

BMR RECORD 1992/54

**SOUTH-EASTERN AUSTRALIA SURFACE GEOCHEMISTRY 2:
LIGHT HYDROCARBON GEOCHEMISTRY IN BOTTOM-WATERS
OF THE GIPPSLAND BASIN, EASTERN OTWAY BASIN, TORQUAY
SUB-BASIN AND THE DURROON SUB-BASIN:
*RIG SEISMIC SURVEY 104.***

PROJECT 121.20

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Executive Summary

The Bureau of Mineral Resources (BMR) collected 1430 line-km of bottom-water Direct Hydrocarbon Detection (DHD) data during a survey aboard R.V. *Rig Seismic* in the Durroon Sub-basin, the Otway Basin, the Torquay Sub-basin, and the Gippsland Basin, during late September and early October of 1991.

No significant bottom-water anomalies were detected in the Durroon Sub-basin.

Anomalous concentrations of light C₂+ hydrocarbons were detected in the eastern Otway Basin. The anomalies were not extensive, comprising only a few data points representing a few kilometres in extent. One anomaly (of methane, ethane and propane) was accompanied by high levels of the biogenic hydrocarbons, ethylene and propylene, suggesting in-situ biogenic activity in the water column. However, anomalous concentrations of C₇ and C₈ hydrocarbons were also found here and at three other locations, and are from an unknown 'source'.

A weak bottom-water anomaly was detected in the Torquay Sub-basin in the same location as an anomaly detected during an earlier survey (Rig Seismic Survey 89), two years previously. The weakness of the anomaly prevents a confident interpretation of the potential 'source' of the hydrocarbon anomaly, but the data suggests it is derived from a gas/condensate, or dry thermogenic gas 'source'.

Several strong bottom-water anomalies were detected in the Gippsland Basin. Bottom-water anomalies were found near the Sunfish and Tuna oil/gas accumulations, in similar locations to anomalies found on Rig Seismic Survey 89, two years earlier. However, another previously-detected anomaly (near Barracouta) was not reproduced. Additional anomalies were found near Flathead, and to the west of Wahoo. The anomaly west of Wahoo was weak and in a similar area to that detected on Survey 89.

The composition of most bottom-water hydrocarbon anomalies in the Gippsland Basin are indicative of a liquid-prone hydrocarbon 'source', while one anomaly in the northern sector of the survey area is indicative of a gas/condensate 'source'.

Introduction

Surface geochemistry and offshore exploration for hydrocarbons

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

Within Australia, the 'sniffer' has been a relatively under-utilised tool in offshore hydrocarbon exploration, with only four surveys being carried out prior to 1988. Those surveys were all located in south eastern Australia, specifically in: (1) the Duntroon Basin, for Getty Oil Development Company Ltd. in 1983, (2) the Otway Basin (Sprigg 1986) for Ultramar Australia in 1981, and (3) two small surveys in the Gippsland Basin for Esso Exploration and Production, Australia Inc., in 1983.

The Bureau of Mineral Resources (BMR), as part of the Continental Margins Program, and a joint Agreement with Transglobal Exploration and Geoscience (TEG) of Leucadia, California, U.S.A. (Heggie et al., 1990), has been conducting surface geochemical (bottom-water DHD and sediment [hydrocarbon-headspace] geochemistry) surveys on parts of the Australian continental margin since 1989. 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 program: overall objectives

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

- 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, i.e. 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, and will be, carried out by the BMR's research vessel *Rig Seismic* (and occasionally on other vessels) around the Australian continental margin. These data are both integrated with each other, and also with sediment geochemical data which may sometimes be collected during the surveys.

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 C₁-C₈ 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 deals with the results obtained from DHD acquisition in south-eastern Australia during late September and early October 1991, *Rig Seismic Survey* 104. This Record combines a preliminary interpretation with the data release.

South-Eastern Australia Surface Geochemistry: Previous Work And Objectives

General Objectives: Survey 104.

The general and primary objectives of the *Rig Seismic* Survey 104 include the following (Heggie et al., 1991).

1. To develop new information on thermogenic hydrocarbon generation, migration and entrapment in the Gippsland Basin, eastern Otway Basin, and the Torquay Sub-basin.
2. To test the application of bottom-water Direct Hydrocarbon Detection (DHD) and sediment 'headspace' hydrocarbon geochemistry techniques to both prospect and reconnaissance scale exploration in these southeastern Australian basins.
3. To test the reproducibility of seepage from the seafloor by resurveying some locations of previously detected hydrocarbon seepage in the Gippsland Basin, eastern Otway Basin, and Torquay Sub-basin.
4. To test the application of cross-plots of molecular and isotopic compositions of anomalous gas concentrations in bottom-waters and sediments, as indicators of hydrocarbon 'source' (biogenic or thermogenic gas, gas-condensate or liquids-prone).

To achieve these objectives, DHD in bottom-waters was conducted (in some cases with high resolution seismic reflection data acquisition) along predetermined cruise tracks. The survey areas and lines are shown in Figure 1. The survey areas included:

- the Durroon Sub-basin
- the Otway Basin
- the Torquay Sub-basin
- the Gippsland Basin

Durroon Sub-basin: Background And Work Program.

A proprietary seismic program was conducted in conjunction with Bridge Oil in the Durroon Sub-basin. The DHD equipment was being prepared for use elsewhere in south-eastern Australia when the Durroon Sub-basin survey was carried out. However, the set-up time for the DHD equipment was minimal, and the opportunity was taken to collect non-proprietary DHD data for most of the seismic survey lines in the Durroon Sub-basin..

Otway Basin: Background And Work Program.

Bitumen strandings on the beaches of South Australia and Victoria and the finding of propane rich anomalies during an earlier InterOcean Systems Inc. 'geochemical sniffer' survey (Sprigg, 1986) suggested that surface geochemistry could contribute to exploration of the offshore Otway Basin.

The BMR has conducted two sediment 'headspace' hydrocarbon geochemistry surveys to the Otway Basin (McKirdy and Heggie, 1987; Heggie and O'Brien, 1988). An integration of the surface geochemical data with geohistory analyses and maturation modelling showed that the wet gas contents of anomalies varied systematically and similarly to the predicted distribution of the basal Early Cretaceous Pretty Hill Sandstone, a potential source rock (McKirdy et al, 1986; McKirdy, 1987). These data showed that the Pretty Hill Sandstone is within the present day oil window

(Williamson et al., 1987) on the Mussel Platform (eastern Otway Basin) where the highest wet gas contents were found in the surface sediment geochemical anomalies. These data were further integrated into a detailed study of the Otway Basin (Williamson et al, in press) to suggest an oil exploration play seaward of the Pecten exploration well.

As part of a combined BMR and TEG survey during 1989, a transit DHD survey line was conducted from Portland to Cape Otway (Heggie and O'Brien, 1989; O'Brien et al., 1992). A weak propane anomaly (with traces of butane) was found to the west of Cape Otway, offshore of earlier gas and condensate discoveries onshore (Miyazaki et al., 1990).

The work program of Survey 104 (conducted in conjunction with BHP) included approximately 310 line-km of bottom-water DHD and tested the application of bottom-water DHD to prospect evaluation in this part of the eastern Otway Basin.

Torquay Sub-Basin: Background And Work Program.

During 1989 the BMR, TEG and Shell Australia conducted a cooperative research DHD survey in an area of the Torquay Sub-basin where Shell Australia had seismic evidence of gases in the sediments. The DHD results in this area showed only a weak anomaly in methane (less than two-fold background) although there was other indirect evidence of seeping hydrocarbons. For example, a 1-2 m depression on the seafloor and anomalous side-scan sonar signals suggested pockmarks on the seafloor. Pockmarks have previously been associated with seafloor seepage (Hovland and Judd, 1988). Furthermore, high resolution seismic reflection data showed a wash-out zone and rising reflectors, beneath the bottom-water gas anomaly, indicative of gases in the sediments. The weak bottom-water methane anomaly was reproduced on resurveying.

However, hydrocarbon concentrations were too low for the 'source' to be predicted from either molecular or isotopic compositional data.

The DHD results also showed strong ethane and propane anomalies to the north of the Nerita exploration well. However, these were not reproducible on a resurvey of the area. These anomalies may represent anthropogenic hydrocarbons from Port Phillip Bay or from either of two ocean outfall sites located nearby and which are transported via local tidal influences.

A limited coring program was subsequently conducted by TEG in the area where seismic data indicated gases in the sediments and where the DHD survey detected a weak methane bottom-water anomaly. A few shallow cores (less than 3m) of unconsolidated sediment were collected, but the total gas concentrations were low and the data could not be adequately interpreted to determine the 'source' of gases in the sediments.

The work program of Survey 104 for the Torquay Sub-basin area included the following.

Approximately 330 line-km of bottom-water data was collected (Table 1). This survey investigated hydrocarbon seepage from three prospects in the Torquay Sub-basin and revisited the locations of some previously observed anomalies to test the reproducibility of the anomalies. Some detailed bottom-water sampling was conducted in the vicinity of pockmarks on the seafloor. A DHD survey line was run along the length of a major fault (reconnaissance exploration) to test if this fault serves as a common conduit for hydrocarbon migration.

Sediments in the vicinity of the seafloor pockmarks including the previously defined bottom-water anomaly (Rig Seismic Survey 89) were sampled with a vibrocore and

analysed for hydrocarbon gases. All gas analyses were conducted at sea. Gases were collected for isotopic analyses to be conducted in the shore-based laboratory. Samples were collected from these cores for basic sedimentology and geochemistry (e.g., water content, calcium carbonate, TOC, grain size). Sediment samples were collected for petroleum biomarker geochemistry.

Adjunct program in environmental geochemistry.

One strong (ethane and propane) anomaly found in the Torquay Sub-basin during the earlier (1989) DHD survey was not reproducible. It was earlier suggested this anomaly originated from Port Phillip Bay (O'Brien et al, 1992).

A limited surface-water DHD program was carried out near the entrance to Port Phillip Bay and also near two ocean outfall sites that discharge into the coastal zone in the vicinity of the approaches to Port Phillip Bay. The ocean outfall from the Geelong Water Board discharges into the sea near Cape Barwon, while approximately 45% of the urban liquid waste from the City of Melbourne is discharged through an ocean outfall site near Cape Schanks, to the west of the entrance to Westernport Bay.

Gippsland Basin: Background And Work Program.

Esso (with InterOcean Systems Inc.) conducted a 'geochemical sniffer' survey in the Gippsland Basin in 1983 (Burns and Emmet, 1984). Anomalous concentrations of hydrocarbons were found. However, these anomalies could not be reliably reproduced and it was concluded that the initial observations were probably artefacts which resulted from hydrocarbon production activities in the area. A more detailed survey was cancelled on the basis of these results.

During 1989 BMR conducted a limited DHD calibration survey of approximately 300

line-km in the Gippsland Basin (Heggie et al., 1989; O'Brien et al., 1992). The survey found bottom-water anomalies at several locations on the Northern Platform, near the trend of the Rosedale fault. Two strong anomalies were identified to the north and east of the Barracouta and Seahorse (oil-gas) accumulations while one anomaly was detected between Sunfish and Tuna and another to the north of Wahoo. Traces of thermogenic hydrocarbons were identified (albeit at low total hydrocarbon concentrations) in sediments from three vibrocores taken in the vicinity of the anomaly near Wahoo. Due to the limited time available, anomalies were not resurveyed and the reproducibility criteria remained untested.

The purpose of the Survey 104 program was to revisit the northern sector of the Gippsland Basin and to test observations from the earlier Esso and BMR surveys. Specifically the locations of some earlier-documented anomalies were revisited and samples collected for isotopic analyses (eg. Bernard et al., 1977; Fuex, 1977).

South-Eastern Australia Results: Survey 104

The data acquired from Survey 104 are summarised in Table 1. The survey track-lines and the approximate locations of bottom-water anomalies are shown in Figure 1 (and Enclosure 1). The table indicates approximately 1430 line-km of bottom-water DHD data collected in various areas of south-eastern Australia. A summary of the bottom-water anomalies found during the survey are summarised in Table 2. Eight vibrocores were collected from the Torquay Sub-basin.

Durroon Sub-basin.

Approximately 350 line-km of bottom-water DHD data was collected in the Durroon Sub-basin (Fig. 1). The survey lines are shown in Figure 2 (and Enclosure 2). This data was collected concurrently with acquisition of 399 line-km of seismic reflection data collected under a proprietary program for Bridge Oil. The DHD data were not part of the proprietary seismic survey. The data collected are summarised in the line-summary plots of Figures 3a-c.

No significant anomalies were found during this survey. Weak THC anomalies (less than two-fold above background) were found on survey lines 104/206, 104/221A, and 104/222, with a very weak increase in THC and methane measured over several shot-points on survey line 104/210 (Fig 3a, Appendix I). These THC anomalies were not accompanied by significant increases in the sum C₁-C₄ hydrocarbons (Fig. 3b), and most C₂, C₃ and C₄ light hydrocarbon concentrations were below the detection limits of the instrumentation (10 ppb), and are not shown here. However, weak increases in propane, sometimes accompanied by increases in butane were occasionally detected. For example, the weak THC anomaly detected on line 104/206 was accompanied by increases in propane and butane.

Otway Basin.

Approximately 310 line-km of data were collected from the Mussel Platform area of the eastern Otway Basin. The survey lines and the approximate locations of the detected bottom-water anomalies are shown in Figure 4 (and Enclosure 3). The DHD data are summarised in Figures 5 a-m.

Four weak THC anomalies were detected during this survey (Fig. 5a), with a very weak THC anomaly being detected on a resurvey (line 104/seep1) of the anomaly detected on line 104/001.

A weak THC anomaly was found on survey line 104/001, and this was accompanied by weak increases in the C₁, C₂, C₃ and C₄ hydrocarbons, including the unsaturated components (Figs 5b-h). At the completion of survey line 104/012, line 104/seep1 was run in the vicinity of the weak anomaly detected earlier on line 104/001. A very weak THC anomaly was again detected but no significant increases in the C₁-C₄ hydrocarbons were measured. However, anomalous concentrations of heavy hydrocarbons, provisionally identified as, n-C₇ and i-C₈ were found associated with this weak THC anomaly (Fig. 5j-l). These data are collected at 8 minute intervals on the vessel and the persistence of a few anomalous data points (these compounds are usually undetectable) is considered significant.

Three other THC anomalies were found (Fig. 5a) which showed similar increases in THC but no corresponding increase in the C₁-C₄ hydrocarbons. All of these THC anomalies were not extensive, and mostly comprised two-to-five shot-point anomalies, equivalent to distances of 1 to 2 km over the seafloor. These elevated THC values were accompanied by elevated concentrations of C₇ and C₈ hydrocarbons (Figs. 5j-l).

The ratios of C_1/C_2 are typically 200-500, C_2/C_3 is greater than 1, and the Bernard parameter about 100-400 (plots not shown). These ratios are similar to those observed elsewhere, where hydrocarbons are low and represent typical background values. Hydrocarbon wetness values are summarised in Figure 5m, and only the weak anomaly on survey line 104/001 shows any increases in wetness. All other high wetness values in Figure 5m are single shot-point data-points and represent analytical artefacts.

Torquay Sub-basin.

Approximately 330 line-km of DHD data were collected from the Torquay Sub-basin. A map of the survey lines and the locations of anomalies are shown in Figure 6 (and Enclosure 4). These data are summarised in Figures 7a-e. A high resolution seismic survey was conducted along DHD lines 104/021 to 104/024 (Table 1).

During this survey THC anomalies were detected on survey lines 104/014, 104/020, 104/022, 104/024, 104/028 and 104/043 (Fig. 7a). However only those anomalies detected on lines 104/022, 104/028, and 104/043 are associated with increases in other light hydrocarbons. On survey line 104/022, two weak THC, sum C_1-C_4 , methane and ethane anomalies were detected with no increases in the unsaturated hydrocarbon, ethylene (Figs 7a-e). One of these anomalies (sp 20-30) was in the same location as the anomaly detected during the 1989 survey. This anomaly was detected when resurveyed (line 104/043), and line 104/seep3 is over a pockmark on the seafloor (detected using side scan sonar on *Rig Seismic Survey 89*), and is indicative of hydrocarbon seepage from the seafloor. The other weak anomaly on survey line 104/022 (sp 75-80) was resurveyed on lines 104/028 and 104/seep2 and also contains trace increases in ethane.

The changes in light hydrocarbons detected were very small and the weak anomalies detected here are not distinguishable from background variations in other parameters such as the C_1/C_2 and C_2/C_3 ratios, the Bernard parameter, and percent hydrocarbon wetness, and hence these are not shown.

As previously reported (O'Brien et al., 1992), strong ethane and propane anomalies were detected to the north of the Nerita exploration well. While strong, these anomalies could not be detected on a resurvey of the area several days later, and it was previously suggested that these anomalies might be derived from an anthropogenic 'source' near to, or from within Port Phillip Bay. As part of Survey 104, DHD data was acquired along a series of lines from Cape Schanks, past the ocean outfall operated by the Melbourne Water Board at Boags Rocks, across the entrance to Port Phillip Bay, to the ocean outfall near Cape Barwon operated by the Geelong Water Board. This data was collected on survey lines 104/031-104/039, but is not reported here, but in a separate BMR record (Bickford et al., in preparation), which also includes DHD data from the Sydney ocean outfall study conducted as part of Survey 104.

During this mini-survey, no significant C_1 - C_4 hydrocarbon anomalies were detected. However, weak THC and methane anomalies were detected in the vicinity of the Geelong Water Board ocean outfall site (west of Port Phillip) and across the entrance to Port Phillip (although the DHD tow-fish was near the surface, less than 5m depth, during this part of the survey).

Torquay Sub-basin: sediment (hydrocarbon-headspace) geochemistry

As part of the Torquay Sub-basin survey, eight vibrocores were taken in the vicinity of the weak bottom-water hydrocarbon anomaly associated with the previously identified pock-mark. A summary of the cores recovered is given in Table 3. The objectives of these operations were to investigate the light hydrocarbon concentrations and

molecular (and isotopic) compositions such that:

- (i) the hydrocarbon 'source' (dry gas, gas/condensate, liquids-prone) producing the bottom-water anomalies may be predicted;
- (ii) empirical methods used to identify thermogenic hydrocarbons in near-surface sediments (from background biogenic hydrocarbons) could be clarified;
- (iii) the processes (thermogenic light hydrocarbon migration versus biogenic production and/or consumption) controlling light hydrocarbon concentrations and distributions in the near-surface sediments might be elucidated.

Table 4 summarises some physical properties in the sediments (water content, dry bulk density and calcium carbonate).

The light hydrocarbon data from the sediments are summarised in Table 5. These analyses were conducted by vigorously agitating 300 ml of wet sediment in an industrial blender for one minute and measuring the headspace hydrocarbon concentrations. This 'blender' method was adopted in an effort to rationalise the headspace technique so that more samples could be analysed at sea. Laboratory trials conducted in the shore-laboratory, suggested that light hydrocarbon concentrations measured using a 'blender' were comparable to those concentrations measured when sediments were shaken in a can for longer periods, up to about 40 minutes. However, the inter-calibrations were limited and need to be conducted over a range of different sediment types.

While the measured sediment hydrocarbon concentrations are not exceedingly high in the area of this seep, the molecular compositional ratios, particularly ethane/ethylene, and propane/propylene exceed those used previously (ethane/ethylene greater than 1, propane/propylene greater than 3: McKirdy and Heggie, 1987; Heggie et al., 1988; Heggie and O'Brien, 1988; O'Brien and Heggie, 1989), to empirically identify

thermogenic hydrocarbons in the sediments (Table 5).

Gippsland Basin.

Approximately 240 line-km of DHD data were collected from the Gippsland Basin, principally along the trend of the Rosedale Fault. The survey track-lines in the Gippsland Basin and the approximate locations of bottom-water anomalies are shown in Figure 8 (and Enclosure 5). The DHD data are summarised in the Gippsland Basin line summary plots in Figures 9 a-m.

Several bottom-water THC anomalies were detected in the Gippsland Basin (Fig. 9a). All of these anomalies were comprised of increases in the saturated C₁-C₄ hydrocarbons (Figs. 9b-g), and unaccompanied by the unsaturated (biogenic) hydrocarbon, ethylene (Fig. 9e). Several anomalies comprised elevated concentrations of the C₅ hydrocarbons (Fig. 9j) and trace increases in the C₆ hydrocarbons (not shown). The anomalies are summarised in Table 2.

A weak anomaly, comprised of trace increases in C₁, C₂ and C₃ hydrocarbons was detected on lines 104/049 to 104/051, west of the Remora-1 exploration well (Figs 9a-g), and shows an increase in wetness values (greater than 2%; Fig. 9k).

Significant anomalies were found on survey lines 104/053 to 104/055 (methane increases about four-fold background, and ethane and propane up to about 1 ppm (fifty-fold background), in the immediate vicinity of the Sunfish oil and gas field (Figs. 9a-g). These anomalous hydrocarbon concentrations were associated with high wetness values, up to 16% (Fig. 9k). Other strong anomalies, more than an order of magnitude increase in hydrocarbon concentration above background, were detected on survey lines 104/057 to 104/059 (Figs. 9a-j). These anomalies were found to the east

of Sunfish and north of Tuna, in the same area as those anomalies detected during the previous *Rig Seismic* survey in 1989 (O'Brien et al., 1992). Hydrocarbon wetness values up to about 12% were found associated with the Survey 104 anomalies (Fig. 9k).

Additional anomalies were found on survey lines 104/060 to 104/062, in the northern sector of the survey area in the vicinity of the Flathead-1 exploration well, and to the west of the Wahoo-1 exploration well (Figs. 8, 9a-j). These anomalies were comprised of increases in the C₂-C₅ hydrocarbons and corresponding wetness values. However, one anomaly observed on line 104/062 (sp 15-30) was associated with decreasing wetness values, and represents a different hydrocarbon 'source' (see below). While discrete increases in methane and other hydrocarbons were not found on survey lines 104/063 and 104/064, the ethane and propane concentrations (with occasional occurrences of butane) are generally higher than background hydrocarbon concentrations (Figs. 8, 9a-g). For example, ethane values in this area approach 0.1 ppm, and typical background is less than 0.02 ppm. These elevated hydrocarbon concentrations were found in the vicinity of the Wahoo-1 exploration well, and were associated with an increase in wetness values at low methane concentrations (Fig. 9k).

The ratios of various hydrocarbons along the survey lines also reflect the locations of anomalous bottom-water hydrocarbon concentrations (Figs. 10a, 10b). For example, the value of C₁/C₂ is highest in the eastern sector of the Gippsland Basin, where distinct anomalies were not detected and varies typically between about 400 and 800. The values for ethane were so low in the eastern sector (lines 104/045 to 104/048) that they were below the analytical detection limit (10 ppb). Ethane values of 0.004 ppm have been used in this plot, hence the ratio of C₁/C₂ (of about 800) is a minimum. Similarly, the plot of the Bernard parameter (Fig. 10b) shows the lowest values corresponding to anomalous C₂+ hydrocarbon concentrations.

Hydrocarbon 'source'

A cross-plot model of methane versus percent hydrocarbon wetness has been used to investigate the 'source' (dry gas, gas-condensate and liquids-prone) of bottom-water anomalies. The rationale behind this model is summarised in Appendix III and Figure III-1, Appendix III. This model has been utilised elsewhere, and data from several basins over known hydrocarbon accumulations (Heggie et al., 1991a, 1991b) suggest this model can be used to predict hydrocarbon 'source'. Cross-plots from each of the survey areas are summarised in Figures 11-14a.

The data from the Durroon Sub-basin (Fig. 11) indicate a tight cluster of data at typical background wetness values (less than 1.5%) and background methane concentrations (less than 5 ppm). Cross-plots without any well developed trend lines are characteristic of basins without moderate-to-strong bottom-water anomalies. There is a very weak trend of increasing wetness values (up to 5% wetness) at low methane concentrations, which comprises the data from survey lines 104/206 where propane increased briefly to levels about two-fold background and butanes occasionally increased significantly above background. The trend is too weak to be interpreted confidently as to its 'source'

The data from the Otway Basin (Fig. 12) indicate a tight cluster of data points at typical background wetness values and methane concentrations. There is a weak trend of increasing percent hydrocarbon wetness values (approaching 12%) at low methane concentrations. This trend comprises the weak anomalous levels of ethane, propane (ethylene and propylene) and butane measured on survey line 104/001. High levels of C₇ and C₈ (up to 5 ppm) were found in this area (line 104/seep1).

The cross-plot of methane versus percent hydrocarbon wetness for the Torquay Sub-basin is shown in Figure 13a. There is a well-developed trend of increasing methane

(up to 12 ppm, or about four-fold background) with near constant wetness values (less than 1%). At low hydrocarbon concentrations this cross-plot model is not a sensitive indicator of hydrocarbon 'source' (compare this data to that from the Gippsland Basin). However, this data suggests that the weak methane and ethane anomaly detected on the Nerita trend is from a gas/condensate or dry gas 'source'.

The plot of methane versus percent hydrocarbon wetness for the sediment hydrocarbon-headspace data of Table 4, is shown in Figure 13b. There is a similar trend of increasing methane (approaching 20 ppm) with near constant wetness values (less than 6%). This trend predicts a gas/condensate hydrocarbon 'source'. It should be noted that the methane concentrations reported in this plot are not directly comparable to those in Fig. 13a. Reported methane concentrations in Figure 13a are concentrations in the extracted gas phase and hence do not represent concentrations in seawater. The methane data in Figure 13b represent concentrations expressed as microlitres of methane per litre of wet sediment.

The cross-plot of methane versus percent hydrocarbon wetness for the Gippsland Basin is shown in Figure 14a. This plot shows at least two, and perhaps three, well-developed trends. There is a trend of constant wetness (less than 2%) with increasing methane values (greater than 25 ppm), indicative of a gas/condensate hydrocarbon 'source'. This data is from the bottom-water anomaly on survey line 104/062. Another well-developed trend of increasing wetness (12%) with increasing methane (greater than 25 ppm) encompasses most other anomalies detected in the Gippsland Basin. This trend is indicative of a liquid-prone hydrocarbon 'source'. Another trend of increasing wetness (greater than 15%) with increasing methane (greater than 10 ppm) is evident which is also indicative of a liquid-prone hydrocarbon 'source'. Similar trends are also evident in the cross-plots of methane versus the individual hydrocarbons ethane, propane and butane (Figs. 14b-d).

Summary

During late September and early October 1991 the BMR carried out a survey in south-eastern Australia using the BMR research vessel R.V. *Rig Seismic*. The survey comprised various programs, sometimes combining seismic with DHD data acquisition. The survey collected DHD data from the Durroon Sub-basin, the Otway Basin, the Torquay Sub-basin and the Gippsland Basin.

No significant bottom-water anomalies were detected in the Durroon Sub-basin survey of 350 line-km. However, a weak THC anomaly was detected on survey line 104/206, comprised of increases in propane and butane above background levels.

Several bottom-water hydrocarbon anomalies were detected in the Mussel Platform (eastern Otway Basin) survey of 310 line-km. Anomalous levels of THC, ethane, propane and butane, accompanied by the unsaturated hydrocarbons ethylene and propylene, were measured on survey line 104/001. Anomalous levels of THC, C₇ and C₈ hydrocarbons were measured in three other locations. The origin and 'source' of these hydrocarbons is unknown.

Weak bottom-water methane and ethane anomalies were detected in the Torquay Sub-basin on the Nerita trend. The anomalies were found in the same location as an anomaly found previously (*Rig Seismic* Survey 89), above a pock-marked depression on the seafloor. The composition of these weak anomalies suggests the hydrocarbons are sourced from a gas/condensate or dry thermogenic gas 'source'.

The light hydrocarbon compositions in the sediments of the sea-floor pock-mark depression, where the bottom-water anomaly was found, are similar to those measured in the bottom-water anomaly.

Most of bottom-water anomalies detected during Survey 104 were found in the Gippsland Basin. Several anomalies were found along the trend of the Rosedale Fault, which was the focus of the Gippsland Basin survey.

Bottom-water anomalies were detected in similar locations to anomalies found on a previous survey (*Rig Seismic Survey 89*). These included anomalies near the Sunfish oil and gas accumulation, and to the north and east of the Tuna oil and gas field. No anomaly was detected north of the Barracouta field, where a very strong anomaly was previously detected on Survey 89.

Other bottom-water anomalies were found near Flathead-1 on survey lines 104/061 and 104/062.

No strong anomaly was found near the Wahoo-1 exploration well (as previously detected on Survey 89), but a distinct anomaly was detected west of Wahoo-1, and the concentrations of the C_2+ hydrocarbons in this area were generally higher than background levels found elsewhere, suggesting a nearby 'source' of anomalous hydrocarbons.

The crossplot model shows three distinct trends or 'sources' of hydrocarbons. One trend, corresponding to the anomaly detected on lines 104/061 and 104/062, is derived from a gas/condensate or dry gas 'source'. The second trend, of about 12% wetness, corresponds to the anomaly detected on lines 104/057 and 104/059, and is derived from a liquid-prone 'source'. The third trend, upto 16% wetness, is also derived from a liquid-prone 'source', and corresponds to the anomaly detected on lines 104/053 and 104/055.

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Table 1. Summary of data collected during *Rig Seismic* Survey 104.

Survey Area	Data Collected
Durroon Sub-basin	350 line-km DHD data 399 line-km seismic reflection data (proprietary)
Otway Basin	310 line-km DHD data
Torquay Sub-basin	330 line-km DHD data 127 line-km high-resolution seismic reflection data 8 sediment vibrocores
Gippsland Basin	240 line-km DHD data

Table 2. Summary of bottom-water light hydrocarbon anomalies found during Survey 104.

<u>Basin or Sub-basin</u>	<u>Anomalous hydrocarbons</u>	<u>Anomaly strength</u>	<u>Survey Line No.</u>
Durroon	THC	weak	104/206, 104/221A, 104/222
Durroon	THC	very weak	104/210
Durroon	Propane, butane	weak	104/206
Otway	THC, methane, ethane, ethylene, propane, propylene, butane	weak	104/001
Otway	THC, n-C ₇ and i-C ₈	very weak	104/seep1
Otway	THC, n-C ₇ and i-C ₈	weak	104/002, 104/009, 104/010
Torquay	THC	weak	104/014, 104/020, 104/024,
Torquay	THC, methane, ethane	weak	104/022 (two anomalies), 104/028, 104/seep3, 104/043
Gippsland	Ethane, propane	weak	104/049, 104/050, 104/051
Gippsland	Methane, ethane, propane	strong	104/053, 104/055
Gippsland	Methane, ethane, propane, butane, pentane	strong	104/057, 104/059, 104/060
Gippsland	Methane, ethane, propane, butane, pentane	strong	104/061, 104/062
Gippsland	Ethane, propane	weak	104/063, 104/064

Table 3. Vibrocores recovered from the Torquay Sub-basin.

Core ID	Recovery (cm.)	Notes
VC10401	525	Stored at BMR
VC10402	257	Sampled for C ₁ -C ₄ hydrocarbon analysis
VC10403	269	Sampled for C ₁ -C ₄ hydrocarbon analysis
VC10404	240	Sampled for C ₁ -C ₄ hydrocarbon analysis
VC10405	176	Stored at BMR
VC10406	245	Stored at BMR
VC10407	248	Sampled for C ₁ -C ₄ hydrocarbon analysis
VC10408	226	Sampled for C ₁ -C ₄ hydrocarbon analysis

Table 4. Summary of physical properties of vibrocore samples from the Torquay Sub-basin.

Core	Latitude	Longitude	Water	Porosity	Dry Bulk	CaCO ₃ %
			Depth (m)		Density	
VC10402	38.672	144.122	76	0.508	2.26	9
VC10402	38.672	144.122	76	0.671	2.82	16
VC10402	38.672	144.122	76	0.732	2.86	25
VC10402	38.672	144.122	76	0.404	2.43	77
VC10402	38.672	144.122	76	0.365	2.40	81
VC10402	38.672	144.122	76	0.406	2.11	18
VC10403	38.672	144.122	76	0.580	2.46	12
VC10403	38.672	144.122	76	0.669	2.61	12
VC10403	38.672	144.122	76	0.614	2.74	45
VC10403	38.672	144.122	76	0.590	2.47	8
VC10403	38.672	144.122	76	0.668	2.87	13
VC10403	38.672	144.122	76	0.660	2.71	12
VC10404	38.673	144.123	76	0.357	2.35	40
VC10404	38.673	144.123	76	0.371	2.66	72
VC10404	38.673	144.123	76	0.467	2.48	14
VC10404	38.673	144.123	76	0.430	2.04	14
VC10404	38.673	144.123	76	0.571	2.55	13
VC10404	38.673	144.123	76	0.538	2.55	19
VC10404	38.673	144.123	76	0.505	2.49	21
VC10407	38.679	144.127	77	0.399	2.27	90
VC10407	38.679	144.127	77	0.374	2.27	89
VC10407	38.679	144.127	77	0.375	2.12	89
VC10407	38.679	144.127	77	0.434	2.32	62
VC10407	38.679	144.127	77	0.449	2.27	34
VC10407	38.679	144.127	77	0.410	2.37	84
VC10408	38.677	144.115	77	0.180	2.27	91
VC10408	38.677	144.115	77	0.418	2.61	63
VC10408	38.677	144.115	77	0.531	2.67	40
VC10408	38.677	144.115	77	0.869	2.66	39

Core	Latitude	Longitude	Water Depth (m)	Depth in Core (cm)	Mean Depth (cm)	C1	C2	C2:1	C3	C3:1	iC4	nC4	iC5	nC5	C1-C4	Wet Gas %	C1/ C2+C3	C2/ C2:1	C3/ C3:1	iC4/ nC4	iC5/ nC5
VC10402	38.6722	144.1220	76.0	67-80	73	0.970	0.016	0.027	0.015	0.010	0.000	0.000	0.000	0.000	1.001	3.097	31.290	0.593	1.500	0.000	0.000
VC10402	38.6722	144.1220	76.0	98-111	105	0.606	0.005	0.010	0.004	0.001	0.000	0.000	0.000	0.000	0.615	1.463	67.333	0.500	4.000	0.000	0.000
VC10402	38.6722	144.1220	76.0	121-134	127	0.946	0.026	0.050	0.011	0.022	0.000	0.000	0.000	0.000	0.983	3.764	25.568	0.520	0.500	0.000	0.000
VC10402	38.6722	144.1220	76.0	174-187	180	10.537	0.373	0.097	0.128	0.036	0.052	0.054	0.000	0.000	11.144	5.447	21.032	3.845	3.556	0.963	0.000
VC10402	38.6722	144.1220	76.0	204-217	210	12.560	0.626	0.159	0.159	0.030	0.055	0.041	0.000	0.000	13.441	6.555	16.000	3.937	5.300	1.341	0.000
VC10402	38.6722	144.1220	76.0	234-247	240	7.603	0.045	0.022	0.012	0.003	0.000	0.000	0.000	0.000	7.660	0.744	133.386	2.045	4.000	0.000	0.000
VC10403	38.6722	144.1220	76.0	35-47	41	4.306	0.424	0.065	0.118	0.016	0.040	0.032	0.000	0.000	4.920	12.480	7.945	6.523	7.375	1.250	0.000
VC10403	38.6722	144.1220	76.0	60-73	66	2.738	0.357	0.053	0.104	0.018	0.038	0.028	0.000	0.000	3.265	16.141	5.939	6.736	5.778	1.357	0.000
VC10403	38.6722	144.1220	76.0	80-93	86	4.741	0.499	0.133	0.122	0.033	0.035	0.000	0.000	0.000	5.397	12.155	7.634	3.752	3.697	0.000	0.000
VC10403	38.6722	144.1220	76.0	120-133	126	2.604	0.017	0.007	0.008	0.002	0.000	0.000	0.000	0.000	2.629	0.951	104.160	2.429	4.000	0.000	0.000
VC10403	38.6722	144.1220	76.0	150-163	156	4.464	0.026	0.009	0.008	0.002	0.000	0.000	0.000	0.000	4.498	0.756	131.294	2.889	4.000	0.000	0.000
VC10403	38.6722	144.1220	76.0	210-223	216	2.995	0.016	0.010	0.006	0.002	0.000	0.000	0.000	0.000	3.017	0.729	136.136	1.600	3.000	0.000	0.000
VC10403	38.6722	144.1220	76.0	235-248	241	5.856	0.047	0.031	0.030	0.009	0.000	0.000	0.000	0.000	5.933	1.298	76.052	1.516	3.333	0.000	0.000
VC10404	38.6728	144.1227	76.0	10-23	16	7.421	0.371	0.124	0.094	0.054	0.000	0.074	0.000	0.000	7.960	6.771	15.959	2.992	1.741	0.000	0.000
VC10404	38.6728	144.1227	76.0	35-48	41	14.158	0.284	0.118	0.055	0.052	0.000	0.034	0.000	0.000	14.531	2.567	41.764	2.407	1.058	0.000	0.000
VC10404	38.6728	144.1227	76.0	80-93	86	18.703	0.352	0.118	0.054	0.039	0.052	0.000	0.000	0.000	19.161	2.390	46.067	2.569	1.385	0.000	0.000
VC10404	38.6728	144.1227	76.0	120-133	126	7.876	0.088	0.042	0.014	0.009	0.000	0.000	0.000	0.000	7.978	1.279	77.216	2.095	1.556	0.000	0.000
VC10404	38.6728	144.1227	76.0	150-163	156	3.643	0.023	0.010	0.005	0.002	0.000	0.000	0.000	0.000	3.671	0.763	130.107	2.300	2.500	0.000	0.000
VC10404	38.6728	144.1227	76.0	180-193	186	1.513	0.016	0.010	0.002	0.002	0.000	0.000	0.000	0.000	1.531	1.176	84.056	1.600	1.000	0.000	0.000
VC10404	38.6728	144.1227	76.0	200-212	206	2.718	0.077	0.016	0.016	0.002	0.000	0.000	0.000	0.000	2.811	3.308	29.226	4.813	8.000	0.000	0.000
VC10407	38.6793	144.1273	77.0	50-63	56	3.780	0.468	0.076	0.135	0.026	0.040	0.036	0.000	0.000	4.459	15.228	6.269	6.158	5.192	1.111	0.000
VC10407	38.6793	144.1273	77.0	80-93	86	3.508	0.440	0.083	0.137	0.052	0.058	0.054	0.000	0.000	4.197	16.416	6.080	5.301	2.635	1.074	0.000
VC10407	38.6793	144.1273	77.0	120-133	126	6.155	0.287	0.367	0.059	0.110	0.000	0.033	0.000	0.000	6.534	5.800	17.789	0.782	0.536	0.000	0.000
VC10407	38.6793	144.1273	77.0	150-163	156	2.862	0.108	0.180	0.025	0.093	0.000	0.008	0.000	0.000	3.003	4.695	21.519	0.600	0.269	0.000	0.000
VC10407	38.6793	144.1273	77.0	180-193	186	5.085	0.257	0.140	0.051	0.047	0.014	0.025	0.000	0.000	5.432	6.388	16.510	1.836	1.085	0.560	0.000
VC10407	38.6793	144.1273	77.0	220-233	226	5.686	0.432	0.133	0.112	0.064	0.029	0.036	0.000	0.000	6.295	9.674	10.452	3.248	1.750	0.806	0.000
VC10408	38.6773	144.1150	77.0	80-93	86	6.548	0.298	0.118	0.066	0.100	0.014	0.034	0.000	0.000	6.960	5.920	17.989	2.525	0.660	0.412	0.000
VC10408	38.6773	144.1150	77.0	120-133	126	15.075	0.552	0.218	0.127	0.054	0.040	0.035	0.000	0.000	15.829	4.763	22.202	2.532	2.352	1.143	0.000
VC10408	38.6773	144.1150	77.0	150-163	156	17.633	0.678	0.633	0.164	0.318	0.000	0.110	0.000	0.000	18.585	5.122	20.942	1.071	0.516	0.000	0.000
VC10408	38.6773	144.1150	77.0	180-193	186	16.782	0.468	0.244	0.110	0.150	0.025	0.074	0.000	0.000	17.459	3.878	29.035	1.918	0.733	0.338	0.000
The detection limit of the gas chromatograph is 0.002ppm of gas in wet sediment.																					

