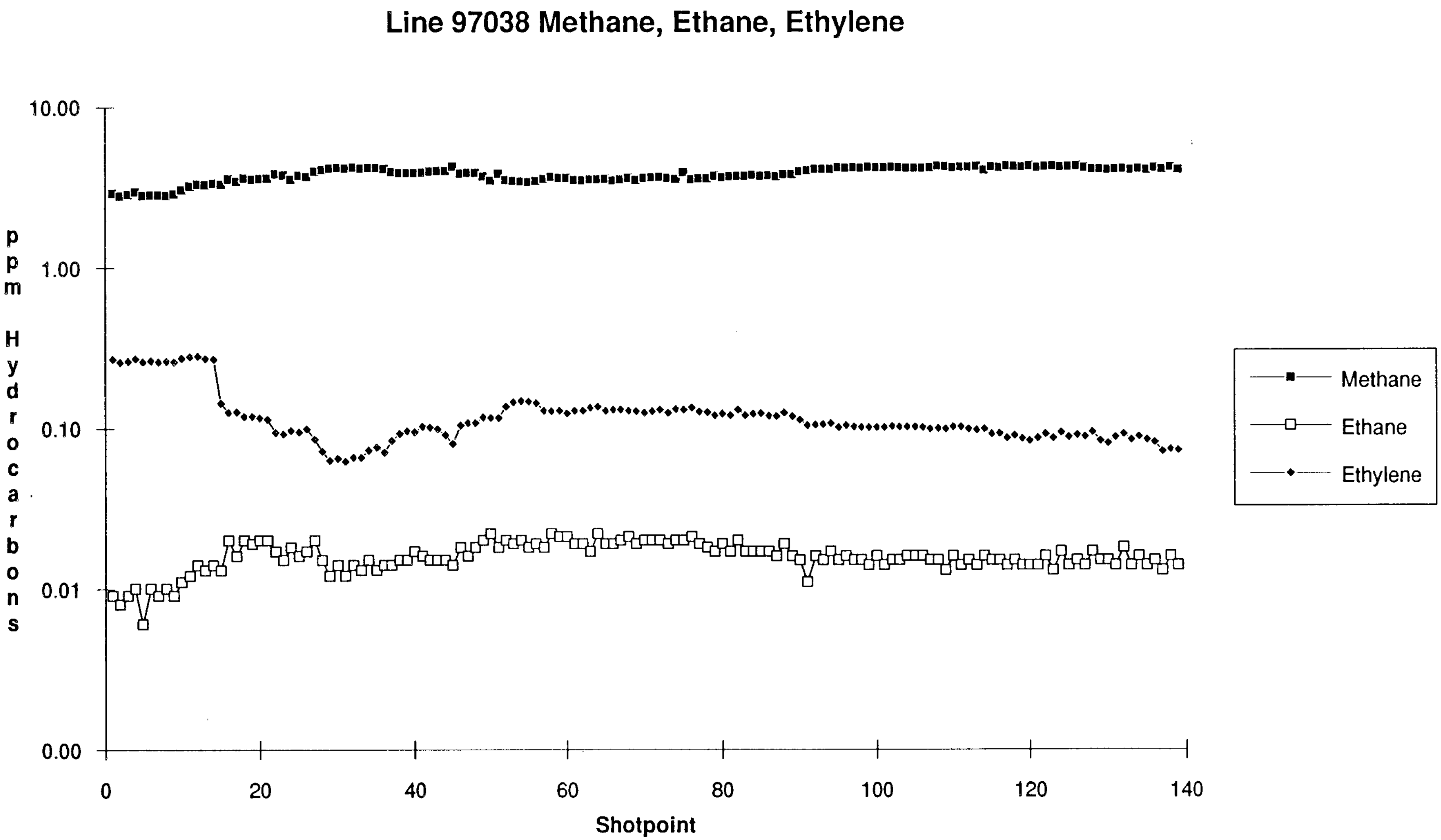
	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	11.038	3.811	0.016	0.122	0.017	0.035	0.015	0.000	0.001	0.092	0.021	0.001	1.271
Std. Dev.	1.687	0.385	0.003	0.053	0.010	0.031	0.022	0.005	0.004	0.046	0.020	0.006	0.735
Minimum	8.600	2.804	0.006	0.062	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.304
Maximum	23.299	4.272	0.022	0.282	0.062	0.159	0.104	0.056	0.033	0.260	0.093	0.047	4.634

	Cond.	Temp.	F. Depth	W.Depth	Altitude
Mean	55.117	26.853	103.656	132.354	28.698
Std. Dev.	0.968	0.862	26.678	22.516	44.684
Minimum	52.680	24.680	7.854	107.410	8.000
Maximum	56.960	28.680	135.762	196.262	188.000

Notes No anomalies

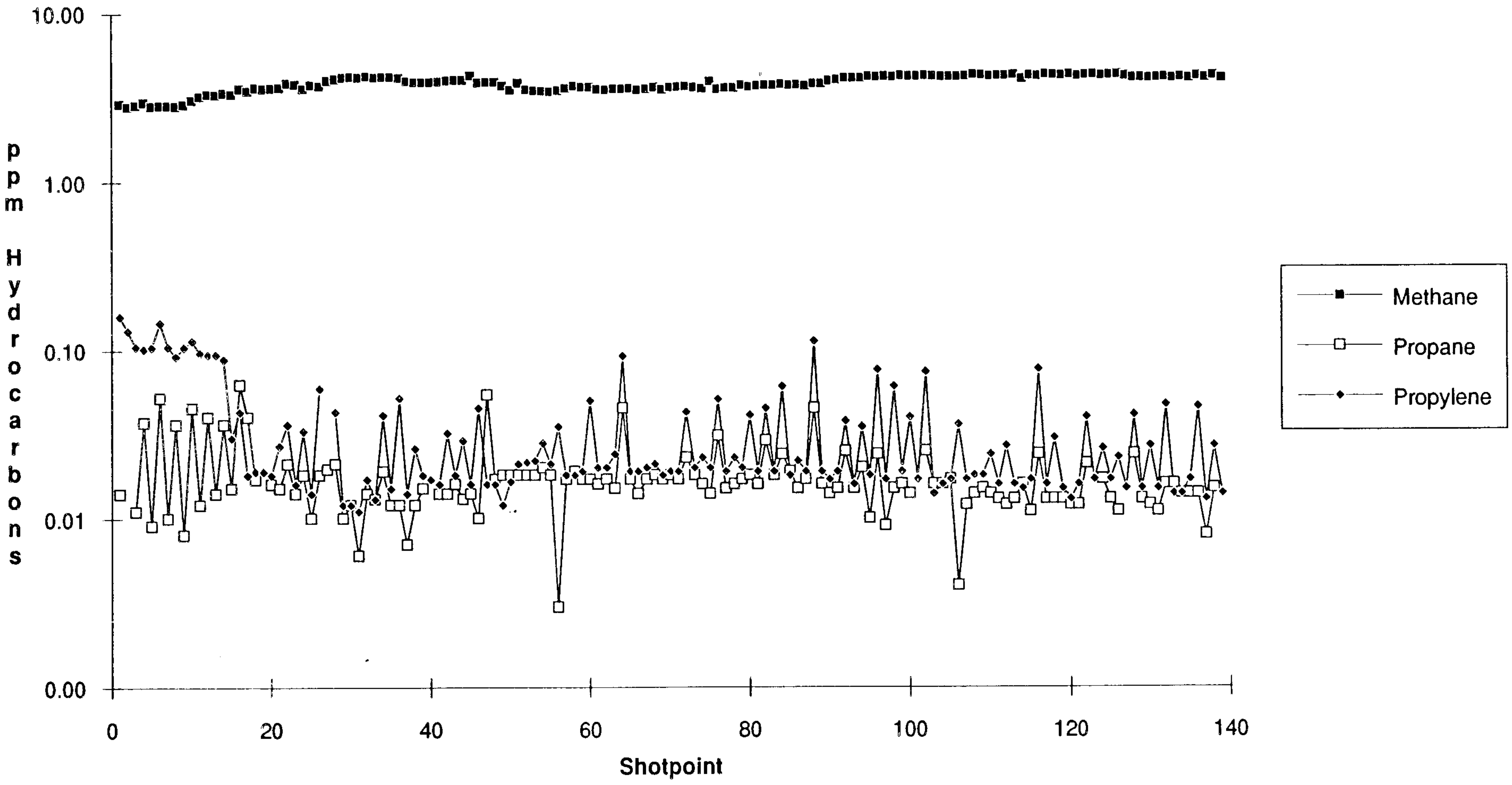
Line 97038 THC, Methane

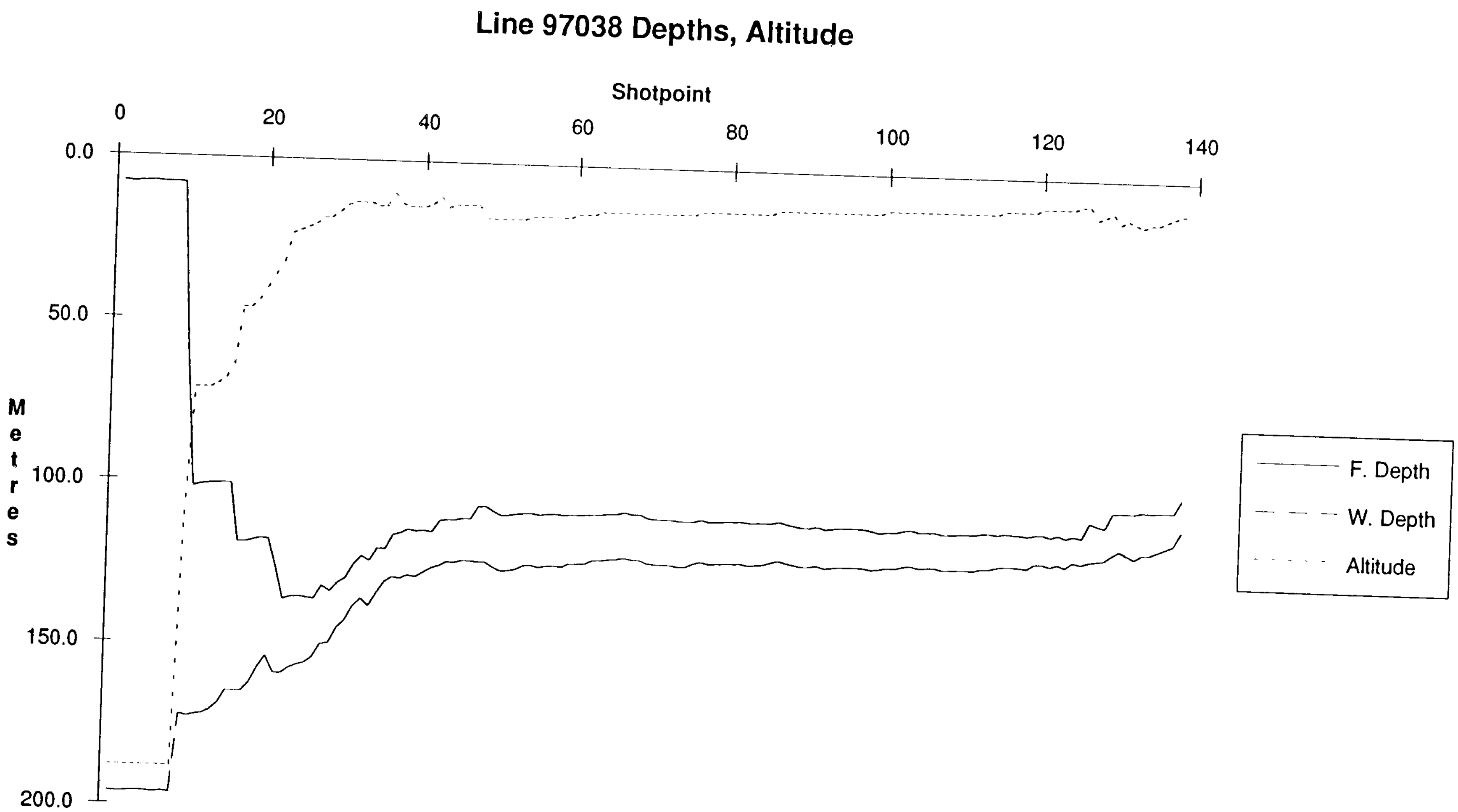




Line 97038 Methane, Ethane, Ethylene
10.00
1.00
0.10
0.01
0.00
ppm Hydrocarbons
0
20
40
60
80
100
120
140
Shotpoint
Methane
Ethane
Ethylene

Line 97038 Methane, Propane, Propylene




Line 97038 Depths, Altitude
Shotpoint
0
20
40
60
80
100
120
140
0.0
50.0
100.0
150.0
200.0
Metres
F. Depth
W. Depth
Altitude

Line Summary

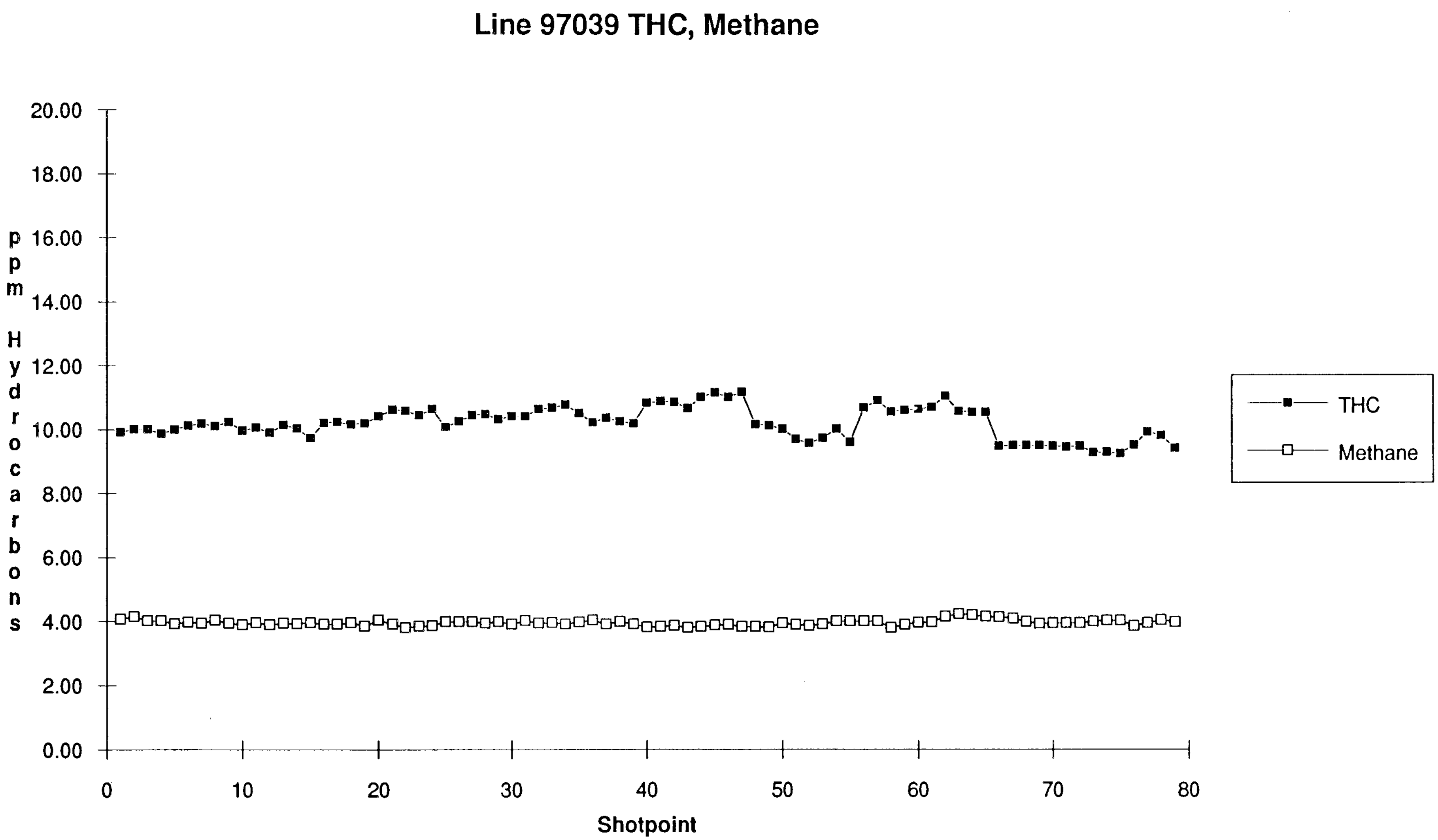
Line Number	97039
No. of Shotpoints	79

	Shotpoint	Date	Time	Latitude		Longitude	
Start	1	5-Nov-90	02:28:05	12	07.761	124	36.950
End	79	5-Nov-90	05:04:08	12	05.132	124	50.285

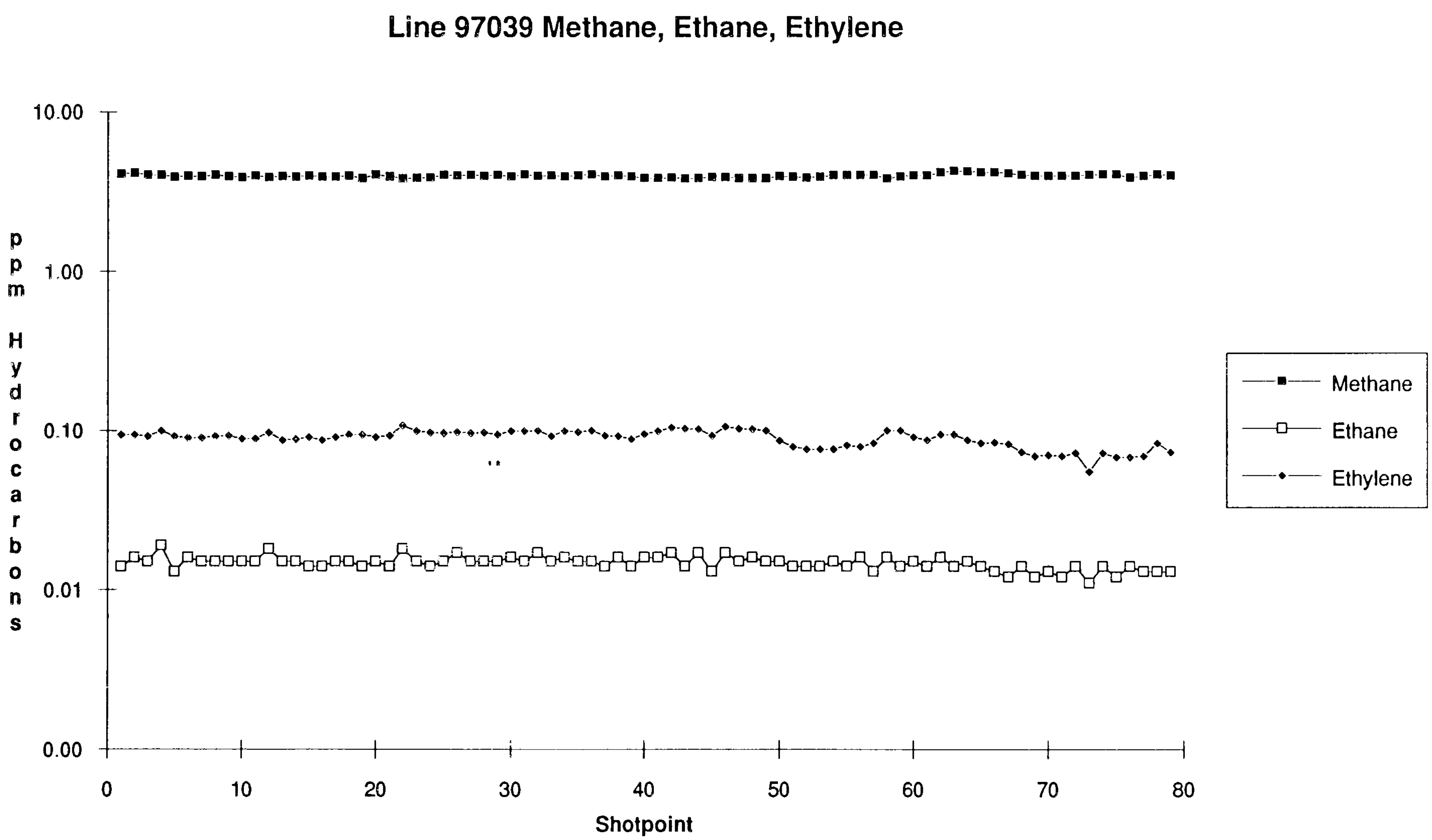
	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	10.197	3.954	0.015	0.089	0.017	0.025	0.014	0.000	0.001	0.102	0.044	0.000	1.121
Std. Dev.	0.488	0.092	0.001	0.011	0.011	0.018	0.020	0.000	0.012	0.047	0.029	0.003	0.641
Minimum	9.234	3.796	0.011	0.055	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.334
Maximum	11.162	4.225	0.019	0.107	0.101	0.089	0.069	0.000	0.103	0.210	0.110	0.018	3.004

	Cond.	Temp.	F Depth	W.Depth	Altitude
Mean	56.617	27.996	104.870	119.389	14.519
Std. Dev.	0.406	0.362	2.075	1.885	1.709
Minimum	55.750	27.240	99.144	115.326	11.000
Maximum	57.370	28.780	108.222	123.814	18.000

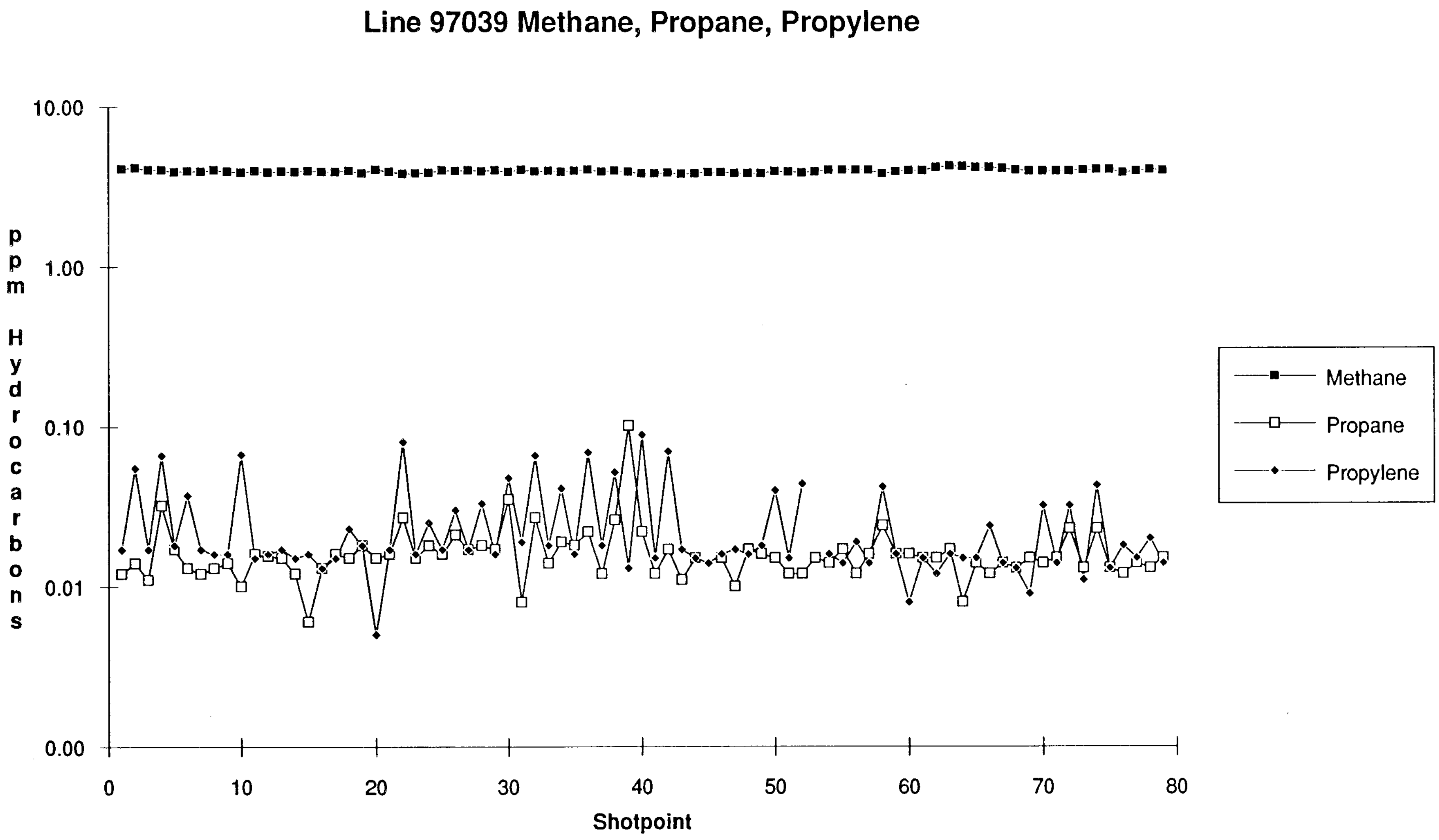
Notes No amomalies



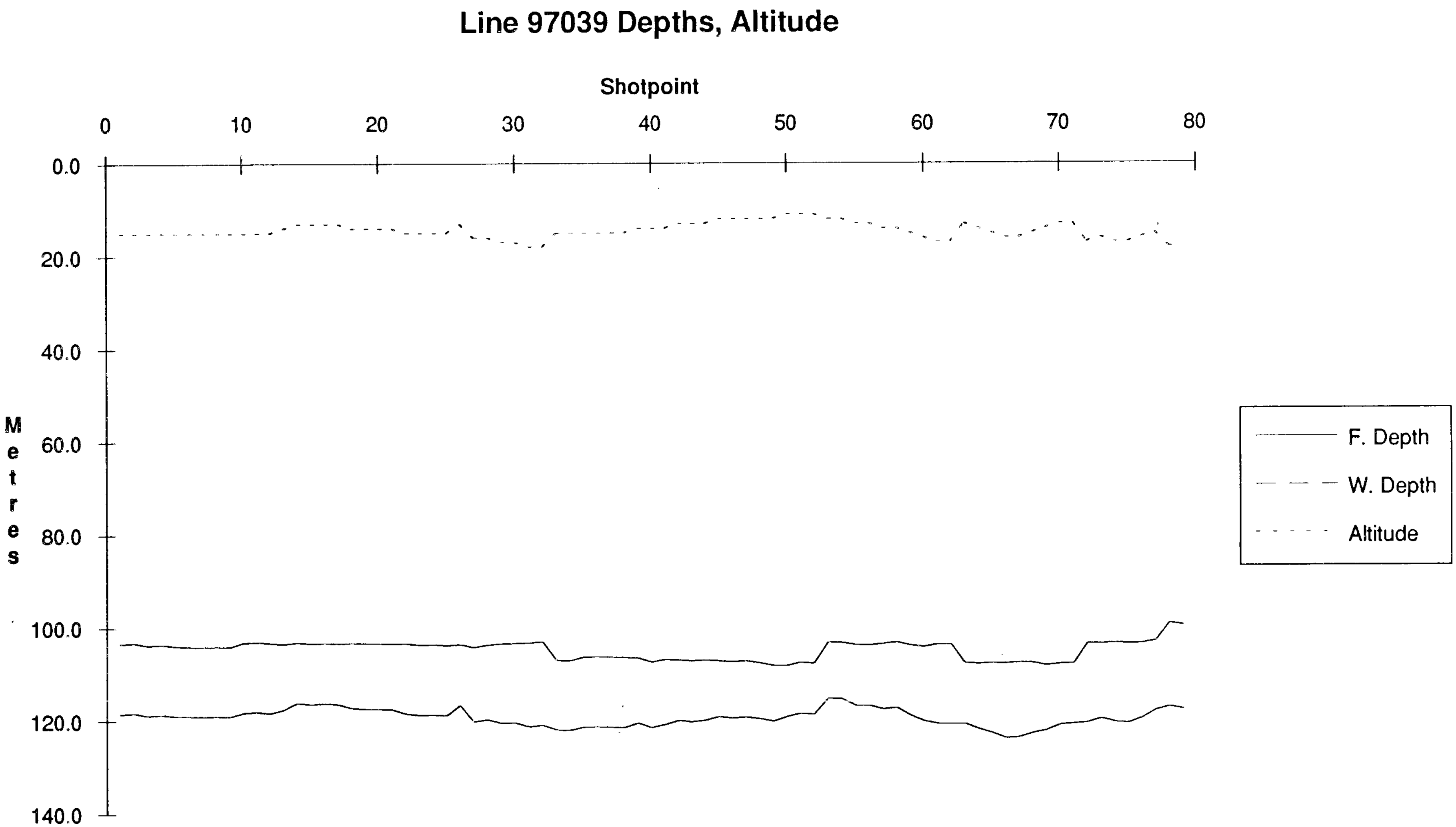
Line 97039 THC, Methane
ppm Hydrocarbons
20.00
18.00
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
0
10
20
30
40
50
60
70
80
Shotpoint
THC
Methane



Line 97039 Methane, Ethane, Ethylene
ppm Hydrocarbons
10.00
1.00
0.10
0.01
0.00
0
10
20
30
40
50
60
70
80
Shotpoint
Methane
Ethane
Ethylene



Line 97039 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 97039 Depths, Altitude
Shotpoint
0
10
20
30
40
50
60
70
80
0.0
20.0
40.0
60.0
80.0
100.0
120.0
140.0
Metres
F. Depth
W. Depth
Altitude

Line Summary

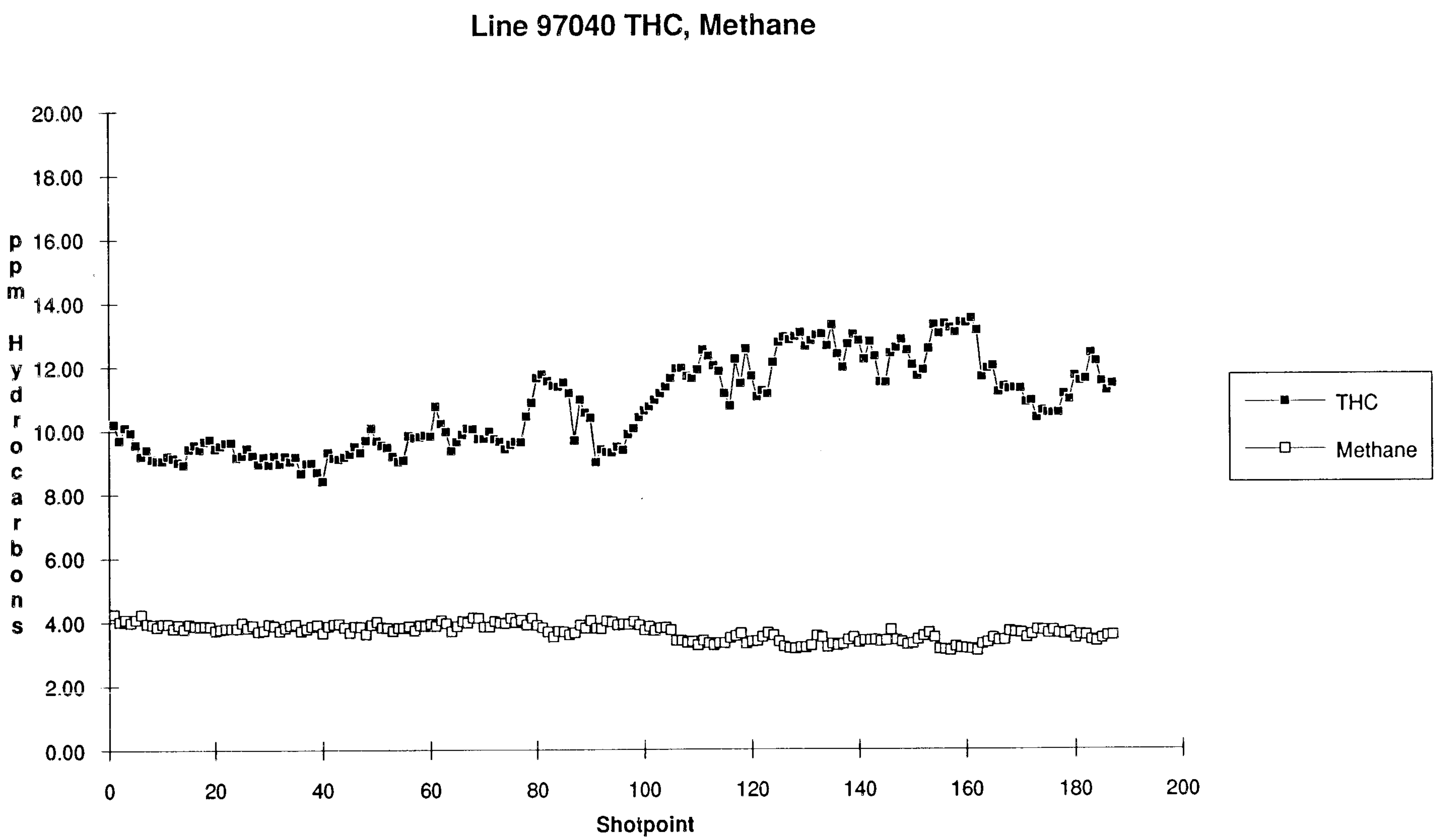
Line Number	97040
No. of Shotpoints	187

	Shotpoint	Date	Time	Latitude		Longitude	
Start	3	5-Nov-90	06:54:11	12	04.350	124	47.121
End	189	5-Nov-90	13:06:22	12	30.675	125	04.552

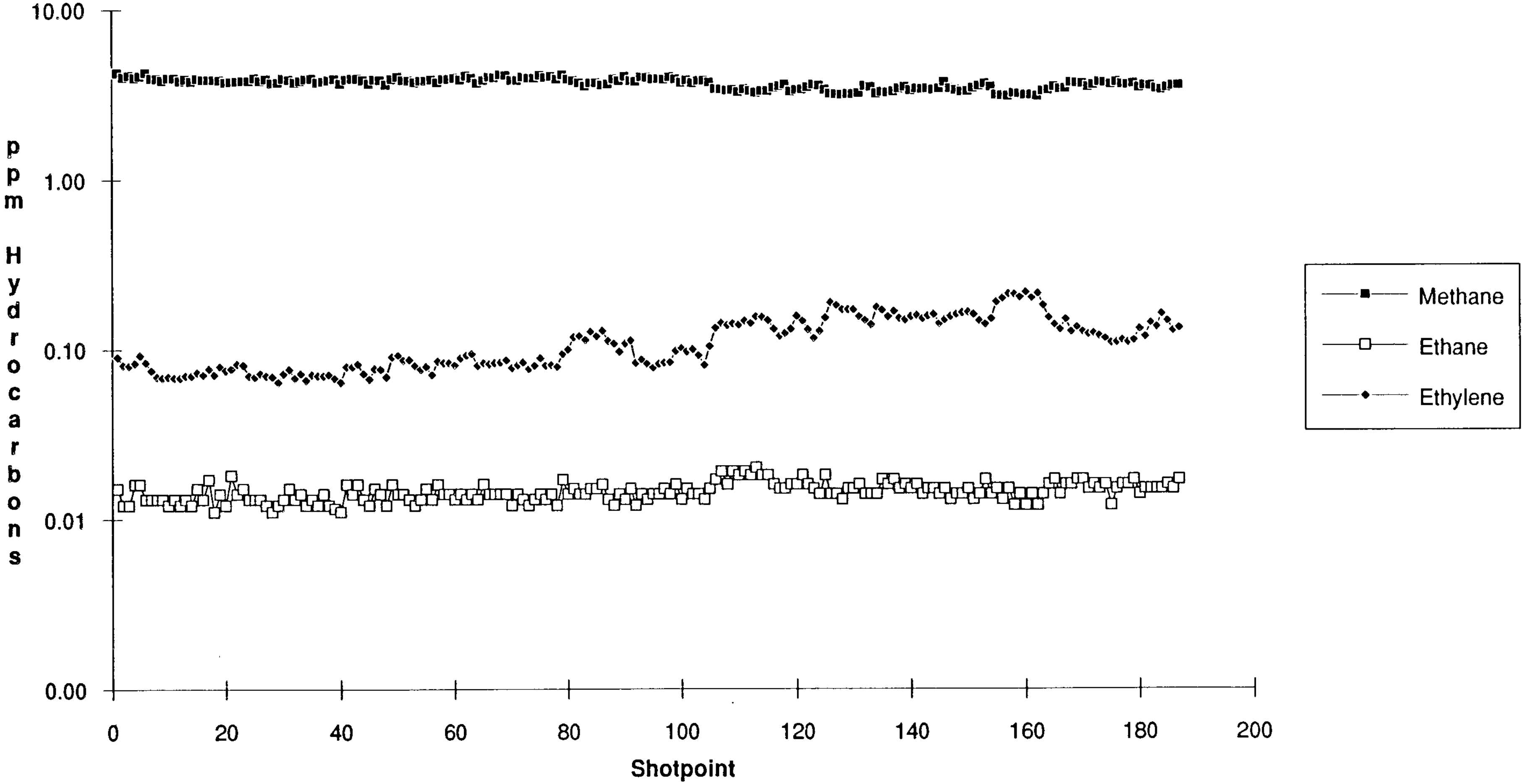
	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	10.739	3.657	0.014	0.113	0.016	0.025	0.011	0.000	0.000	0.109	0.035	0.020	1.152
Std. Dev.	1.380	0.275	0.002	0.039	0.006	0.015	0.019	0.006	0.000	0.064	0.031	0.045	0.581
Minimum	8.400	3.073	0.011	0.064	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.284
Maximum	13.476	4.245	0.020	0.216	0.046	0.081	0.069	0.083	0.000	0.285	0.100	0.186	3.141

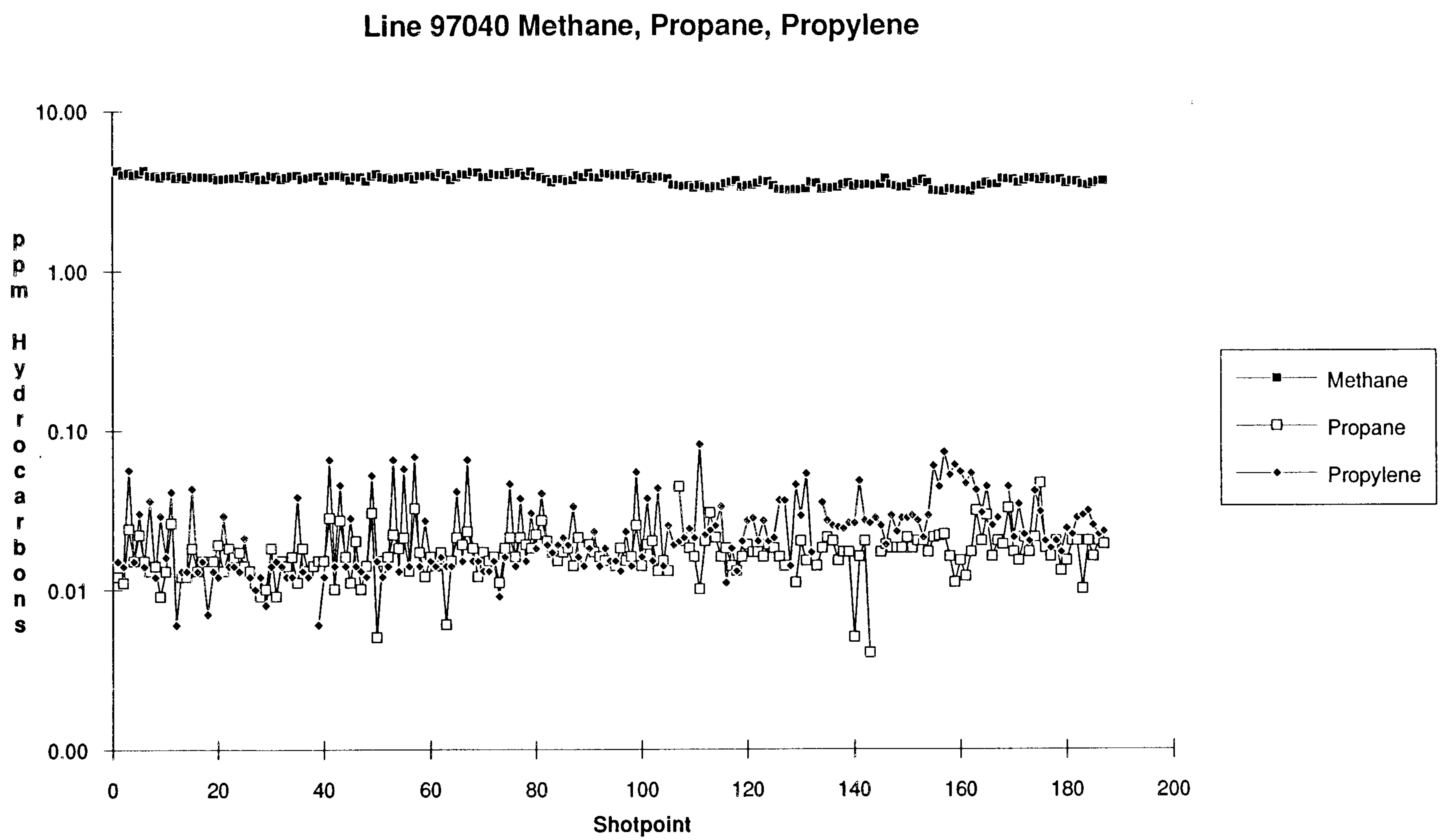
	Cond.	Temp.	F. Depth	W.Depth	Altitude
Mean	55.110	26.701	84.194	99.654	15.460
Std. Dev.	0.549	0.500	14.879	14.549	2.249
Minimum	54.110	25.750	45.084	55.492	10.000
Maximum	56.410	28.010	110.772	123.120	27.000

Notes No anomalies

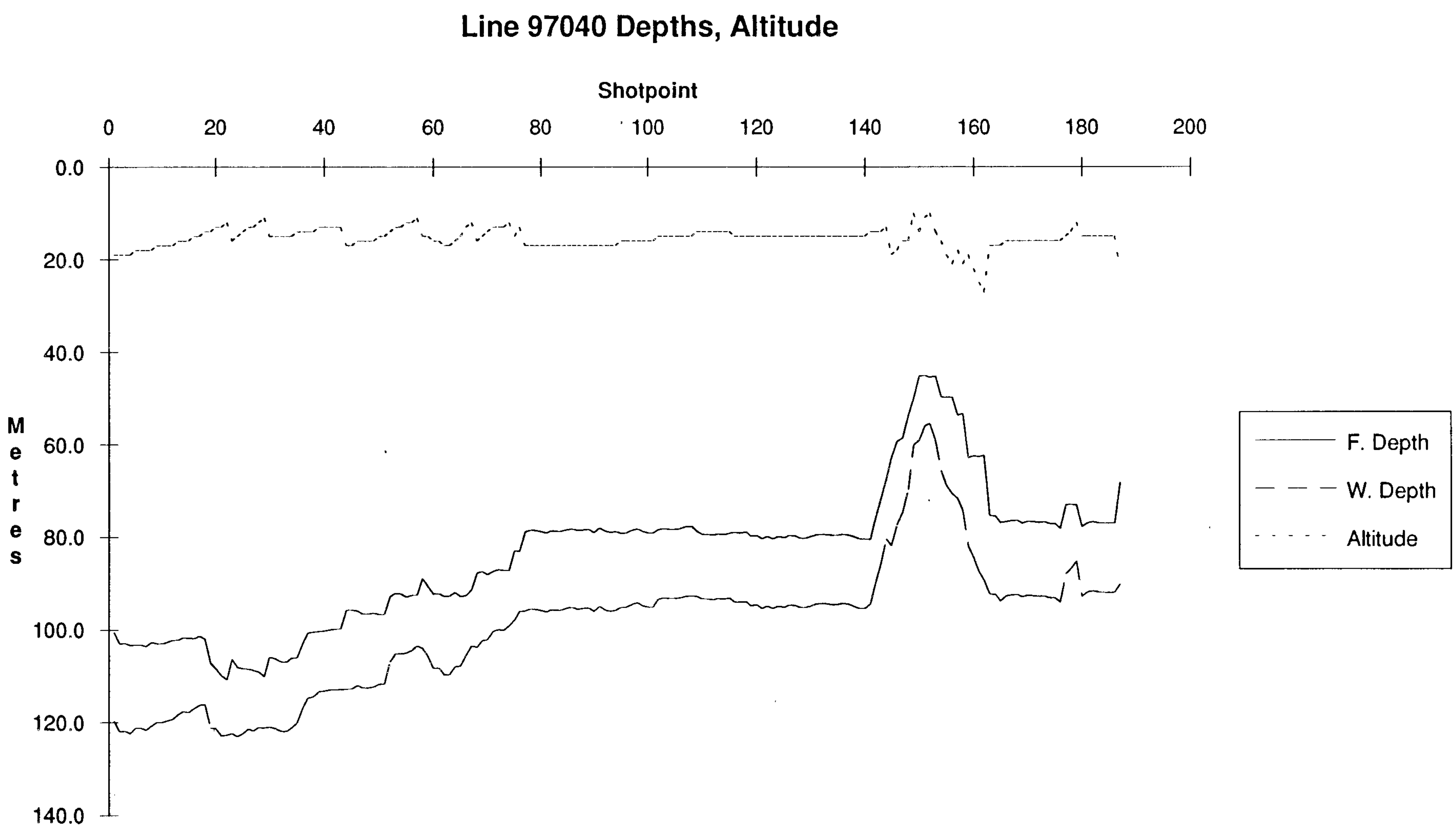

Line 97040 THC, Methane
ppm Hydrocarbons
20.00
18.00
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
0
20
40
60
80
100
120
140
160
180
200
Shotpoint
THC
Methane

Line 97040 Methane, Ethane, Ethylene





Line 97040 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 97040 Depths, Altitude
Shotpoint
0
20
40
60
80
100
120
140
160
180
200
Metres
0.0
20.0
40.0
60.0
80.0
100.0
120.0
140.0
F. Depth
W. Depth
Altitude

Line Summary

Line Number	97041
No. of Shotpoints	198

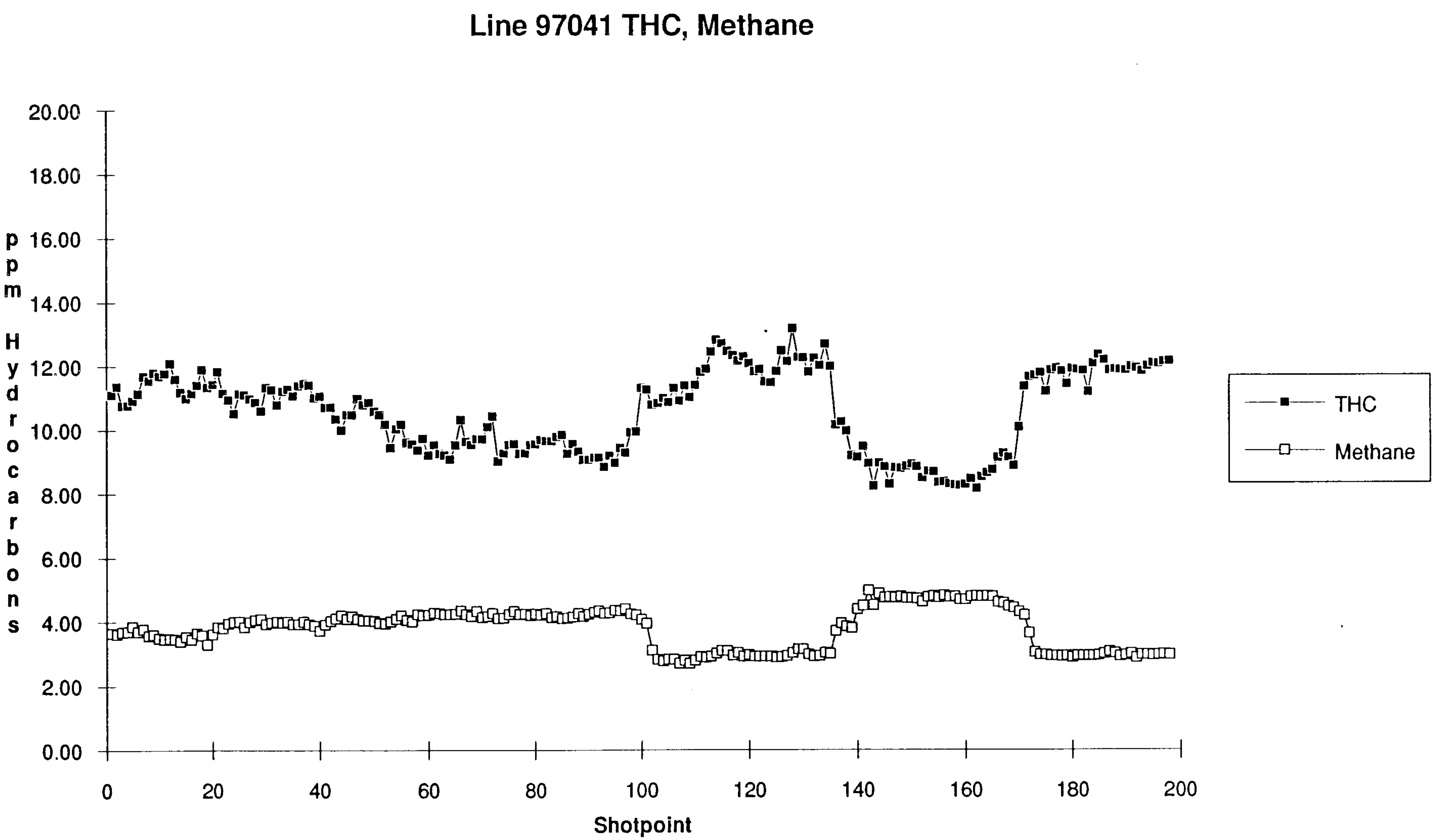
	Shotpoint	Date	Time	Latitude		Longitude	
Start	1	5-Nov-90	17:00:16	12	22.954	125	11.797
End	199	6-Nov-90	02:06:10	11	54.214	124	57.606

	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	10.566	3.787	0.018	0.155	0.026	0.051	0.015	0.002	0.002	0.111	0.096	0.066	1.700
Std. Dev.	1.266	0.643	0.013	0.066	0.021	0.039	0.020	0.008	0.005	0.049	0.106	0.106	1.466
Minimum	8.168	2.696	0.004	0.072	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.283
Maximum	13.167	4.968	0.102	0.271	0.132	0.149	0.064	0.049	0.032	0.207	0.334	0.380	8.123

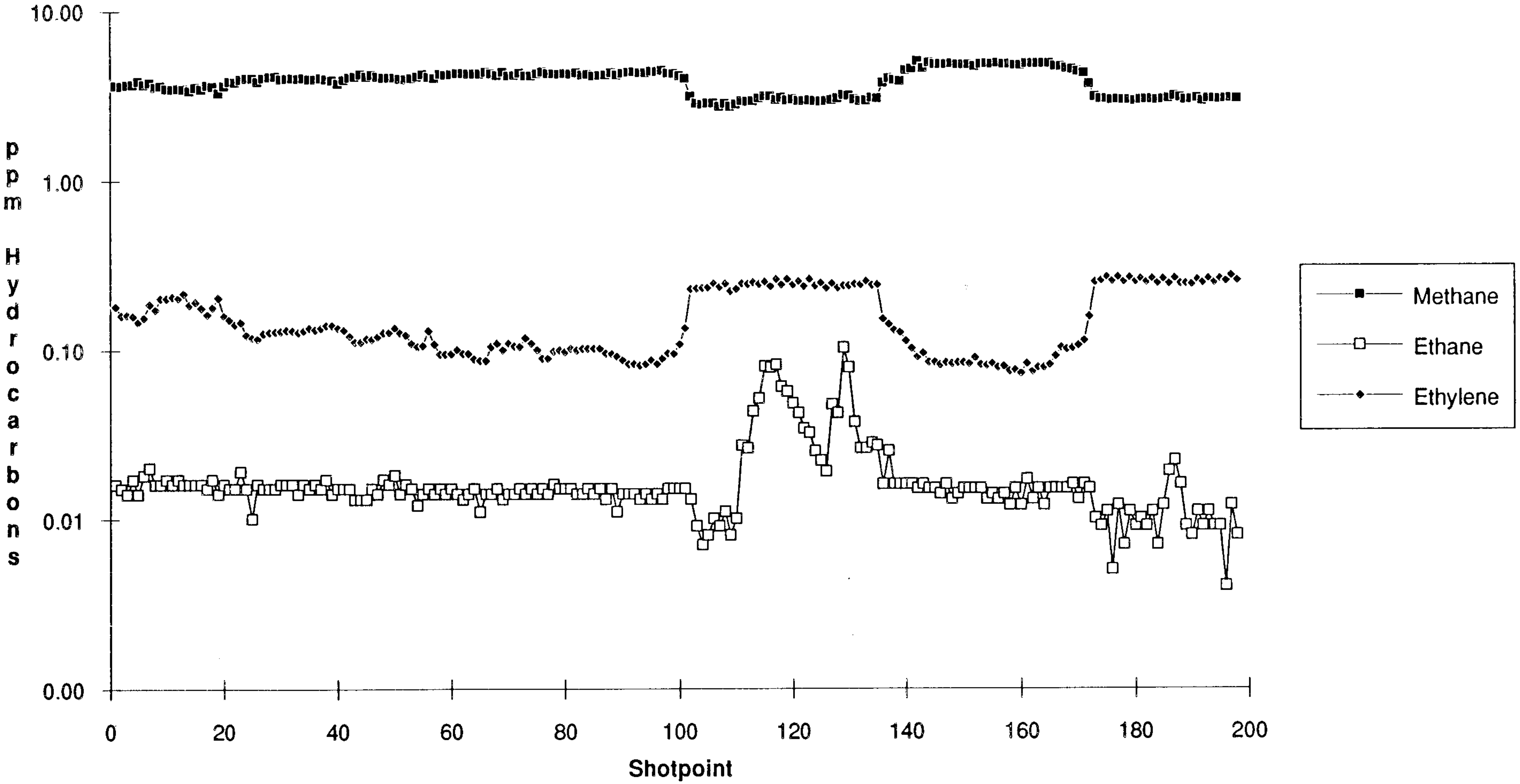
	Cond.	Temp.	F. Depth	W.Depth	Altitude
Mean	56.179	27.489	56.163	96.133	39.970
Std. Dev.	1.841	1.520	34.410	13.837	35.841
Minimum	53.580	25.170	9.282	54.678	8.000
Maximum	59.680	30.420	99.042	116.710	106.000

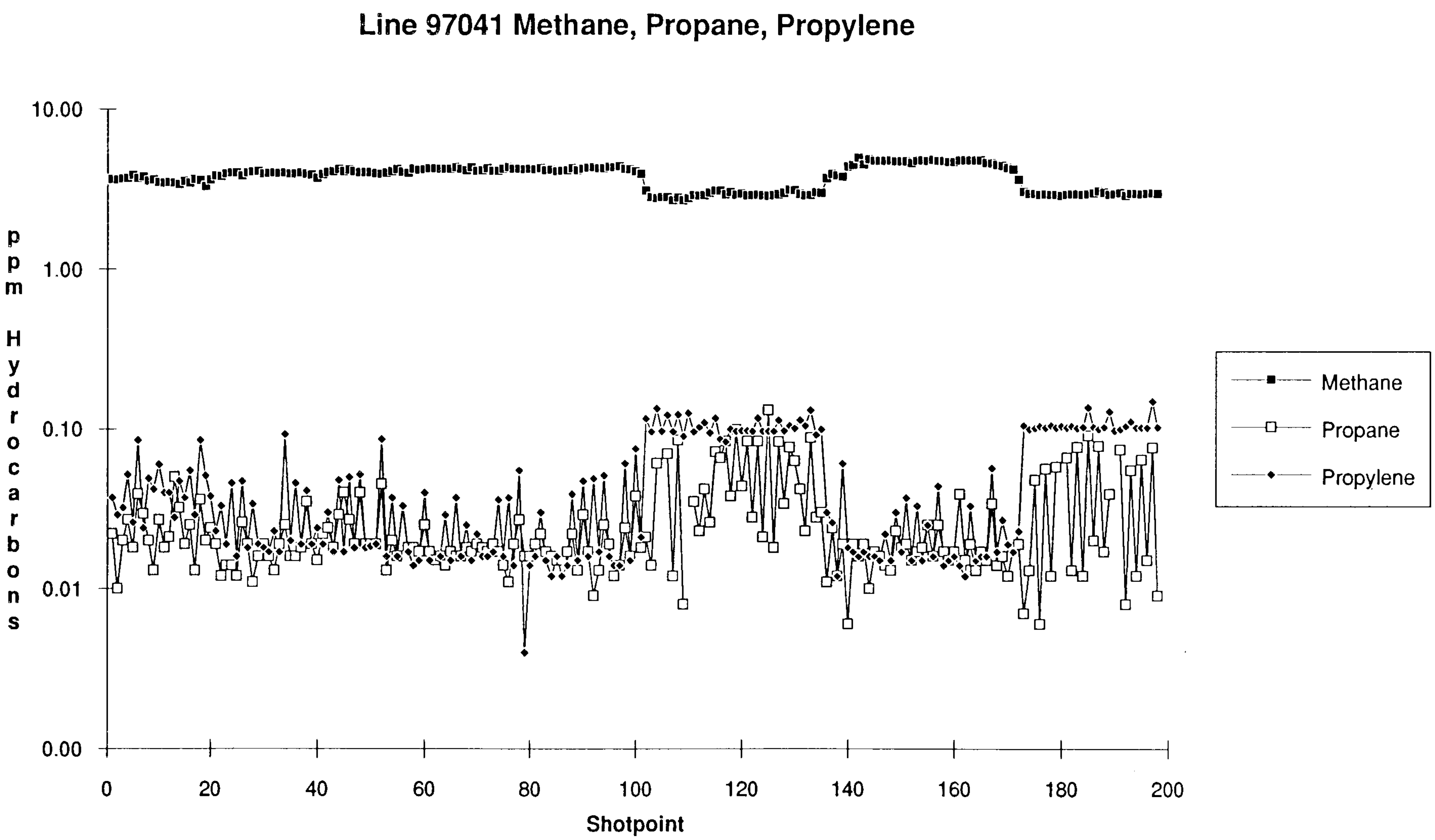
Notes

Significant ethane and propane enrichment associated with raising the fish to the near surface over th Challis and Jabiru oil field.


Line 97041 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

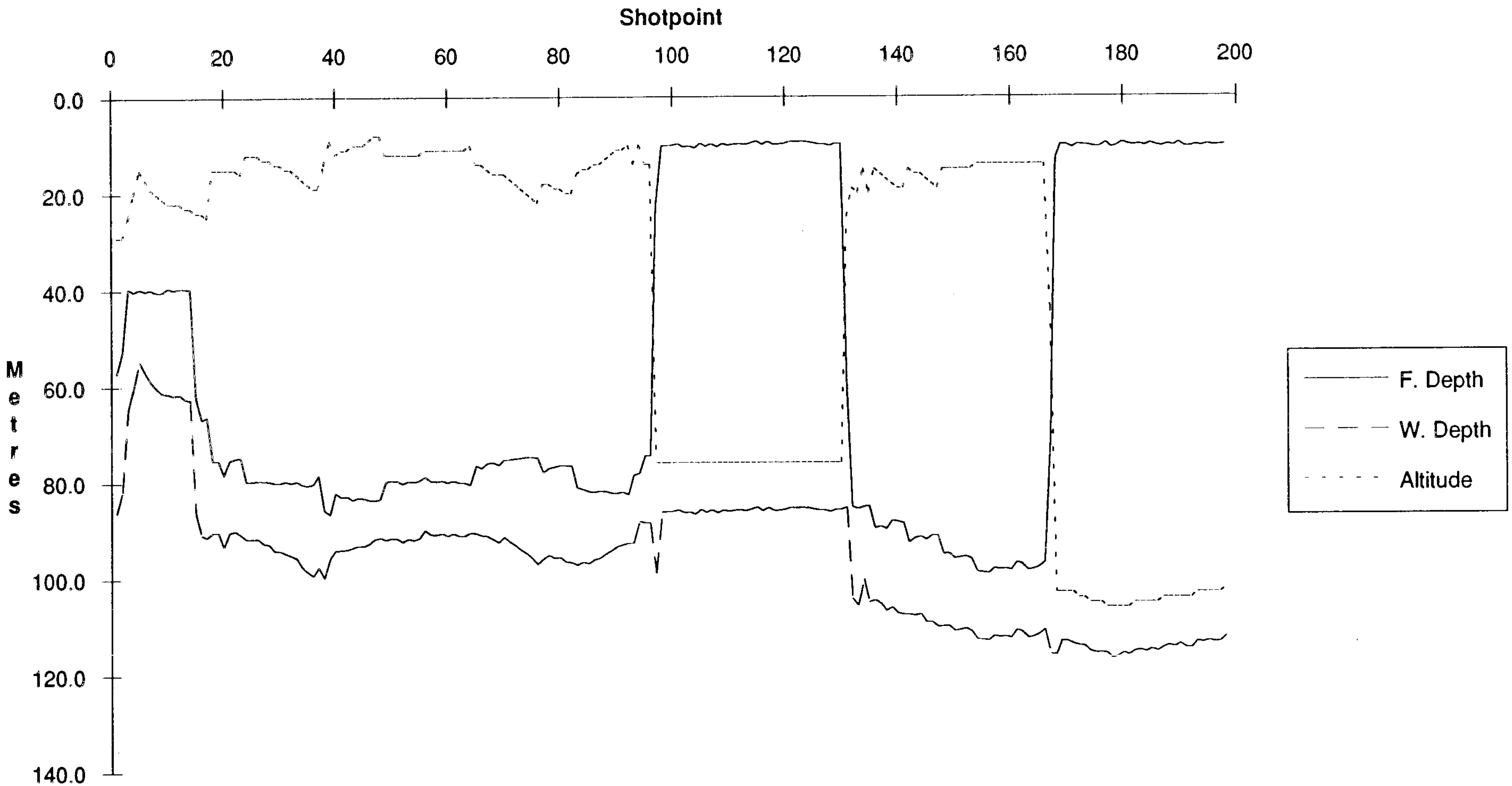
Line 97041 Methane, Ethane, Ethylene





Line 97041 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 97041 Depths, Altitude



Line Summary

Line Number	97042
No. of Shotpoints	188

	Shotpoint	Date	Time	Latitude		Longitude	
Start	1	6-Nov-90	05:54:22	11	59.479	125	00.454
End	189	6-Nov-90	12:15:00	11	33.080	124	41.851

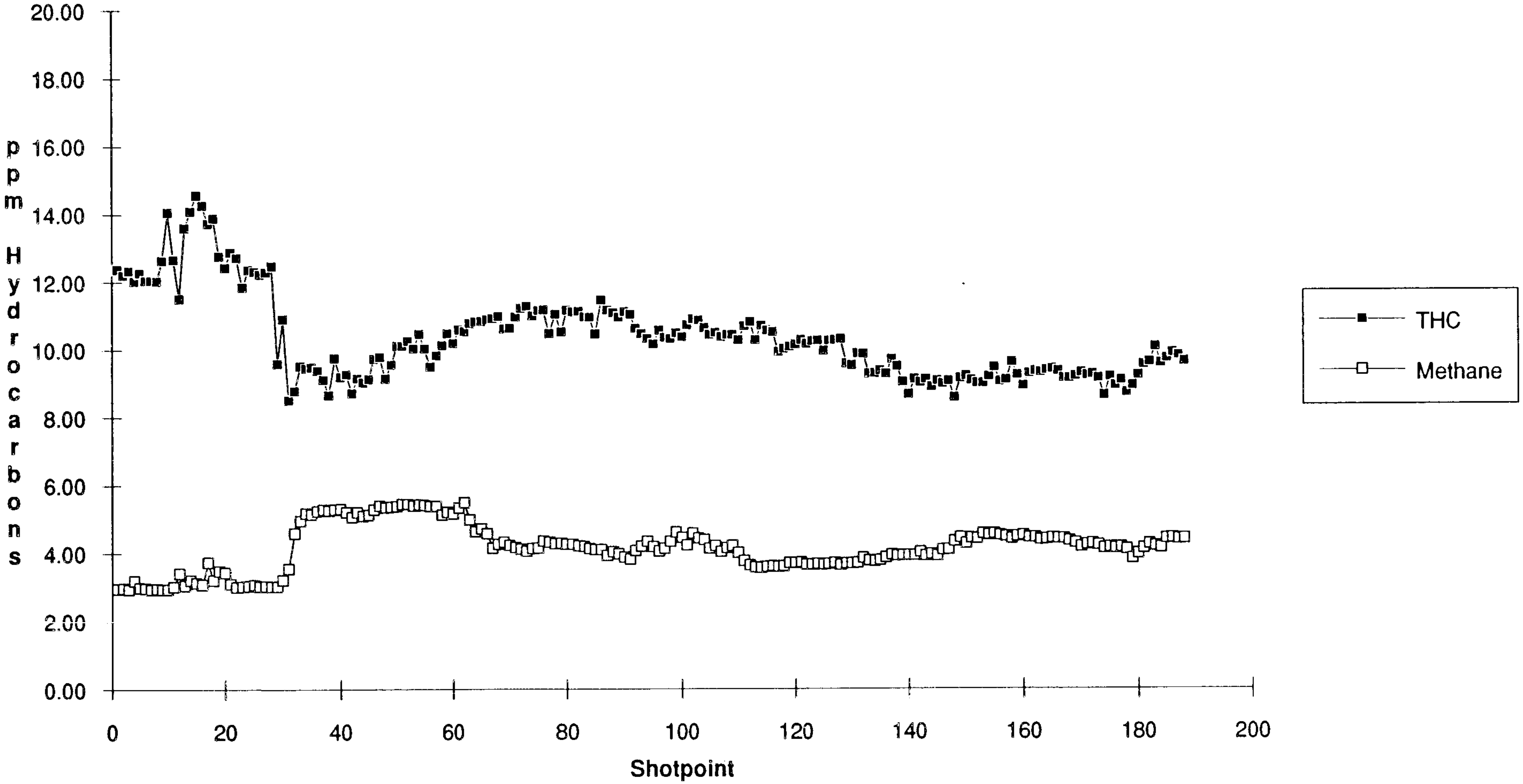
	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	10.315	4.133	0.018	0.144	0.023	0.043	0.015	0.003	0.001	0.082	0.001	0.006	1.471
Std. Dev.	1.263	0.669	0.010	0.058	0.018	0.038	0.021	0.014	0.003	0.039	0.002	0.009	1.186
Minimum	8.495	2.932	0.008	0.081	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.272
Maximum	14.555	5.473	0.104	0.296	0.106	0.178	0.069	0.130	0.015	0.178	0.013	0.043	7.503

	Cond.	Temp.	F. Depth	W.Depth	Altitude
Mean	56.202	27.391	93.575	265.601	172.027
Std. Dev.	1.974	1.630	33.741	118.279	103.579
Minimum	54.070	25.530	9.384	114.098	16.000
Maximum	60.810	31.290	111.078	425.752	316.000

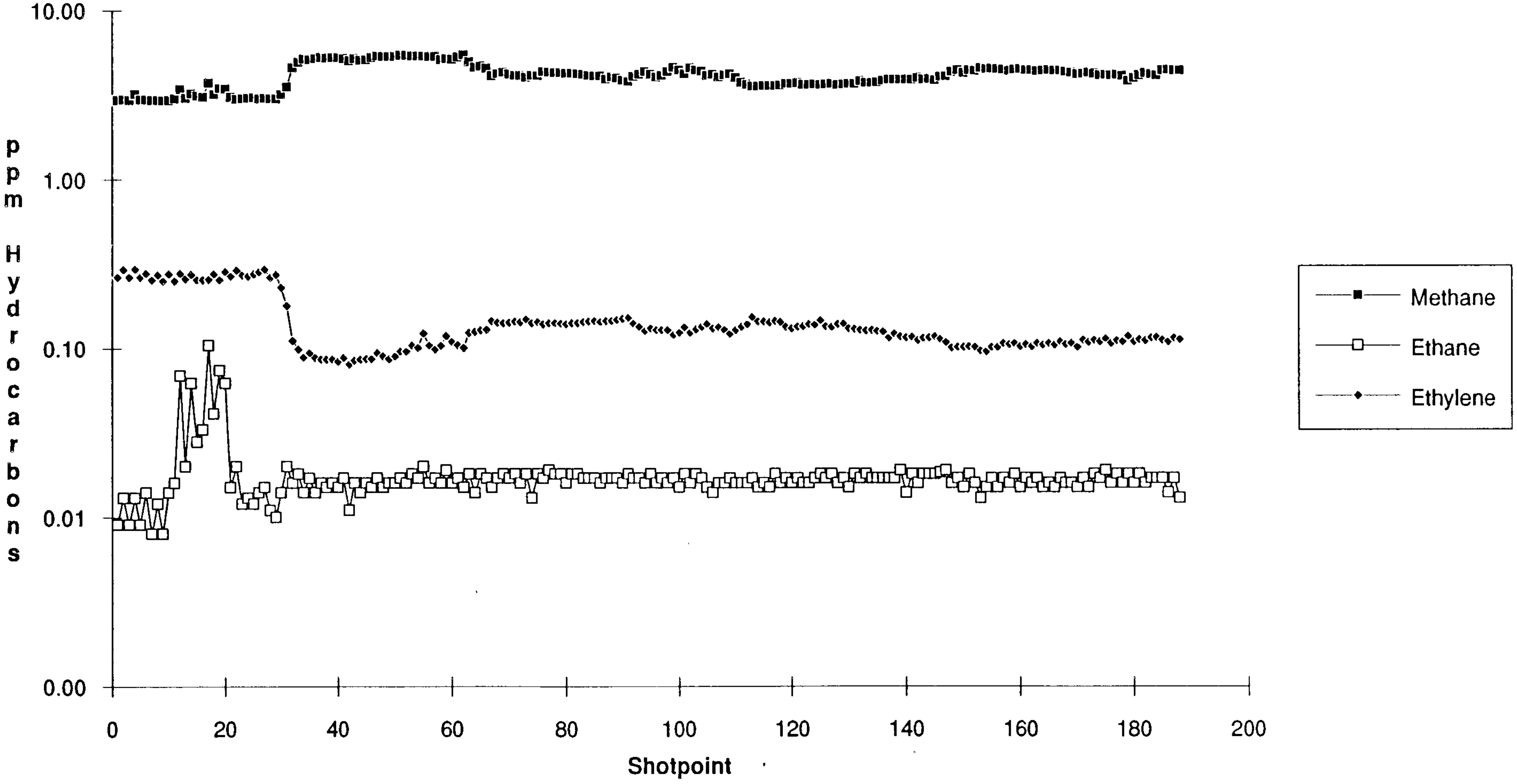
Notes

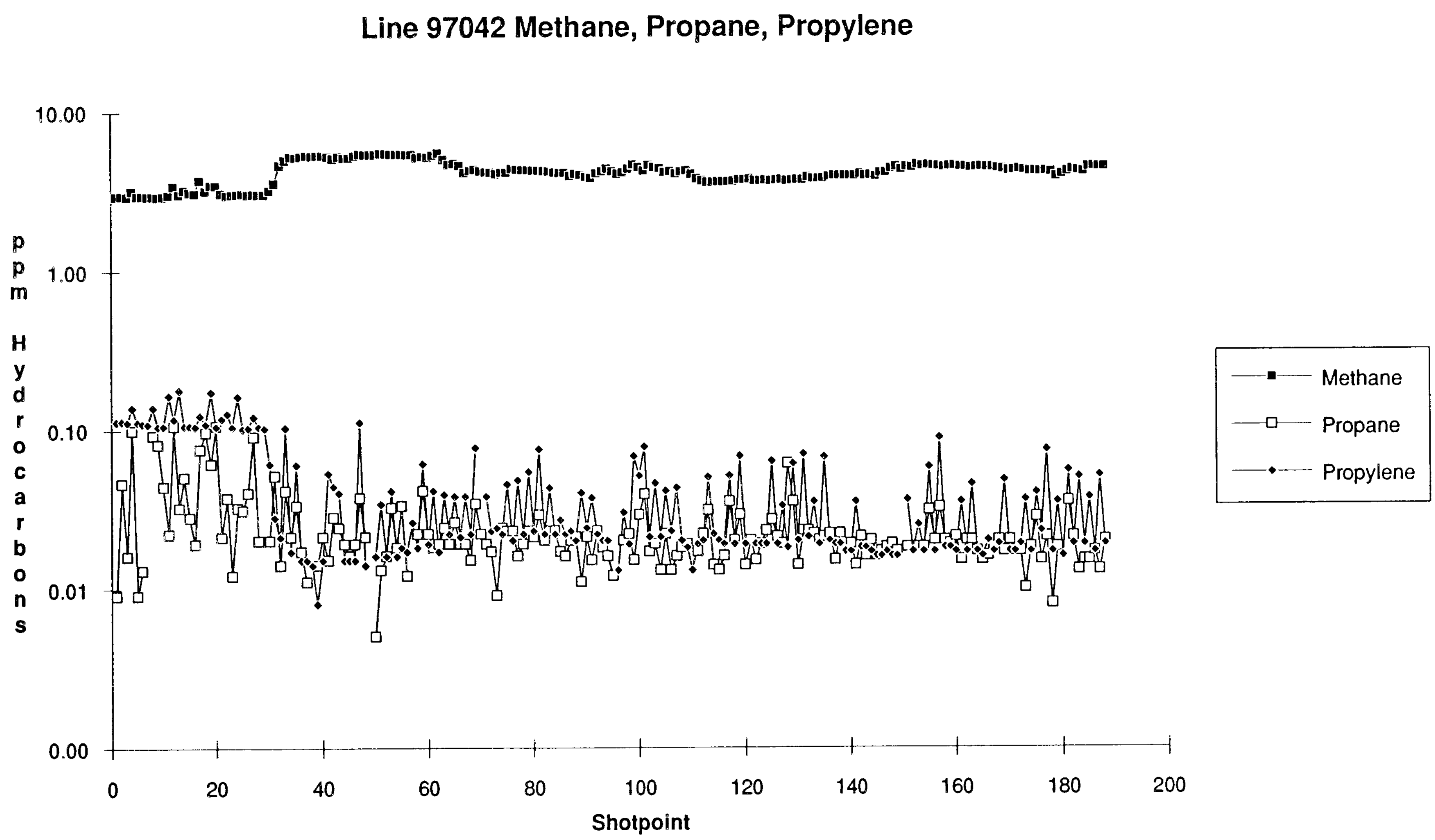
Significant ethane and propane enrichment associated with raising the fish to near the surface over the Jabiru oil field.