Table 5. Sediment (headspace-hydrocarbon) analyses of vibrocore samples from the Torquay Sub-basin.

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- Figure 7c. Methane versus line number in the Torquay Sub-basin.
- Figure 7d. Ethane versus line number in the Torquay Sub-basin.
- Figure 7e. Ethylene versus line number in the Torquay Sub-basin.
- Figure 8. Map of the DHD survey lines in the Gippsland Basin showing the approximate locations of bottom-water hydrocarbon anomalies.
- Figure 9a. Total hydrocarbons (THC) versus line number in the Gippsland Basin.
- Figure 9b. Sum C_1 - C_4 hydrocarbons versus line number in the Gippsland Basin.
- Figure 9c. Methane versus line number in the Gippsland Basin.
- Figure 9d. Ethane versus line number in the Gippsland Basin.
- Figure 9e. Ethylene versus line number in the Gippsland Basin.
- Figure 9f. Propane versus line number in the Gippsland Basin.
- Figure 9g. Butanes versus line number in the Gippsland Basin.
- Figure 9h. Iso-pentane versus line number in the Gippsland Basin.
- Figure 9j. Normal-pentane versus line number in the Gippsland Basin.
- Figure 9k. Percent hydrocarbon wetness versus line number in the Gippsland Basin.
- Figure 10a. C_1/C_2 ratio versus line number in the Gippsland Basin.
- Figure 10b. Bernard parameter versus line number in the Gippsland Basin.
- Figure 11. Durroon Sub-basin: percent hydrocarbon wetness versus methane.

Figure 12. Otway Basin: percent hydrocarbon wetness versus methane.

Figure 13a. Torquay Sub-basin DHD data: percent hydrocarbon wetness versus methane.

Figure 13b. Torquay Sub-basin sediment data: percent hydrocarbon wetness versus methane.

Figure 14a. Gippsland Basin: percent hydrocarbon wetness versus methane.

Figure 14b. Gippsland Basin: methane versus ethane.

Figure 14c. Gippsland Basin: methane versus propane.

Figure 14d. Gippsland Basin: methane versus iso- plus normal-butane.

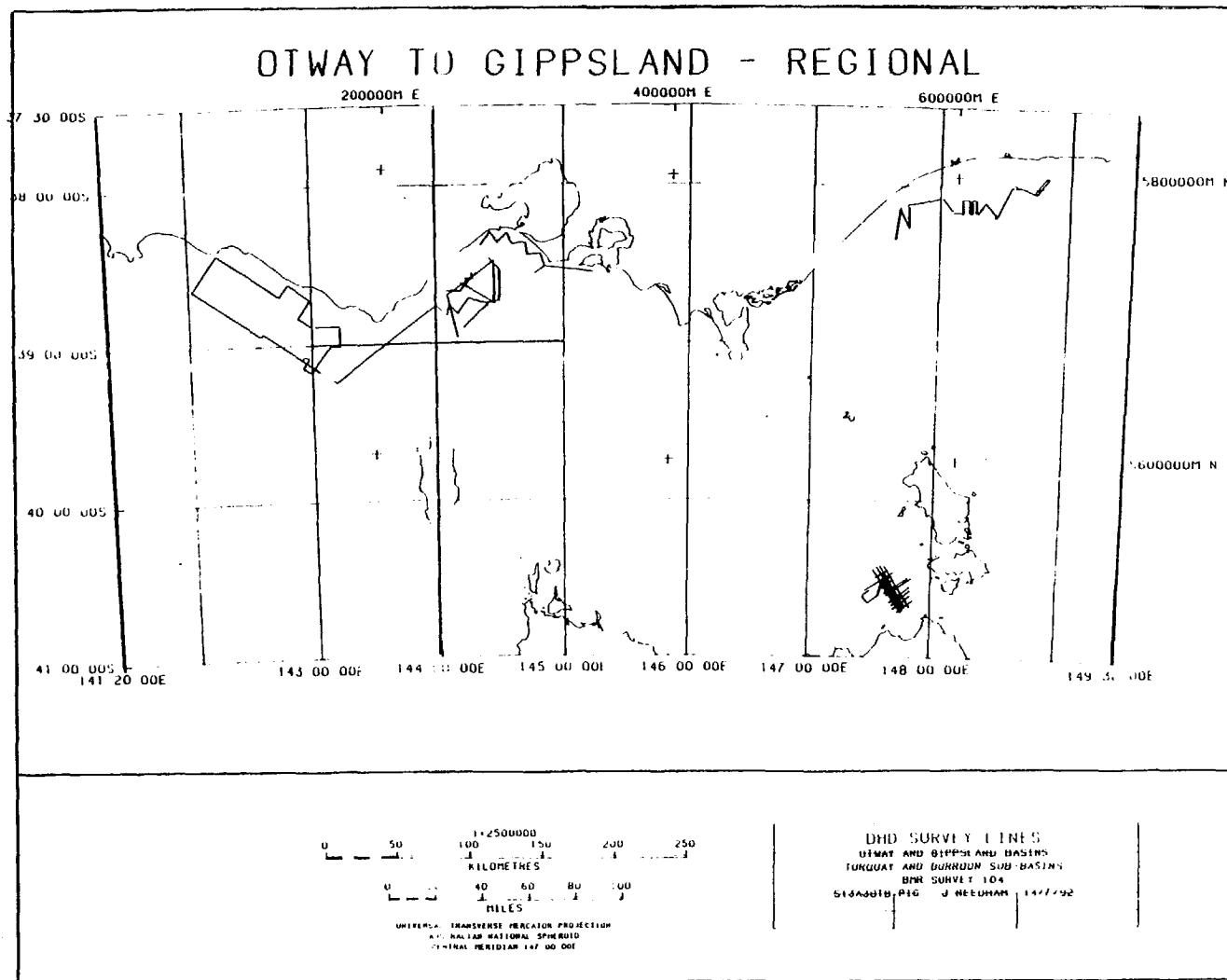


Figure 1. Regional map of south-eastern Australia showing the DHD survey lines and the approximate locations of bottom-water hydrocarbon anomalies.

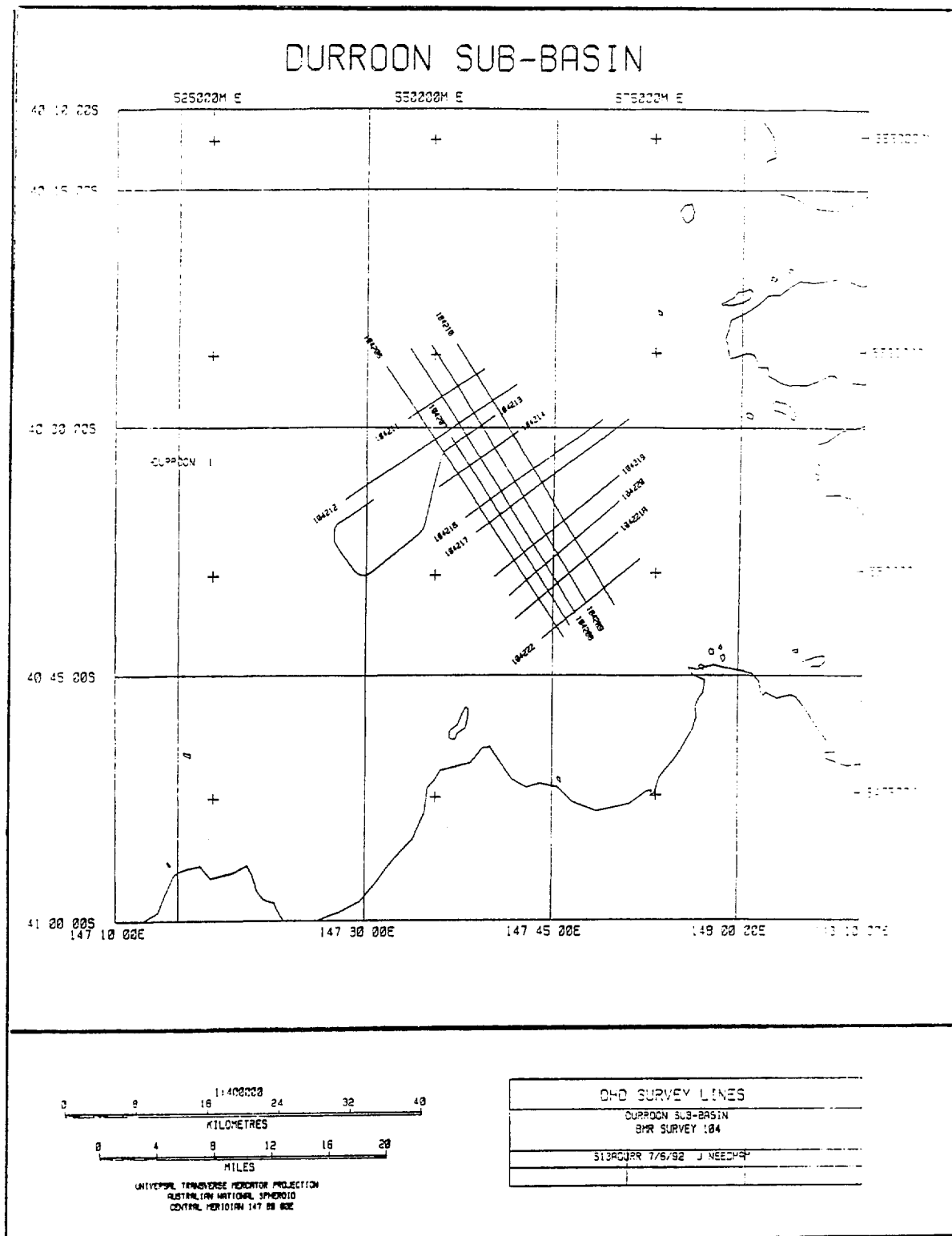


Figure 2. Map of the survey lines in the Durroon Sub-basin.

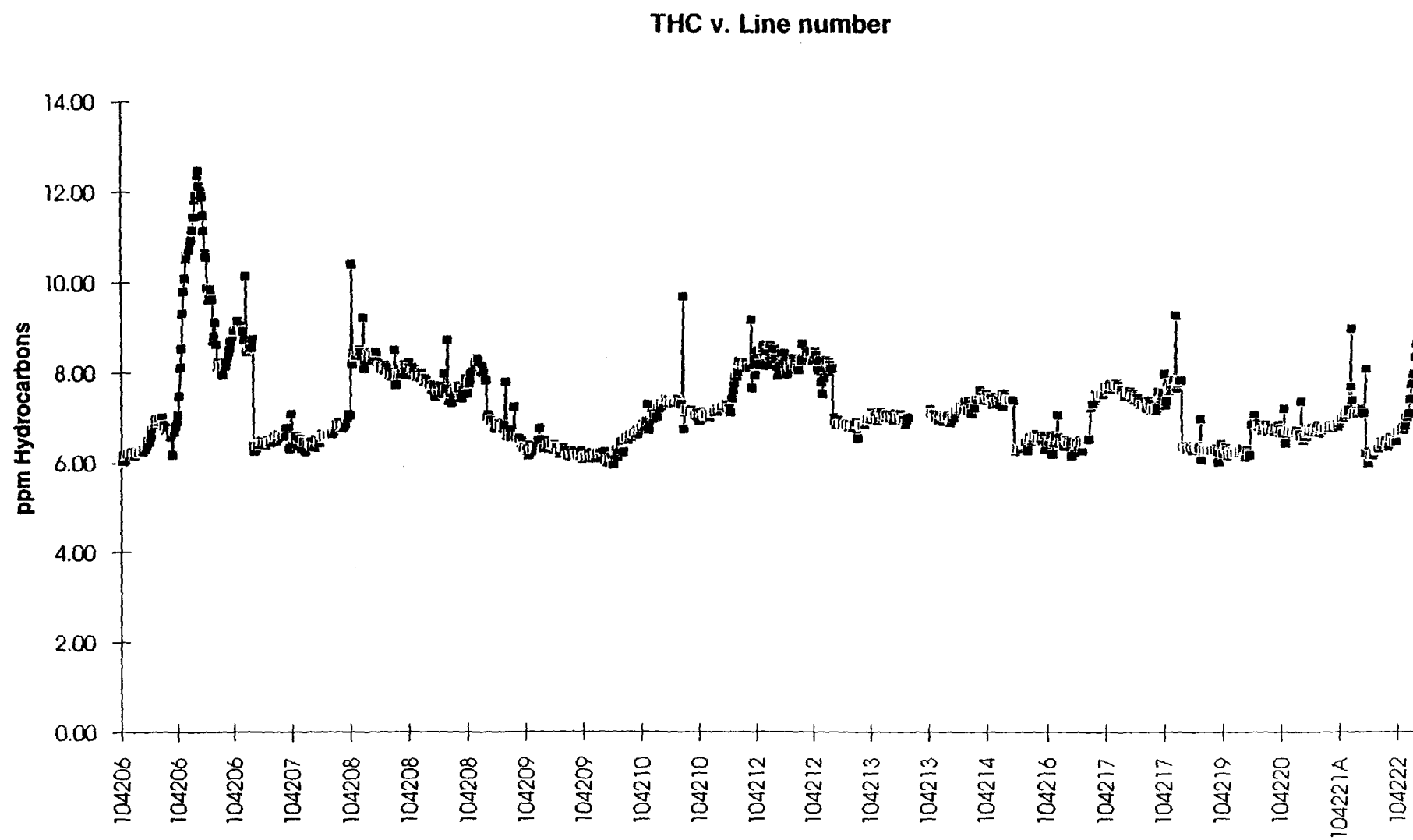


Figure 3a. Total hydrocarbons (THC) versus line number in the Durroon Sub-basin.

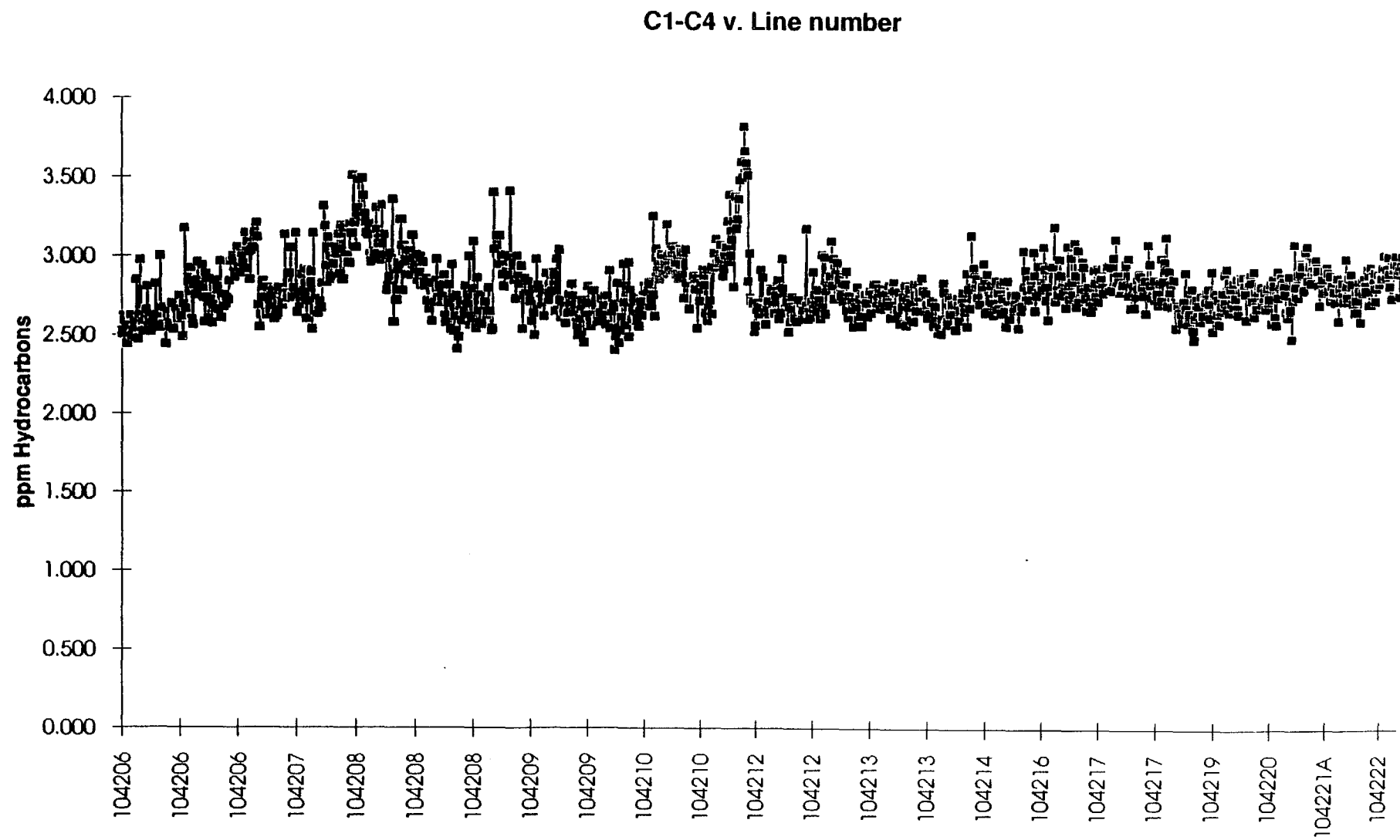


Figure 3b. Sum C1-C4 hydrocarbons versus line number in the Durroon Sub-basin.

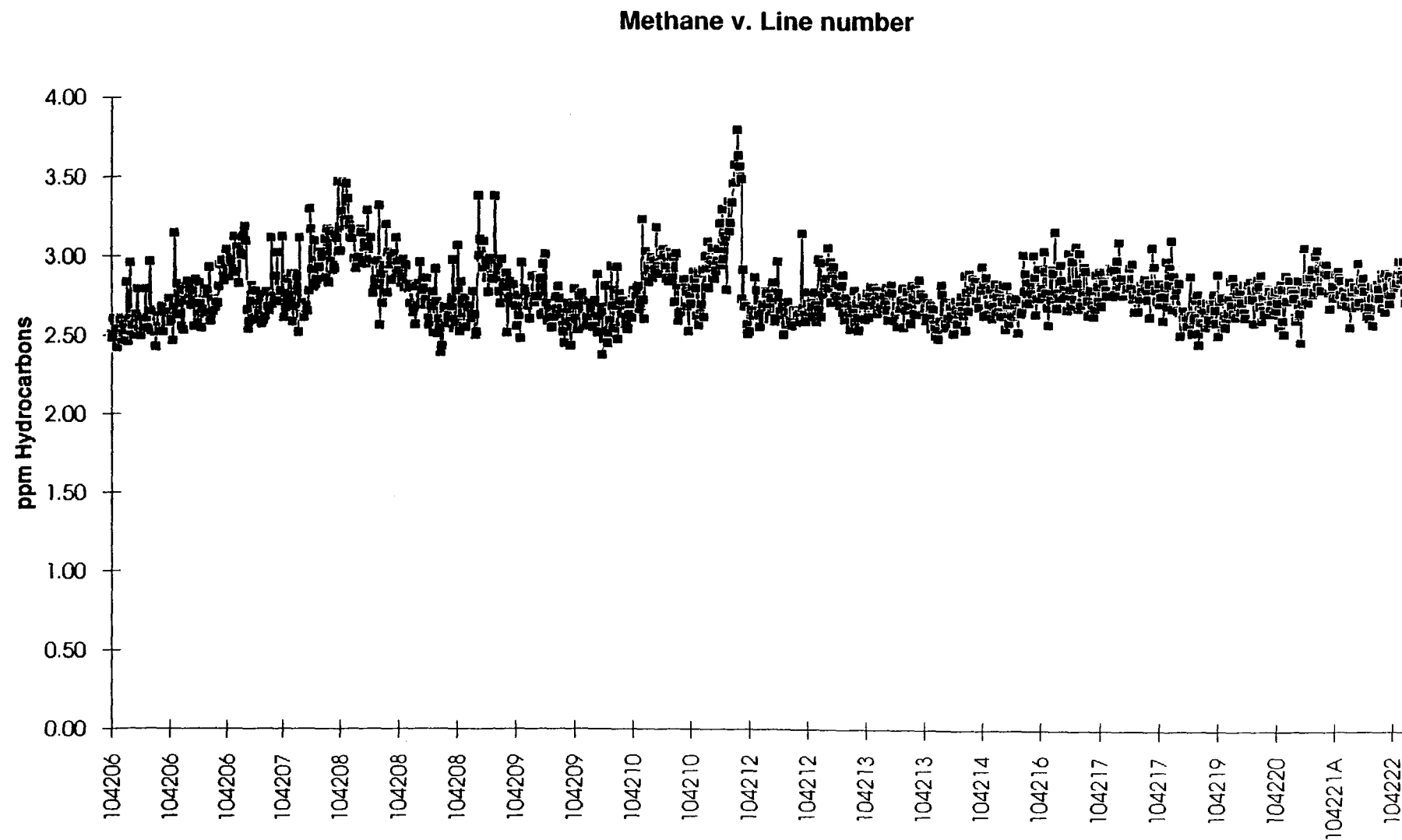


Figure 3c. Methane versus line number in the Durroon Sub-basin.

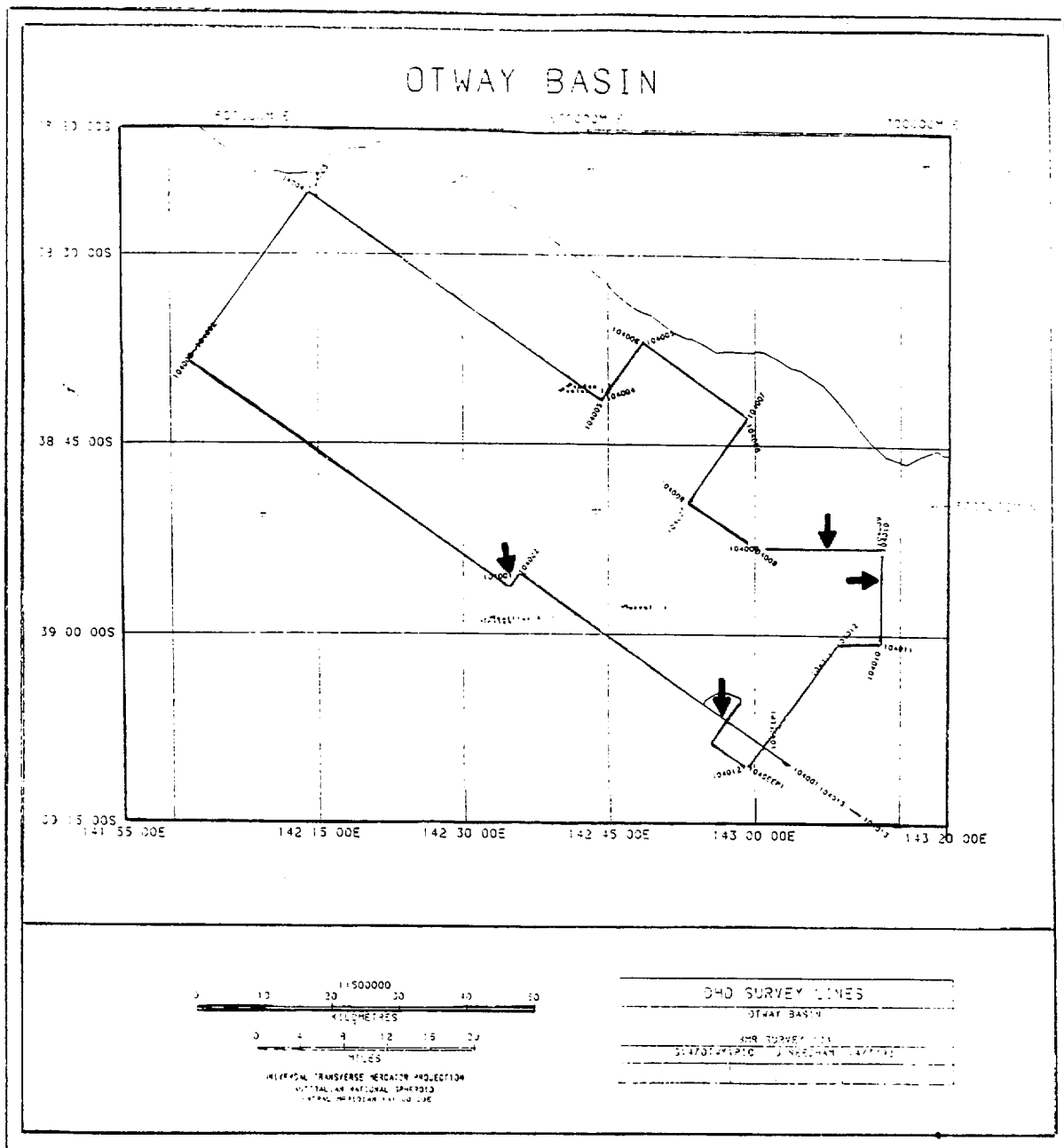


Figure 4. Map of the DHD survey lines in the Otway Basin showing the approximate locations of bottom-water hydrocarbon anomalies.

Survey 104 (Otway Basin) - THC v. Line Number

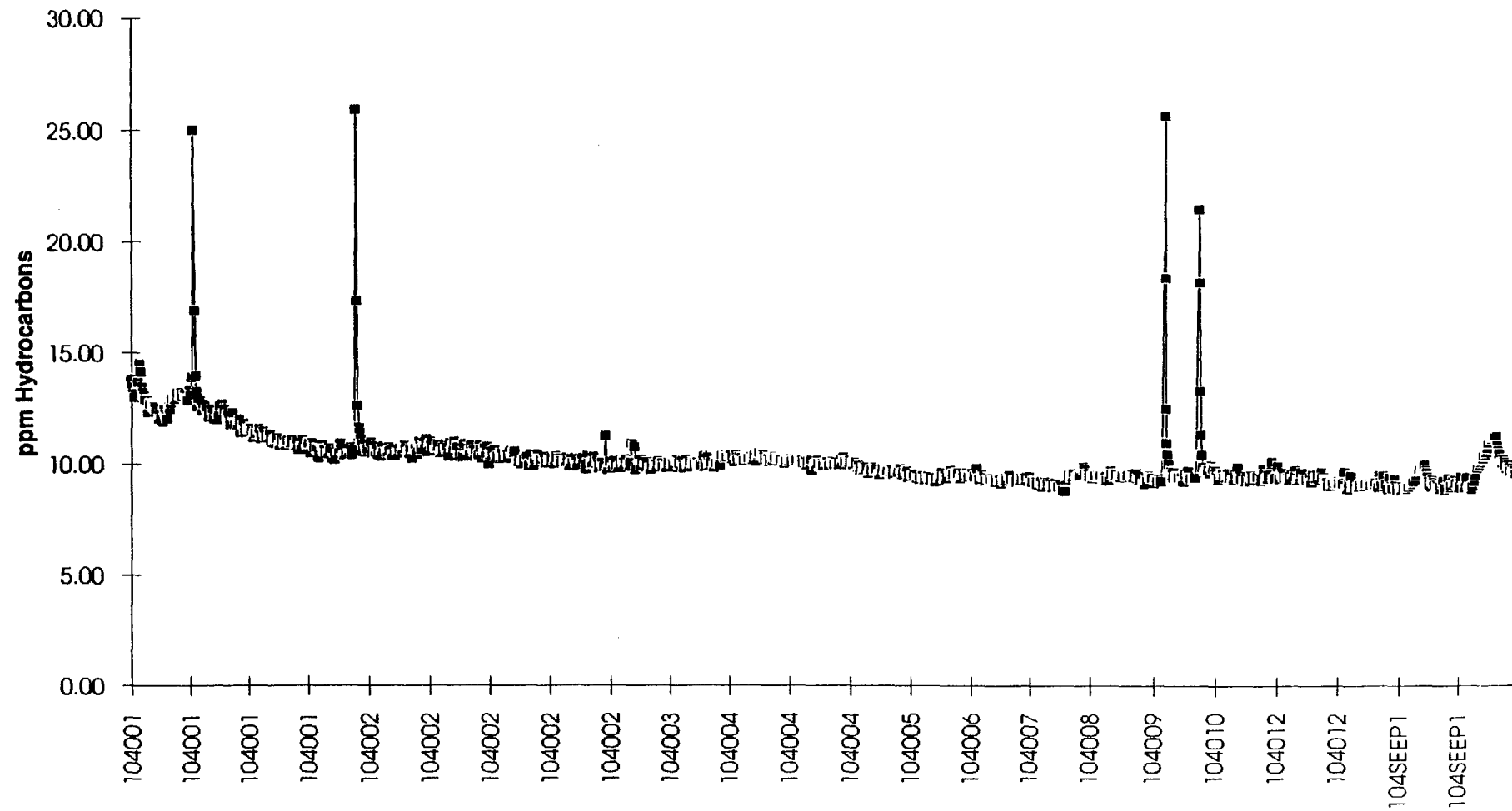


Figure 5a. Total hydrocarbons (THC) versus line number in the Otway Basin.

Survey 104 (Otway Basin) - C1-C4 v. Line number

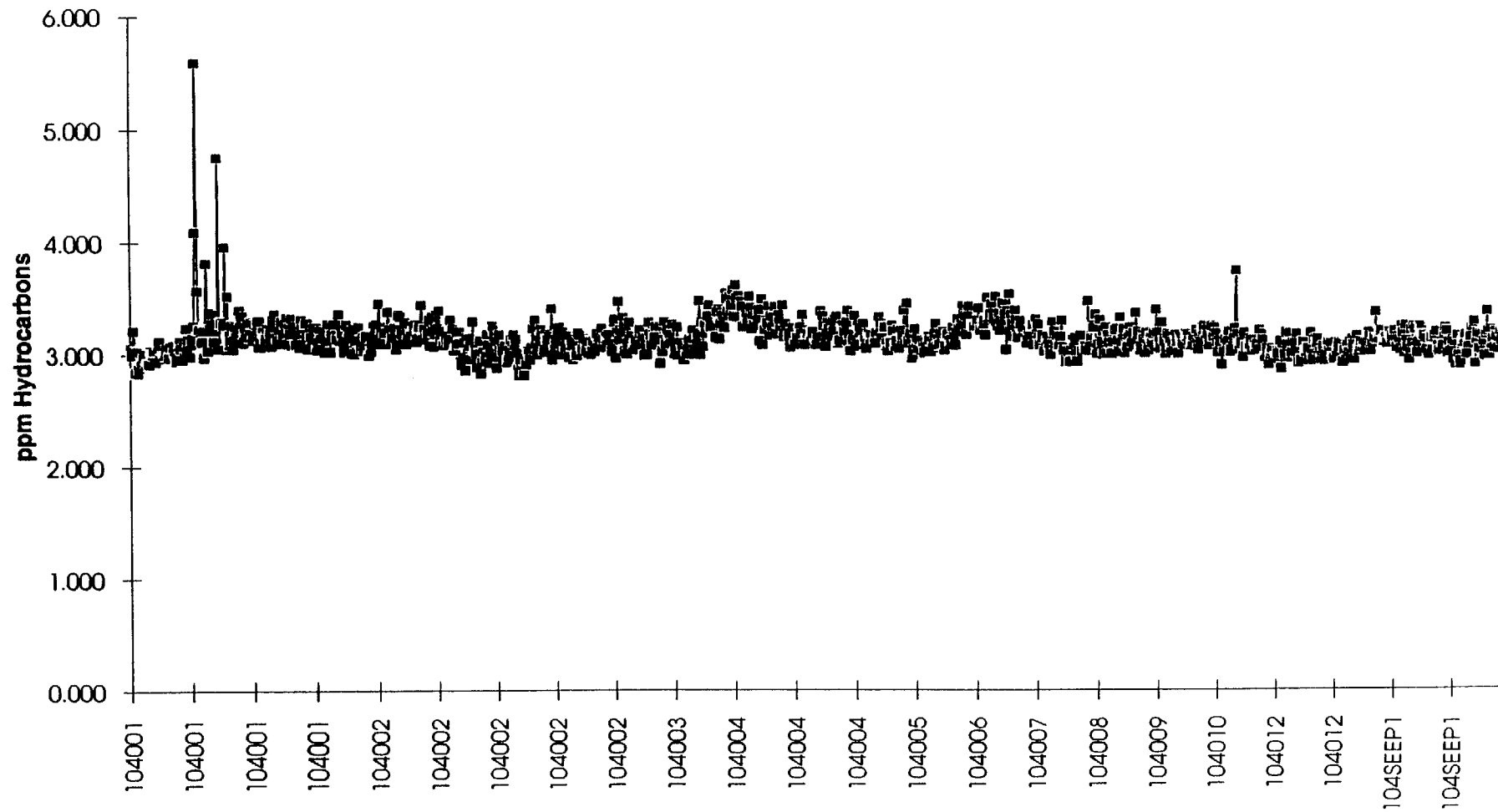


Figure 5b. Sum C₁-C₄ hydrocarbons versus line number in the Otway Basin.

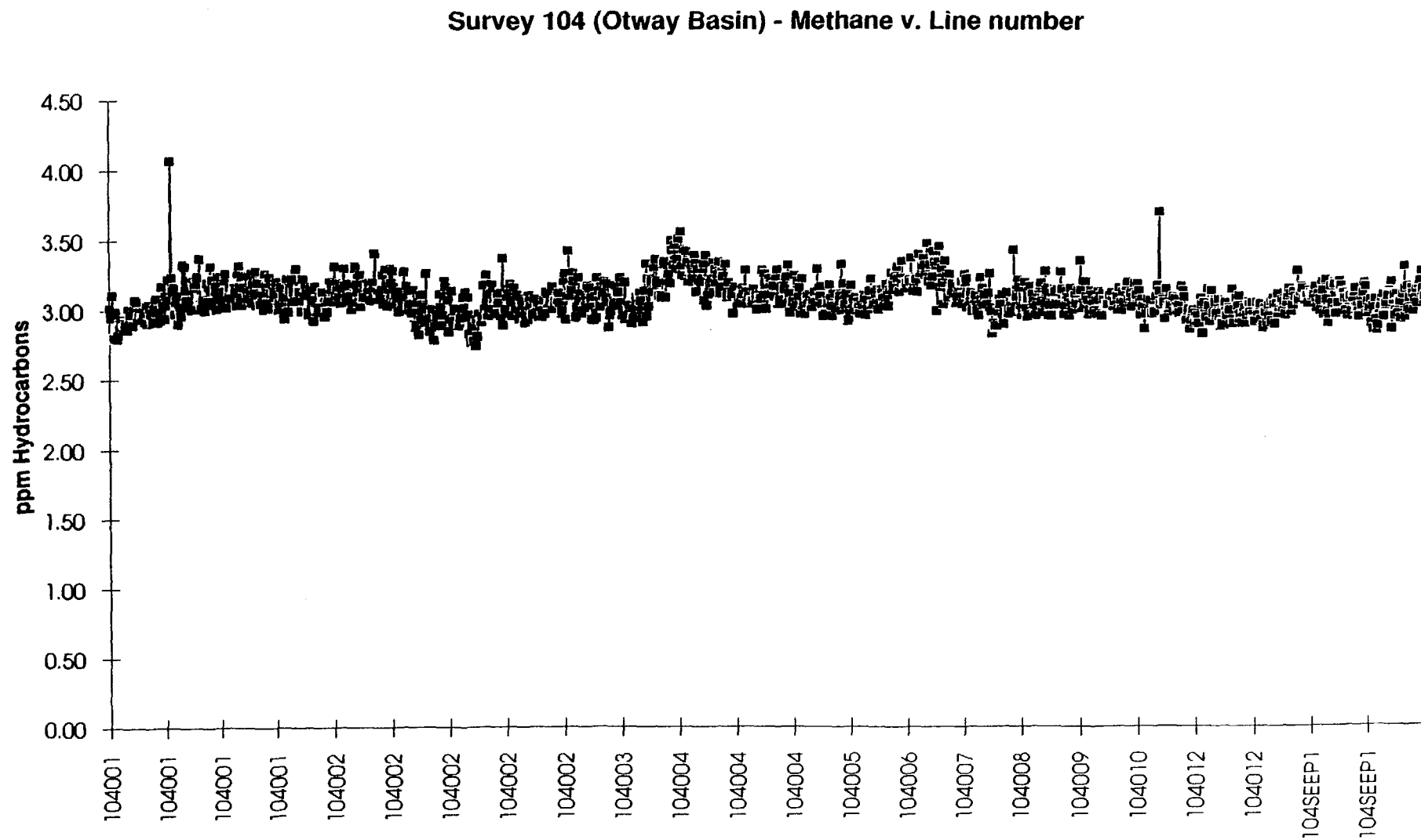


Figure 5c. Methane versus line number in the Otway Basin.

Survey 104 (Otway Basin) - Ethane v. Line number

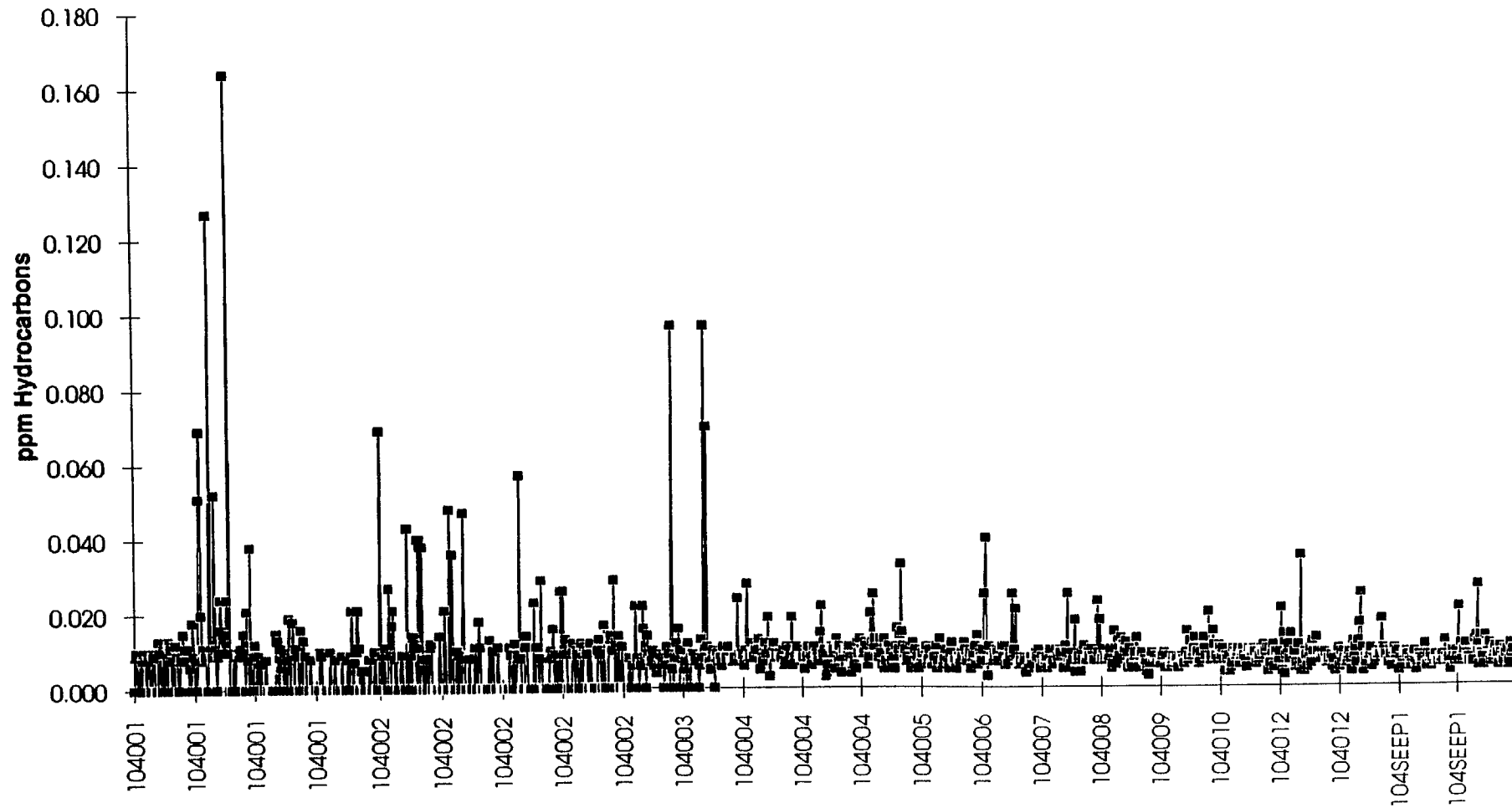


Figure 5d. Ethane versus line number in the Otway Basin.