Line 97042 THC, Methane

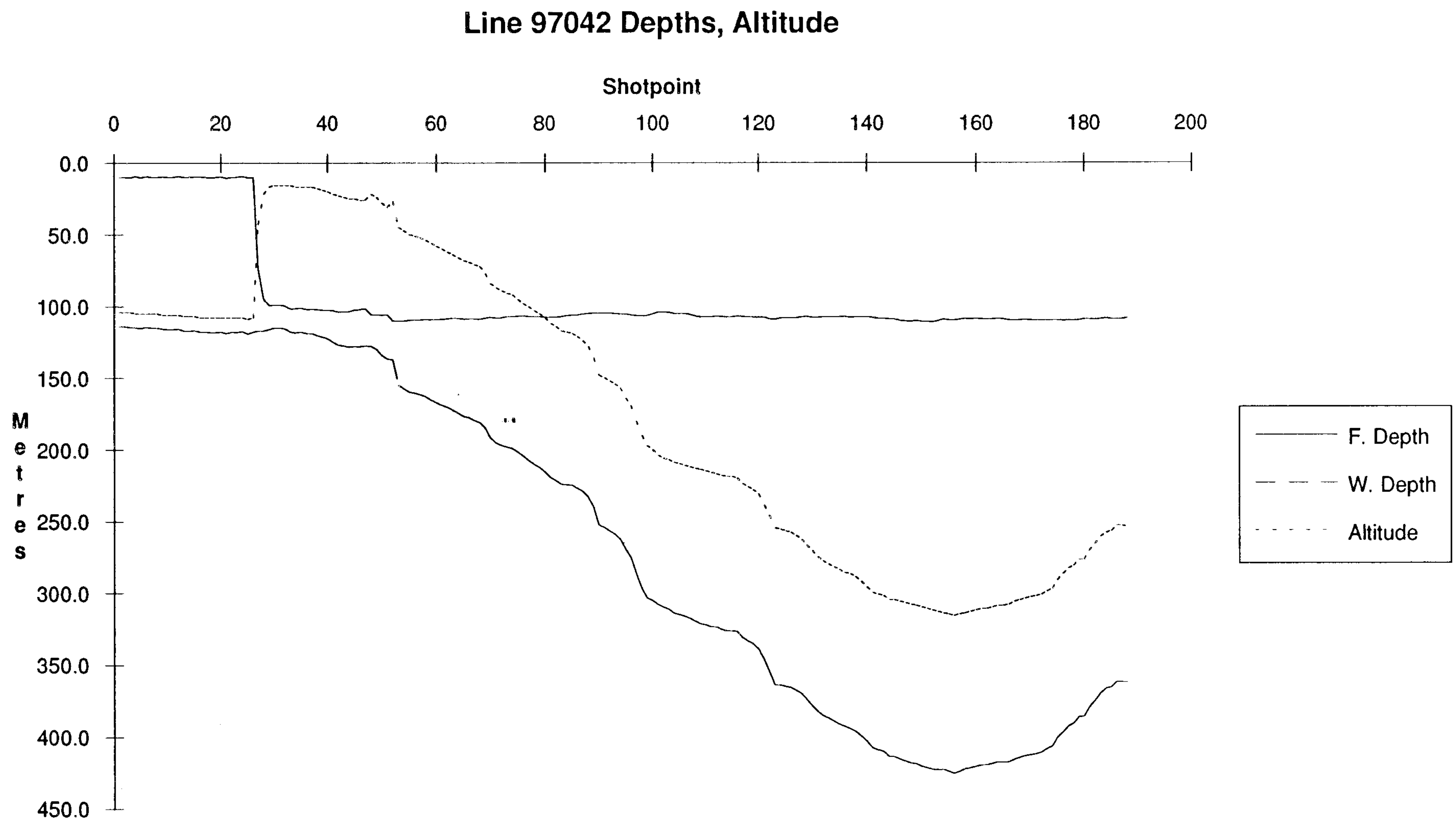


Line 97042 Methane, Ethane, Ethylene





Line 97042 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
200
Shotpoint
Methane
Propane
Propylene



Line 97042 Depths, Altitude
Shotpoint
0
20
40
60
80
100
120
140
160
180
200
0.0
50.0
100.0
150.0
200.0
250.0
300.0
350.0
400.0
450.0
Metres
F. Depth
W. Depth
Altitude

Line Summary

Line Number	97043
No. of Shotpoints	100

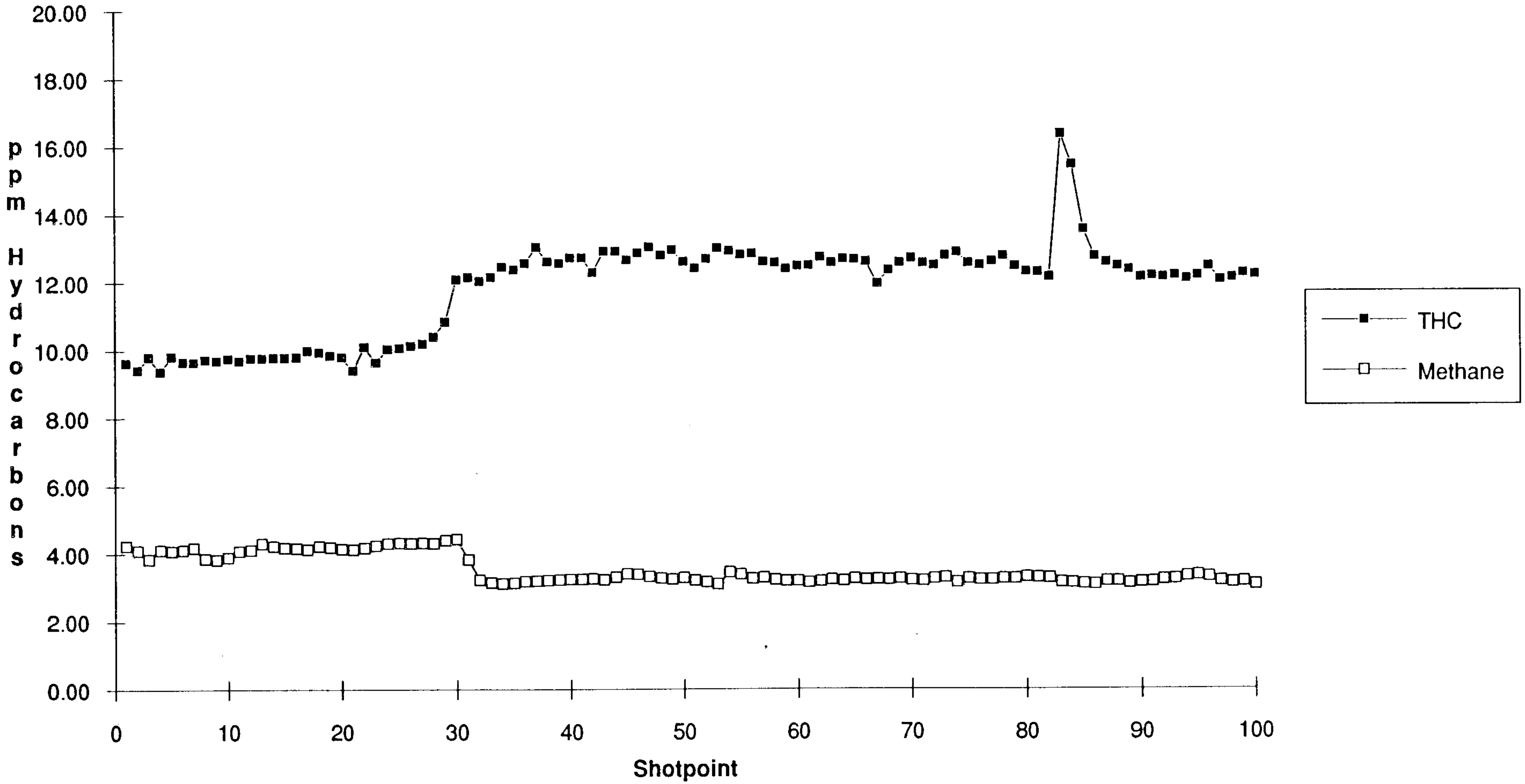
	Shotpoint	Date	Time	Latitude		Longitude	
Start	1	6-Nov-90	13:41:00	11	34.660	124	43.240
End	101	6-Nov-90	17:02:19	11	23.478	124	30.391

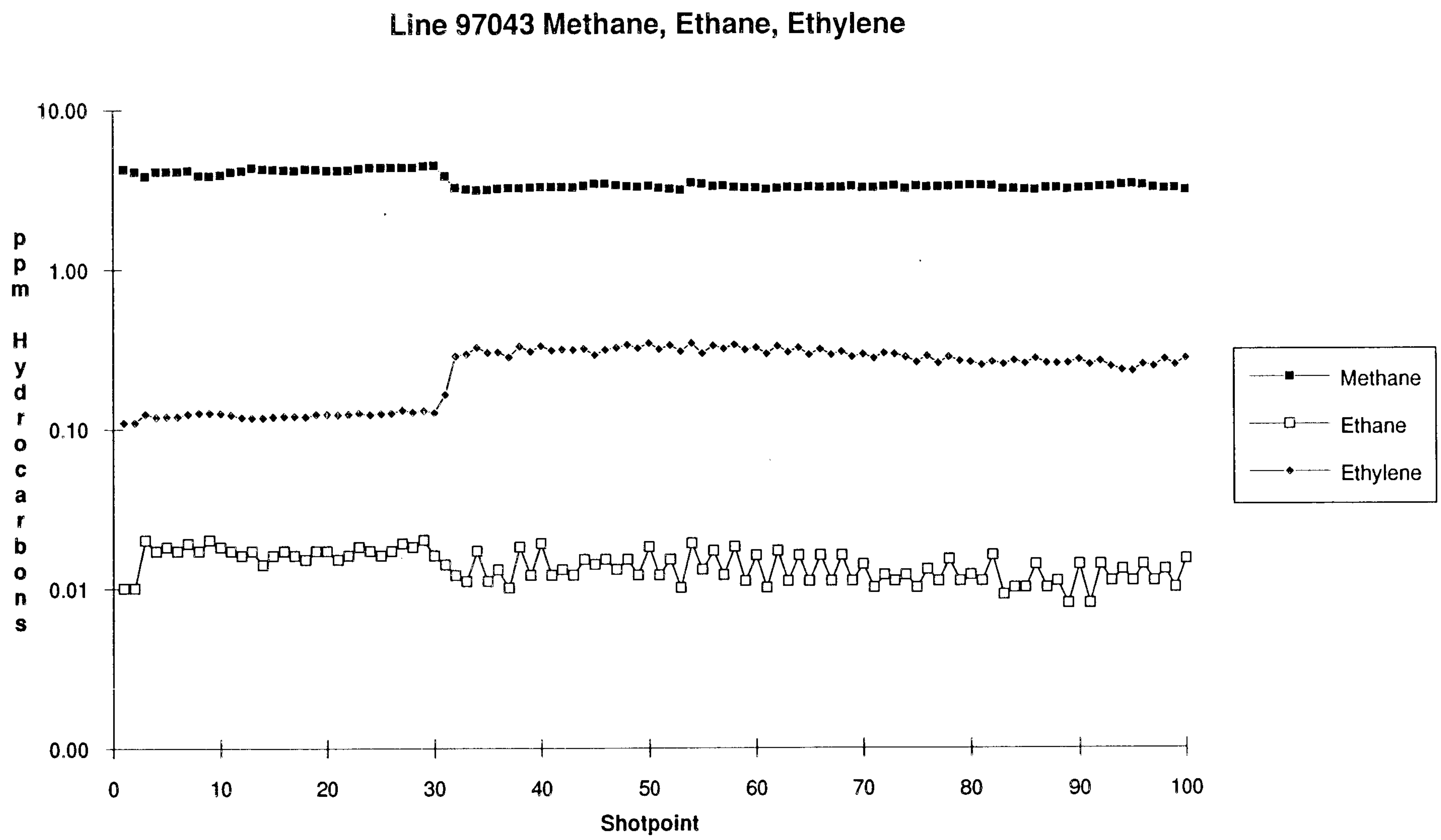
	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	11.814	3.500	0.014	0.237	0.030	0.085	0.016	0.000	0.000	0.120	0.000	0.000	1.713
Std. Dev.	1.390	0.445	0.003	0.081	0.025	0.039	0.023	0.000	0.000	0.051	0.000	0.000	1.263
Minimum	9.355	3.053	0.008	0.110	0.000	0.017	0.000	0.000	0.000	0.000	0.000	0.000	0.315
Maximum	16.355	4.418	0.020	0.342	0.109	0.157	0.109	0.000	0.000	0.189	0.000	0.000	5.518

	Cond.	Temp.	F. Depth	W.Depth	Altitude
Mean	56.244	27.482	36.211	196.521	160.310
Std. Dev.	1.108	0.963	42.504	110.356	80.614
Minimum	54.460	25.720	7.752	24.832	13.000
Maximum	57.490	28.550	109.242	396.630	288.000

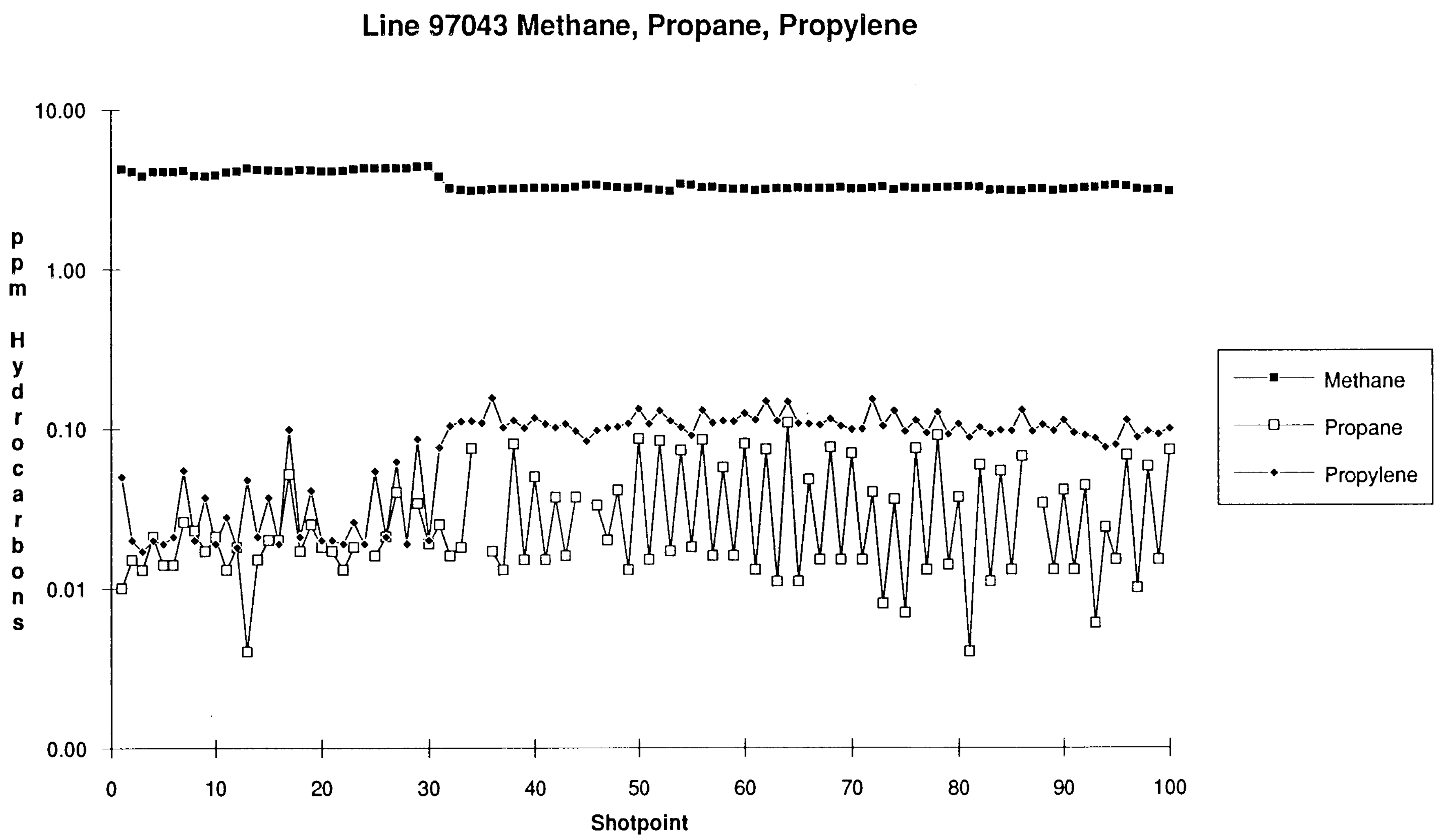
Notes No anomalies

Line 97043 THC, Methane

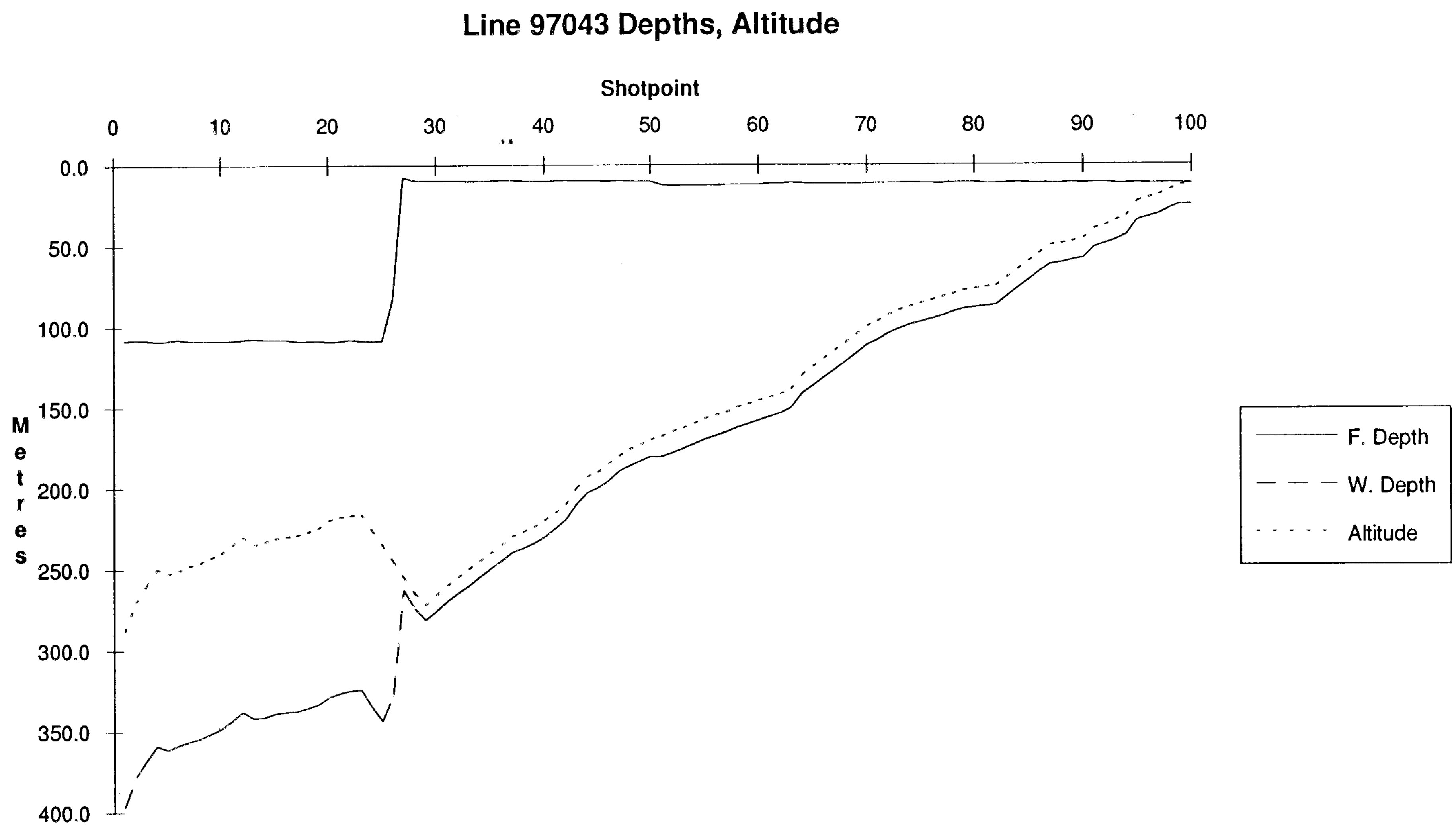




Line 97043 Methane, Ethane, Ethylene
10.00
1.00
0.10
0.01
0.00
ppm Hydrocarbons
0
10
20
30
40
50
60
70
80
90
100
Shotpoint
Methane
Ethane
Ethylene



Line 97043 Methane, Propane, Propylene
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 97043 Depths, Altitude
Shotpoint
0
10
20
30
40
50
60
70
80
90
100
0.0
50.0
100.0
150.0
200.0
250.0
300.0
350.0
400.0
Metres
F. Depth
W. Depth
Altitude

Line Summary

Line Number	97044
No. of Shotpoints	251

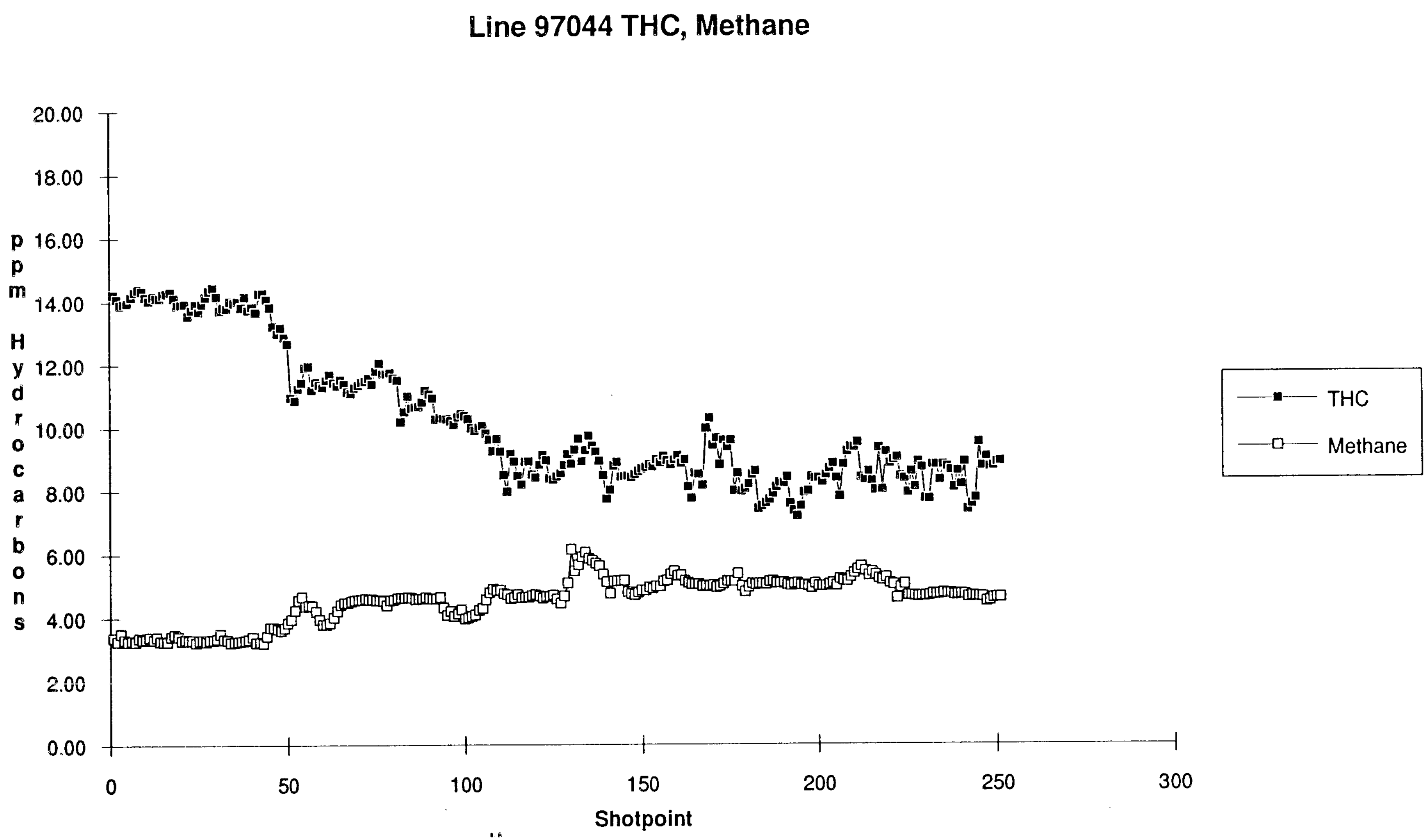
	Shotpoint	Date	Time	Latitude		Longitude	
Start	1	6-Nov-90	22:59:13	11	32.023	124	26.971
End	252	7-Nov-90	07:23:12	12	03.414	124	55.446

	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	10.196	4.520	0.015	0.126	0.016	0.048	0.021	0.000	0.004	0.084	0.001	0.000	1.147
Std. Dev.	2.160	0.692	0.002	0.081	0.006	0.041	0.029	0.000	0.011	0.050	0.004	0.002	0.718
Minimum	7.185	3.205	0.009	0.052	0.000	0.007	0.000	0.000	0.000	0.000	0.000	0.000	0.279
Maximum	14.428	6.133	0.021	0.306	0.047	0.215	0.155	0.000	0.050	0.215	0.045	0.027	4.409

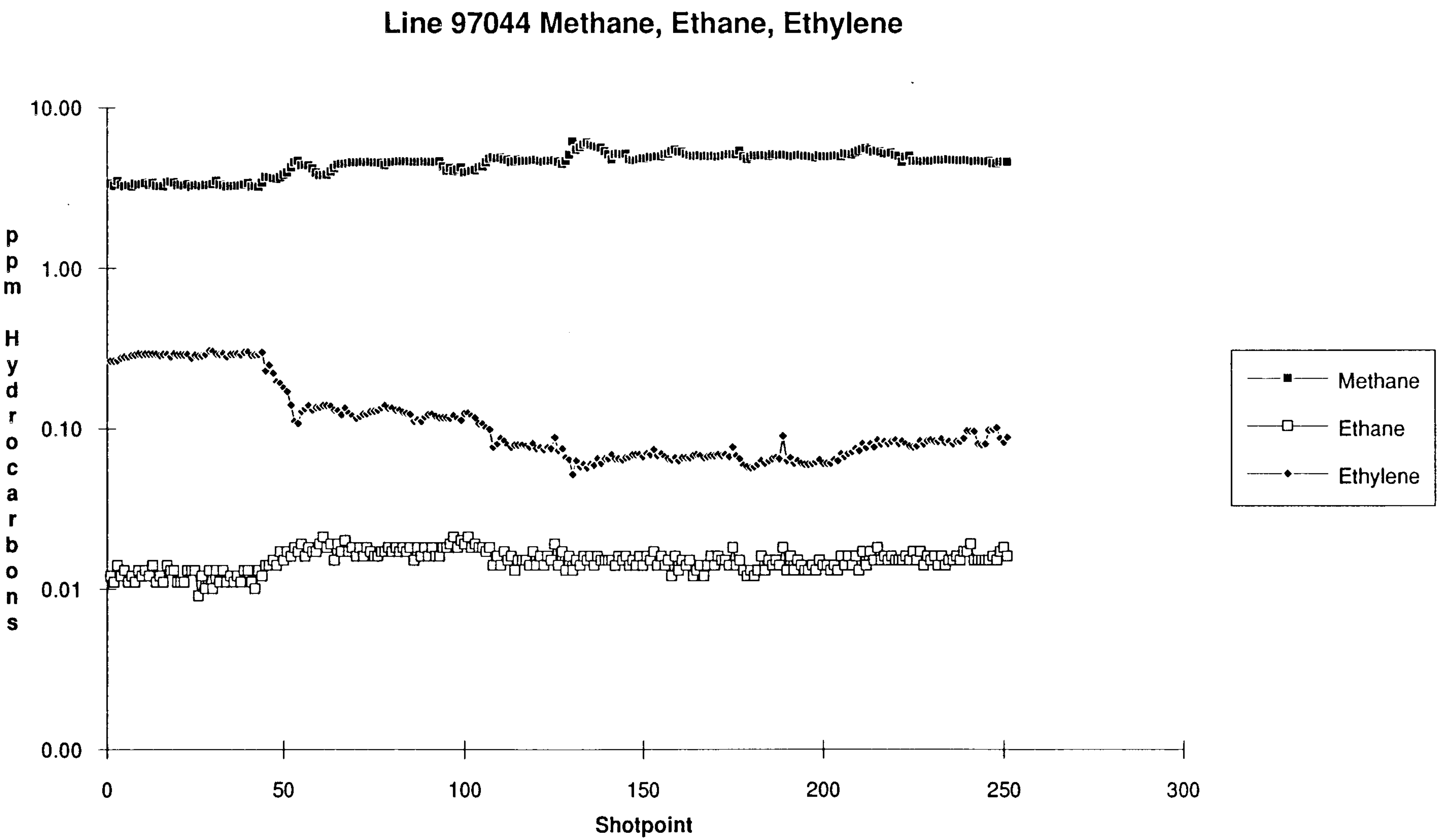
	Cond.	Temp.	F. Depth	W.Depth	Altitude
Mean	55.798	26.911	87.244	203.826	116.582
Std. Dev.	1.729	1.477	33.996	74.987	76.797
Minimum	53.620	24.860	11.628	24.628	12.000
Maximum	59.400	30.050	115.668	317.408	215.000

Notes

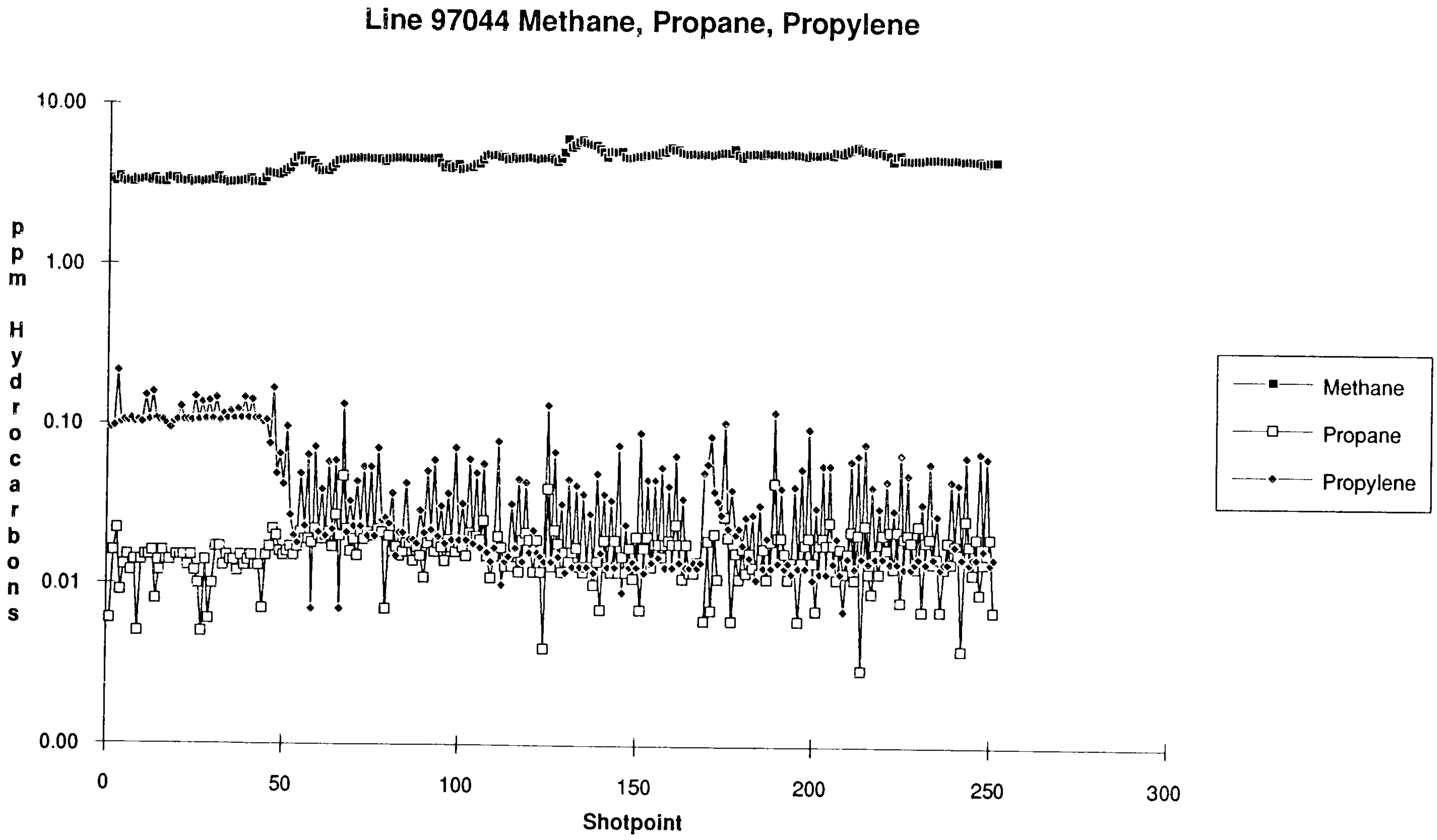
Erratic THC and methane values associated with large variations in fish depth.



Line 97044 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
50
100
150
200
250
300
Shotpoint
THC
Methane

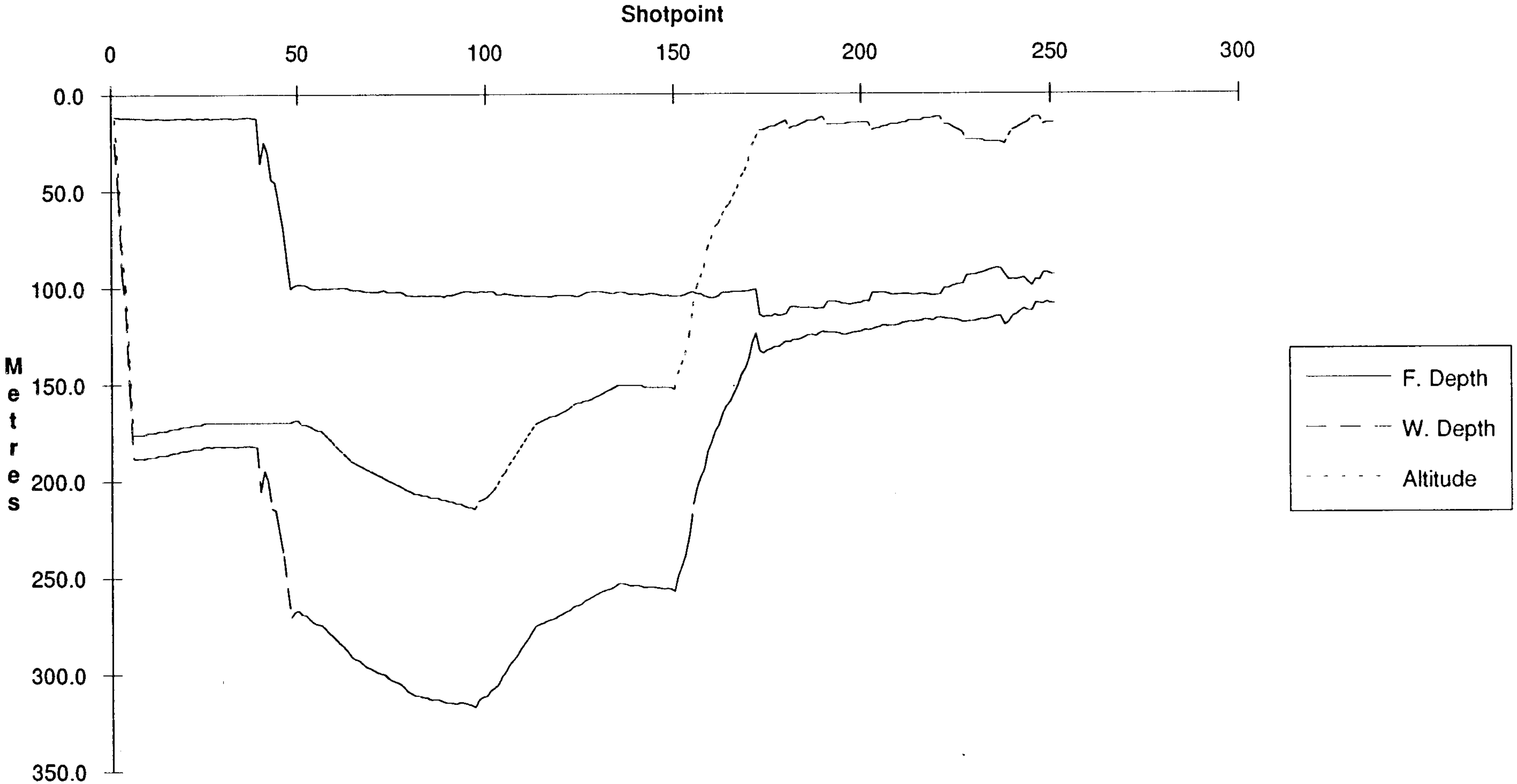


Line 97044 Methane, Ethane, Ethylene
ppm Hydrocarbons
10.00
1.00
0.10
0.01
0.00
0
50
100
150
200
250
300
Shotpoint
Methane
Ethane
Ethylene



Line 97044 Methane, Propane, Propylene
10.00
1.00
0.10
0.01
0.00
ppm Hydrocarbons
0
50
100
150
200
250
300
Shotpoint
Methane
Propane
Propylene

Line 97044 Depths, Altitude



Line Summary

Line Number	97045
No. of Shotpoints	188

	Shotpoint	Date	Time	Latitude		Longitude	
Start	3	7-Nov-90	09:19:24	12	00.842	124	52.384
End	190	7-Nov-90	15:34:09	12	17.207	125	20.001

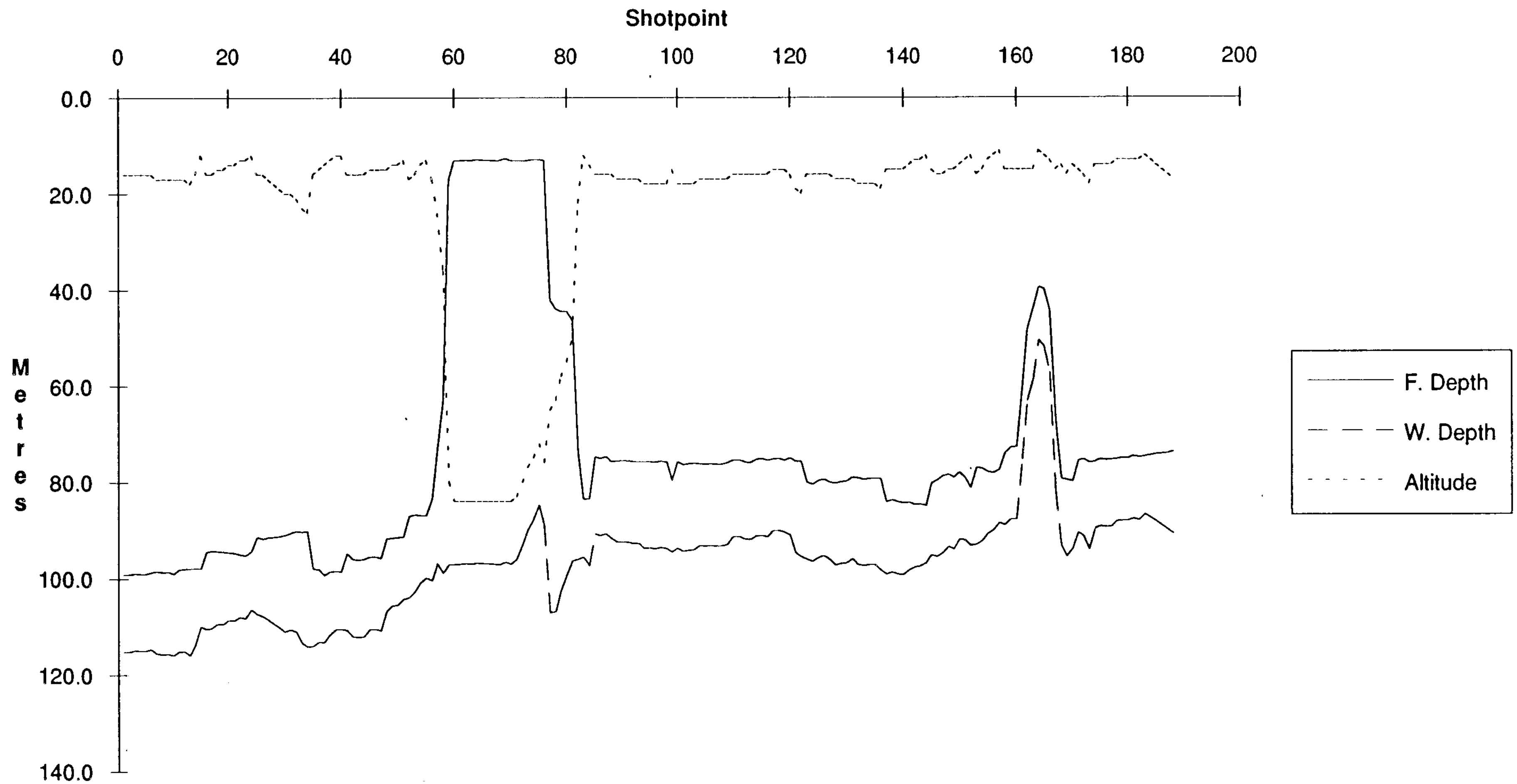
	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	10.265	4.159	0.021	0.139	0.021	0.044	0.023	0.005	0.002	0.094	0.000	0.001	1.719
Std. Dev.	1.745	0.450	0.023	0.060	0.017	0.035	0.028	0.016	0.008	0.046	0.005	0.010	1.587
Minimum	7.529	2.900	0.011	0.075	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.333
Maximum	14.583	4.681	0.174	0.299	0.116	0.149	0.126	0.114	0.065	0.224	0.064	0.124	10.260

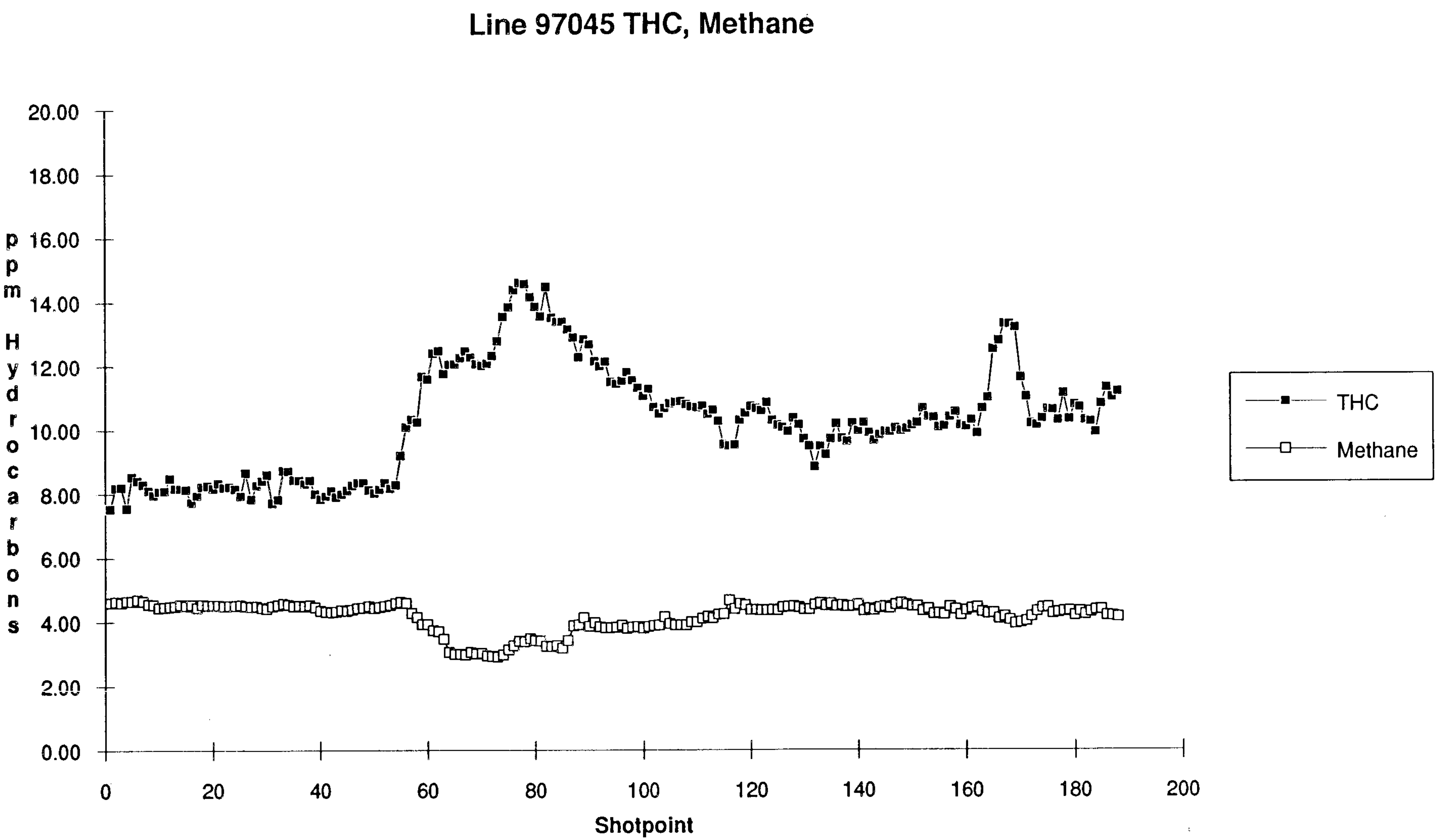
	Cond.	Temp.	F. Depth	W.Depth	Altitude
Mean	55.013	26.192	74.400	97.655	23.255
Std. Dev.	1.279	1.096	23.469	11.171	20.408
Minimum	53.350	24.620	12.648	50.474	11.000
Maximum	57.830	28.700	99.348	116.042	84.000

Notes

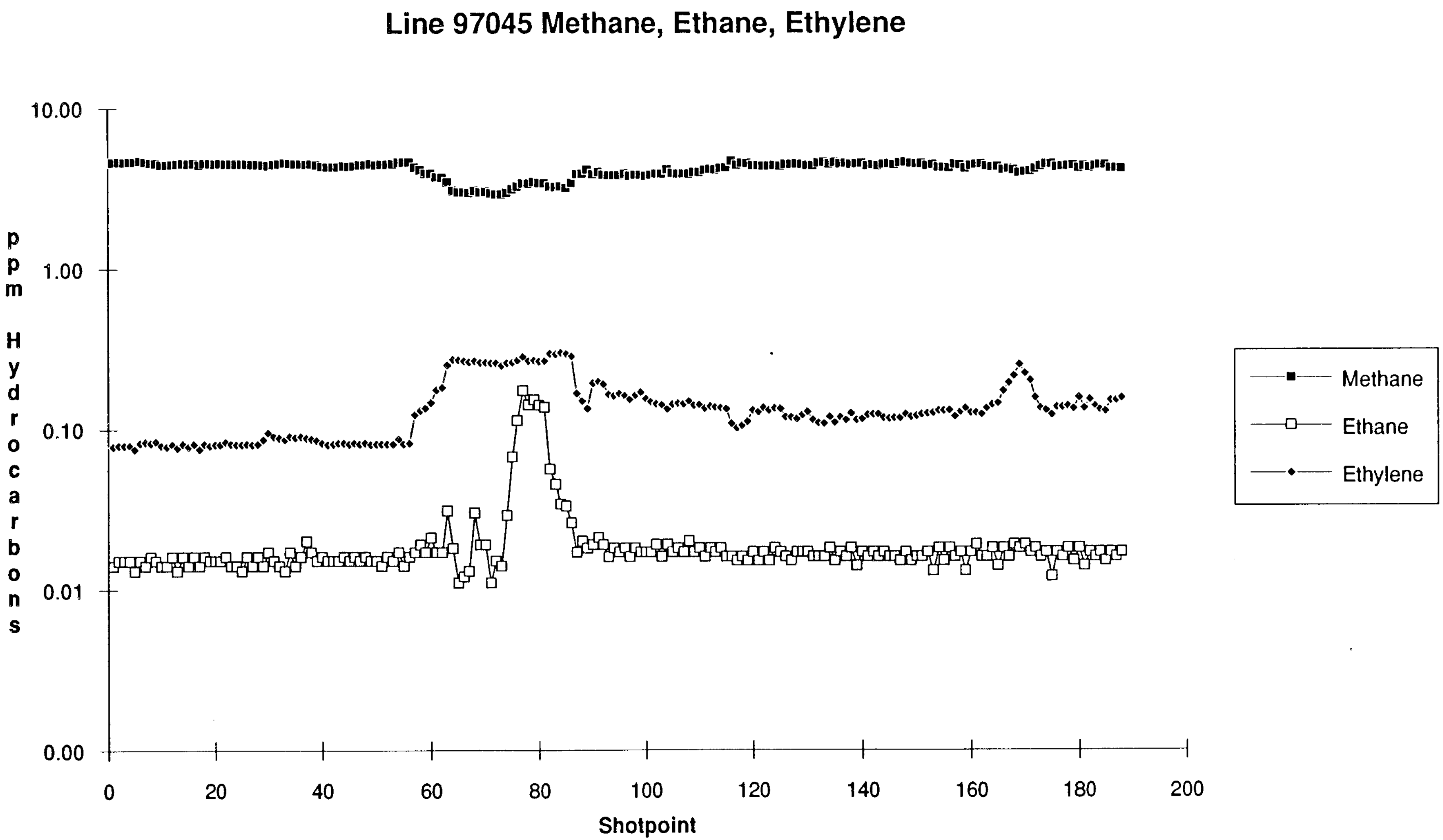
Significant ethane and propane enrichment associated with raising the fish to near the surface over the Challis oil field.

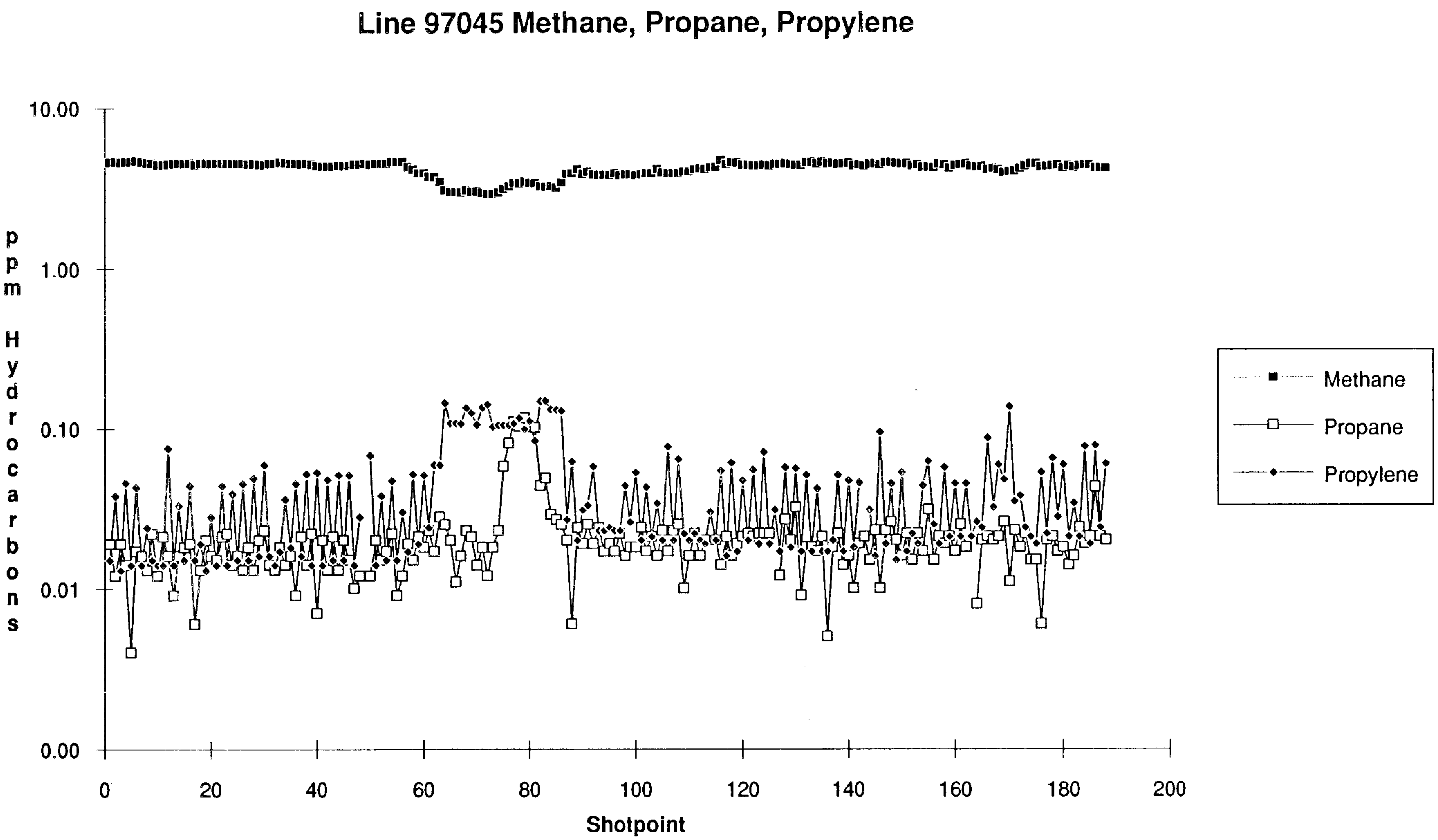
Line 97045 Depths, Altitude



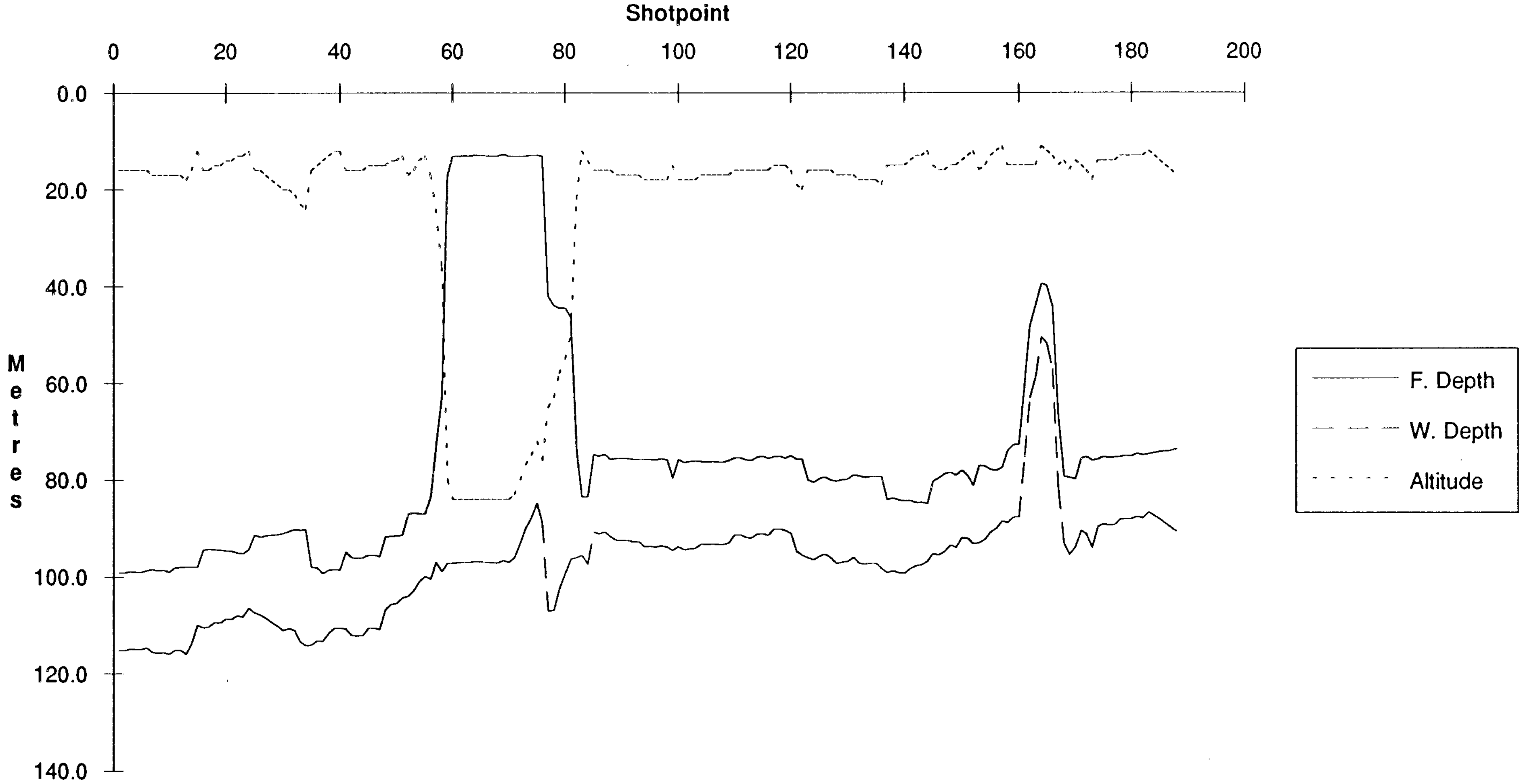


Line 97045 THC, Methane
20.00
18.00
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
ppm Hydrocarbons
0
20
40
60
80
100
120
140
160
180
200
Shotpoint
THC
Methane


Line 97045 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 97045 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
200
Shotpoint
Methane
Propane
Propylene

Line 97045 Depths, Altitude



Line Summary

Line Number	97046
No. of Shotpoints	442

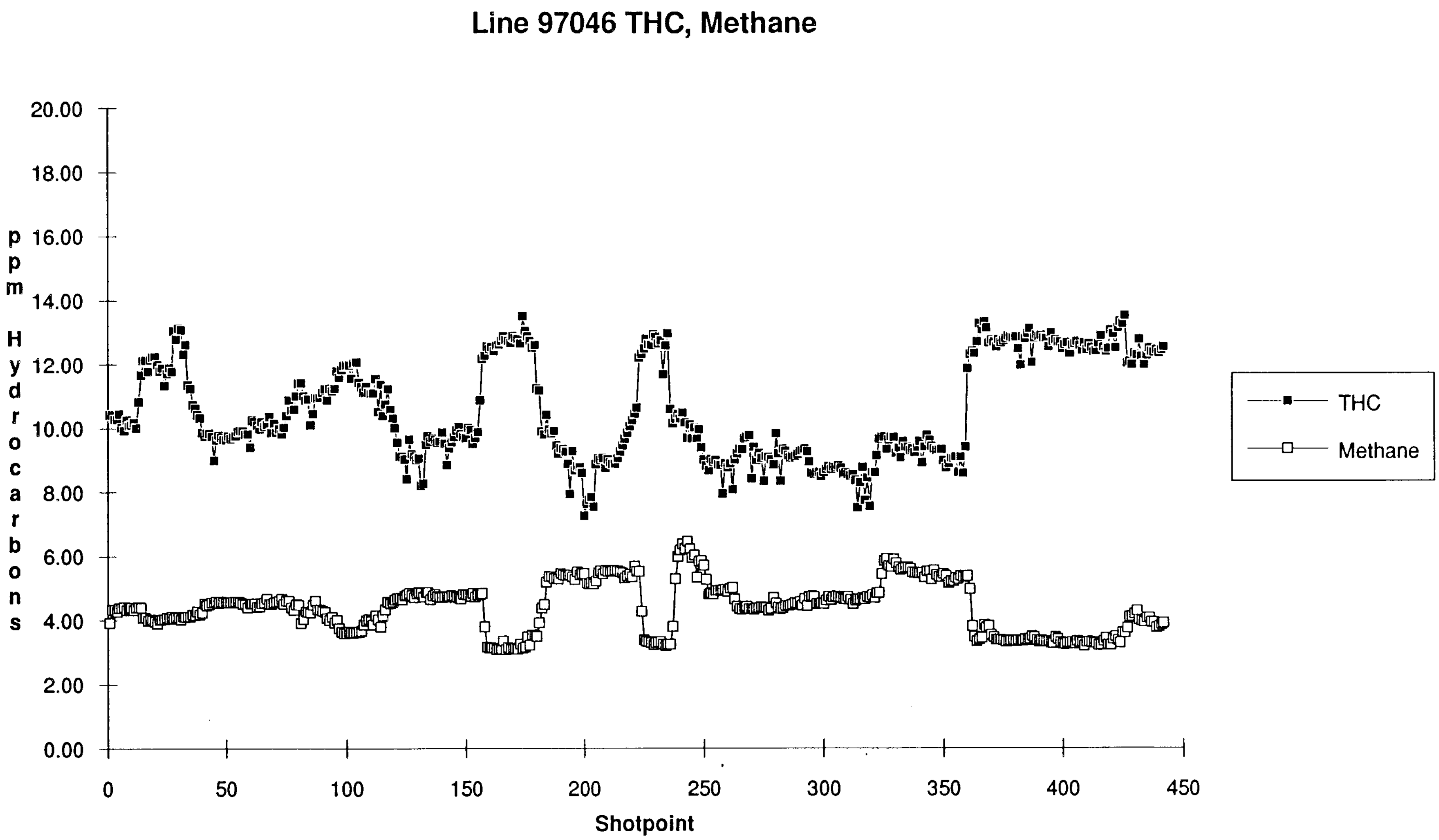
	Shotpoint	Date	Time	Latitude		Longitude	
Start	1	7-Nov-90	21:52:39	12	17.816	125	16.758
End	442	8-Nov-90	12:35:03	11	14.421	124	37.641

	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	10.555	4.384	0.016	0.152	0.017	0.050	0.019	0.003	0.000	0.100	0.000	0.002	1.266
Std. Dev.	1.571	0.771	0.003	0.078	0.010	0.041	0.026	0.014	0.004	0.053	0.000	0.007	0.837
Minimum	7.244	3.070	0.008	0.048	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.263
Maximum	13.503	6.435	0.030	0.316	0.145	0.204	0.149	0.118	0.045	0.256	0.000	0.045	6.857

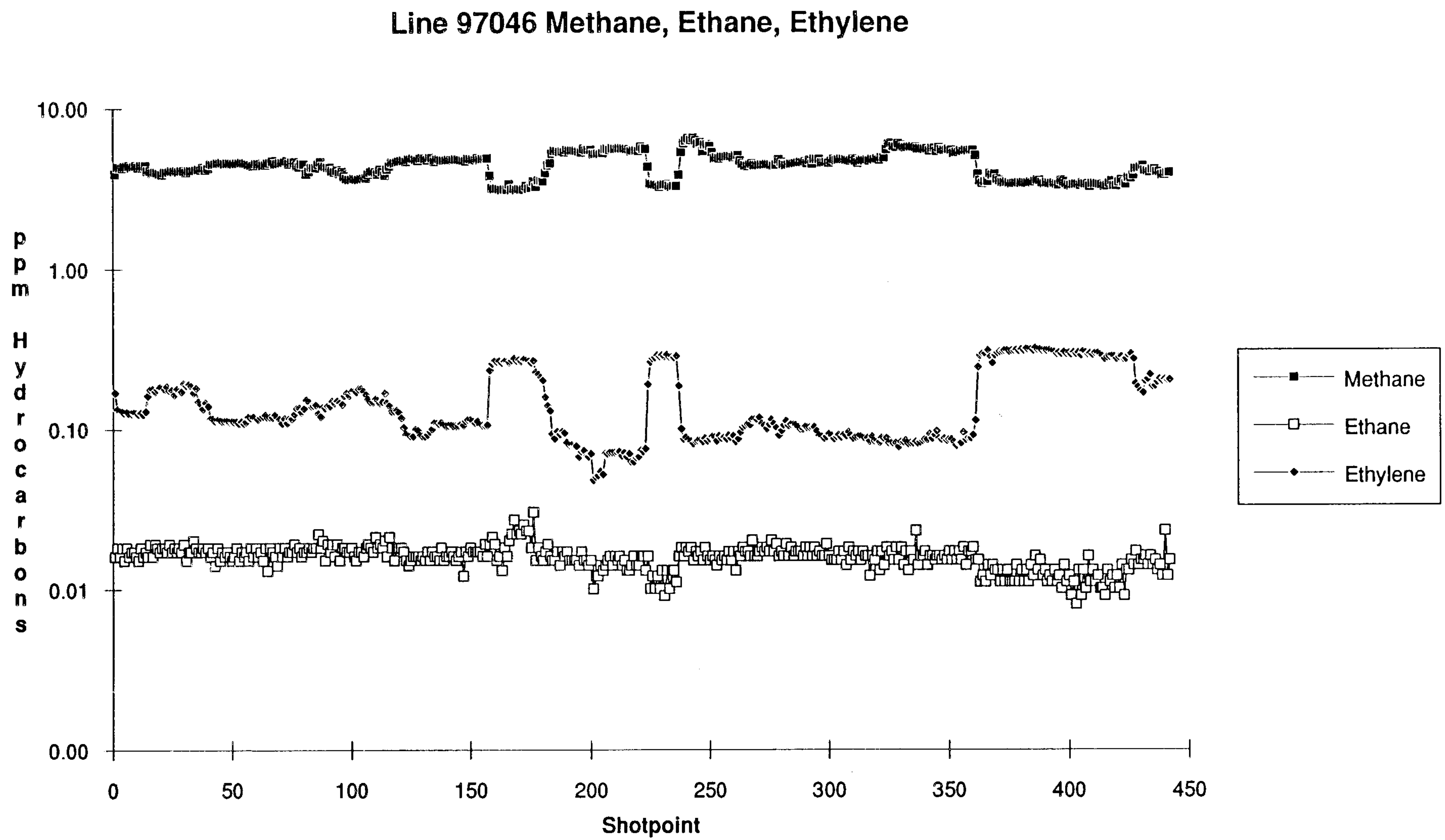
	Cond.	Temp.	F. Depth	W.Depth	Altitude
Mean	56.133	27.012	74.183	192.174	117.991
Std. Dev.	1.367	1.162	36.621	126.122	117.234
Minimum	53.640	24.790	7.242	23.752	12.000
Maximum	59.900	30.240	119.544	433.570	328.000

Notes

No anomalies Erratic THC and methane values associated with rapid fluctuations in fish depth.

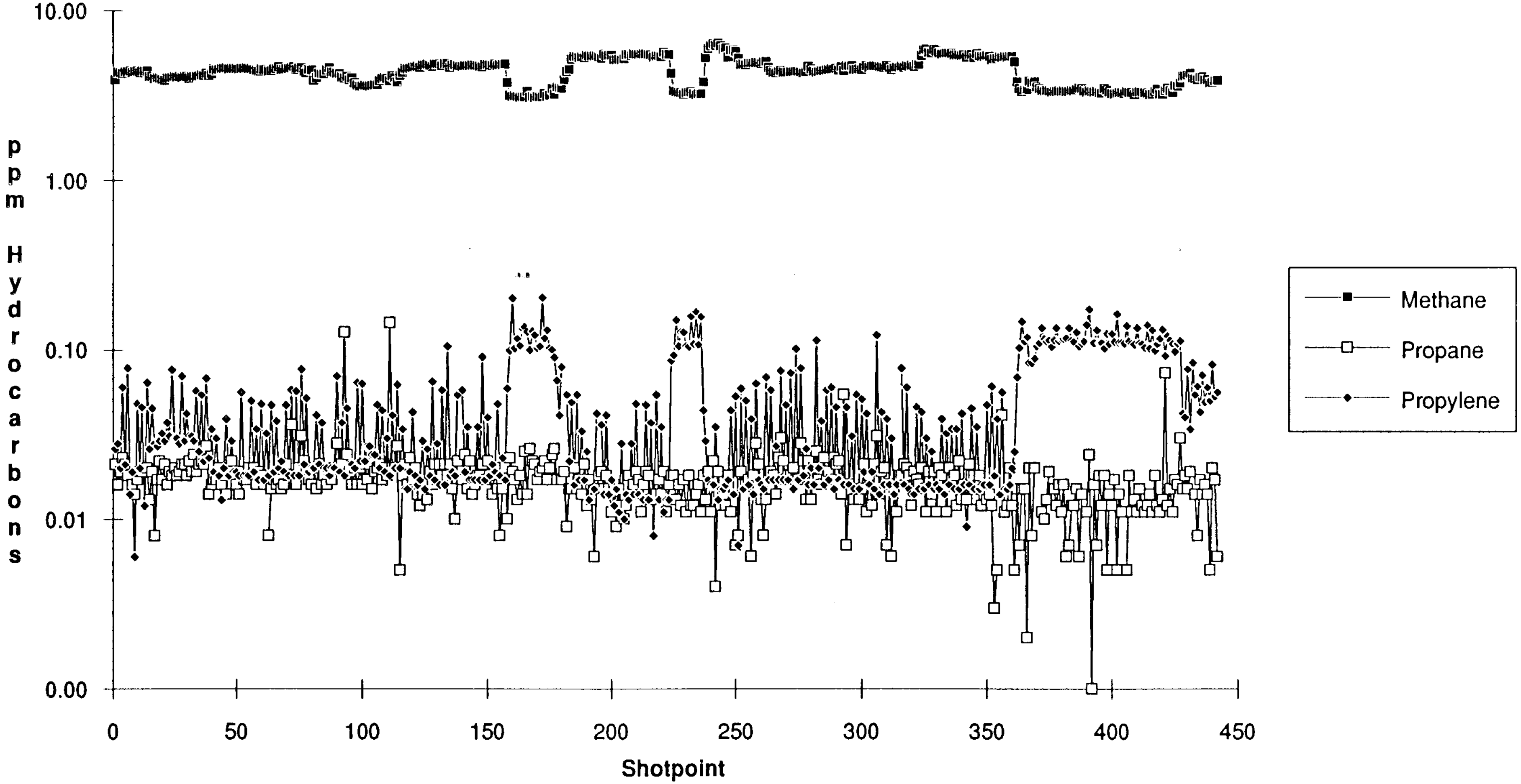


Line 97046 THC, Methane
ppm Hydrocarbons
20.00
18.00
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
0
50
100
150
200
250
300
350
400
450
Shotpoint
THC
Methane

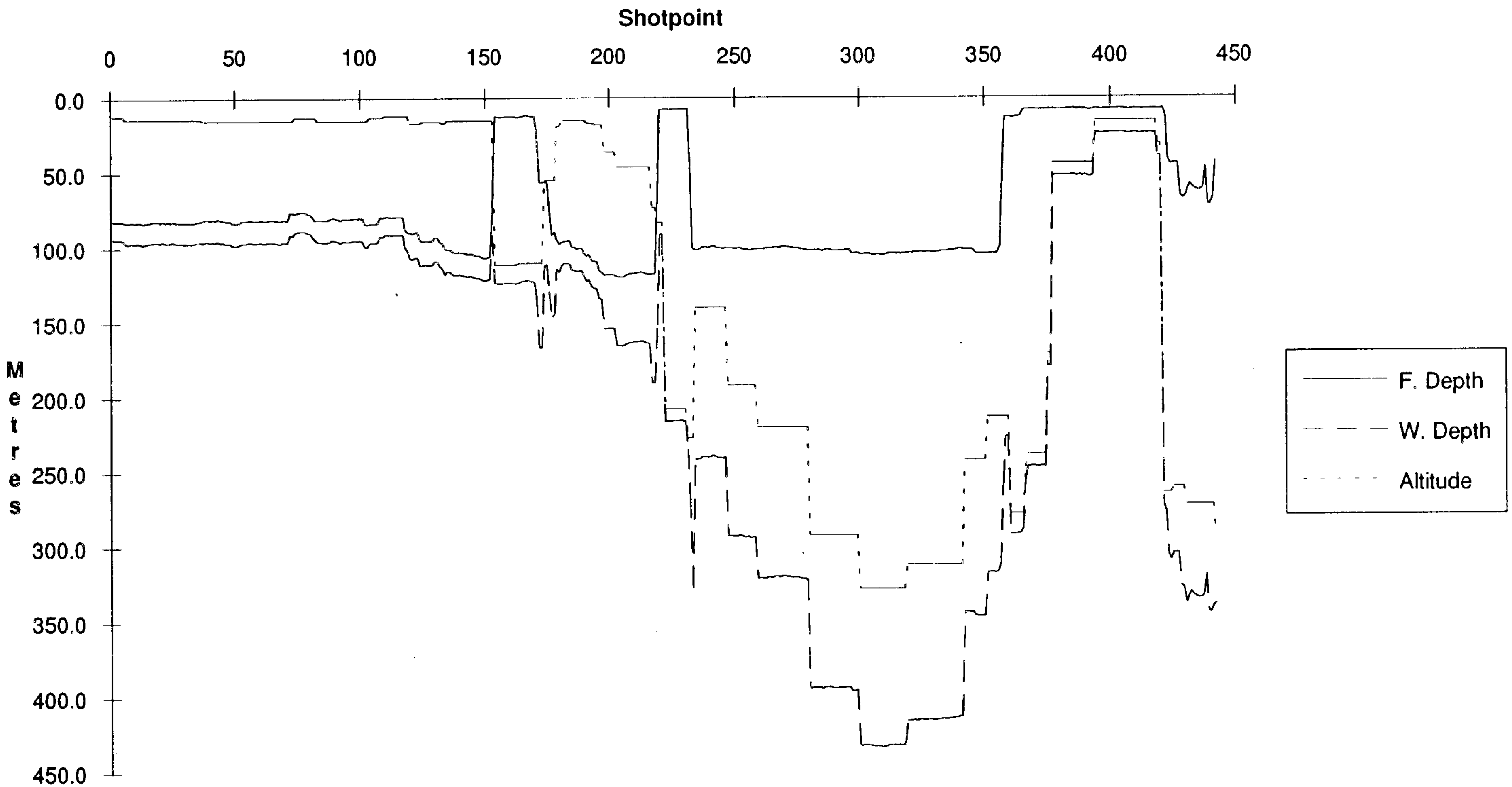


Line 97046 Methane, Ethane, Ethylene
ppm Hydrocarbons
10.00
1.00
0.10
0.01
0.00
0
50
100
150
200
250
300
350
400
450
Shotpoint
Methane
Ethane
Ethylene

Line 97046 Methane, Propane, Propylene



Line 97046 Depths, Altitude



Line Summary

Line Number	97047
No. of Shotpoints	422

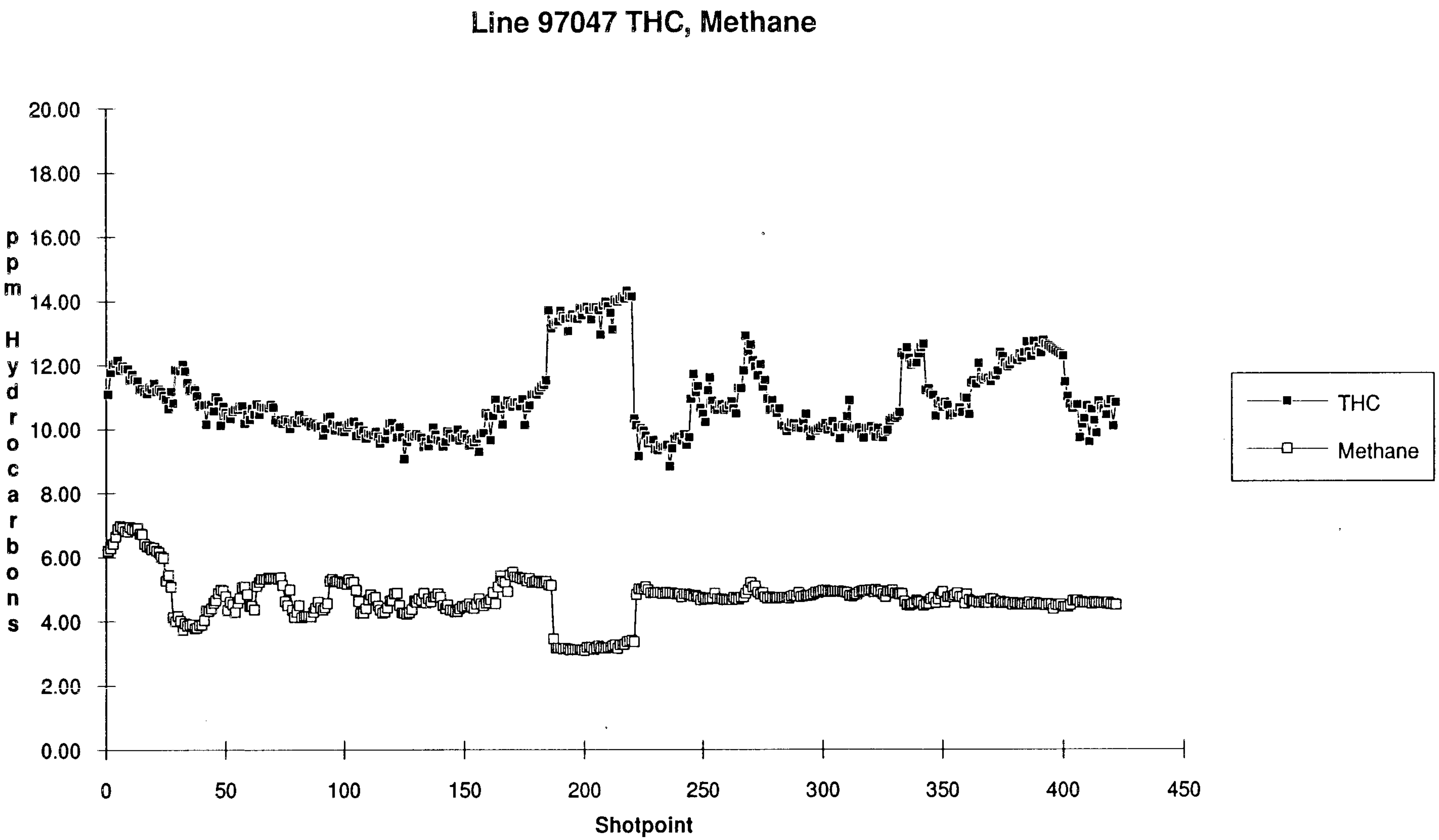
	Shotpoint	Date	Time	Latitude		Longitude	
Start	1	8-Nov-90	15:50:11	11	11.601	124	47.163
End	422	9-Nov-90	05:55:30	12	15.318	125	18.727

	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	10.899	4.675	0.017	0.123	0.016	0.035	0.019	0.002	0.001	0.076	0.001	0.000	1.189
Std. Dev.	1.181	0.690	0.003	0.047	0.005	0.029	0.025	0.008	0.005	0.043	0.007	0.003	0.726
Minimum	8.815	3.079	0.012	0.076	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.223
Maximum	14.272	6.957	0.037	0.280	0.034	0.140	0.119	0.075	0.044	0.233	0.099	0.043	4.822

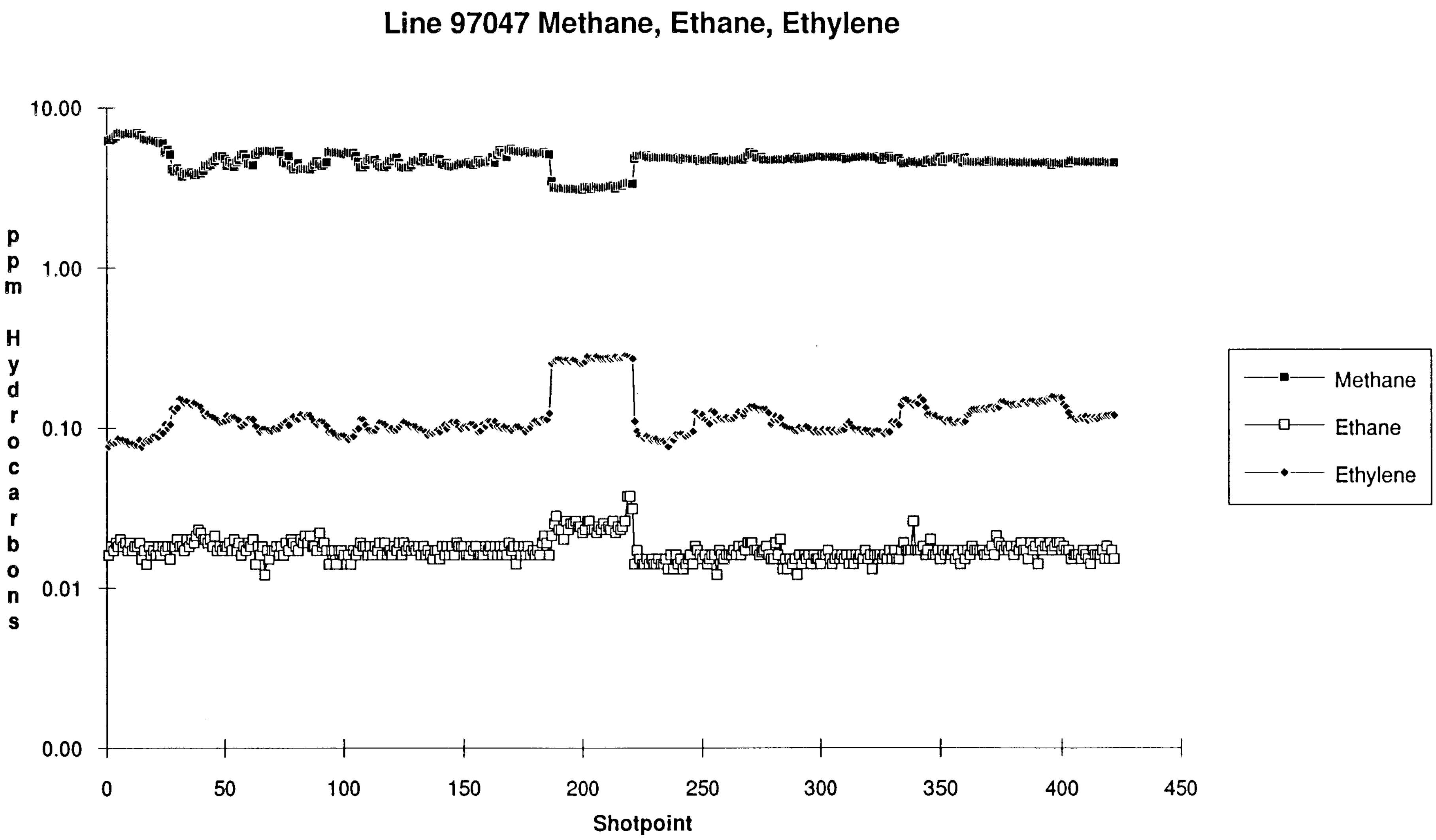
	Cond.	Temp.	F. Depth	W.Depth	Altitude
Mean	55.563	26.305	88.912	228.873	139.961
Std. Dev.	1.858	1.496	25.812	130.237	127.238
Minimum	52.730	23.900	8.262	85.114	9.000
Maximum	59.000	29.420	129.132	430.450	331.000

Notes

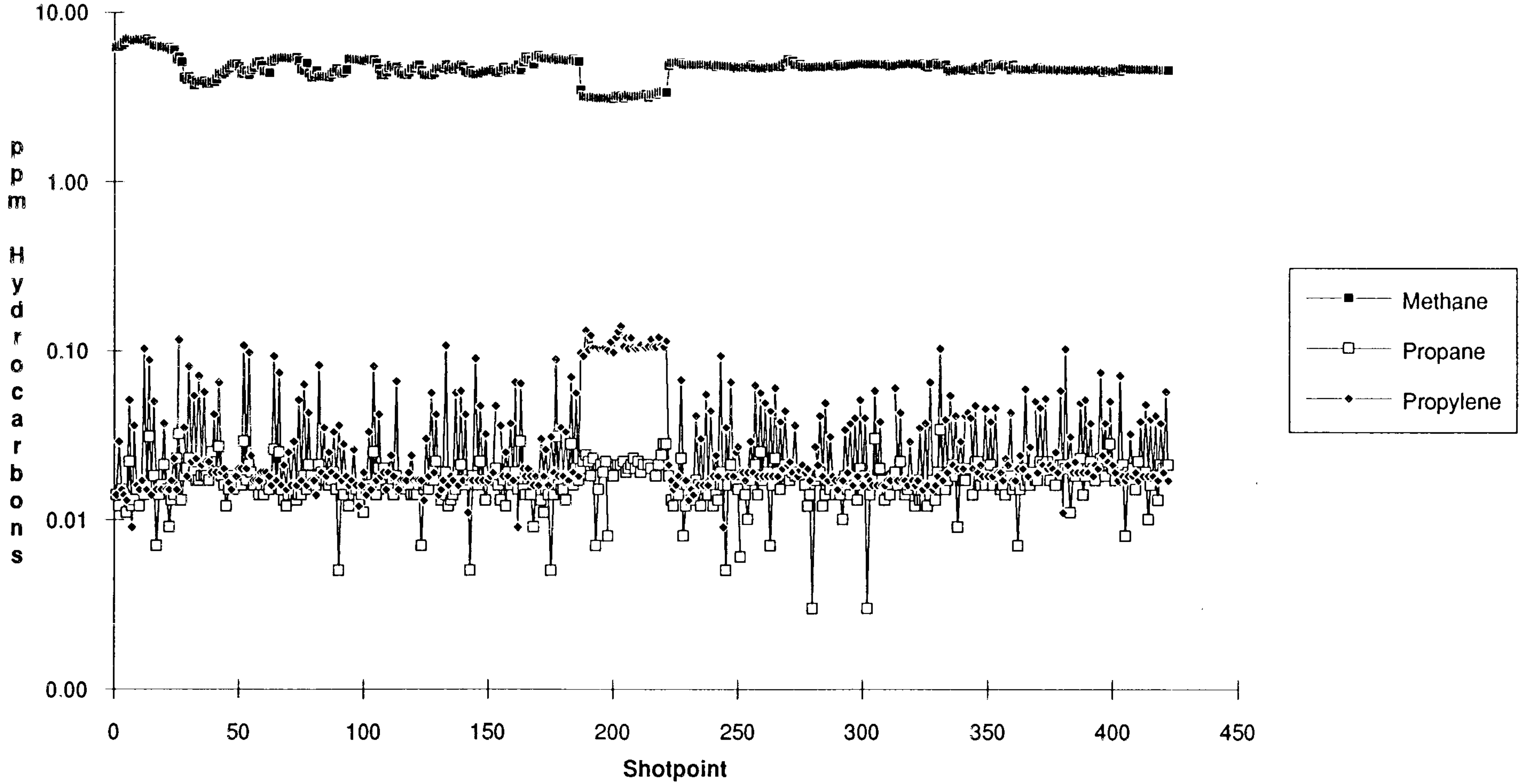
No anomalies. Erratic THC and methane values associated with rapid fluctuations in fish depth.

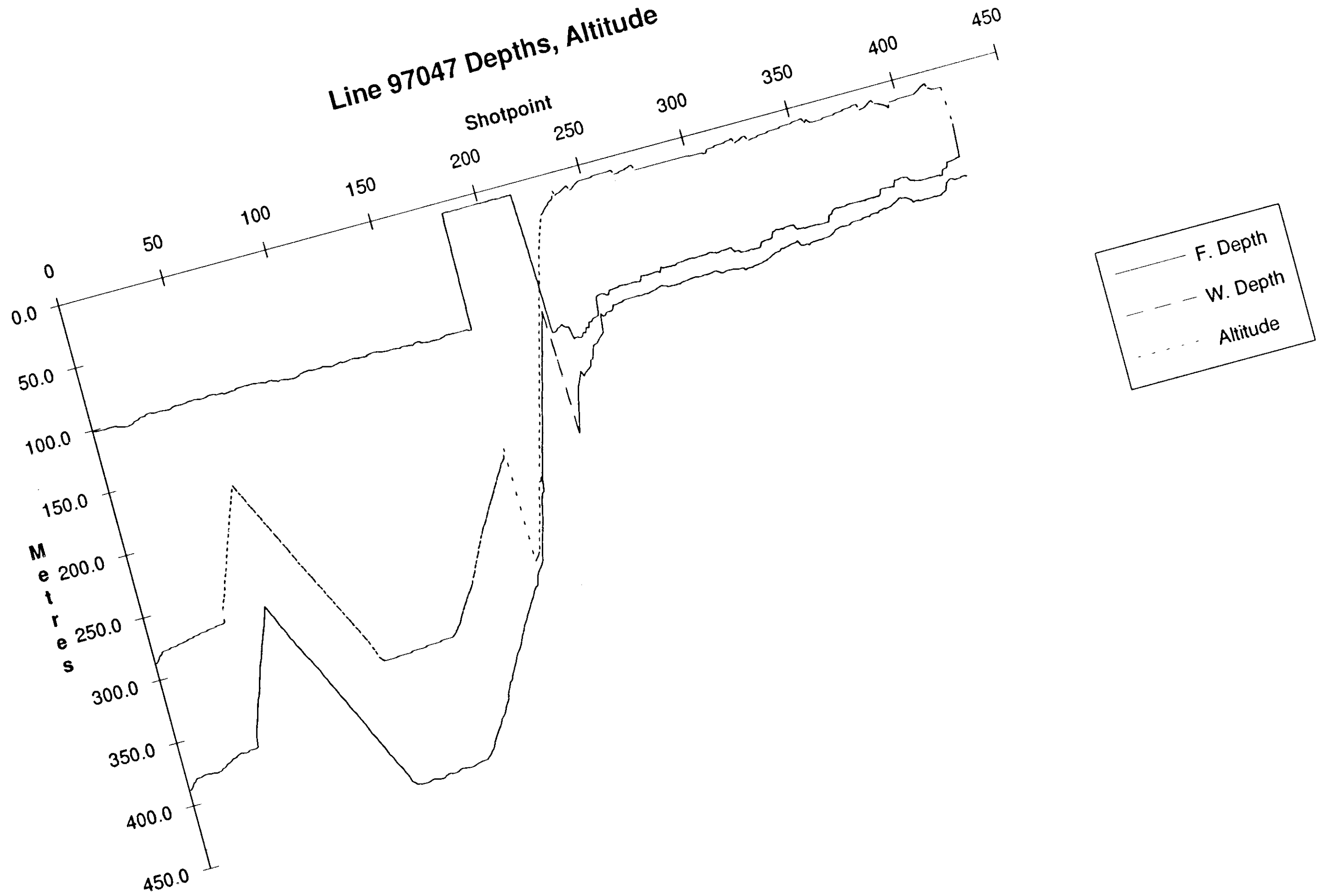


Line 97047 THC, Methane
20.00
18.00
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
ppm Hydrocarbons
0
50
100
150
200
250
300
350
400
450
Shotpoint
THC
Methane


Line 97047 Methane, Ethane, Ethylene
ppm Hydrocarbons
10.00
1.00
0.10
0.01
0.00
0
50
100
150
200
250
300
350
400
450
Shotpoint
Methane
Ethane
Ethylene

Line 97047 Methane, Propane, Propylene





Line 97047 Depths, Altitude
Shotpoint
0
50
100
150
200
250
300
350
400
450
0.0
50.0
100.0
150.0
200.0
250.0
300.0
350.0
400.0
450.0
Metres
F. Depth
W. Depth
Altitude

Line Summary

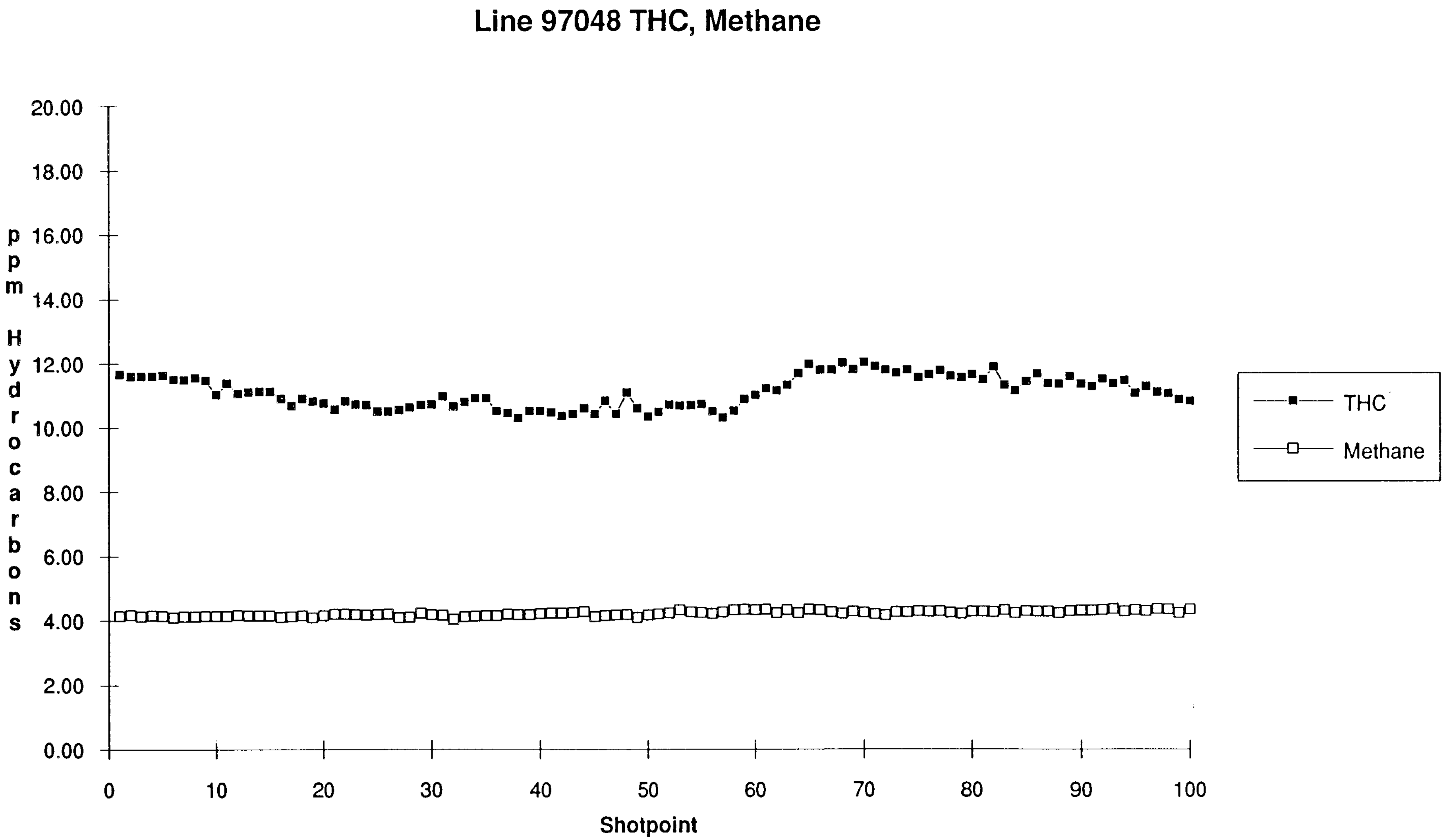
Line Number	97048
No. of Shotpoints	100

	Shotpoint	Date	Time	Latitude		Longitude	
Start	1	9-Nov-90	09:30:57	12	10.952	125	25.635
End	100	9-Nov-90	12:49:28	11	57.473	125	16.482

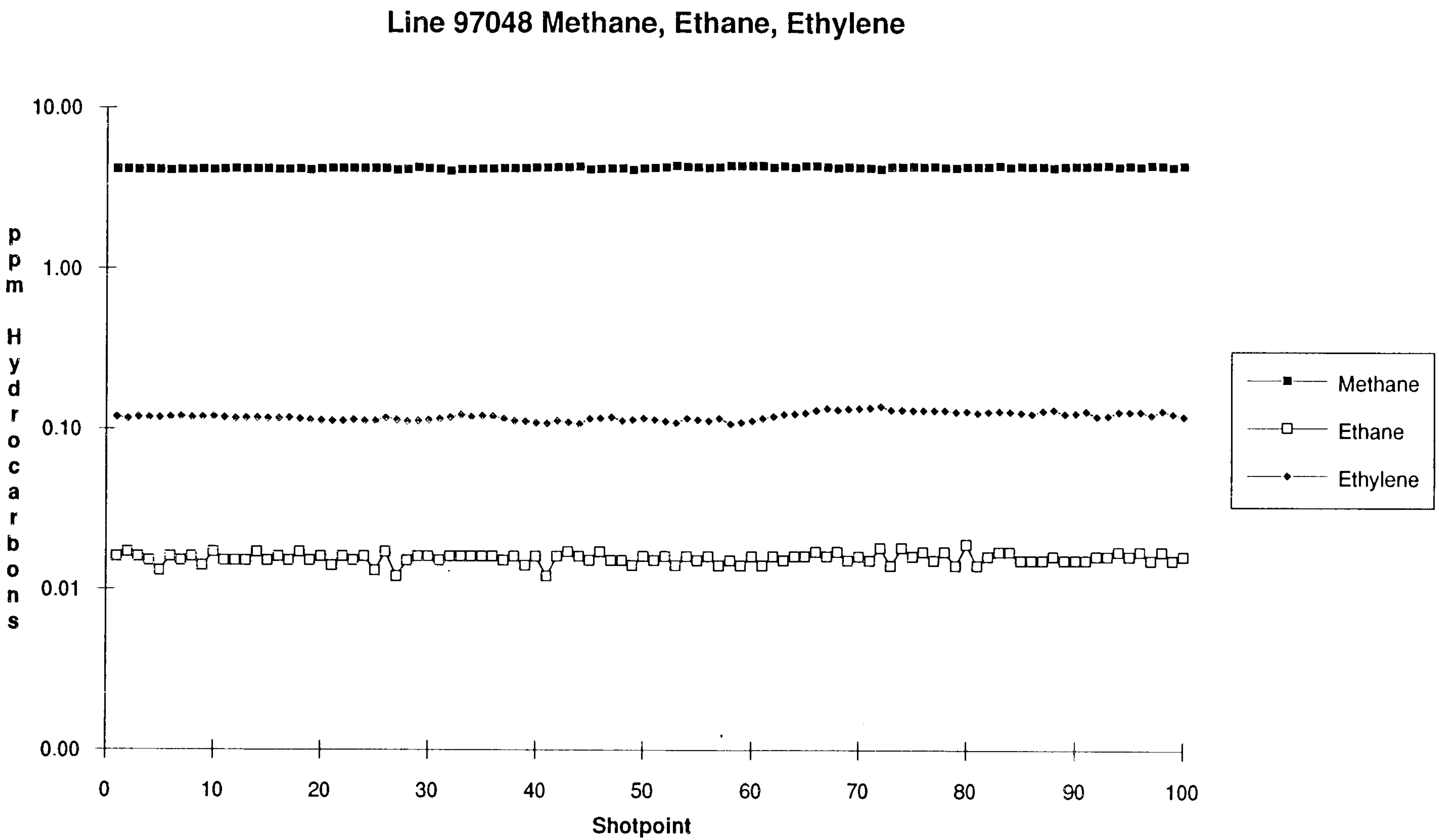
	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	11.103	4.214	0.016	0.120	0.017	0.027	0.014	0.000	0.002	0.109	0.067	0.000	1.105
Std. Dev.	0.487	0.078	0.001	0.008	0.006	0.017	0.022	0.000	0.009	0.037	0.038	0.000	0.556
Minimum	10.294	4.038	0.012	0.107	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.333
Maximum	12.036	4.357	0.019	0.138	0.032	0.078	0.071	0.000	0.048	0.205	0.197	0.000	2.511

	Cond.	Temp.	F. Depth	W.Depth	Altitude
Mean	55.452	25.882	77.257	93.337	16.080
Std. Dev.	0.183	0.197	3.252	3.511	1.674
Minimum	55.100	25.420	70.074	86.074	12.000
Maximum	55.780	26.420	83.232	100.232	21.000

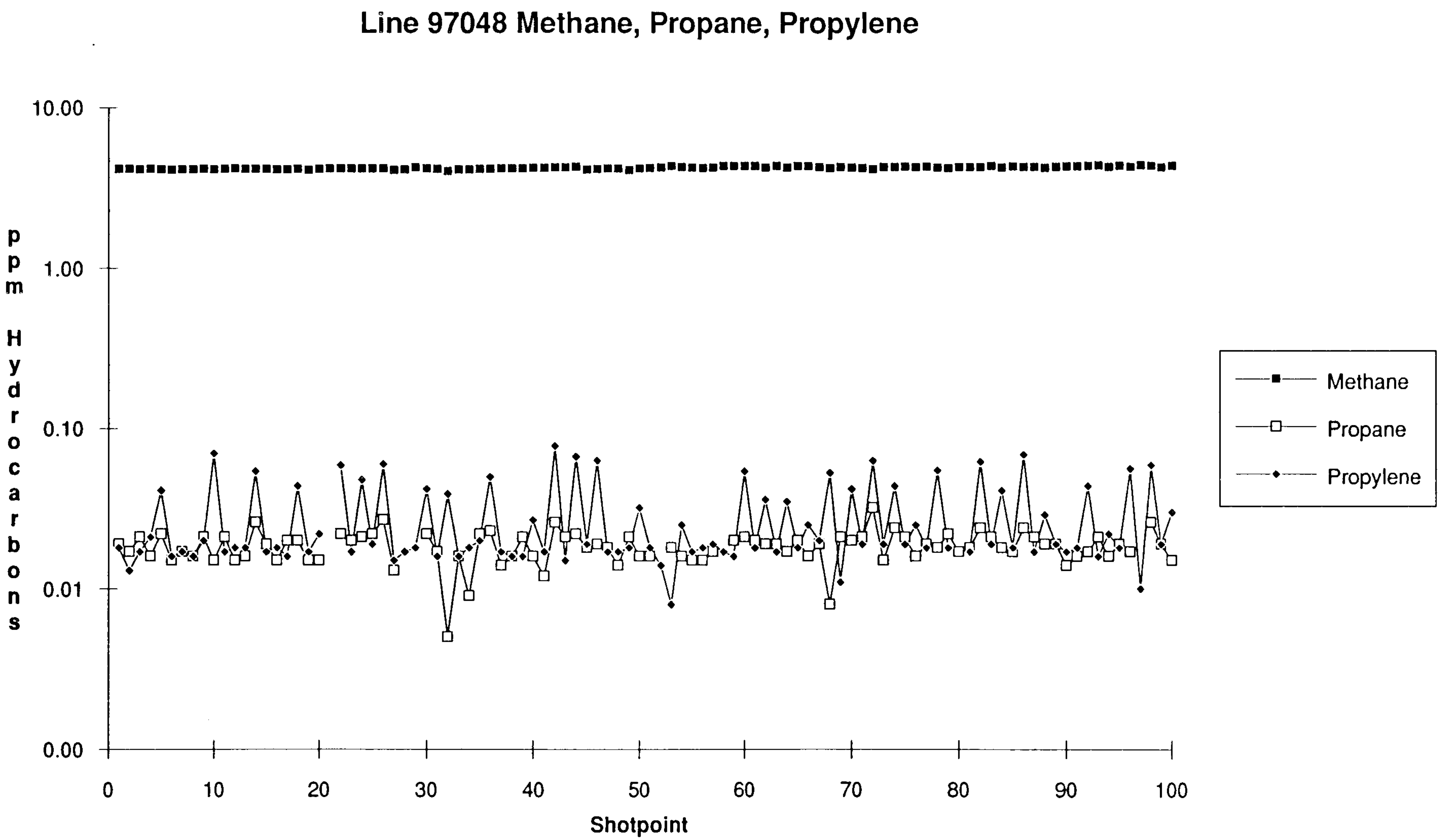
Notes No anomalies



Line 97048 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

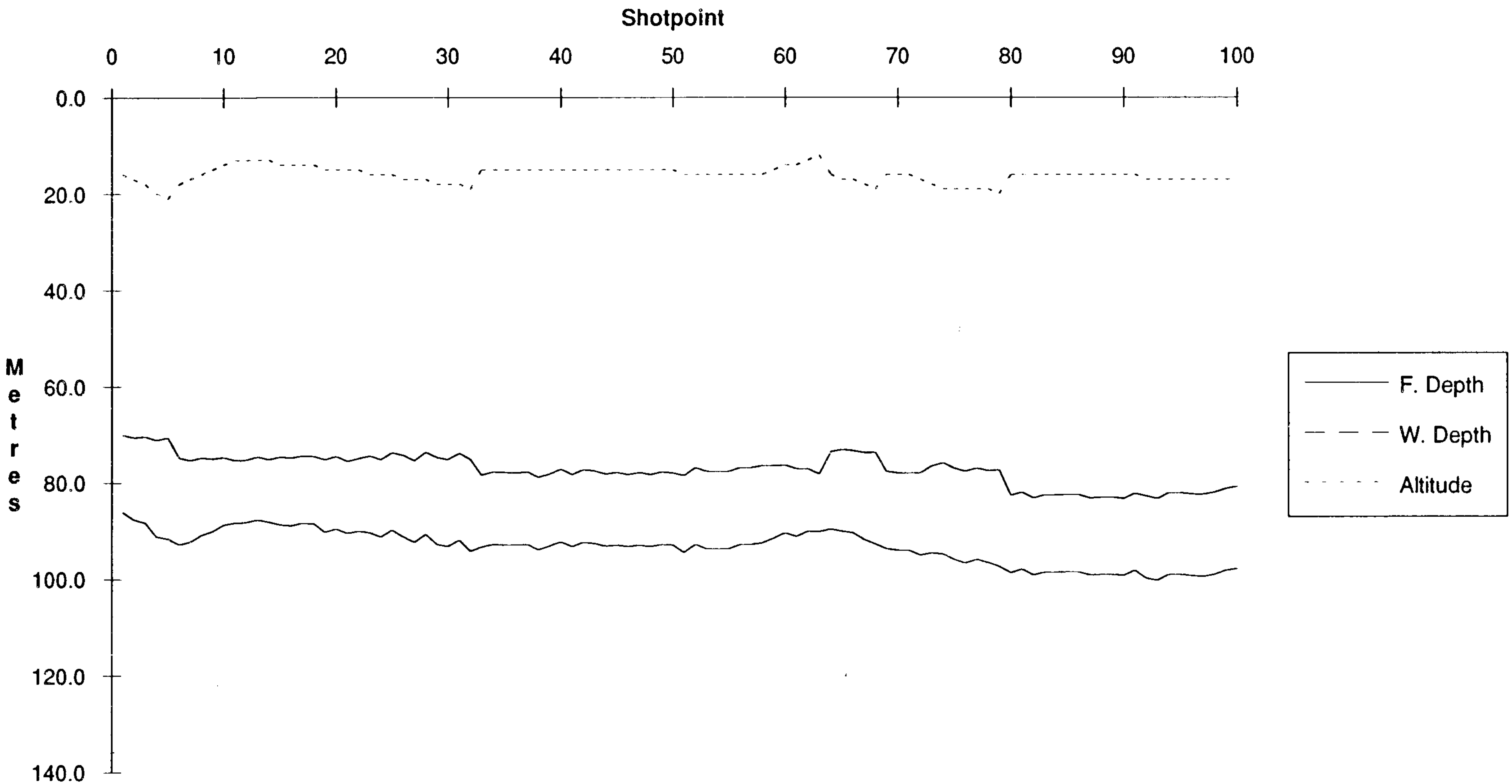


Line 97048 Methane, Ethane, Ethylene
ppm Hydrocarbons
10.00
1.00
0.10
0.01
0.00
0
10
20
30
40
50
60
70
80
90
100
Shotpoint
Methane
Ethane
Ethylene



Line 97048 Methane, Propane, Propylene
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 97048 Depths, Altitude



Line Summary

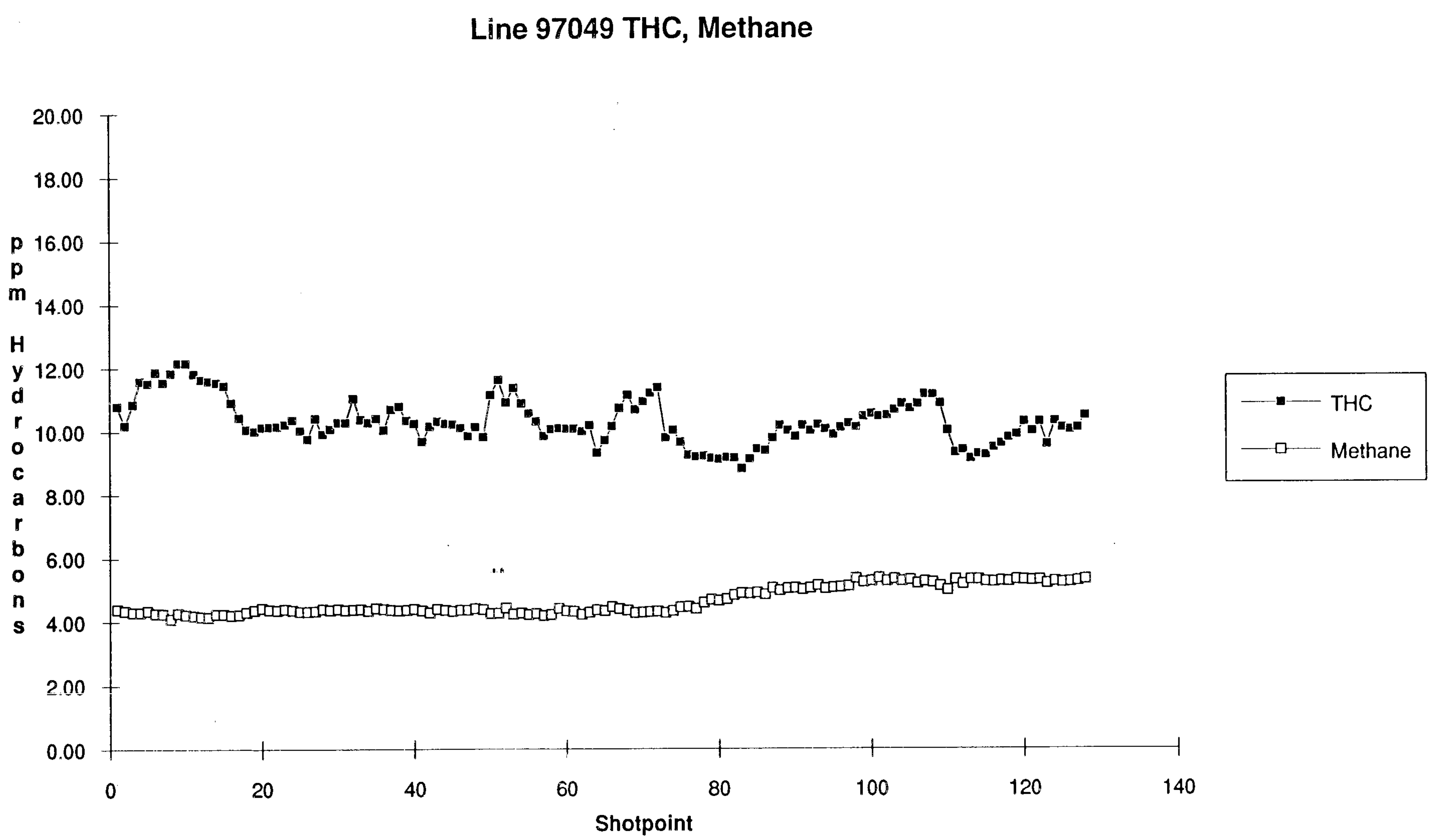
Line Number	97049
No. of Shotpoints	128

	Shotpoint	Date	Time	Latitude		Longitude	
Start	1	9-Nov-90	14:37:37	12	02.916	125	18.349
End	128	9-Nov-90	18:51:54	11	41.062	125	17.668

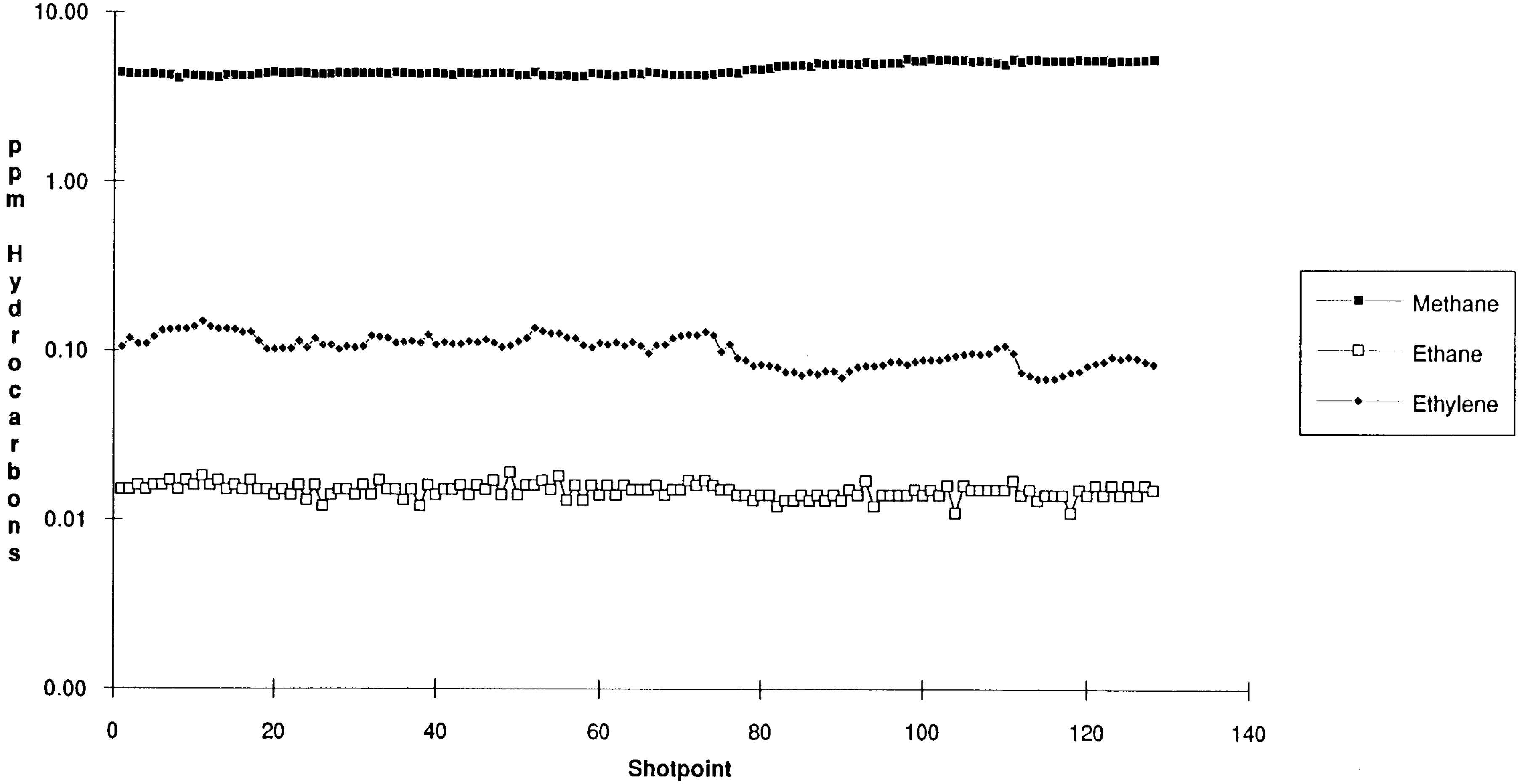
	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	10.283	4.632	0.015	0.103	0.016	0.026	0.017	0.000	0.000	0.065	0.033	0.000	1.015
Std. Dev.	0.716	0.417	0.001	0.019	0.005	0.017	0.022	0.000	0.000	0.037	0.030	0.000	0.544
Minimum	8.800	4.092	0.011	0.069	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.267
Maximum	12.147	5.342	0.019	0.149	0.034	0.084	0.083	0.000	0.000	0.203	0.191	0.000	2.669

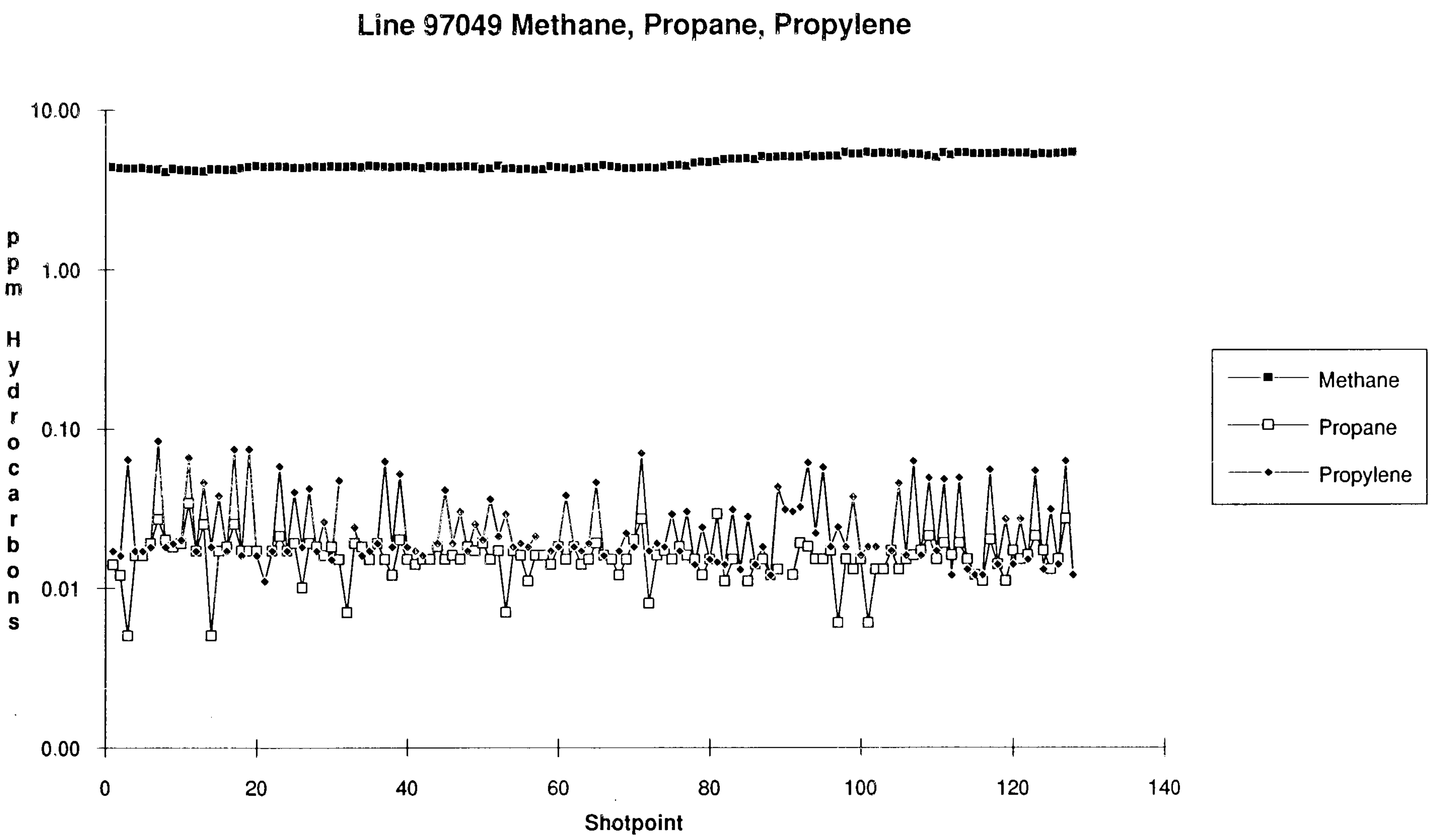
	Cond.	Temp.	F. Depth	W.Depth	Altitude
Mean	54.342	24.878	90.679	105.390	14.711
Std. Dev.	0.775	0.656	7.147	6.434	1.712
Minimum	52.920	23.620	75.786	93.500	8.000
Maximum	55.660	26.230	101.082	114.756	19.000

Notes: No anomalies. Methane increases slightly towards the end of line.