Survey 104 (Otway Basin) - Ethylene v. Line number

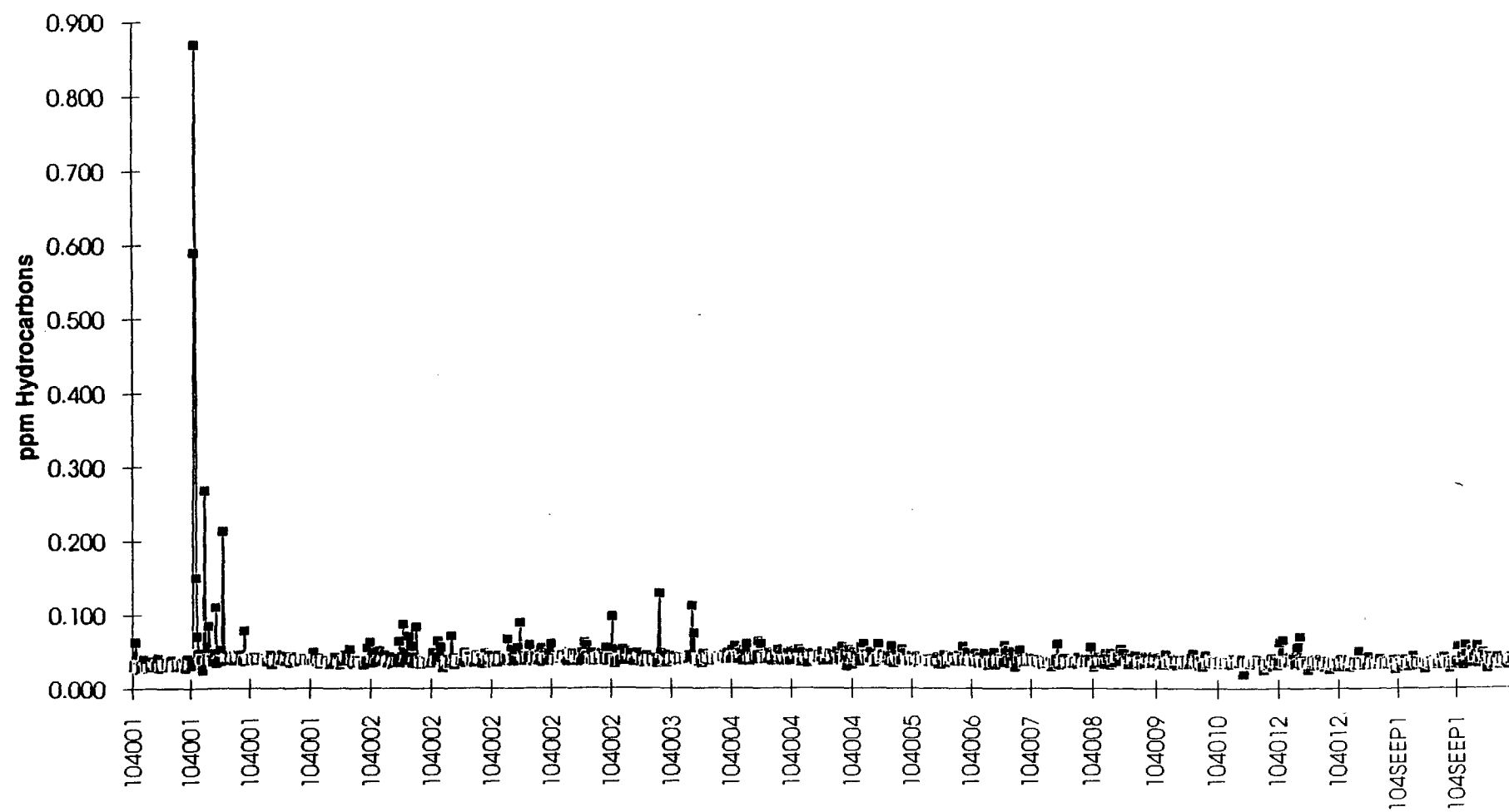


Figure 5e. Ethylene versus line number in the Otway Basin.

Survey 104 (Otway Basin) - Propane v. Line number

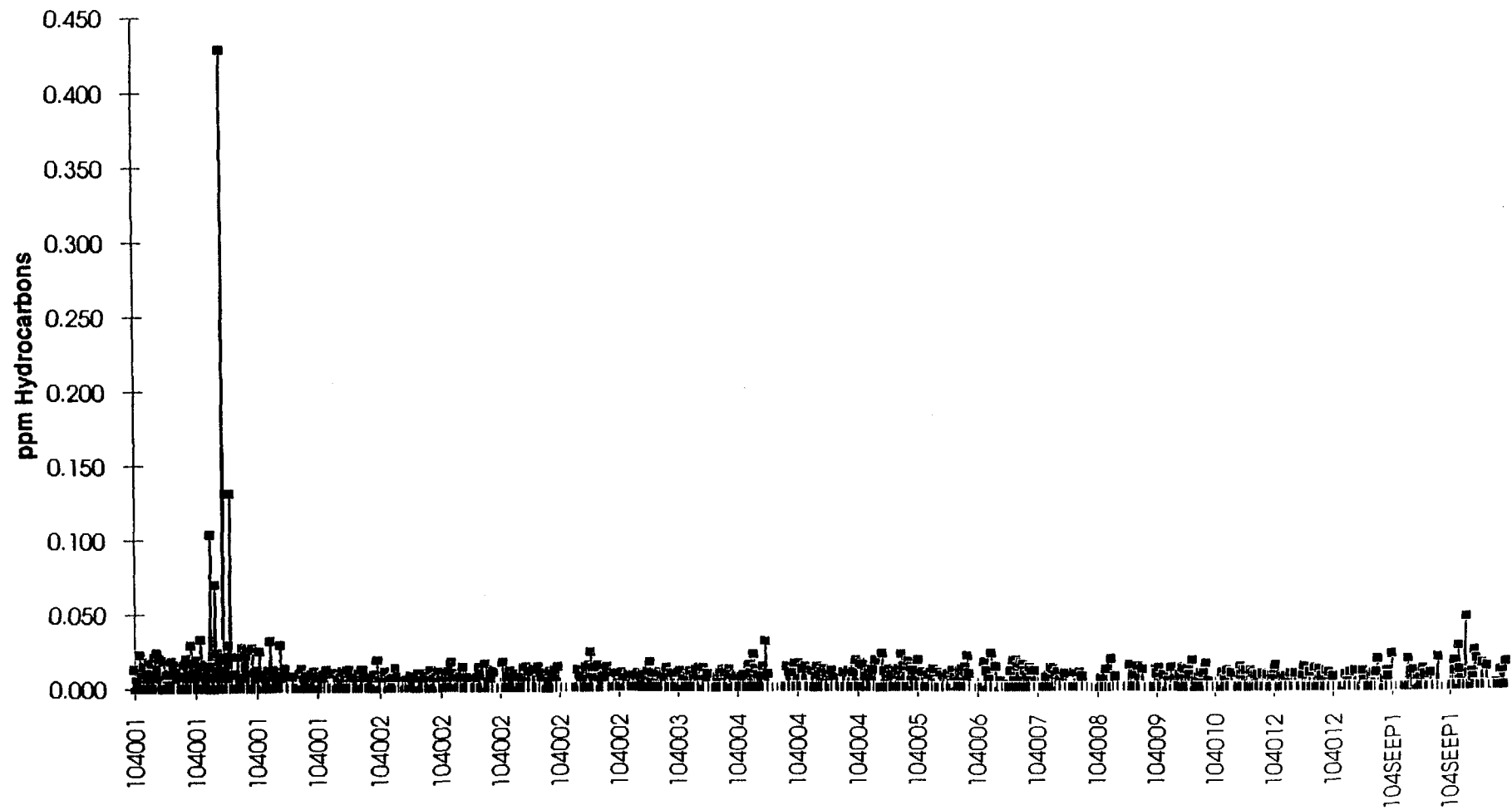


Figure 5f. Propane versus line number in the Otway Basin.

Survey 104 (Otway Basin) - Propylene v. Line number

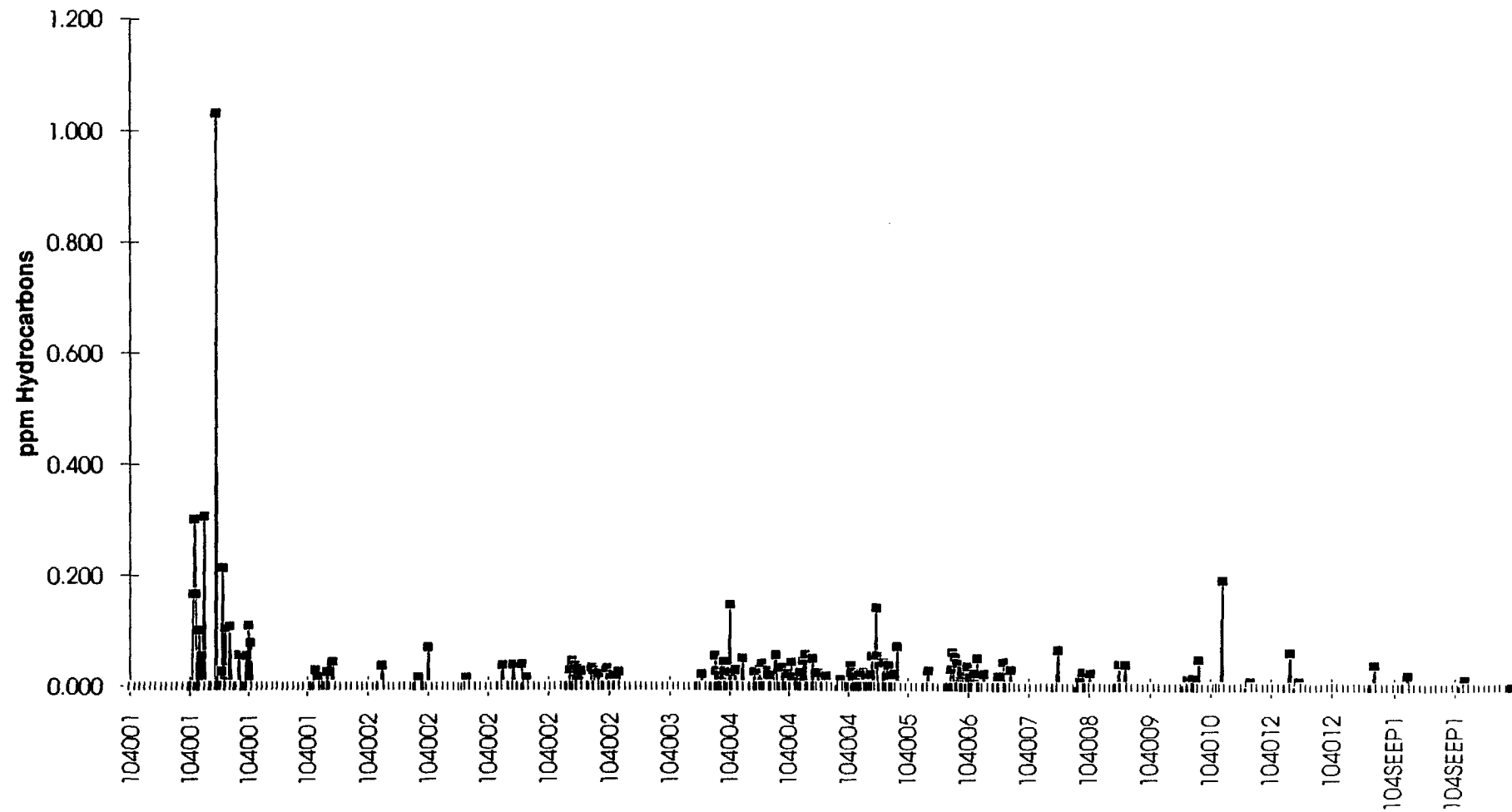


Figure 5g. Propylene versus line number in the Otway Basin.

Survey 104 (Otway Basin) - Butanes v. Line number

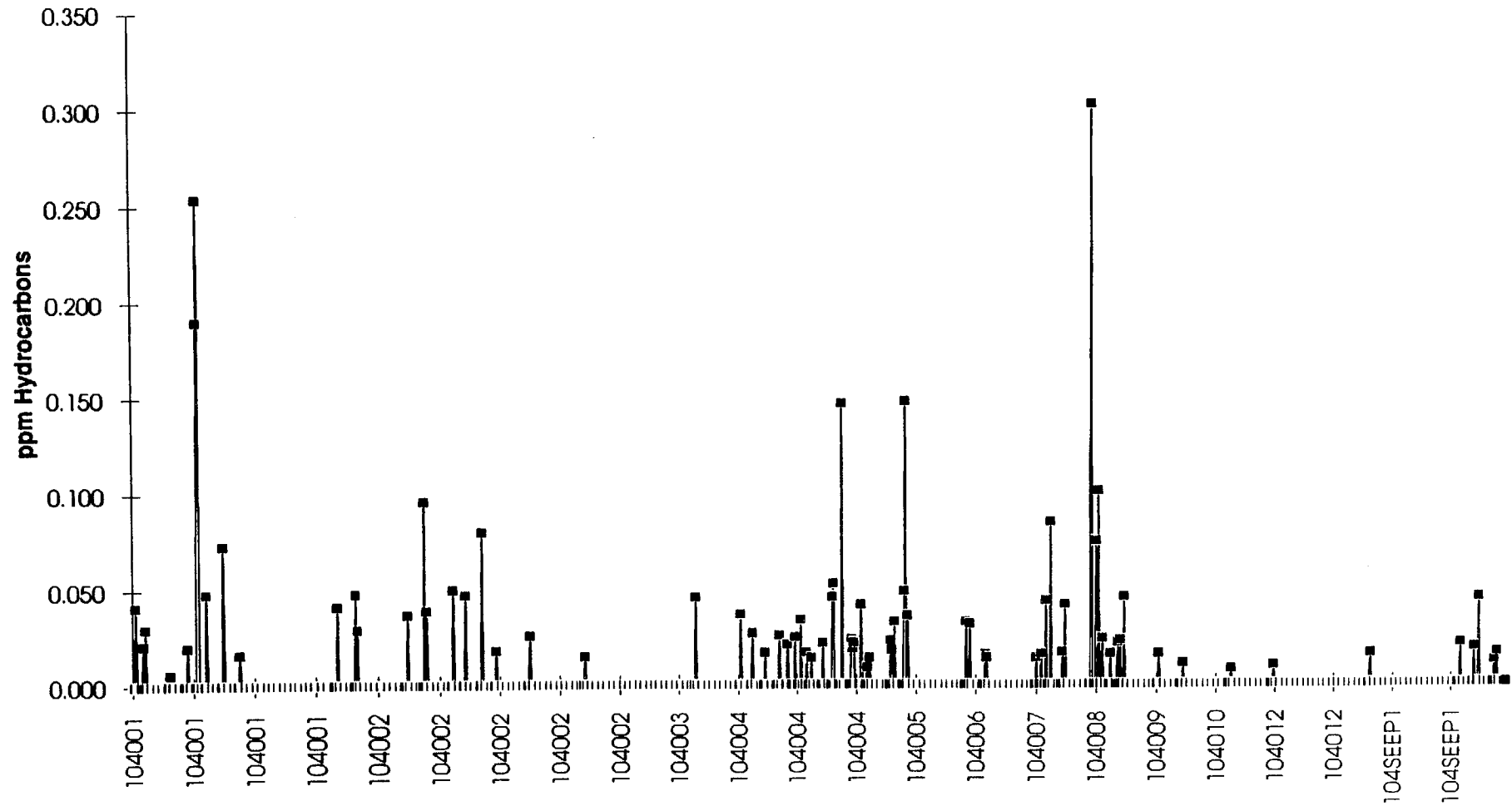


Figure 5h. Butanes versus line number in the Otway Basin.

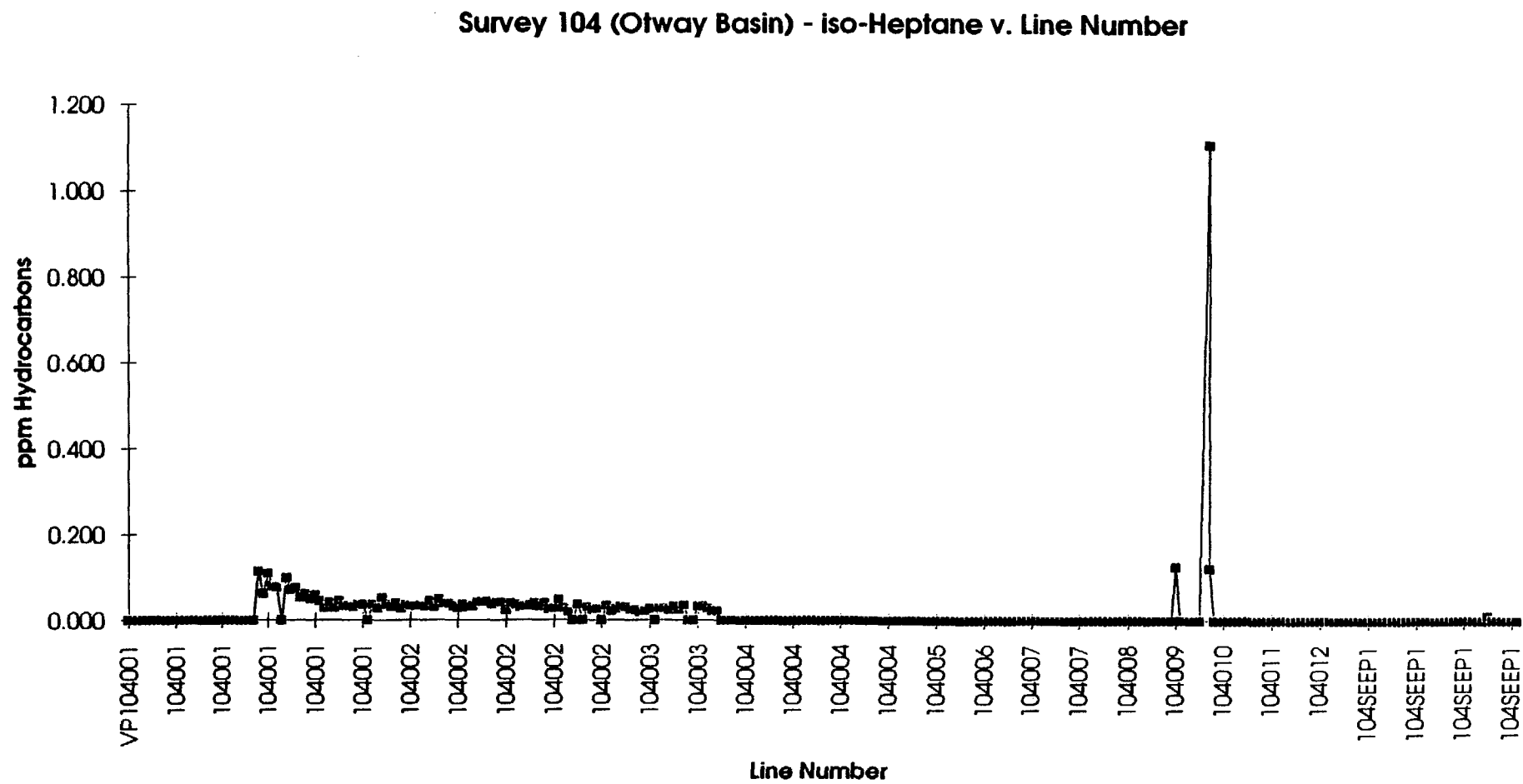


Figure 5j. Iso-heptane versus line number in the Otway Basin.

Survey 104 (Otway Basin) - Normal Heptane v. Line Number

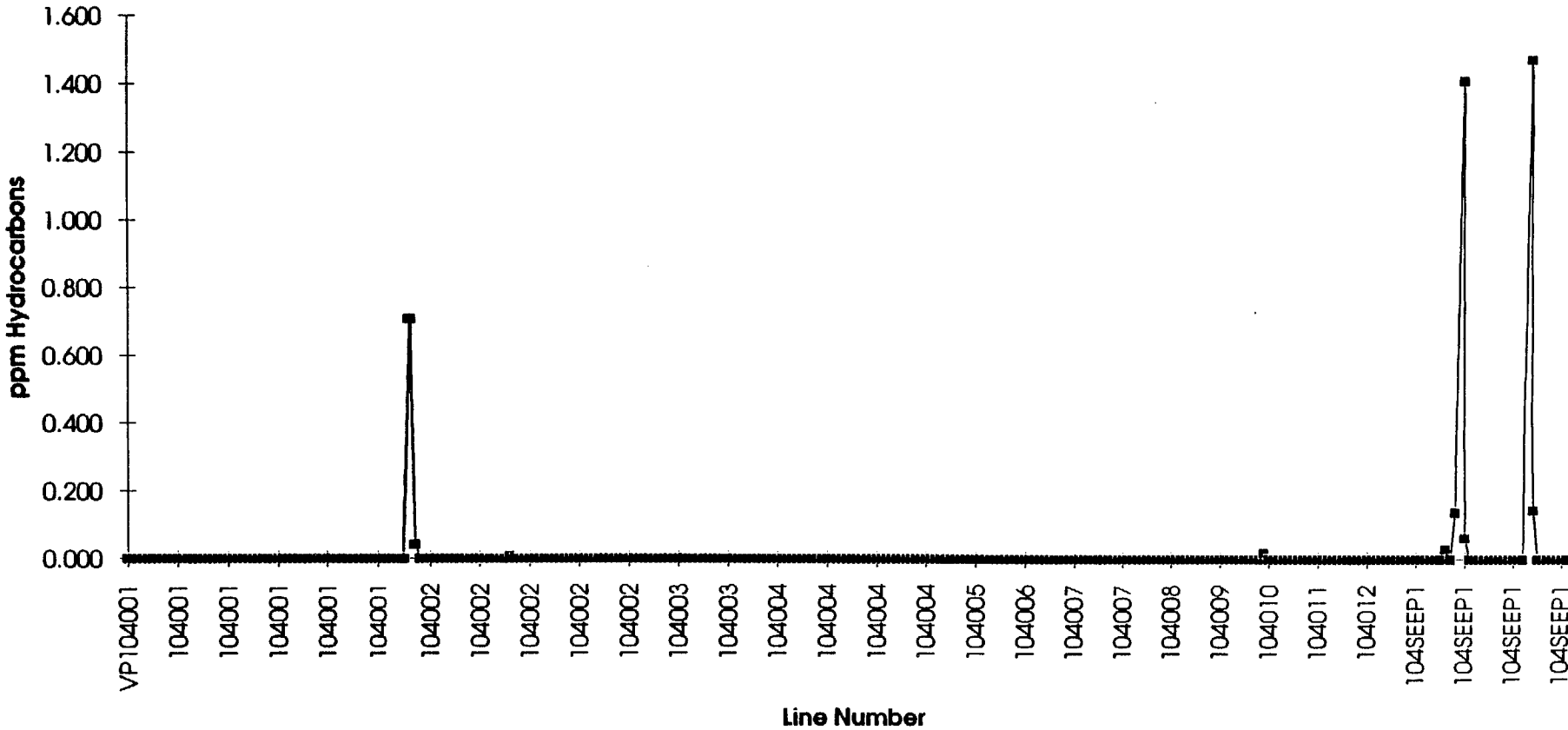


Figure 5k. Normal-heptane versus line number in the Otway Basin.

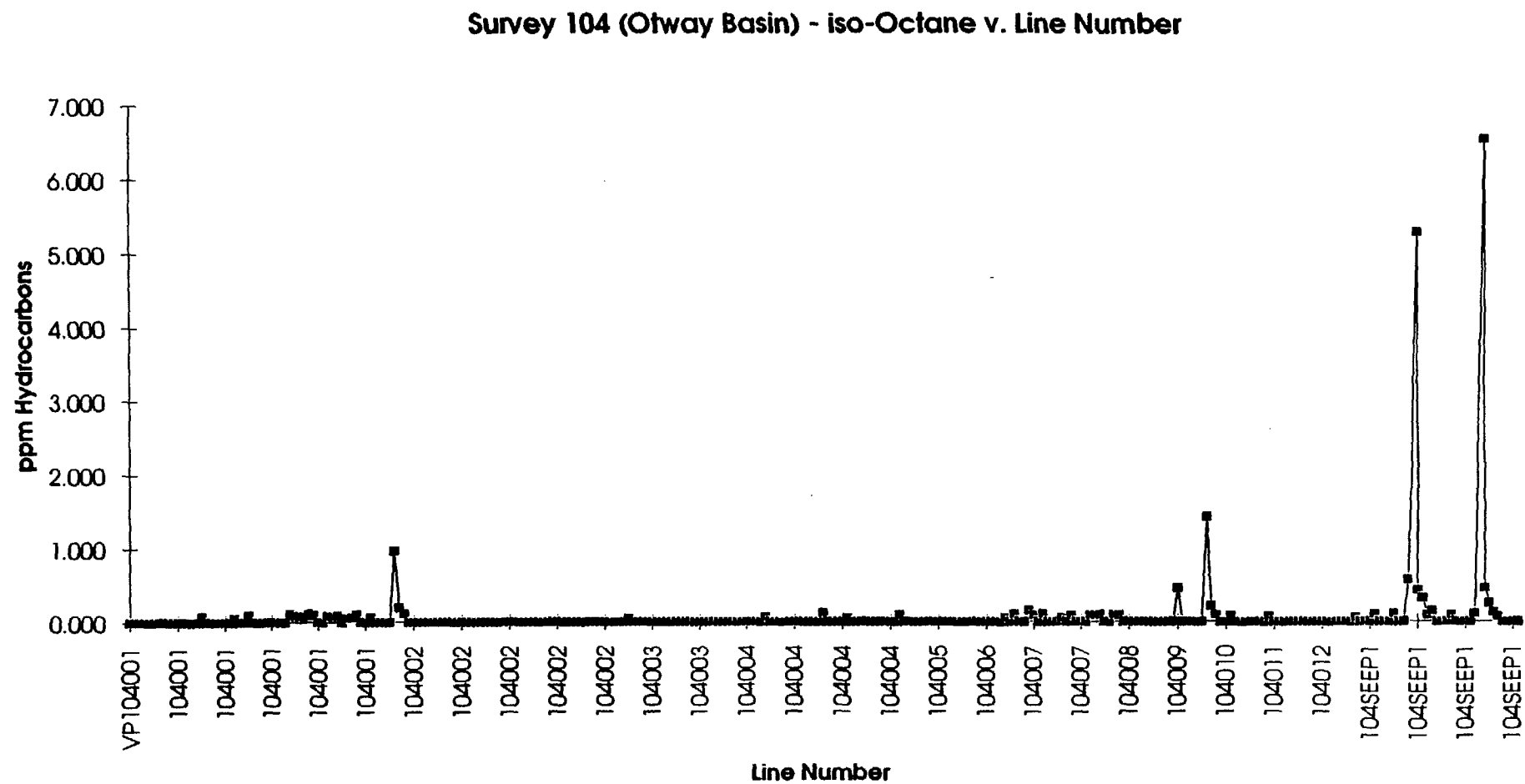


Figure 51. Iso-octane versus line number in the Otway Basin.

Survey 104 (Otway Basin) - % Wetness v. Line number

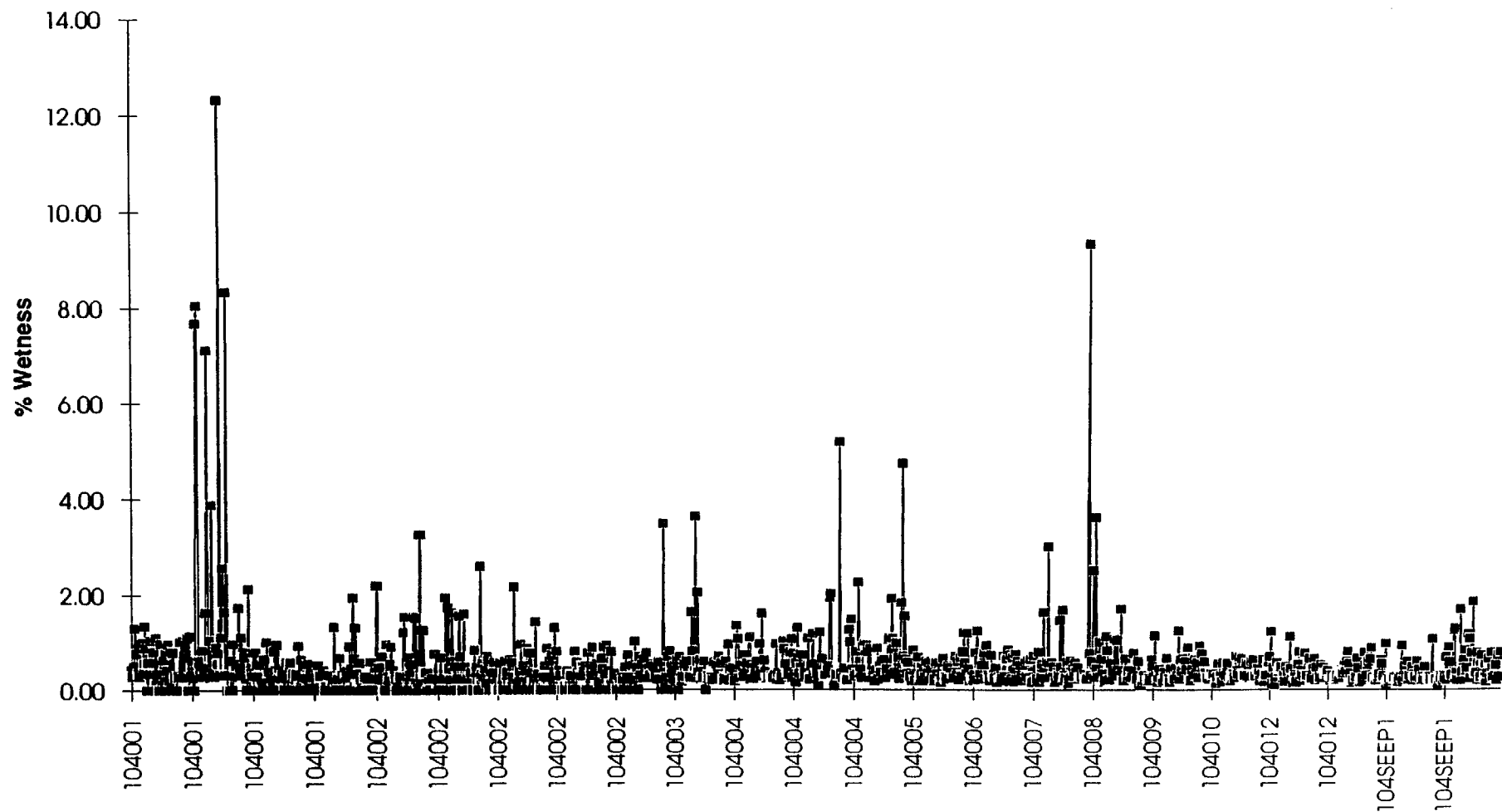


Figure 5m. Percent hydrocarbon wetness versus line number in the Otway Basin.

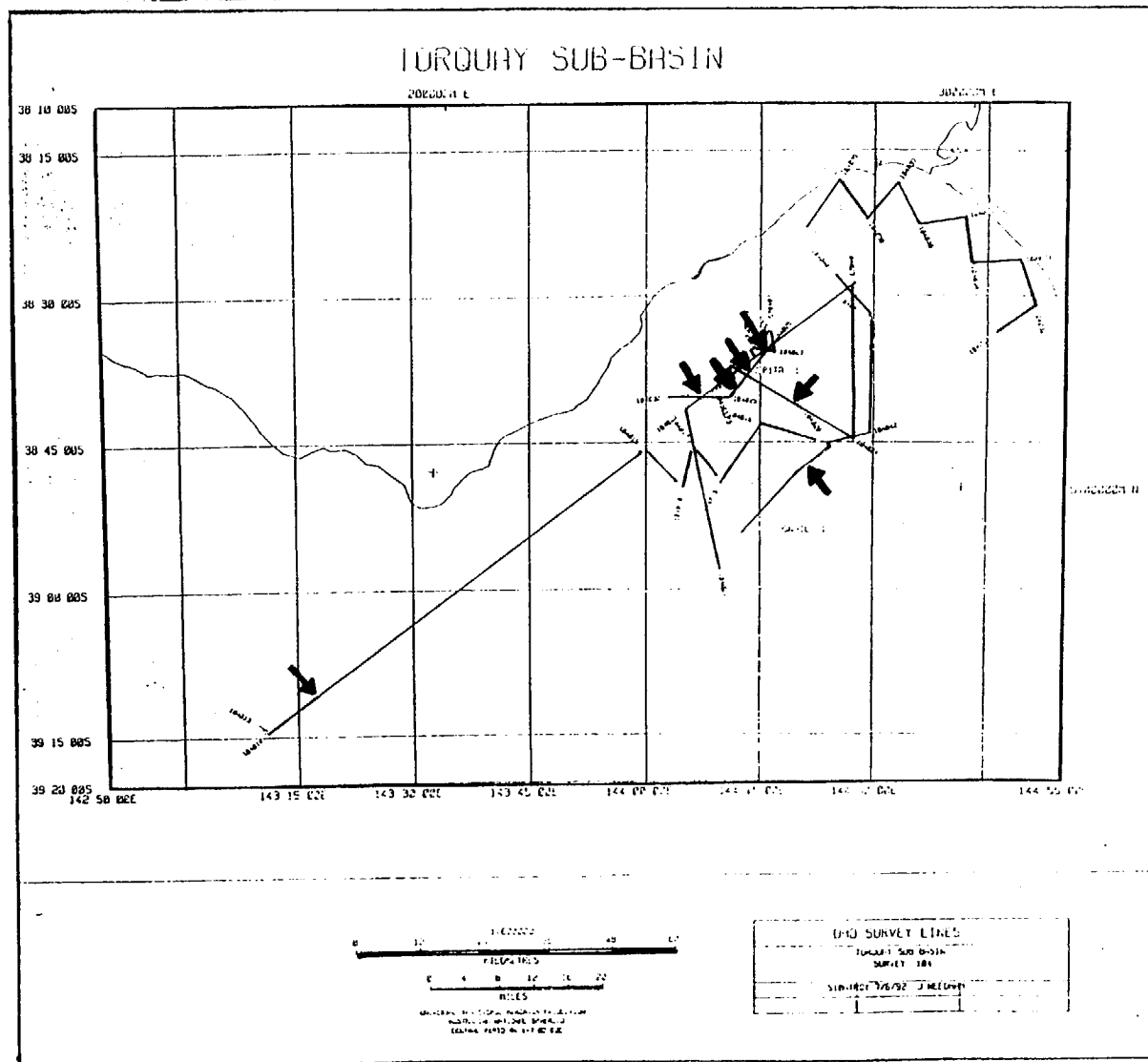


Figure 6. Map of the DHD survey lines in the Torquay Sub-basin showing the approximate locations of bottom-water hydrocarbon anomalies.

THC v. Line number

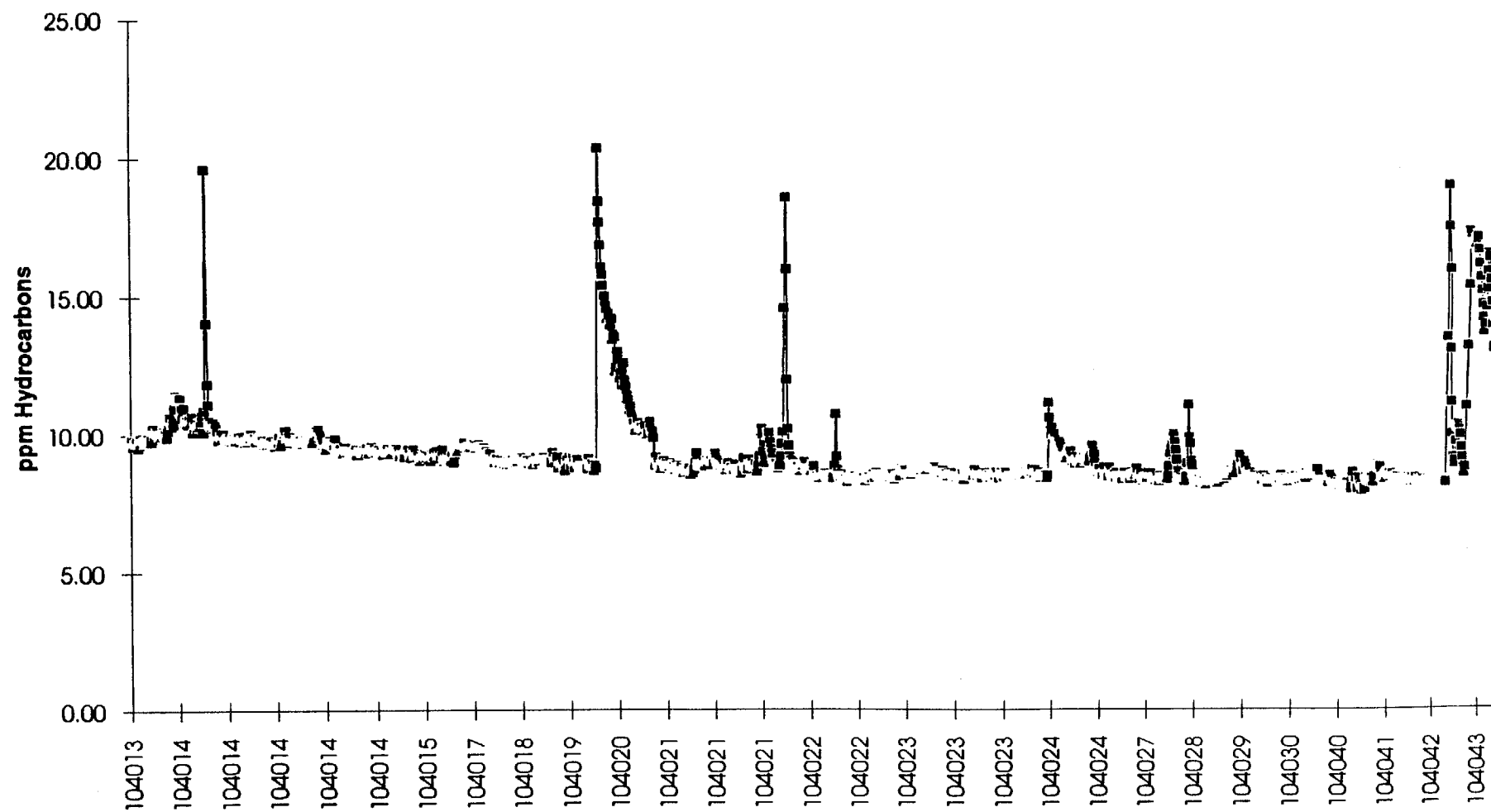


Figure 7a. Total hydrocarbons (THC) versus line number in the Torquay Sub-basin.