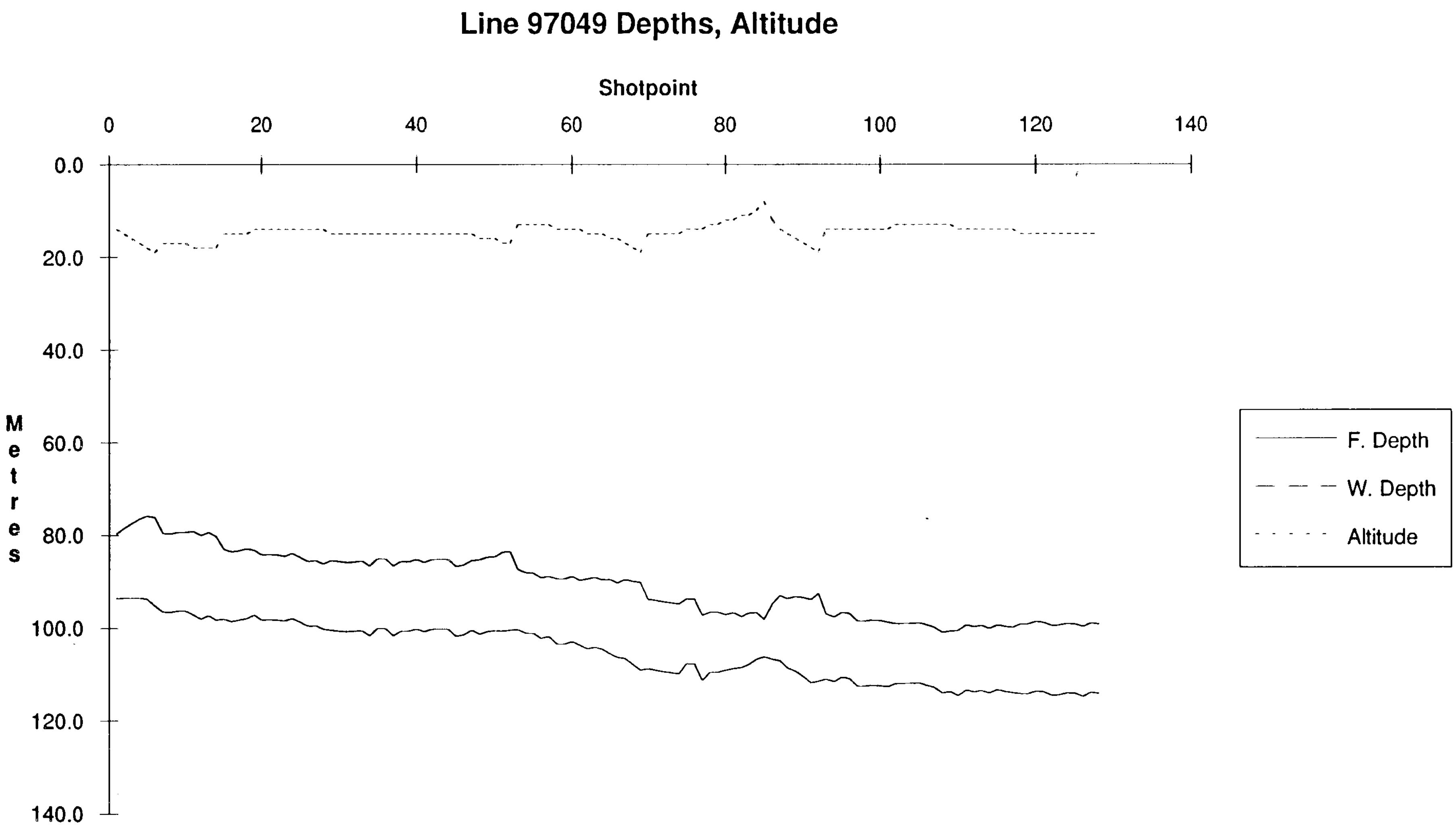

Line 97049 THC, Methane
ppm Hydrocarbons
20.00
18.00
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
0
20
40
60
80
100
120
140
Shotpoint
THC
Methane

Line 97049 Methane, Ethane, Ethylene





Line 97049 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 97049 Depths, Altitude
Shotpoint
0
20
40
60
80
100
120
140
0.0
20.0
40.0
60.0
80.0
100.0
120.0
140.0
Metres
F. Depth
W. Depth
Altitude

Line Summary

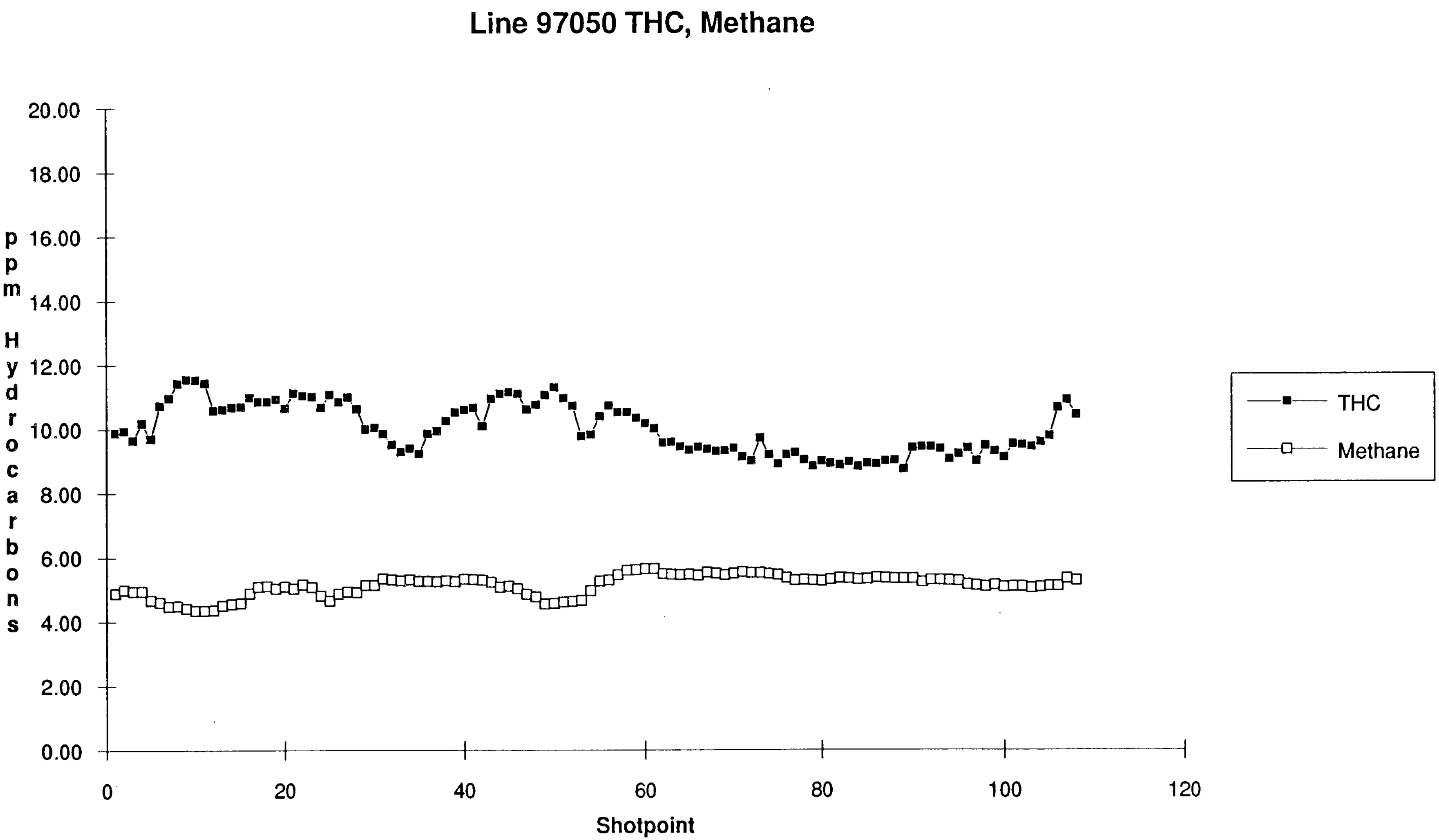
Line Number	97050
No. of Shotpoints	108

	Shotpoint	Date	Time	Latitude		Longitude	
Start	1	9-Nov-90	21:34:11	11	46.331	125	19.691
End	108	10-Nov-90	01:08:54	11	33.162	125	07.140

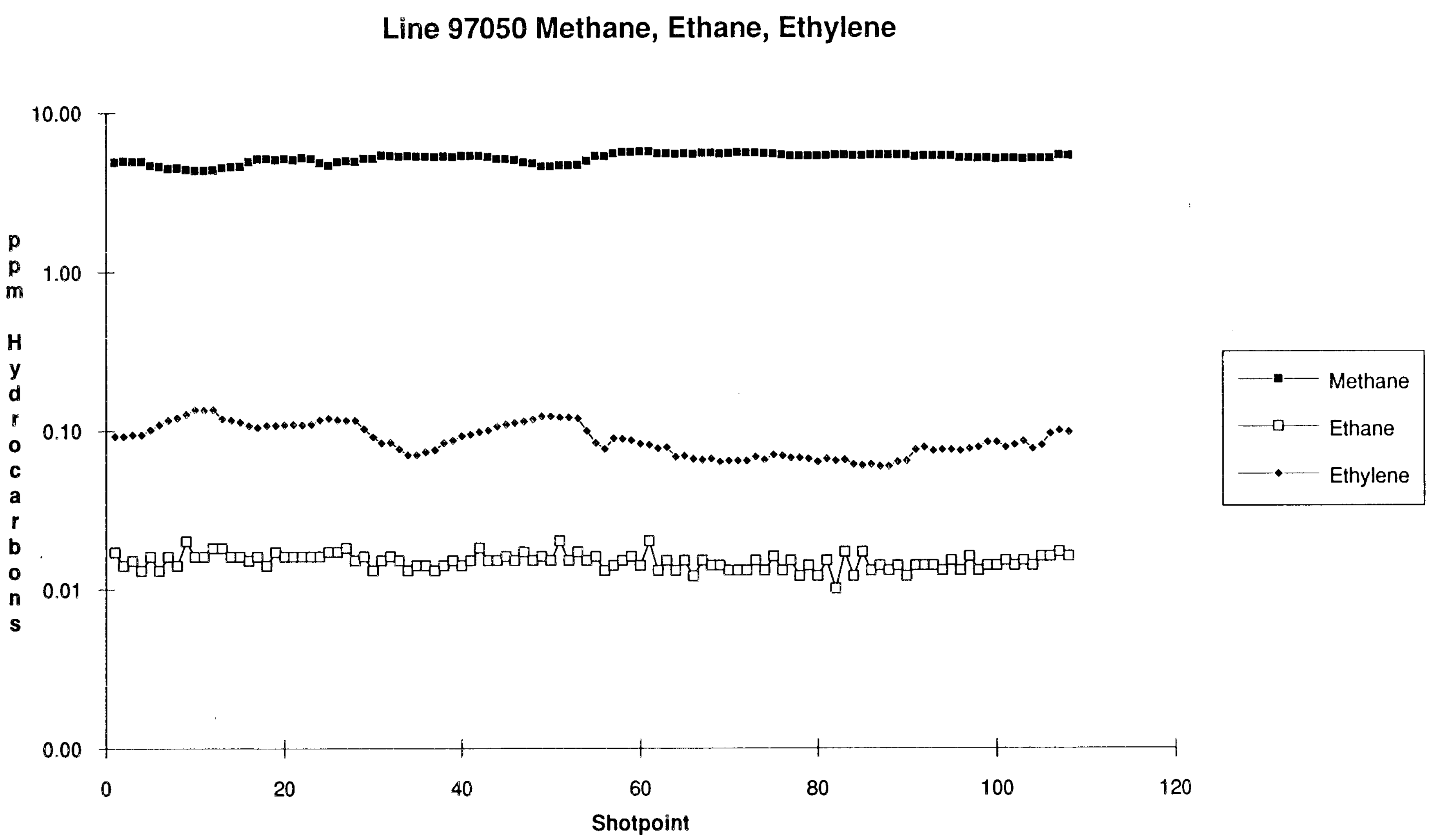
	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	10.005	5.119	0.015	0.089	0.015	0.027	0.020	0.000	0.000	0.056	0.038	0.000	0.962
Std. Dev.	0.794	0.321	0.002	0.021	0.005	0.018	0.024	0.000	0.000	0.030	0.030	0.000	0.519
Minimum	8.740	4.337	0.010	0.059	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.226
Maximum	11.549	5.632	0.020	0.136	0.031	0.070	0.073	0.000	0.000	0.144	0.181	0.000	2.381

	Cond.	Temp.	F Depth	W.Depth	Altitude
Mean	54.535	25.028	104.728	161.432	56.704
Std. Dev.	0.590	0.521	7.336	61.907	56.830
Minimum	53.710	24.120	91.494	105.494	12.000
Maximum	55.860	26.260	114.750	311.936	203.000

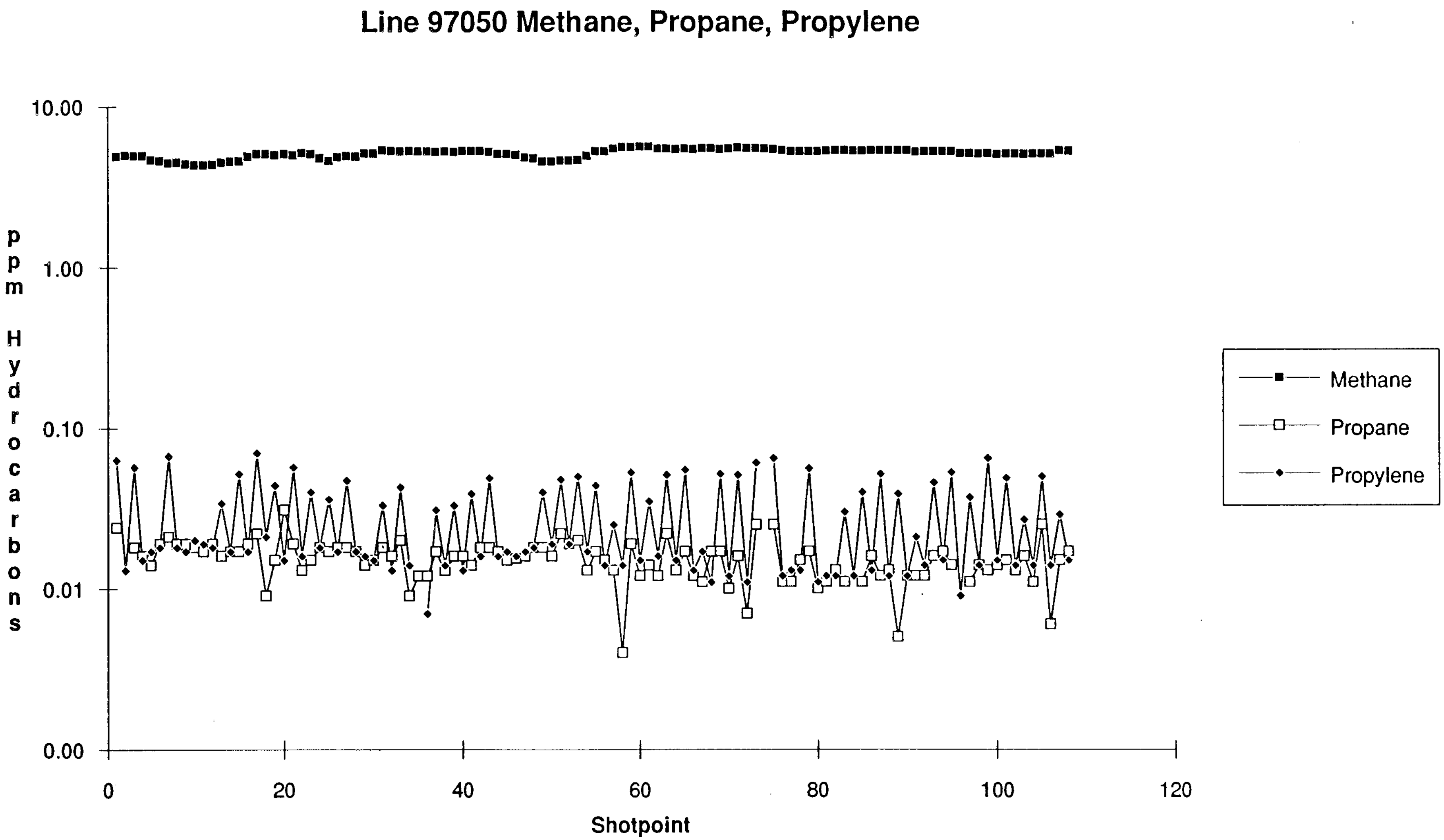
Notes No anomalies.



Line 97050 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
20
40
60
80
100
120
Shotpoint
THC
Methane

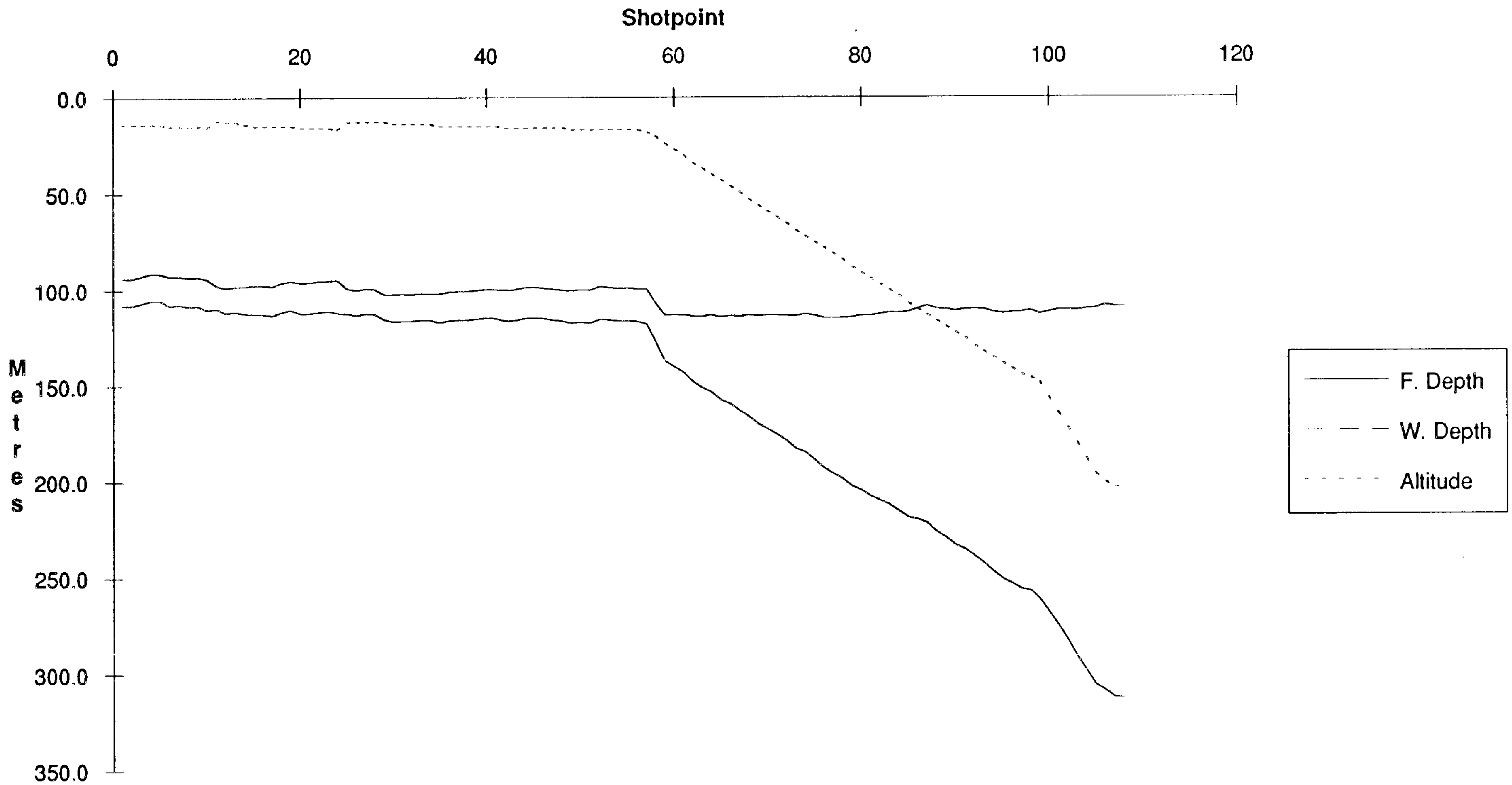


Line 97050 Methane, Ethane, Ethylene
10.00
1.00
0.10
0.01
0.00
ppm Hydrocarbons
0
20
40
60
80
100
120
Shotpoint
Methane
Ethane
Ethylene



Line 97050 Methane, Propane, Propylene
10.00
1.00
0.10
0.01
0.00
ppm Hydrocarbons
0
20
40
60
80
100
120
Shotpoint
Methane
Propane
Propylene

Line 97050 Depths, Altitude



Line Summary

Line Number	97051
No. of Shotpoints	207

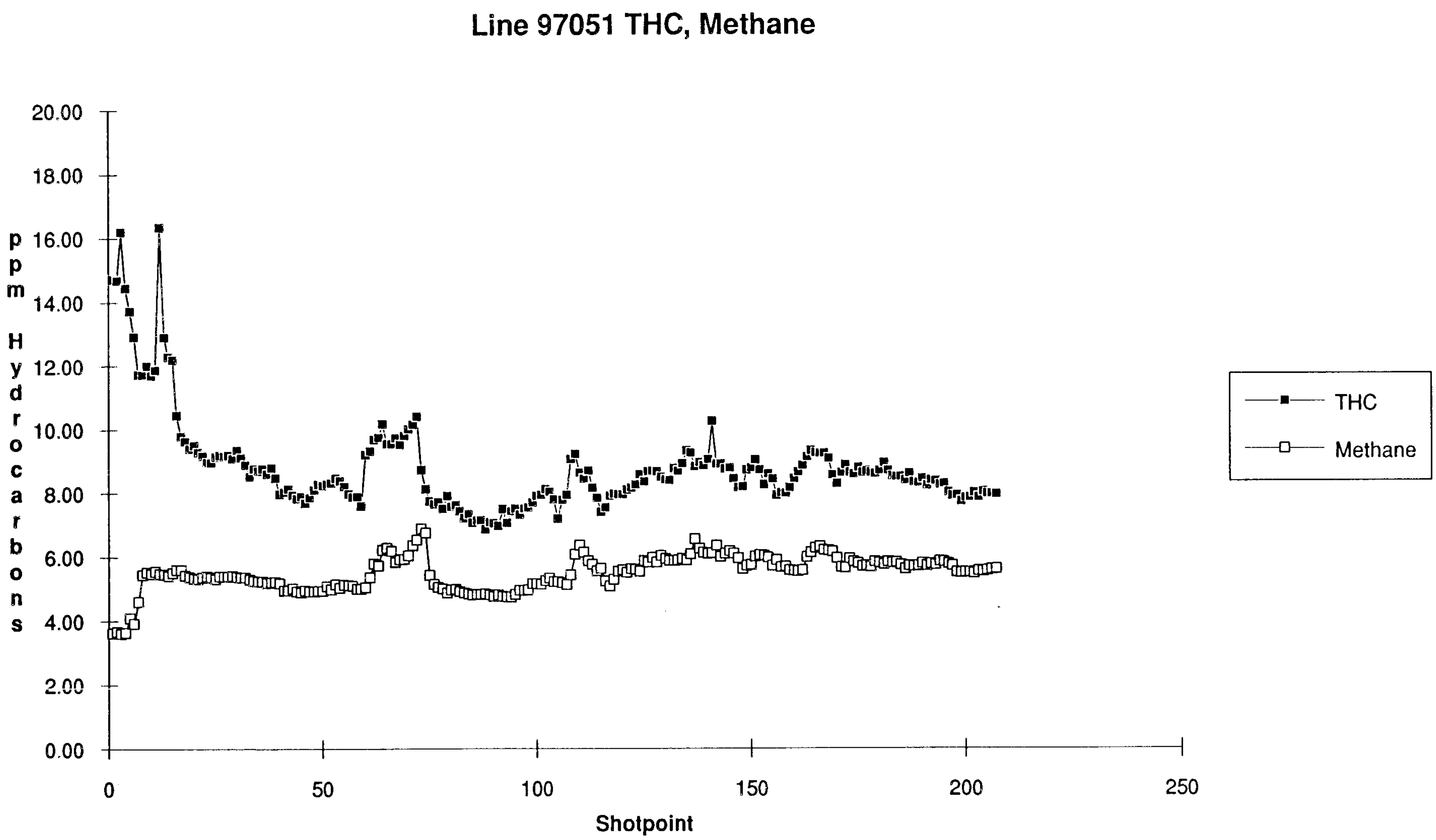
	Shotpoint	Date	Time	Latitude		Longitude	
Start	1	10-Nov-90	03:49:33	11	36.917	125	09.375
End	207	10-Nov-90	10:41:36	11	04.620	124	55.799

	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	8.779	5.472	0.013	0.055	0.013	0.022	0.017	0.000	0.002	0.049	0.013	0.000	0.786
Std. Dev.	1.500	0.534	0.002	0.043	0.008	0.021	0.022	0.002	0.025	0.042	0.046	0.003	0.458
Minimum	6.855	3.599	0.007	0.031	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.198
Maximum	16.333	6.870	0.019	0.307	0.107	0.118	0.076	0.032	0.362	0.393	0.575	0.033	3.151

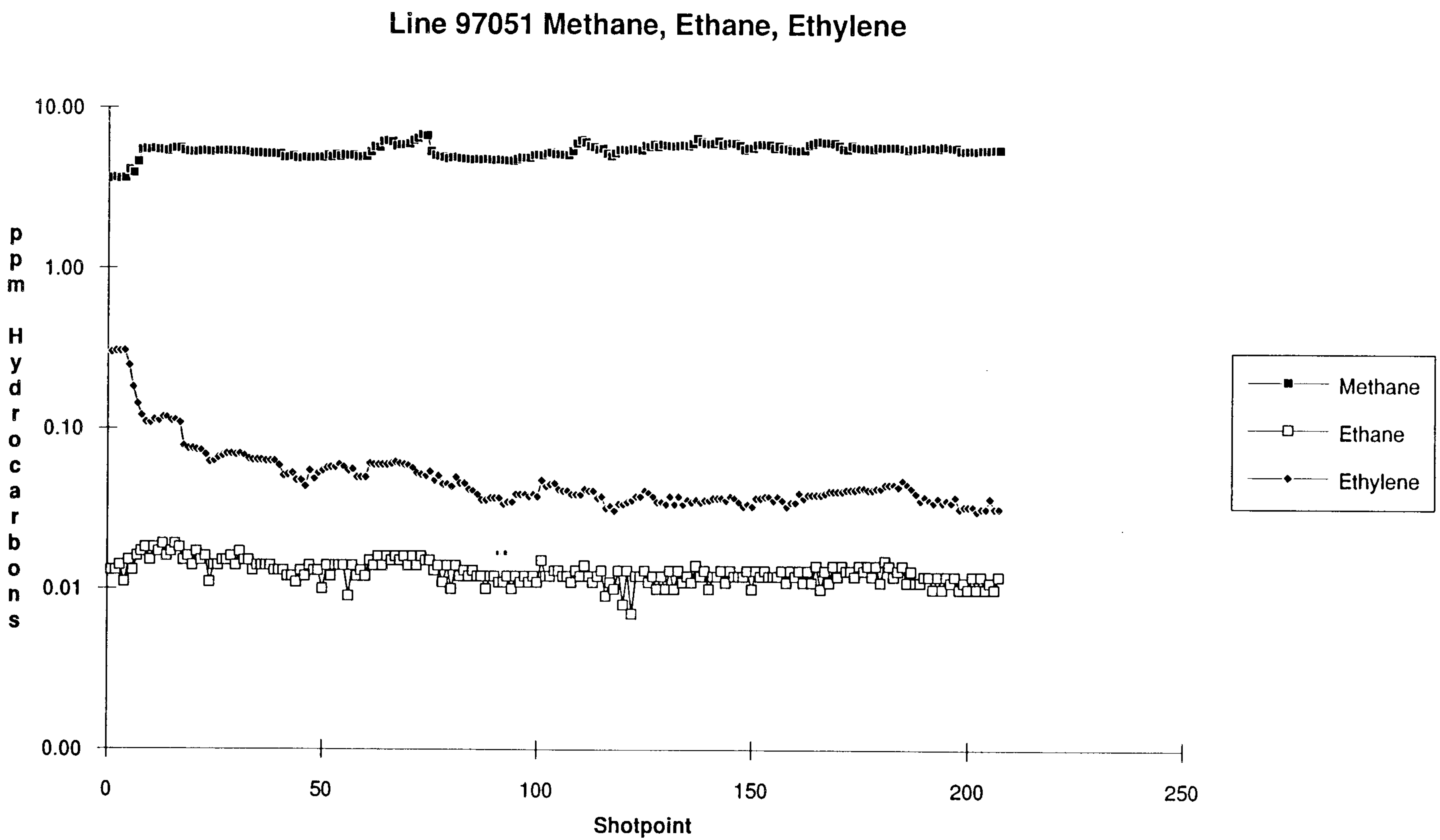
	Cond.	Temp.	F. Depth	W.Depth	Altitude
Mean	53.195	23.791	146.458	401.738	255.280
Std. Dev.	1.686	1.528	16.784	84.008	69.555
Minimum	50.960	21.580	54.978	210.022	112.000
Maximum	60.400	29.820	171.666	508.666	337.000

Notes

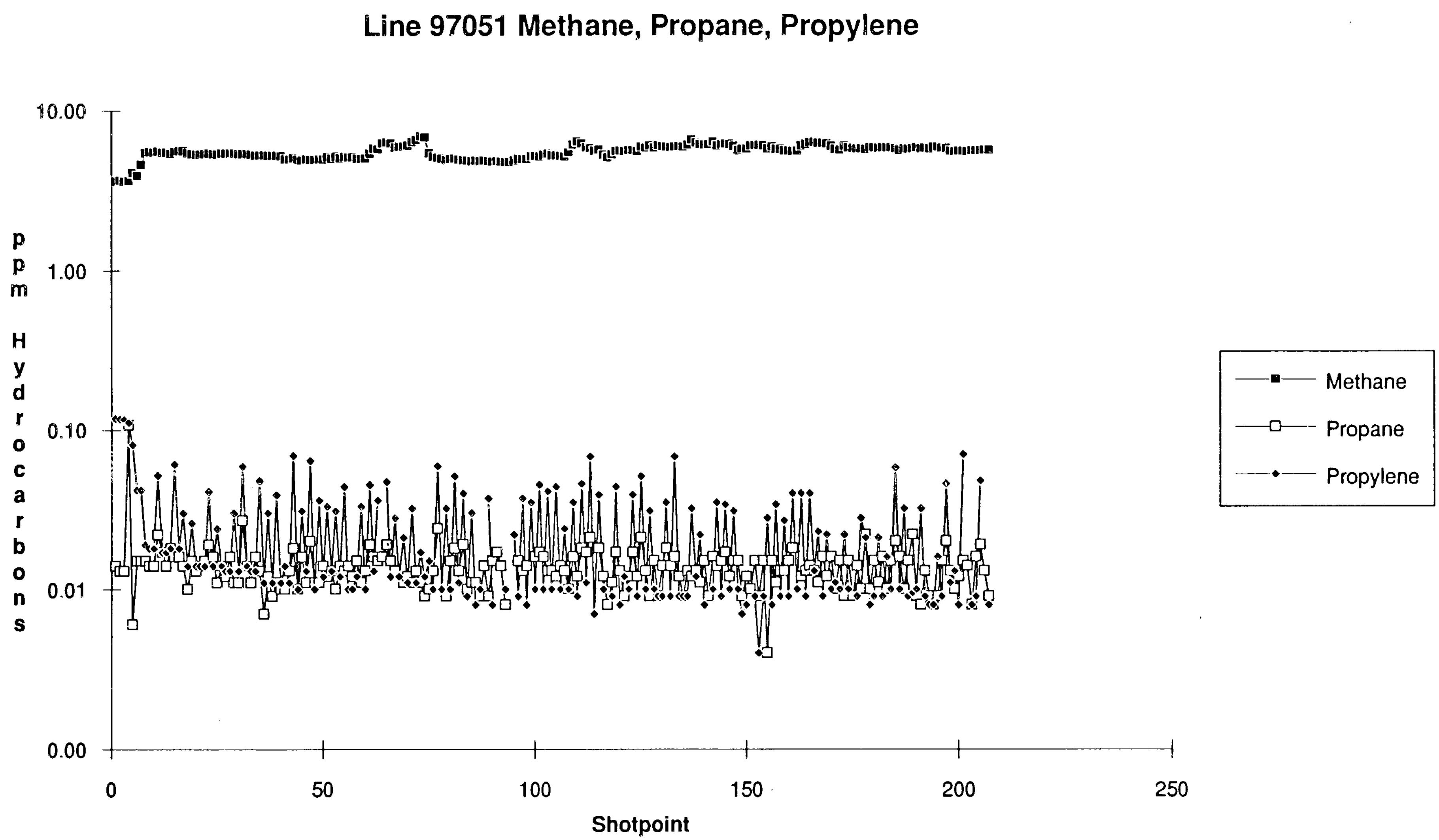
No anomalies Erratic THC and methane values, associated with fluctuations in fish depth



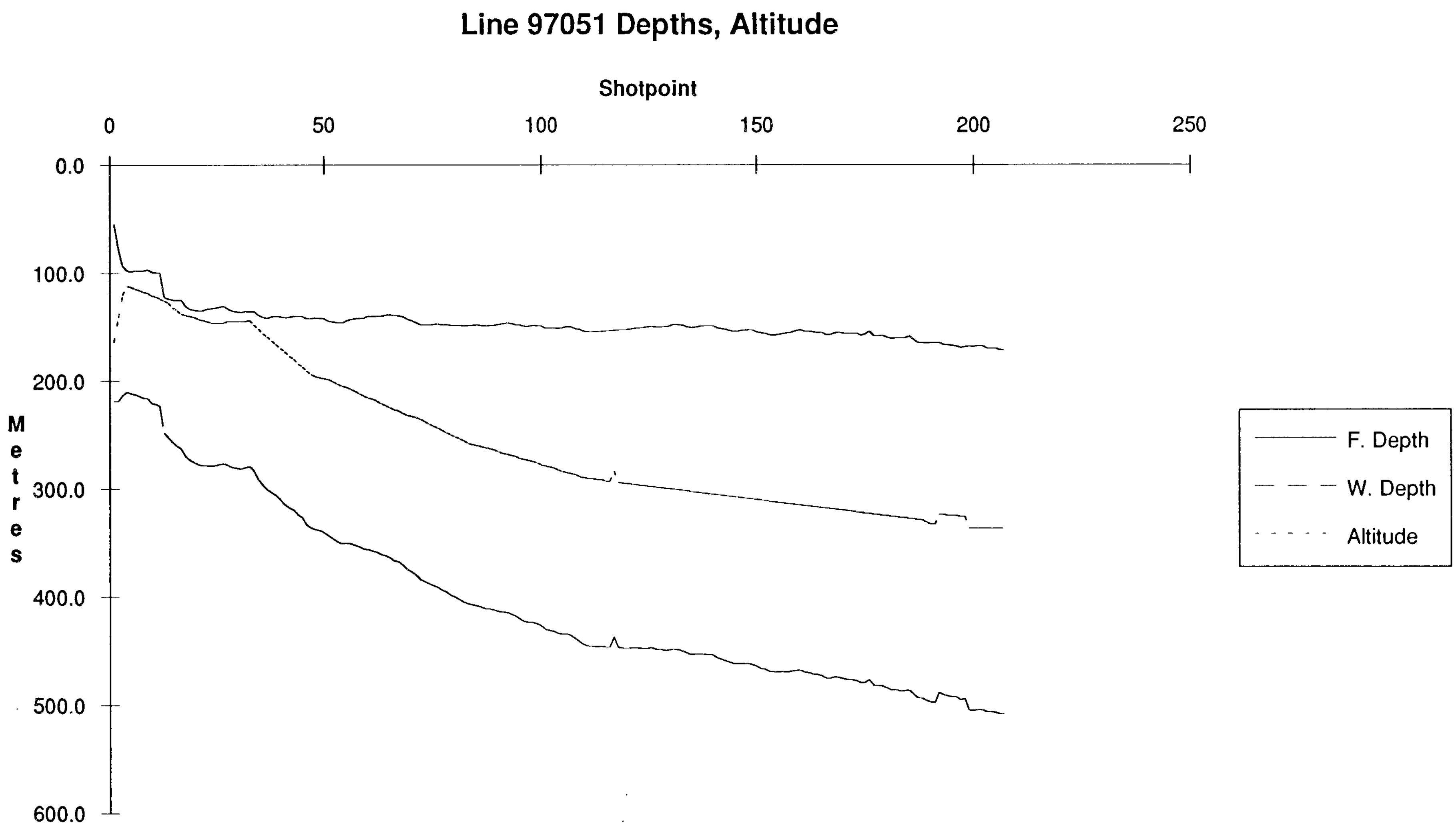
Line 97051 THC, Methane
20.00
18.00
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
ppm Hydrocarbons
0
50
100
150
200
250
Shotpoint
THC
Methane



Line 97051 Methane, Ethane, Ethylene
10.00
1.00
0.10
0.01
0.00
ppm Hydrocarbons
0
50
100
150
200
250
Shotpoint
Methane
Ethane
Ethylene



Line 97051 Methane, Propane, Propylene
ppm Hydrocarbons
10.00
1.00
0.10
0.01
0.00
0
50
100
150
200
250
Shotpoint
Methane
Propane
Propylene



Line 97051 Depths, Altitude
Shotpoint
0
50
100
150
200
250
0.0
100.0
200.0
300.0
400.0
500.0
600.0
Metres
F. Depth
W. Depth
Altitude

Line Summary

Line Number	97052
No. of Shotpoints	125

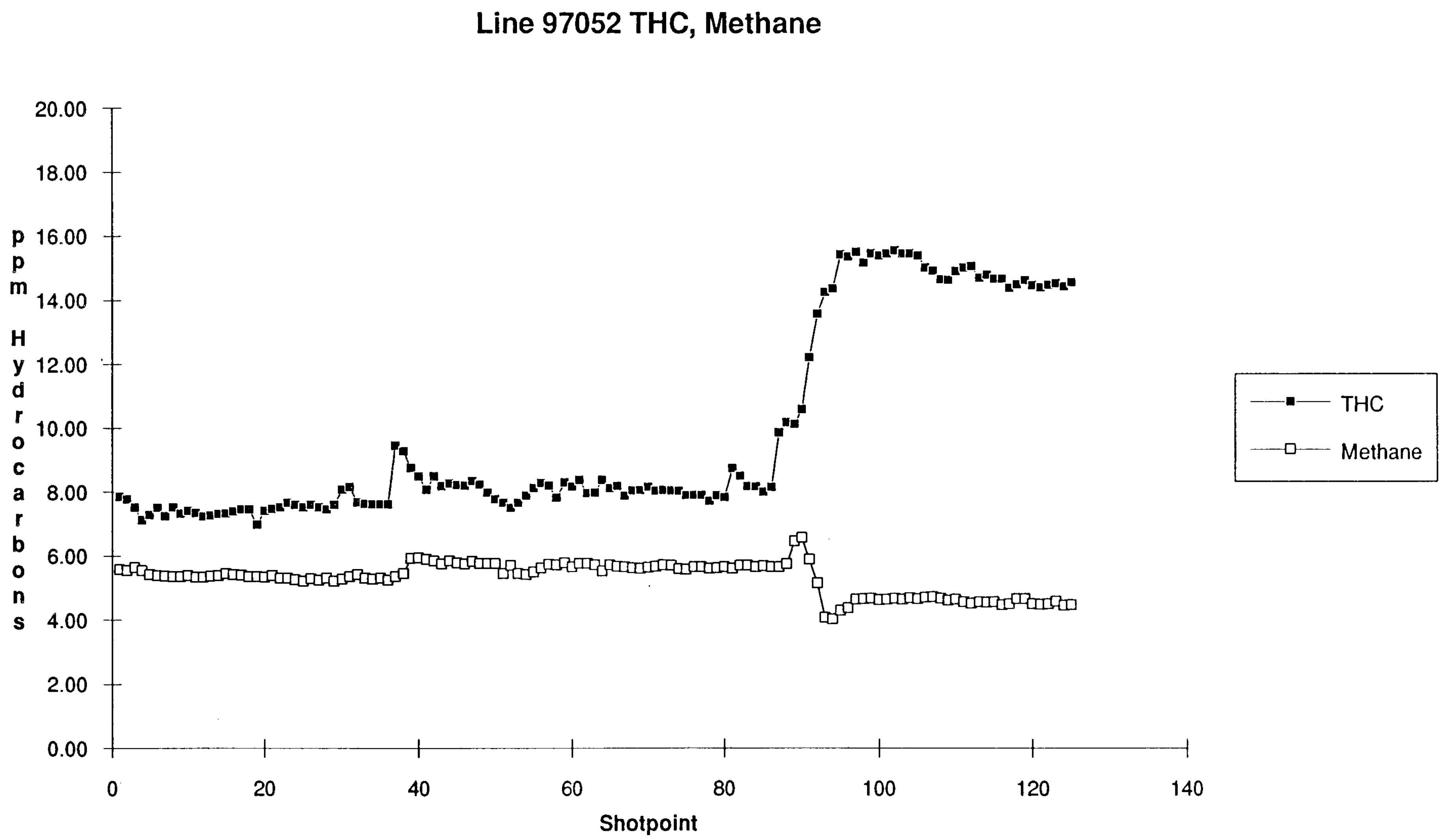
	Shotpoint	Date	Time	Latitude		Longitude	
Start	4	10-Nov-90	11:47:41	11	03.954	125	00.353
End	129	10-Nov-90	16:19:25	11	12.397	125	21.920

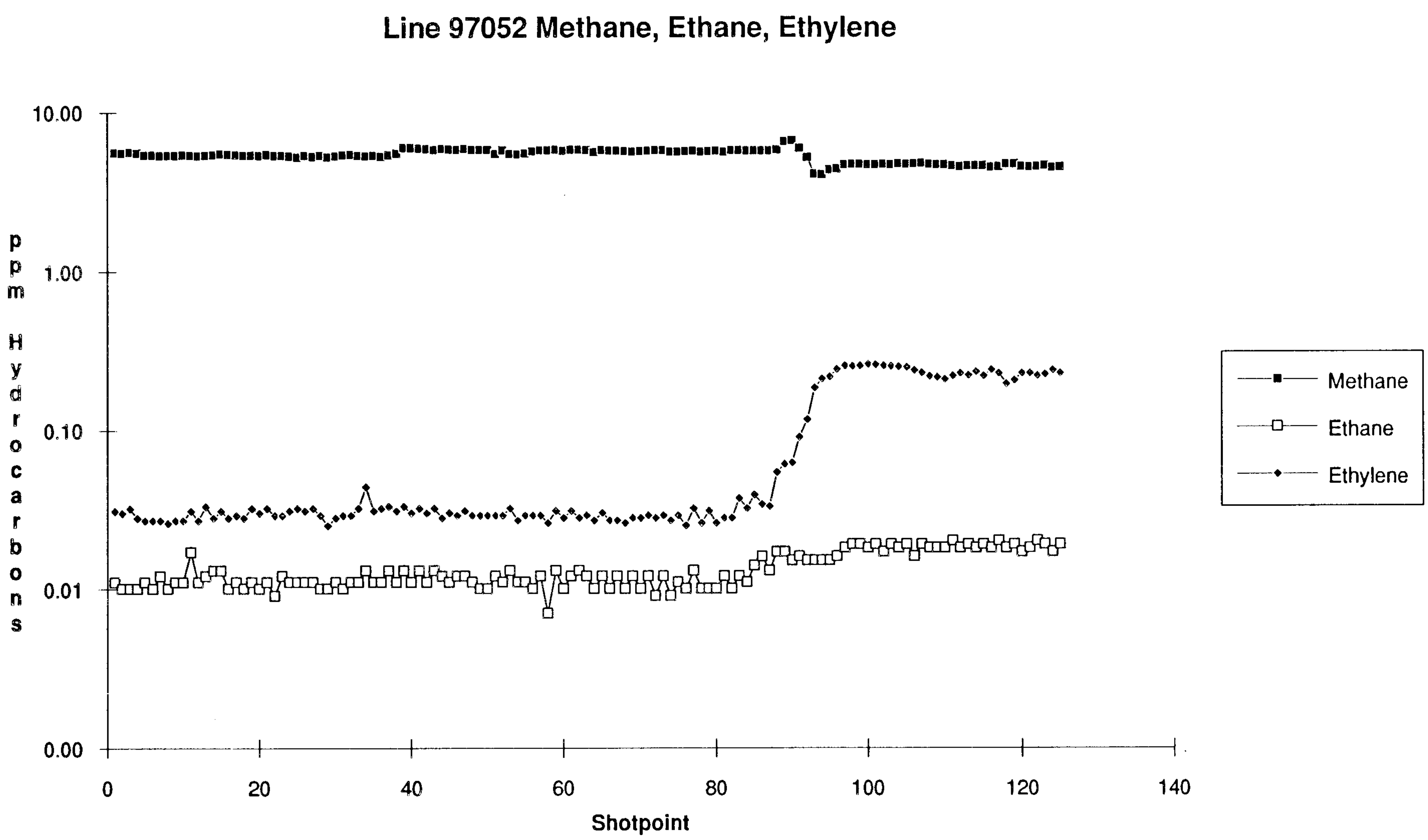
	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	9.880	5.294	0.013	0.084	0.014	0.029	0.015	0.000	0.000	0.075	0.012	0.000	0.806
Std. Dev.	3.132	0.504	0.003	0.089	0.005	0.023	0.021	0.000	0.000	0.059	0.028	0.000	0.465
Minimum	6.983	4.021	0.007	0.025	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.184
Maximum	15.539	6.570	0.020	0.258	0.033	0.093	0.064	0.000	0.000	0.232	0.155	0.000	2.186

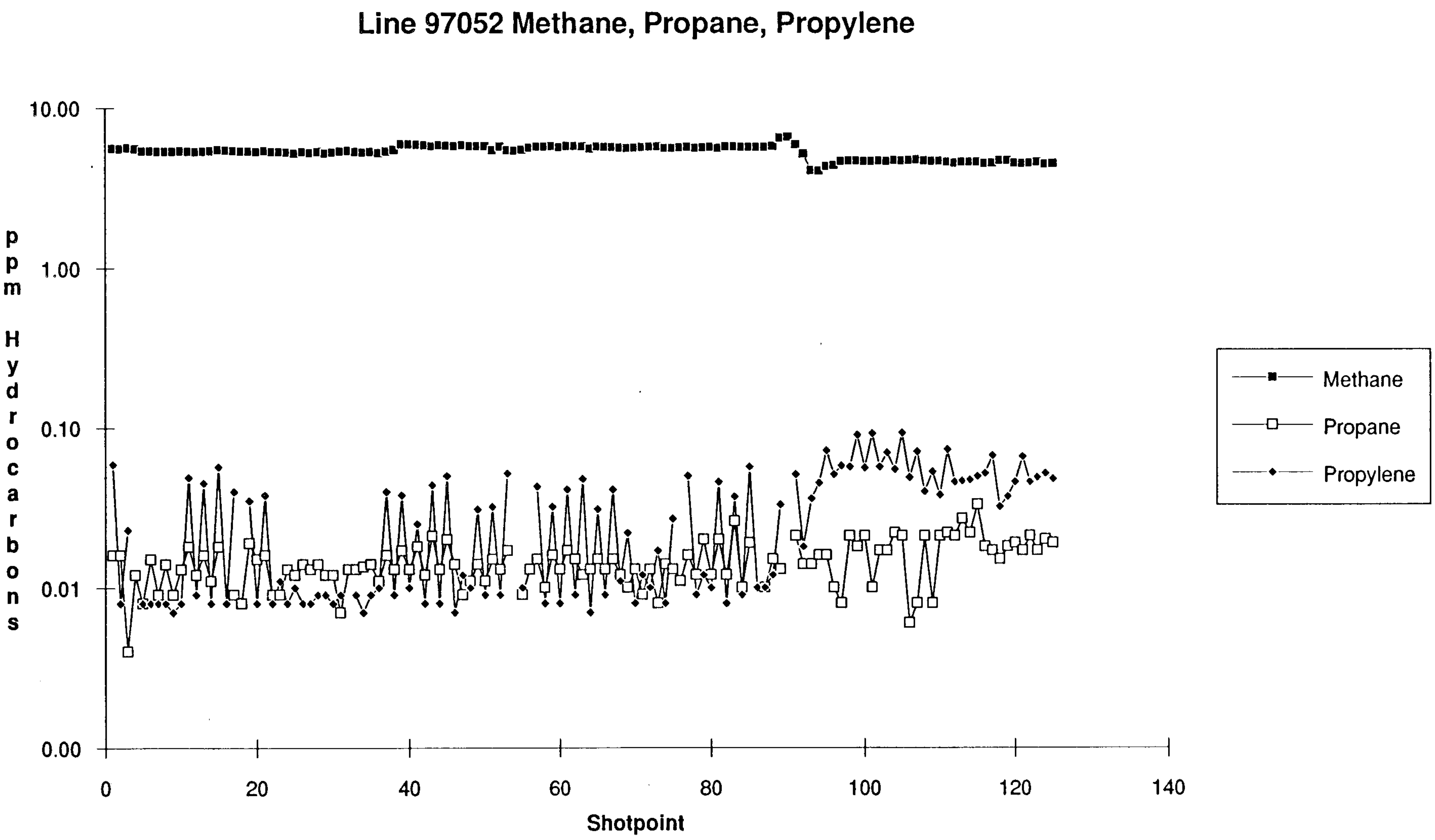
	Cond.	Temp.	F. Depth	W.Depth	Altitude
Mean	52.358	22.860	113.663	468.010	353.164
Std. Dev.	2.010	1.894	44.826	84.287	44.825
Minimum	50.870	21.230	36.108	288.244	235.000
Maximum	55.750	26.150	170.952	556.158	391.000

Notes

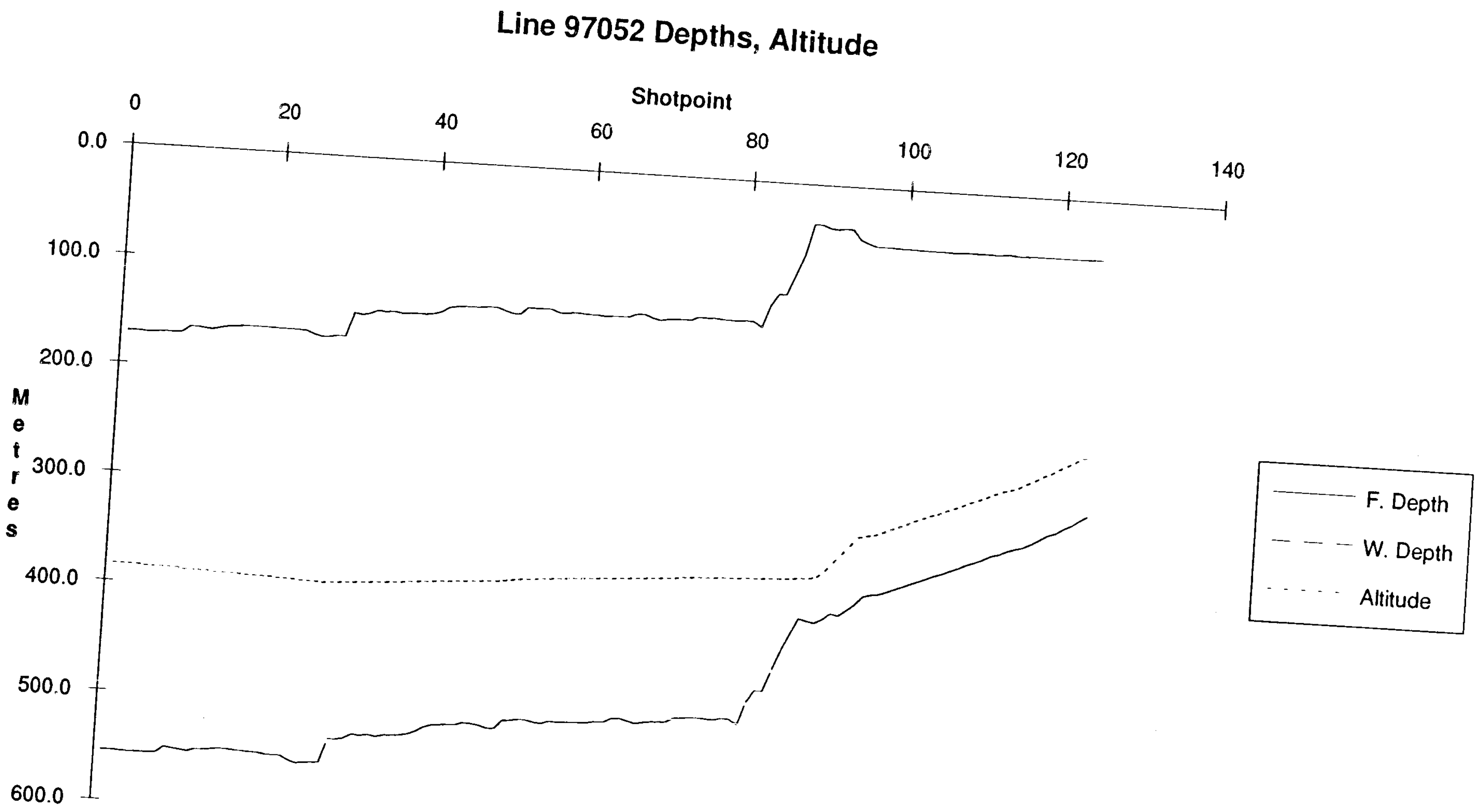
No anomalies Fluctuating THC, methane, ethane, propane, ethylene and propylene values associated with rapidly decreasing fish depth towards the end of line.


Line 97052 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 97052 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 97052 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 97052 Depths, Altitude
Shotpoint
0
20
40
60
80
100
120
140
0.0
100.0
200.0
300.0
400.0
500.0
600.0
Metres
F. Depth
W. Depth
Altitude

Line Summary

Line Number	97053
No. of Shotpoints	73

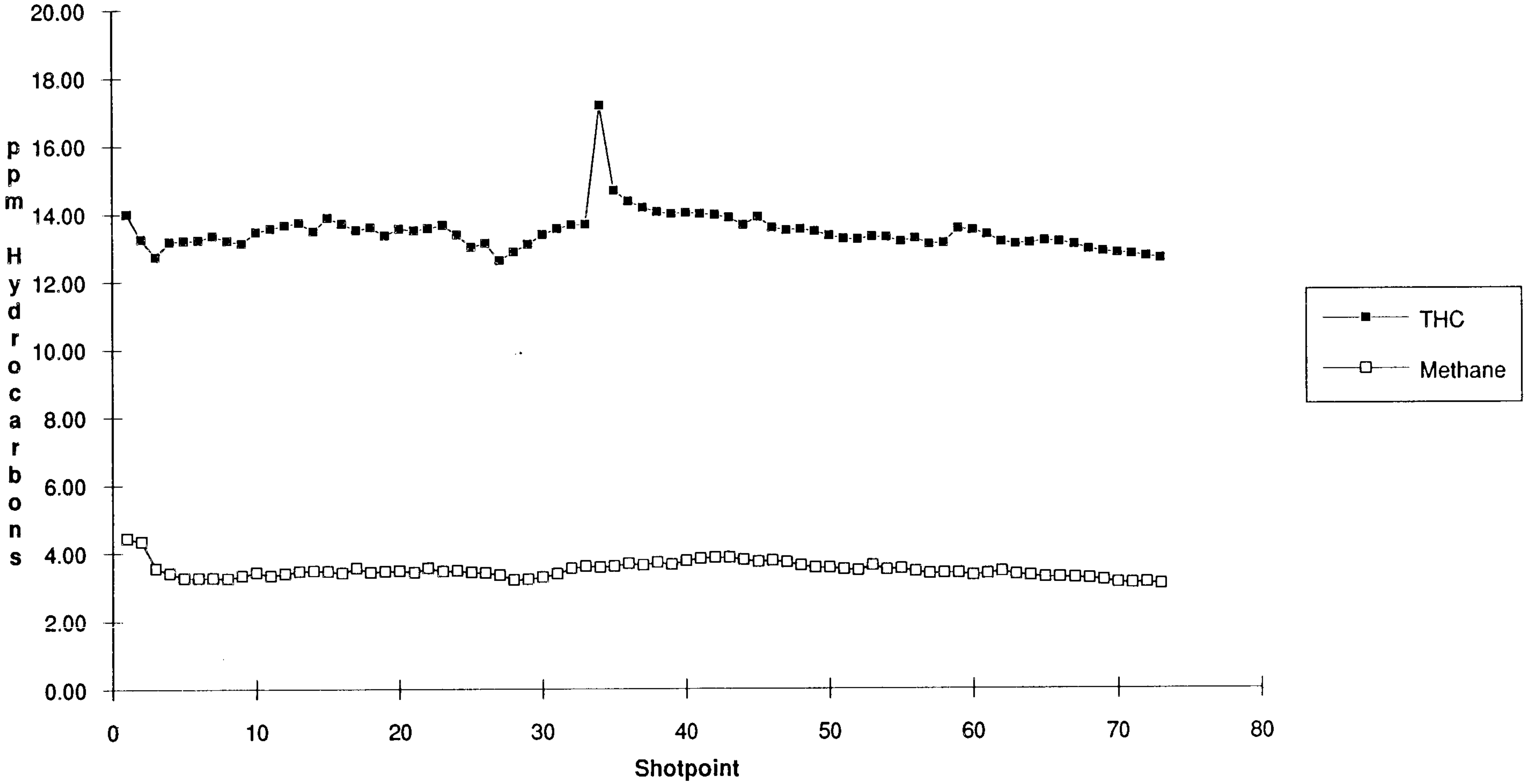
	Shotpoint	Date	Time	Latitude		Longitude	
Start	1	10-Nov-90	18:27:38	11	09.980	125	17.572
End	73	10-Nov-90	20:51:52	11	17.043	125	27.813

	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	13.445	3.472	0.012	0.289	0.012	0.122	0.016	0.002	0.000	0.126	0.015	0.000	1.199
Std. Dev.	0.598	0.239	0.002	0.017	0.009	0.022	0.022	0.013	0.000	0.046	0.021	0.001	0.710
Minimum	12.606	3.064	0.008	0.197	0.000	0.054	0.000	0.000	0.000	0.000	0.000	0.000	0.321
Maximum	17.158	4.431	0.019	0.313	0.075	0.180	0.068	0.092	0.000	0.219	0.076	0.008	3.342

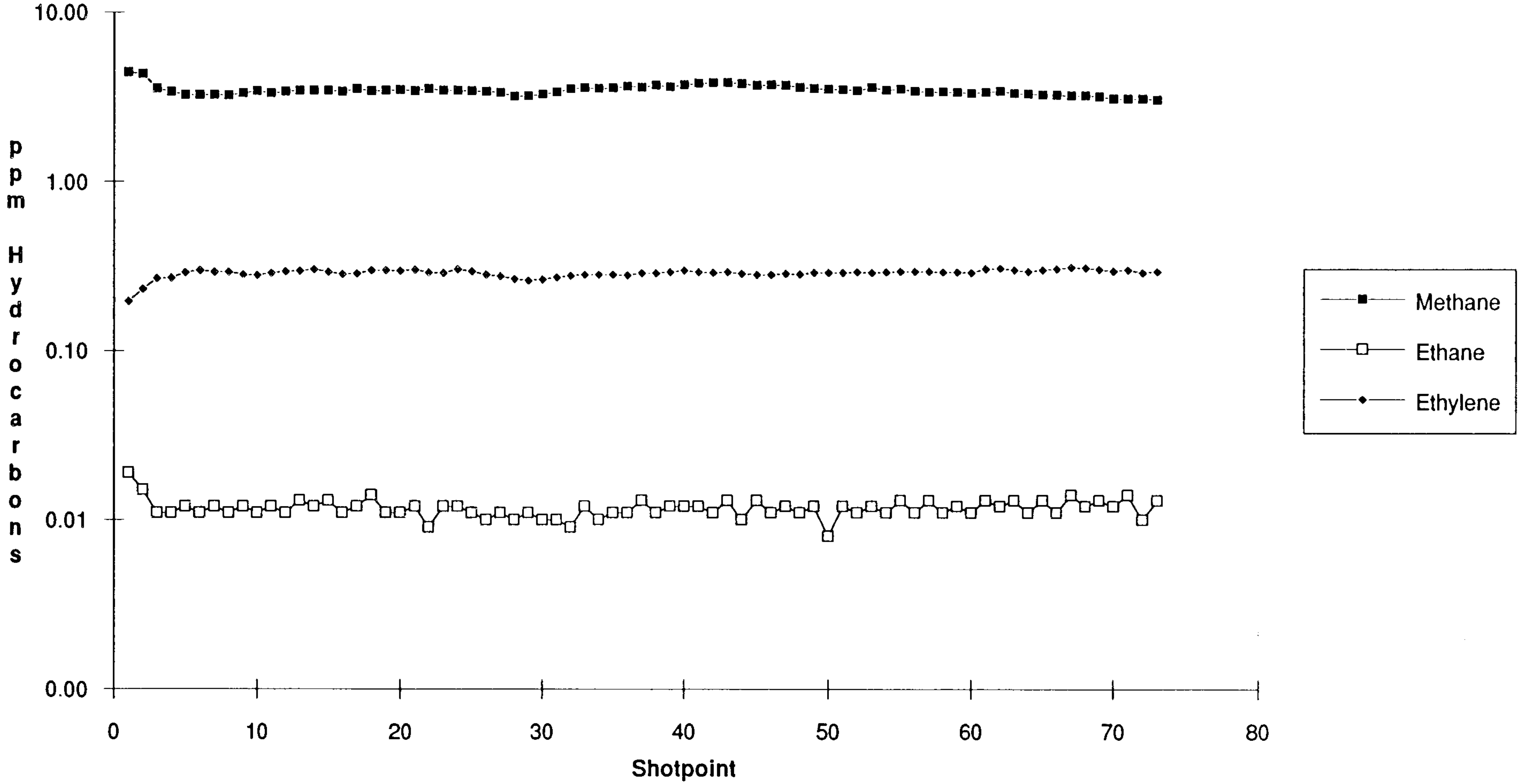
	Cond.	Temp.	F. Depth	W.Depth	Altitude
Mean	57.339	29.121	12.466	234.768	222.301
Std. Dev.	0.433	1.801	0.642	96.222	95.895
Minimum	55.870	26.210	11.220	100.322	89.000
Maximum	57.920	30.870	14.382	402.342	390.000

Notes No anomalies.

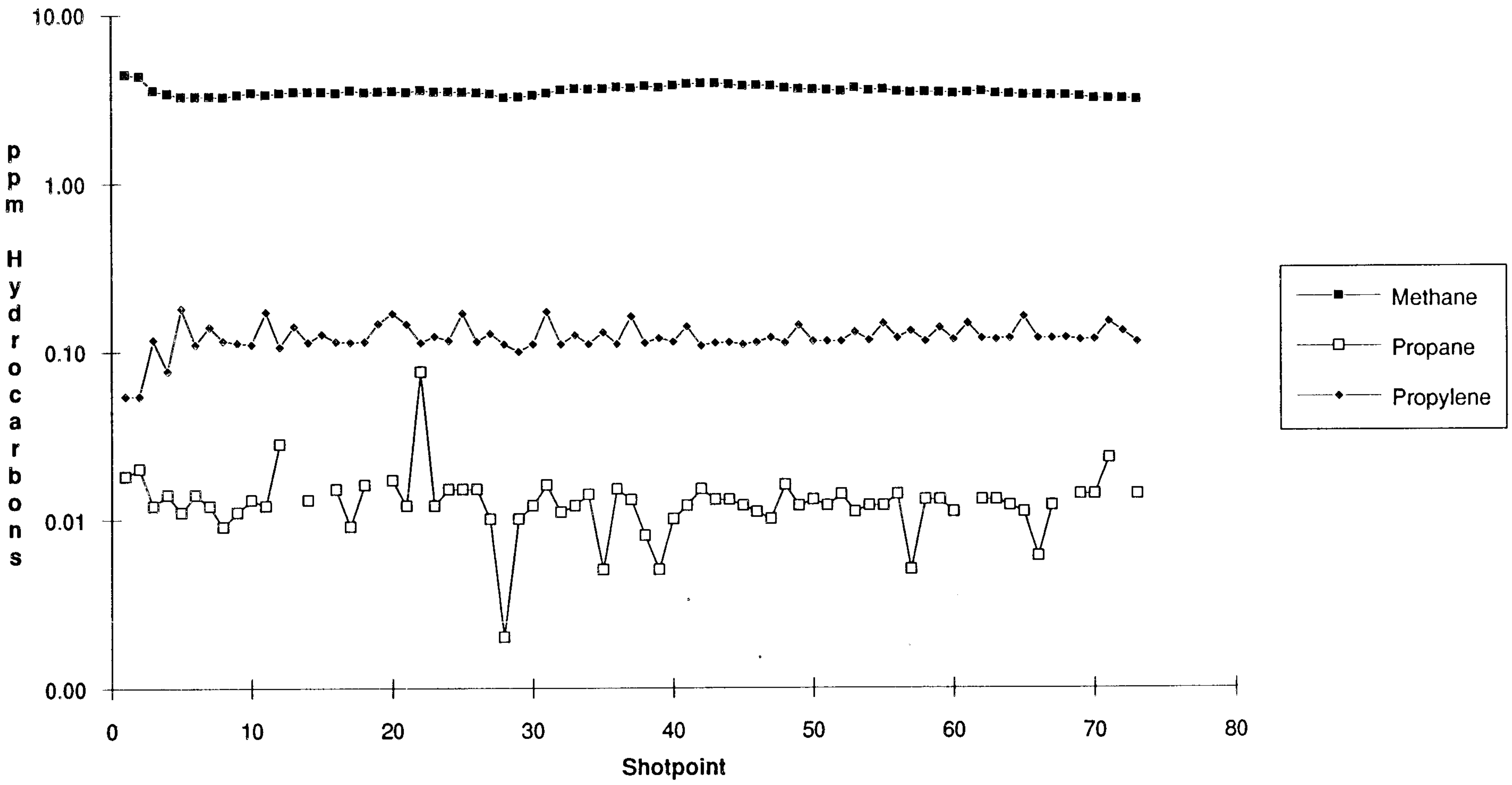
Line 97053 THC, Methane

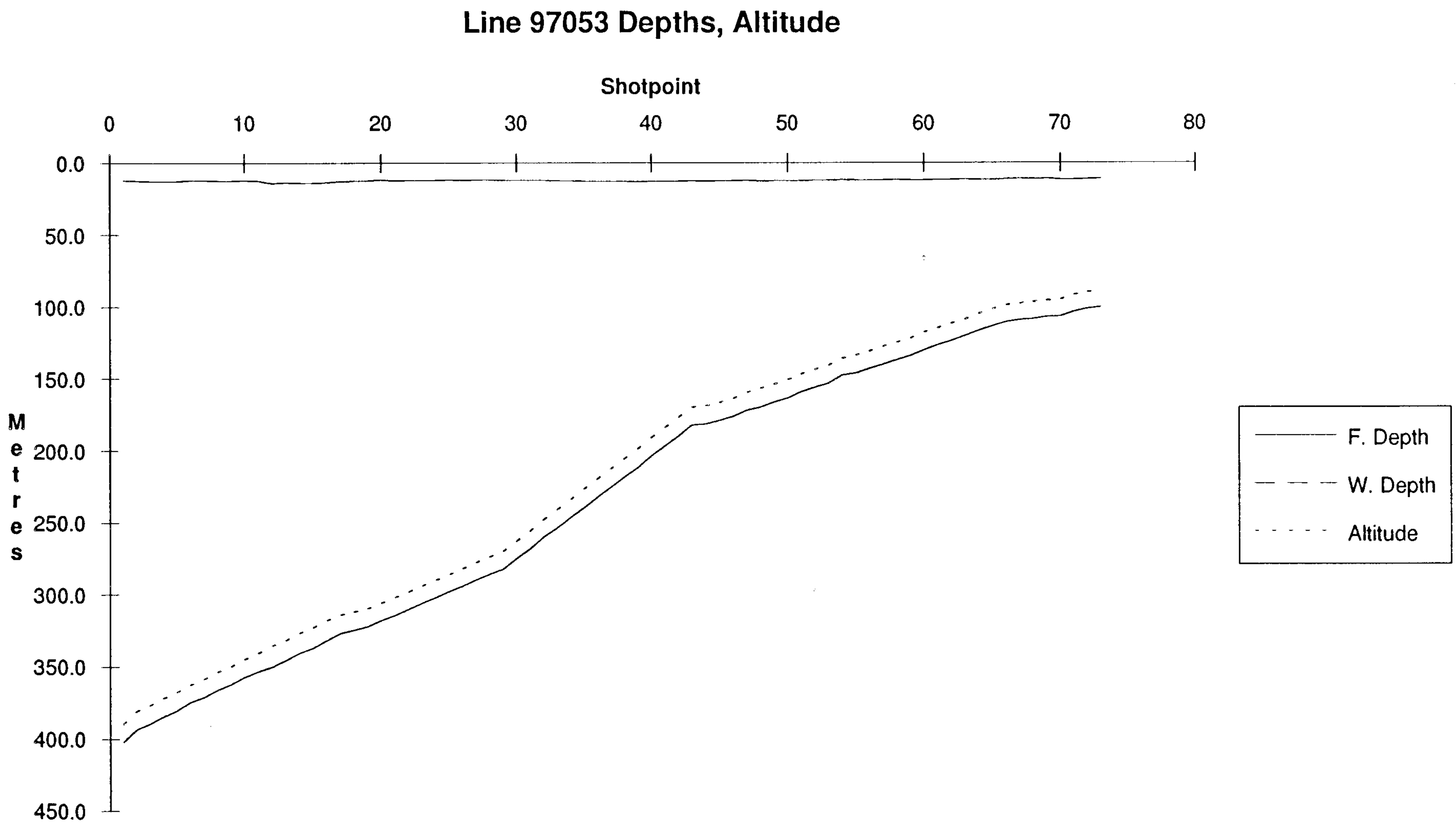


Line 97053 Methane, Ethane, Ethylene



Line 97053 Methane, Propane, Propylene




Line 97053 Depths, Altitude
Shotpoint
0
10
20
30
40
50
60
70
80
0.0
50.0
100.0
150.0
200.0
250.0
300.0
350.0
400.0
450.0
Metres
F. Depth
W. Depth
Altitude

Line Summary

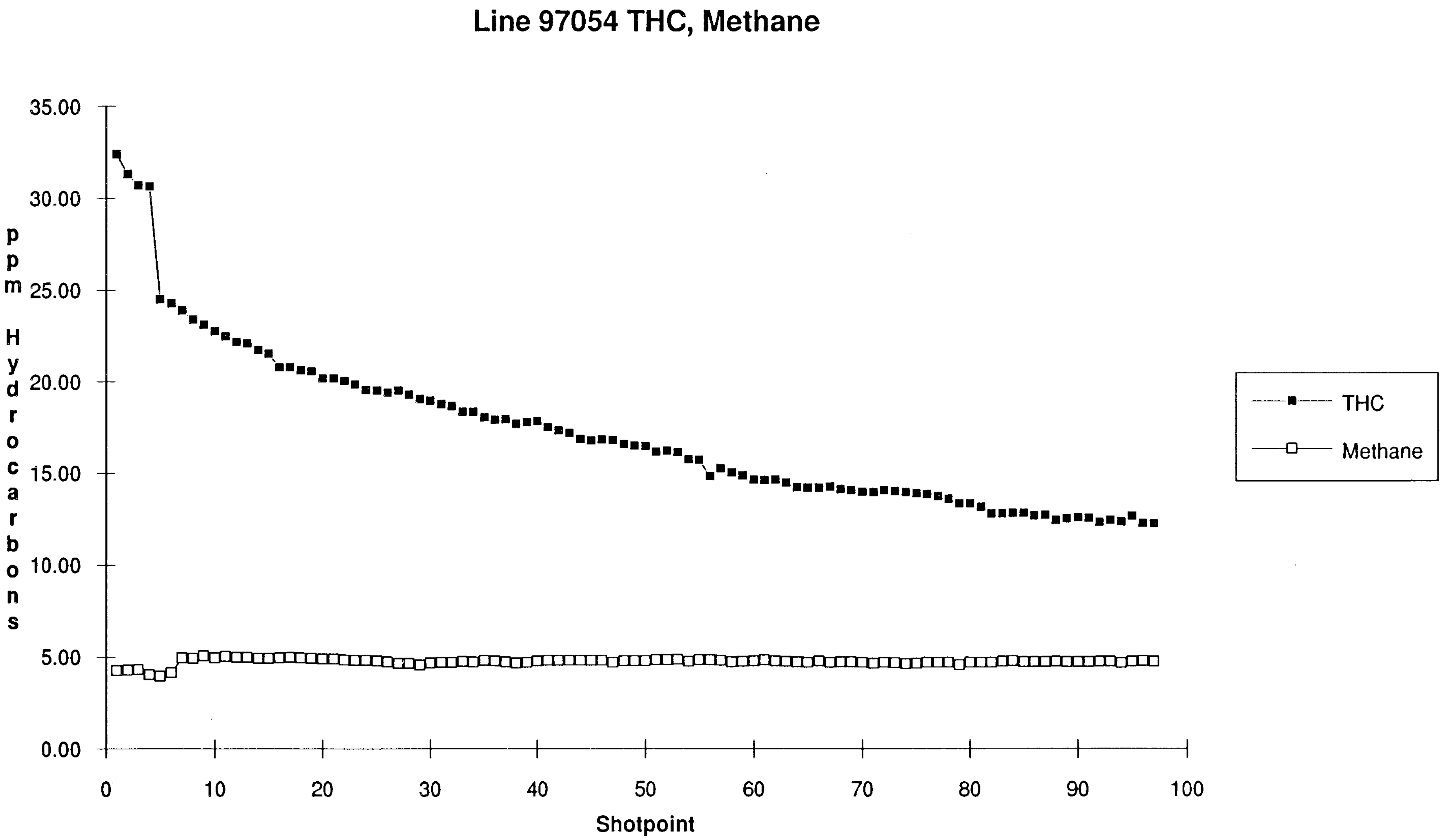
Line Number	97054
No. of Shotpoints	97

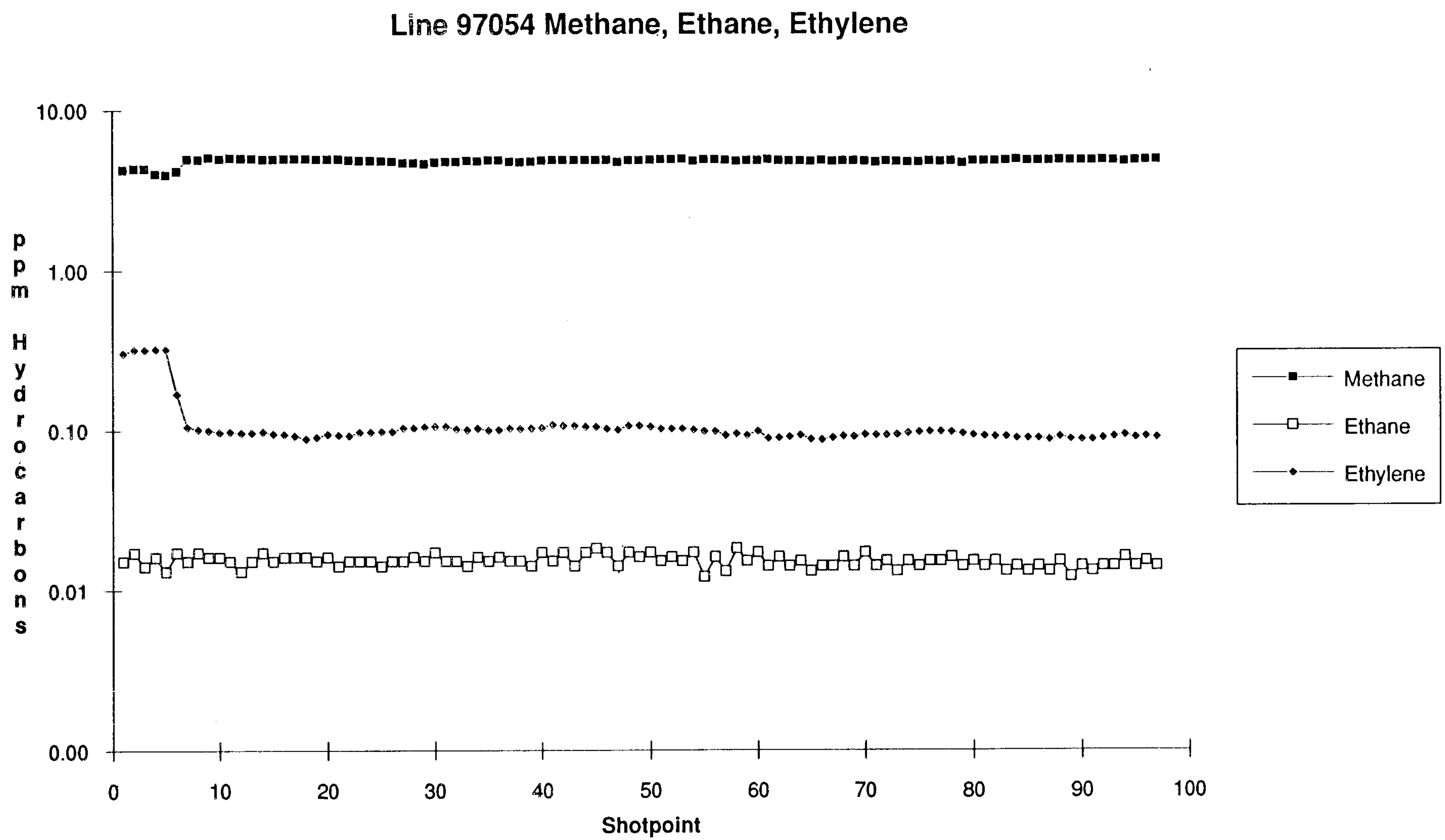
	Shotpoint	Date	Time	Latitude		Longitude	
Start	1	10-Nov-90	22:43:50	11	15.296	125	24.645
End	97	11-Nov-90	01:56:02	11	09.310	125	40.000

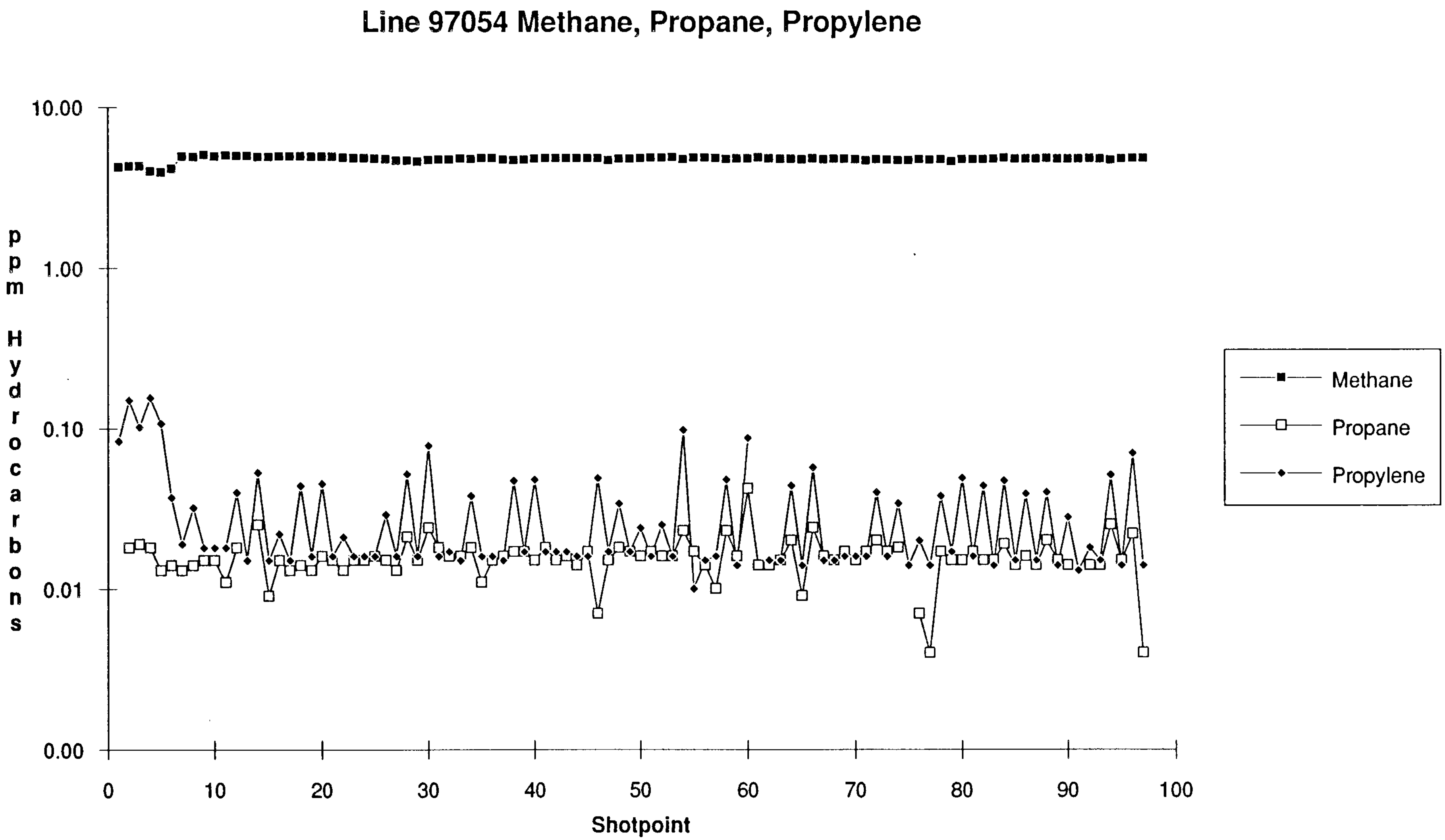
	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	17.262	4.727	0.015	0.108	0.015	0.031	0.018	0.001	0.000	0.037	0.000	0.000	1.042
Std. Dev.	4.429	0.180	0.001	0.050	0.006	0.028	0.026	0.008	0.000	0.033	0.002	0.000	0.633
Minimum	12.241	3.927	0.012	0.086	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.275
Maximum	32.363	5.035	0.018	0.323	0.042	0.155	0.127	0.079	0.000	0.175	0.018	0.000	3.752

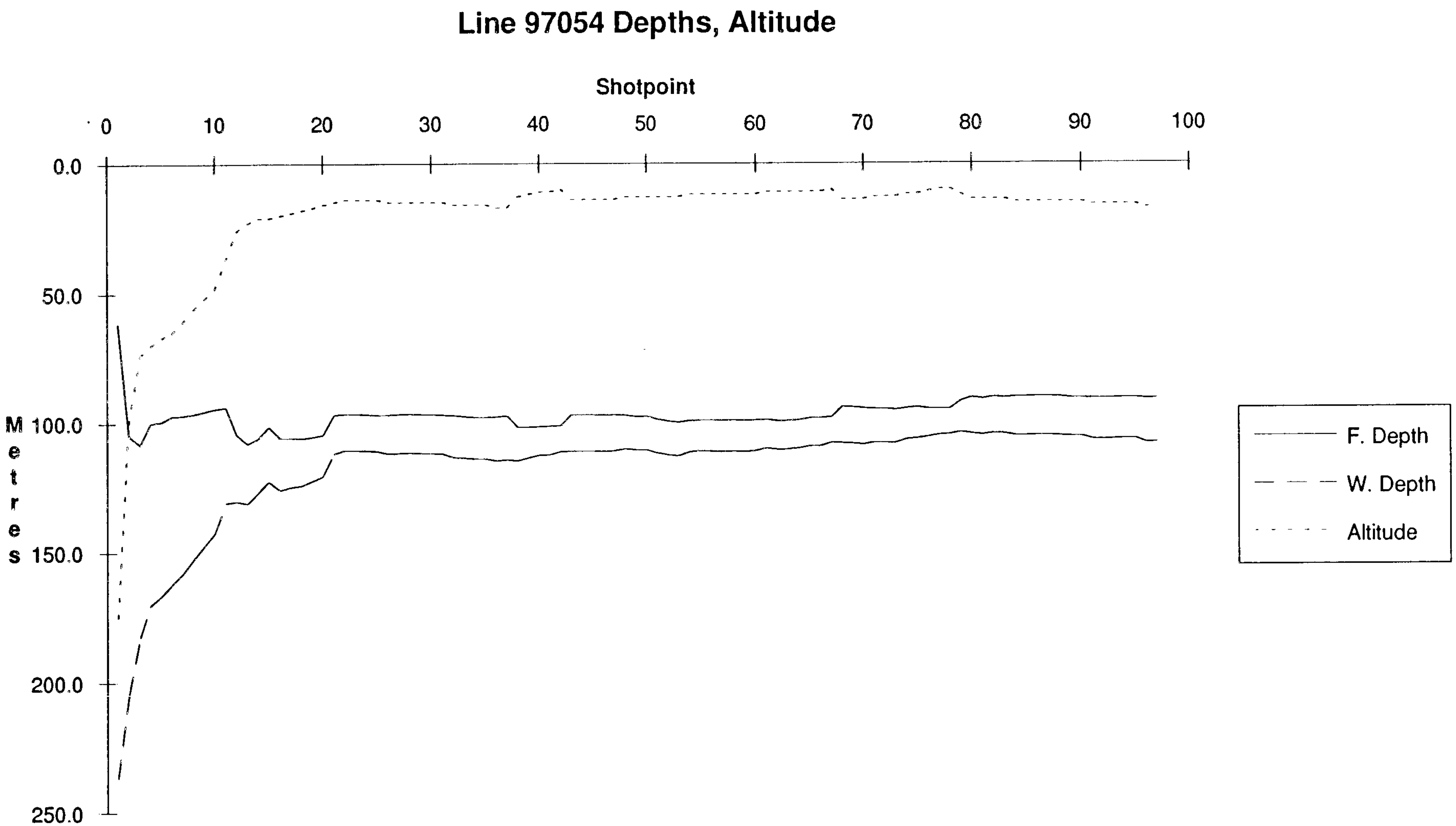
	Cond.	Temp.	F. Depth	W.Depth	Altitude
Mean	55.963	29.028	96.649	117.607	20.959
Std. Dev.	0.610	0.519	5.733	21.458	22.492
Minimum	54.820	27.950	61.608	103.800	10.000
Maximum	58.000	30.790	108.426	236.608	175.000

Notes: No anomalies. Decreasing THC from the beginning of the line.


Line 97054 THC, Methane
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00
ppm Hydrocarbons
0
10
20
30
40
50
60
70
80
90
100
Shotpoint
THC
Methane


Line 97054 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
100
Shotpoint
Methane
Ethane
Ethylene


Line 97054 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
100
Shotpoint
Methane
Propane
Propylene



Line 97054 Depths, Altitude
Shotpoint
0
10
20
30
40
50
60
70
80
90
100
0.0
50.0
100.0
150.0
200.0
250.0
Metres
F. Depth
W. Depth
Altitude

Line Summary

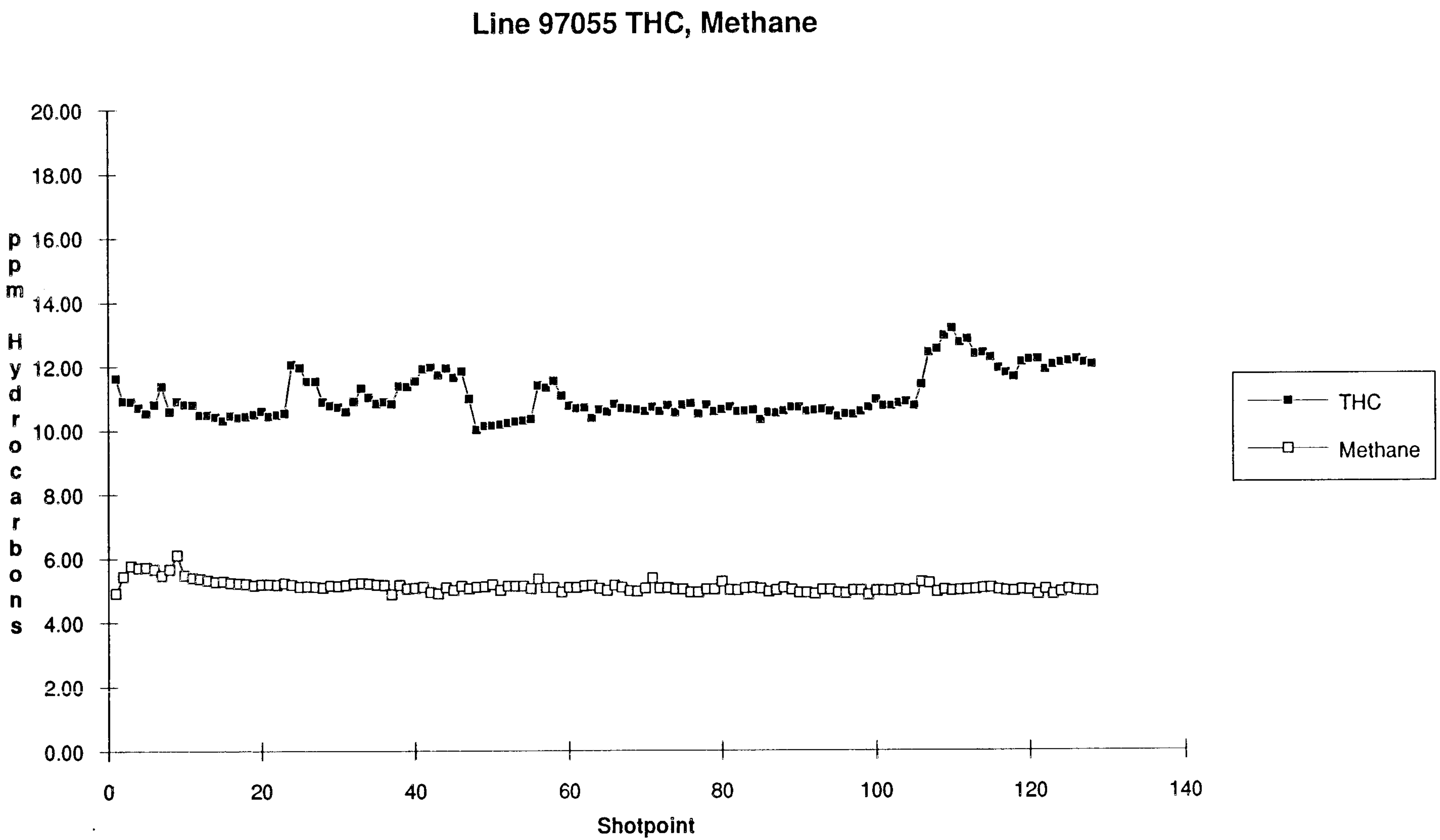
Line Number	97055
No. of Shotpoints	128

	Shotpoint	Date	Time	Latitude		Longitude	
Start	1	11-Nov-90	03:56:37	11	08.186	125	35.435
End	128	11-Nov-90	08:10:36	11	24.384	125	47.236

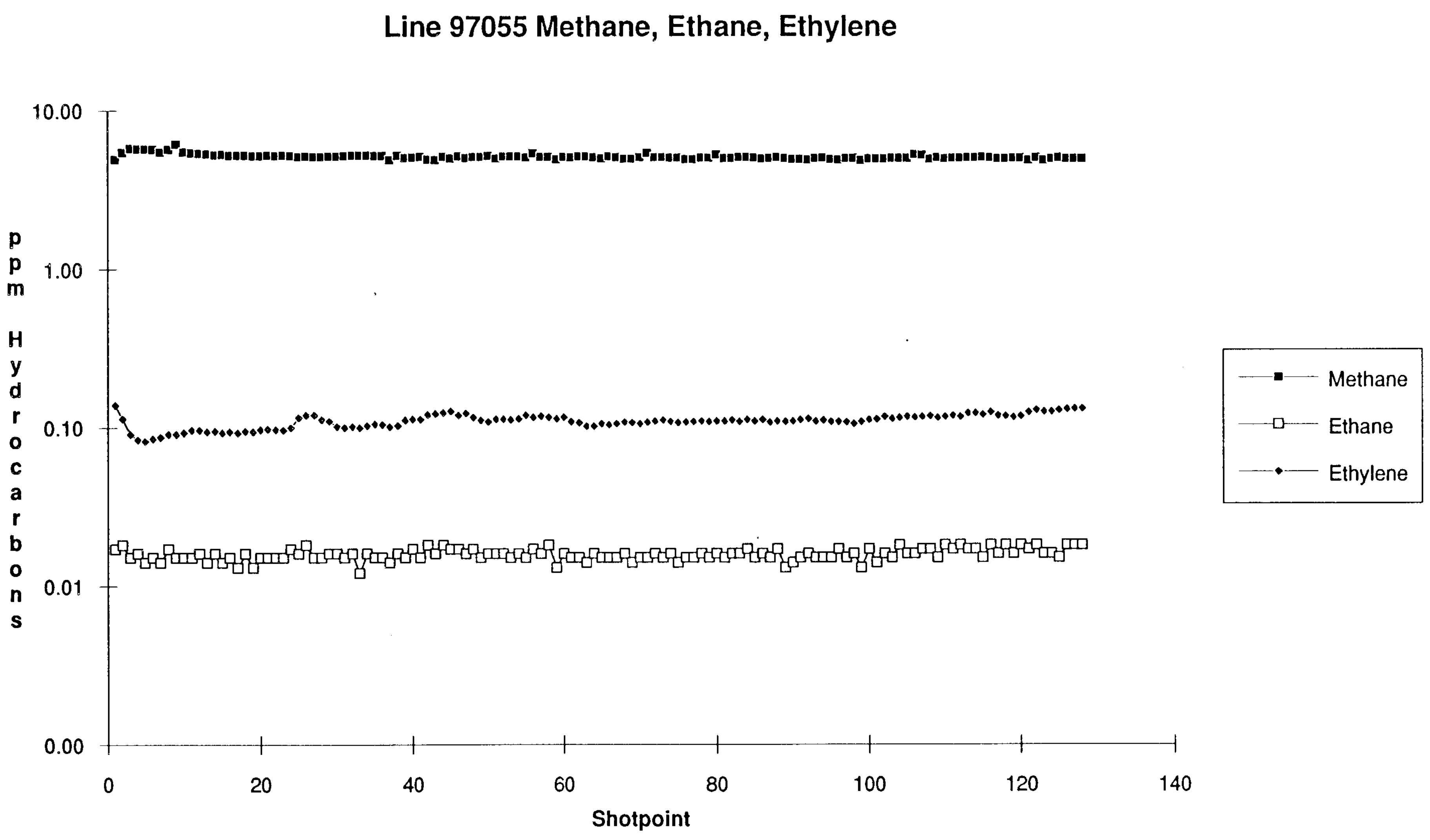
	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	11.037	5.088	0.016	0.110	0.016	0.027	0.015	0.000	0.000	0.076	0.075	0.000	0.923
Std. Dev.	0.702	0.201	0.001	0.011	0.005	0.016	0.021	0.000	0.000	0.033	0.047	0.000	0.457
Minimum	10.000	4.829	0.012	0.082	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.263
Maximum	13.122	6.086	0.018	0.138	0.035	0.084	0.082	0.005	0.000	0.159	0.205	0.000	2.459

	Cond.	Temp.	F. Depth	W.Depth	Altitude
Mean	55.693	29.158	87.745	103.221	15.477
Std. Dev.	0.320	0.389	4.616	4.296	2.553
Minimum	54.660	28.140	79.560	94.560	7.000
Maximum	56.320	29.840	104.652	115.900	21.000

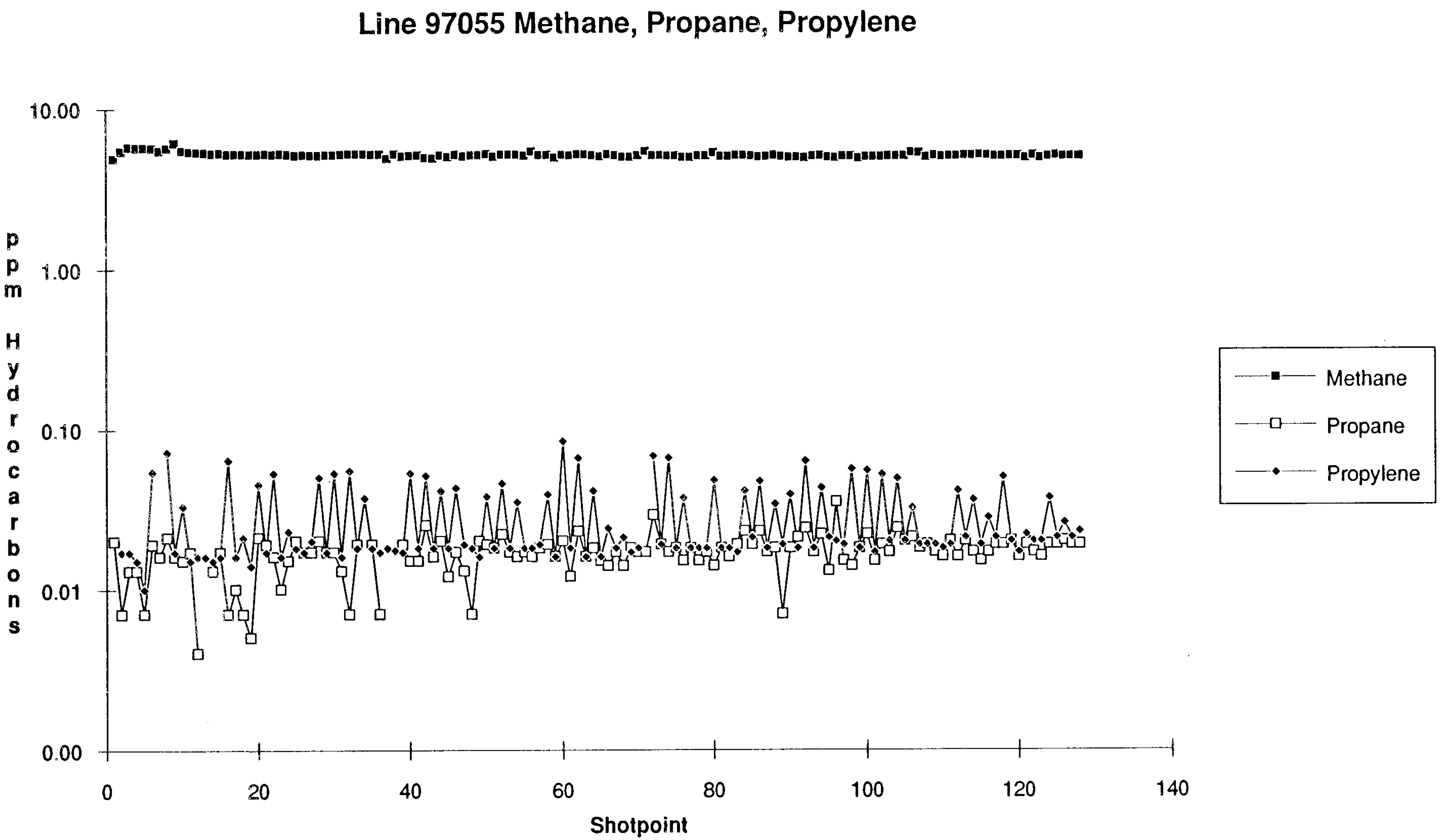
Notes No anomalies.



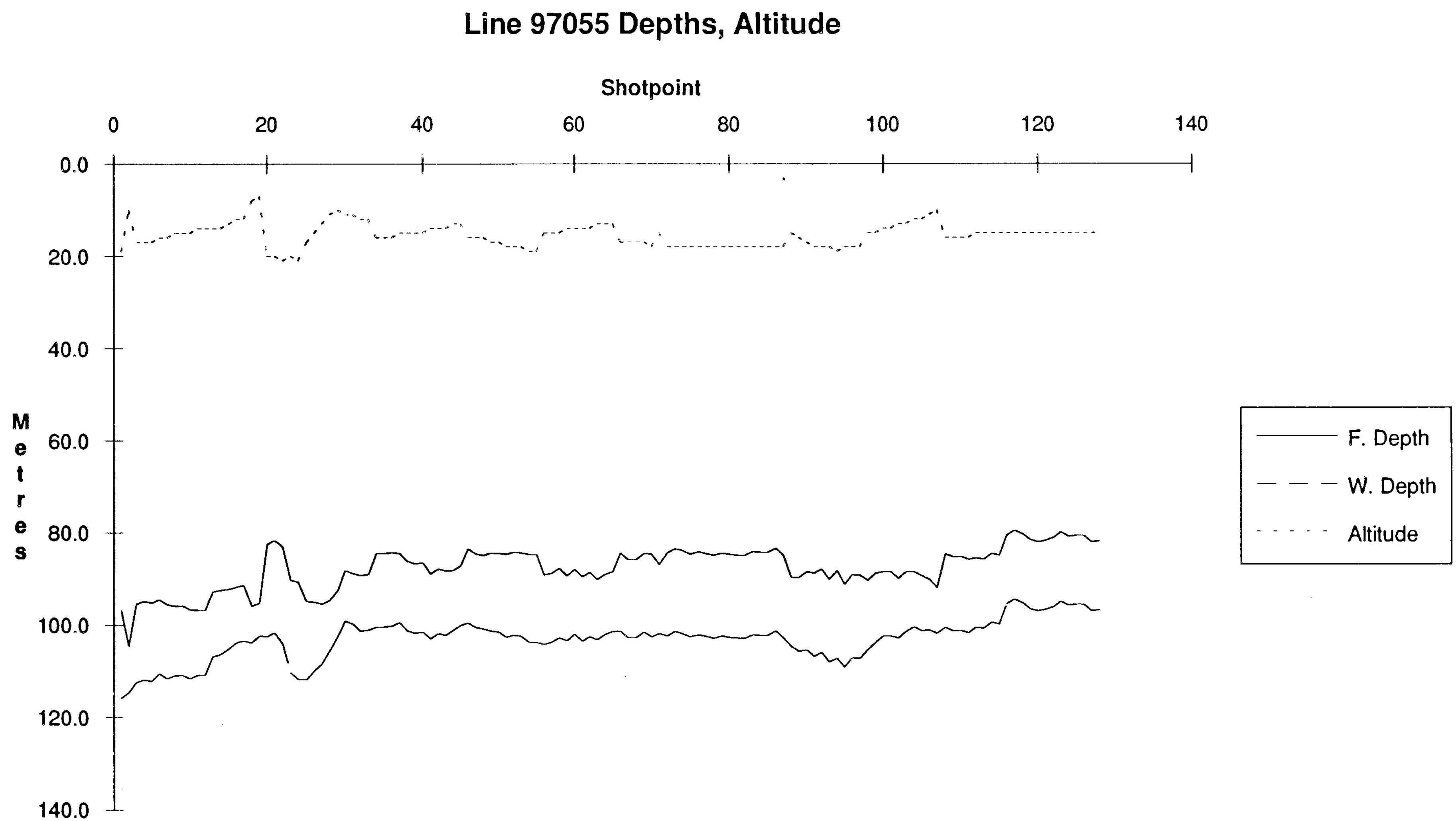
Line 97055 THC, Methane
ppm Hydrocarbons
20.00
18.00
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
0
20
40
60
80
100
120
140
Shotpoint
THC
Methane



Line 97055 Methane, Ethane, Ethylene
10.00
1.00
0.10
0.01
0.00
ppm Hydrocarbons
0
20
40
60
80
100
120
140
Shotpoint
Methane
Ethane
Ethylene



Line 97055 Methane, Propane, Propylene
10.00
1.00
0.10
0.01
0.00
ppm Hydrocarbons
0
20
40
60
80
100
120
140
Shotpoint
Methane
Propane
Propylene



Line 97055 Depths, Altitude
Shotpoint
0
20
40
60
80
100
120
140
0.0
20.0
40.0
60.0
80.0
100.0
120.0
140.0
Metres
F. Depth
W. Depth
Altitude

Line Summary

Line Number	97056
No. of Shotpoints	260

	Shotpoint	Date	Time	Latitude		Longitude	
Start	1	11-Nov-90	10:00:22	11	19.047	125	44.465
End	261	11-Nov-90	18:41:23	11	56.773	125	57.362

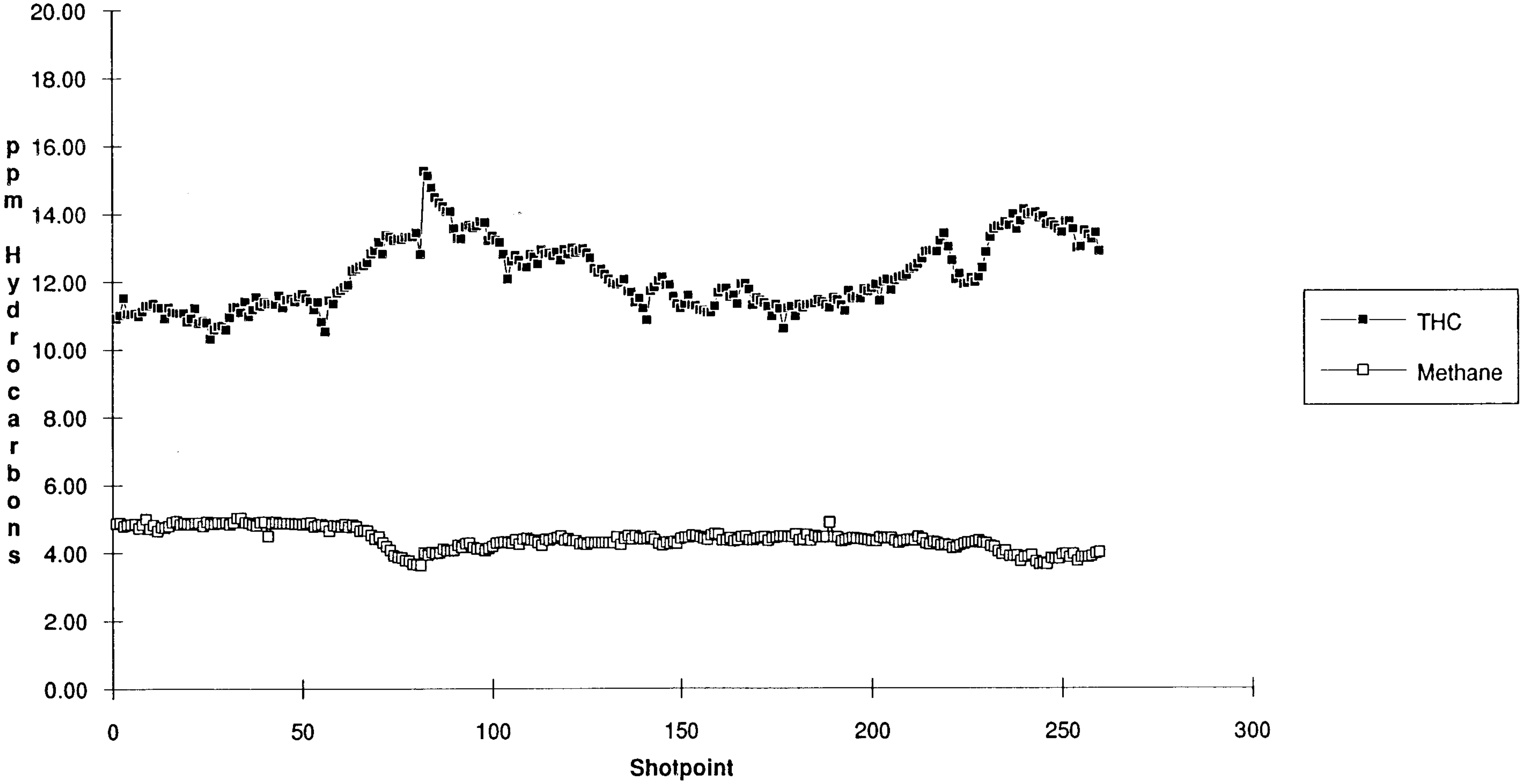
	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	12.177	4.384	0.019	0.156	0.019	0.036	0.016	0.000	0.000	0.089	0.026	0.000	1.225
Std. Dev.	1.022	0.329	0.002	0.029	0.007	0.017	0.021	0.000	0.000	0.050	0.026	0.000	0.554
Minimum	10.304	3.625	0.012	0.112	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.305
Maximum	15.242	5.023	0.027	0.263	0.069	0.097	0.075	0.000	0.000	0.325	0.268	0.000	2.861

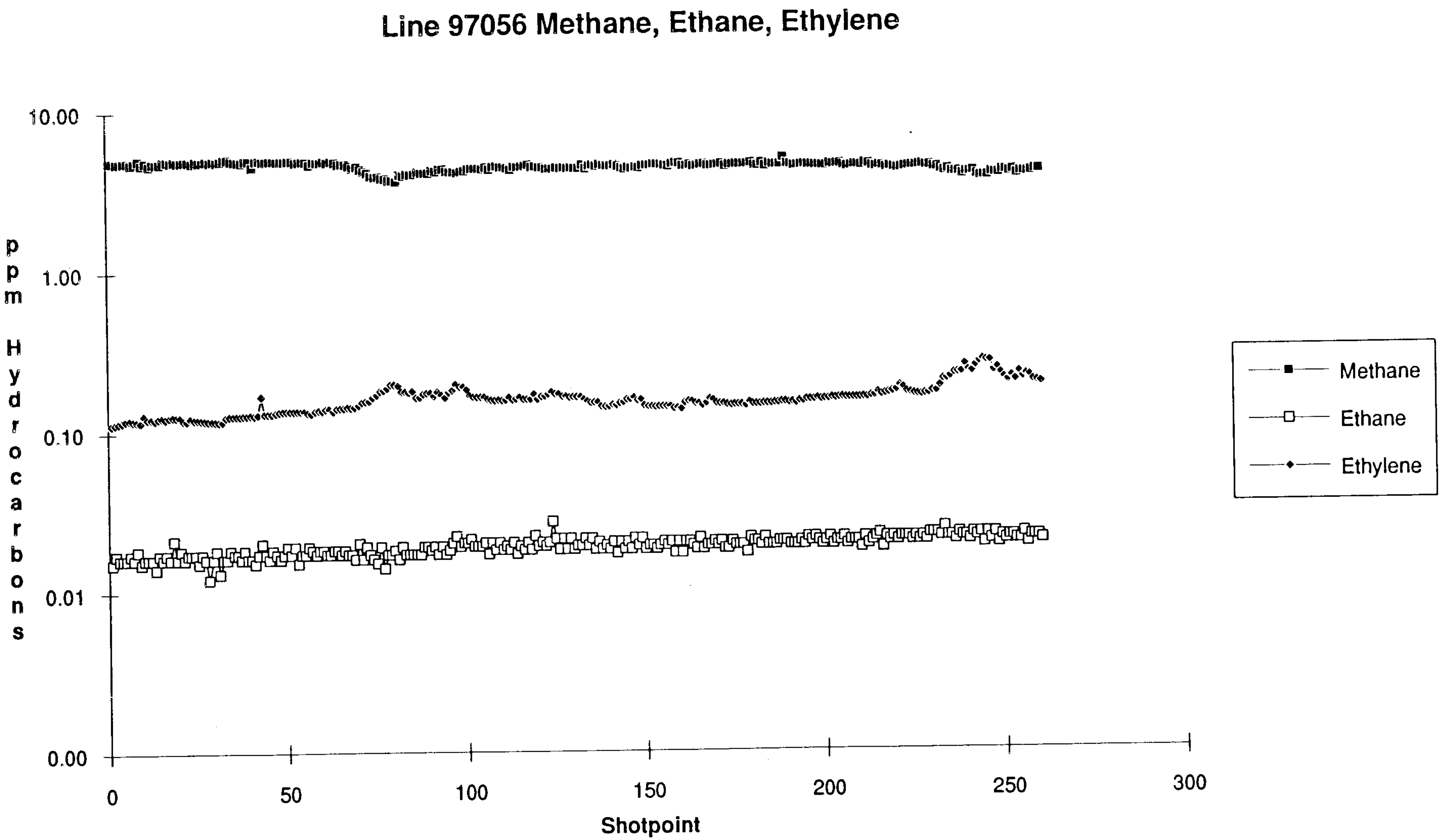
	Cond.	Temp.	F. Depth	W.Depth	Altitude
Mean	55.568	33.504	75.822	90.084	14.242
Std. Dev.	0.292	4.547	7.293	8.381	3.556
Minimum	55.000	27.020	61.608	75.138	8.000
Maximum	56.400	41.840	88.434	103.884	22.000

Notes

No anomalies. Slightly erratic THC and methane values associated with fluctuations in fish depth.

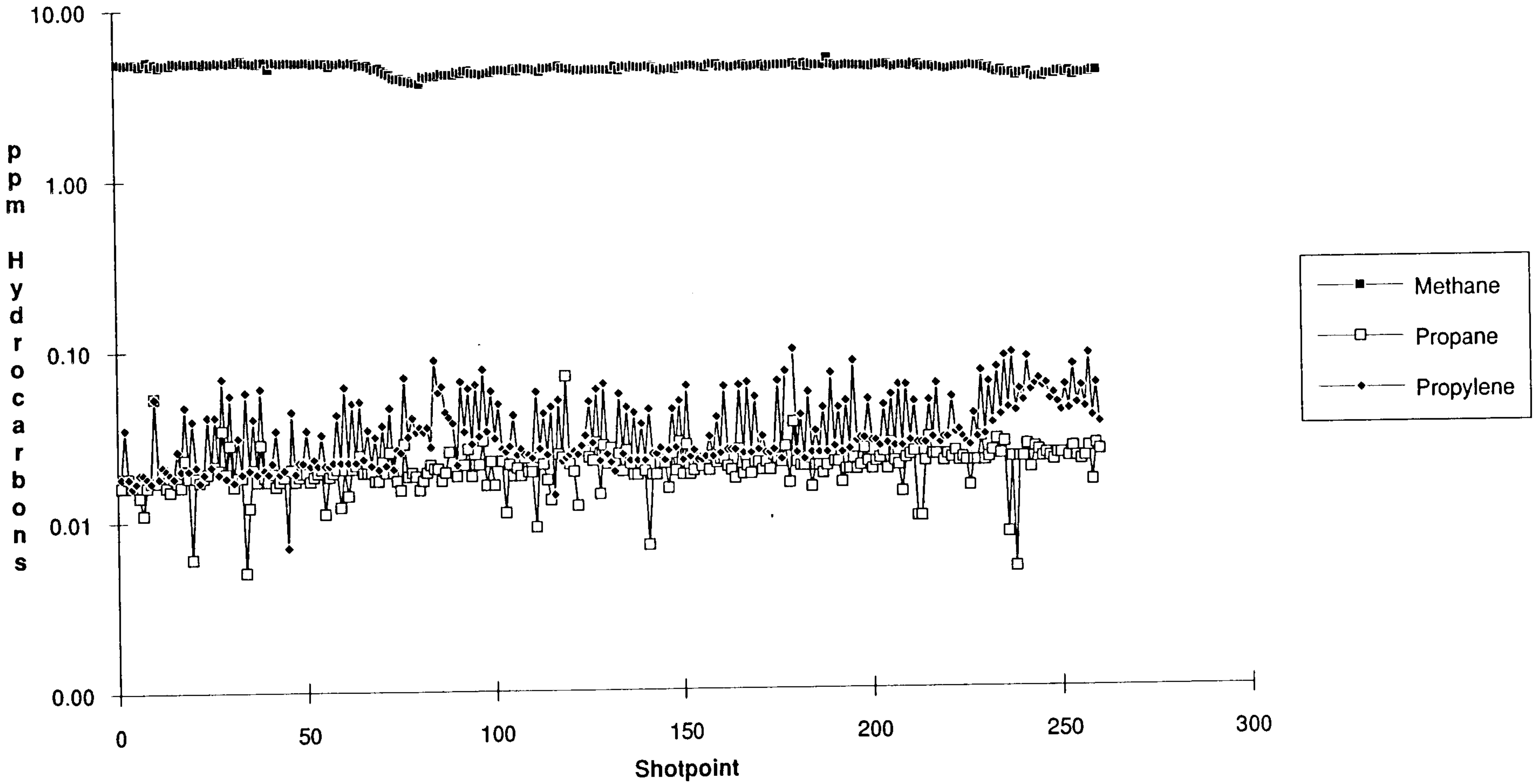
Line 97056 THC, Methane

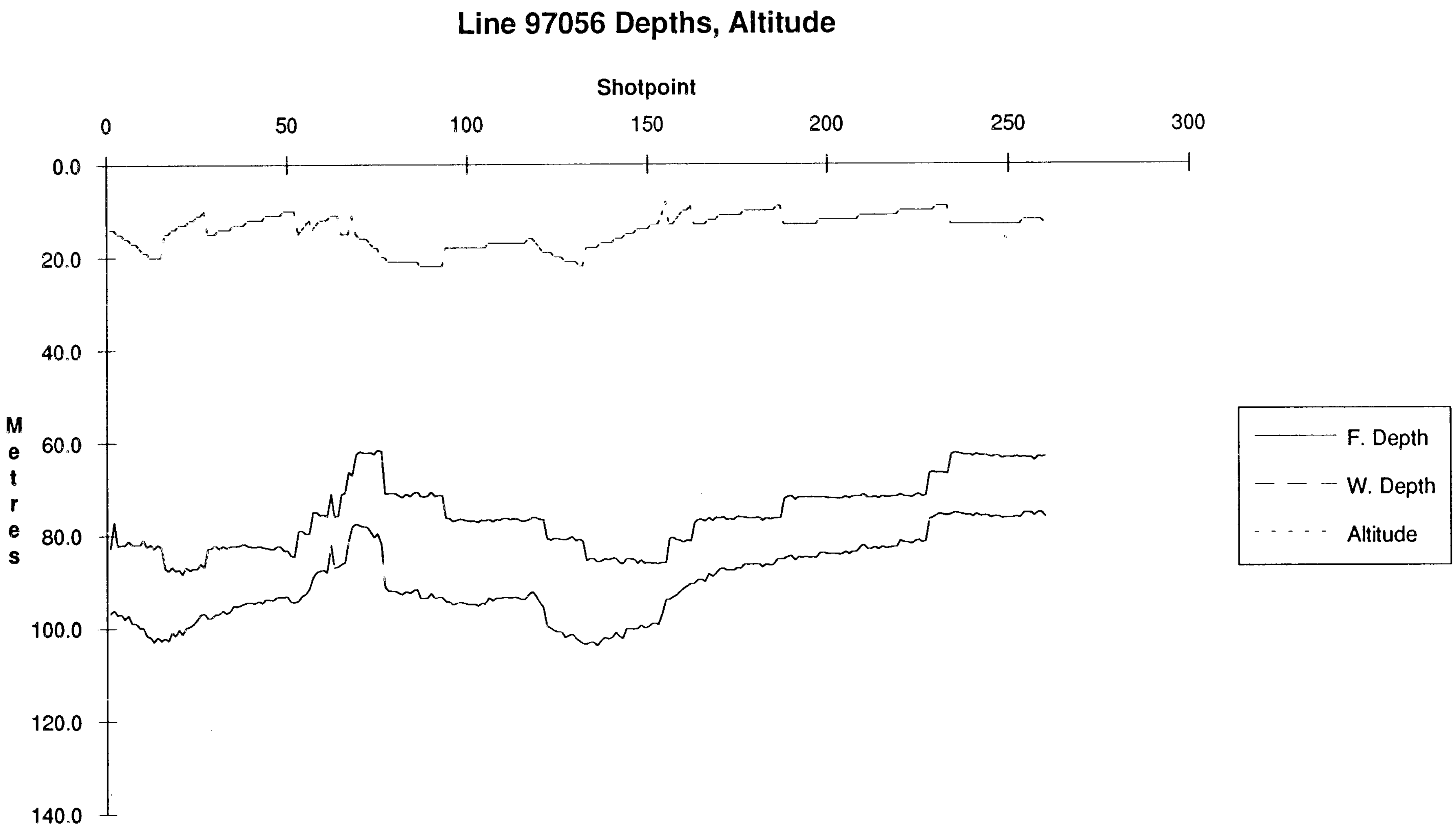




Line 97056 Methane, Ethane, Ethylene
ppm Hydrocarbons
10.00
1.00
0.10
0.01
0.00
0
50
100
150
200
250
300
Shotpoint
Methane
Ethane
Ethylene

Line 97056 Methane, Propane, Propylene




Line 97056 Depths, Altitude
Shotpoint
0
50
100
150
200
250
300
0.0
20.0
40.0
60.0
80.0
100.0
120.0
140.0
Metres
F. Depth
W. Depth
Altitude

Line Summary

Line Number	97057
No. of Shotpoints	239

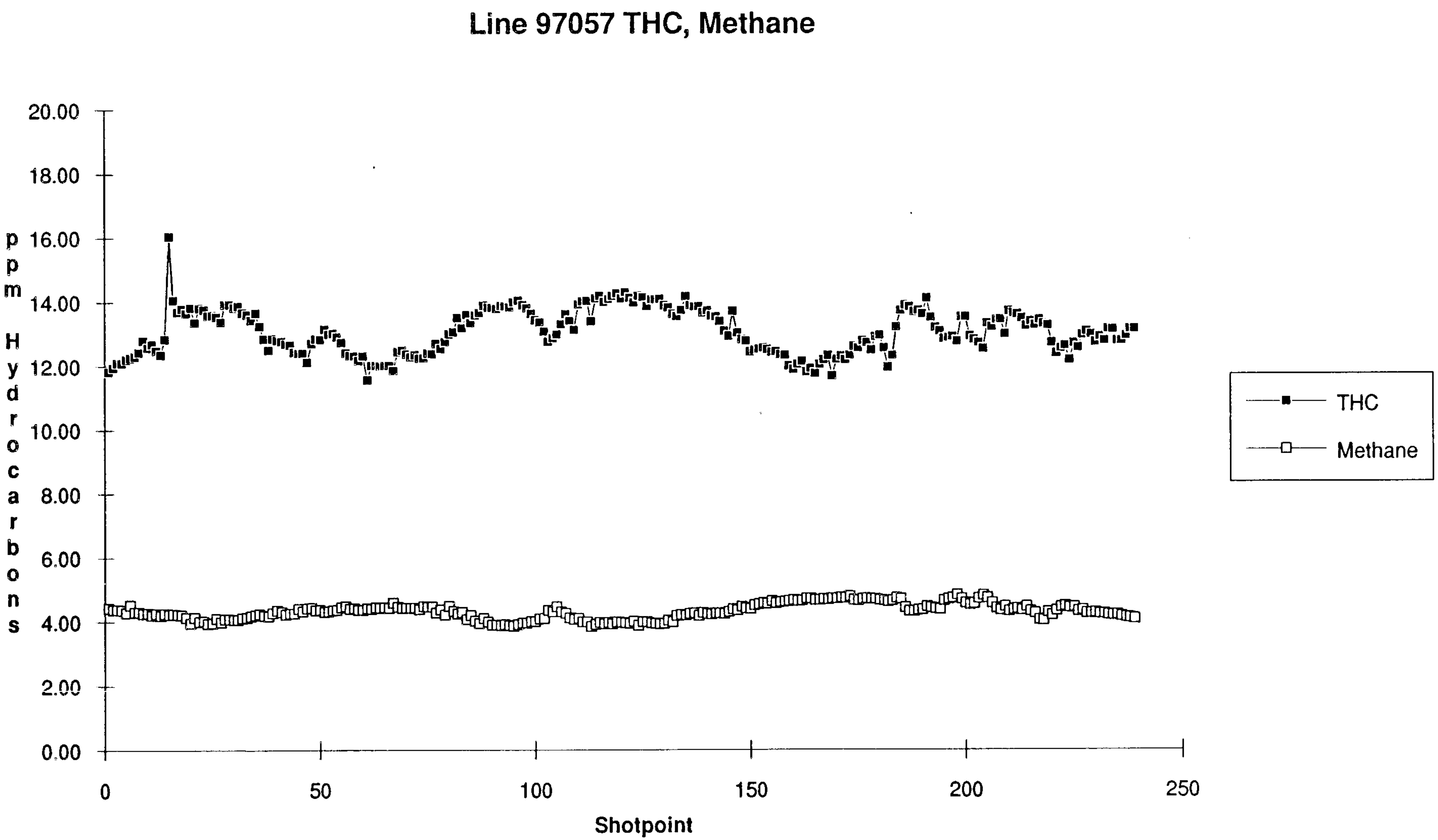
	Shotpoint	Date	Time	Latitude		Longitude	
Start	1	11-Nov-90	21:04:02	11	56.500	126	05.690
End	239	12-Nov-90	05:00:12	11	18.365	125	54.067

	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	13.040	4.296	0.020	0.175	0.022	0.042	0.023	0.000	0.000	0.125	0.012	0.000	1.487
Std. Dev.	0.697	0.241	0.003	0.025	0.007	0.021	0.029	0.003	0.000	0.051	0.021	0.000	0.713
Minimum	11.553	3.831	0.015	0.122	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.428
Maximum	16.036	4.818	0.052	0.238	0.066	0.114	0.123	0.044	0.000	0.381	0.141	0.000	3.760

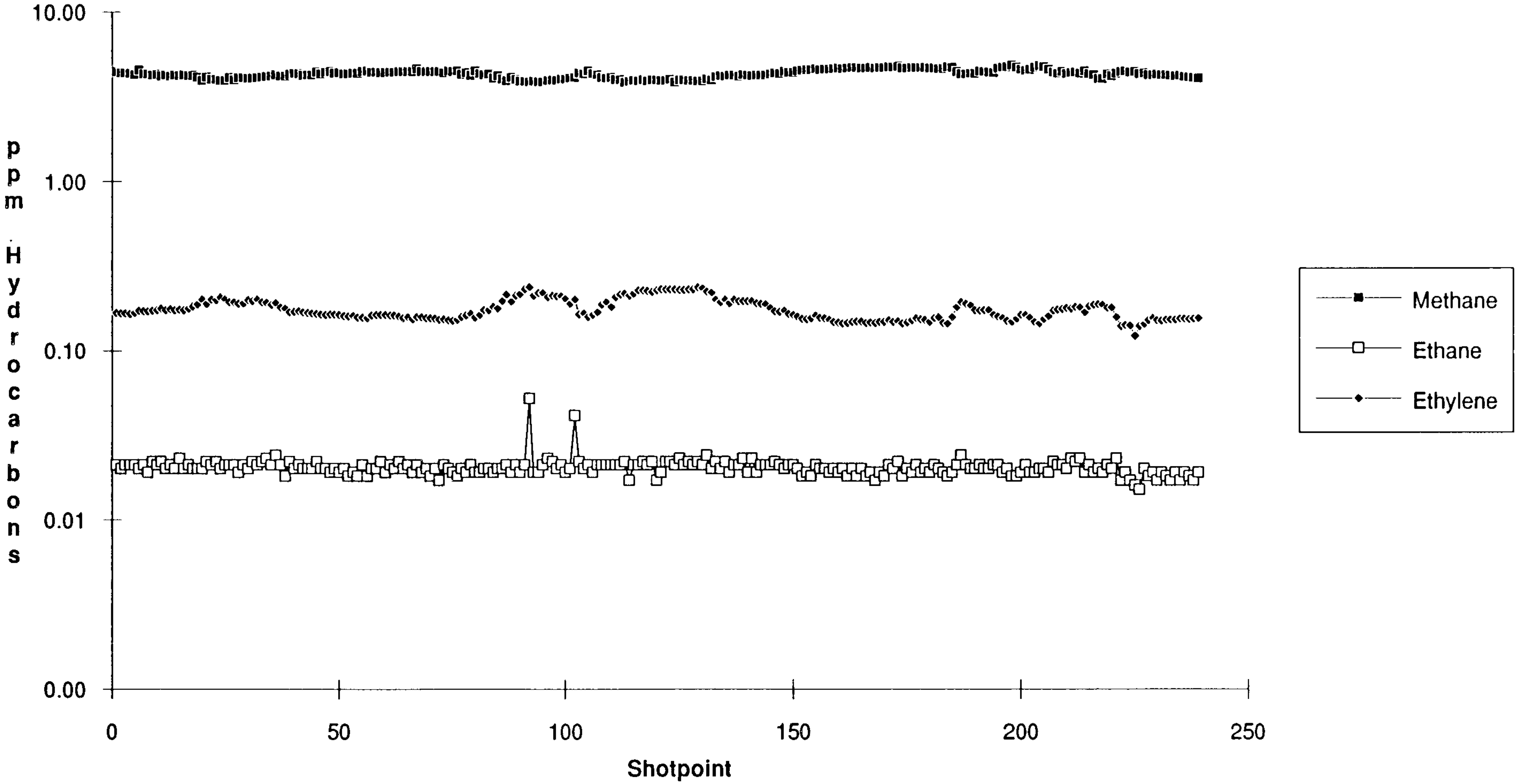
	Cond.	Temp.	F. Depth	W.Depth	Altitude
Mean	57.300	29.879	71.151	85.561	14.410
Std. Dev.	0.930	0.746	6.031	6.548	3.238
Minimum	55.760	28.430	57.834	73.546	5.000
Maximum	58.510	30.870	85.578	102.578	23.000

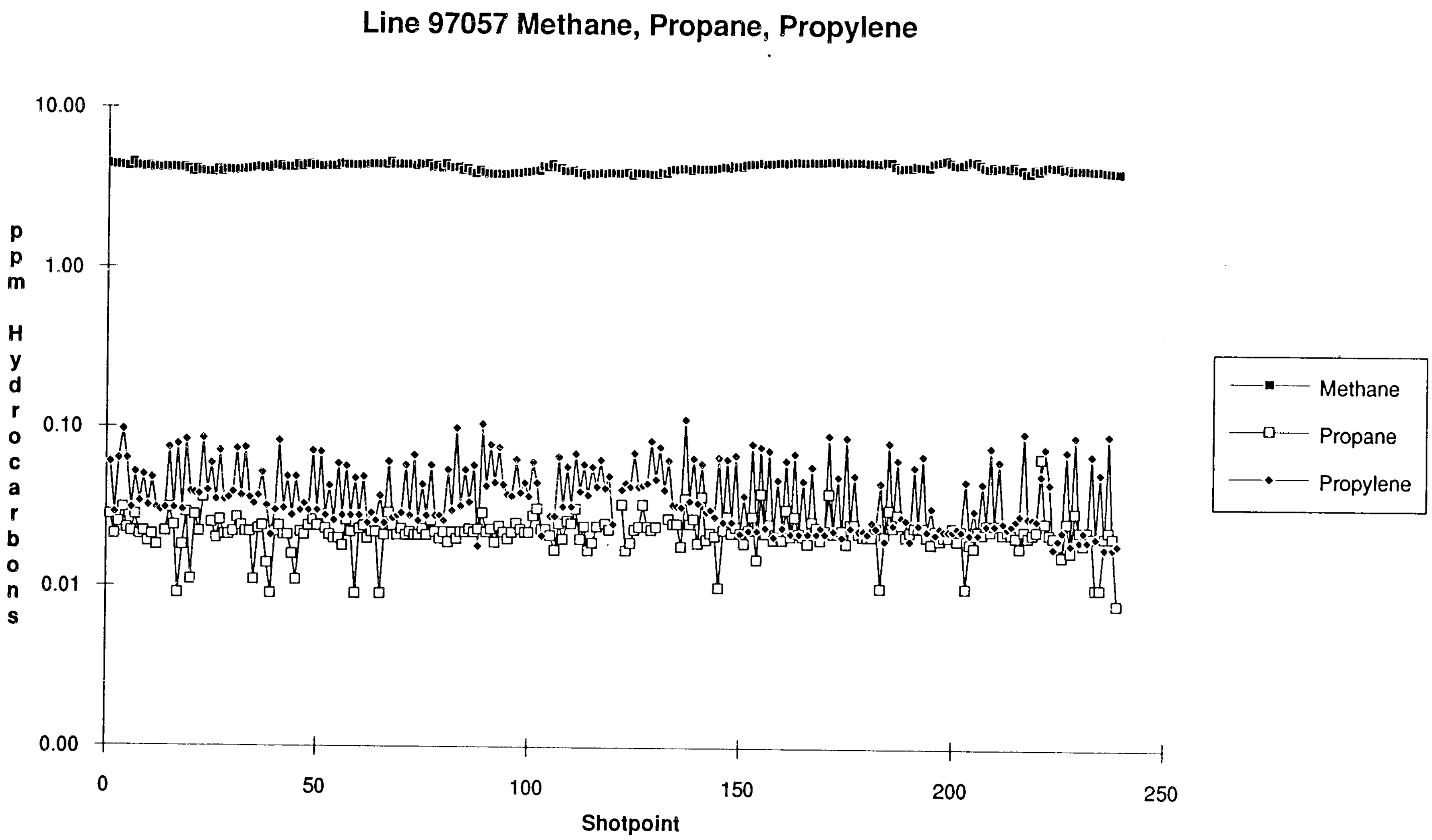
Notes

No anomalies. Erratic THC and methane values associated with rapid fluctuations in fish depth.