C1-C4 v. Line number

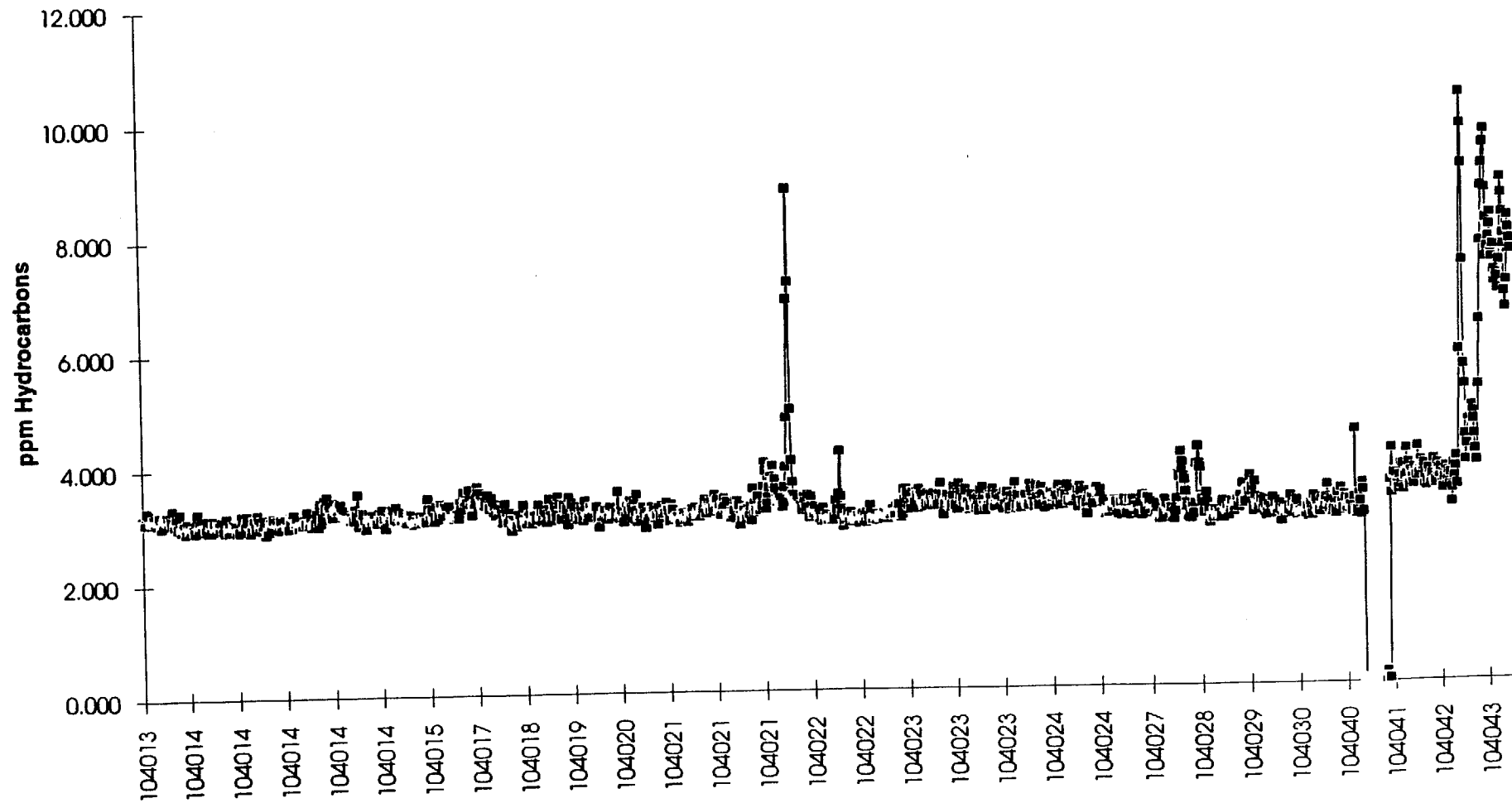


Figure 7b. Sum C1-C4 versus line number in the Torquay Sub-basin.

Methane v. Line number

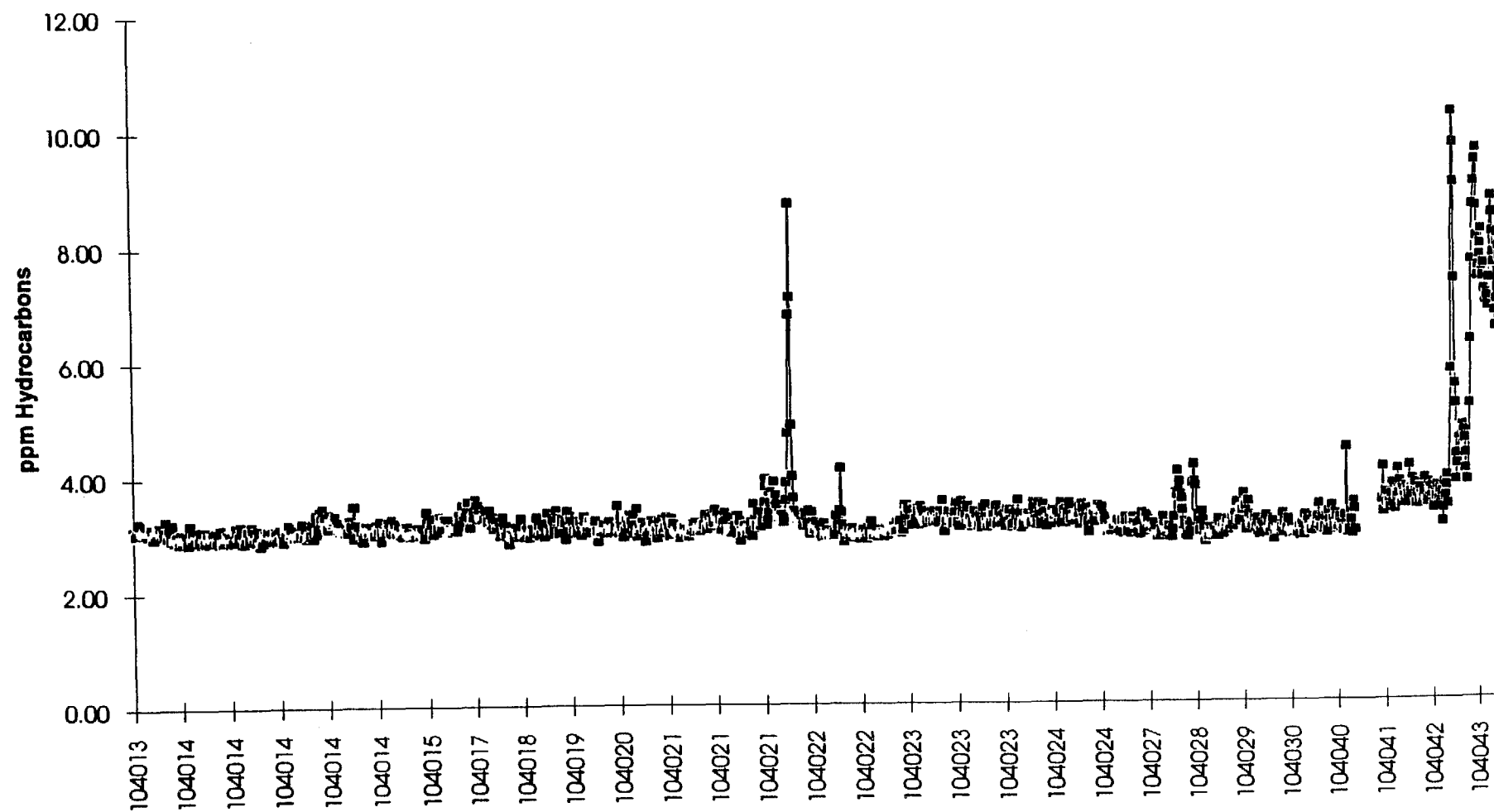


Figure 7c. Methane versus line number in the Torquay Sub-basin.

Ethane v. Line number

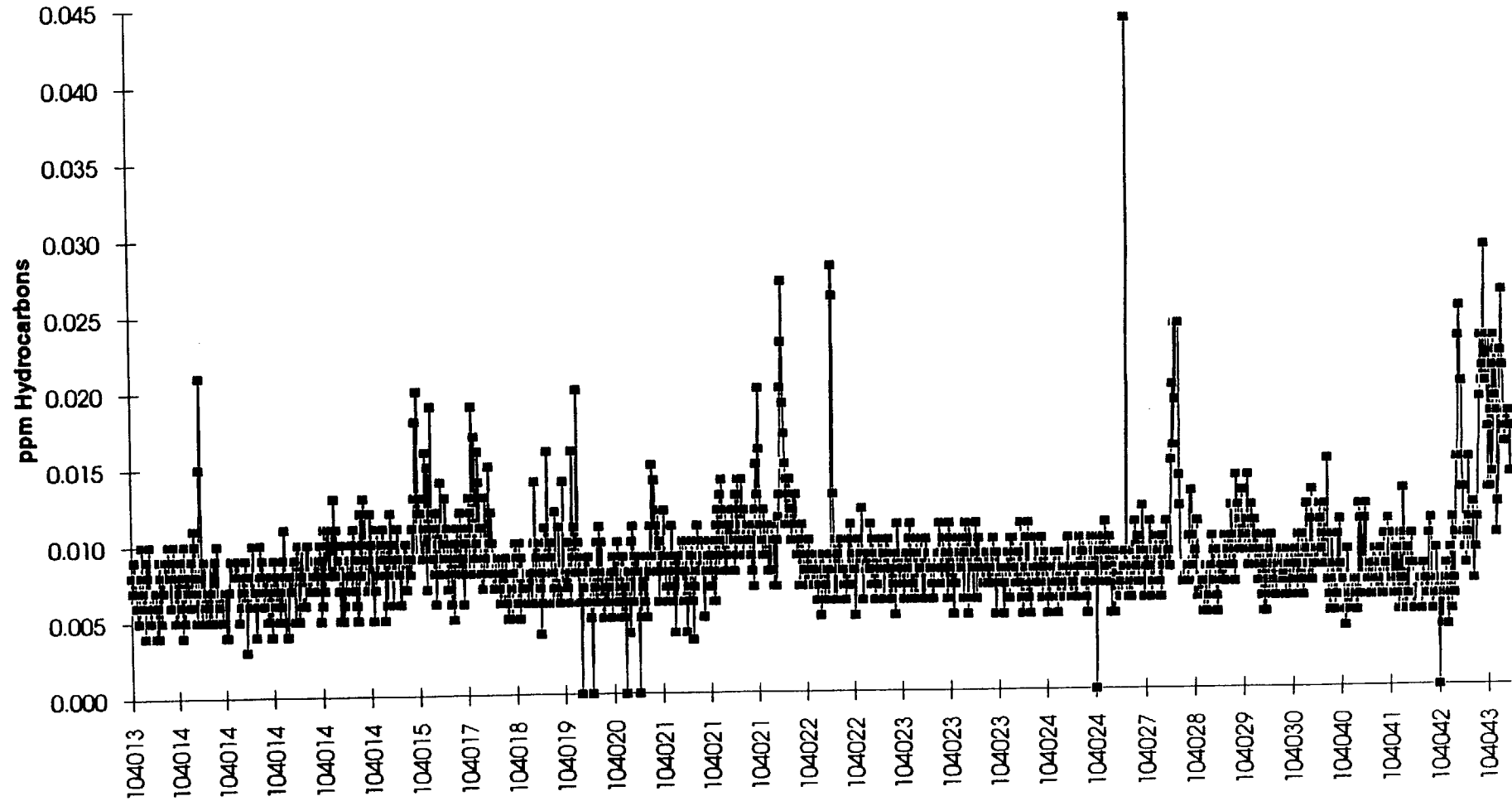


Figure 7d. Ethane versus line number in the Torquay Sub-basin.

Ethylene v. Line number

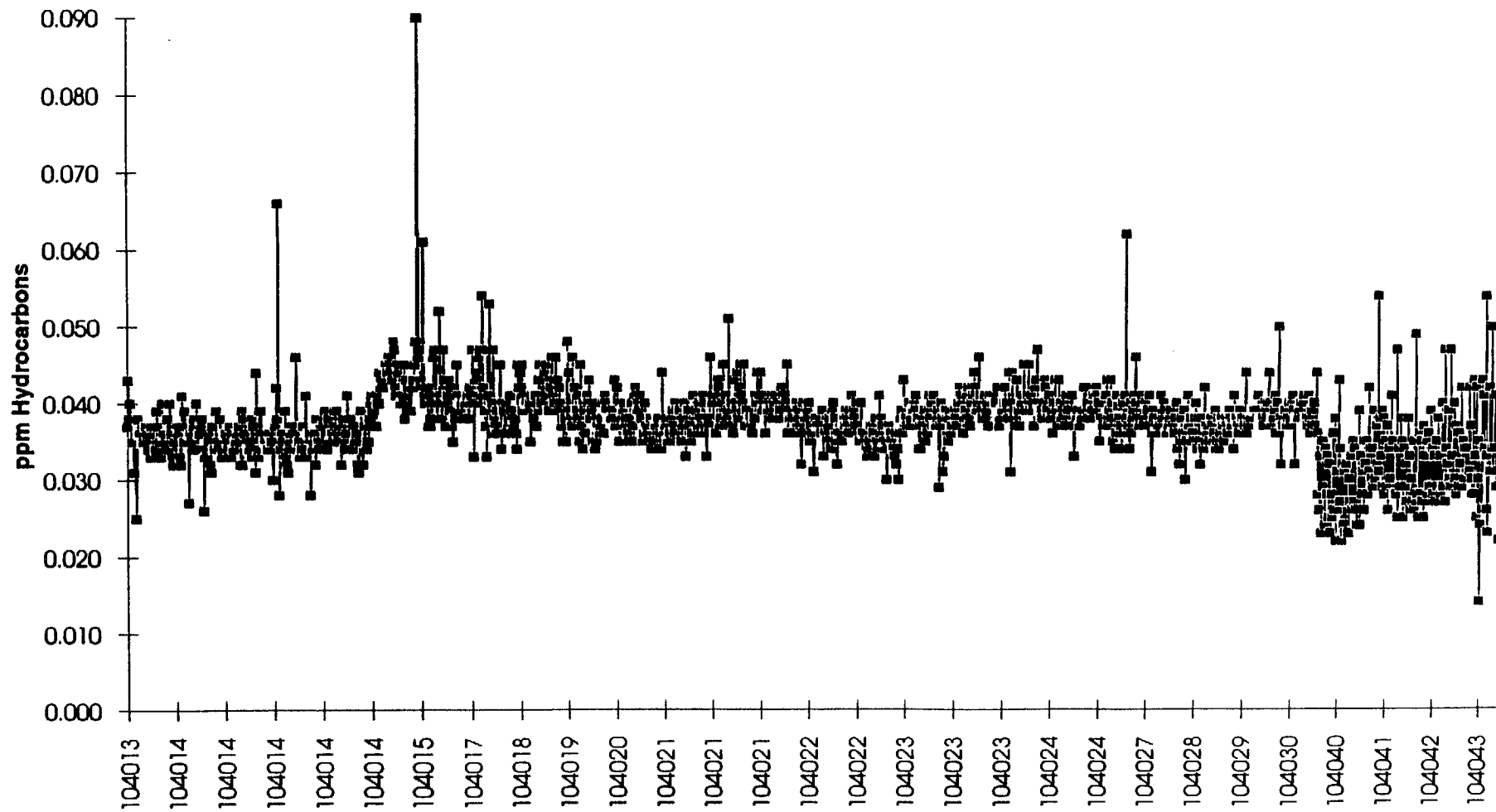


Figure 7e. Ethylene versus line number in the Torquay Sub-basin.

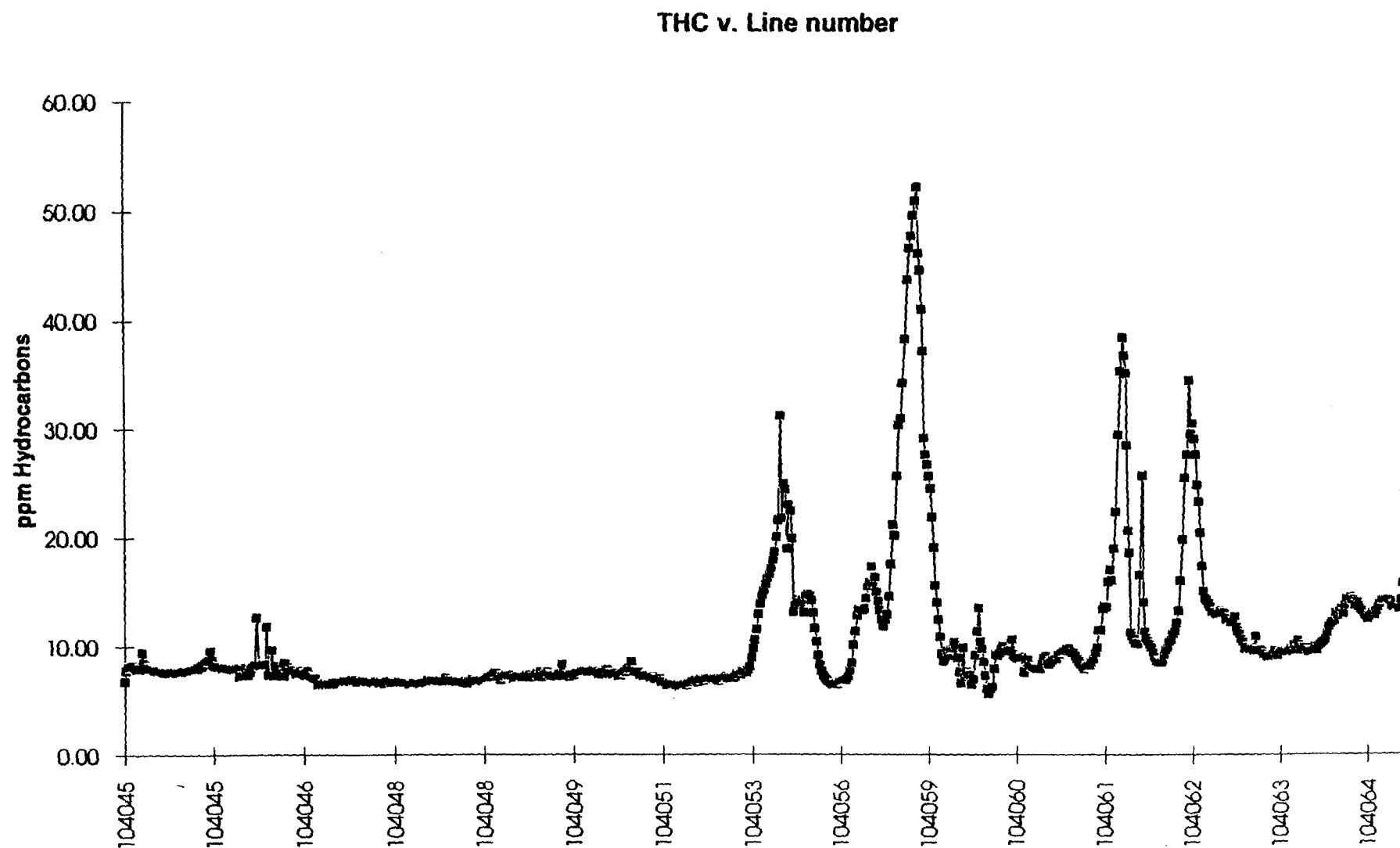


Figure 9a. THC (Total hydrocarbons) along the survey lines in the Gippsland Basin.

C1-C4 v. Line number

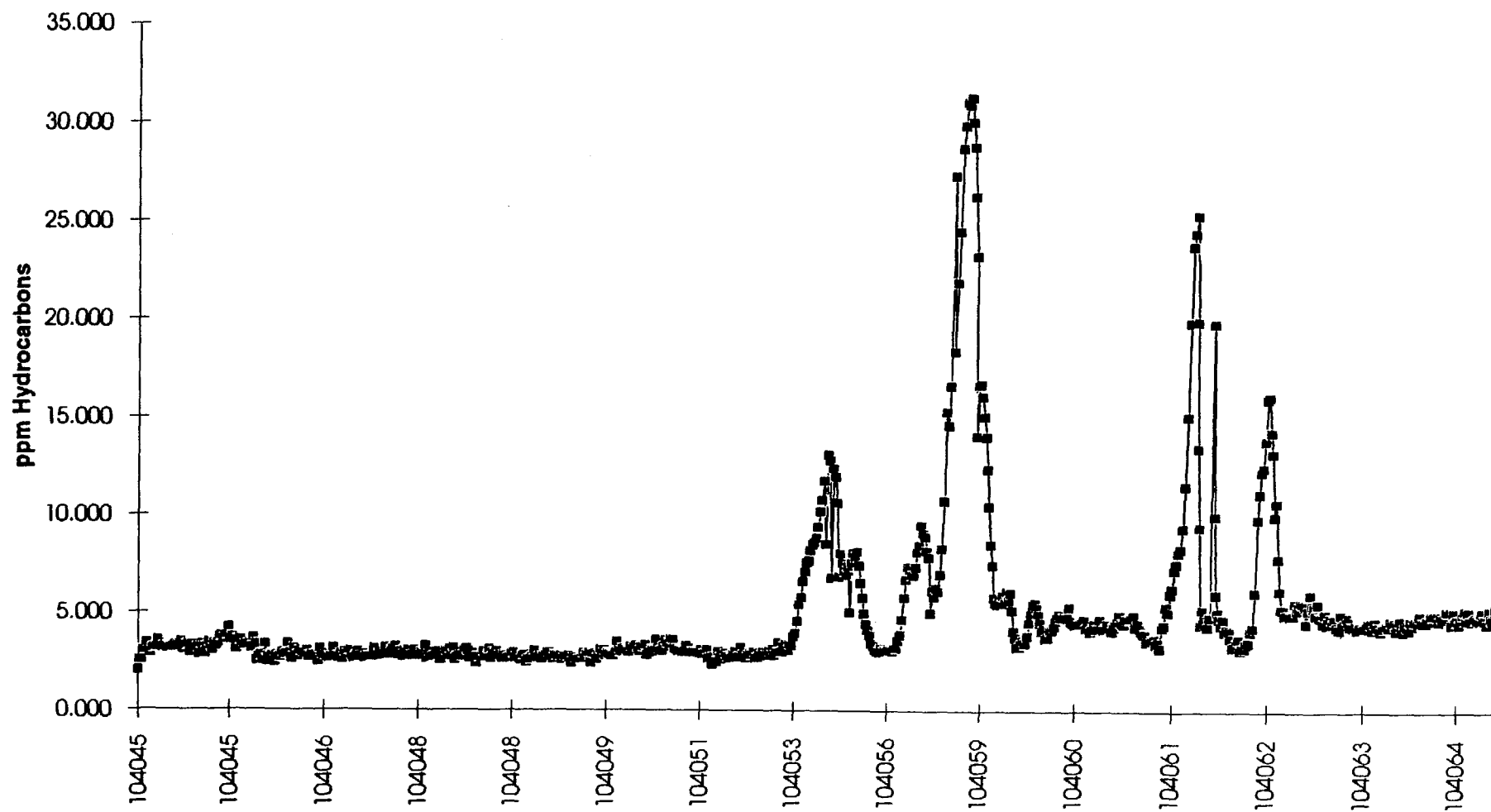


Figure 9b. Sum C1-C4 along the survey lines in the Gippsland Basin.

Methane v. Line number

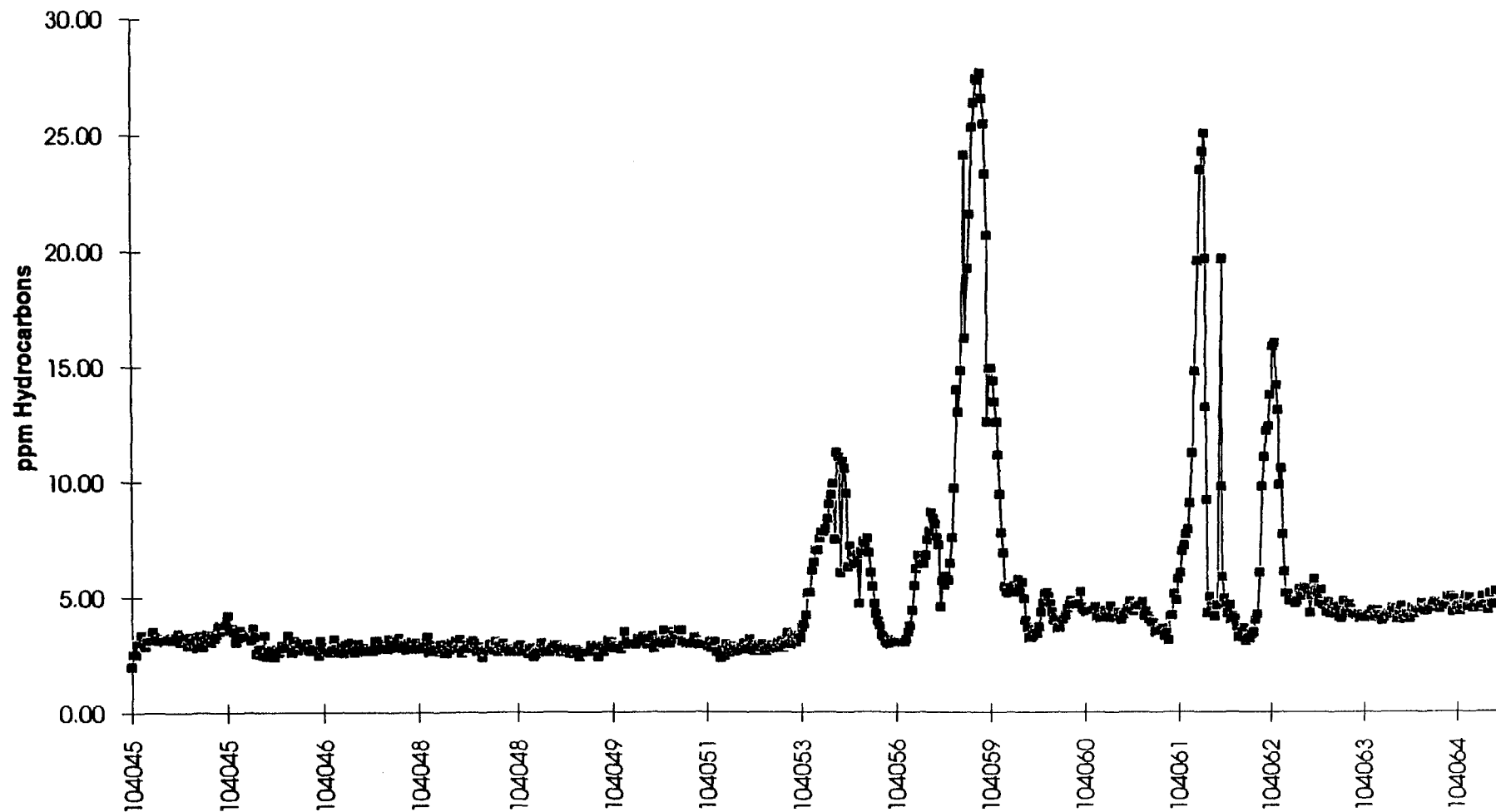


Figure 9c. Methane along the survey lines in the Gippsland Basin.

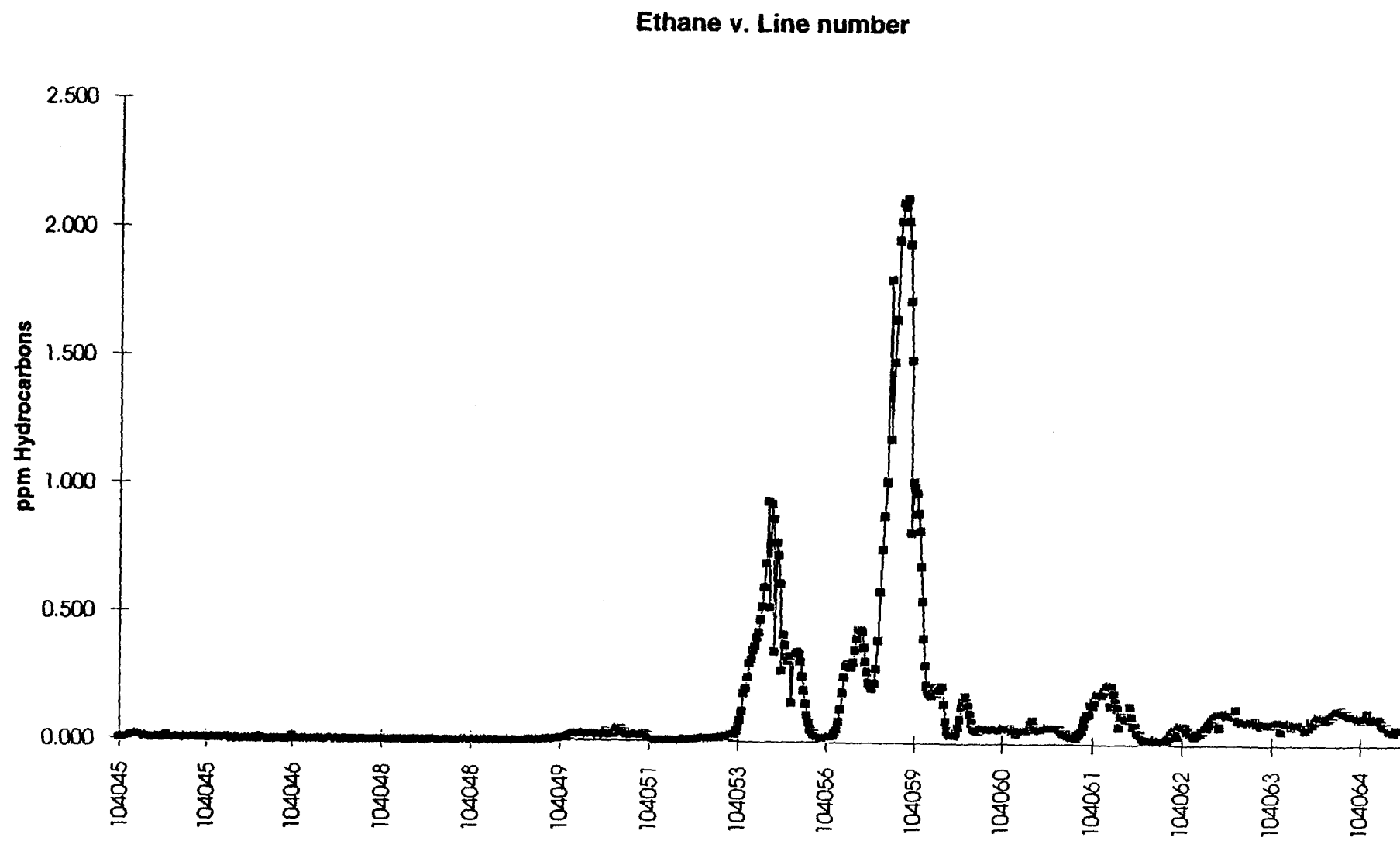


Figure 9d. Ethane along the survey lines in the Gippsland Basin.

Ethylene v. Line number

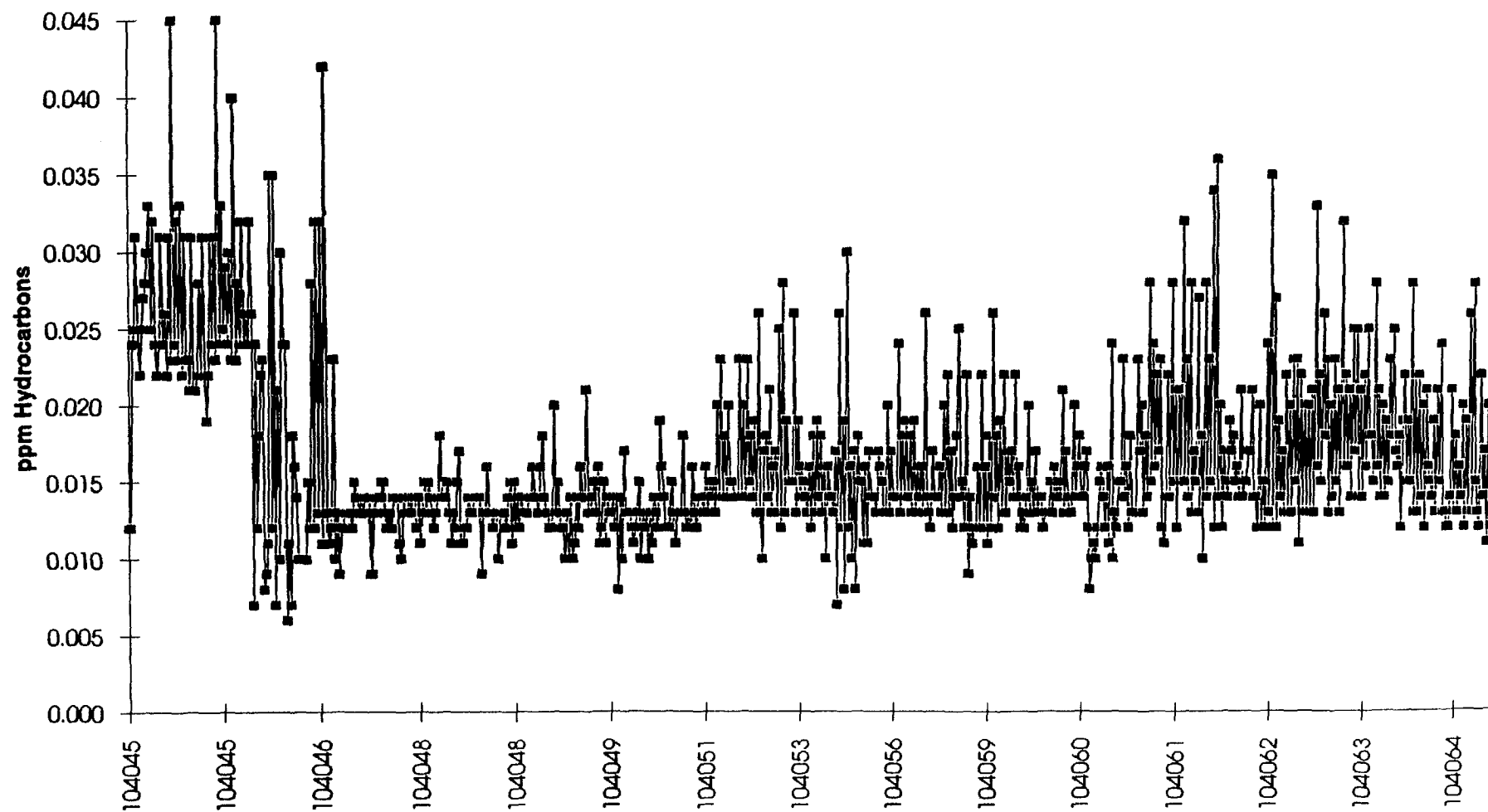


Figure 9e. Ethylene along the survey lines in the Gippsland Basin.

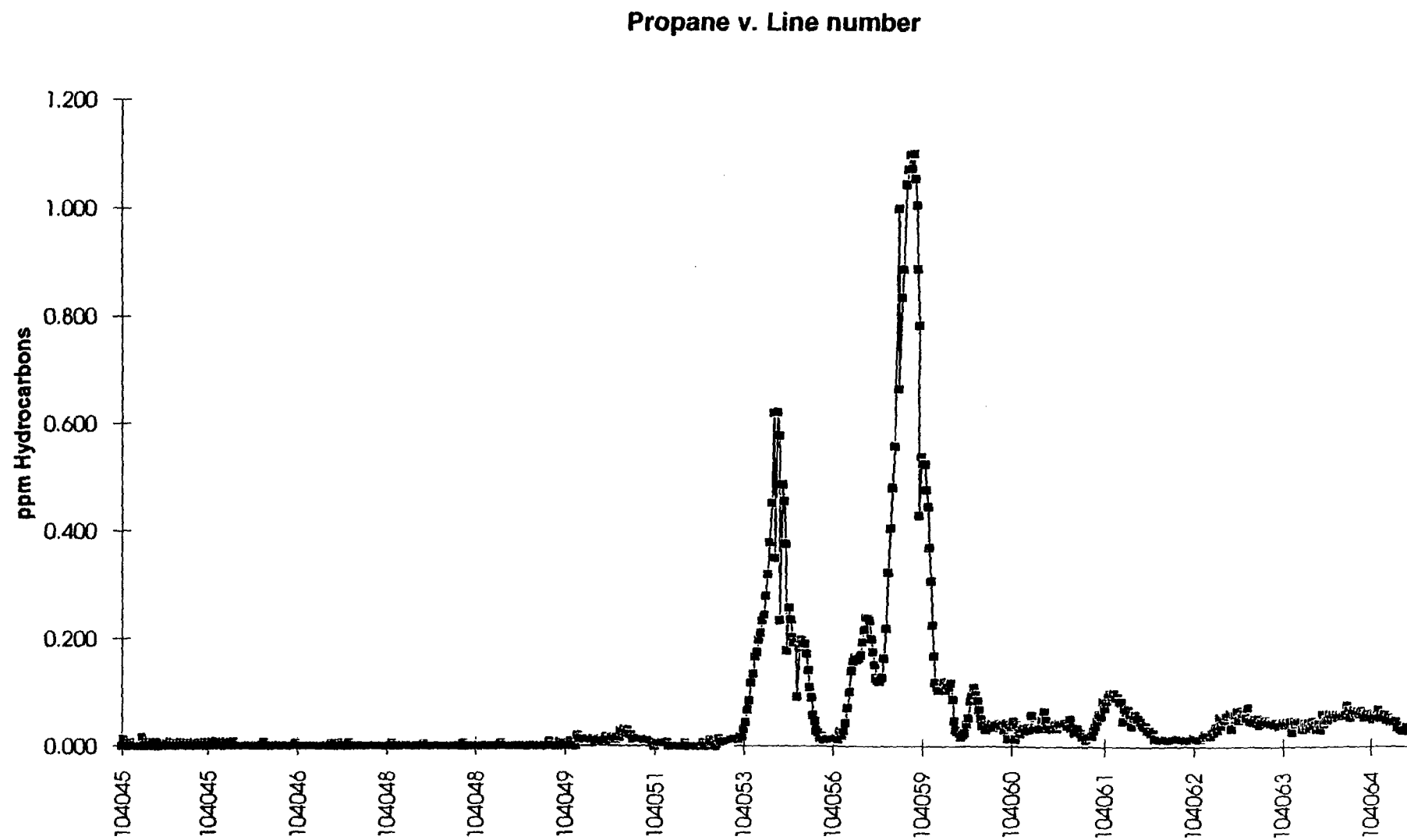


Figure 9f. Propane versus line number in the Gippsland Basin.