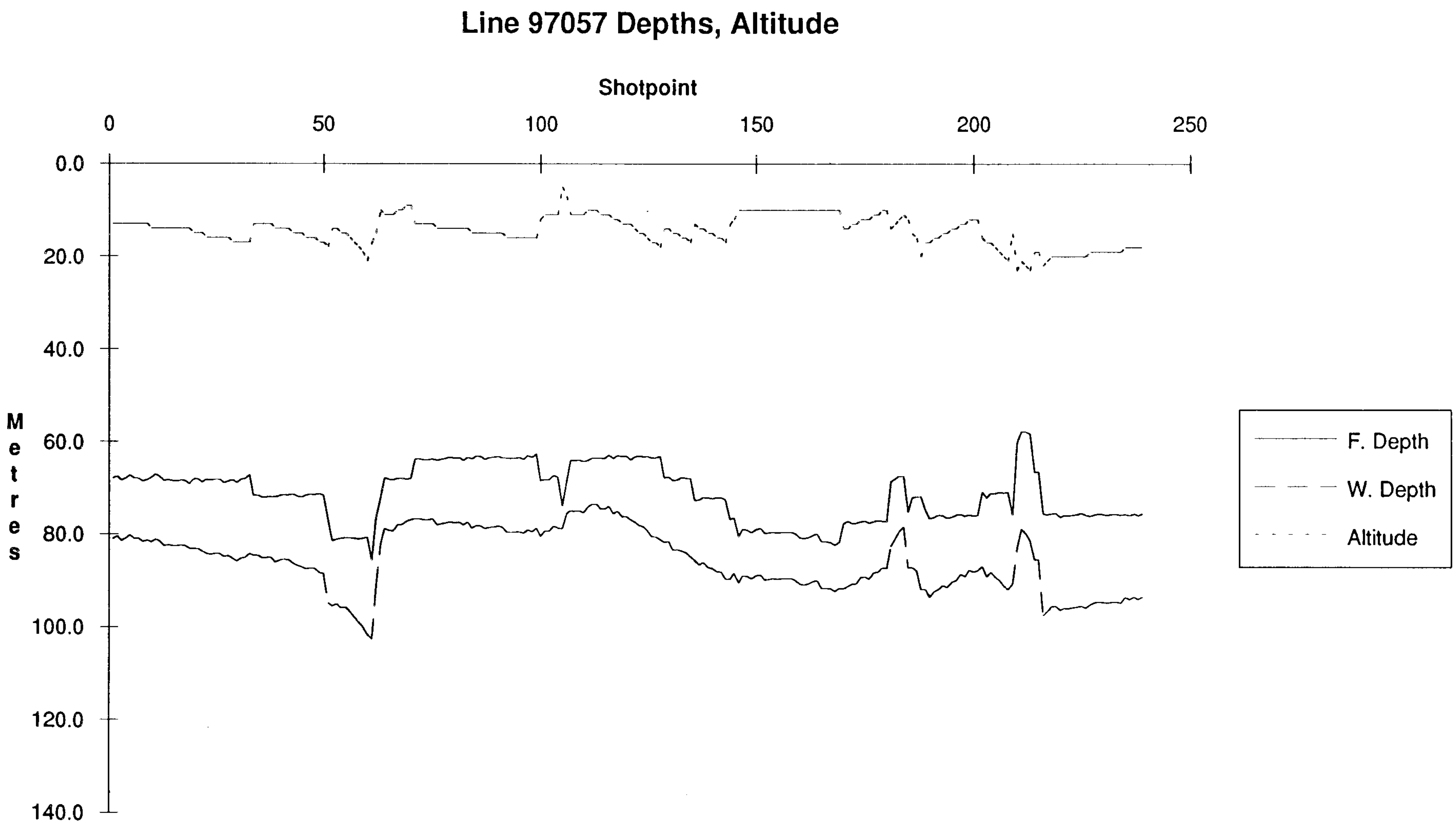

Line 97057 THC, Methane
ppm Hydrocarbons
20.00
18.00
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
0
50
100
150
200
250
Shotpoint
THC
Methane

Line 97057 Methane, Ethane, Ethylene





Line 97057 Methane, Propane, Propylene
ppm Hydrocarbons
10.00
1.00
0.10
0.01
0.00
0
50
100
150
200
250
Shotpoint
Methane
Propane
Propylene


Line 97057 Depths, Altitude
Shotpoint
0
50
100
150
200
250
0.0
20.0
40.0
60.0
80.0
100.0
120.0
140.0
Metres
F. Depth
W. Depth
Altitude

Line Summary

Line Number	97058
No. of Shotpoints	93

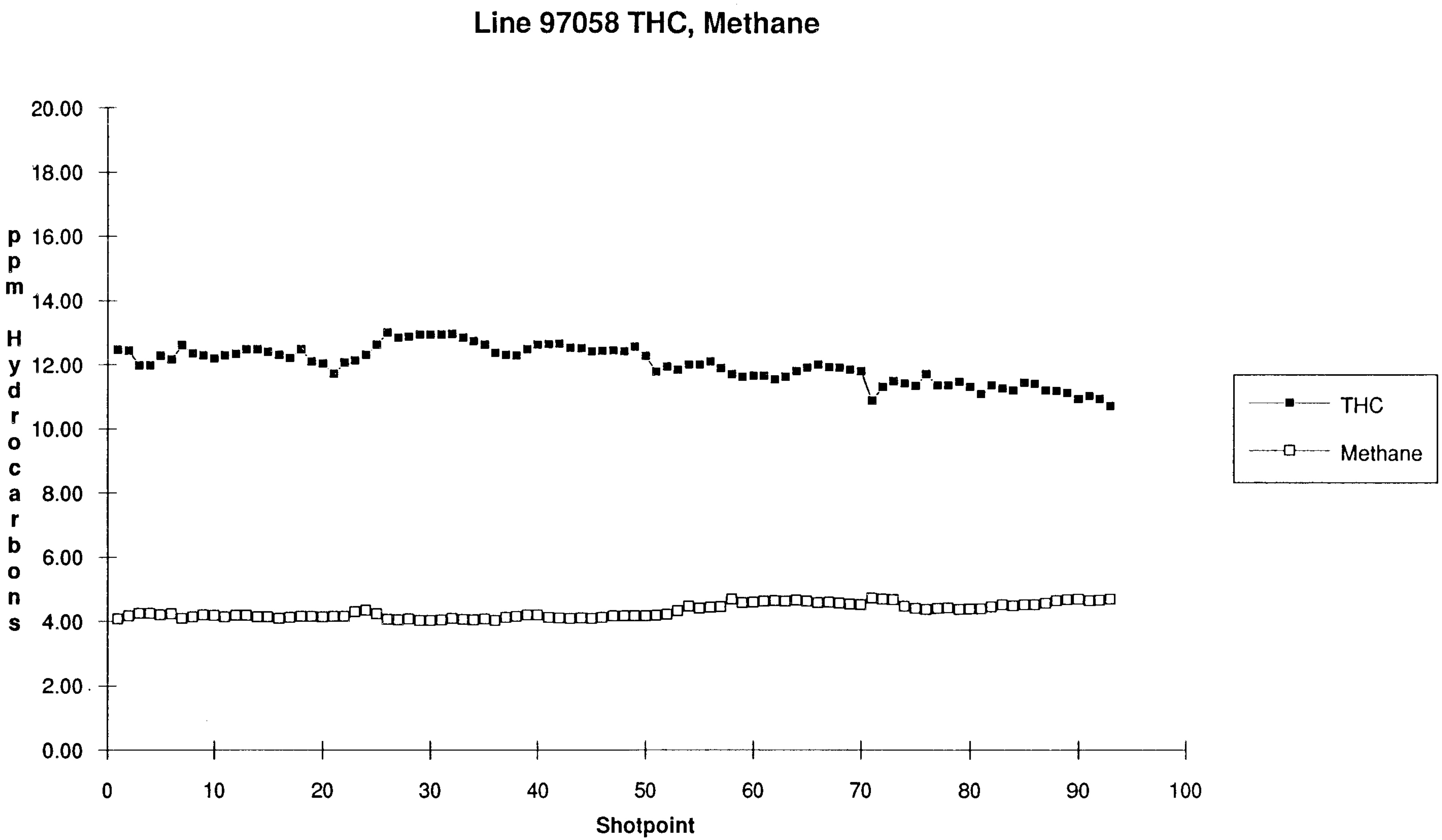
	Shotpoint	Date	Time	Latitude		Longitude	
Start	1	12-Nov-90	06:48:14	11	21.262	125	57.762
End	139	12-Nov-90	11:24:19	11	21.997	125	42.317

	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	12.012	4.313	0.017	0.137	0.020	0.032	0.020	0.000	0.000	0.099	0.024	0.000	1.330
Std. Dev.	0.566	0.221	0.001	0.012	0.008	0.024	0.032	0.000	0.000	0.042	0.034	0.000	0.804
Minimum	10.700	4.014	0.015	0.117	0.000	0.008	0.000	0.000	0.000	0.000	0.000	0.000	0.357
Maximum	13.001	4.716	0.020	0.186	0.055	0.095	0.094	0.000	0.000	0.256	0.215	0.000	3.238

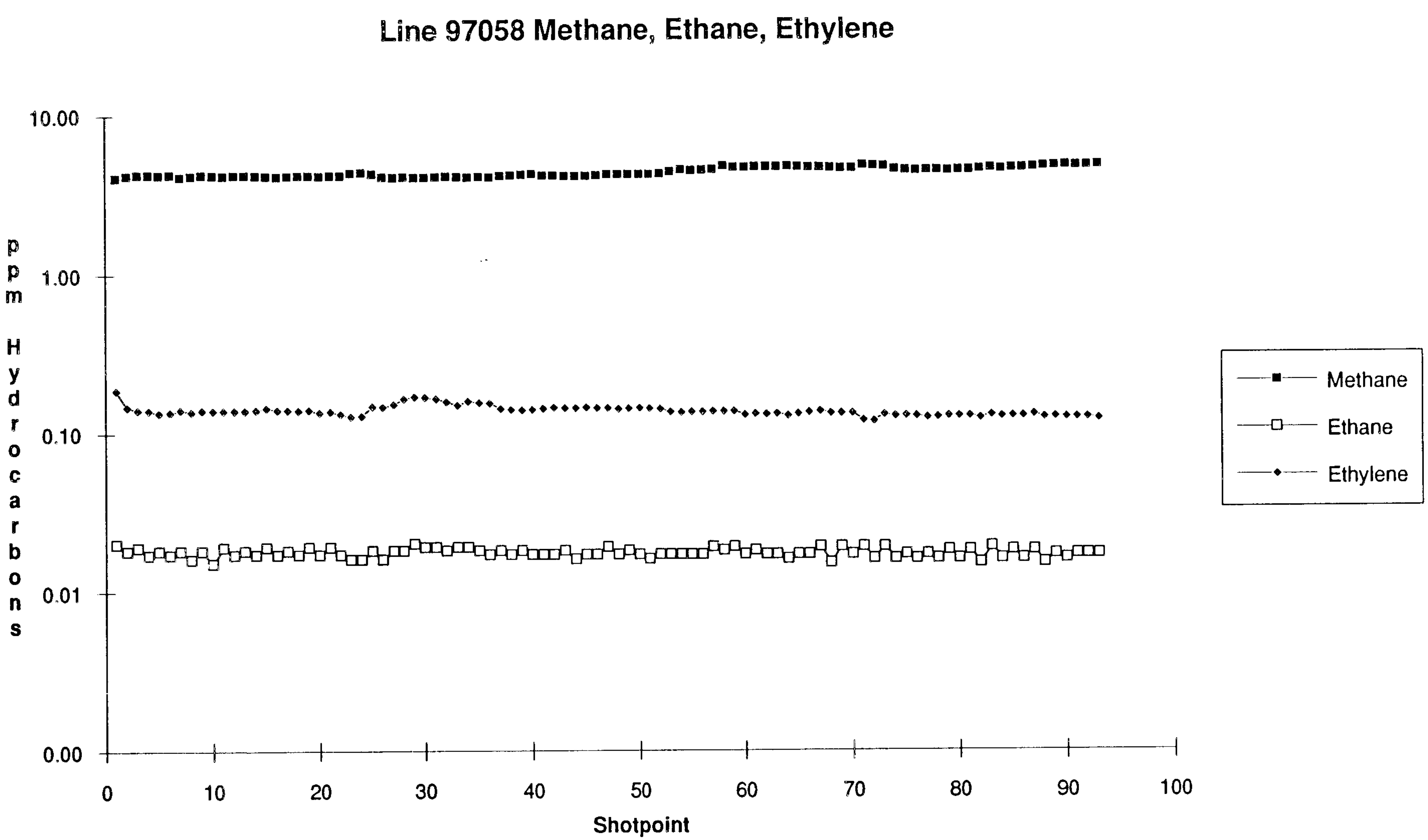
	Cond.	Temp.	F. Depth	W.Depth	Altitude
Mean	56.355	28.912	78.301	95.871	17.570
Std. Dev	0.672	0.661	3.802	5.817	4.837
Minimum	55.280	27.790	72.216	89.216	14.000
Maximum	57.650	30.180	86.496	132.214	55.000

Notes

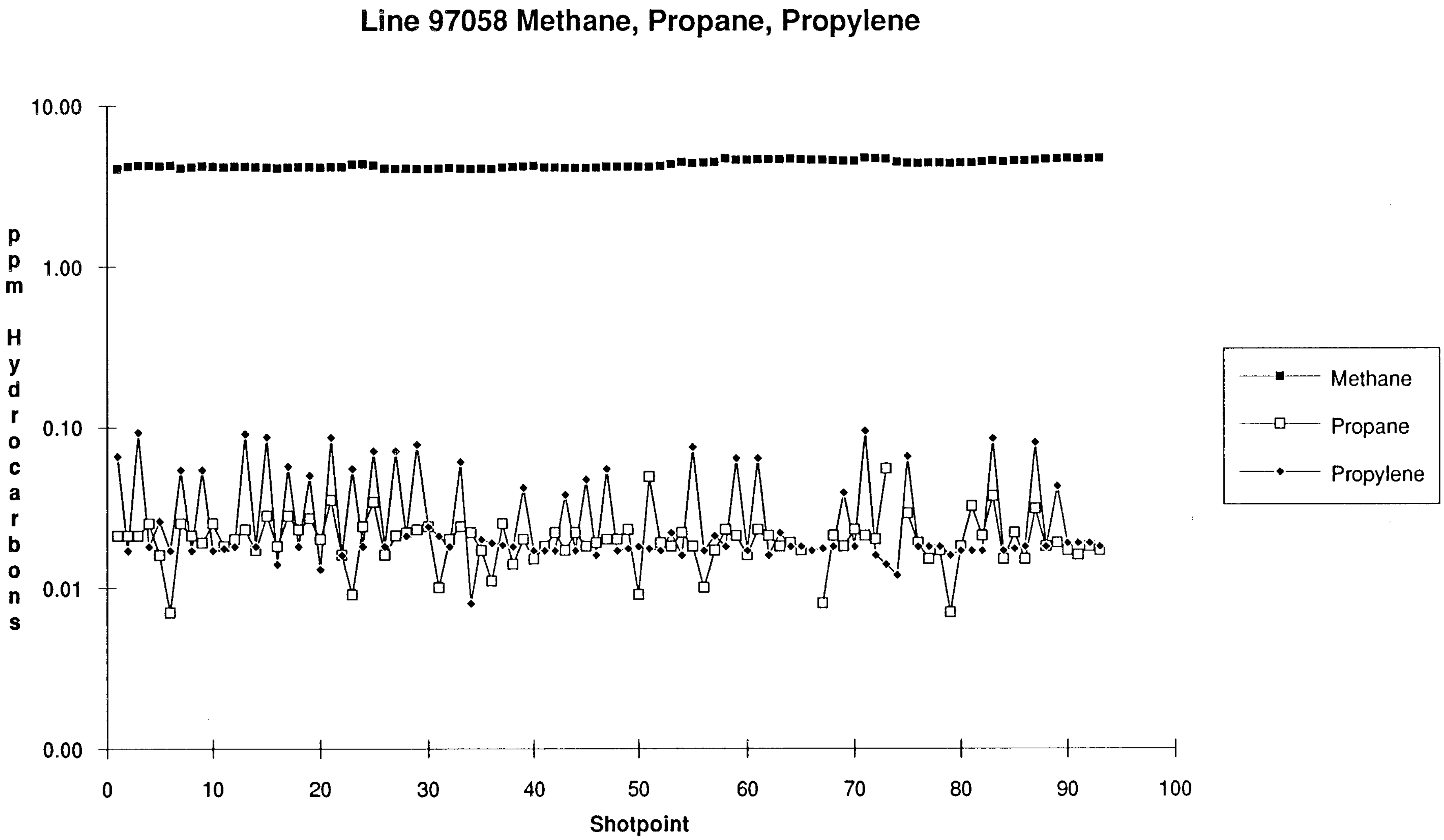
No anomalies. Erratic THC and methane values associated with rapid fluctuations in fish depth.



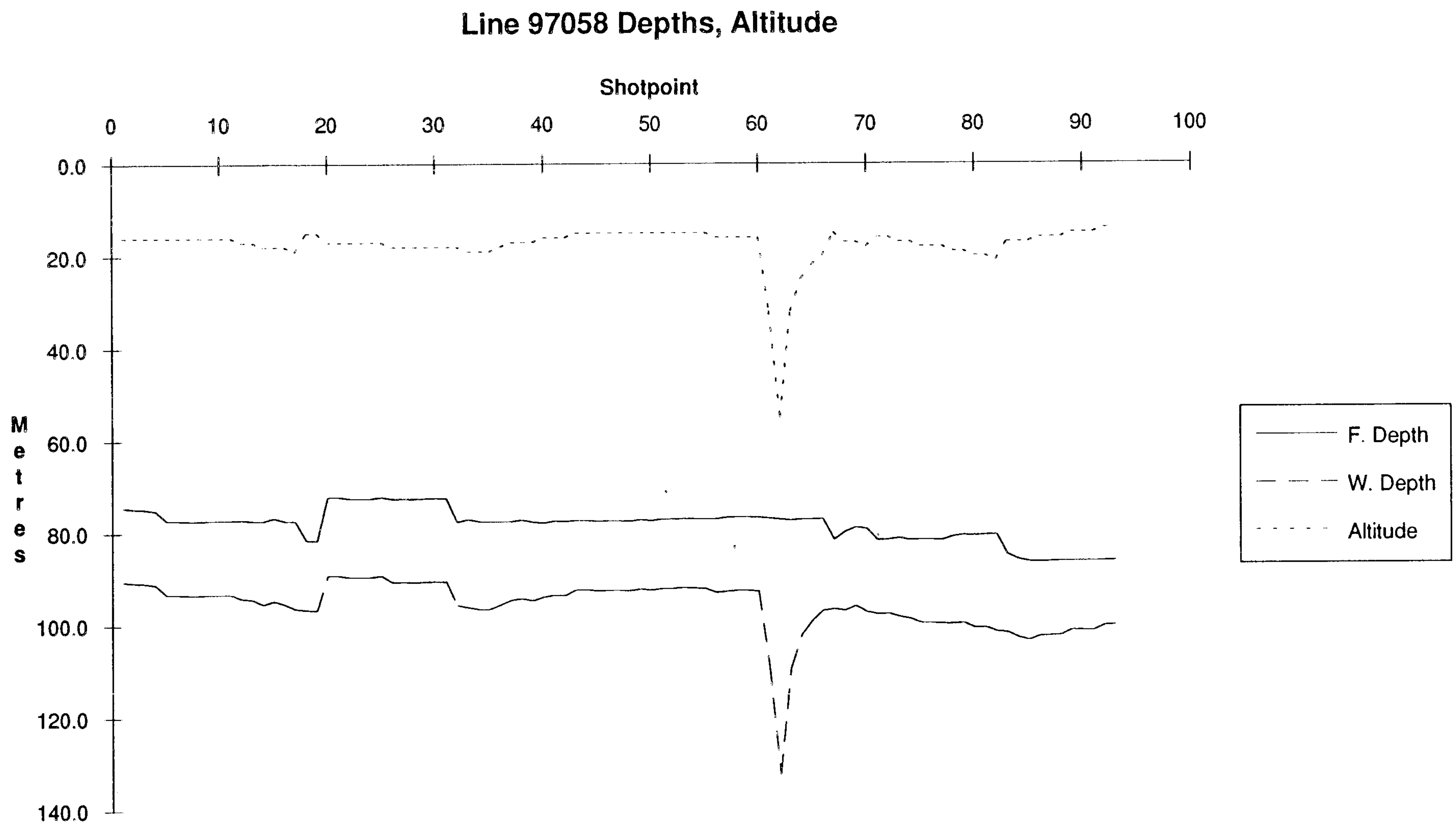
Line 97058 THC, Methane
20.00
18.00
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
ppm Hydrocarbons
0
10
20
30
40
50
60
70
80
90
100
Shotpoint
THC
Methane



Line 97058 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
100
Shotpoint
Methane
Ethane
Ethylene



Line 97058 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
100
Shotpoint
Methane
Propane
Propylene


Line 97058 Depths, Altitude
Shotpoint
0
10
20
30
40
50
60
70
80
90
100
0.0
20.0
40.0
60.0
80.0
100.0
120.0
140.0
Metres
F. Depth
W. Depth
Altitude

Line Summary

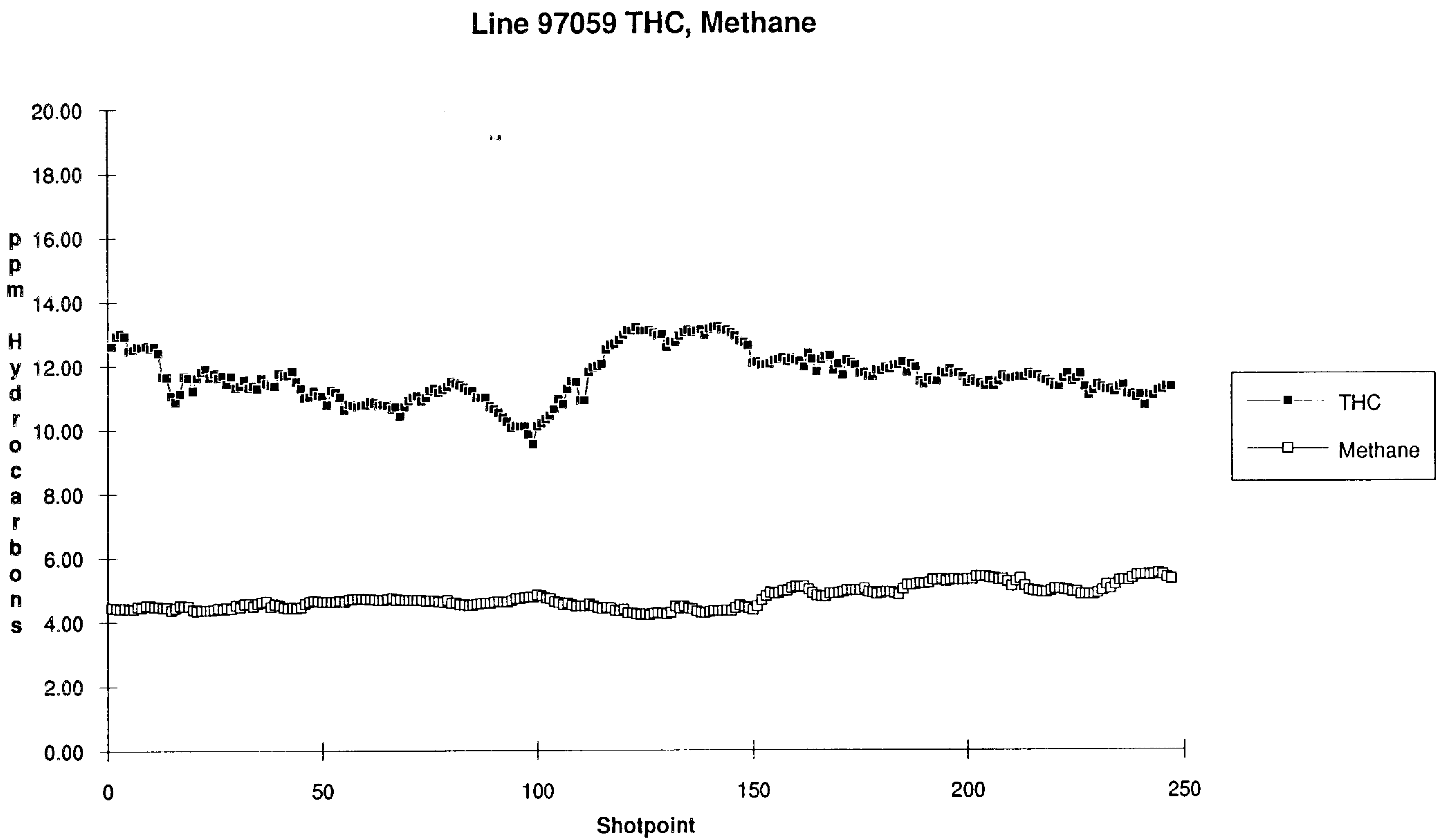
Line Number 97059
No. of Shotpoints 247

	Shotpoint	Date	Time	Latitude		Longitude	
Start	1	12-Nov-90	14:01:57	11	20.020	125	47.685
End	247	12-Nov-90	22:15:03	11	46.247	125	15.253

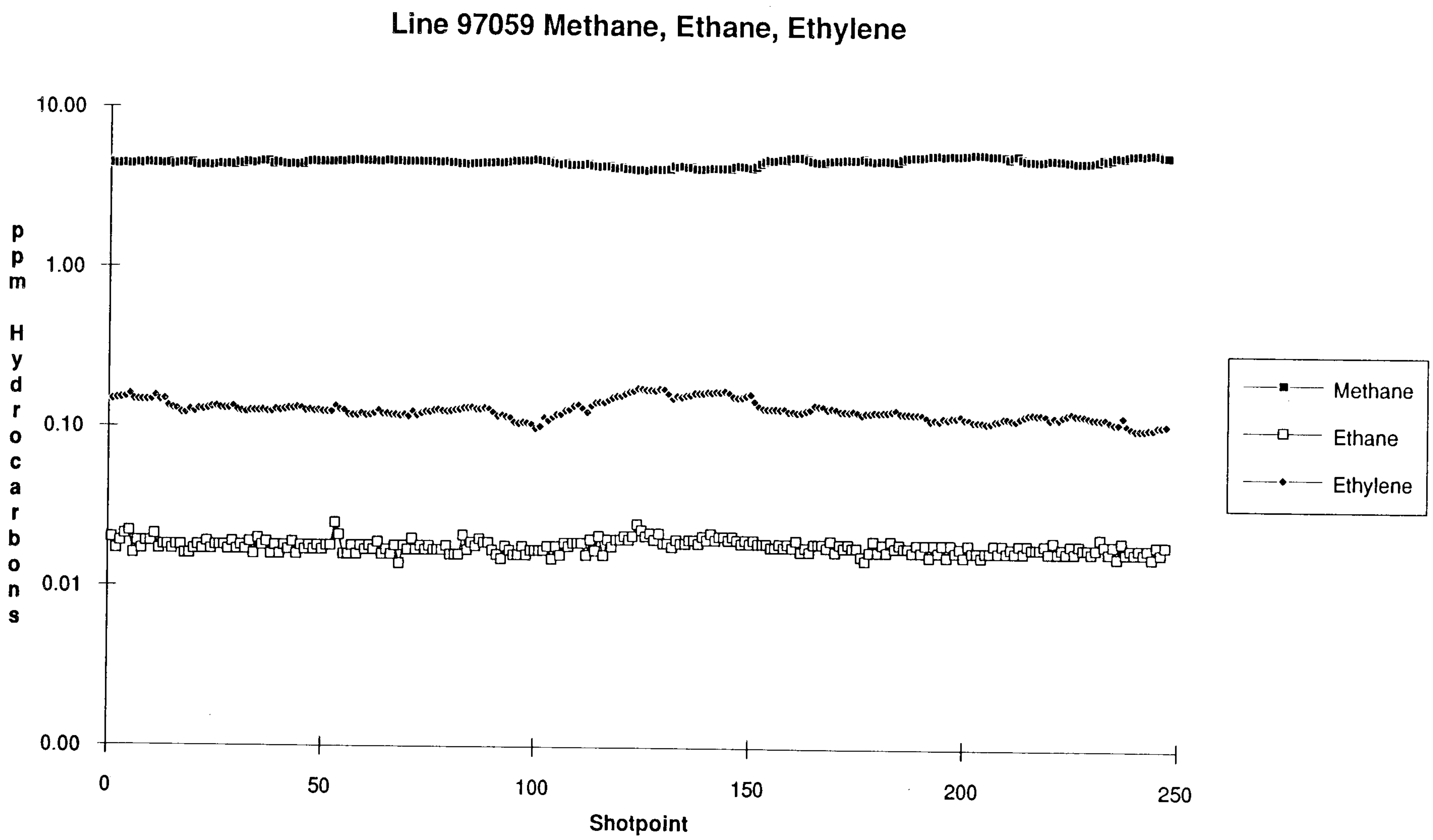
	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	11.632	4.727	0.018	0.132	0.020	0.025	0.008	0.000	0.000	0.062	0.012	0.000	0.975
Std. Dev.	0.760	0.329	0.002	0.017	0.009	0.017	0.020	0.000	0.000	0.031	0.019	0.000	0.535
Minimum	9.535	4.194	0.014	0.100	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.351
Maximum	13.191	5.492	0.025	0.180	0.060	0.098	0.095	0.000	0.000	0.172	0.140	0.000	3.068

	Cond.	Temp.	F. Depth	W.Depth	Altitude
Mean	55.187	27.757	87.711	102.043	14.332
Std. Dev.	0.358	0.310	6.427	7.002	3.256
Minimum	54.460	27.020	77.316	88.724	6.000
Maximum	55.930	28.460	103.224	125.756	41.000

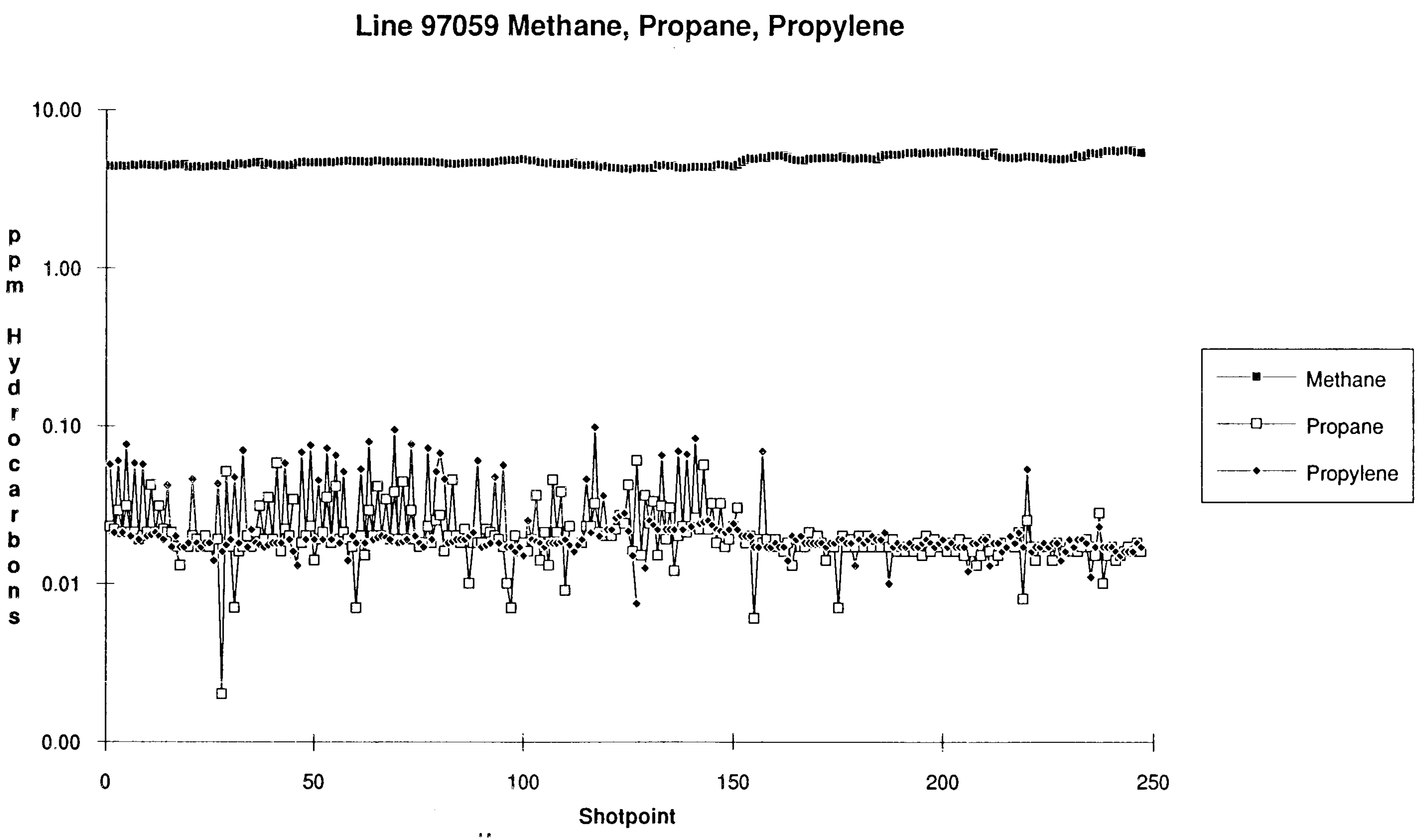
Notes No anomalies.



Line 97059 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
50
100
150
200
250
Shotpoint
THC
Methane

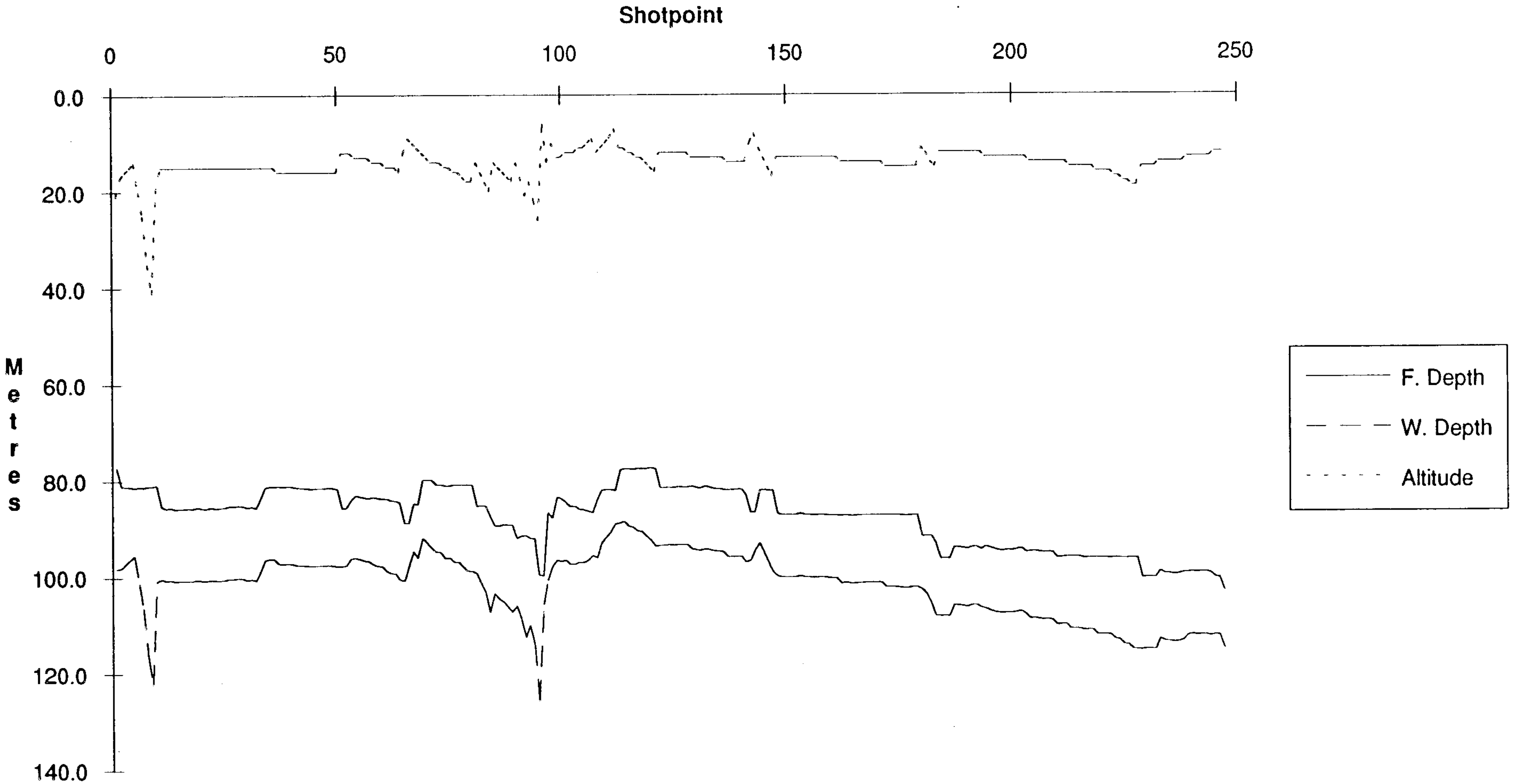


Line 97059 Methane, Ethane, Ethylene
10.00
1.00
0.10
0.01
0.00
ppm Hydrocarbons
0
50
100
150
200
250
Shotpoint
Methane
Ethane
Ethylene



Line 97059 Methane, Propane, Propylene
ppm Hydrocarbons
10.00
1.00
0.10
0.01
0.00
0
50
100
150
200
250
Shotpoint
Methane
Propane
Propylene

Line 97059 Depths, Altitude



Line Summary

Line Number	97060
No. of Shotpoints	150

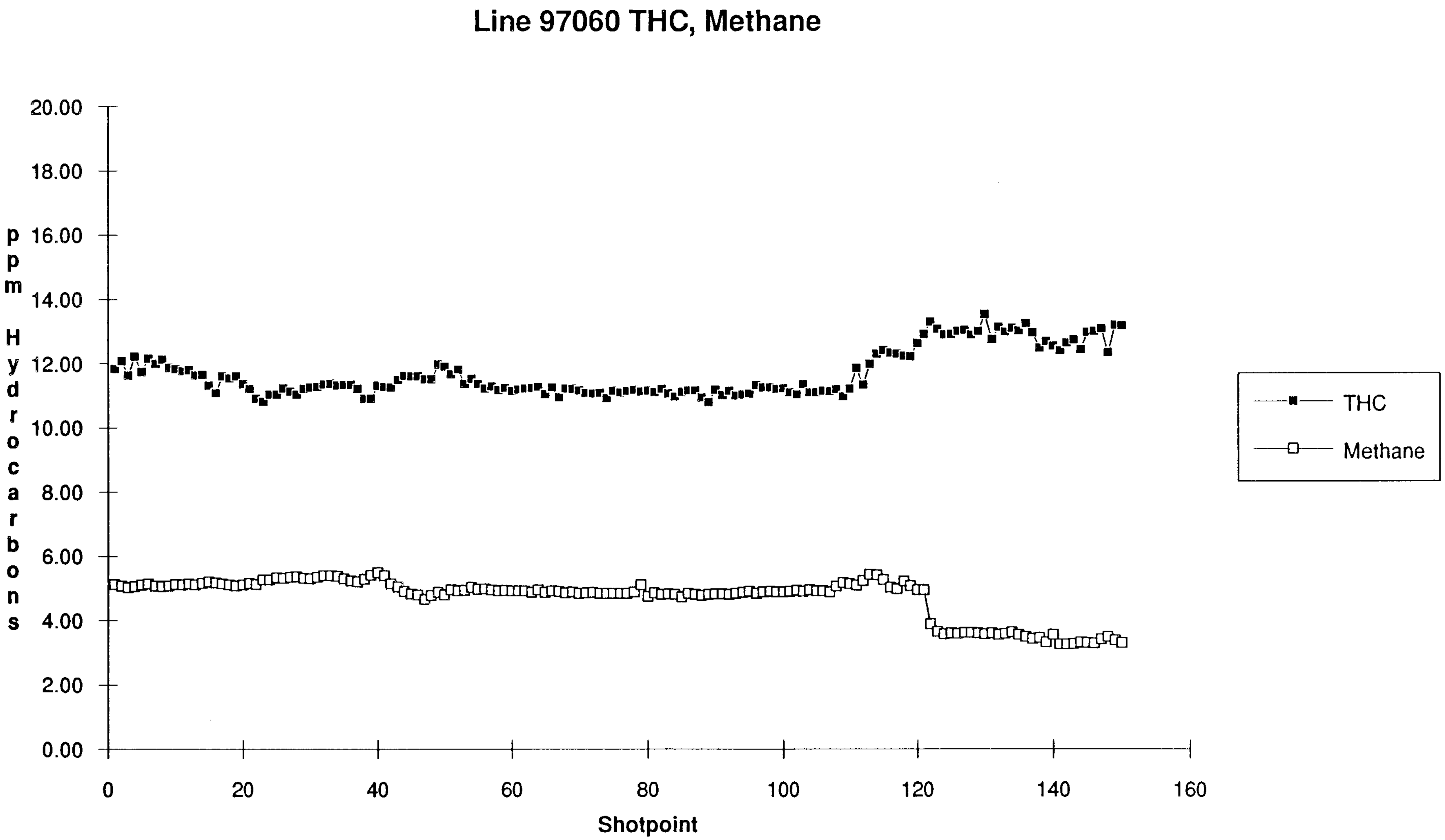
	Shotpoint	Date	Time	Latitude		Longitude	
Start	1	11/13/90	00:41:06	11	42.698	125	20.244
End	253	11/13/90	09:05:09	11	56.169	124	58.106

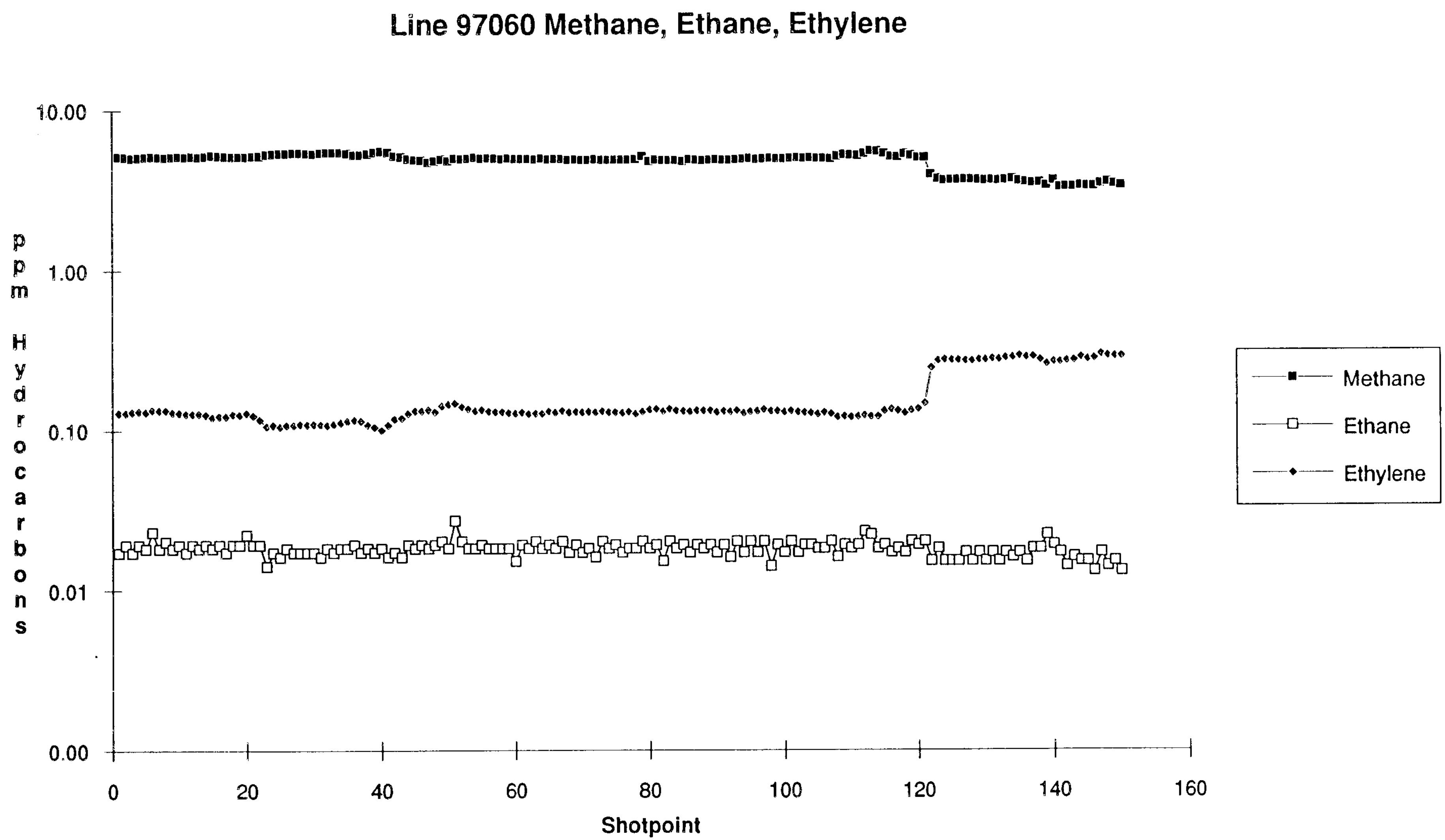
	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	11.676	4.716	0.018	0.155	0.018	0.031	0.000	0.002	0.000	0.084	0.010	0.000	0.816
Std. Dev.	0.720	0.634	0.002	0.060	0.005	0.029	0.003	0.010	0.000	0.051	0.030	0.004	0.340
Minimum	10.790	3.248	0.013	0.100	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.300
Maximum	13.516	5.473	0.027	0.295	0.030	0.124	0.029	0.080	0.000	0.252	0.265	0.048	3.329

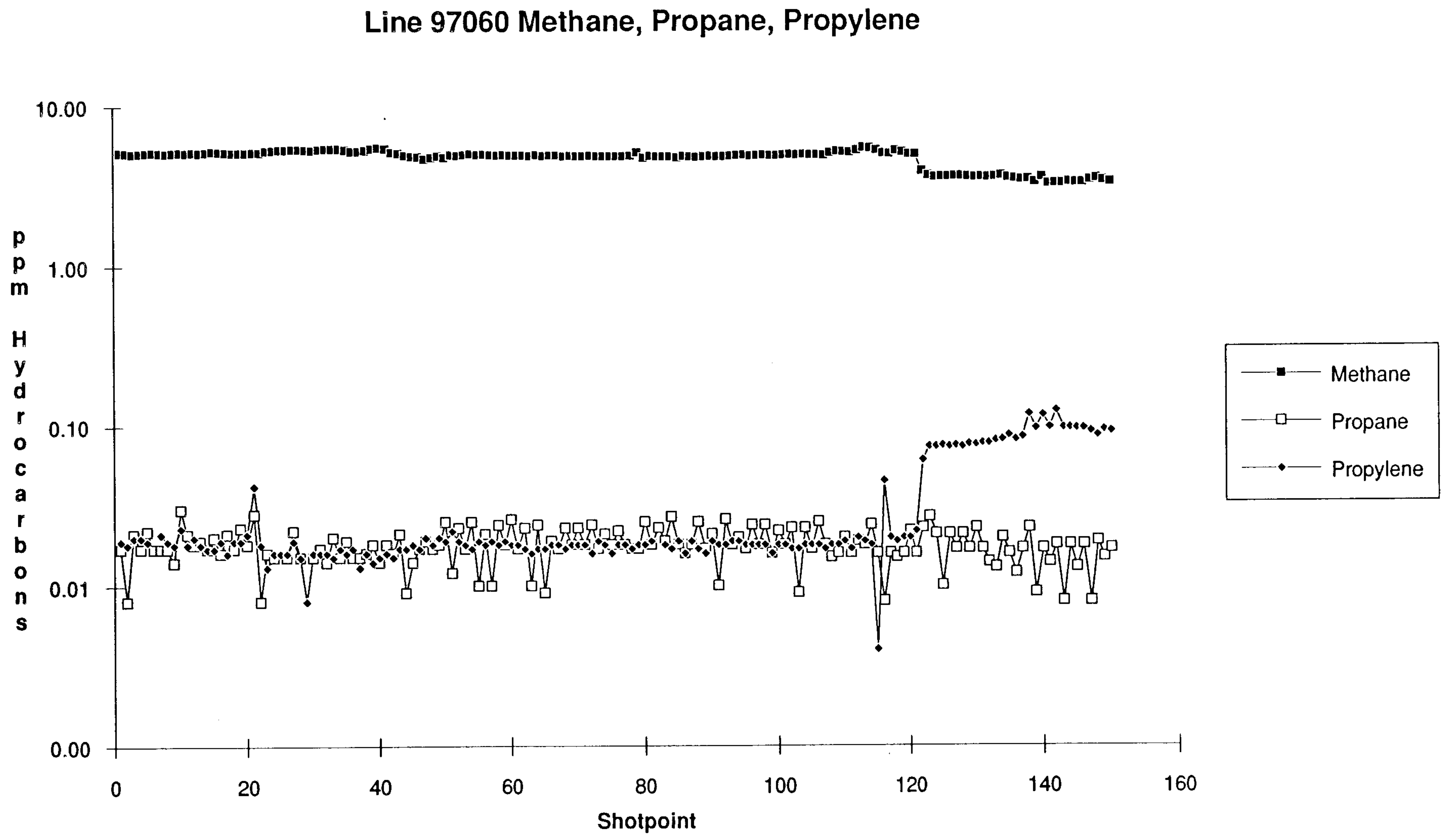
	Cond.	Temp.	F. Depth	W.Depth	Altitude
Mean	57.014	29.282	81.608	112.888	31.280
Std. Dev.	0.535	0.472	27.961	1.201	28.201
Minimum	55.860	28.330	25.704	108.840	10.000
Maximum	58.170	30.440	103.734	116.430	87.000

Notes

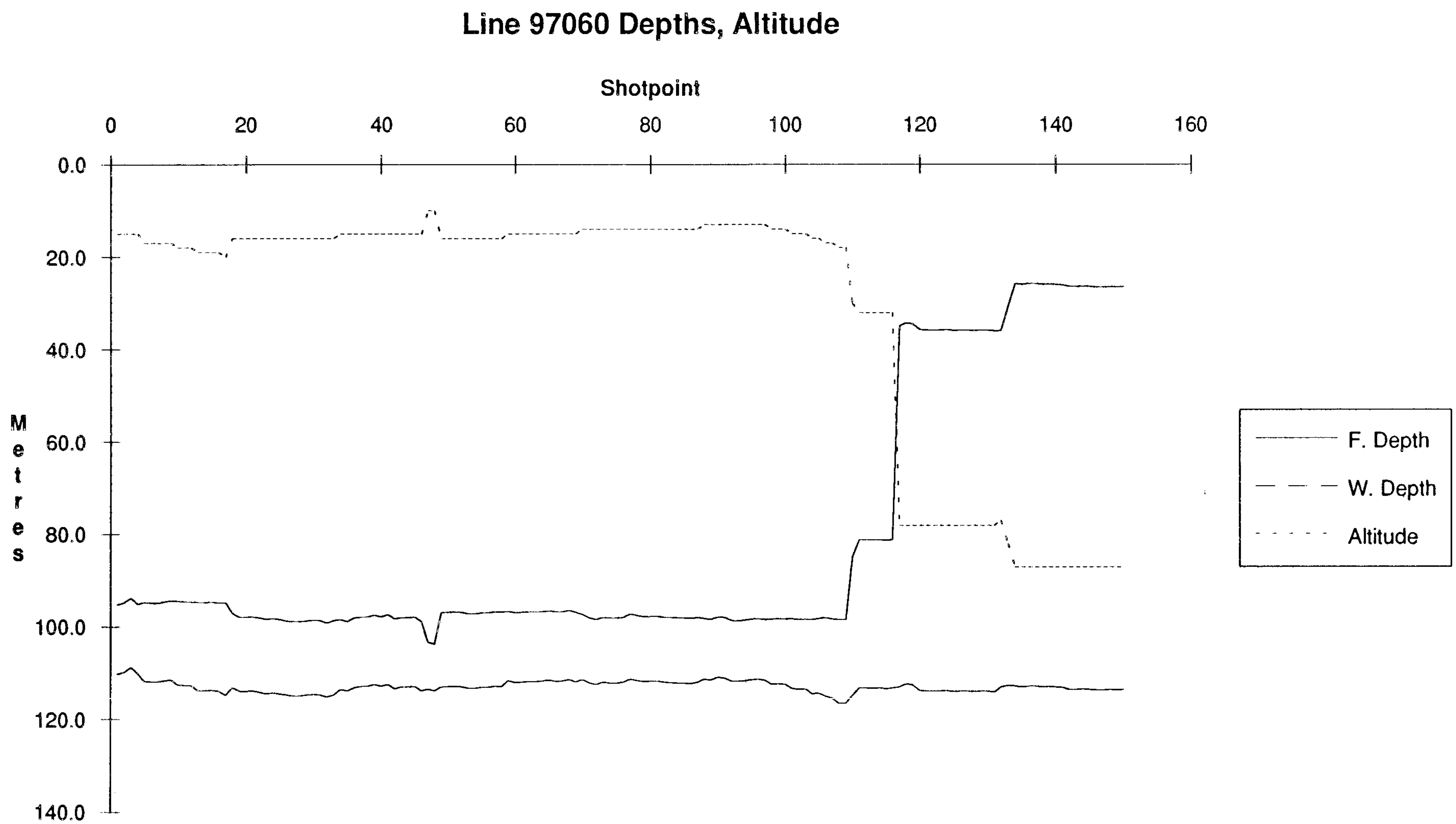
Significant changes in THC and methane concentrations associated with raising the fish to near the surface over the Jabiru oil field (near end of line).


Line 97060 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
Shotpoint
THC
Methane


Line 97060 Methane, Ethane, Ethylene
10.00
1.00
0.10
0.01
0.00
ppm Hydrocarbons
0
20
40
60
80
100
120
140
160
Shotpoint
Methane
Ethane
Ethylene



Line 97060 Methane, Propane, Propylene
ppm Hydrocarbons
10.00
1.00
0.10
0.01
0.00
0
20
40
60
80
100
120
140
160
Shotpoint
Methane
Propane
Propylene



Line 97060 Depths, Altitude
Shotpoint
0
20
40
60
80
100
120
140
160
0.0
20.0
40.0
60.0
80.0
100.0
120.0
140.0
Metres
F. Depth
W. Depth
Altitude

Line Summary

Line Number	97061
No. of Shotpoints	207

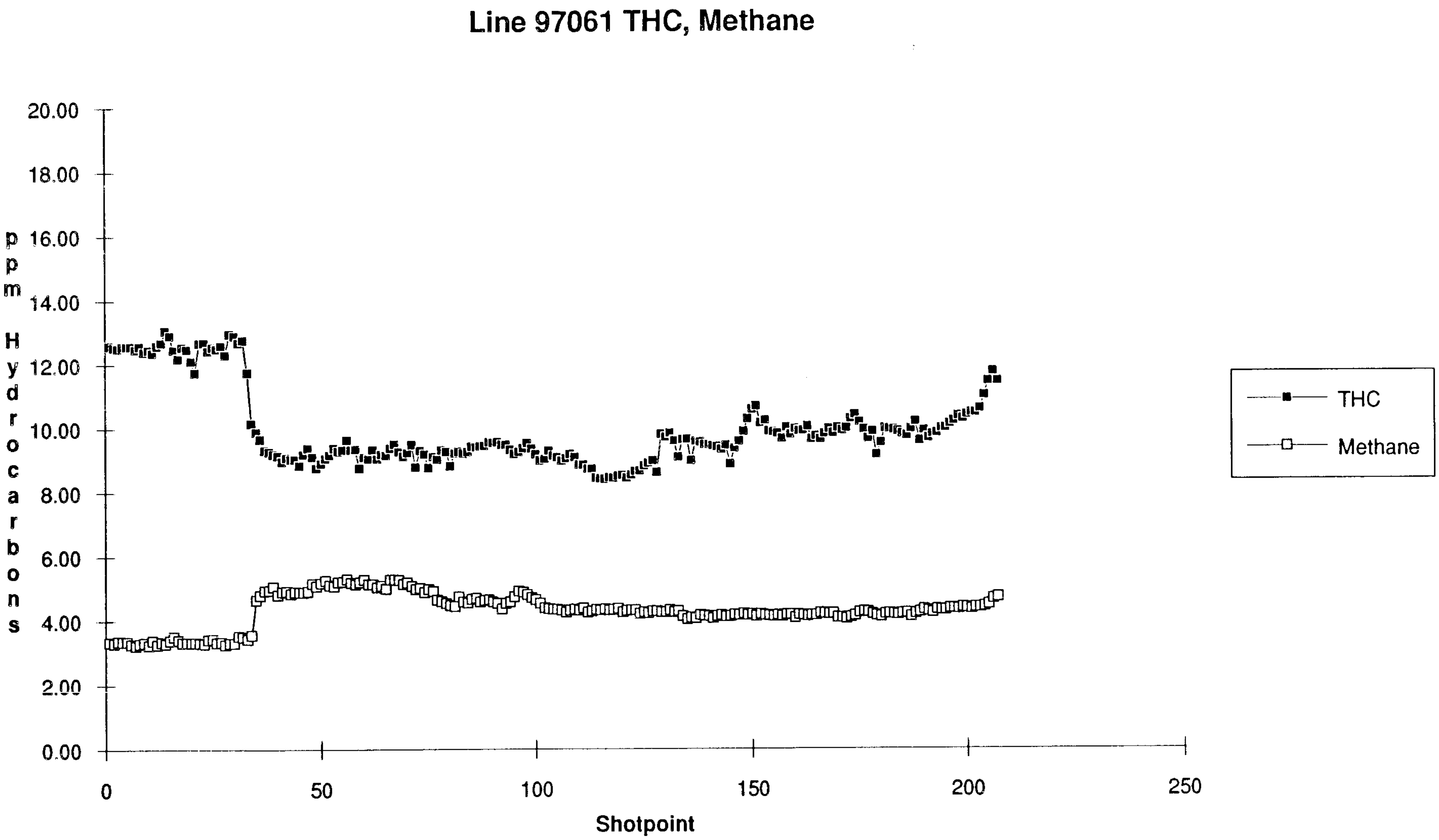
	Shotpoint	Date	Time	Latitude		Longitude	
Start	1	13-Nov-90	11:31:29	11	52.946	125	02.545
End	207	13-Nov-90	18:23:35	12	16.419	124	36.246

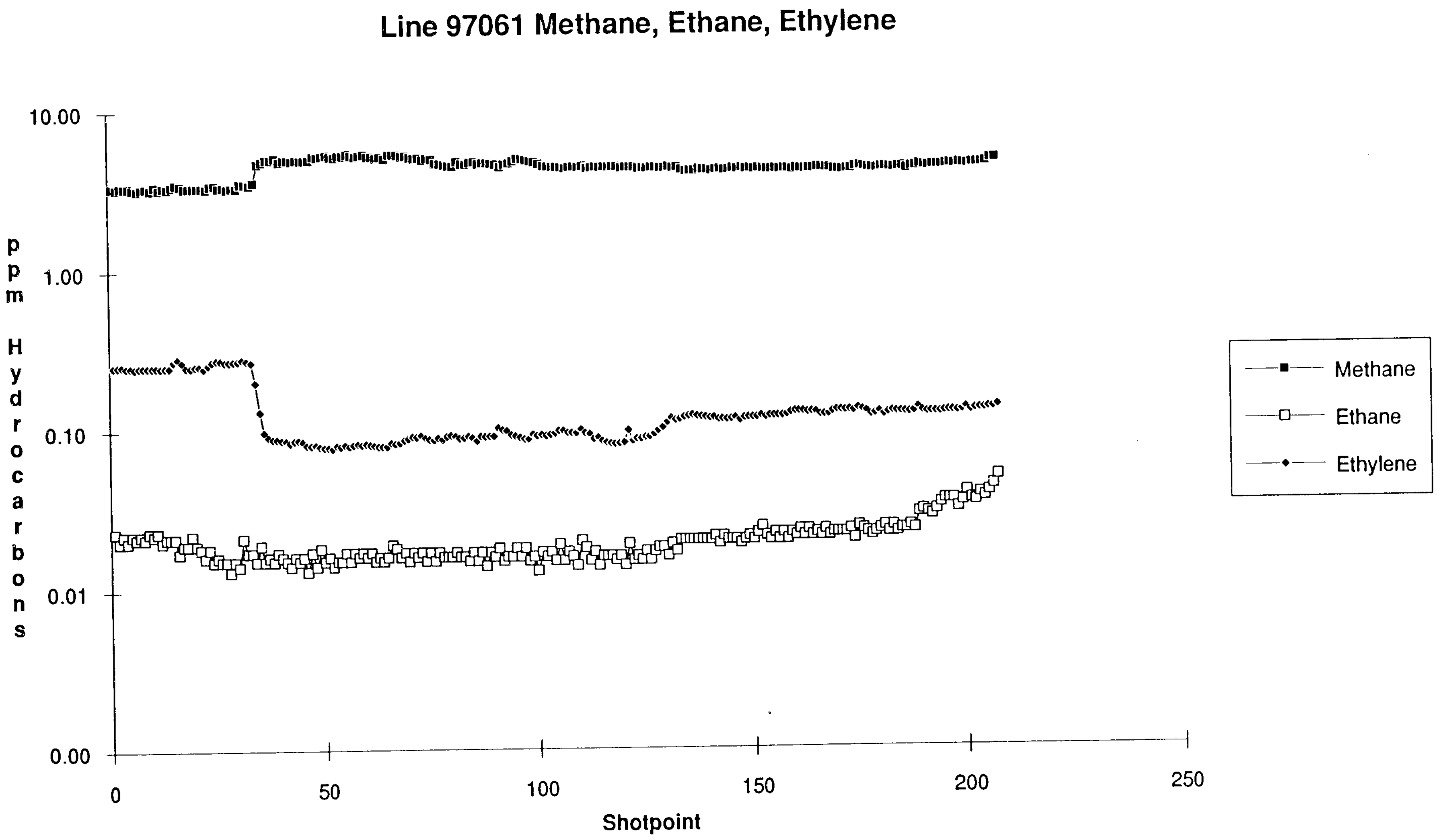
	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	9.958	4.295	0.020	0.129	0.016	0.029	0.000	0.003	0.000	0.059	0.028	0.000	0.932
Std. Dev.	1.238	0.542	0.006	0.061	0.006	0.030	0.000	0.014	0.003	0.040	0.031	0.000	0.509
Minimum	8.402	3.216	0.013	0.077	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.283
Maximum	13.049	5.291	0.049	0.285	0.051	0.132	0.004	0.108	0.038	0.253	0.187	0.000	3.790

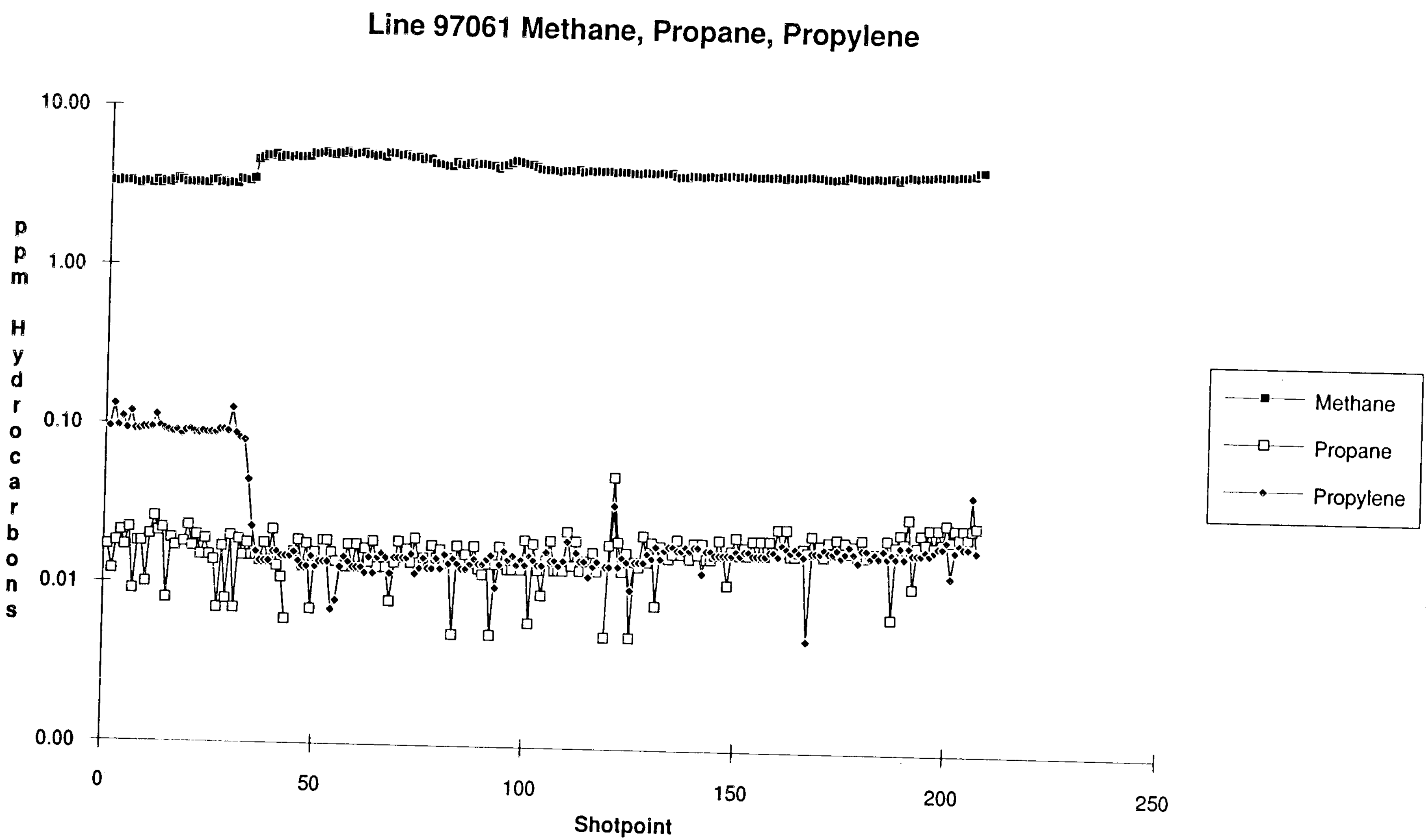
	Cond.	Temp.	F. Depth	W.Depth	Altitude
Mean	54.865	27.320	91.693	115.557	23.865
Std. Dev.	1.339	1.196	26.452	6.038	28.549
Minimum	53.610	26.120	26.316	100.596	6.000
Maximum	58.050	30.320	111.180	126.520	100.000

Notes

Significant changes to THC and methane concentrations associated with raising the fish to near the surface over the Jabiru oil field (at beginning of line).

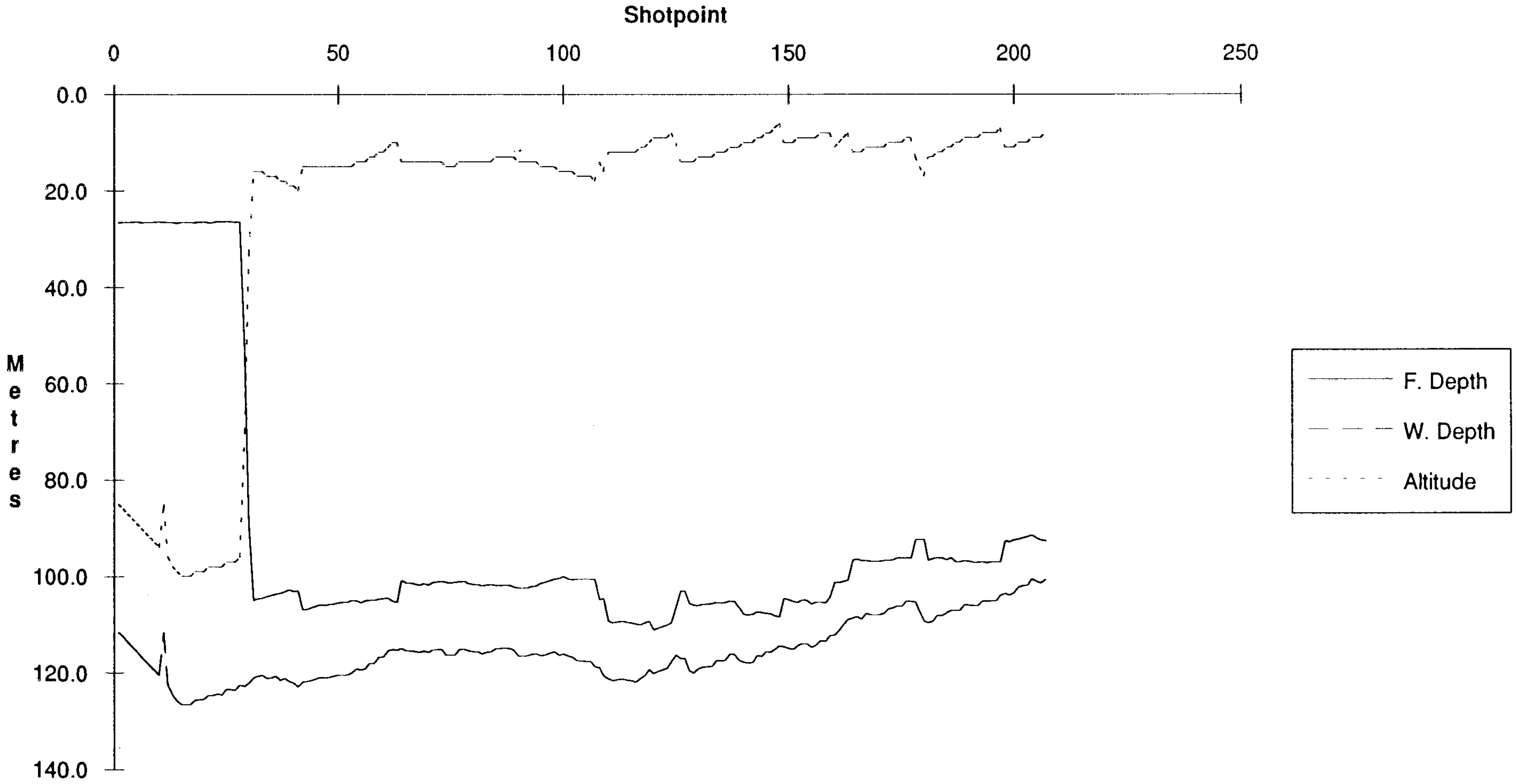

Line 97061 THC, Methane
ppm Hydrocarbons
20.00
18.00
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
0
50
100
150
200
250
Shotpoint
THC
Methane


Line 97061 Methane, Ethane, Ethylene
10.00
1.00
0.10
0.01
0.00
ppm Hydrocarbons
0
50
100
150
200
250
Shotpoint
Methane
Ethane
Ethylene



Line 97061 Methane, Propane, Propylene
ppm Hydrocarbons
10.00
1.00
0.10
0.01
0.00
0
50
100
150
200
250
Shotpoint
Methane
Propane
Propylene

Line 97061 Depths, Altitude



Line Summary

Line Number	97062
No. of Shotpoints	207

	Shotpoint	Date	Time	Latitude		Longitude	
Start	1	13-Nov-90	20:43:42	12	12.216	124	40.414
End	207	14-Nov-90	03:37:26	12	38.944	124	17.518

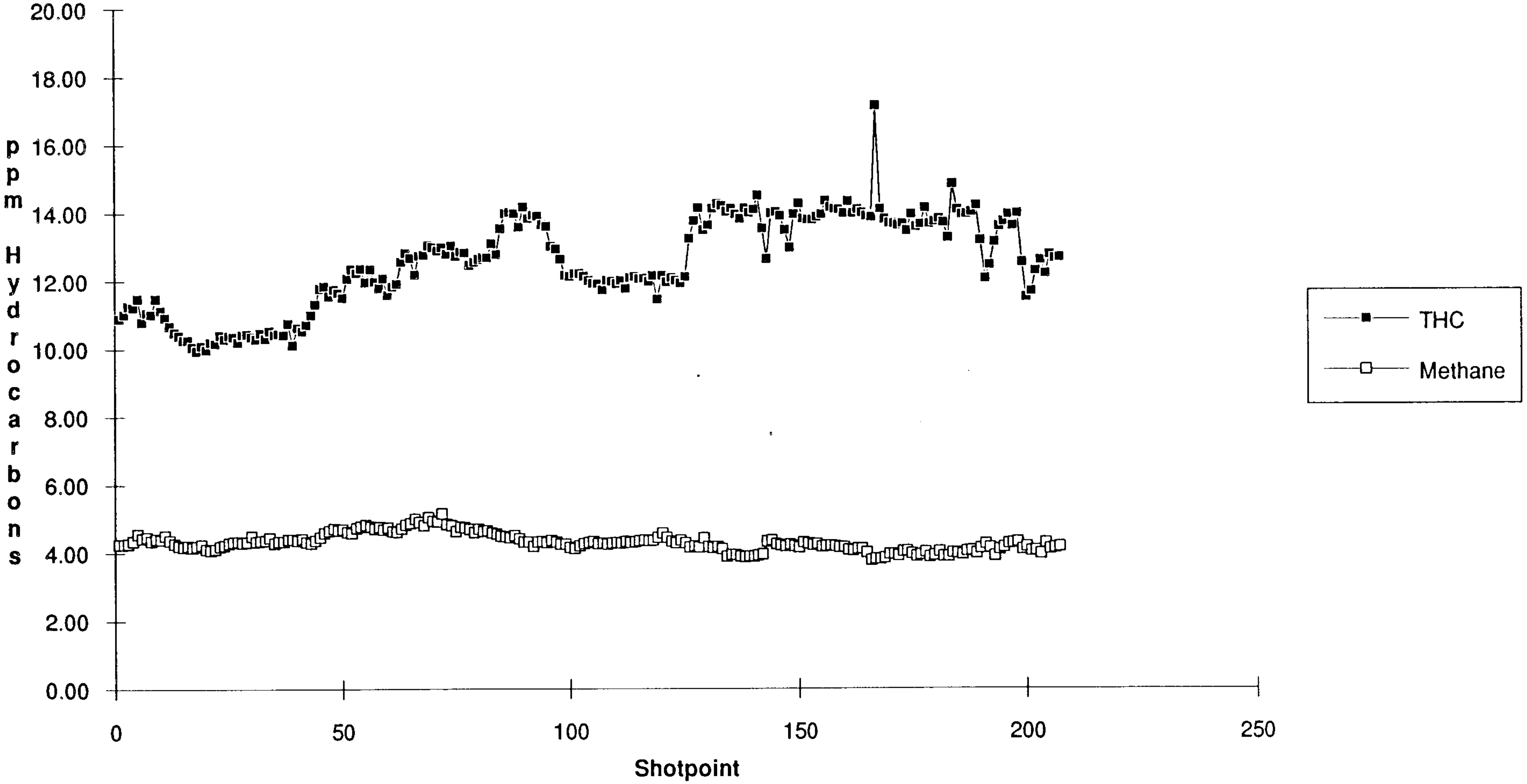
	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	12.550	4.295	0.032	0.161	0.022	0.029	0.001	0.003	0.000	0.120	0.001	0.000	1.302
Std. Dev.	1.340	0.271	0.011	0.035	0.006	0.011	0.005	0.013	0.000	0.059	0.005	0.000	0.467
Minimum	9.934	3.770	0.018	0.119	0.008	0.009	0.000	0.000	0.000	0.000	0.000	0.000	0.771
Maximum	17.142	5.141	0.062	0.249	0.044	0.061	0.038	0.101	0.000	0.297	0.053	0.000	3.621

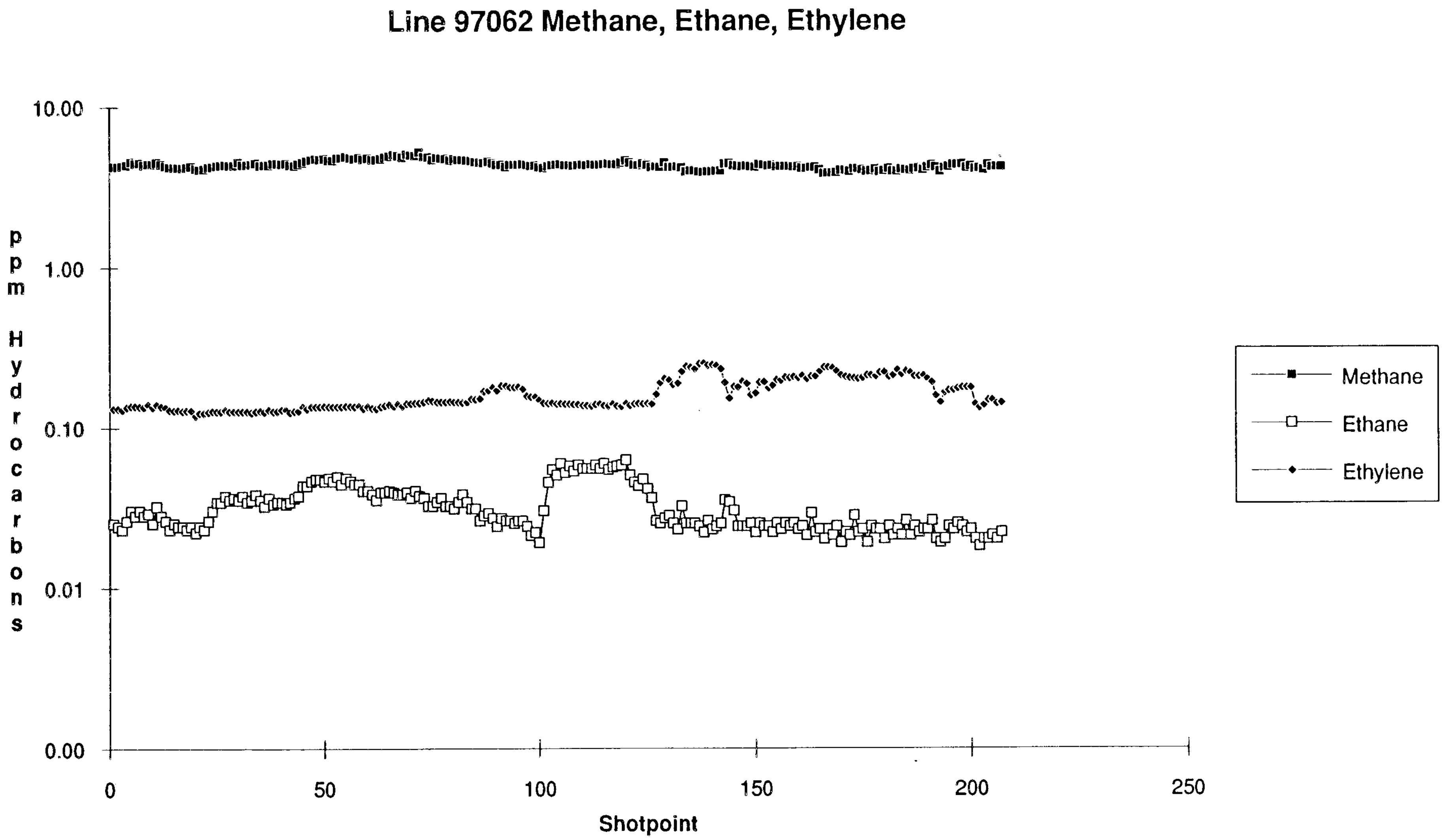
	Cond.	Temp.	F. Depth	W.Depth	Altitude
Mean	56.780	28.791	75.744	88.474	12.729
Std. Dev.	1.462	1.270	15.358	14.400	4.941
Minimum	54.710	26.880	41.106	53.106	7.000
Maximum	59.140	30.970	99.348	112.472	37.000

Notes

Weak anomaly characterised by increases in ethane and propane to the northeast of, over, and to the southwest of the Skua field (SP approximately 1-150).

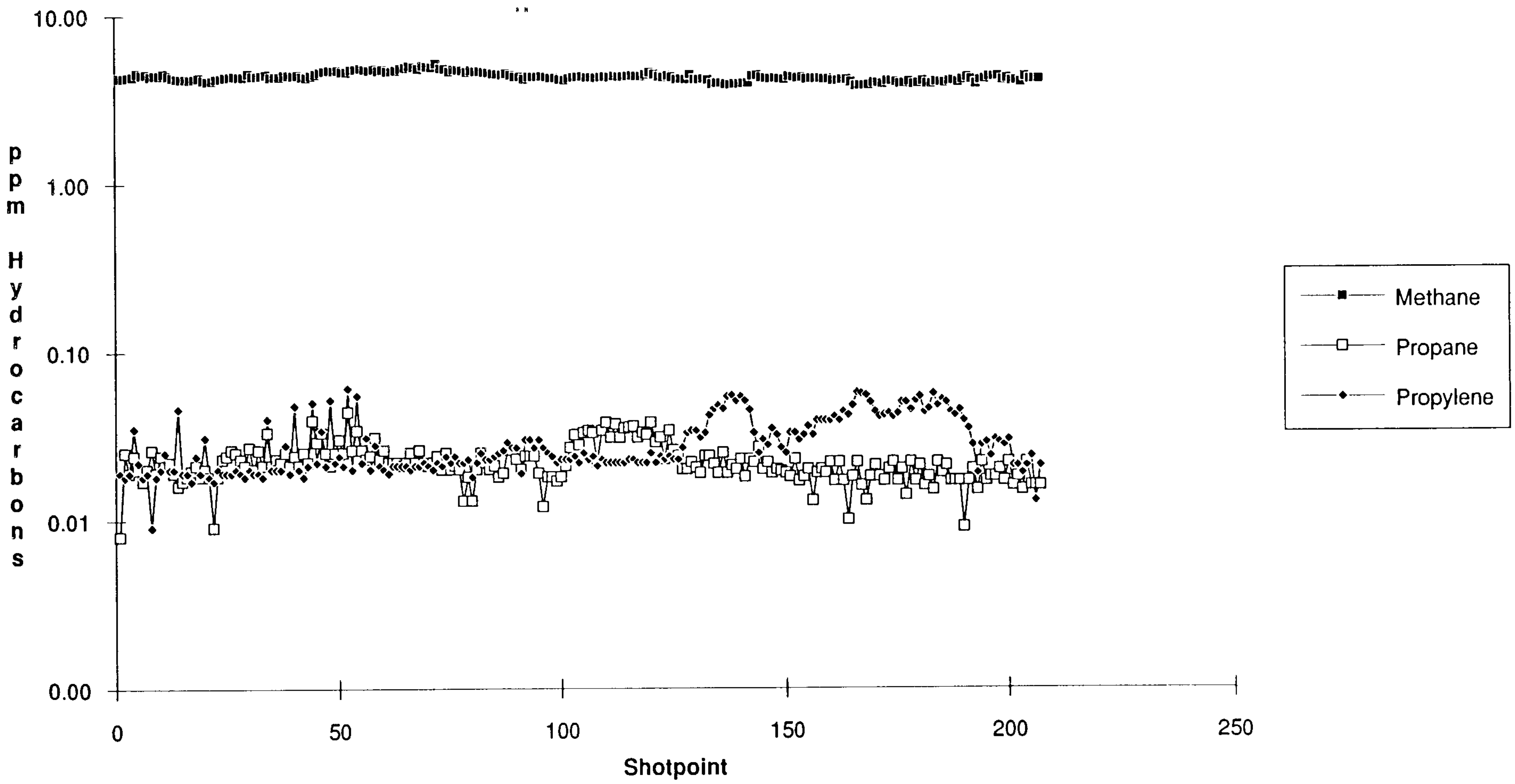
Line 97062 THC, Methane



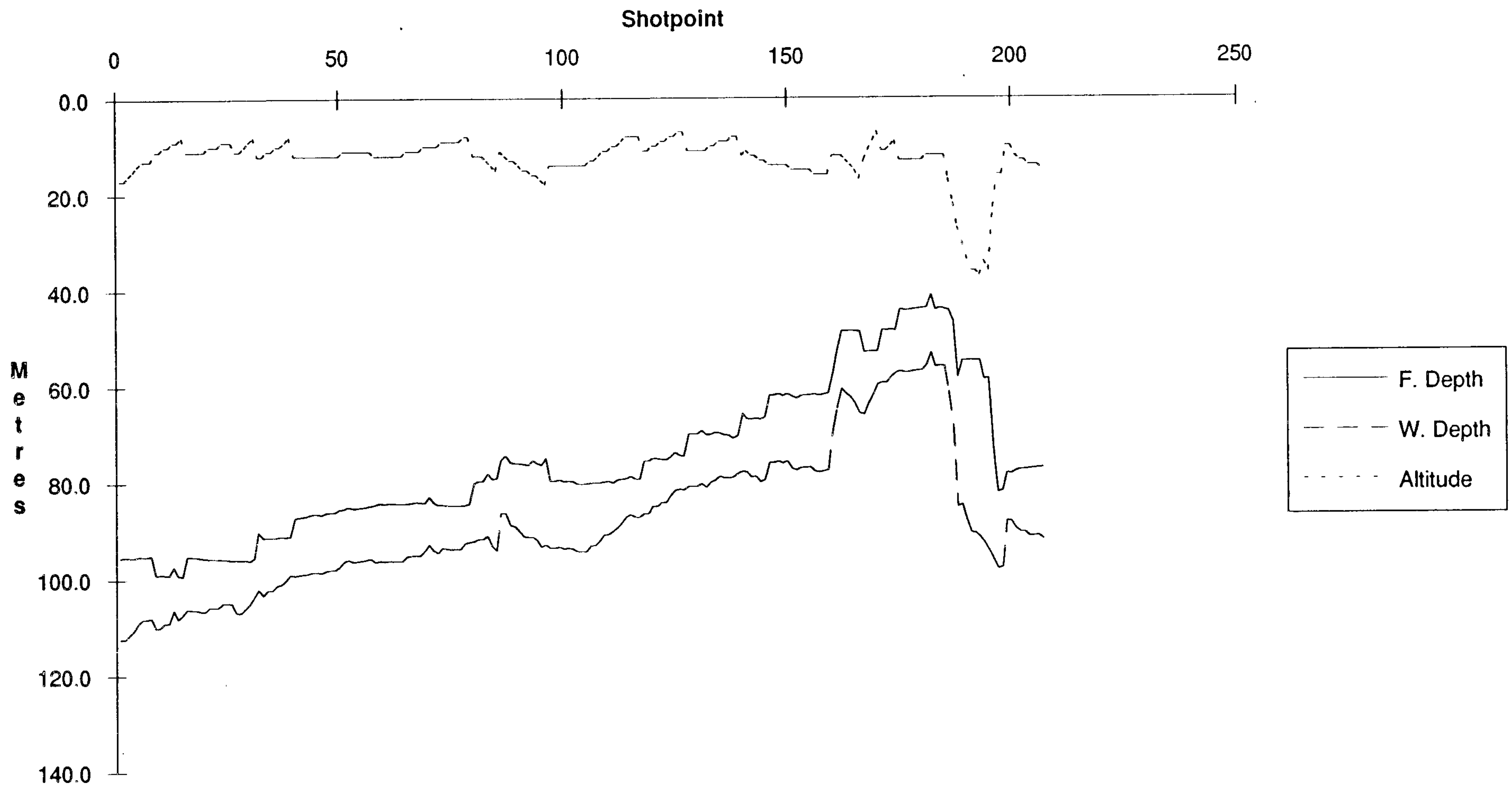


Line 97062 Methane, Ethane, Ethylene
ppm Hydrocarbons
10.00
1.00
0.10
0.01
0.00
0
50
100
150
200
250
Shotpoint
Methane
Ethane
Ethylene

Line 97062 Methane, Propane, Propylene



Line 97062 Depths, Altitude



Line Summary

Line Number	97063
No. of Shotpoints	208

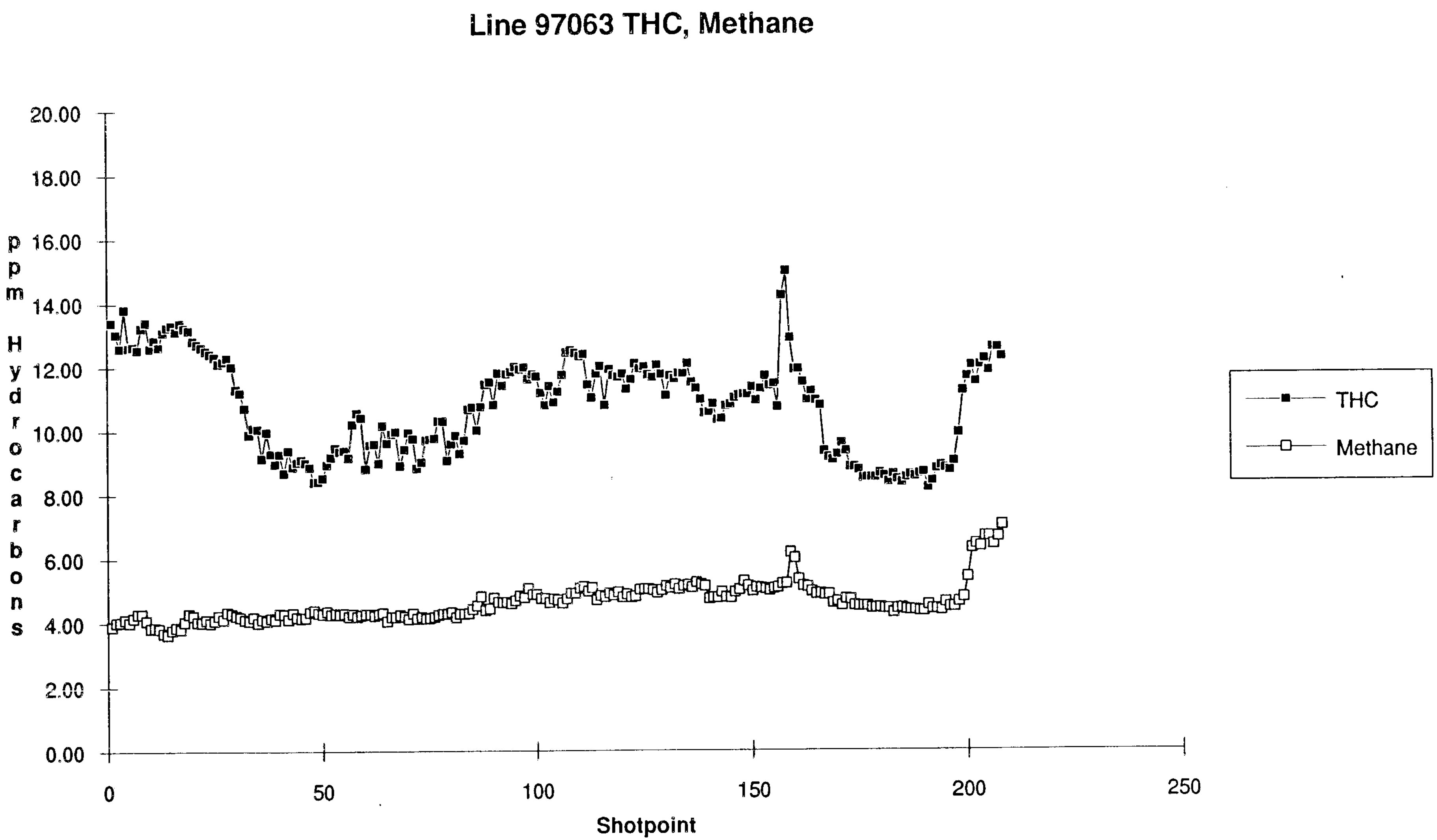
	Shotpoint	Date	Time	Latitude		Longitude	
Start	1	14-Nov-90	06:06:09	12	33.060	124	17.182
End	208	14-Nov-90	13:00:13	13	02.788	124	35.951

	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	10.764	4.600	0.022	0.127	0.017	0.022	0.000	0.000	0.000	0.104	0.000	0.018	0.837
Std. Dev.	1.512	0.567	0.006	0.037	0.006	0.012	0.000	0.001	0.000	0.065	0.000	0.043	0.162
Minimum	8.181	3.631	0.012	0.082	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.340
Maximum	14.948	6.990	0.040	0.244	0.029	0.074	0.000	0.014	0.000	0.308	0.000	0.255	1.329

	Cond.	Temp.	F. Depth	W.Depth	Altitude
Mean	55.539	27.621	83.710	100.993	17.284
Std. Dev.	1.206	1.124	17.035	20.595	6.825
Minimum	53.690	25.880	43.962	54.166	6.000
Maximum	58.410	30.370	112.506	138.506	52.000

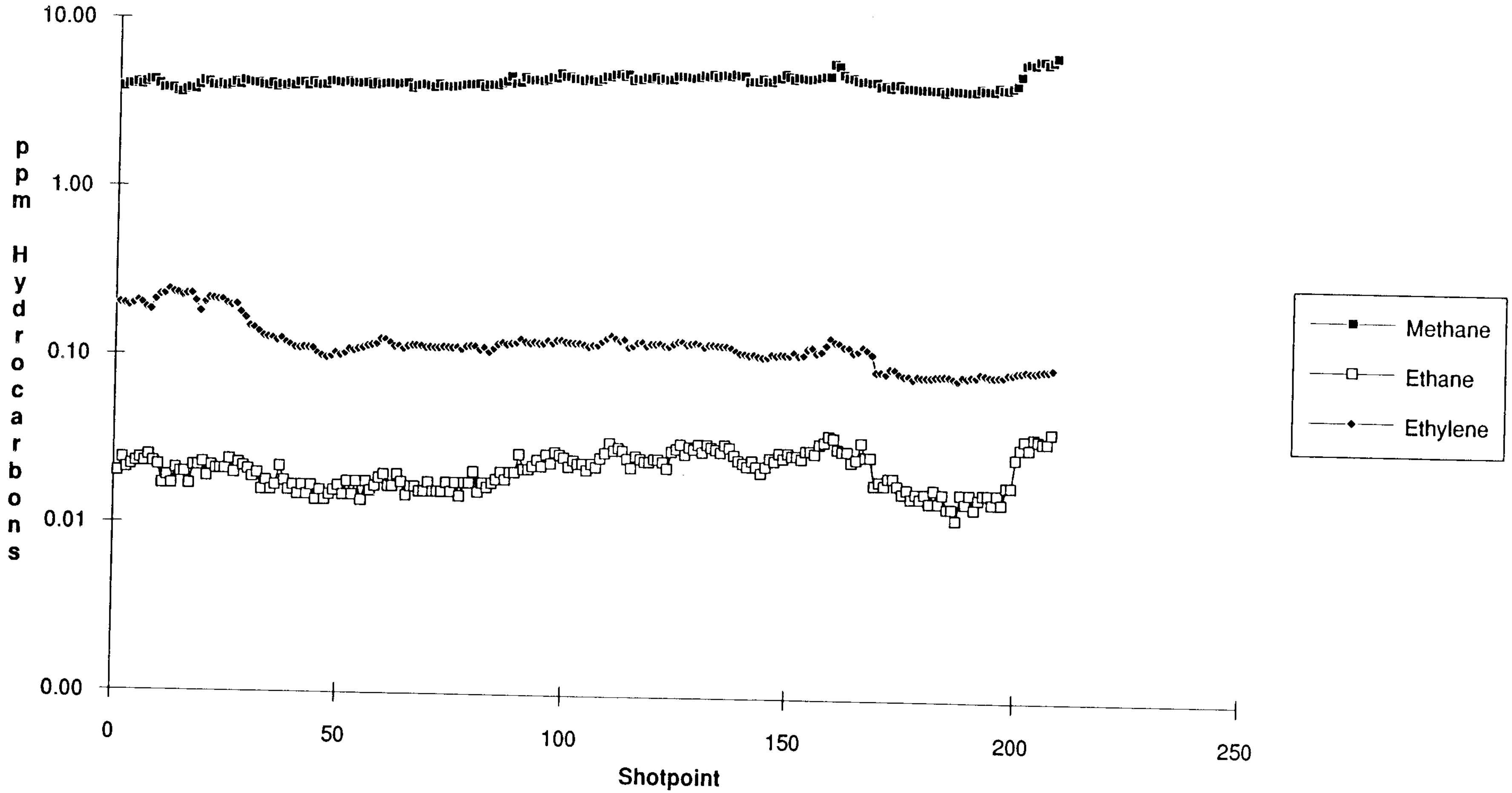
Notes

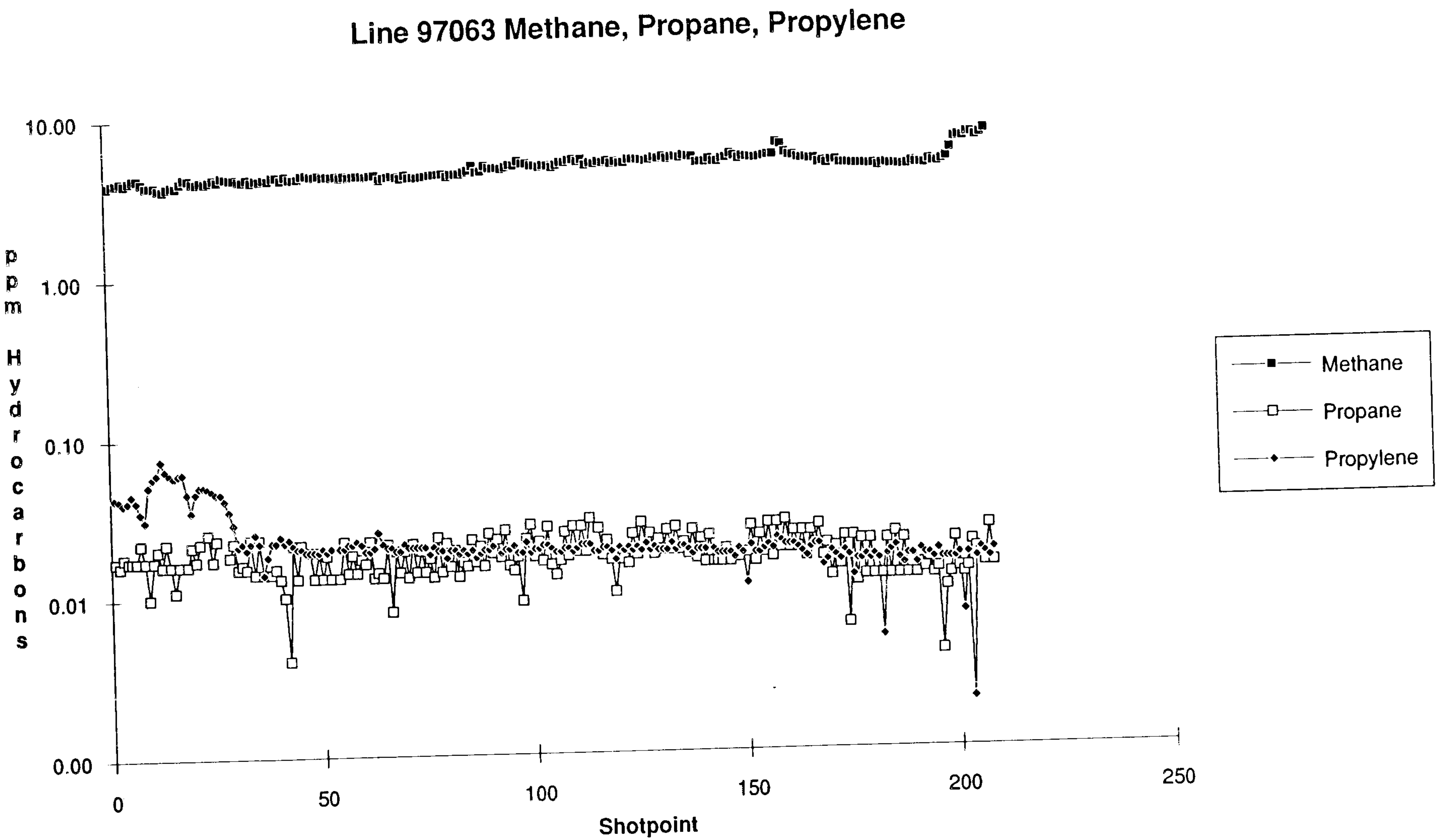
Weak methane and ethane anomaly associated with large aeromagnetically-defined 'high' on the edge of the Vulcan Graben. Anomaly is located towards the end of the line between approximately SP 140-210.



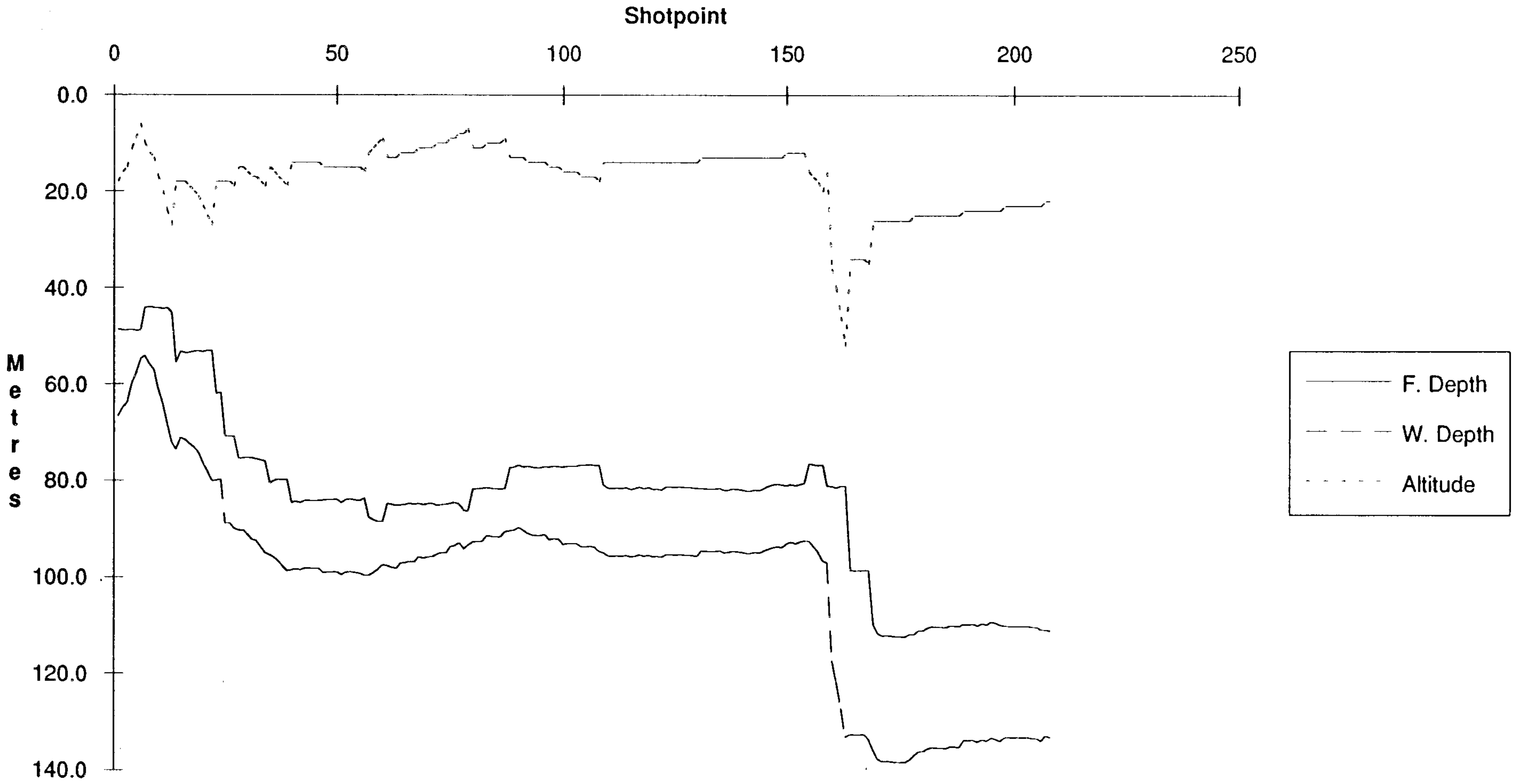
Line 97063 THC, Methane
ppm Hydrocarbons
20.00
18.00
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
0
50
100
150
200
250
Shotpoint
THC
Methane

Line 97063 Methane, Ethane, Ethylene




Line 97063 Methane, Propane, Propylene
10.00
1.00
0.10
0.01
0.00
ppm Hydrocarbons
0
50
100
150
200
250
Shotpoint
Methane
Propane
Propylene

Line 97063 Depths, Altitude



Line Summary

Line Number	97064
No. of Shotpoints	398

	Shotpoint	Date	Time	Latitude		Longitude	
Start	1	14-Nov-90	14:36:23	13	02.109	124	30.656
End	398	15-Nov-90	03:50:14	12	10.759	125	15.318

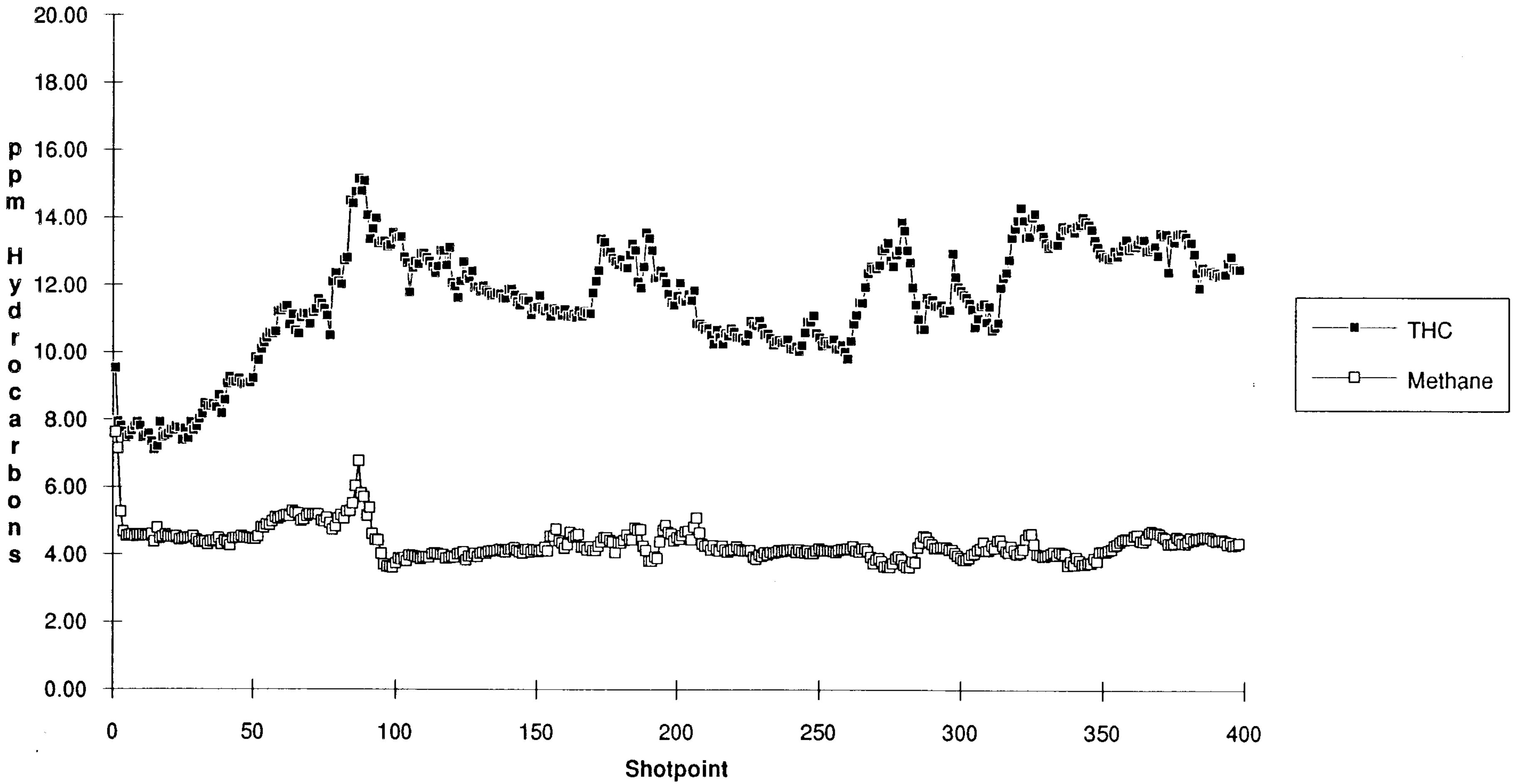
	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	11.555	4.331	0.023	0.138	0.019	0.021	0.000	0.000	0.000	0.100	0.000	0.000	0.947
Std. Dev.	1.720	0.460	0.006	0.034	0.006	0.007	0.000	0.000	0.000	0.051	0.001	0.001	0.197
Minimum	7.105	3.613	0.012	0.058	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.359
Maximum	15.154	7.610	0.056	0.248	0.048	0.057	0.000	0.007	0.000	0.273	0.021	0.024	1.833

	Cond.	Temp.	F Depth	W.Depth	Altitude
Mean	55.525	27.725	82.879	95.327	12.447
Std. Dev.	1.524	1.414	17.894	17.959	2.483
Minimum	52.450	24.670	53.754	66.856	4.000
Maximum	58.790	30.710	146.166	158.166	33.000

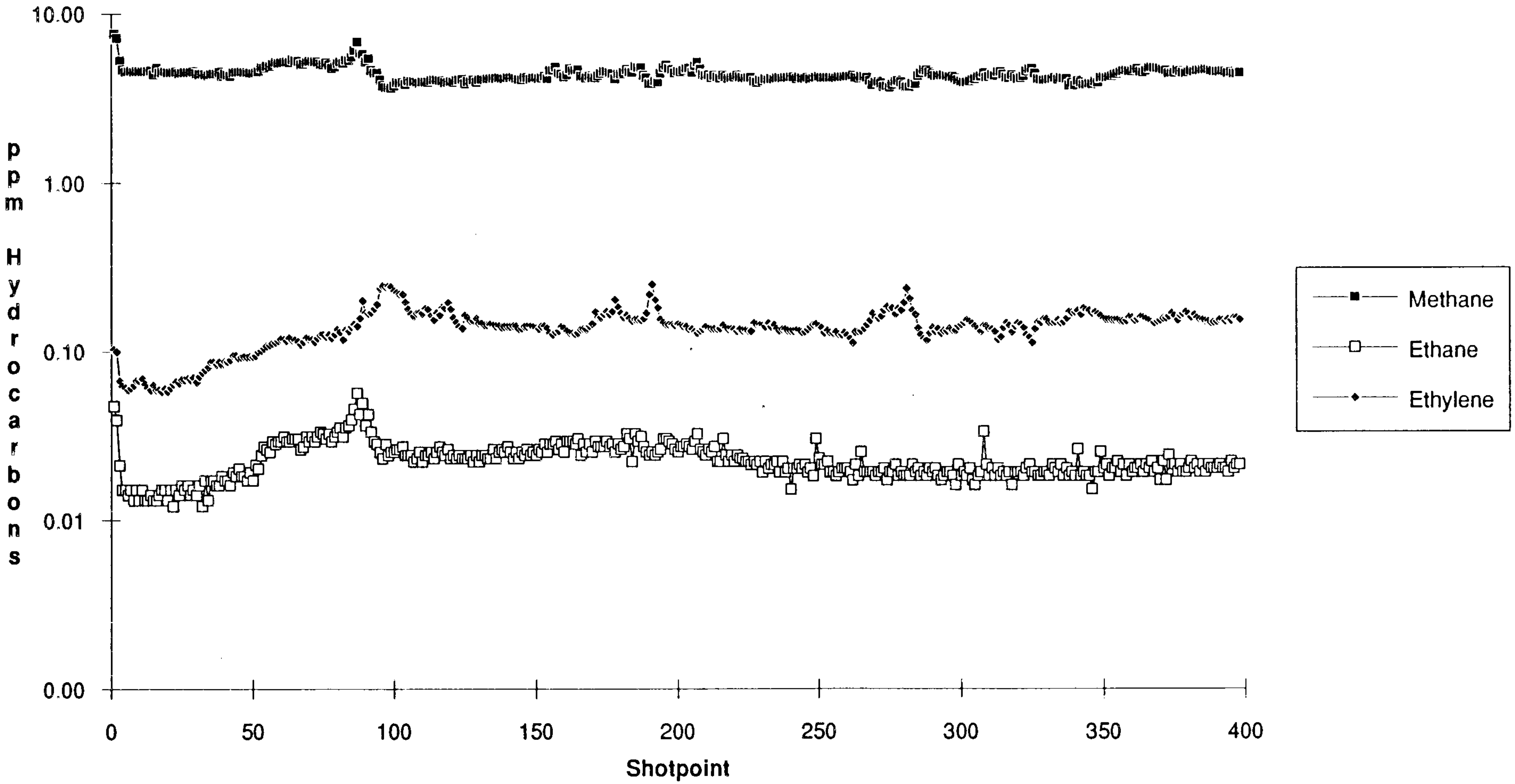
Notes

Weak methane and ethane anomalies associated with transfer zone on the edge of the Vulcan Graben (approximately SP 1-110).

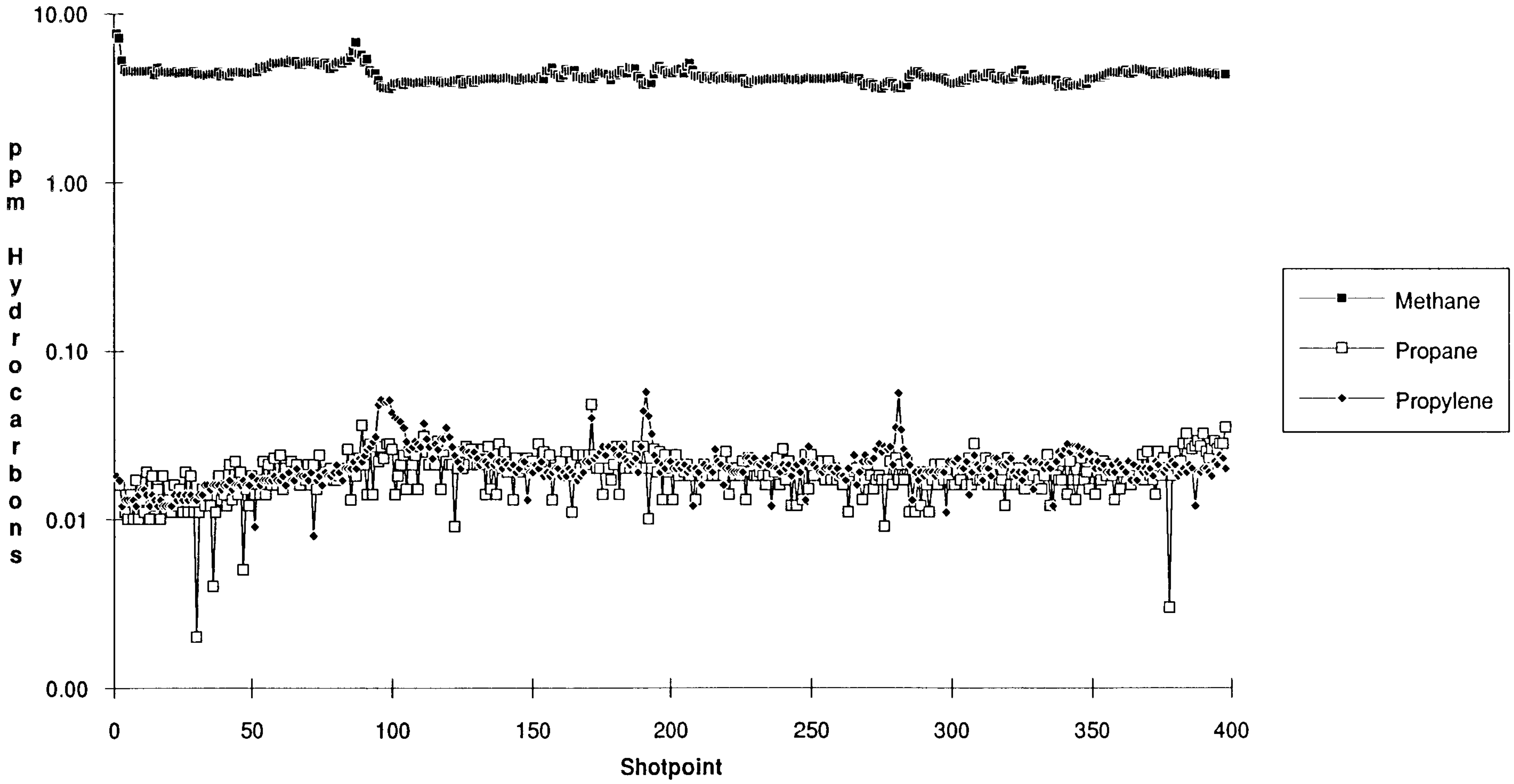
Line 97064 THC, Methane

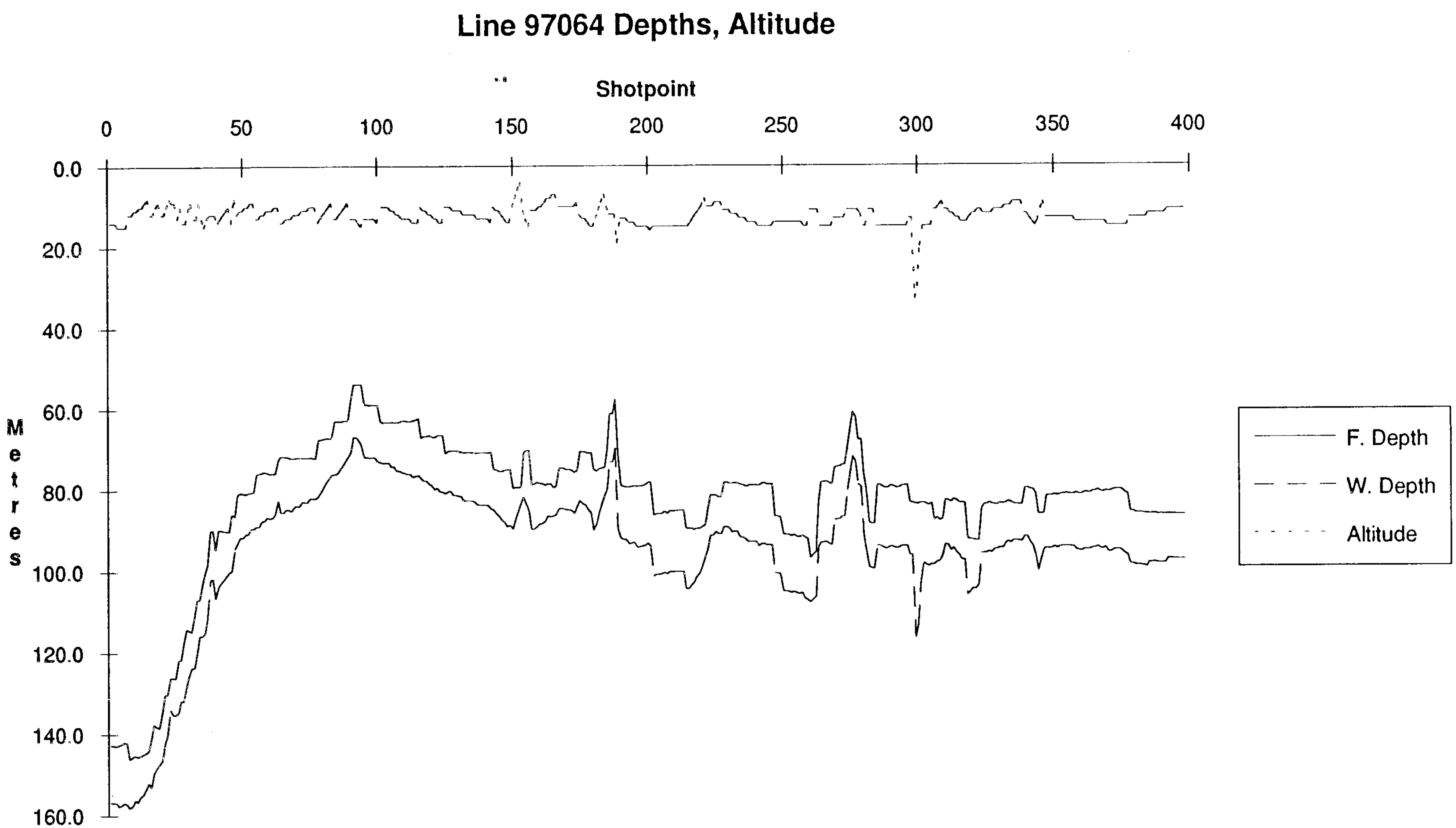


Line 97064 Methane, Ethane, Ethylene



Line 97064 Methane, Propane, Propylene





Line 97064 Depths, Altitude
Shotpoint
0
50
100
150
200
250
300
350
400
0.0
20.0
40.0
60.0
80.0
100.0
120.0
140.0
160.0
Metres
F. Depth
W. Depth
Altitude

Line Summary

Line Number	97065
No. of Shotpoints	180

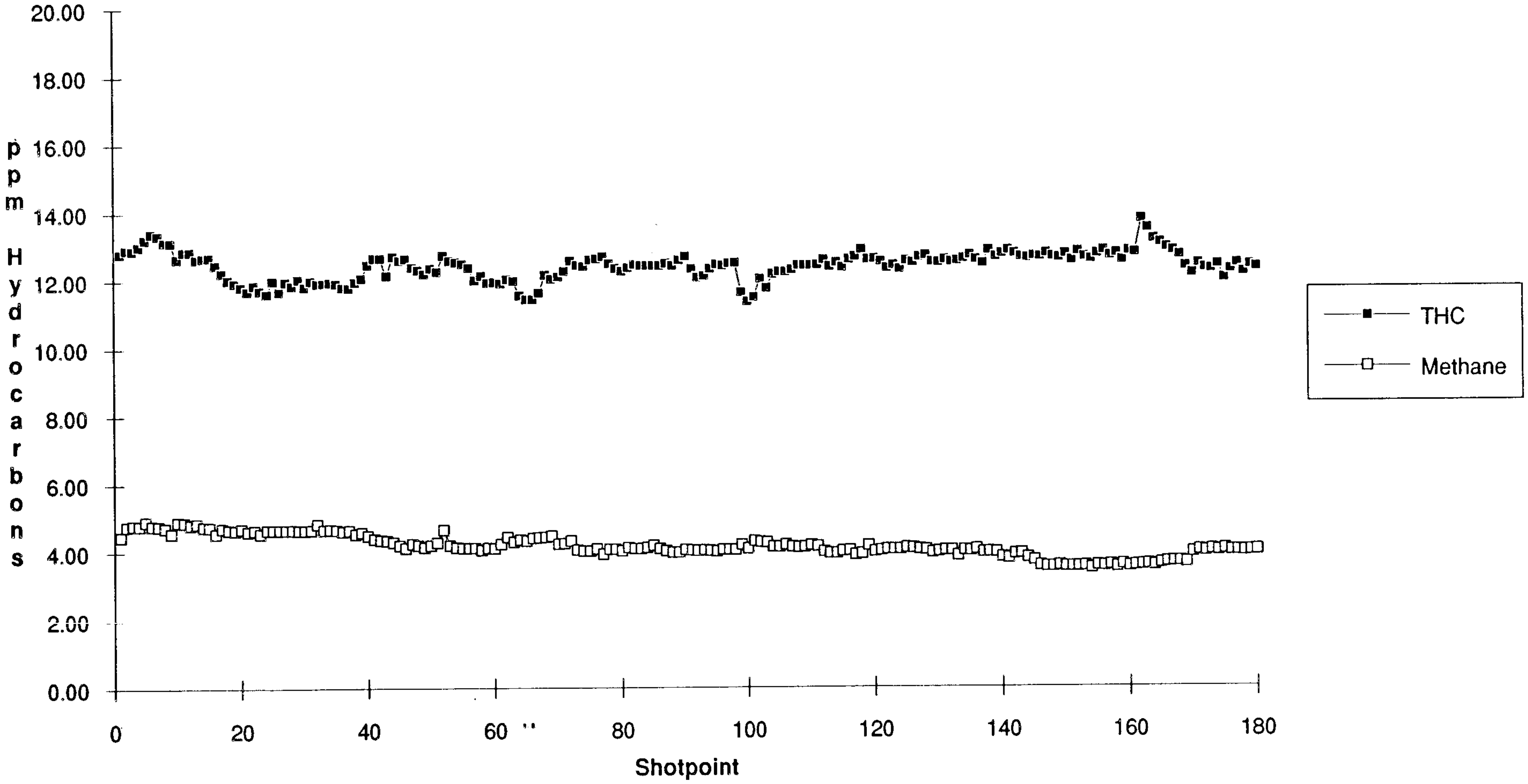
	Shotpoint	Date	Time	Latitude		Longitude	
Start	1	15-Nov-90	06:14:29	12	13.788	125	10.472
End	180	15-Nov-90	12:12:35	12	06.793	125	40.900

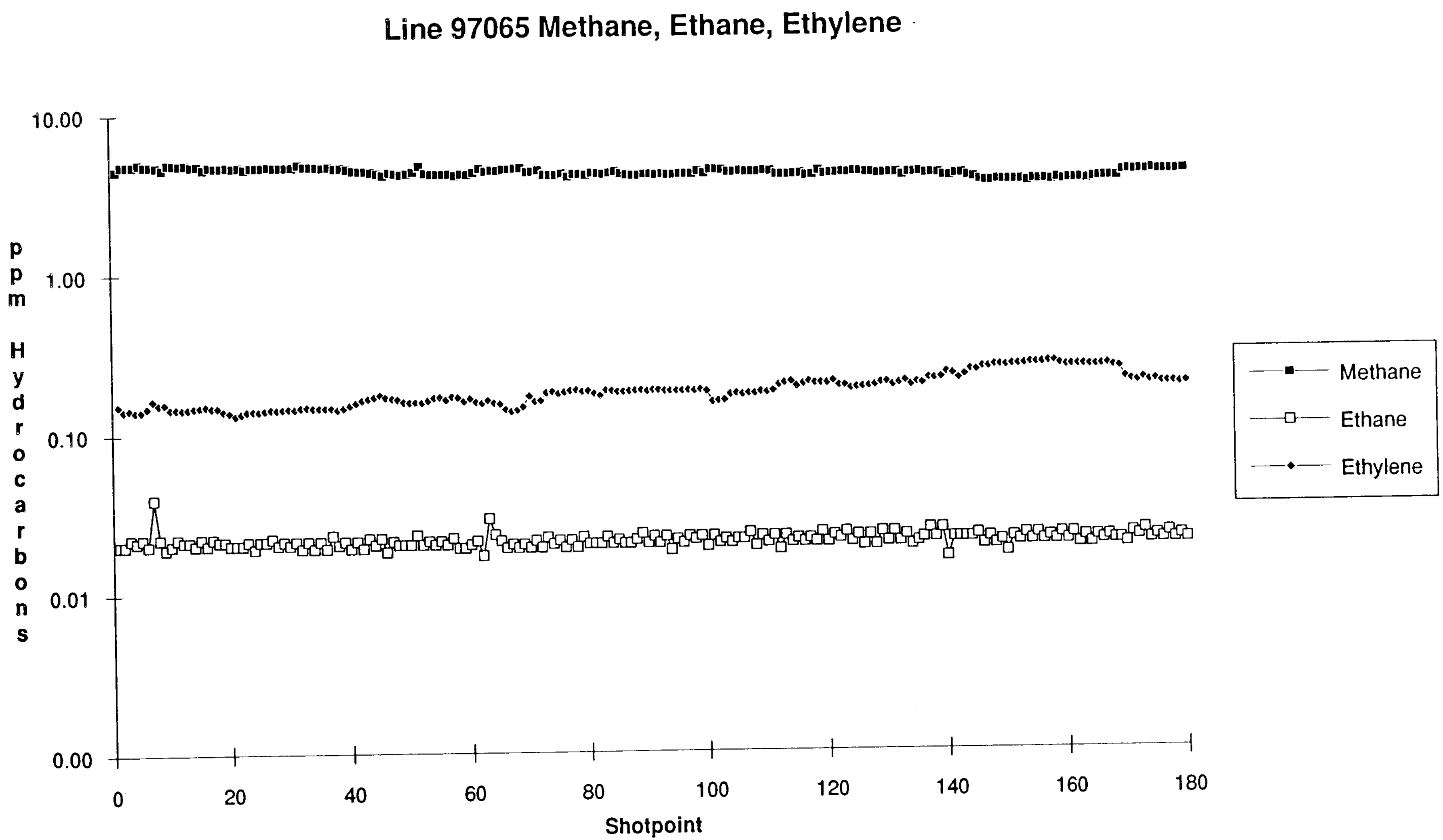
	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	12.390	4.140	0.021	0.181	0.022	0.029	0.000	0.000	0.000	0.138	0.000	0.002	1.020
Std. Dev.	0.403	0.357	0.002	0.034	0.005	0.011	0.000	0.000	0.000	0.053	0.000	0.012	0.155
Minimum	11.346	3.464	0.016	0.131	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.501
Maximum	13.727	4.890	0.039	0.259	0.032	0.056	0.000	0.000	0.000	0.431	0.000	0.150	1.423

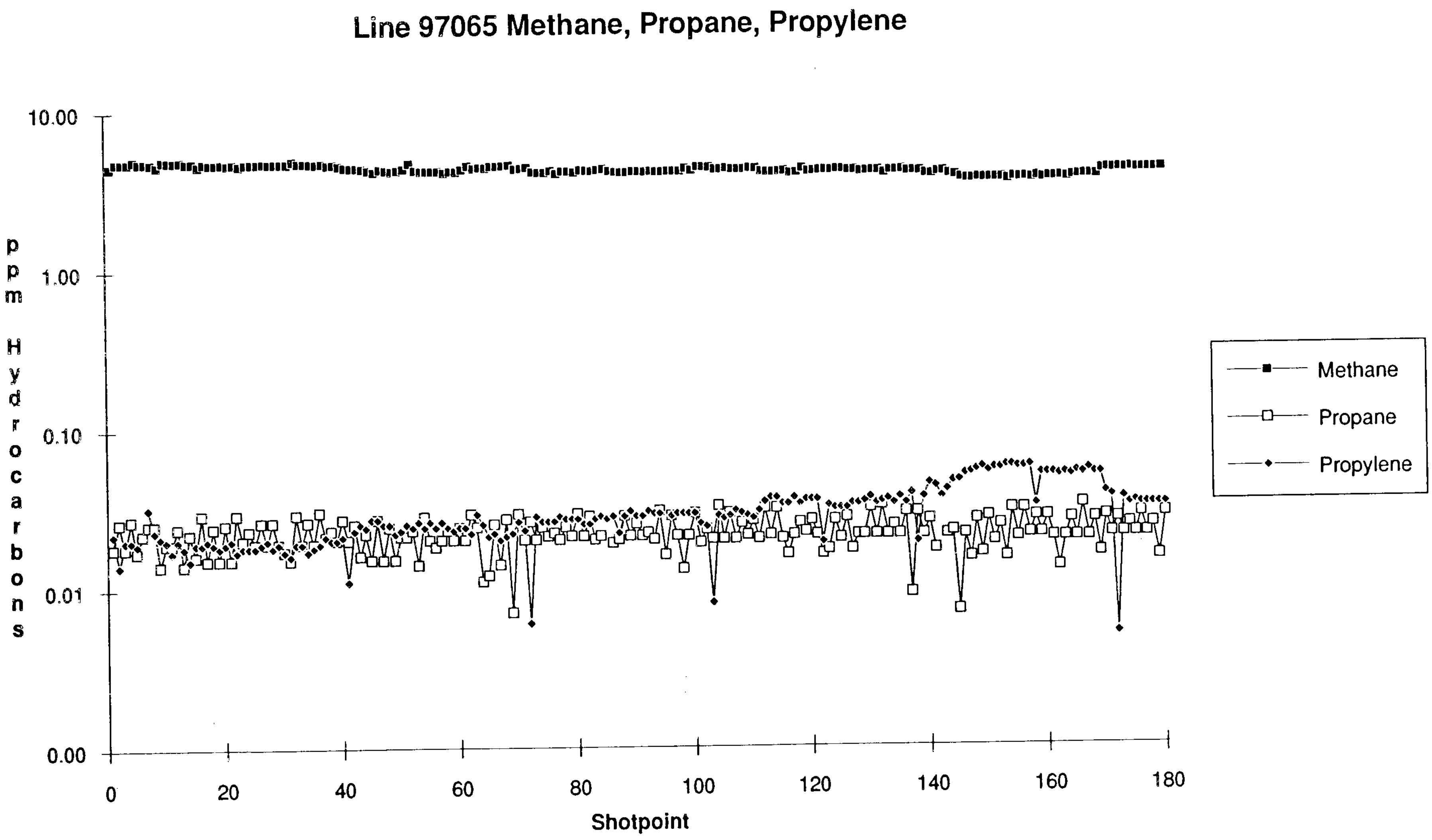
	Cond.	Temp.	F. Depth	W.Depth	Altitude
Mean	57.037	29.175	72.757	84.396	11.639
Std. Dev.	0.446	0.379	6.729	7.248	1.623
Minimum	56.320	28.410	58.548	67.548	8.000
Maximum	57.800	29.970	84.660	96.660	15.000

Notes No anomalies.