Butanes v. Line number

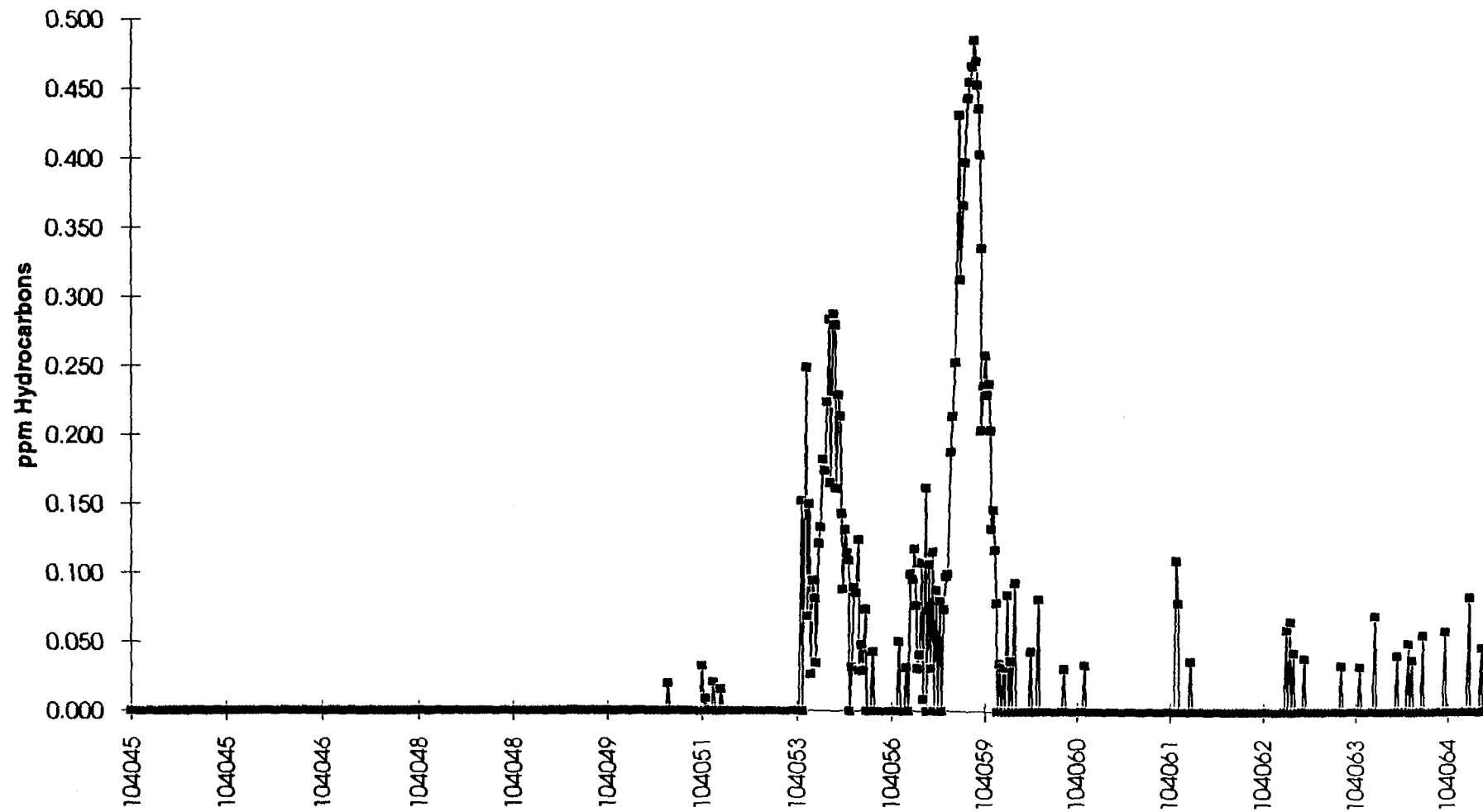


Figure 9g. Butanes versus line number in the Gippsland Basin.

Iso-Pentane v. Line number

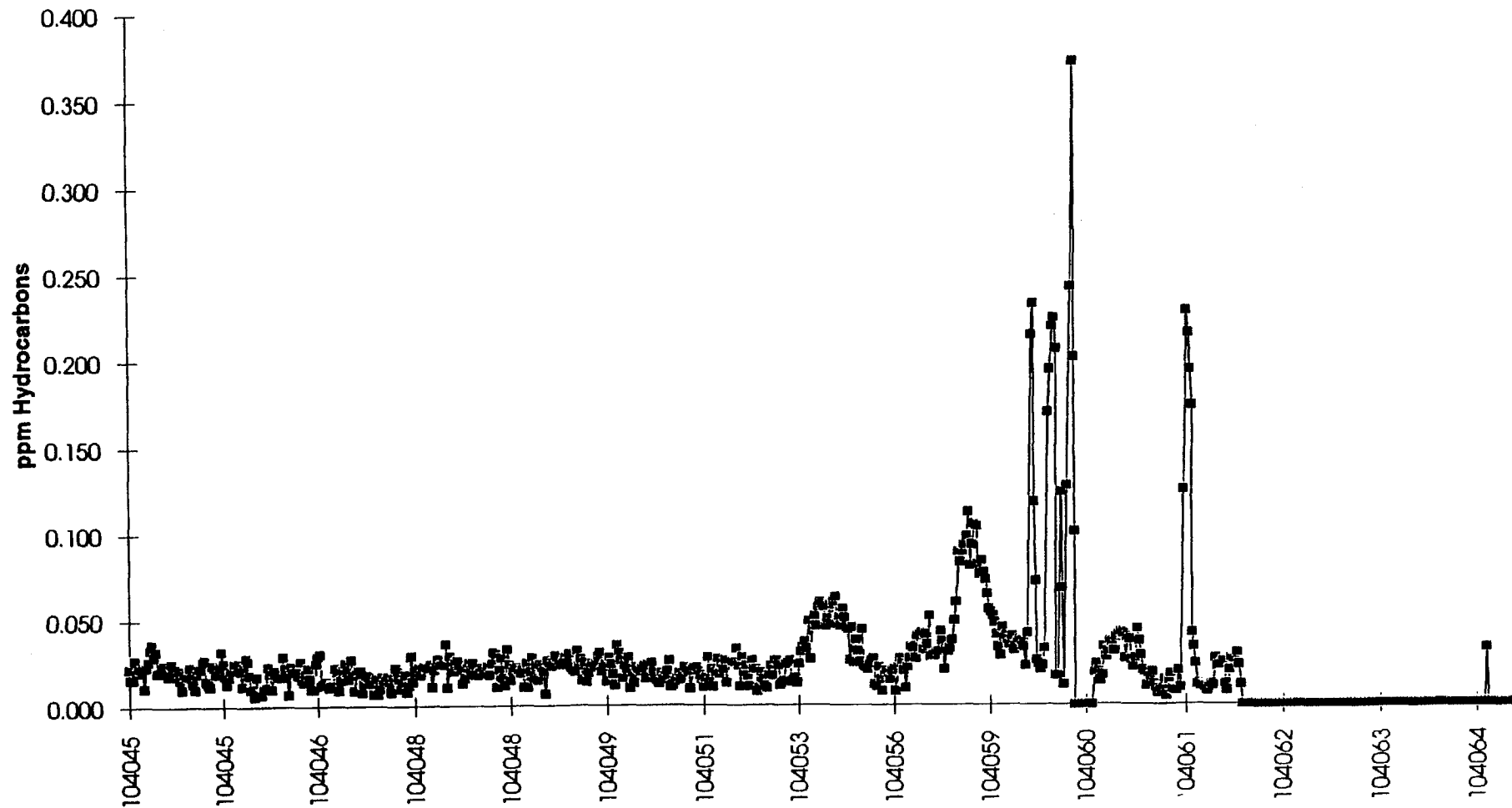


Figure 9h. Iso-pentane versus line number in the Gippsland Basin.

Normal-Pentane v. Line number

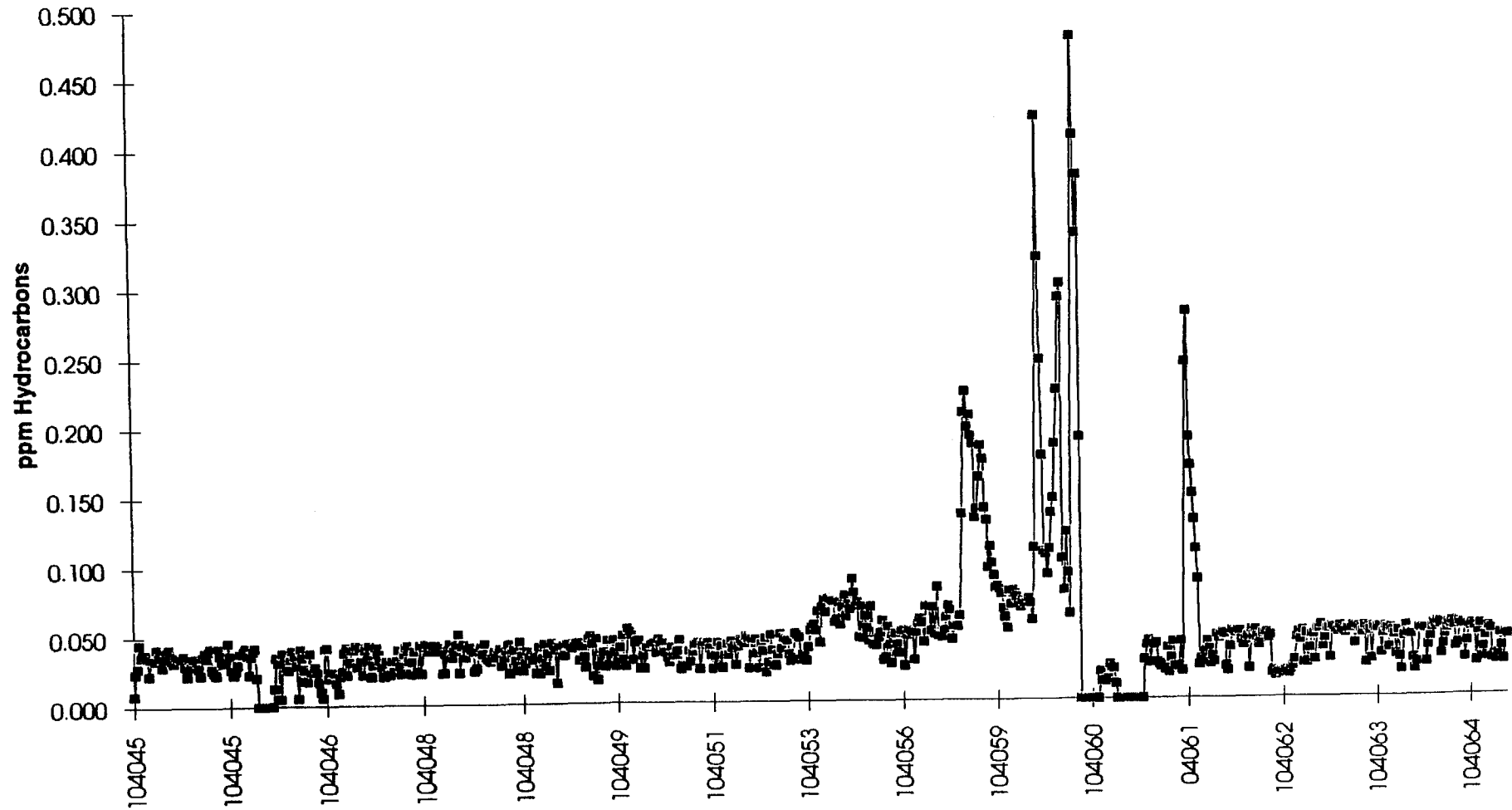


Figure 9j. Normal-pentane versus line number in the Gippsland Basin.

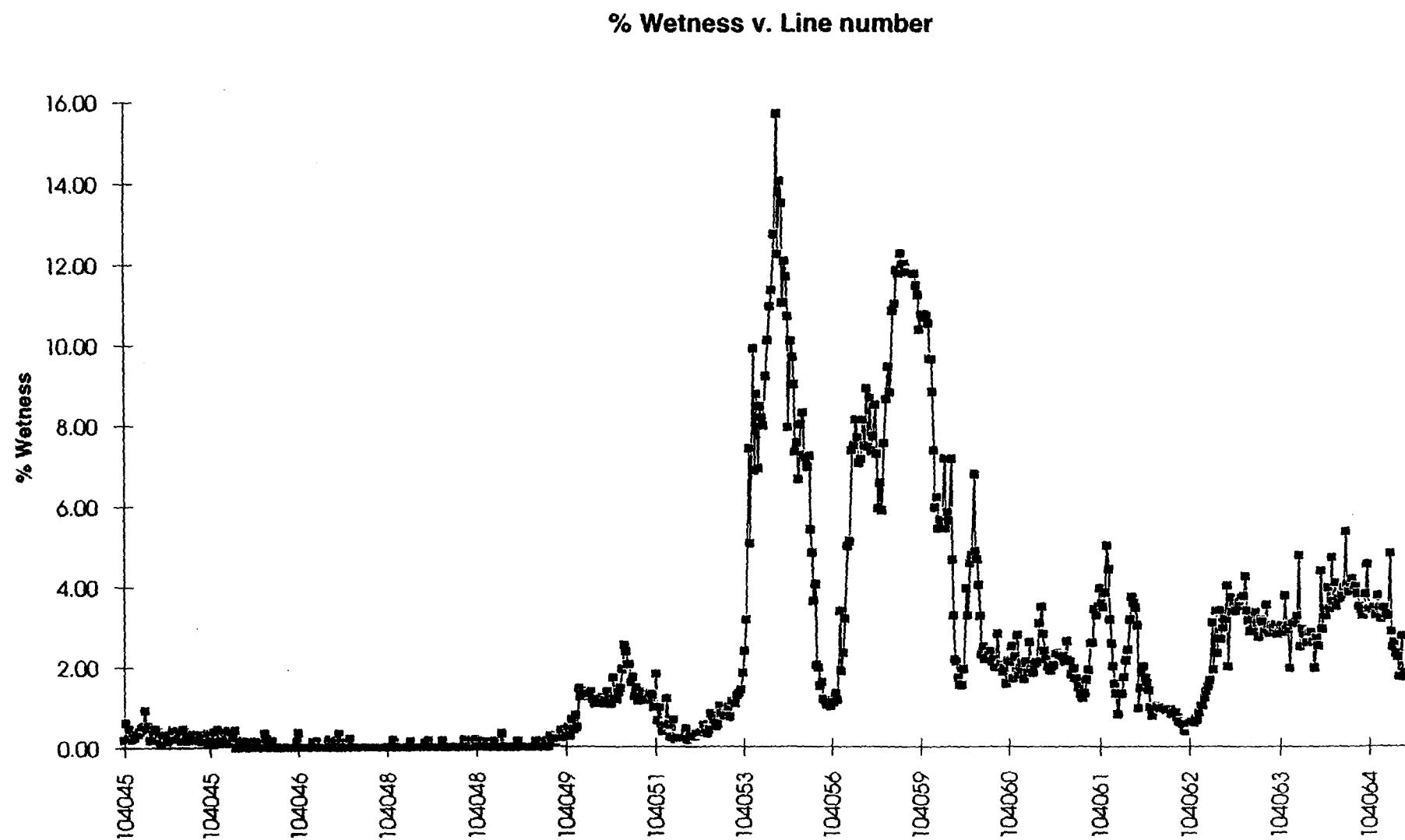


Figure 9k. Percent hydrocarbon wetness versus line number in the Gippsland Basin.

C1/C2 v. Line number

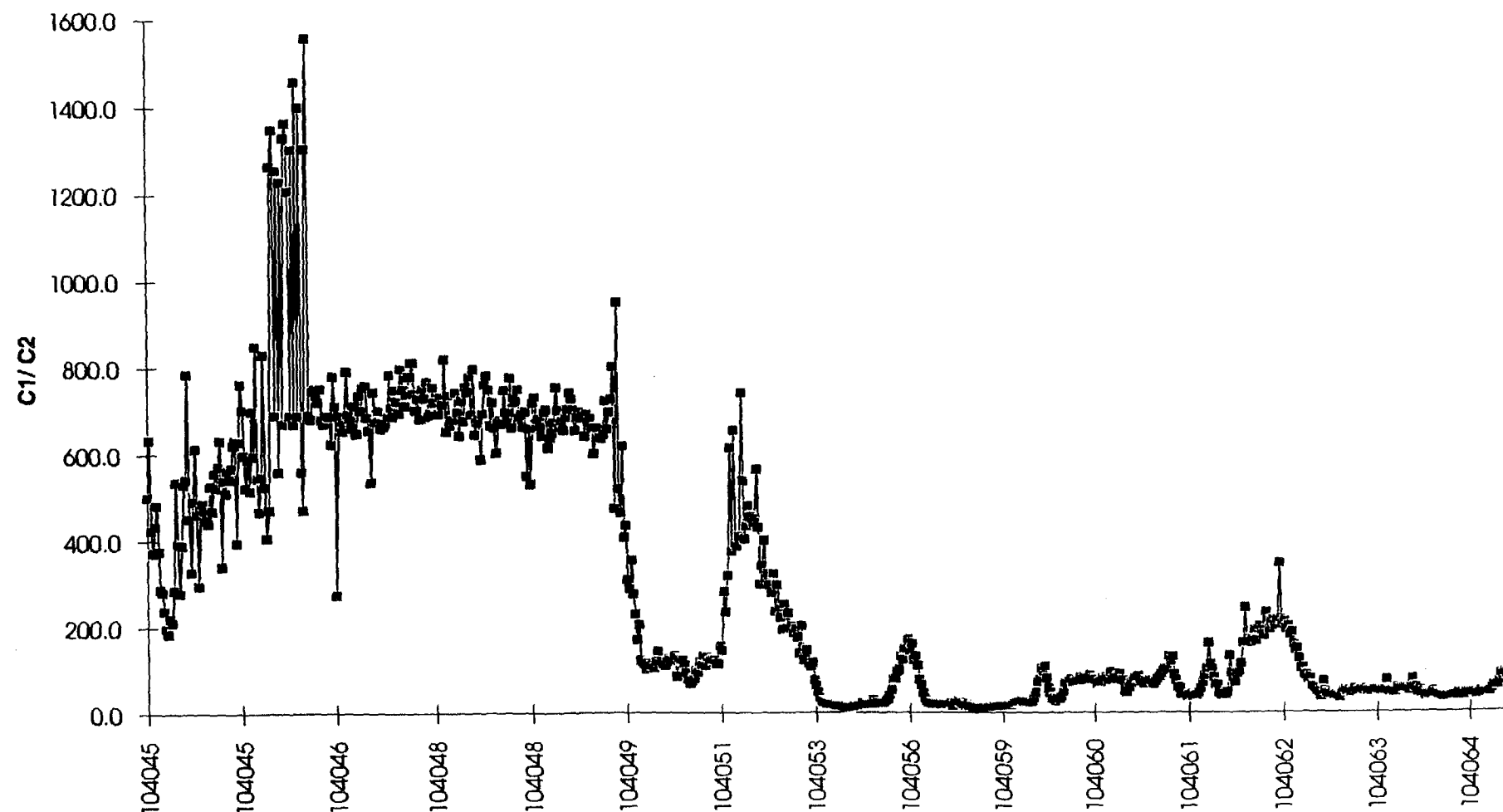


Figure 10a. C₁/C₂ ratio versus line number in the Gippsland Basin.

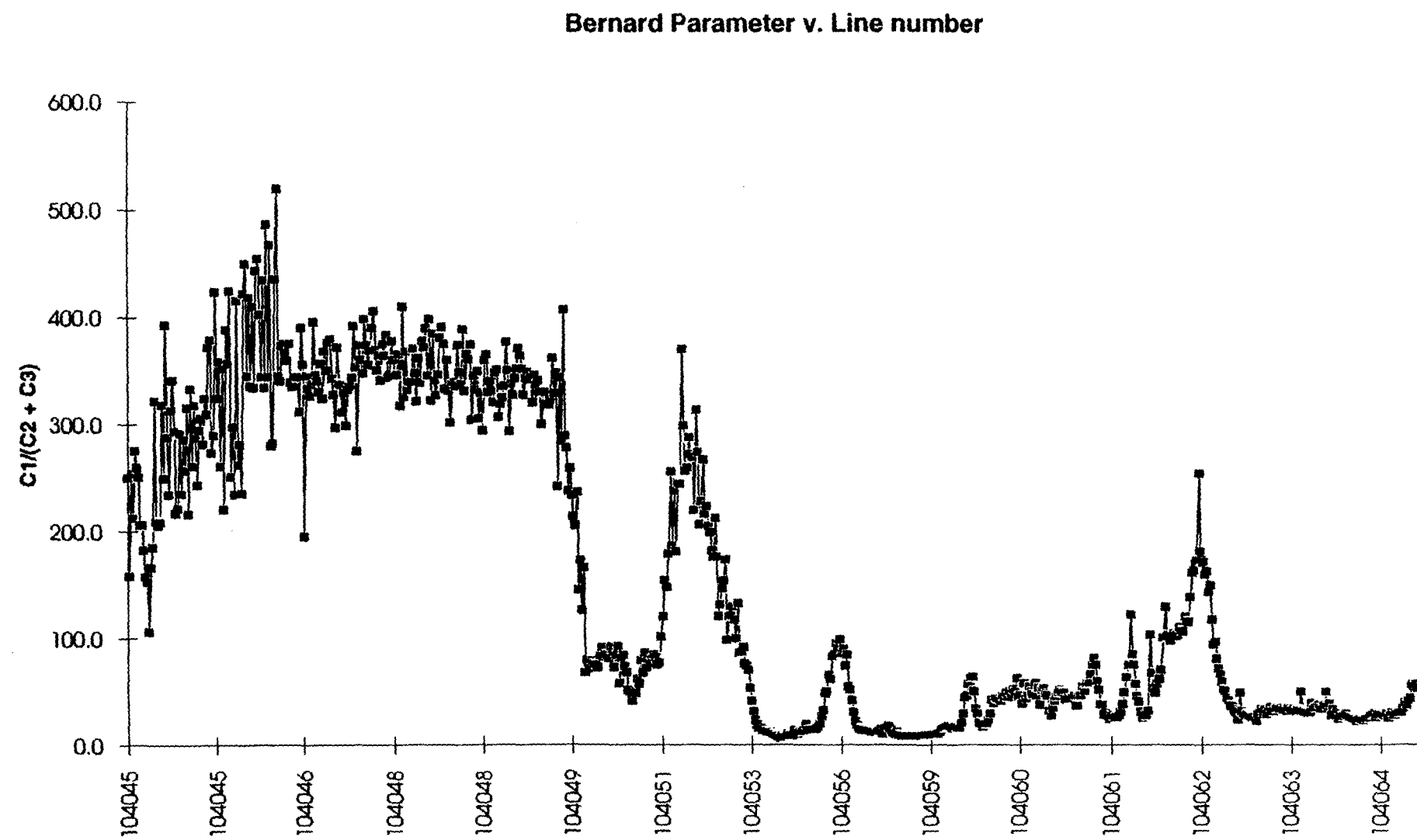


Figure 10b. Bernard parameter versus line number in the Gippsland Basin.

Durroon Sub-basin Methane v. % Wetness

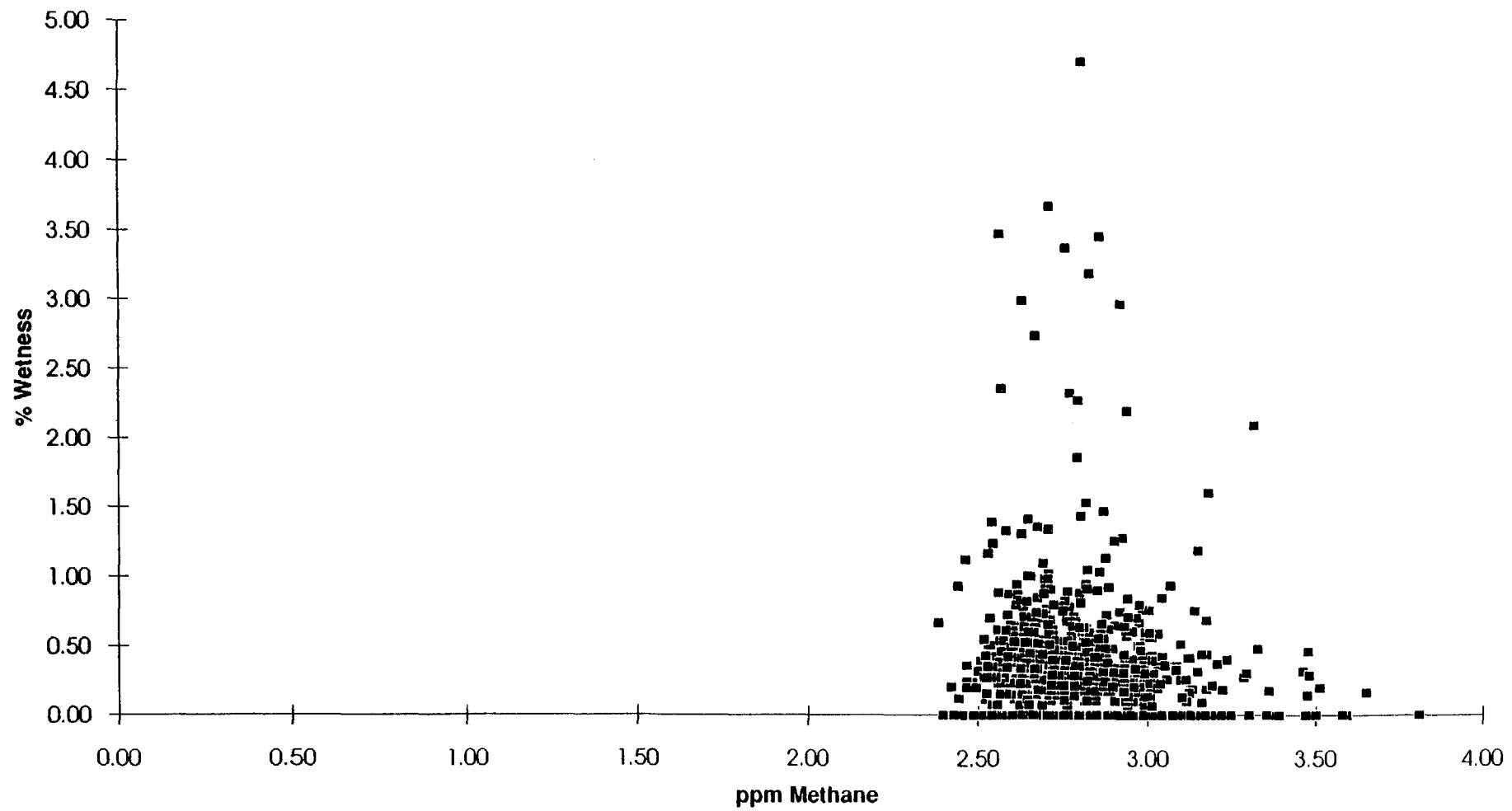


Figure 11. Percent hydrocarbon wetness versus methane for the Durroon Basin.

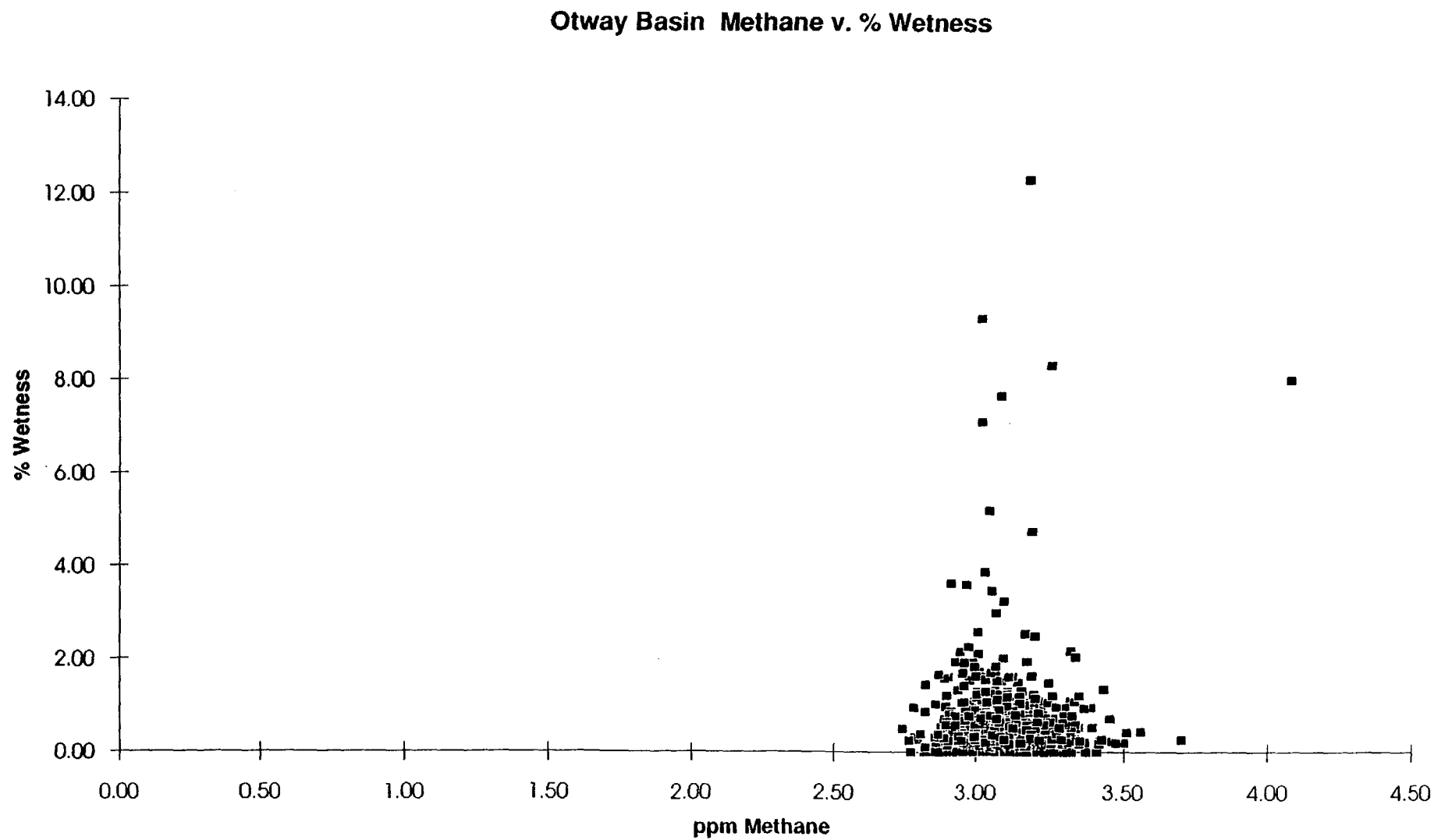


Figure 12. Percent hydrocarbon wetness versus methane for the Otway Basin.

Torquay Sub-basin Methane vs %Wetness

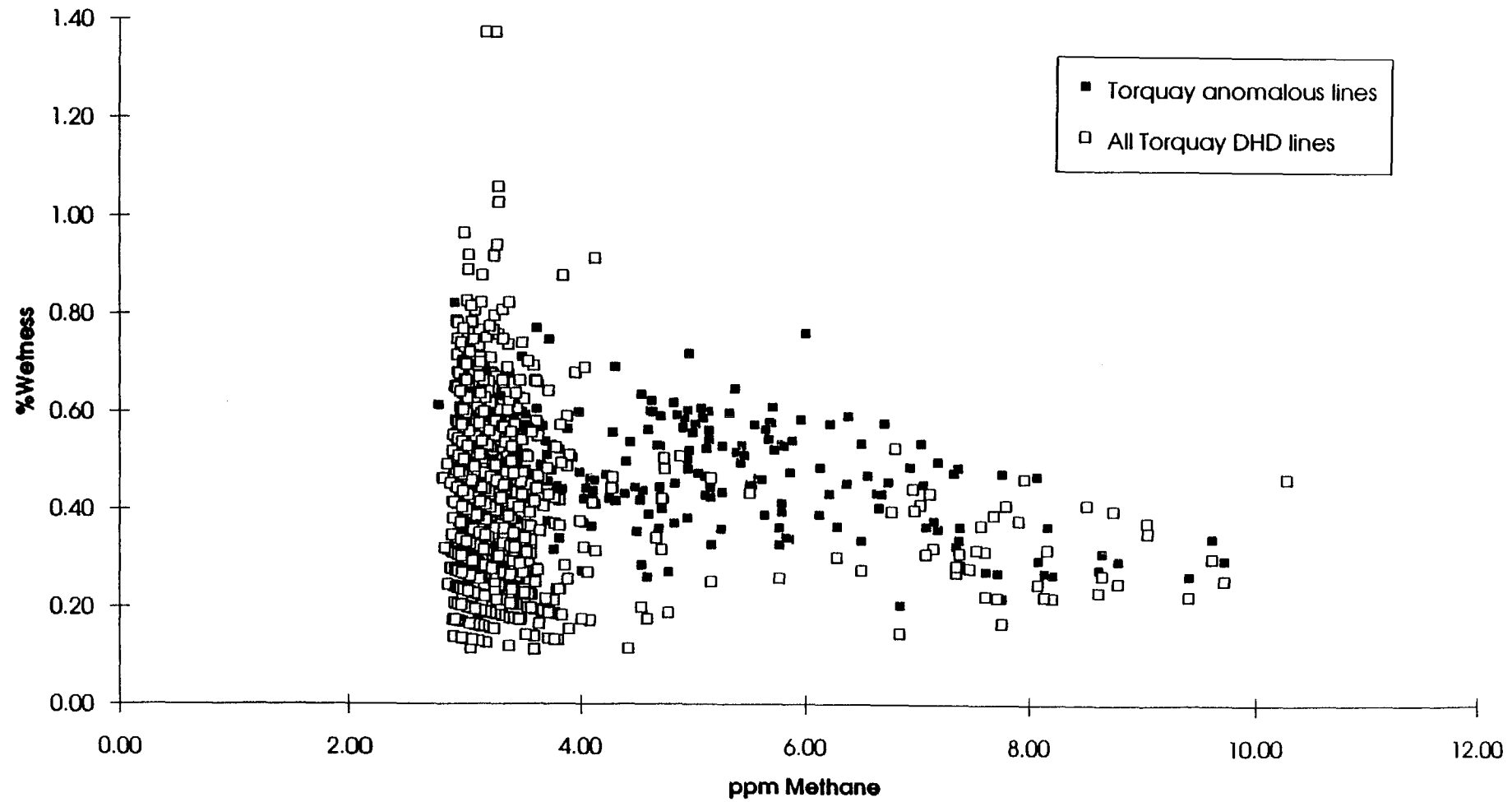


Figure 13a. Torquay Sub-basin DHD data: percent hydrocarbon wetness versus methane.

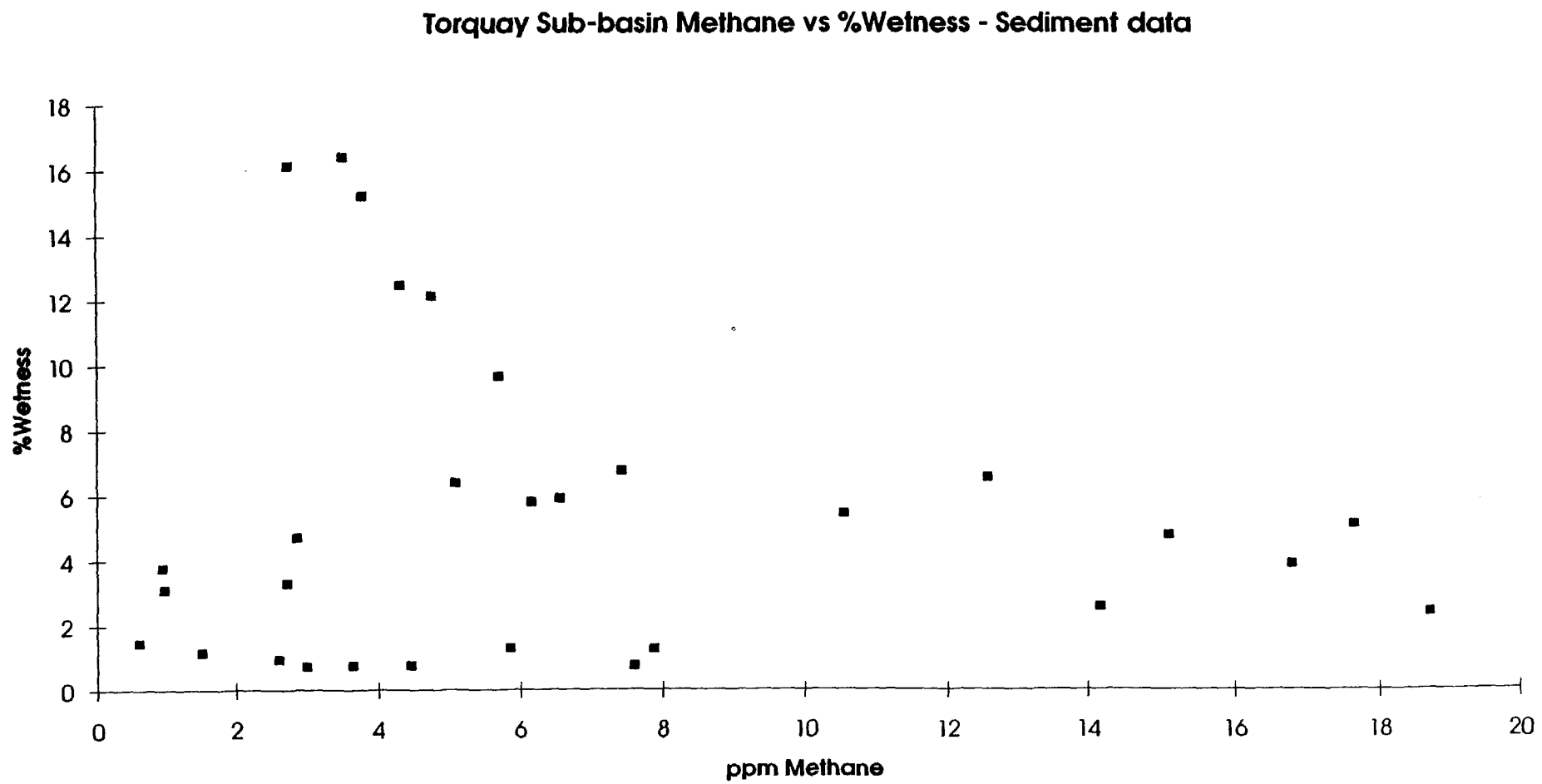


Figure 13b. Torquay Sub-basin sediment data: percent hydrocarbon wetness versus methane.

Gippsland Basin DHD Anomalies - Methane v. % Wetness

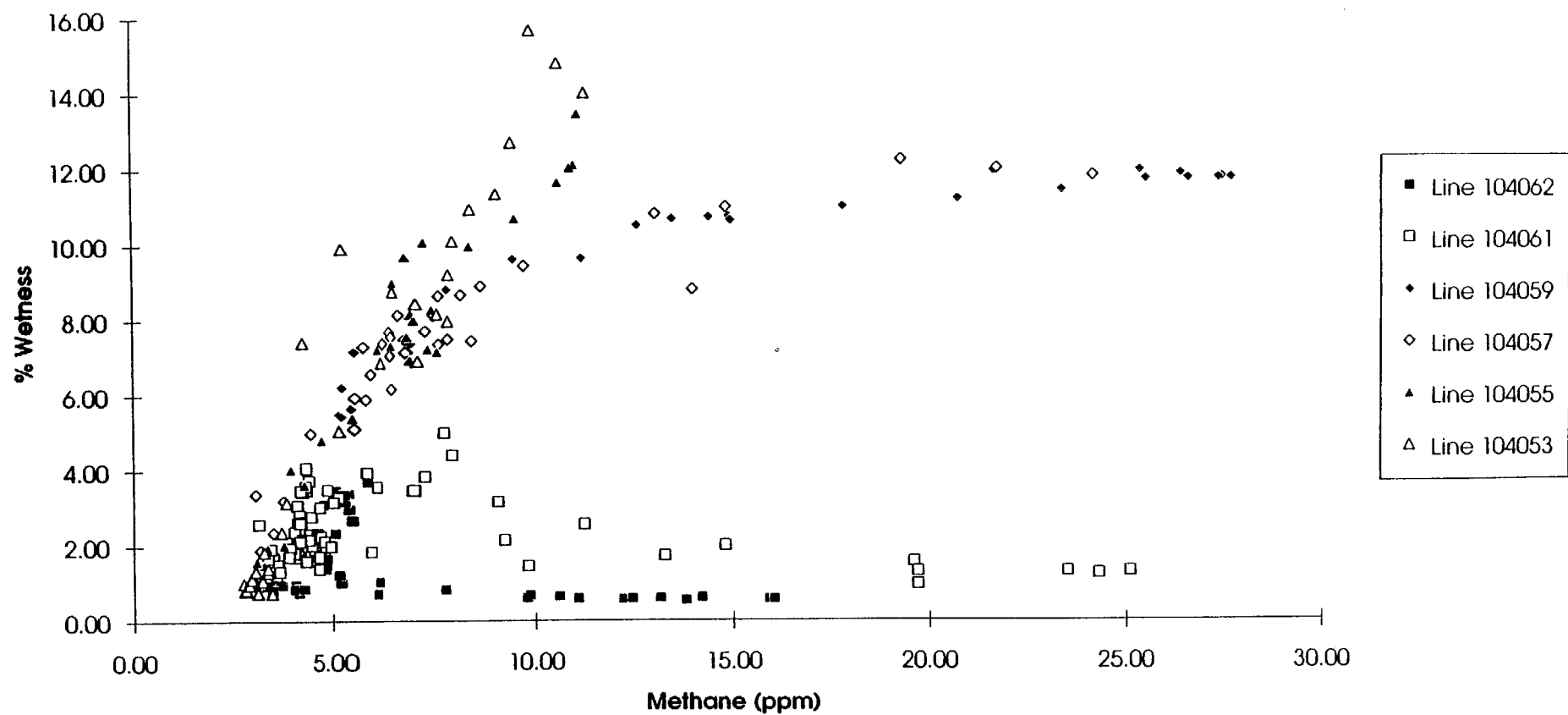


Figure 14a. Gippsland Basin: percent hydrocarbon wetness versus methane.

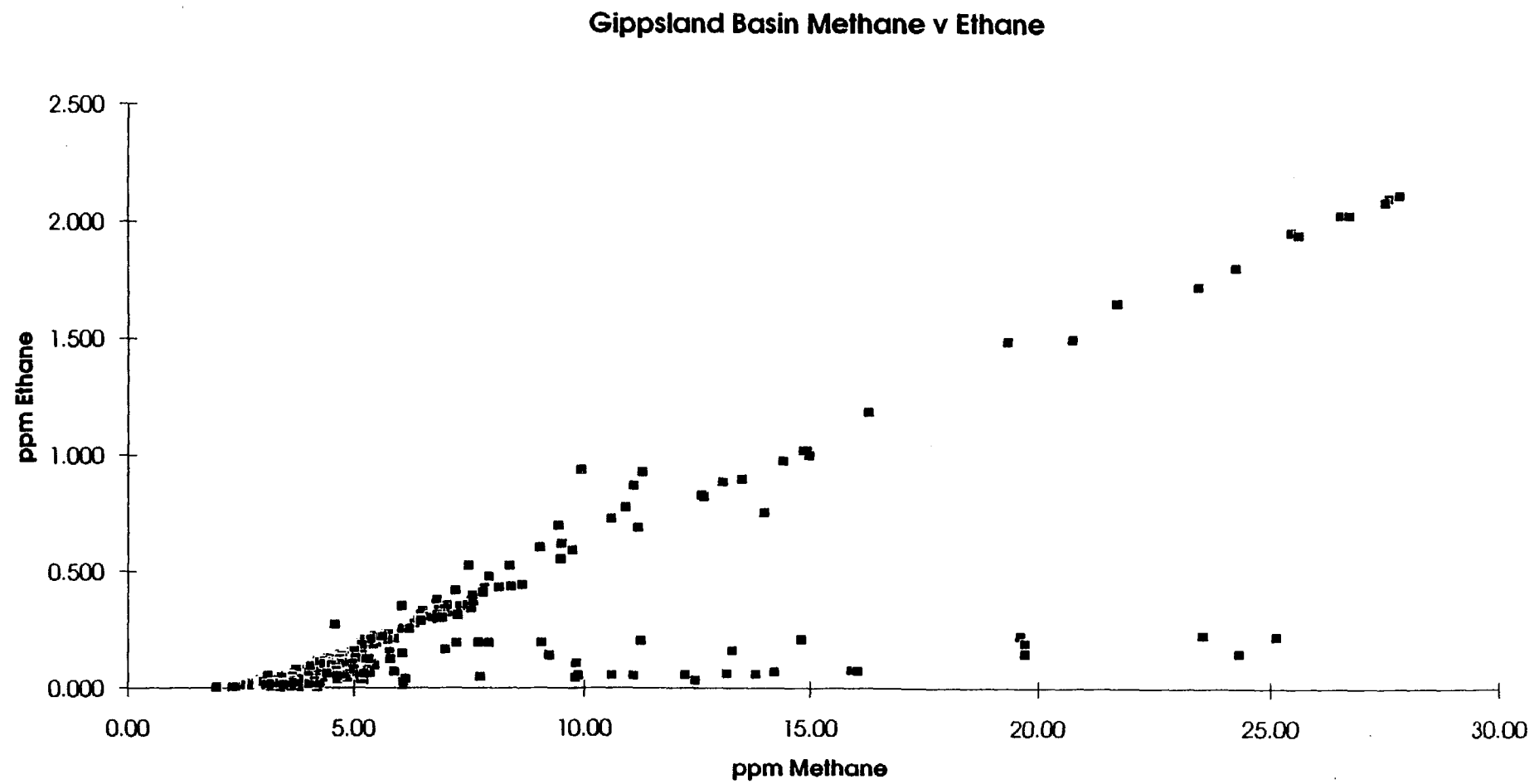


Figure 14b. Gippsland Basin: methane versus ethane.

Gippsland Basin Methane v Propane

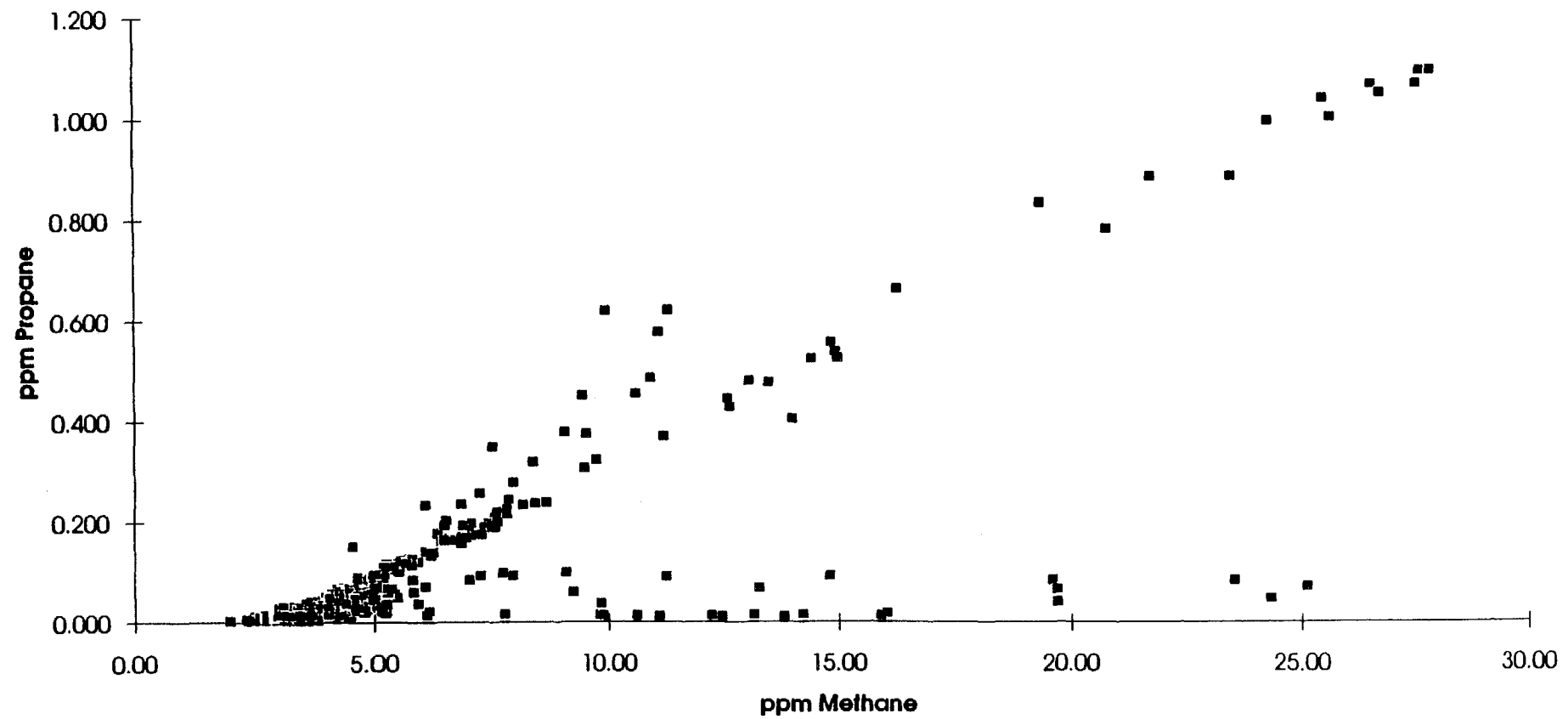


Figure 14c. Gippsland Basin: methane versus propane.

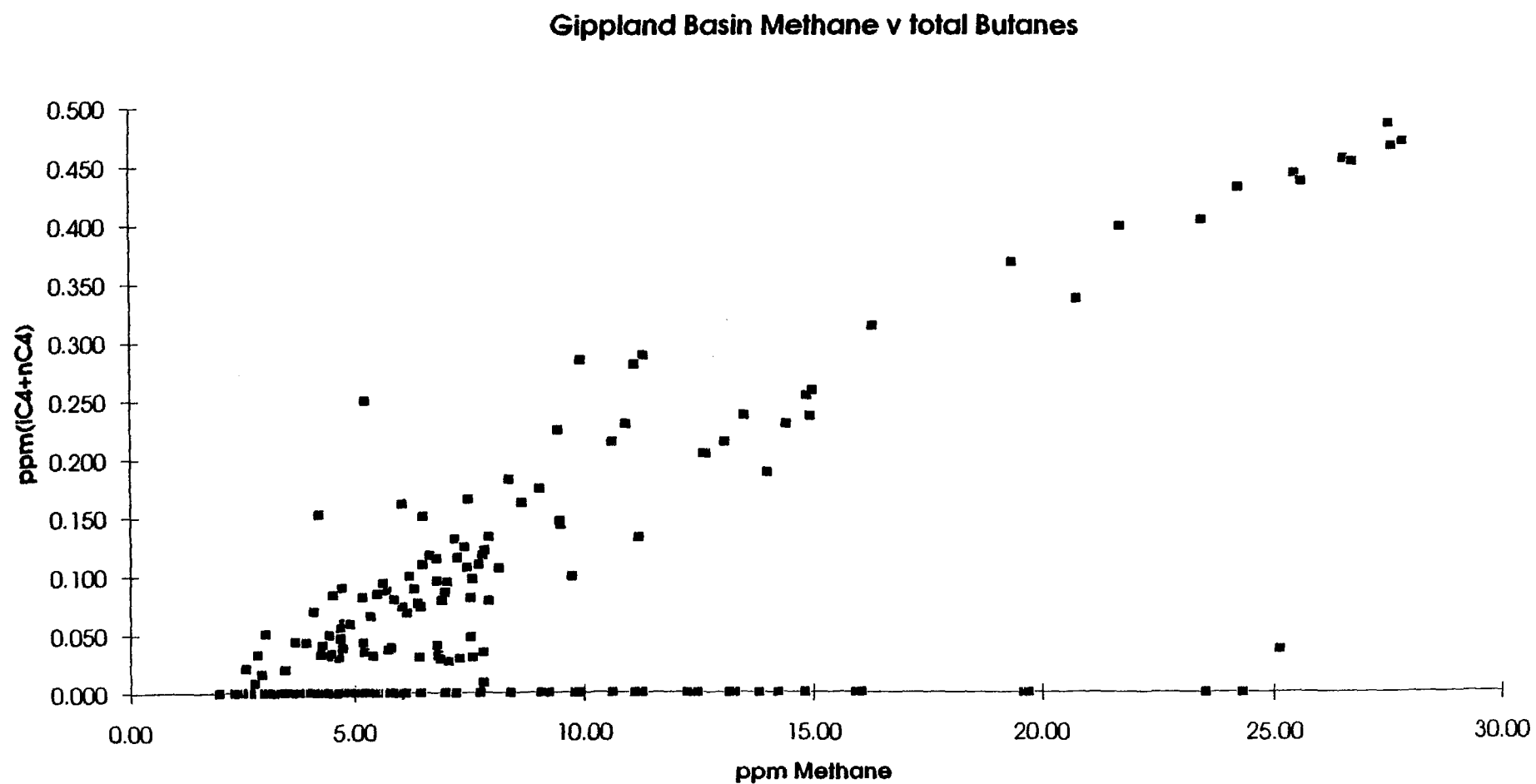


Figure 14d. Gippsland Basin: methane versus iso- plus normal-butane.

Appendix I. Individual line plots and summary sheets

Durroon Sub-basin: Individual line plots and line summary sheets

Line Summary

Line Number 104206
No. of Shotpoints 117

	Shotpoint	Date	Time	Latitude	Longitude	
Start	1	23/09/91	20:21:39	40	26.158 147	31.490
End	119	24/09/91	00:18:26	40	42.711 147	45.893

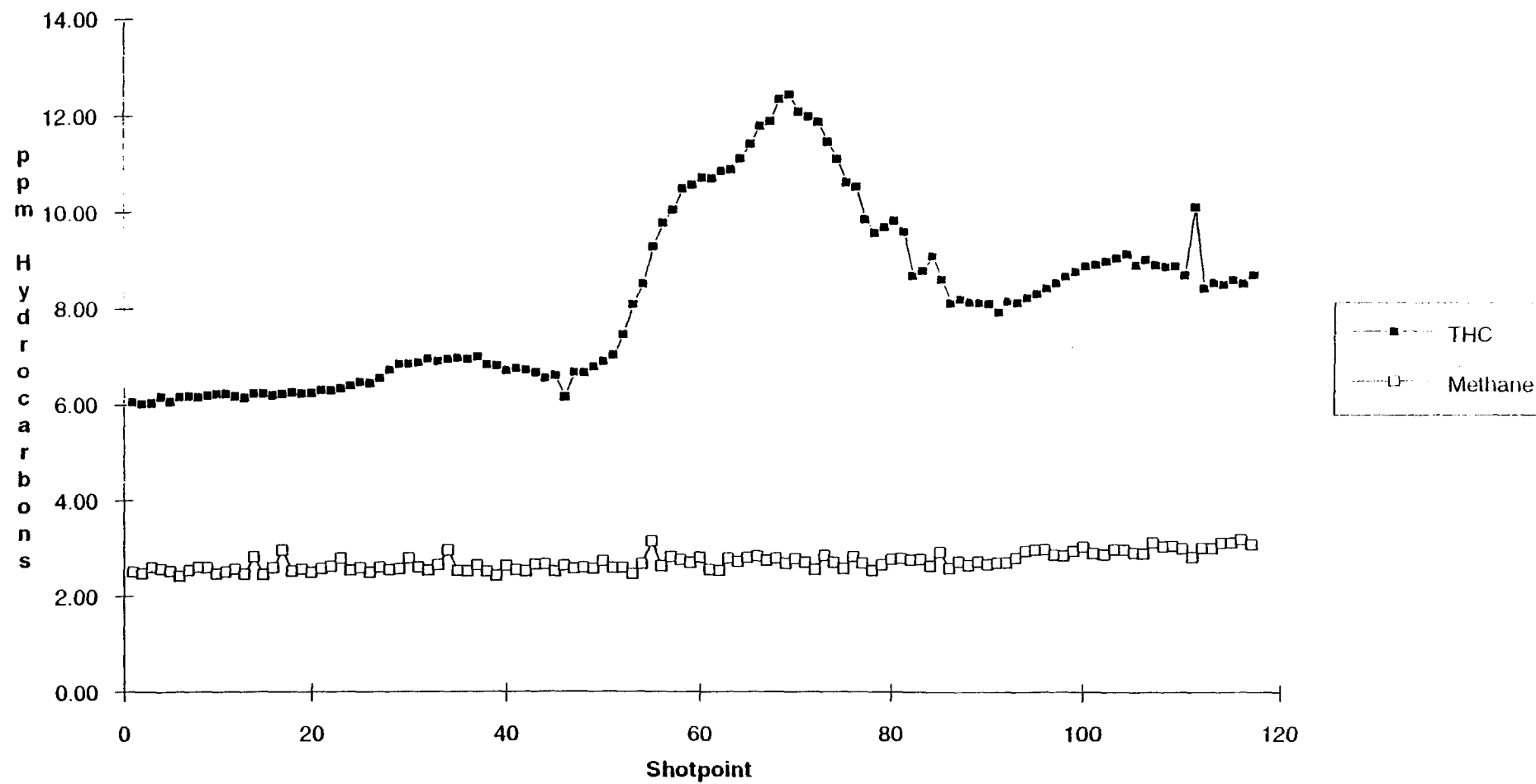
	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	8.214	2.722	0.000	0.016	0.006	0.000	0.003	0.000	0.005	0.043	0.000	0.000	0.324
Std. Dev.	1.814	0.188	0.000	0.004	0.007	0.000	0.015	0.000	0.009	0.024	0.000	0.000	0.656
Minimum	6.025	2.422	0.000	0.009	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Maximum	12.480	3.192	0.000	0.036	0.037	0.000	0.130	0.000	0.030	0.103	0.000	0.000	4.723

	Cond.	Temp.	Altitude	F. Depth	W.Depth
Mean	45.088	14.302	12.459	32.365	44.812
Std. Dev.	0.452	0.500	1.746	3.099	3.887
Minimum	44.270	13.520	9.400	29.500	39.300
Maximum	45.780	15.140	16.500	38.600	51.000

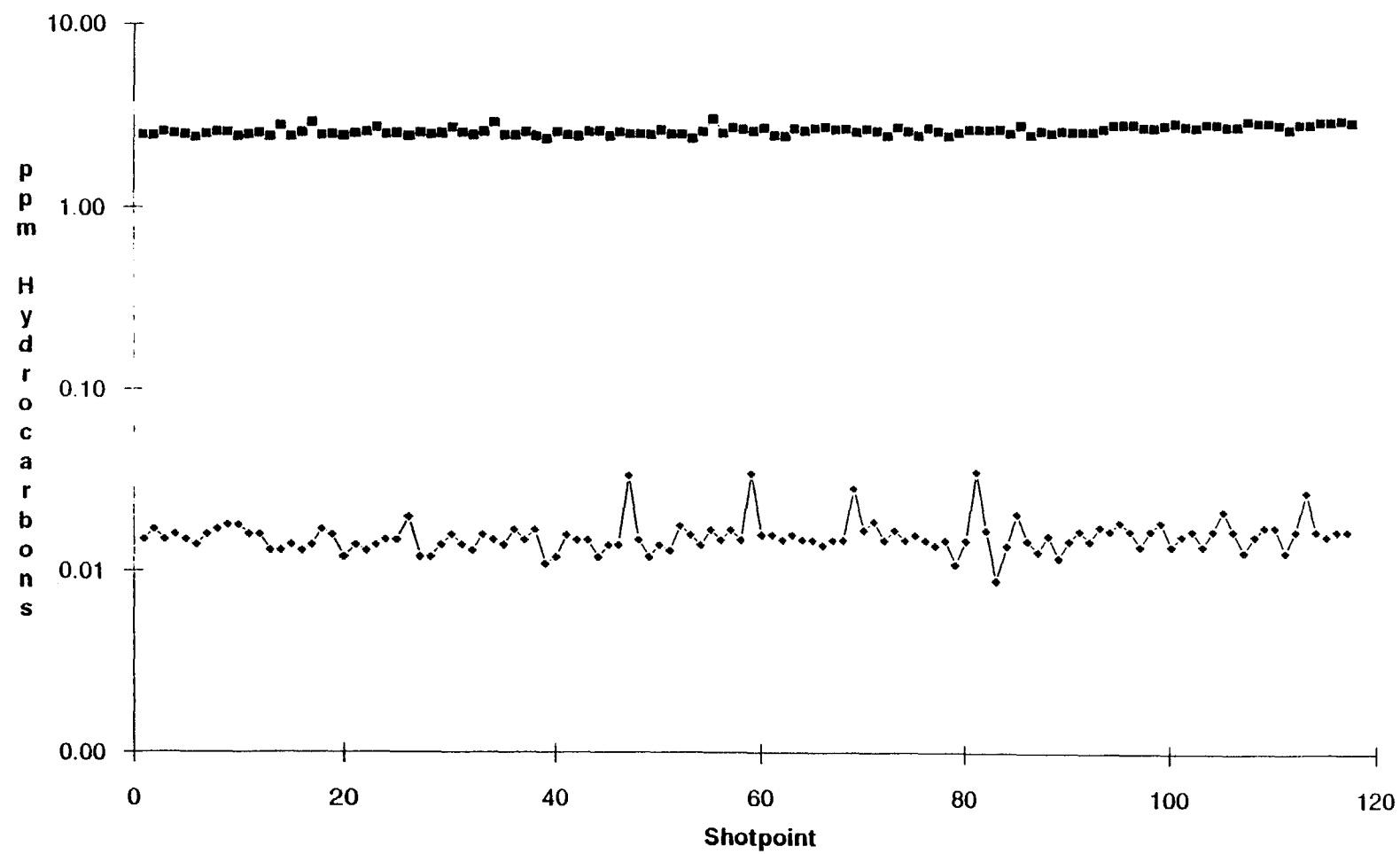
Notes

THC anomaly from shotpoint 52 to 85, with slight increase towards end of line.

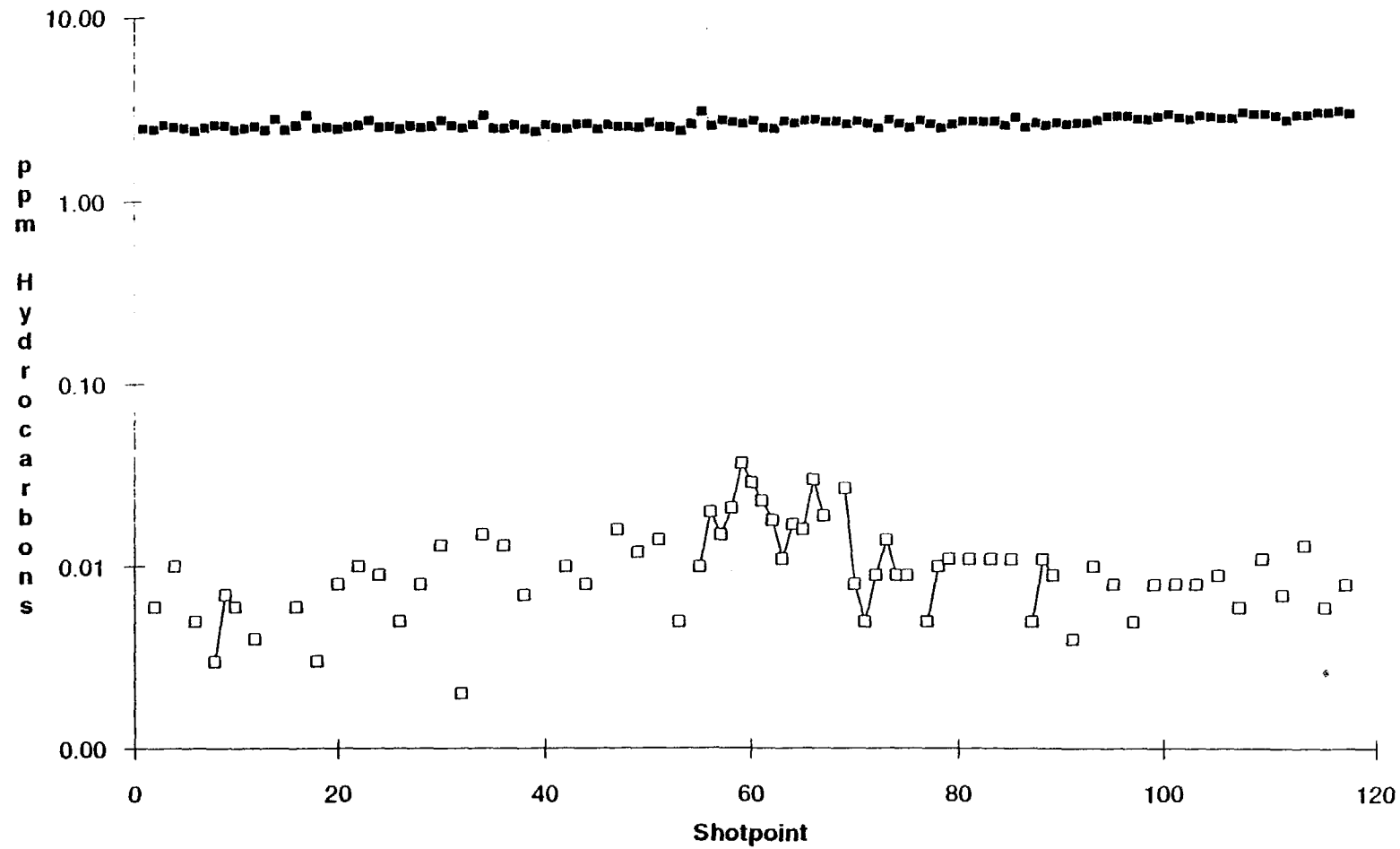
Line 104206 THC, Methane



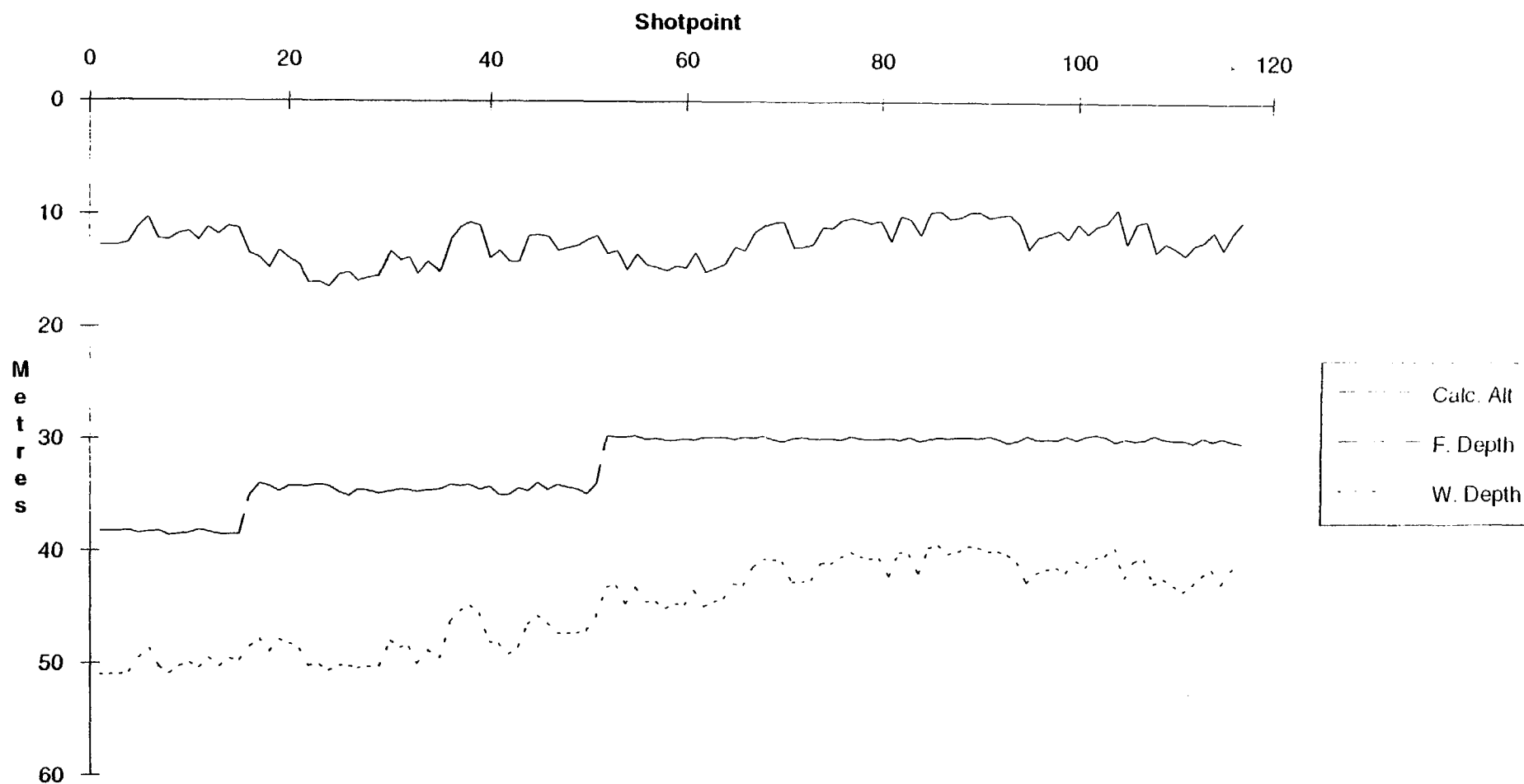
Line 104206 Methane, Ethane, Ethylene



Line 104206 Methane, Propane, Propylene



Line 104206 Depths, Altitude



Line Summary

Line Number 104207
No. of Shotpoints 83

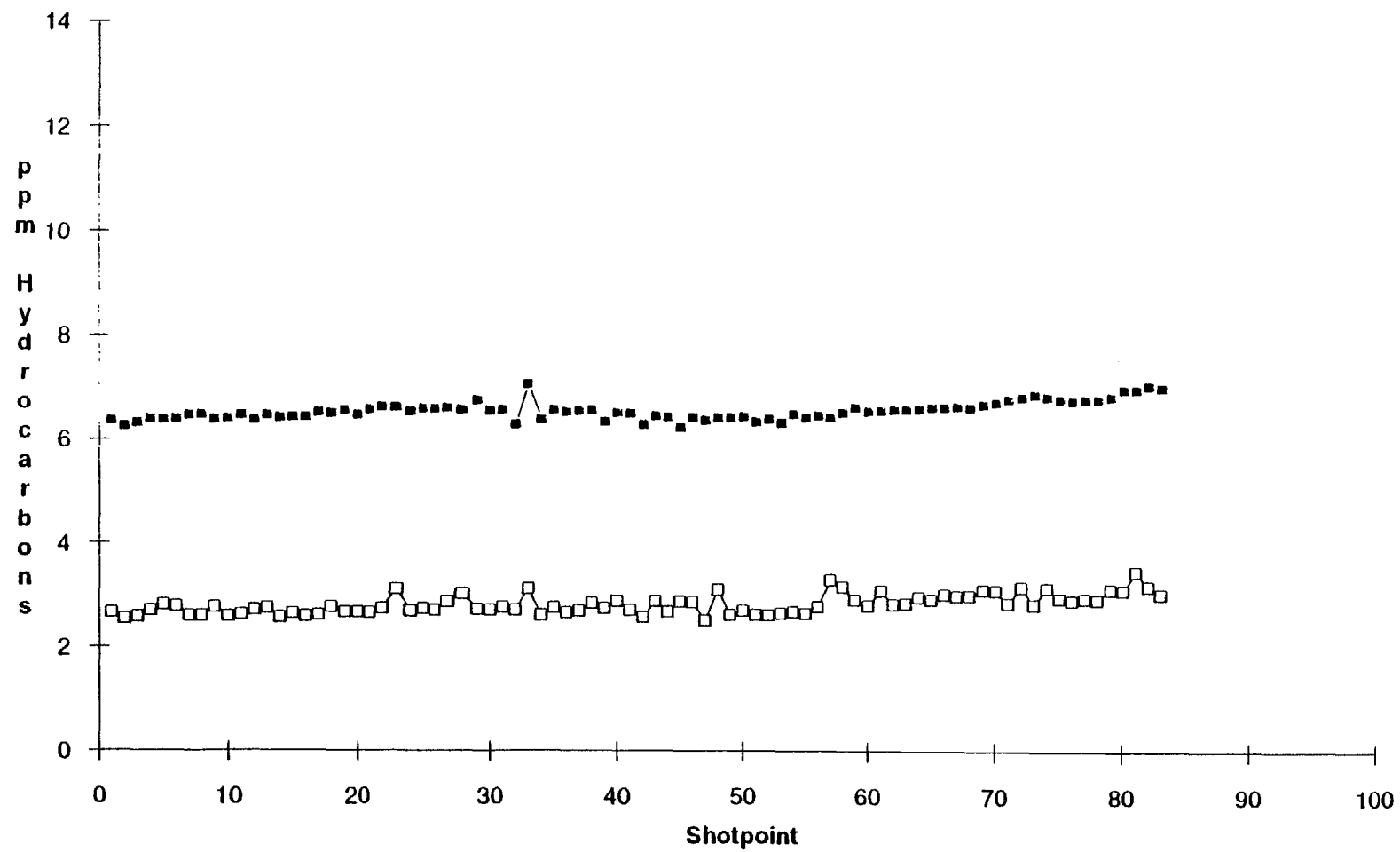
	Shotpoint	Date	Time	Latitude	Longitude	
Start	2	23/09/91	09:44:52	S 40	30.871 E 147	36.943
End	84	23/09/91	12:29:06	S 40	42.434 E 147	46.758

	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	6.570	2.832	0.000	0.016	0.006	0.000	0.000	0.000	0.000	0.036	0.000	0.000	0.222
Std. Dev.	0.190	0.201	0.000	0.005	0.008	0.000	0.000	0.000	0.001	0.019	0.000	0.000	0.263
Minimum	6.257	2.523	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Maximum	7.081	3.478	0.000	0.052	0.038	0.000	0.000	0.000	0.010	0.081	0.000	0.000	1.286

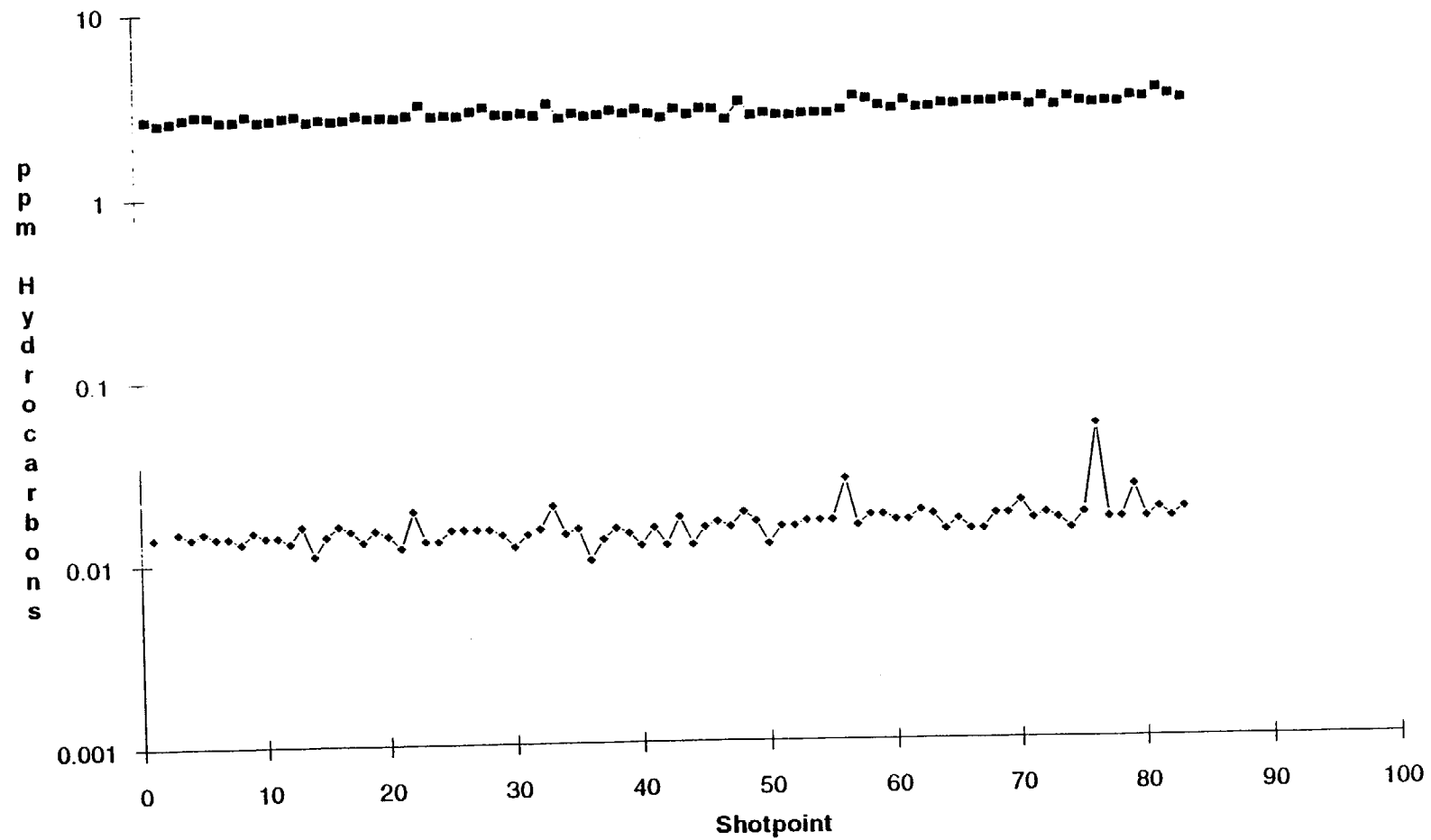
	Cond.	Temp.	Altitude	F. Depth	W.Depth
Mean	44.350	17.901	12.191	29.648	42.346
Std. Dev.	0.152	0.207	2.614	2.280	2.071
Minimum	44.060	17.190	2.310	15.100	38.500
Maximum	44.540	18.290	22.530	32.080	46.900

Notes
No hydrocarbon anomalies detected.