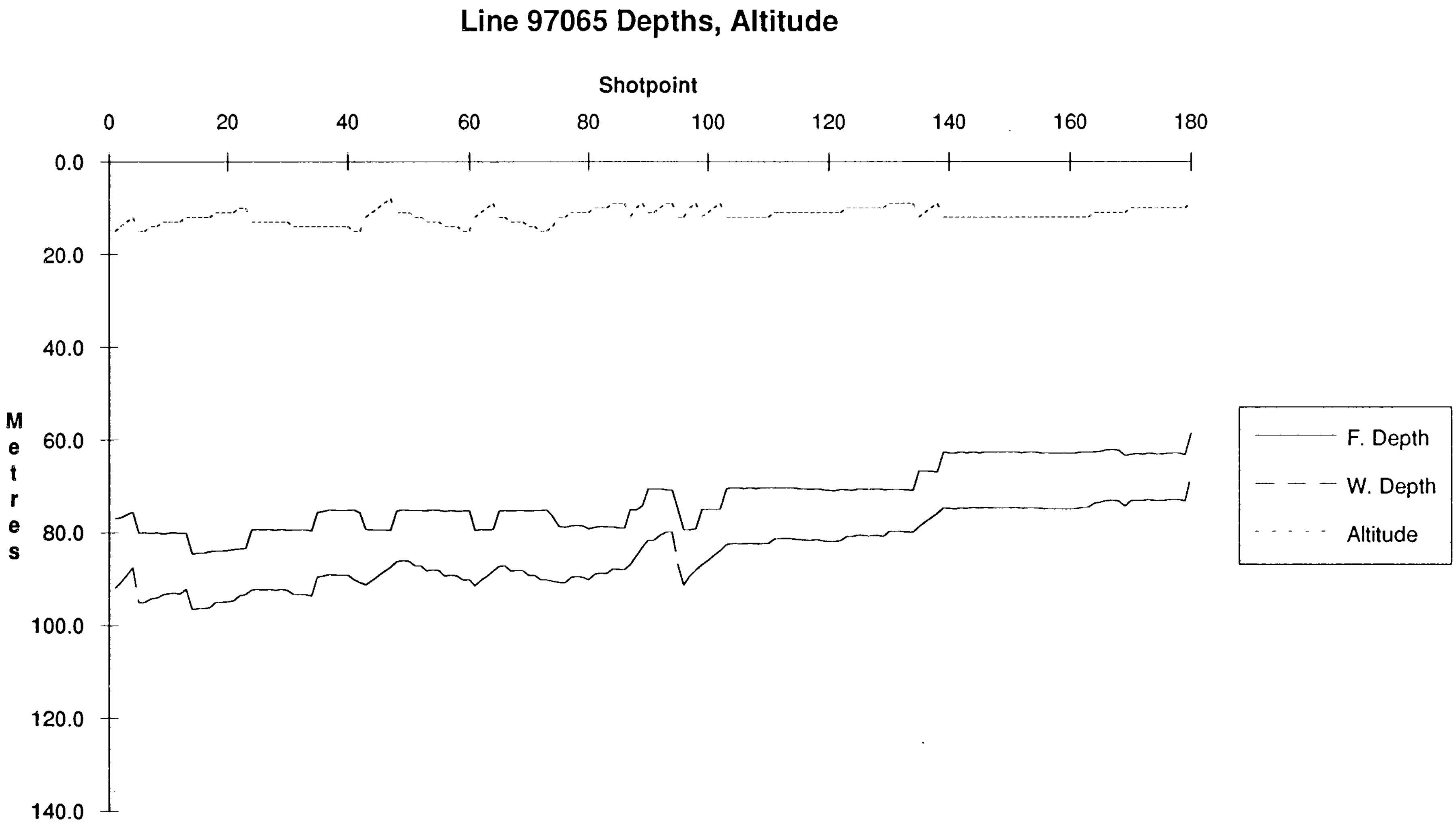
Line 97065 THC, Methane




Line 97065 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 97065 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 97065 Depths, Altitude
Shotpoint
0
20
40
60
80
100
120
140
160
180
0.0
20.0
40.0
60.0
80.0
100.0
120.0
140.0
Metres
F. Depth
W. Depth
Altitude

Line Summary

Line Number	97066
No. of Shotpoints	393

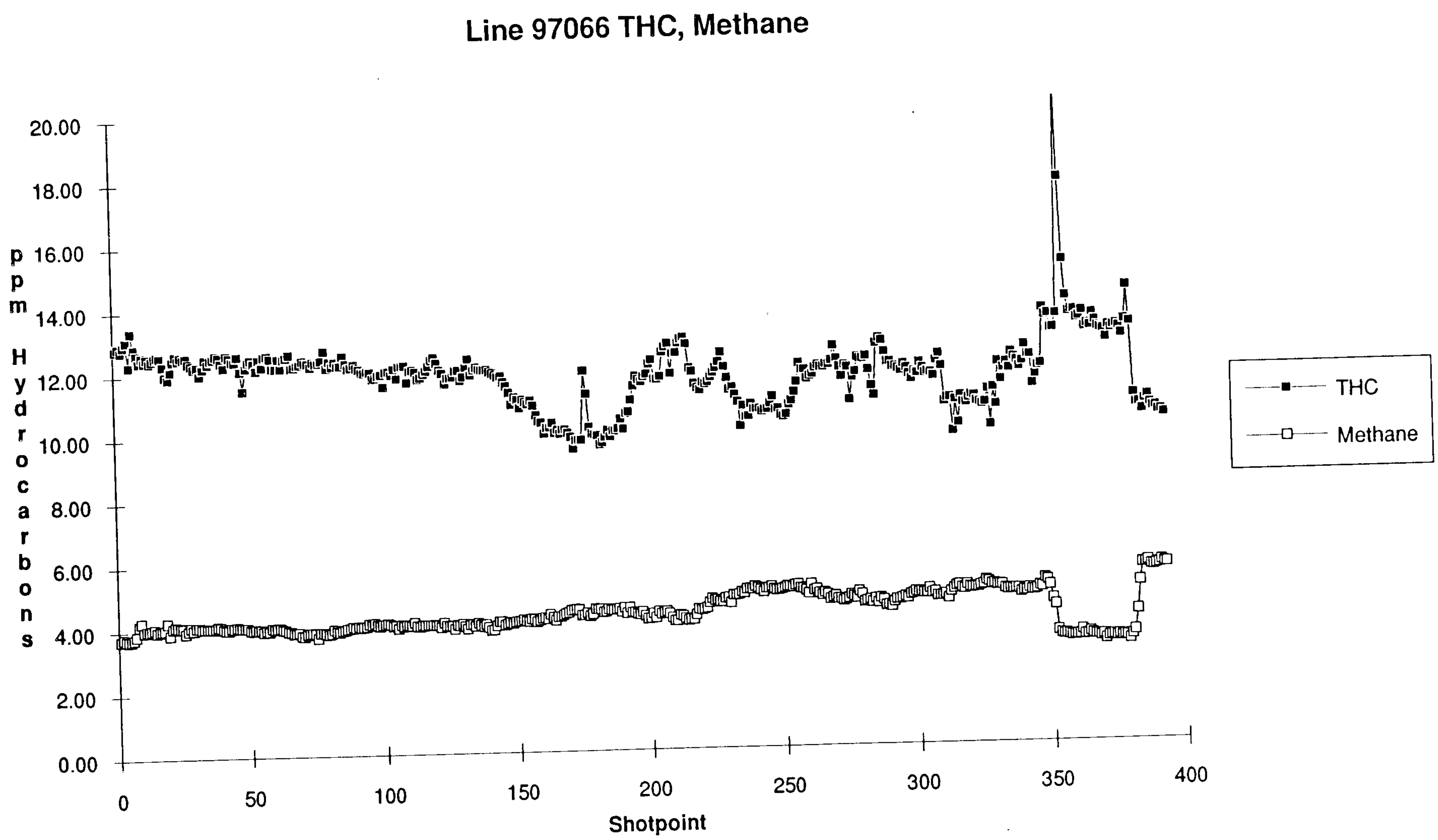
	Shotpoint	Date	Time	Latitude		Longitude	
Start	1	15-Nov-90	14:24:10	12	10.085	125	38.216
End	393	16-Nov-90	07:44:23	11	06.450	125	25.202

	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	11.783	4.273	0.020	0.170	0.020	0.032	0.000	0.000	0.001	0.110	0.002	0.002	0.946
Std. Dev.	1.070	0.489	0.002	0.054	0.005	0.028	0.000	0.000	0.005	0.048	0.009	0.012	0.170
Minimum	9.474	3.134	0.013	0.095	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.406
Maximum	20.868	5.573	0.029	0.338	0.031	0.130	0.000	0.000	0.053	0.302	0.102	0.130	1.326

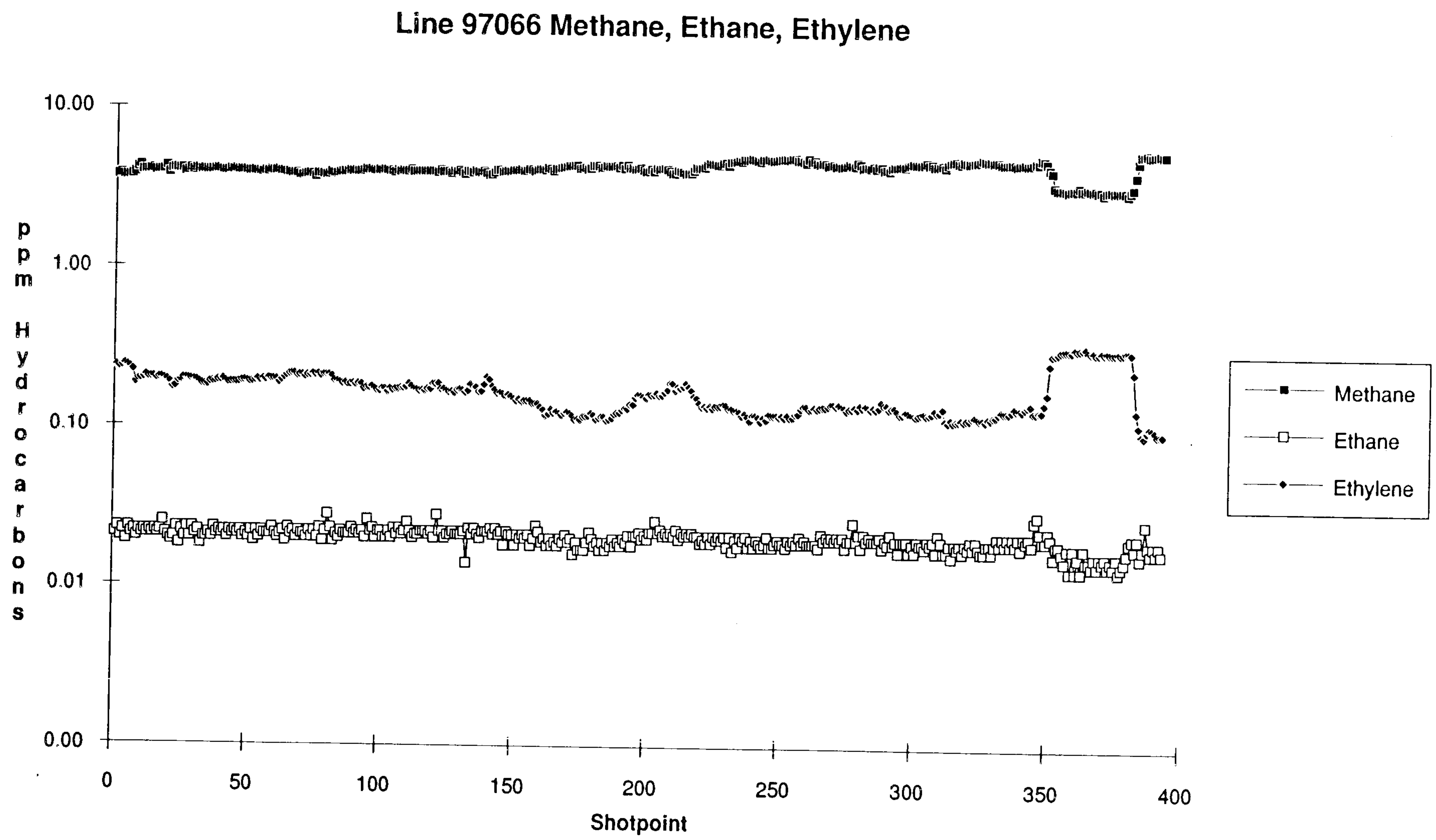
	Cond.	Temp	F. Depth	W.Depth	Altitude
Mean	57.313	29.372	75.018	109.466	34.448
Std. Dev	1.356	1.152	20.862	59.141	64.232
Minimum	56.000	28.060	10.098	24.404	7.000
Maximum	61.260	32.820	105.264	364.754	290.000

Notes

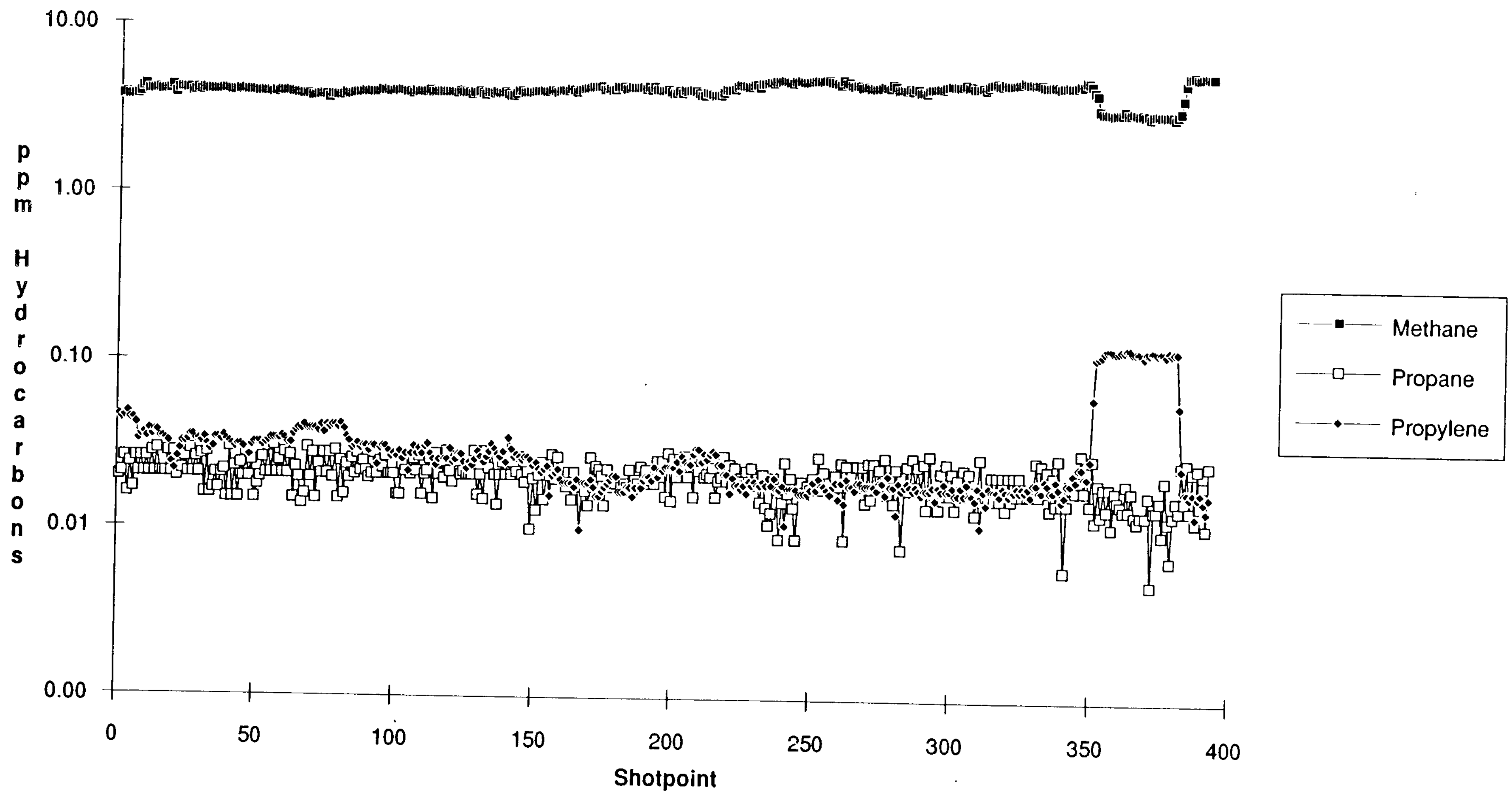
No anomalies. Fluctuating THC, methane, ethylene and propylene values associated with rapidly decreasing fish depth towards the end of line.

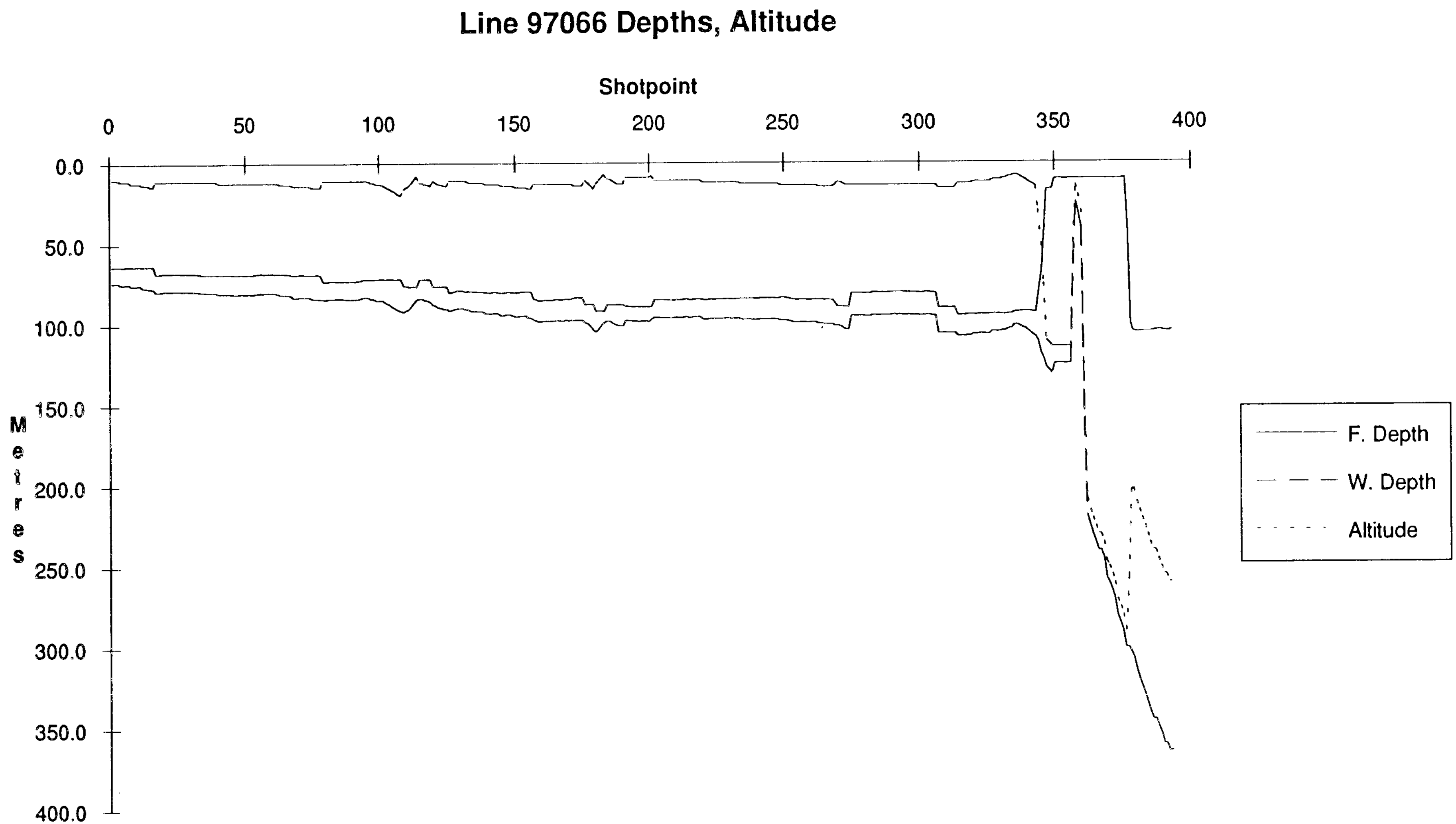


Line 97066 THC, Methane
ppm Hydrocarbons
20.00
18.00
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
0
50
100
150
200
250
300
350
400
Shotpoint
THC
Methane


Line 97066 Methane, Ethane, Ethylene
10.00
1.00
0.10
0.01
0.00
ppm Hydrocarbons
0
50
100
150
200
250
300
350
400
Shotpoint
Methane
Ethane
Ethylene

Line 97066 Methane, Propane, Propylene




Line 97066 Depths, Altitude
Shotpoint
0
50
100
150
200
250
300
350
400
0.0
50.0
100.0
150.0
200.0
250.0
300.0
350.0
400.0
Metres
F. Depth
W. Depth
Altitude

Line Summary

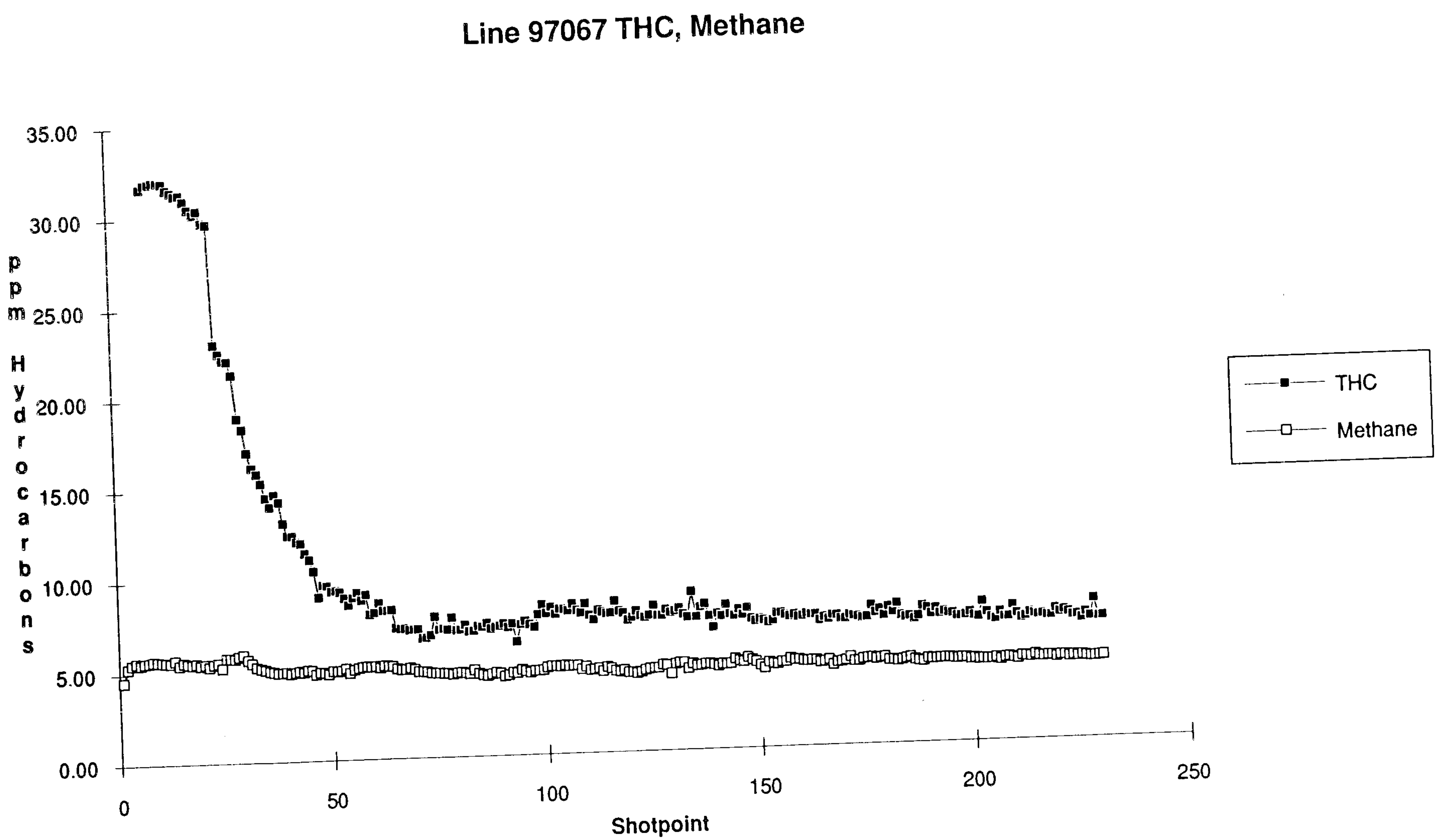
Line Number	97067
No. of Shotpoints	230

	Shotpoint	Date	Time	Latitude		Longitude	
Start	1	11/16/90	08:53:43	11	08.590	125	22.067
End	284	11/16/90	23:46:38	11	41.310	124	58.641

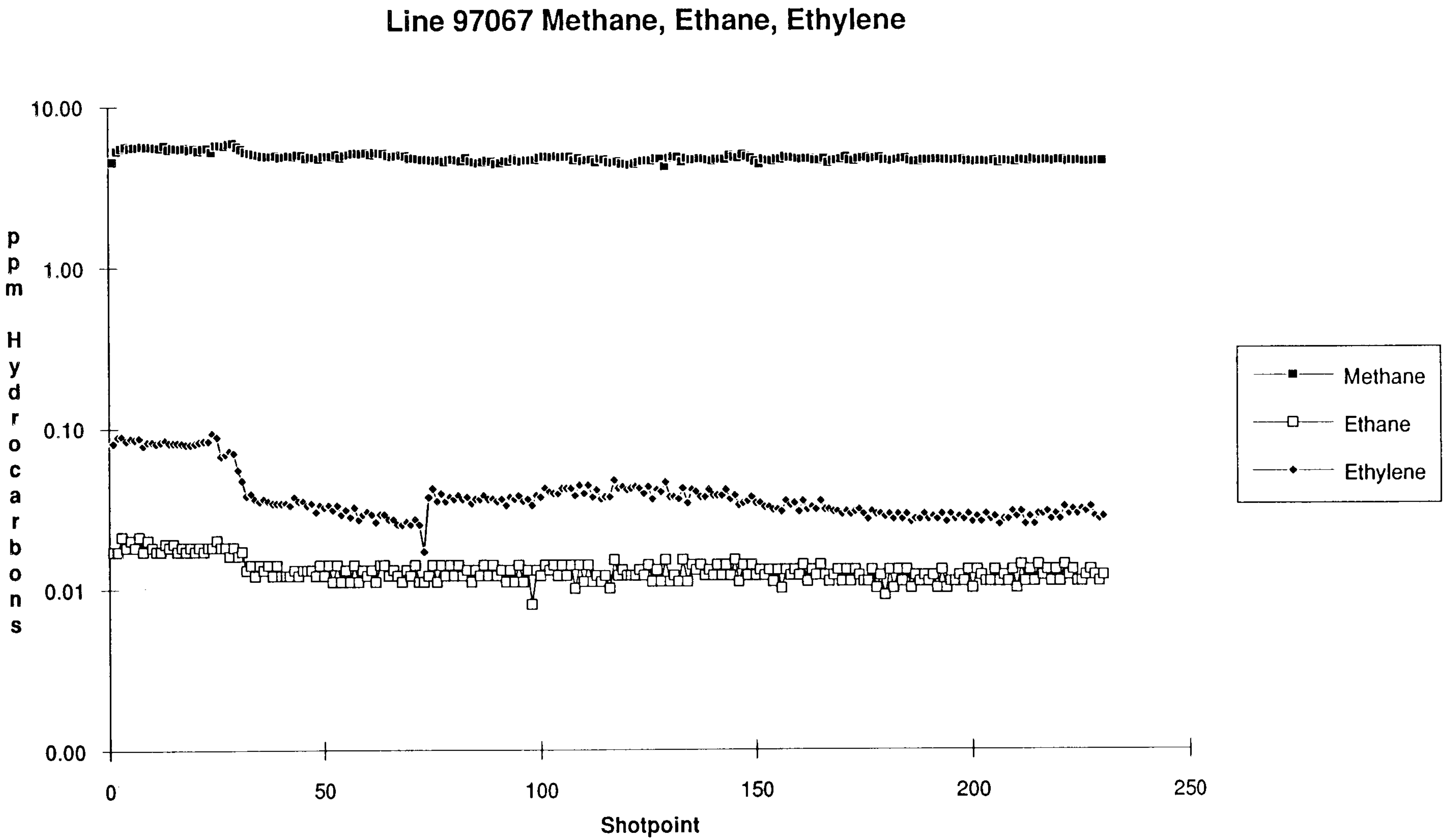
	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	9.929	4.751	0.013	0.039	0.012	0.008	0.000	0.000	0.000	0.046	0.014	0.001	0.527
Std. Dev.	6.594	0.350	0.002	0.017	0.005	0.003	0.000	0.000	0.001	0.037	0.024	0.008	0.099
Minimum	6.213	4.192	0.008	0.017	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.218
Maximum	31.996	5.883	0.021	0.093	0.026	0.018	0.003	0.000	0.013	0.269	0.104	0.109	0.791

	Cond.	Temp.	F. Depth	W.Depth	Altitude
Mean	51.978	24.549	160.265	315.778	155.513
Std. Dev.	1.017	0.987	19.091	15.053	28.360
Minimum	50.460	22.970	105.876	280.344	120.000
Maximum	55.100	27.630	186.456	363.304	256.000

Notes No anomalies.

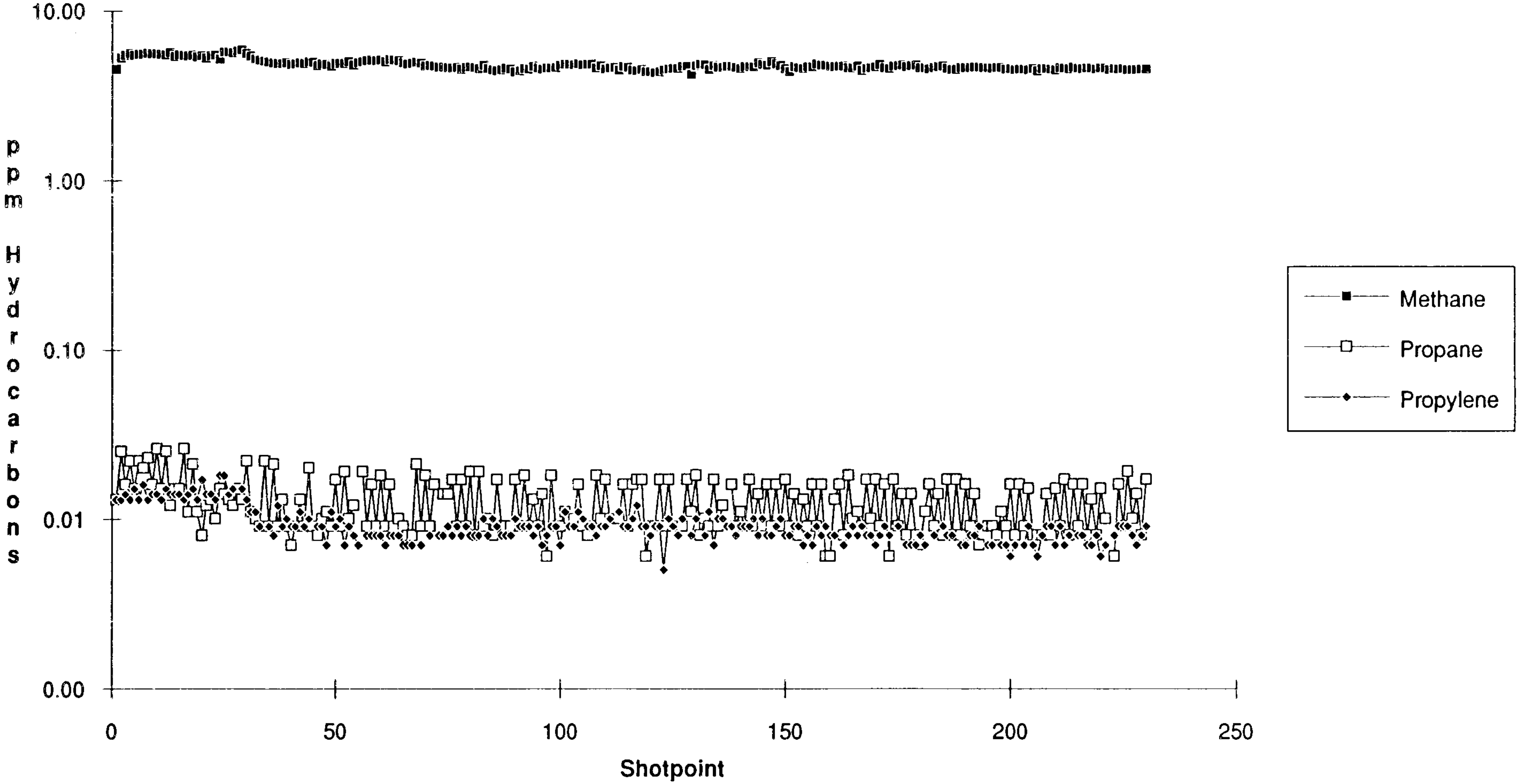


Line 97067 THC, Methane
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00
ppm Hydrocarbons
0
50
100
150
200
250
Shotpoint
THC
Methane

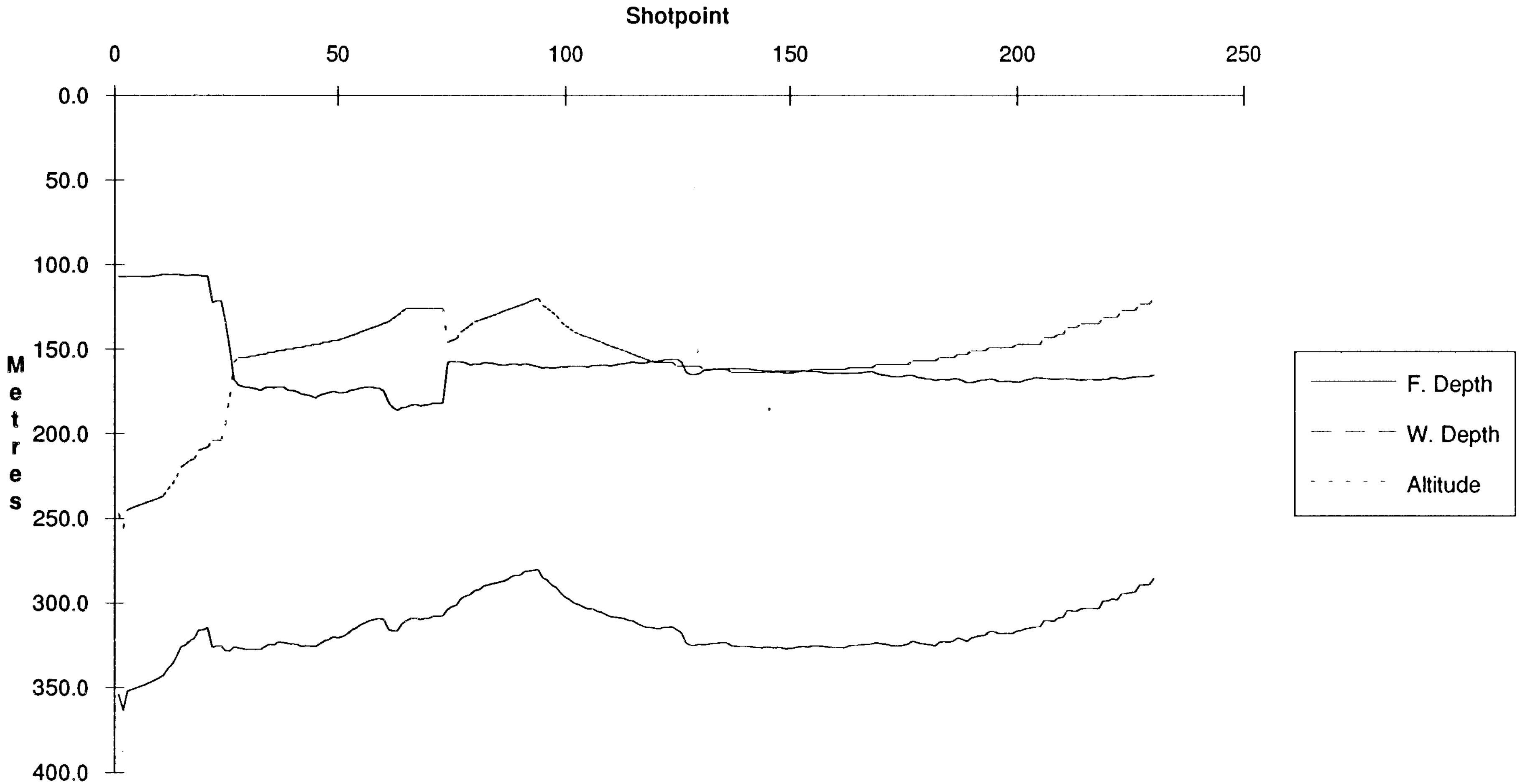


Line 97067 Methane, Ethane, Ethylene
10.00
1.00
0.10
0.01
0.00
ppm Hydrocarbons
0
50
100
150
200
250
Shotpoint
Methane
Ethane
Ethylene

Line 97067 Methane, Propane, Propylene



Line 97067 Depths, Altitude



Line Summary

Line Number	97068
No. of Shotpoints	239

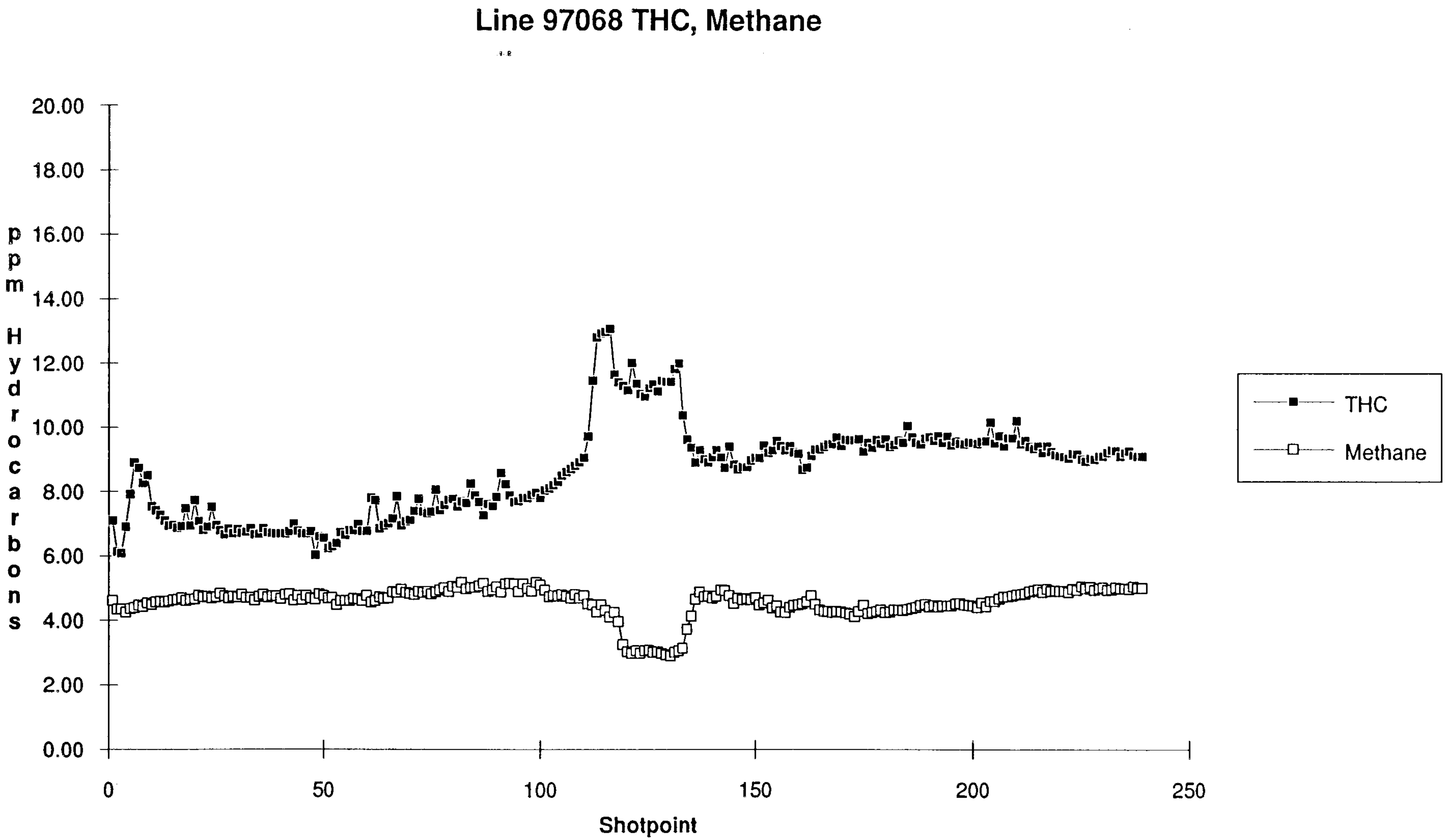
	Shotpoint	Date	Time	Latitude		Longitude	
Start	1	11/17/90	02:30:46	11	36.921	125	02.955
End	239	11/17/90	10:34:33	12	01.076	124	26.918

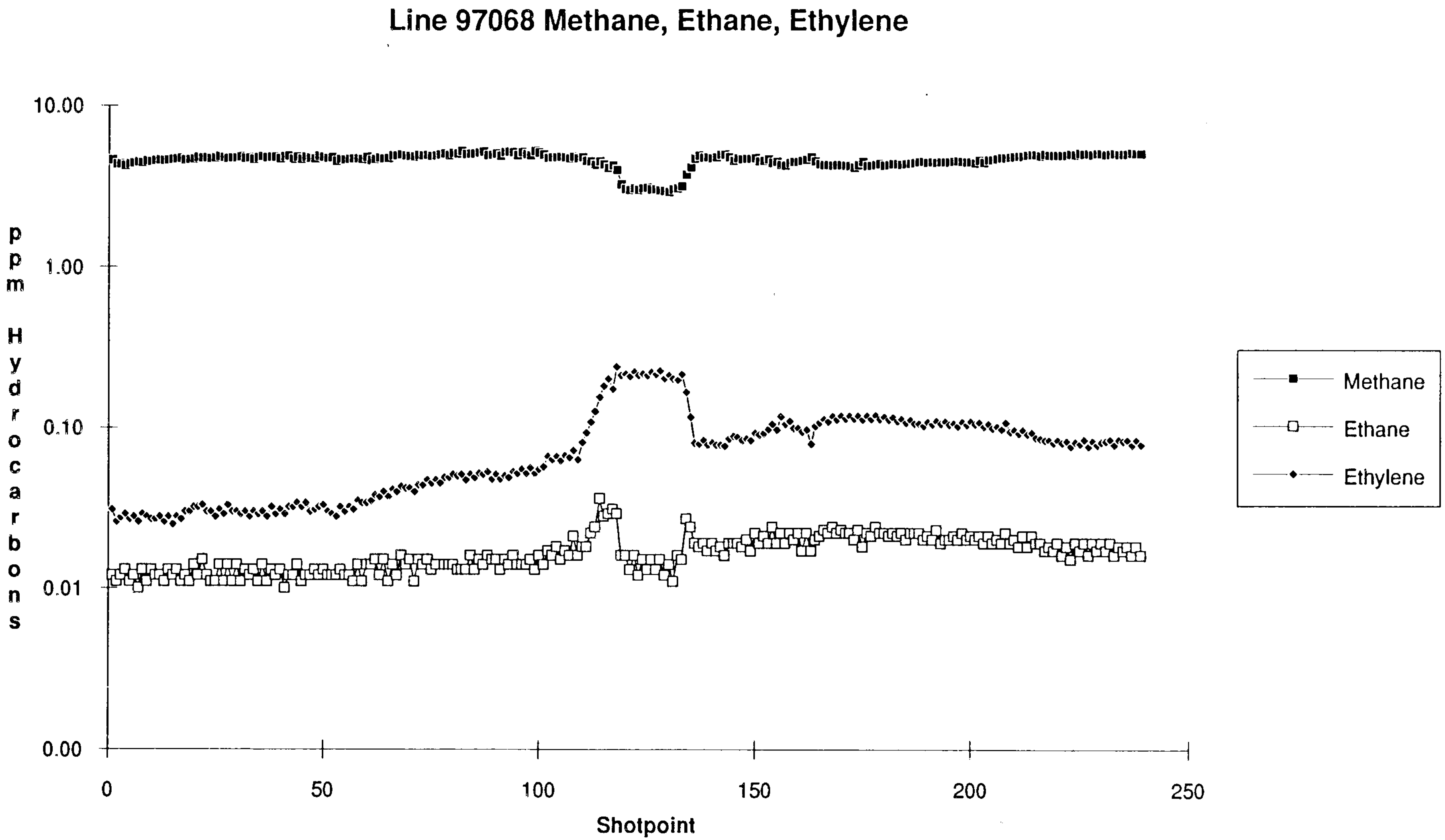
	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	8.628	4.566	0.017	0.080	0.015	0.019	0.000	0.000	0.000	0.066	0.003	0.000	0.695
Std. Dev.	1.466	0.472	0.004	0.049	0.005	0.019	0.000	0.000	0.000	0.045	0.038	0.000	0.207
Minimum	6.025	2.901	0.000	0.025	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.238
Maximum	13.064	5.179	0.036	0.239	0.025	0.088	0.003	0.000	0.000	0.263	0.583	0.000	1.298

	Cond.	Temp.	F. Depth	W.Depth	Altitude
Mean	54.558	26.856	129.478	214.218	84.741
Std. Dev.	1.553	1.313	35.409	73.773	68.434
Minimum	52.910	25.220	17.850	120.732	8.000
Maximum	59.540	31.070	160.446	306.508	220.000

Notes

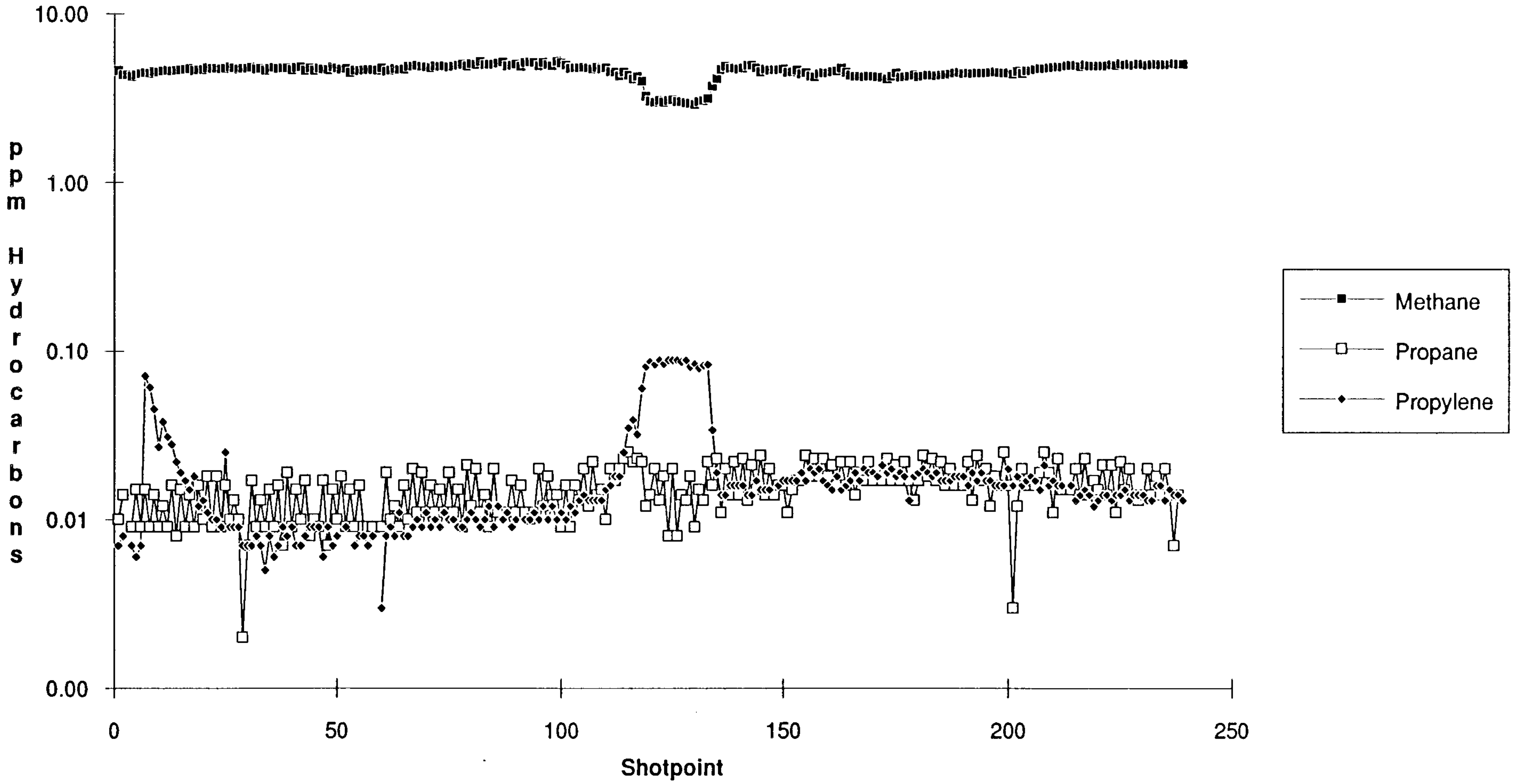
No anomalies. Fluctuating THC, methane, ethane, ethylene and propylene values associated with rapidly decreasing fish depth towards the end of line.


Line 97068 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
50
100
150
200
250
Shotpoint
THC
Methane

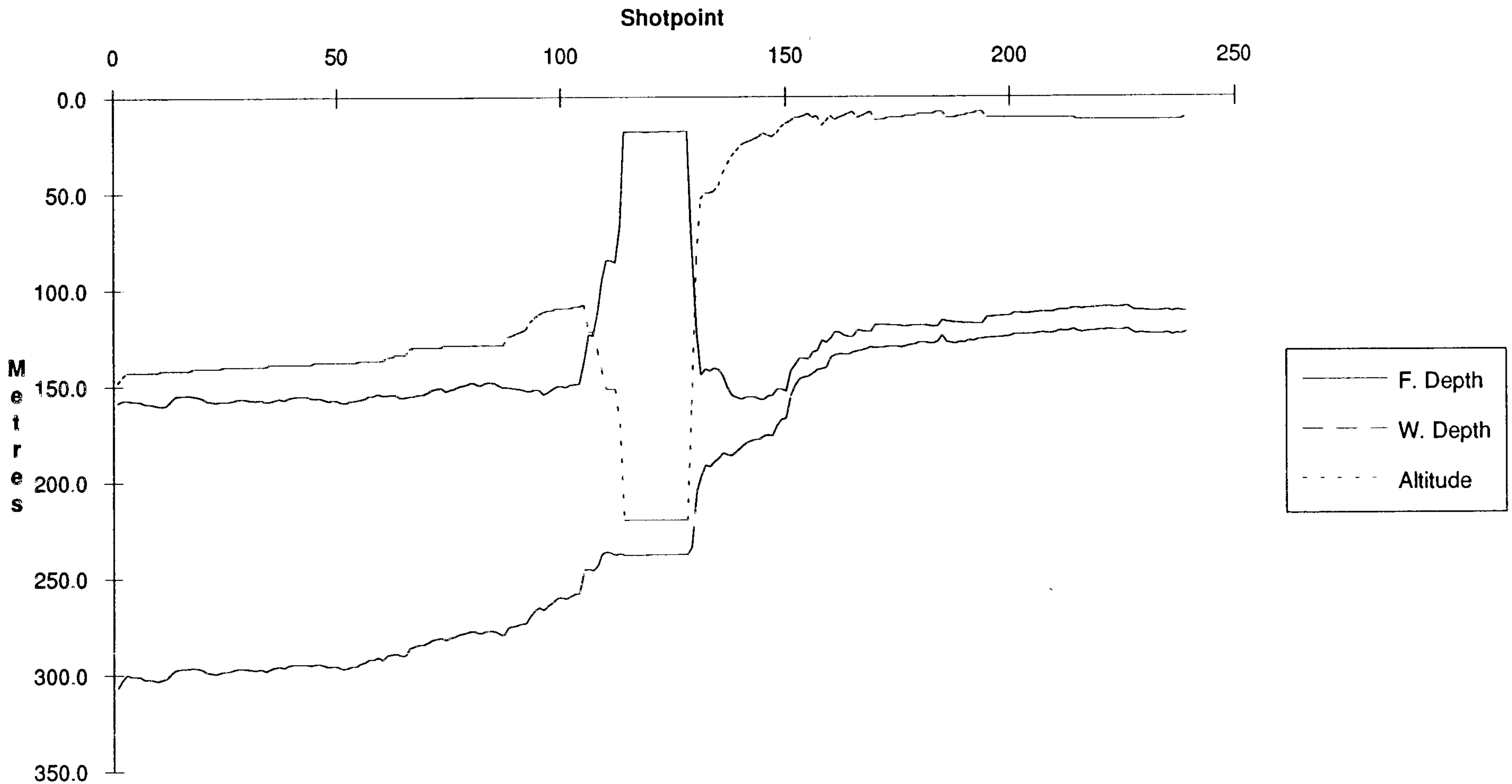


Line 97068 Methane, Ethane, Ethylene
ppm Hydrocarbons
10.00
1.00
0.10
0.01
0.00
0
50
100
150
200
250
Shotpoint
Methane
Ethane
Ethylene

Line 97068 Methane, Propane, Propylene



Line 97068 Depths, Altitude



APPENDIX II

DHD Methodology

Direct hydrocarbon detection in bottom-water (DHD) is accomplished with the equipment schematically shown in Figure II-1. The equipment comprises four major components.

(1) The over-the-side gear includes a towed 'fish' fitted with a submersible pump which delivers seawater to the geochemical laboratory on the ship via a hollow cable. A conductivity/temperature/depth sensor (CTD) in the 'fish' measures the depth of the 'fish' as well as the temperature and salinity of the seawater (to relate the depth of sampling to the depth of the thermocline, to detect hydrographic 'fronts', and to detect sub-seafloor freshwater aquifers that may drain through sedimentary layers from the continent). A sonar measures and continuously displays the altitude of the 'fish' above the seafloor allowing the operator to maintain the 'fish' at an altitude of about 10 m.

(2) A hollow cable (consisting of medical grade nylon tubing wrapped with insulated conductors which both transmit power to the fish and relay CTD and sonar data from the 'fish') delivers bottom-water to the geochemical laboratory. The tubing and conductors are wrapped in a stainless steel braid. Plastic fairings, which are attached to the cable to reduce frictional drag, allow the 'fish' to be towed almost directly beneath the ship.

(3) The analytical equipment includes a gas extraction unit and gas chromatographs connected in parallel to measure the concentrations of a variety of (C_1-C_8) hydrocarbons extracted from the seawater. The total hydrocarbon concentrations are measured every 30 seconds or at a ship speed of 5 knots, a distance of about 75 m on the seafloor. The light hydrocarbons (C_1-C_4) are measured at 2 minute intervals (approximately 300 m on the seafloor), whereas the C_5-C_8 hydrocarbons are measured every 8 minutes (approximately 1200 m). Sub-samples of extracted gas may be taken and stored for subsequent shore-based isotopic analyses.

(4) The data acquisition system is PC based: all data is displayed, edited and stored in a database for plotting at sea.

The towed 'fish' is deployed over the port side from the *Rig Seismic*. Echo sounder data and GPS navigation are displayed in the laboratory and these, together with the side scan sonar, provide clues to the locations of surface expressions of gas seeps on the seafloor. All data are recorded continuously so that any hydrocarbon anomalies in the water column can be quickly recognised and additional measurements (or samples can be collected) if appropriate.

Detector sensitivity is < 10 parts per billion in the stripped headspace sample. Calibrations were conducted on a daily basis and were within 10% for the entire program and system blanks were less than 2 ppm for methane and 5 ppb for C_{2+} compounds. The following parameters are measured:

Parameter	Units	Equipment Used
Total Hydrocarbon (THC)	ppm	Shimadzu GC with FID Detector using 6" Glass bead column
Methane	ppm	Shimadzu GC with FID Detector using 42" Activated alumina column
Ethane	ppm	"
Ethylene	ppm	"
Propane	ppm	"
Propylene	ppm	"
i-Butane	ppm	"
n-Butane	ppm	"
i-Pentane	ppm	Shimadzu GC with FID Detector using 30 Megabore DB1 column
n-Pentane	ppm	"
i-Hexane	ppm	Shimadzu GC with FID Detector using 30 Megabore DB1 column
n-Hexane	ppm	"
Water Depth	Metres	On-board Echo sounders
Fish Altitude	metres	Water Depth minus Fish Depth
Conductivity	mmhos/cm	Conductivity Meter
Water Temperature	°Celsius	Temperature thermistor
Fish Depth	d-bar	Pressure transducer

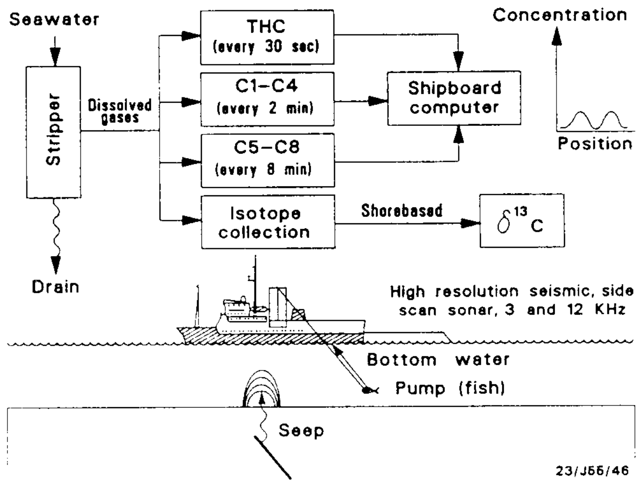


Figure II -1. Schematic of the geochemical equipment aboard *Rig Seismic* for the continuous profiling of hydrocarbons in seawater: the bottom-water DHD technique.

APPENDIX III

Interpretative methodology

The DHD equipment installed on *Rig Seismic* can be used for measuring hydrographic, environmental or petroliferous parameters. The light hydrocarbon data (C_1 to C_6) contained in this report can be produced by a variety of sources. These sources include biological activity associated with the degradation of organic matter in seawater and near-surface sediments and reservoired petroleum products (oil, gas and condensate). The aim of the data interpretation is to determine the origin (biogenic or thermogenic) of the light hydrocarbon gases measured, and via a variety of cross-plots of molecular and isotopic compositions of gases, to infer the 'source' (dry gas, gas-condensate or liquids) of detected seepage.

Light Hydrocarbons In Seawater

Light (C_1-C_4) and intermediate (C_5-C_8) hydrocarbons are present in seawater and sediments principally as a result of the following three processes.

(1) **Thermogenic processes.** The effect of heat on organic matter (catagenesis and metagenesis) buried to depths of several kilometres in sedimentary basins produces thermogenic hydrocarbons (Hunt 1979; Tissot and Welte 1984). The products of these reactions include methane and the saturated (C_2-C_8) hydrocarbons, which are the hydrocarbons mostly analysed in surface geochemical techniques. Some of the thermogenic hydrocarbons migrate to the surface, either directly from source rocks (primary migration) or indirectly, from gas, gas-condensate or liquid reservoirs (secondary migration). Hydrocarbons may migrate kilometres to permeate the near-surface sediments and seep into the overlying bottom-water resulting in thermogenic anomalies.

(2) **Biological processes.** Hydrocarbons are produced microbially and photochemically in seawater. In addition, during early diagenesis, a variety of hydrocarbons are produced by the activities of microbial organisms during aerobic and anaerobic destruction of organic matter which occurs primarily in the top few tens of metres of sediments. The products of these reactions include methane and minor quantities of both saturated and unsaturated hydrocarbons (Hunt 1979; Claypool & Kvenvolden 1983 and references cited therein).

The presence of the unsaturated hydrocarbons, which are only produced biochemically (Primrose & Dilworth 1976; Claypool & Kvenvolden 1983), provides one criteria to distinguish between biogenic and thermogenic hydrocarbons.

These compounds produced *in situ* generally occur in low concentrations as background hydrocarbons in seawater (Claypool & Kvenvolden 1983). However, high concentrations of biogenically-produced hydrocarbons may accumulate in relatively shallow-buried sediments and seep into the overlying water, resulting in biogenic anomalies (Brooks et al. 1974; Bernard et al. 1976).

(3) **Anthropogenic processes**. Man's activities can introduce anthropogenically-sourced hydrocarbons into the marine environment. Anthropogenic hydrocarbons may be of a thermogenic origin (e.g., ship spills, refined petroleum products used in industrial processes) or a biogenic origin (such as those produced from urban sewage when excessive loads of organic matter are dumped into the sea and degraded microbially).

The concentrations of *in situ* biogenic (ie., background) light hydrocarbons in seawater are generally an order of magnitude lower than those in the underlying seafloor sediments (Claypool & Kvenvolden 1983). Consequently, it is relatively easier to detect migrated thermogenic hydrocarbons in seawater (low background concentration) than in seafloor sediments (high and variable background concentrations). Herein, lies one perceived advantage in the use of bottom-water DHD compared with sediment geochemistry in offshore petroleum exploration.

The bottom-water DHD technique is dependent upon hydrocarbons migrating from hydrocarbon reservoirs or petroleum source rocks to the seafloor. Although the exact mechanism(s) of migration may be variable or even unknown, some form of vertical migration, as evidenced by the many observations of seepage (eg., Brooks et al. 1974; Bernard et al. 1976; Reed & Kaplan 1977; Cline & Holmes 1977; Nelson et al. 1978; Reitsma et al. 1978; Brooks et al. 1979; Kvenvolden et al. 1979; Kvenvolden & Field 1981; Hovland & Judd 1988) does occur (via porous sediments, fault planes and microfissures etc). It is generally accepted that migration by diffusion is not important (Leythaeuser etal., 1982; Reitsma et al. 1981; Whelan et al. 1984) although bubble ebullition from saturated solution, oil and gas transport in solution in carbon dioxide and advective processes involving basinal fluids are all likely mechanisms (eg., Kvenvolden & Claypool 1980; Hunt 1984; Sweeney 1988; Hovland & Judd 1988).

Data interpretation: the mixing model

The detection of seepage requires that anomalous concentrations of hydrocarbons be distinguished from the background inventory of hydrocarbons. Thermogenic hydrocarbons that seep into the bottom-waters mix with the background concentration of hydrocarbons. One approach to defining anomalies and distinguishing seep hydrocarbons from background hydrocarbons requires that a mean background concentration be defined (either statistically or graphically), and this mean concentration is then subtracted from the measured concentrations. Because of variability in the background concentrations, this approach may be problematic, particularly where seepage is weak and the anomalies are very subtle.

Our initial approach is to review the data on a line-by-line basis and compare measured concentrations with the regional background. Then, a variety of hydrocarbon cross-plots are constructed, particularly that where methane is plotted versus percent hydrocarbon wetness (wetness % = $[SUM(C_2\text{-}C_4)/SUM(C_1\text{-}C_4)]$ x100) to delineate seepage. The rationale behind this plot (Figure III-1) is that different hydrocarbon 'sources' eg., biogenic versus thermogenic gas, condensate and liquids, can be distinguished on the basis of differences in their light hydrocarbon molecular compositions (Hunt 1979; Tissot & Welte 1984; Claypool & Kvenvolden 1983). In this model background hydrocarbons plot in a narrow range towards the left origin (low concentrations), while end-member 'source' hydrocarbons ie., hydrocarbons from either oil-prone, condensate-prone or gas-prone source rocks or reservoirs, plot to the right (high concentrations).

As the hydrocarbons in bottom-waters represent mixtures of the end-member background (low) and 'source' (high) concentrations, the trends between the end-members in these plots are indicative of the 'source' of the hydrocarbons comprising the anomalies. For example, when the % hydrocarbon wetness increases with increasing methane concentration, the trend indicates that the anomaly was probably derived from a gas-condensate or oil-prone 'source'. In contrast, increasing methane concentrations, coupled with decreasing % hydrocarbon wetness, suggest that the anomaly was derived from a gas-prone thermogenic 'source' or is of a biogenic origin. This model cannot distinguish between biogenic and gas-prone thermogenic anomalies. Carbon isotope (eg., Fuex 1977; Bernard <u>et al.</u> 1977) and molecular compositional data are required to discriminate between biogenic gas and 'dry' thermogenic anomalies.

Classification of anomalies

'Strong' (arbitrarily defined here as when some of the measured C_1-C_4 concentrations increase more than an order of magnitude above the background concentration) and 'moderate' thermogenic anomalies (some C_1-C_4 increase 5-10 fold above background) are obvious and are accompanied by large increases in individual C_1-C_4 hydrocarbons with no increase in the biogenic components (ethylene and propylene). 'Weak' anomalies (individual C_1-C_4 is less than five-fold the background concentration) are more difficult to discern. In some cases, what appear to be weak anomalies may result from variations in the depth of the fish above the seafloor, a shoaling of the water depth, penetration of the fish above the local thermocline or combinations of these factors. In these cases, plotting the saturated hydrocarbon (methane, ethane, propane) concentrations against the 'fish' depth, seawater temperature and salinity, or against the biogenic hydrocarbons (ethylene, propylene), generally resolves apparent anomalies from those anomalies related to seepage.

A cross-plot of two compounds (eg., ethane vs. methane) indicates whether the compounds are being added to the natural hydrocarbons in an area. Positive trends on plots of one compound versus another indicate that both compounds are being added concurrently and thus, the source of the anomaly contains both compounds. Because a mixing trend is created by one hydrocarbon source supplying hydrocarbons to the background, all data on the same trend reflect the same source regardless of the absolute concentrations or absolute ratios. For example, an anomaly with ethane at 0.1 ppm would reflect the same hydrocarbon source as a second anomaly with ethane values at 1.0 ppm if the data from the two anomalies lie on the same mixing trend. Similarly, an anomaly with a wetness of 2% (oil-like) may actually represent a dry gas source if it falls on a mixing trend that has low wetness values at higher concentrations.

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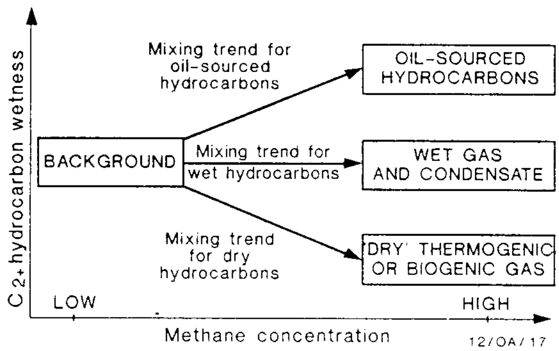


Figure III-1. Cross-plot of methane versus hydrocarbon wetness, showing the general decrease in wetness with increasing methane for gas-prone or biogenic sources. Conversely, oil-prone sources are indicated by increasing wetness with increasing wetness with increasing methane. Gas-condensate sources fall between the dry gas and oil-prone trends.

APPENDIX IV

General details: R.V. *Rig Seismic*

Rig Seismic is a seismic research vessel with dynamic positioning capability, chartered and equipped by BMR to carry out the Continental Margins Program. The ship was built in Norway in 1982 and arrived in Australia to be fitted out for geoscientific research in October 1984. It is registered in Newcastle, New South Wales, and is operated for BMR by the Federal Department of Transport and Communications.

Gross Registered Tonnage:	1545 tonnes	
Length, overall:	72.5 m	
Breadth:	13.8 m	
Draft:	6.0 m	
Engines:	Main: Norma KVMB-12	2640 HP/825 rpm
	Aux: 3x Caterpillar	564 HP/482 KVA
	1x Mercedes	78 HP/56 KVA
	Shaft generator:	AVK 1000KVA; 440 V/60 Hz
Side Thrusters:		2 forward, 1 aft, each 600 HP
Helicopter Deck:		20 m diameter
Accommodation:		39 single cabins and hospital

Scientific equipment

General

Raytheon echo sounders: 3.5 Khz (2 KW) and 12 Khz (2 KW)

Geometrics G801/803 magnetometer/gradiometer

Bodenseewerk Geosystem KSS-31 marine gravity meter

E.G. & G. model 990 side scan sonar

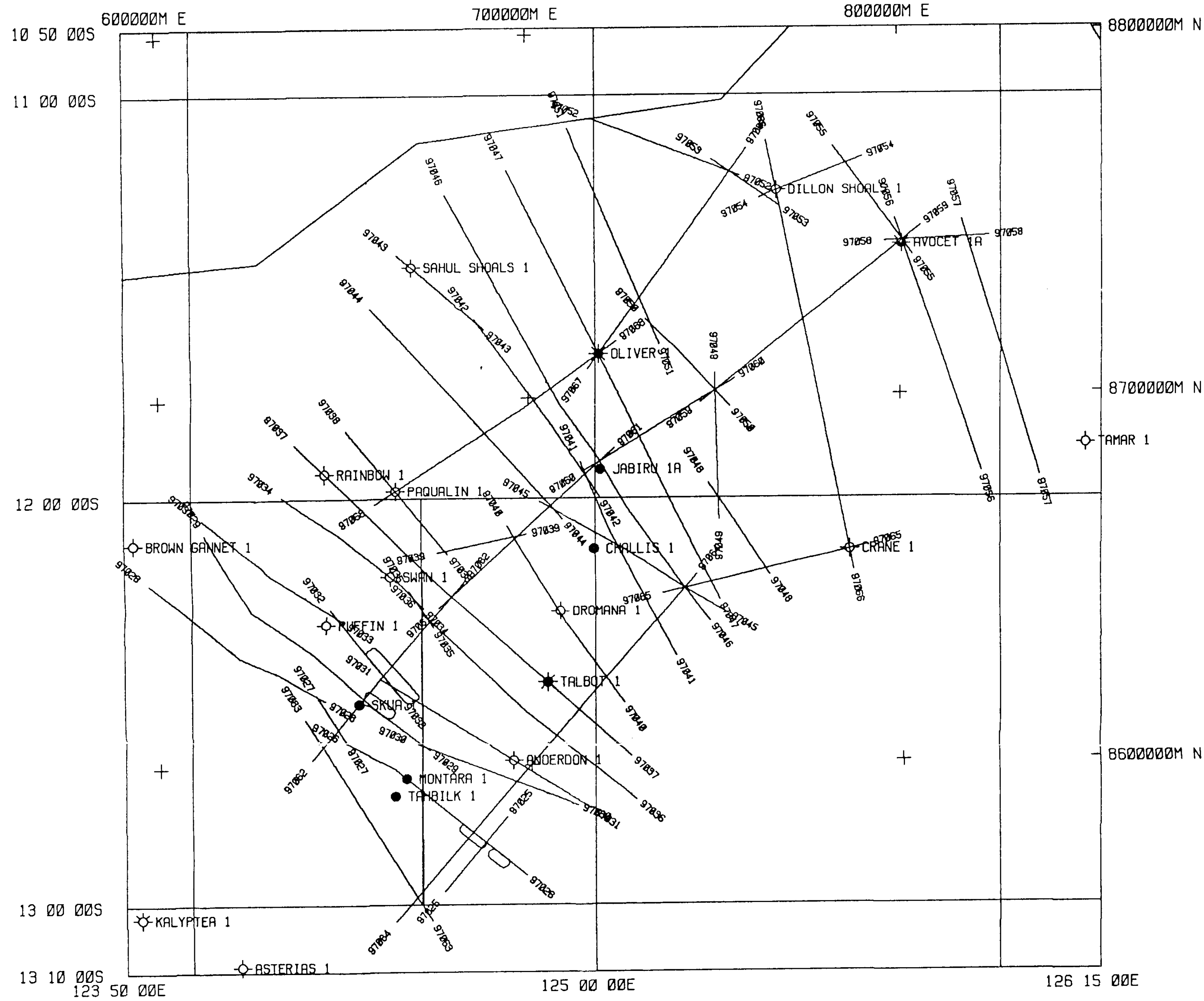
Nichiyu Giken Kogyo model NTS-11Au heatflow probe

Navigation
Trimble Differential GPS System
Magnavox T-set Global Positioning System
Magnavox MX 1107RS and MX 1142 transit satellite receivers
Magnavox MX 610D and Raytheon DSN 450 dual axis sonar dopplers
Arma Brown and Robertson gyro-compasses; plus Ben paddle log

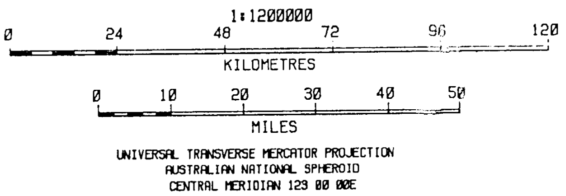
Cruise narrative

R.V. *Rig Seismic* departed from Fremantle and arrived in the southern Timor Sea, approximately 30 km southeast of Montara 1 exploration well, on Wednesday, October 31, 1990. The seismic and DHD systems were then tested and data acquisition began at about 0800 hours (October 31) with the acquisition of survey line 97/025. Over the next two and a half weeks, 34 dip lines and 10 strike lines were acquired between the southernmost Vulcan Sub-Basin and the Sahul Syncline to the north.

VULCAN SUB-BASIN



Enclosure 1



DHD SURVEY LINES
BHP VULCAN SUB-BASIN SURVEY 97
S8VULCAN 7/6/92 J NEEDHAM