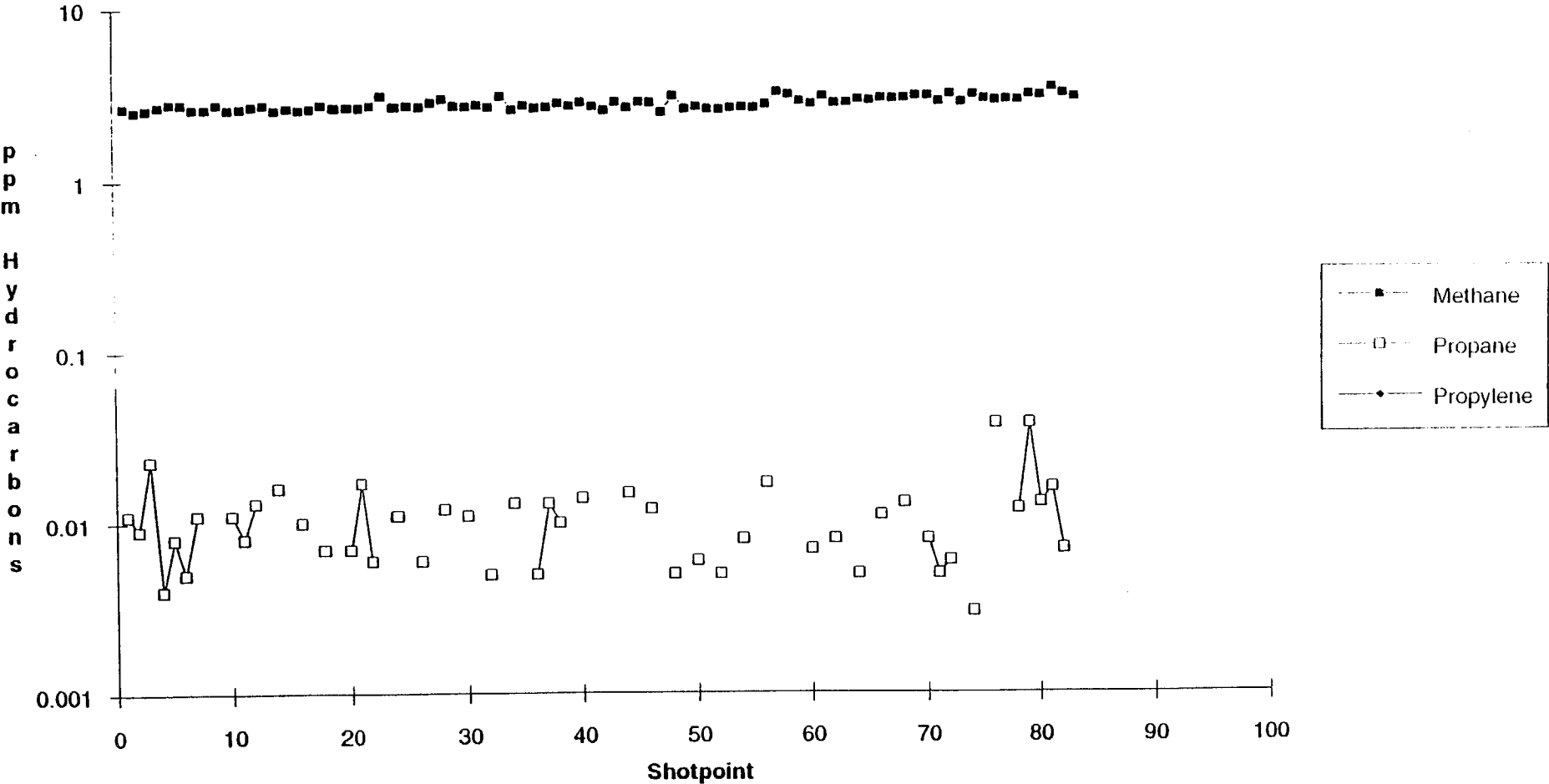
Line 104207 THC, Methane



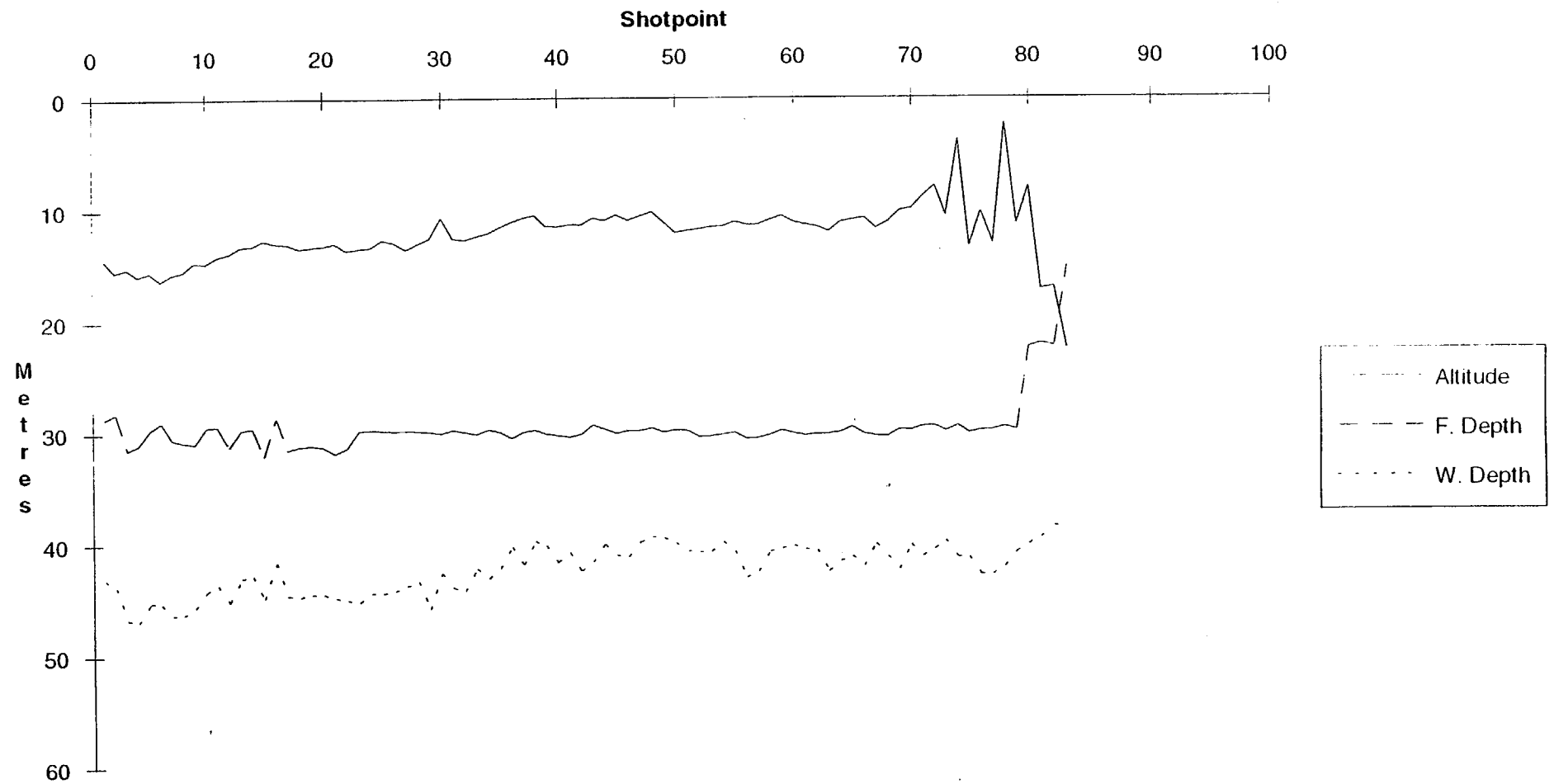
Line 104207 Methane, Ethane, Ethylene



Line 104207 Methane, Propane, Propylene



Line 104207 Depths, Altitude



Line Summary

Line Number 104208
No. of Shotpoints 116

	Shotpoint	Date	Time	Latitude	Longitude
Start	1	24/09/91	02:50:49	S 40	40.890 E 147 46.533
End	116	24/09/91	06:40:46	S 40	24.638 E 147 33.091

	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	8.016	2.851	0.000	0.018	0.006	0.000	0.000	0.000	0.015	0.053	0.006	0.000	0.222
Std. Dev.	0.394	0.232	0.000	0.014	0.011	0.000	0.001	0.000	0.010	0.025	0.020	0.000	0.410
Minimum	7.339	2.398	0.000	0.010	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Maximum	10.416	3.470	0.000	0.113	0.092	0.000	0.008	0.000	0.032	0.103	0.118	0.000	3.485

	Cond.	Temp.	Altitude	F. Depth	W. Depth
Mean	44.569	14.488	11.363	31.796	43.161
Std. Dev.	5.932	1.935	1.838	4.061	3.560
Minimum	0.000	0.000	7.430	24.930	38.200
Maximum	45.710	15.080	15.580	38.460	49.400

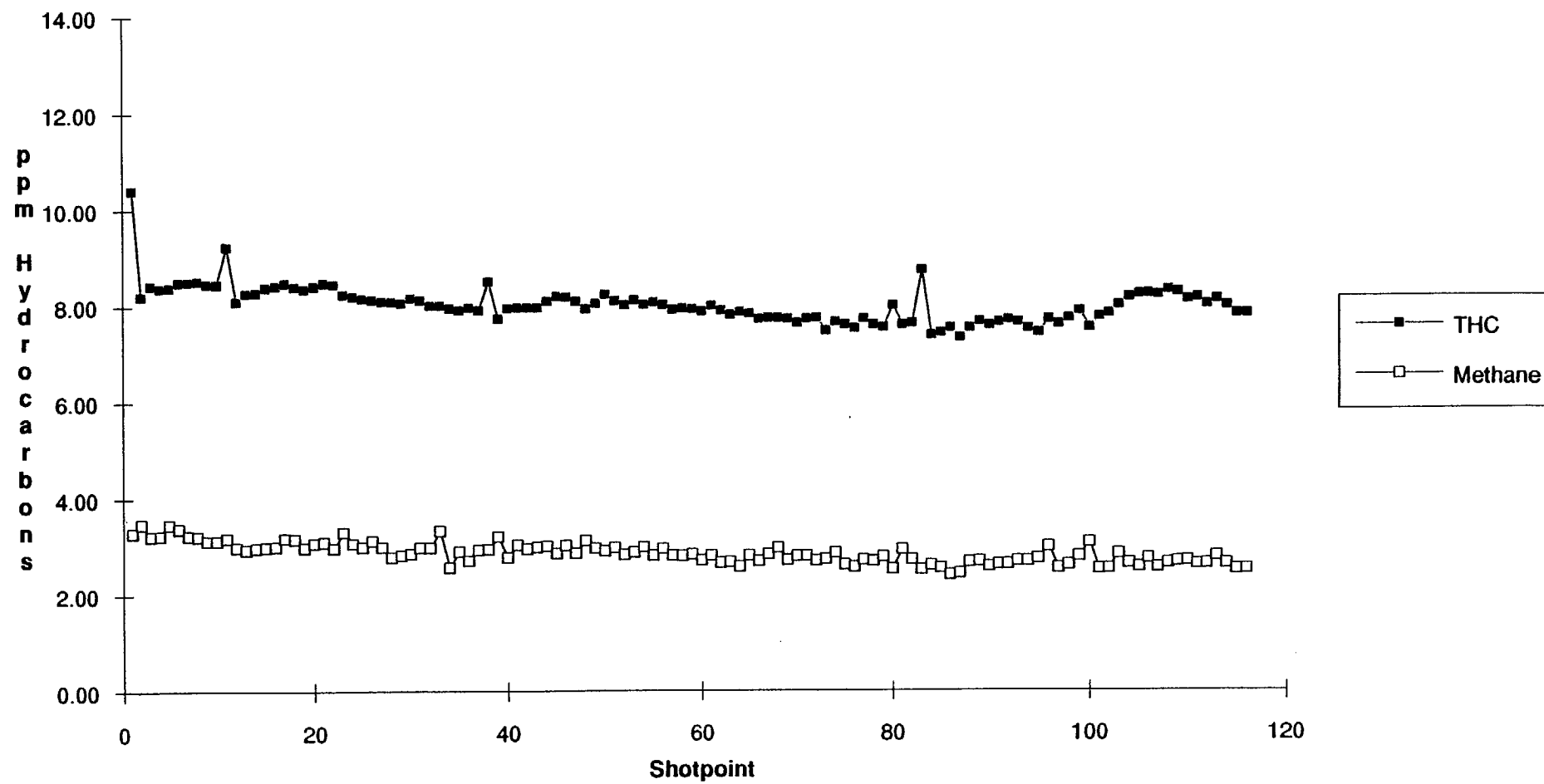
Notes

No hydrocarbon anomalies detected.

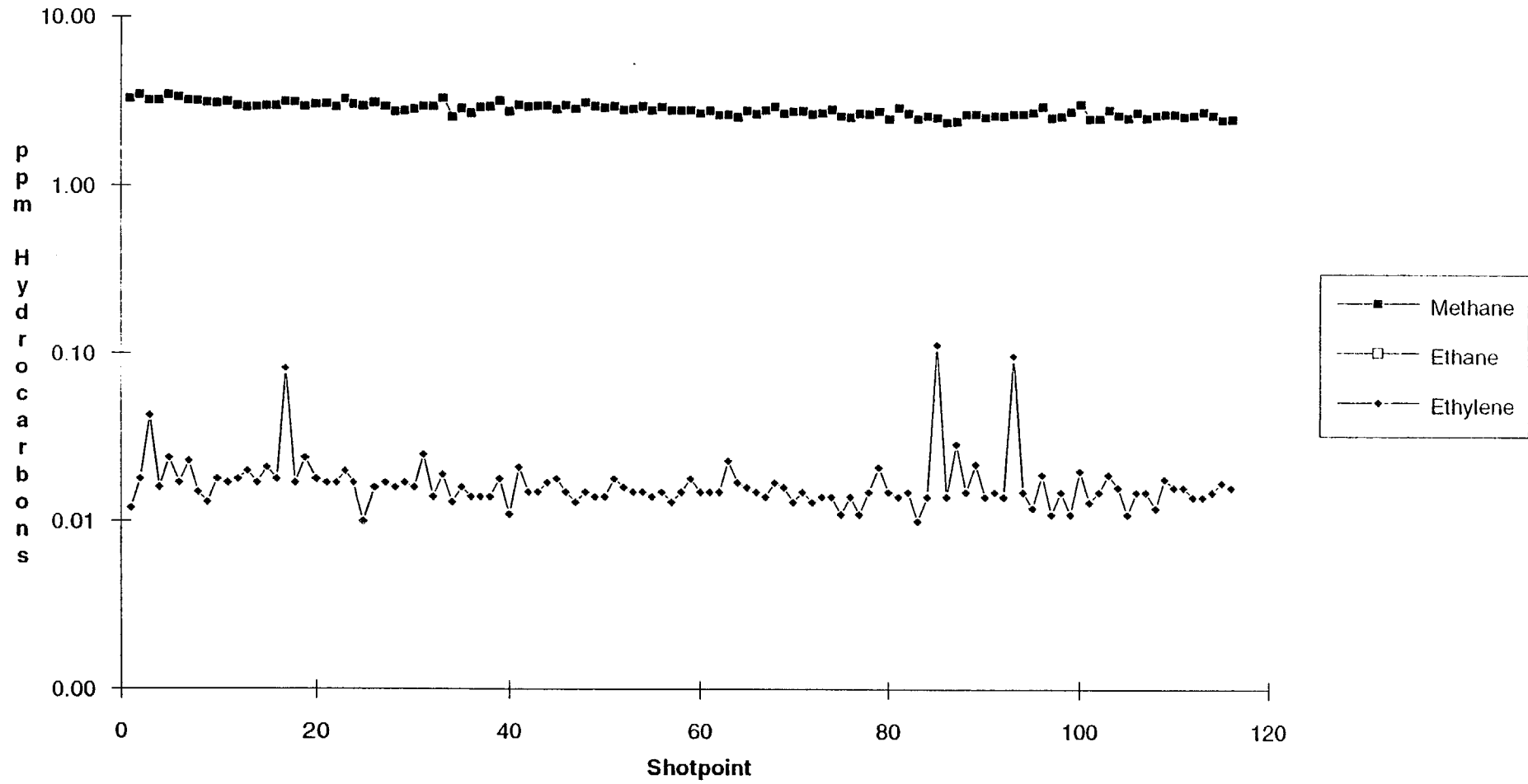
R9205402



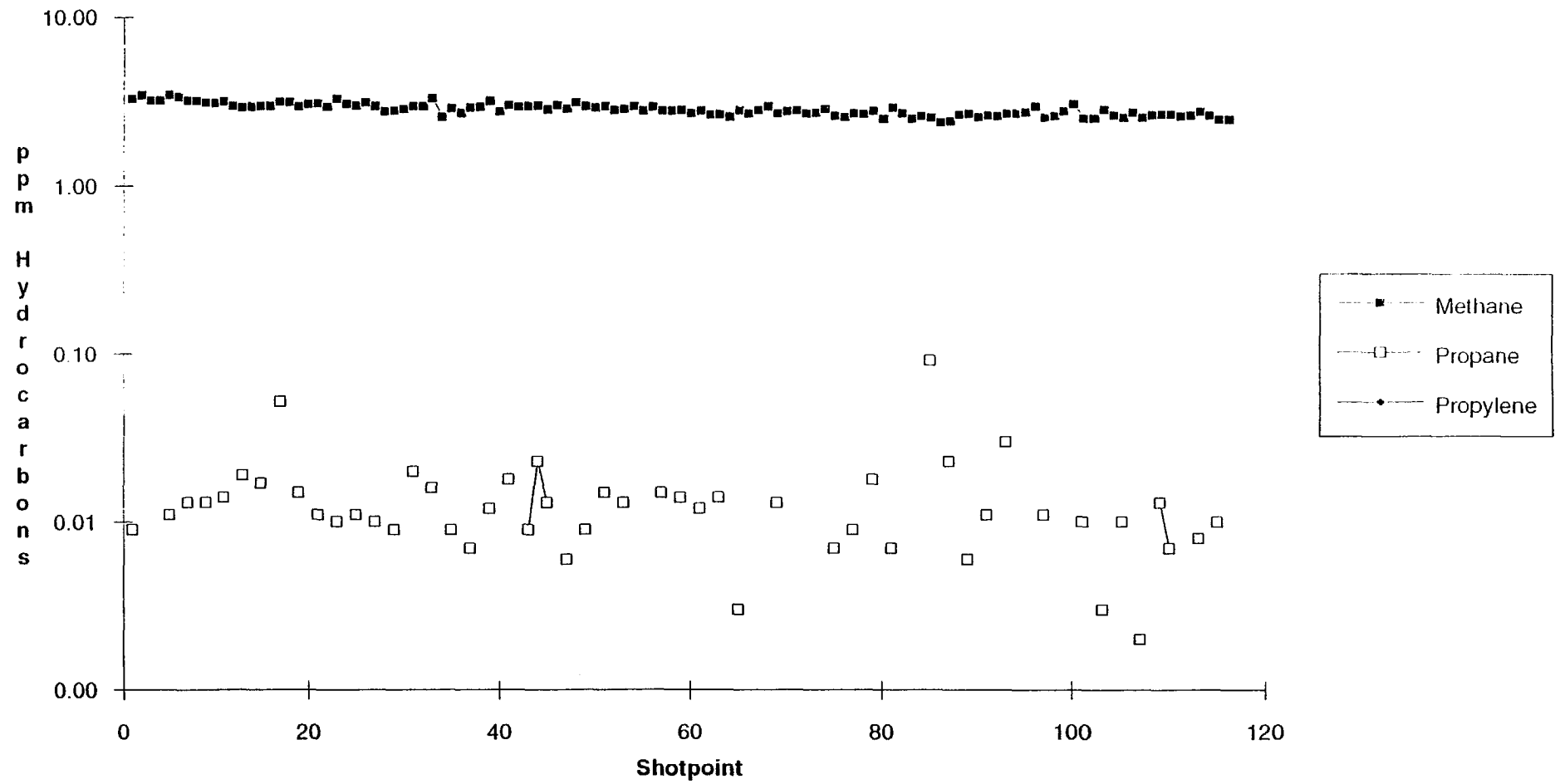
Line 104208 THC, Methane



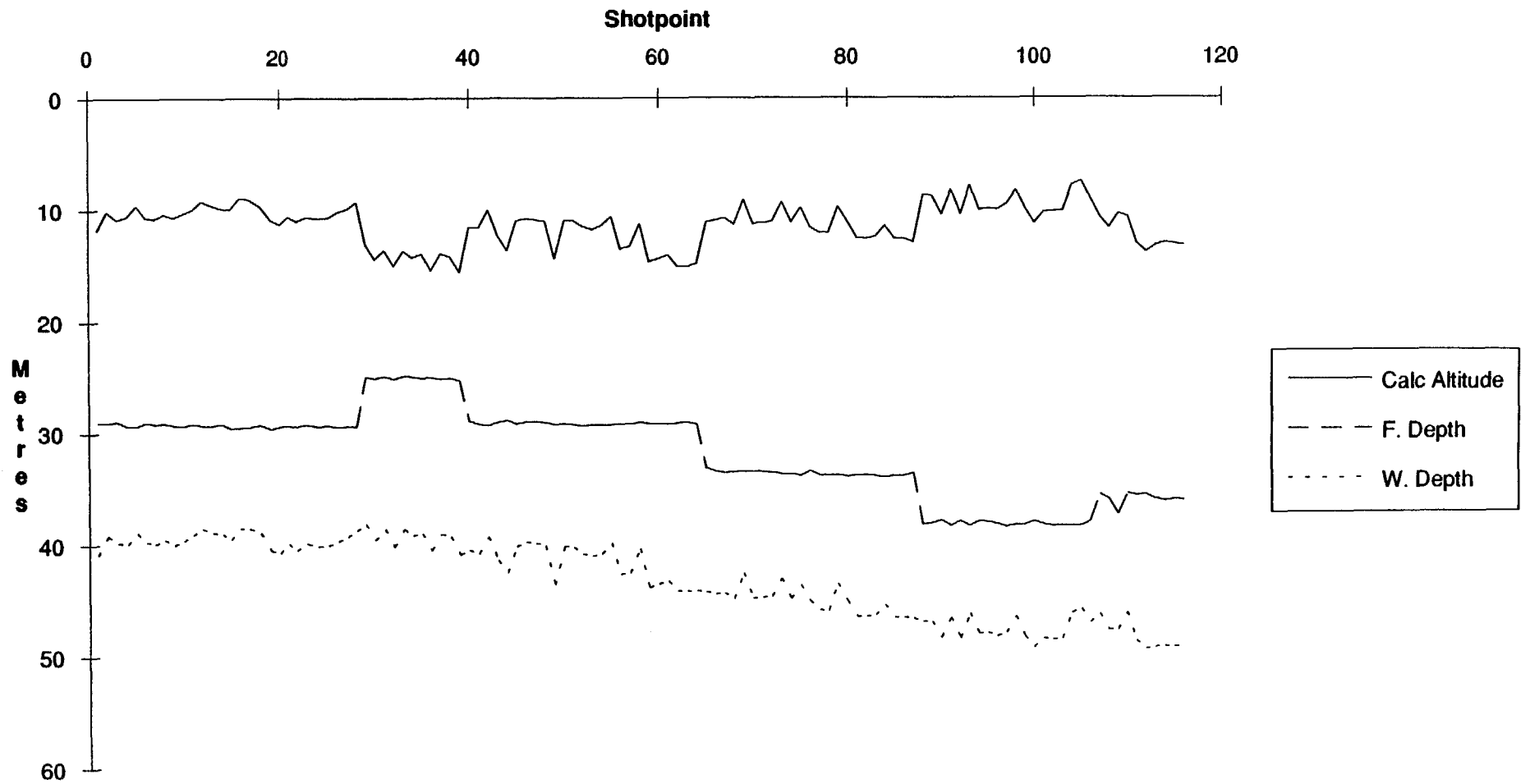
Line 104208 Methane, Ethane, Ethylene



Line 104208 Methane, Propane, Propylene



Line 104208 Depths, Altitude



Line Summary

Line Number 104209
No. of Shotpoints 110

	Shotpoint	Date	Time	Latitude	Longitude
Start	1	23/09/91	14:47:33	40	47.683
End	112	23/09/91	18:33:22	40	35.084

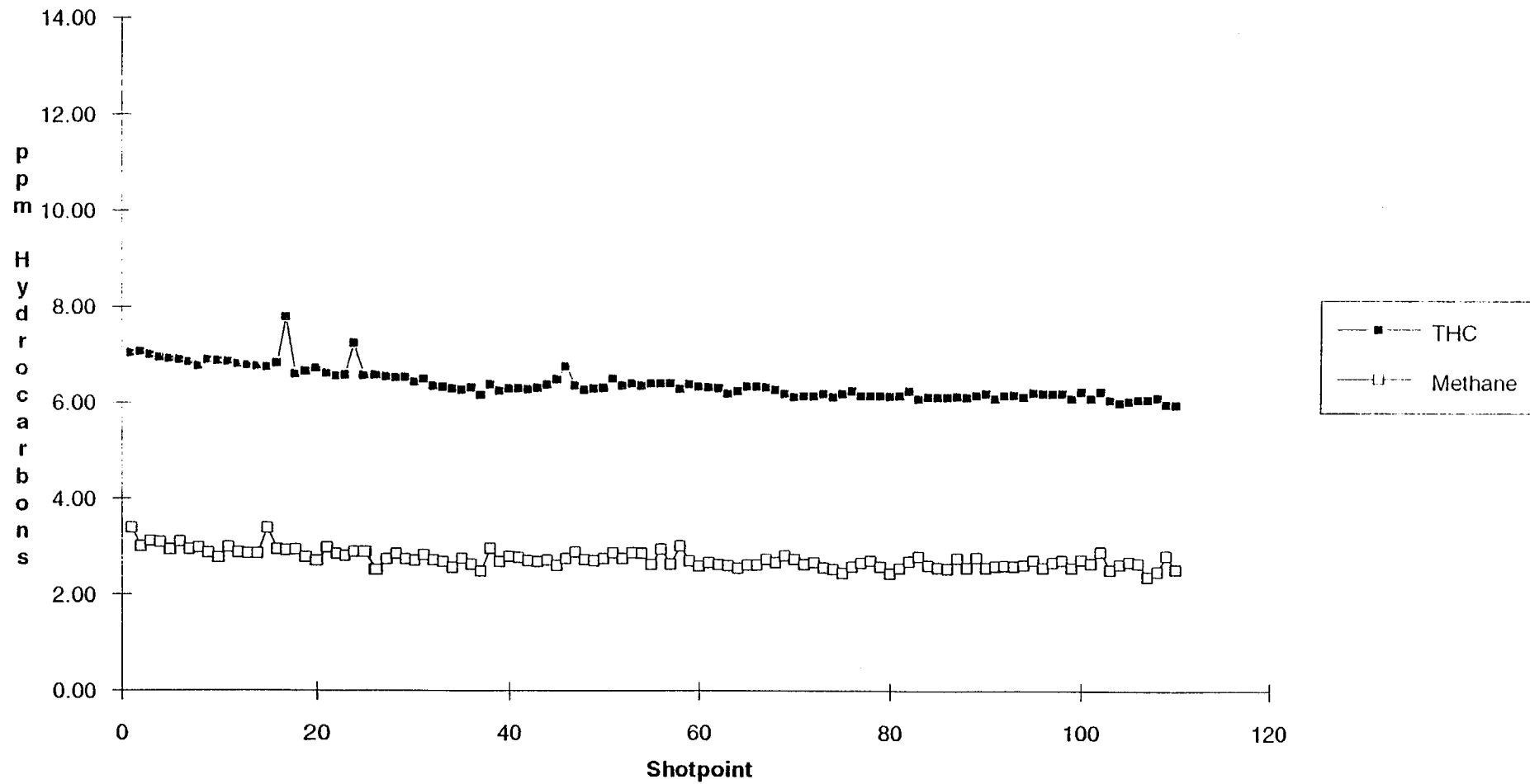
	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	6.394	2.743	0.000	0.016	0.006	0.000	0.001	0.000	0.000	0.037	0.000	0.000	0.250
Std. Dev.	0.310	0.177	0.000	0.006	0.009	0.000	0.005	0.000	0.002	0.019	0.000	0.000	0.372
Minimum	5.964	2.384	0.000	0.007	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Maximum	7.796	3.393	0.000	0.061	0.053	0.000	0.050	0.000	0.014	0.086	0.000	0.000	2.364

	Cond.	Temp.	Altitude	F. Depth	W.Depth
Mean	44.023	13.132	16.000	25.728	41.721
Std. Dev.	0.043	0.027	1.791	2.746	3.417
Minimum	43.910	13.080	12.500	20.200	37.100
Maximum	44.120	13.180	19.600	30.200	49.000

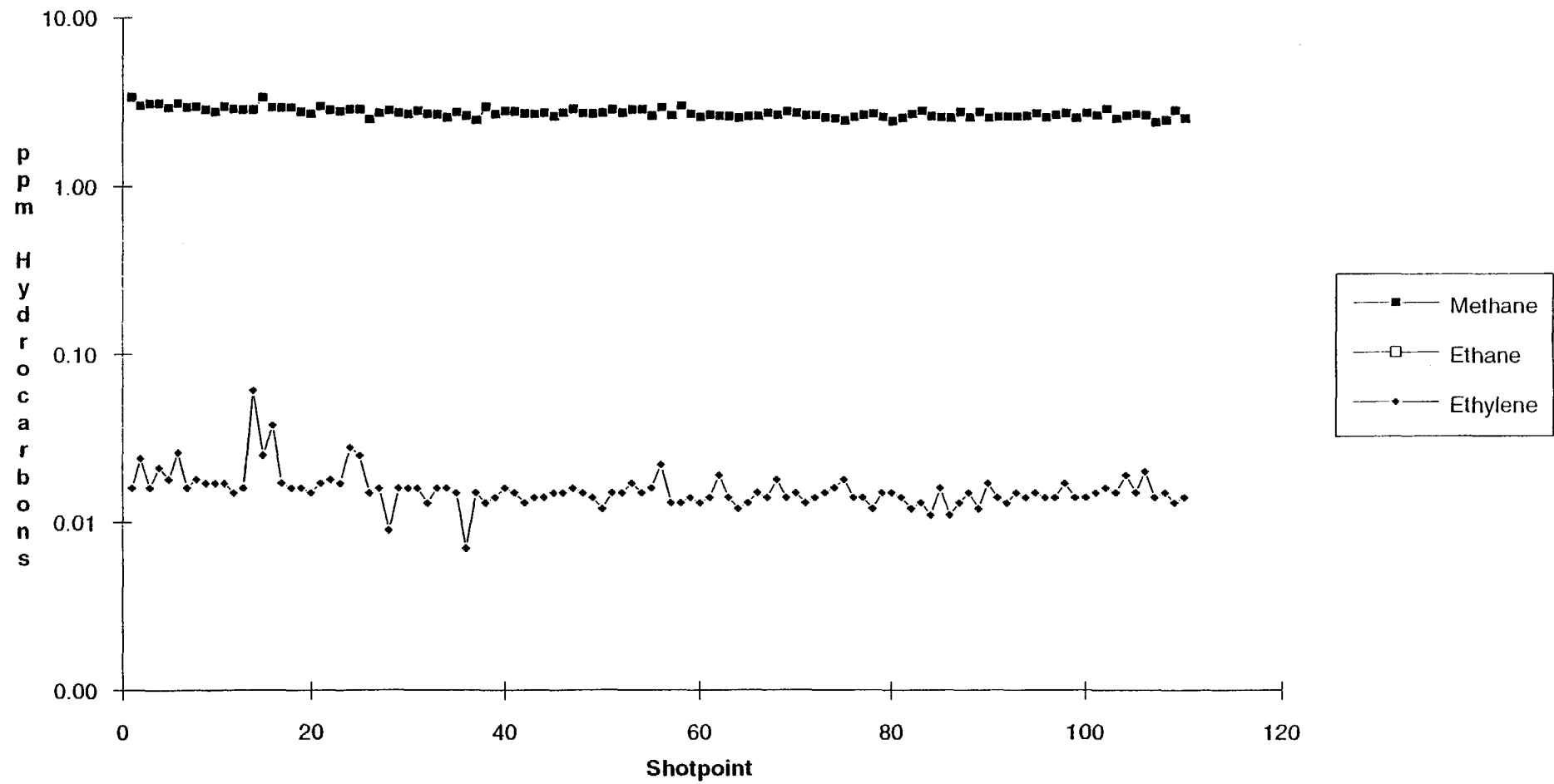
Notes

No hydrocarbon anomalies detected.

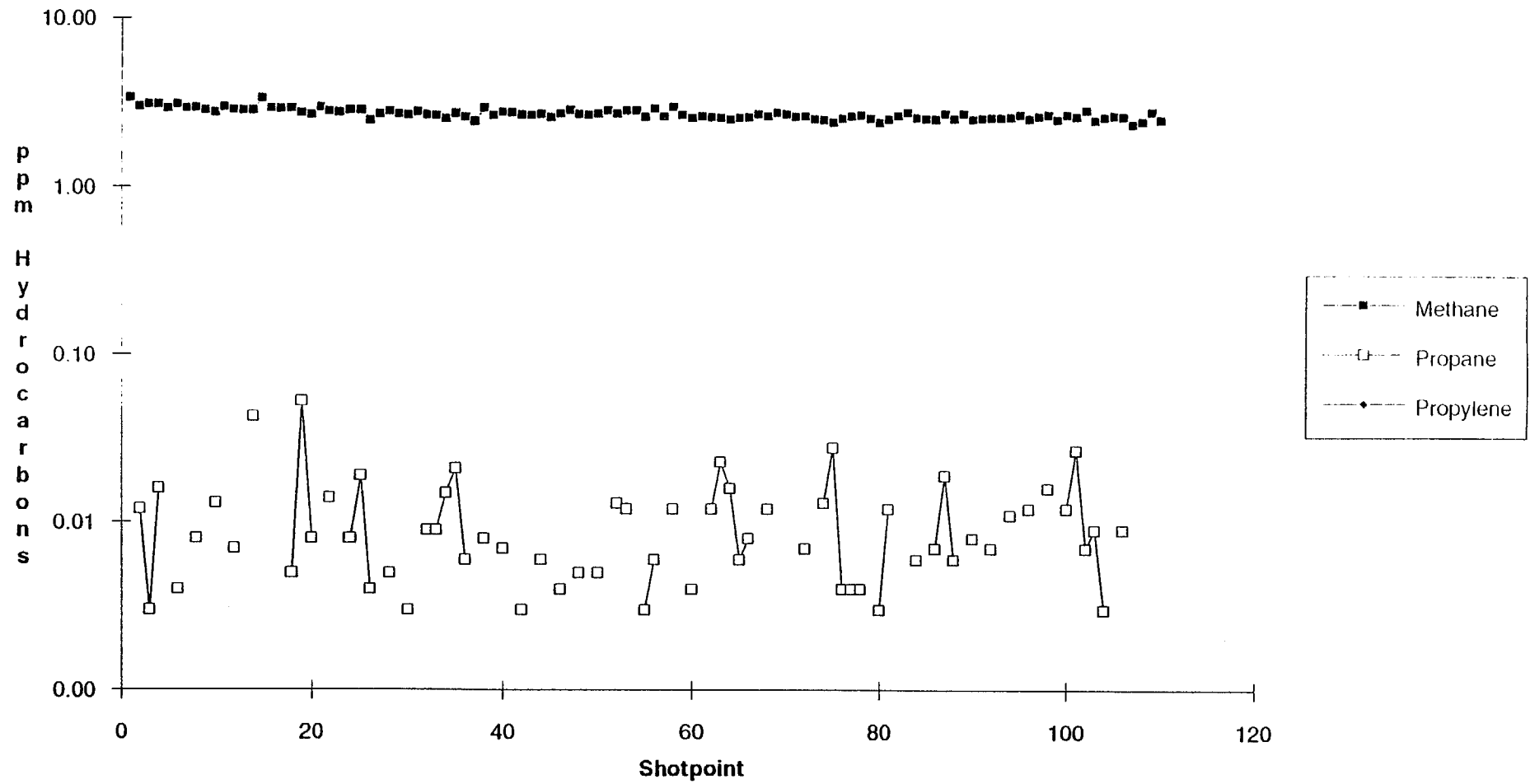
Line 104209 THC, Methane



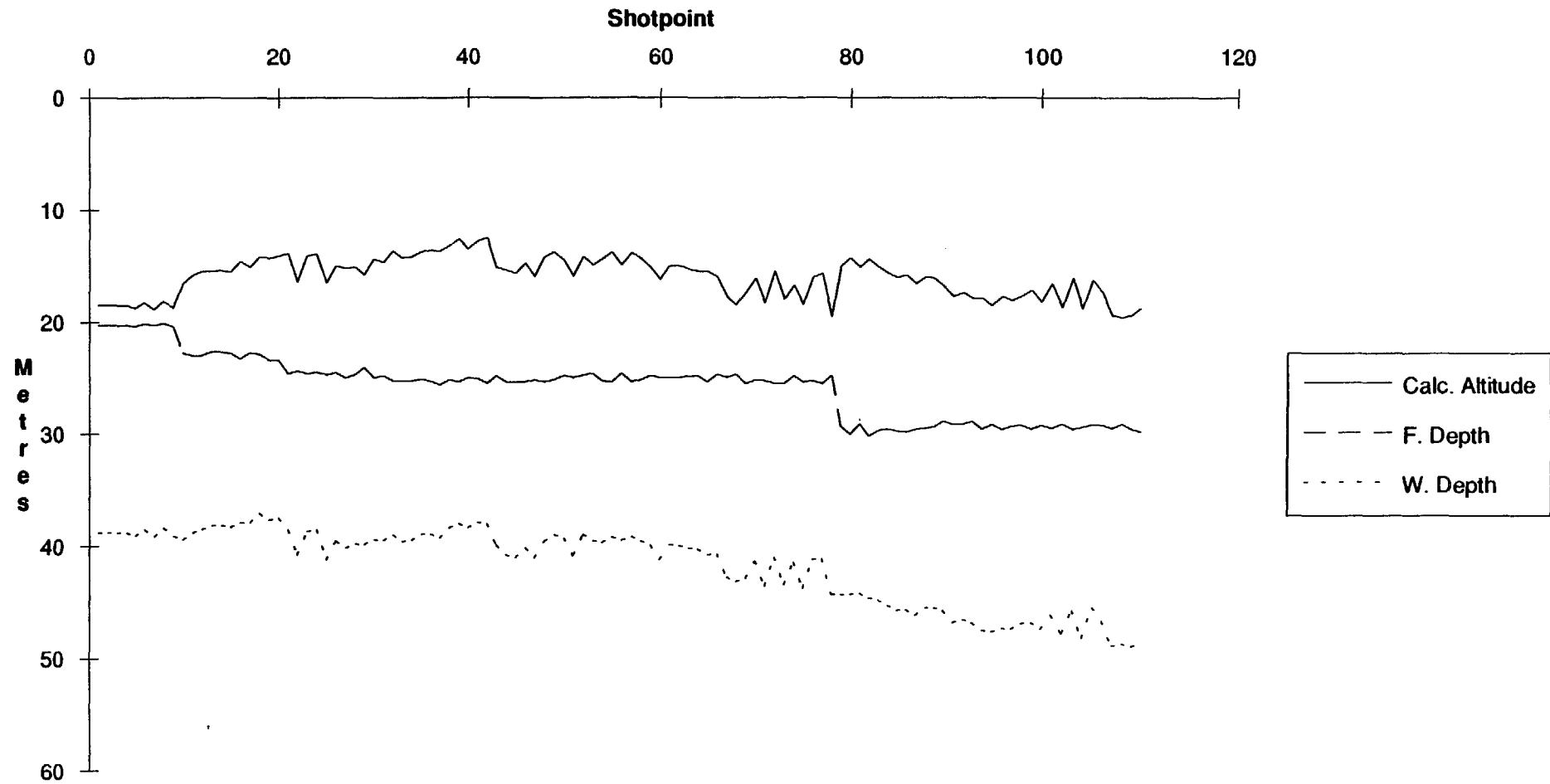
Line 104209 Methane, Ethane, Ethylene



Line 104209 Methane, Propane, Propylene



Line 104209 Depths, Altitude



Line Summary

Line Number 104210
No. of Shotpoints 114

	Shotpoint	Date	Time	Latitude	Longitude
Start	2	24/09/91	09:50:32	S 40	25.084 E 147 37.379
End	115	24/09/91	13:36:29	S 40	41.352 E 147 50.468

	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	7.142	2.909	0.000	0.017	0.005	0.000	0.000	0.000	0.012	0.047	0.000	0.000	0.177
Std. Dev.	0.505	0.266	0.000	0.013	0.013	0.000	0.003	0.000	0.014	0.024	0.001	0.000	0.431
Minimum	6.133	2.459	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Maximum	9.699	3.811	0.000	0.105	0.103	0.000	0.023	0.000	0.066	0.095	0.015	0.000	3.684

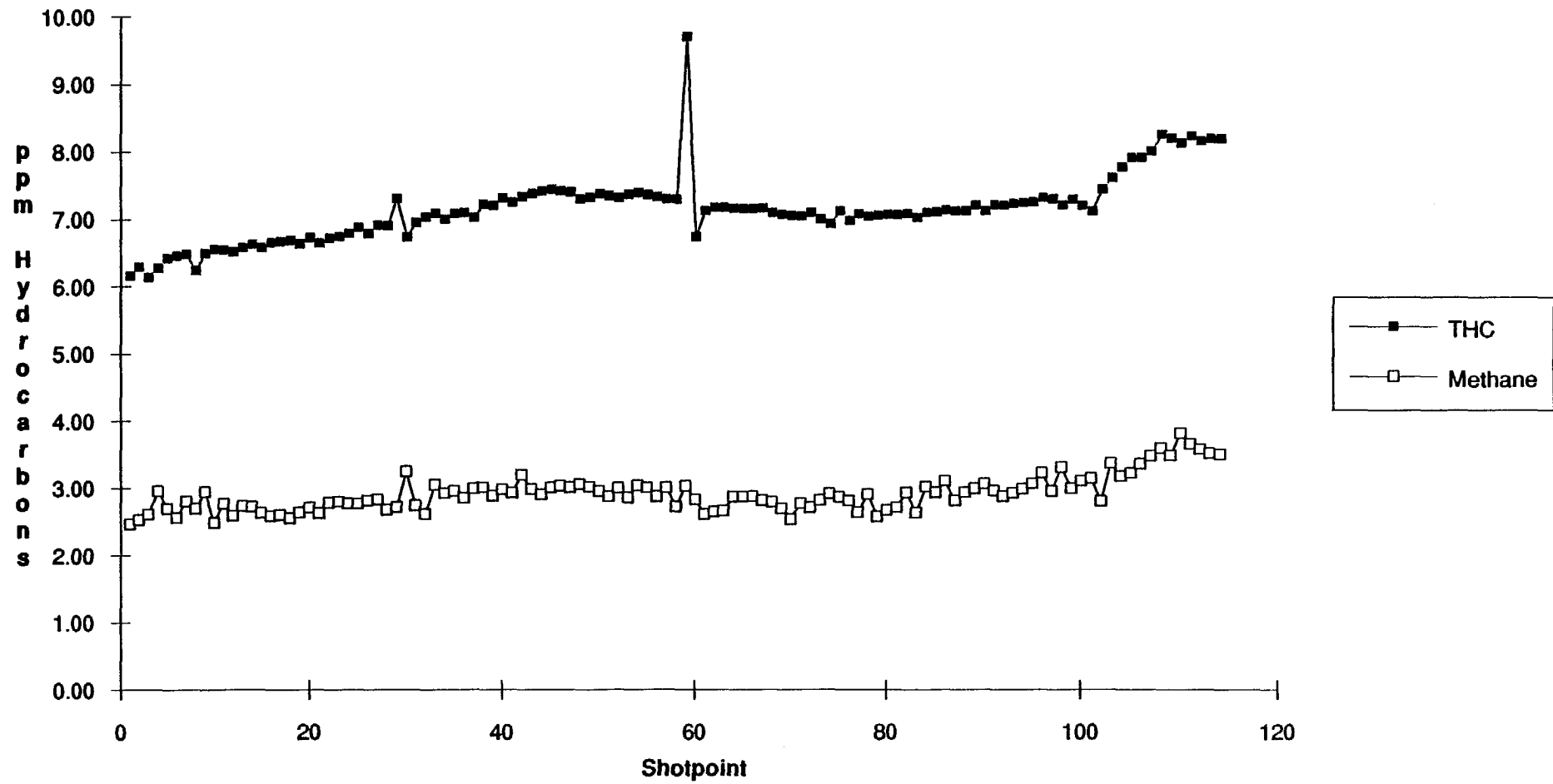
	Cond.	Temp.	Altitude	F. Depth	W.Depth
Mean	44.504	13.612	10.874	29.679	40.528
Std. Dev.	0.058	0.327	2.185	4.442	3.951
Minimum	44.400	13.310	8.420	12.410	30.300
Maximum	44.610	14.180	24.320	36.890	48.600

Notes

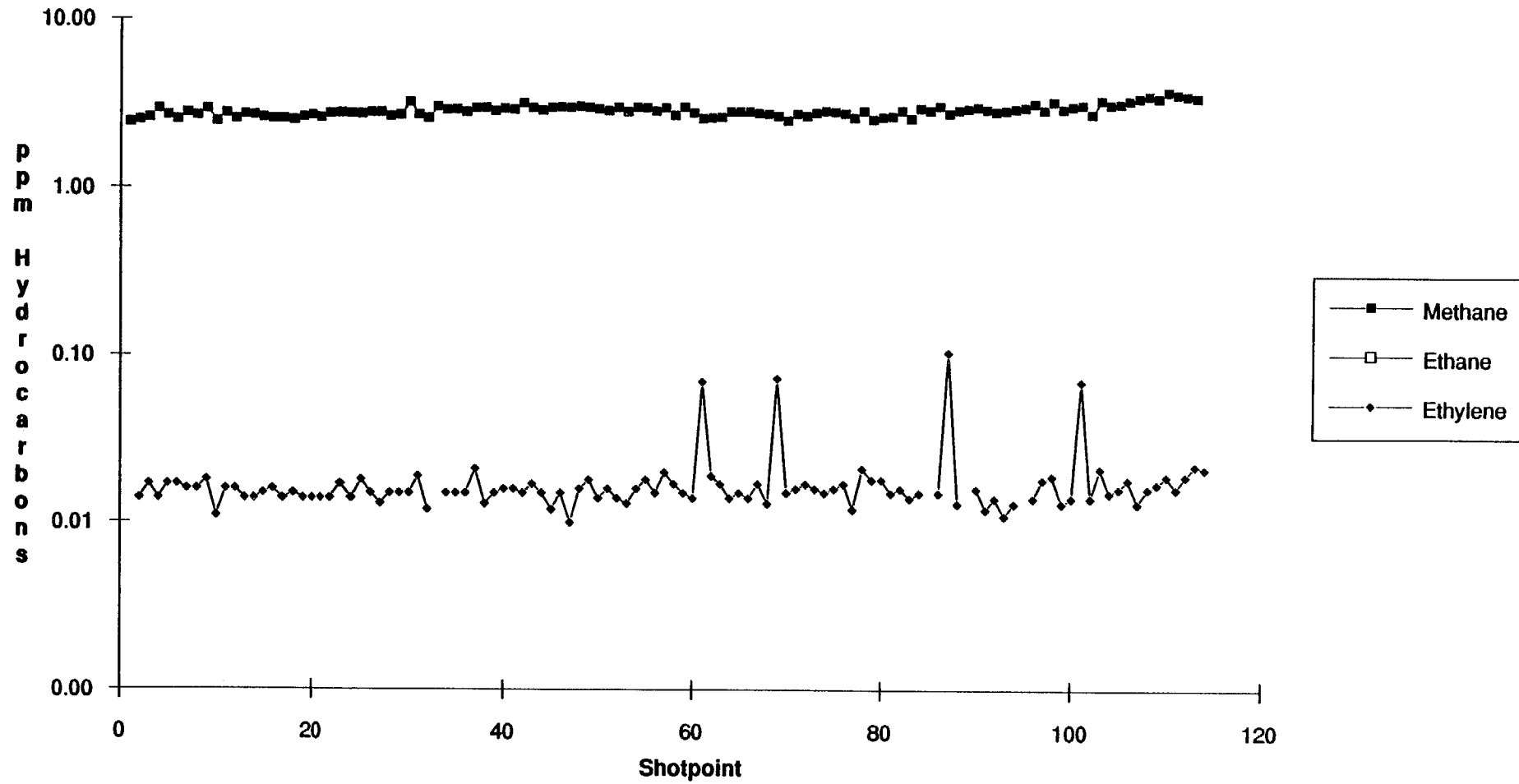
THC anomaly at shotpoint 60

Slight increase in THC, Methane, and Ethylene towards end of line.

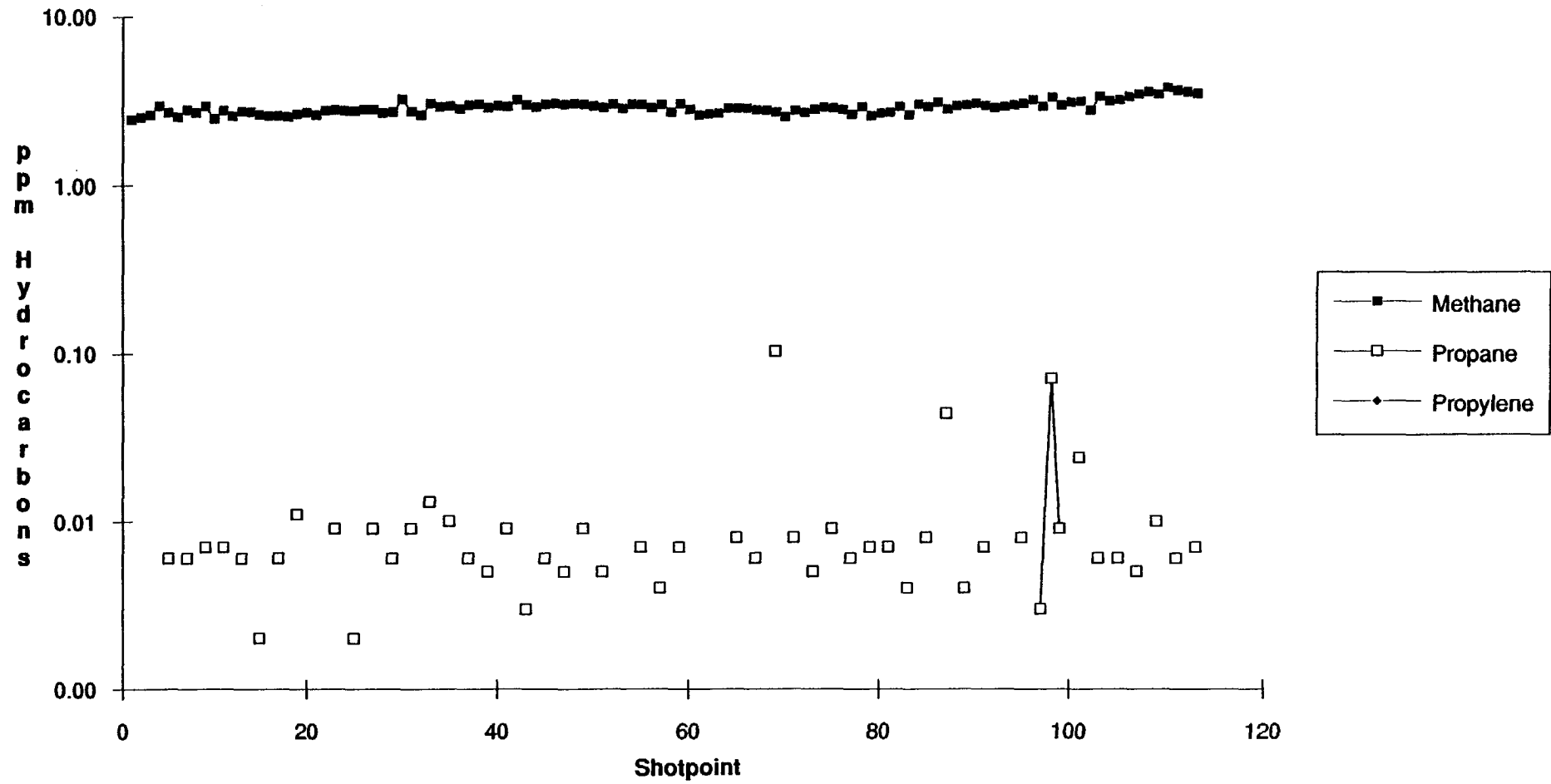
Line 104210 THC, Methane



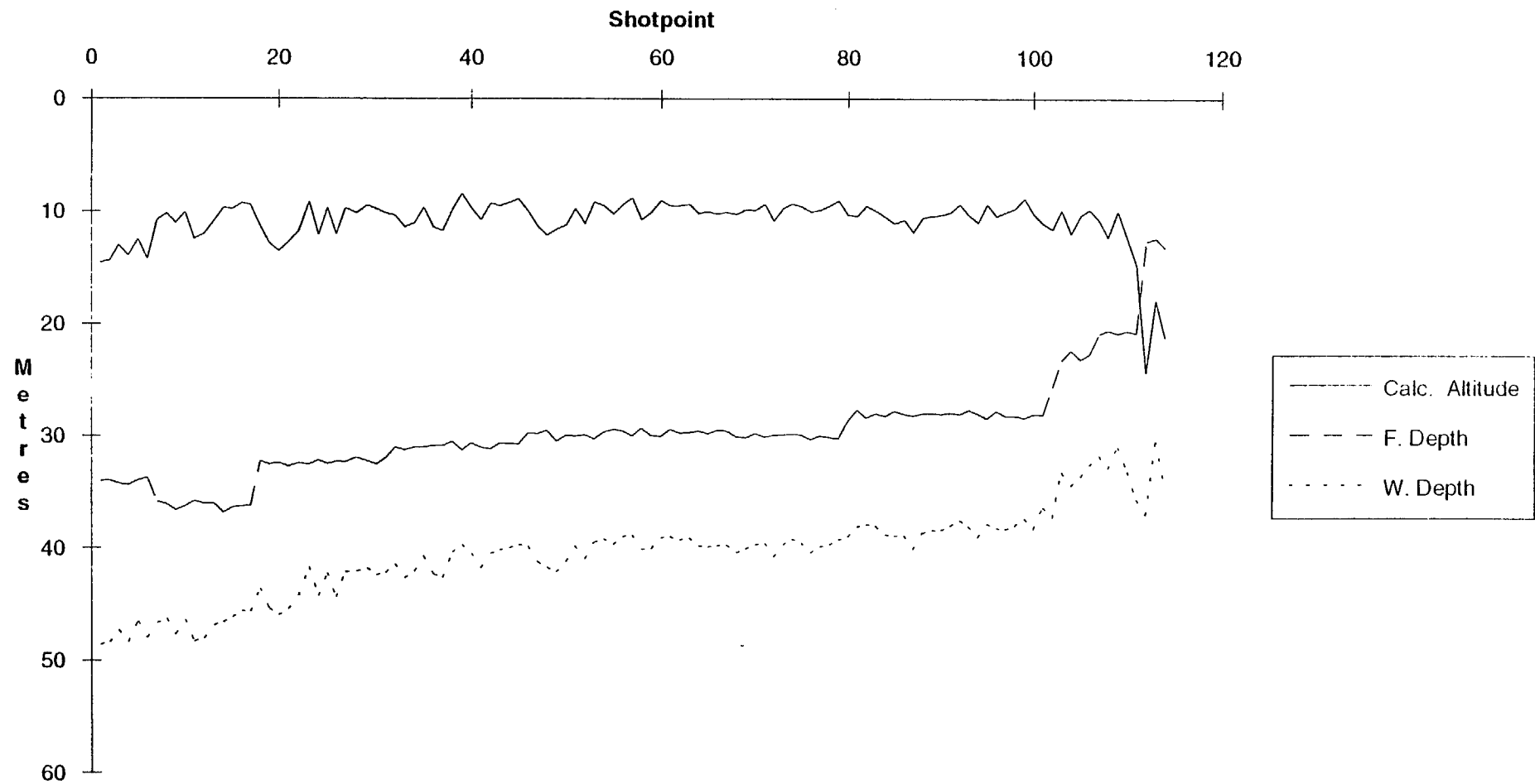
Line 104210 Methane, Ethane, Ethylene



Line 104210 Methane, Propane, Propylene



Line 104210 Depths, Altitude



Line Summary

Line Number 104211
No. of Shotpoints 36

	Shotpoint	Date	Time	Latitude	Longitude
Start	1	21/09/91	12:56:06	40 29.484	147 33.184
End	36	21/09/91	14:06:06	40 26.247	147 39.503

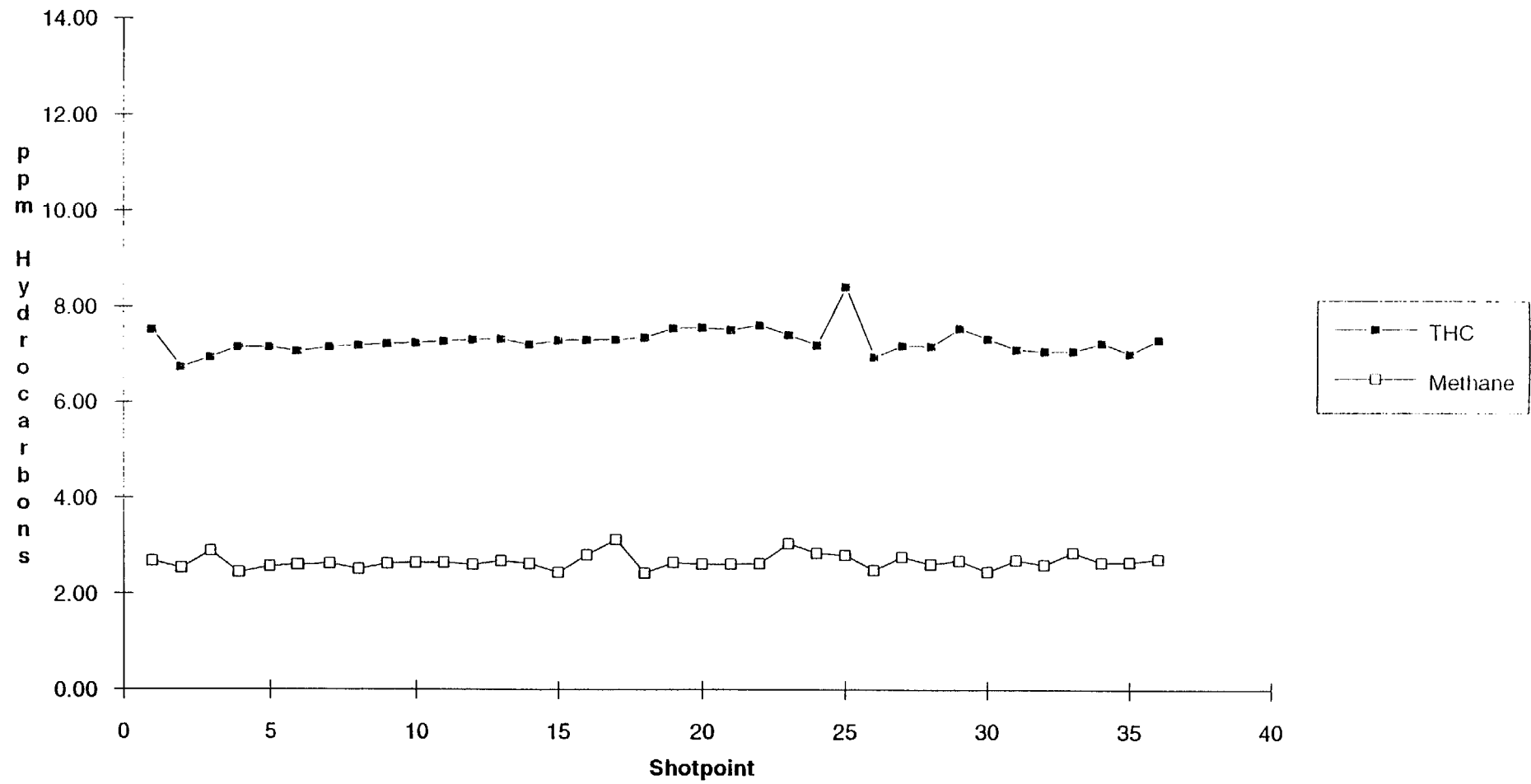
	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	7.283	2.672	0.000	0.017	0.003	0.001	0.000	0.000	0.015	0.063	0.000	0.000	0.115
Std. Dev.	0.272	0.154	0.000	0.003	0.004	0.004	0.000	0.000	0.009	0.028	0.000	0.000	0.170
Minimum	6.739	2.438	0.000	0.013	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Maximum	8.419	3.133	0.000	0.028	0.014	0.021	0.000	0.000	0.031	0.106	0.000	0.000	0.571

	Cond.	Temp.	Altitude	F. Depth	W.Depth
Mean	43.865	13.520	9.622	38.911	48.547
Std. Dev.	0.032	0.031	0.429	1.592	1.806
Minimum	43.800	13.440	8.700	36.100	43.600
Maximum	43.920	13.570	11.200	41.200	51.500

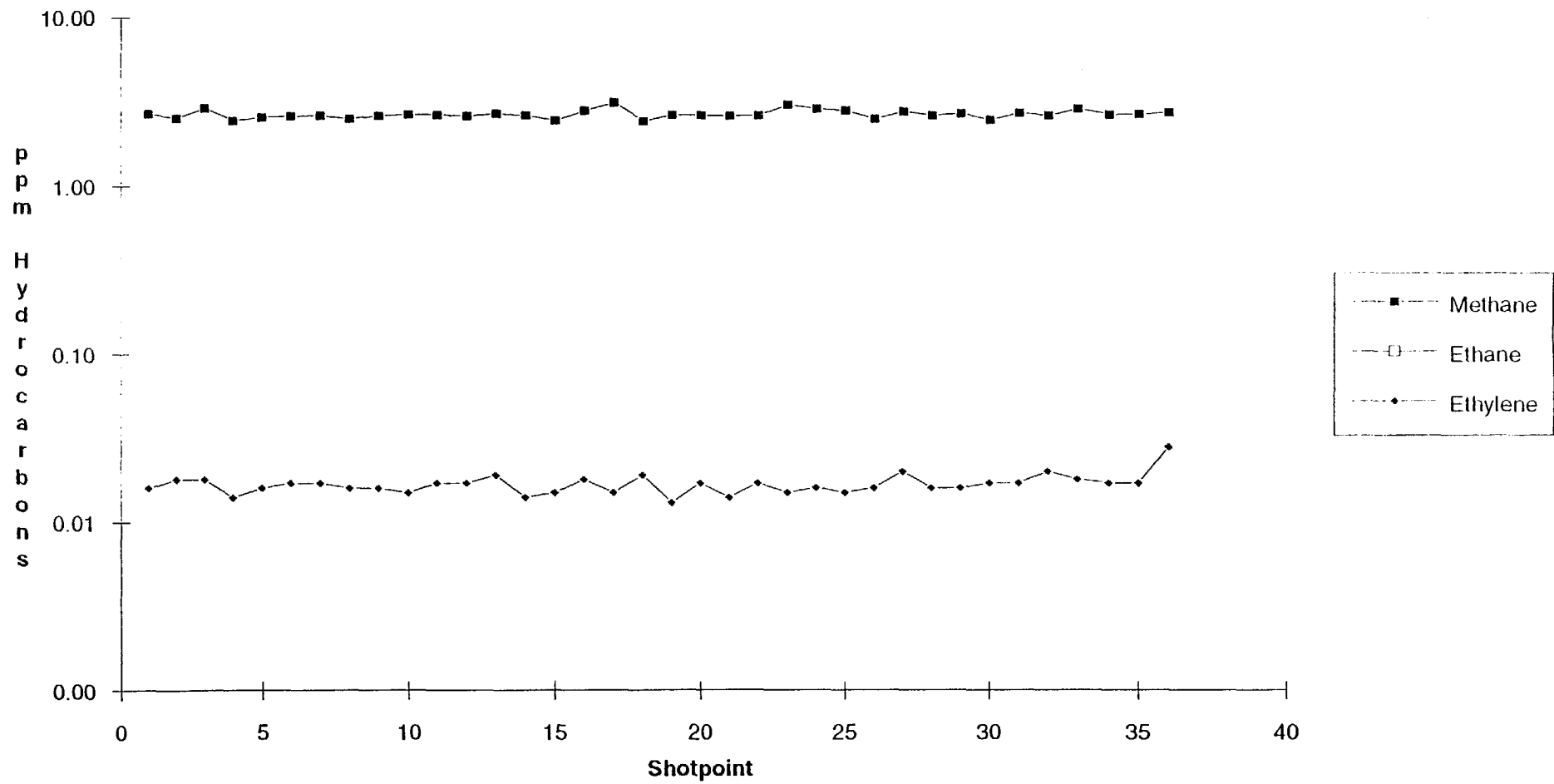
Notes

No hydrocarbon anomalies detected.

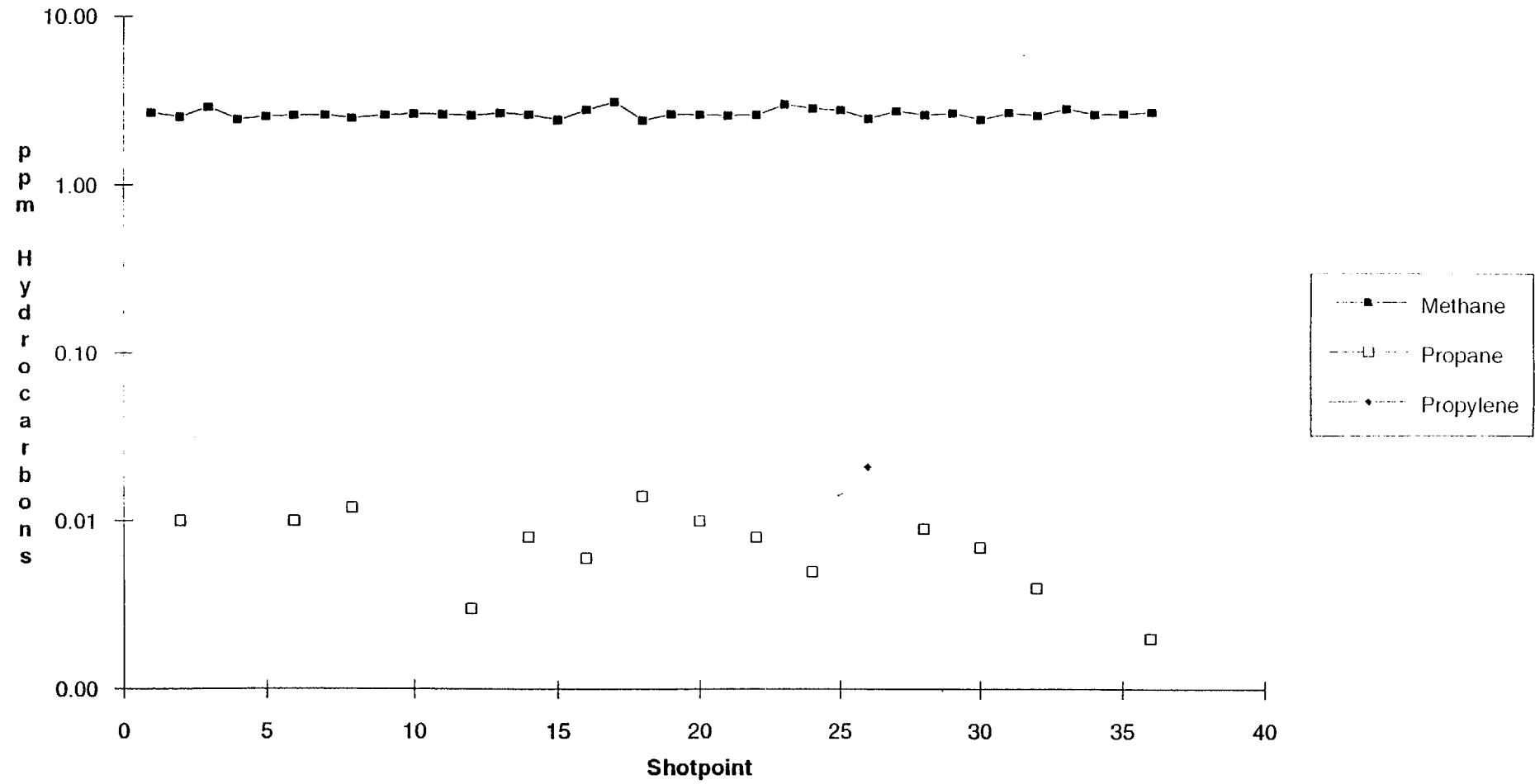
Line 104211 THC, Methane



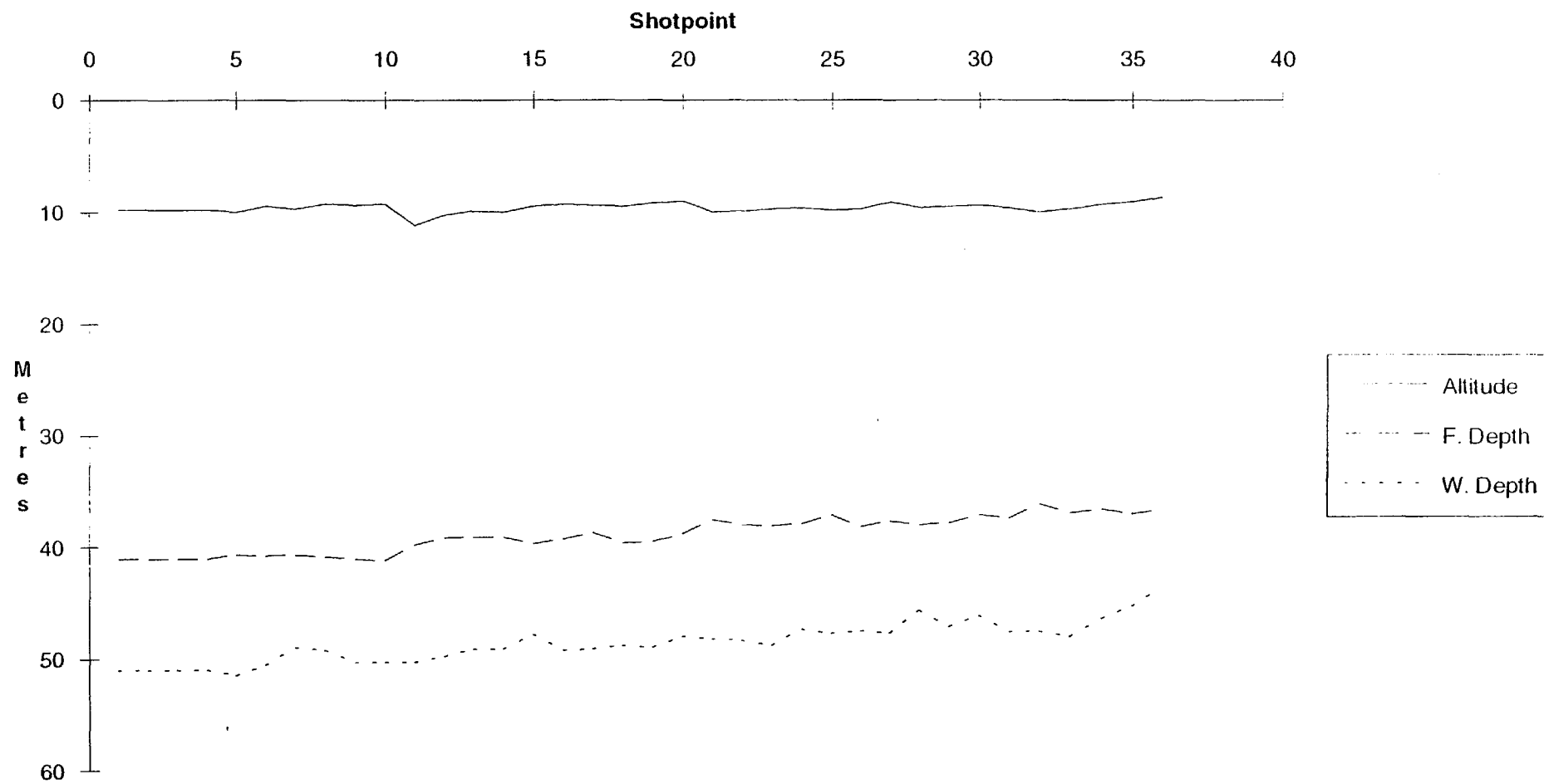
Line 104211 Methane, Ethane, Ethylene



Line 104211 Methane, Propane, Propylene



Line 104211 Depths, Altitude



Line Summary

Line Number 104212
No. of Shotpoints 75

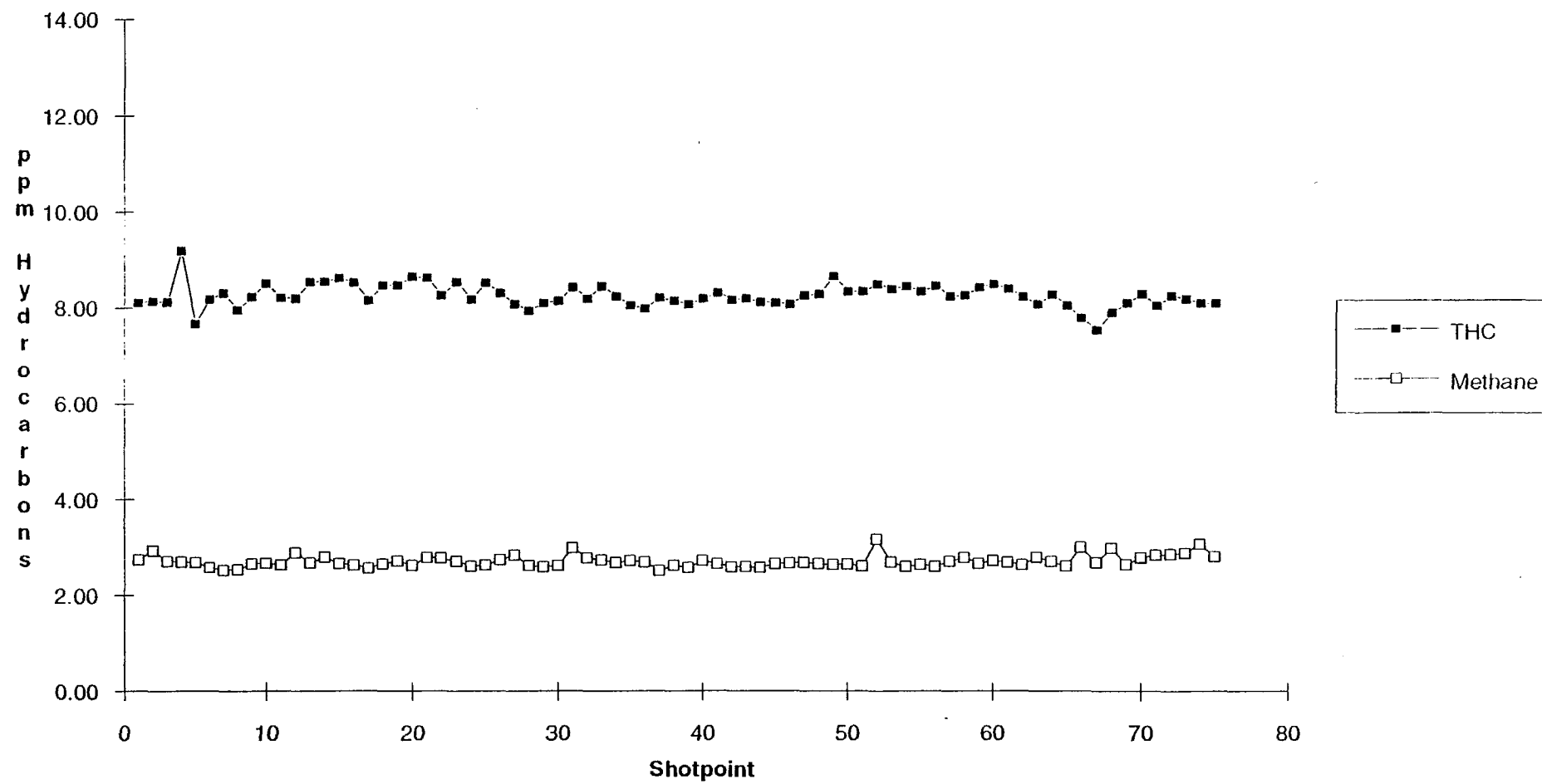
	Shotpoint	Date	Time	Latitude	Longitude
Start	1	21/09/91	03:43:41	40 34.402	147 28.278
End	76	21/09/91	06:15:46	40 27.314	147 41.938

	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	8.255	2.706	0.000	0.017	0.008	0.001	0.001	0.001	0.026	0.060	0.014	0.000	0.682
Std. Dev.	0.243	0.124	0.000	0.008	0.012	0.008	0.007	0.005	0.011	0.027	0.061	0.001	0.466
Minimum	7.530	2.517	0.000	0.010	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.350
Maximum	9.188	3.161	0.000	0.065	0.060	0.062	0.049	0.047	0.048	0.120	0.324	0.007	3.383

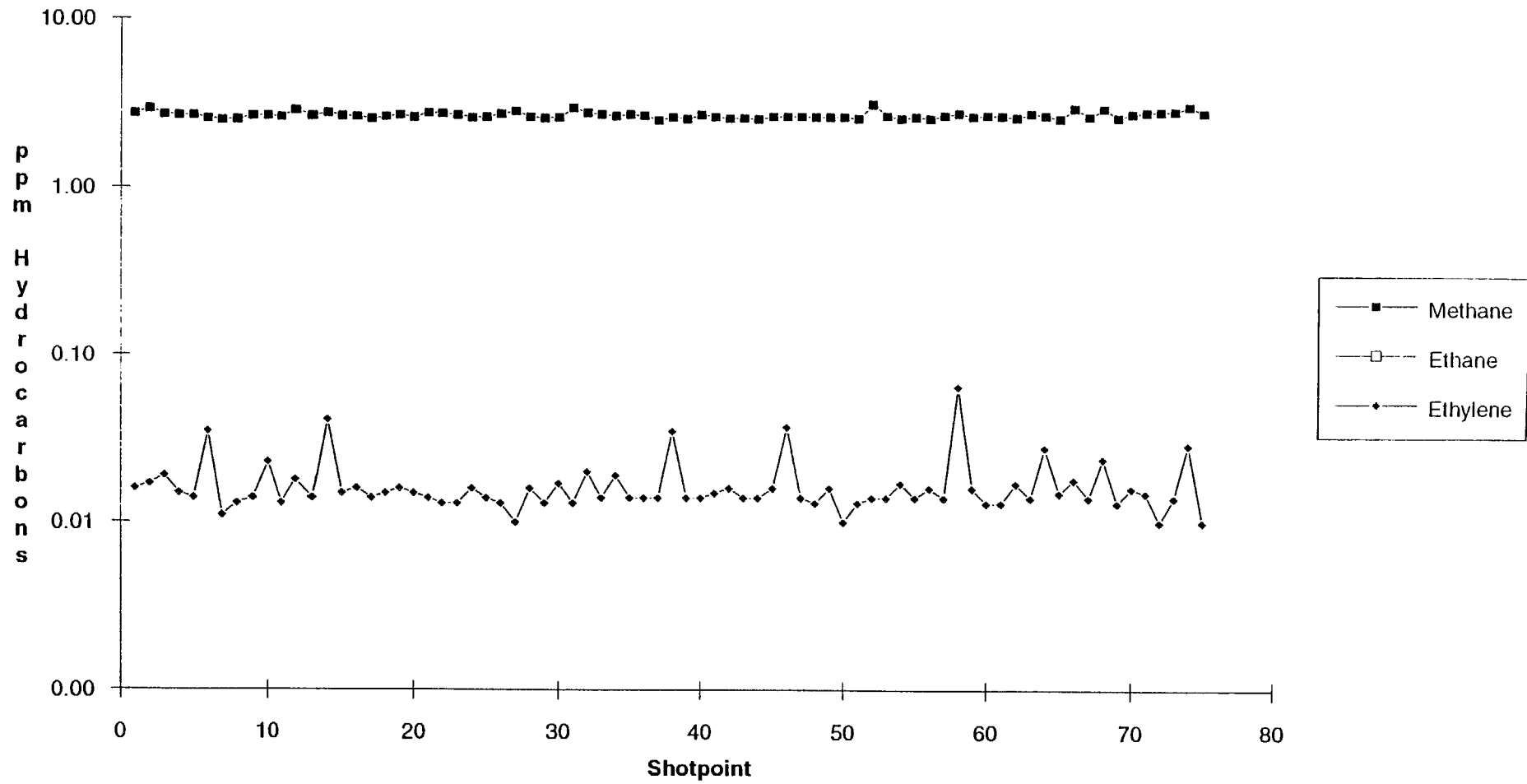
	Cond.	Temp.	Altitude	F. Depth	W.Depth
Mean	44.687	13.727	10.997	36.759	47.103
Std. Dev.	0.231	0.264	1.180	2.608	2.968
Minimum	44.310	13.200	6.400	32.100	40.800
Maximum	45.160	14.060	13.400	40.600	52.300

Notes
No hydrocarbon anomalies detected.

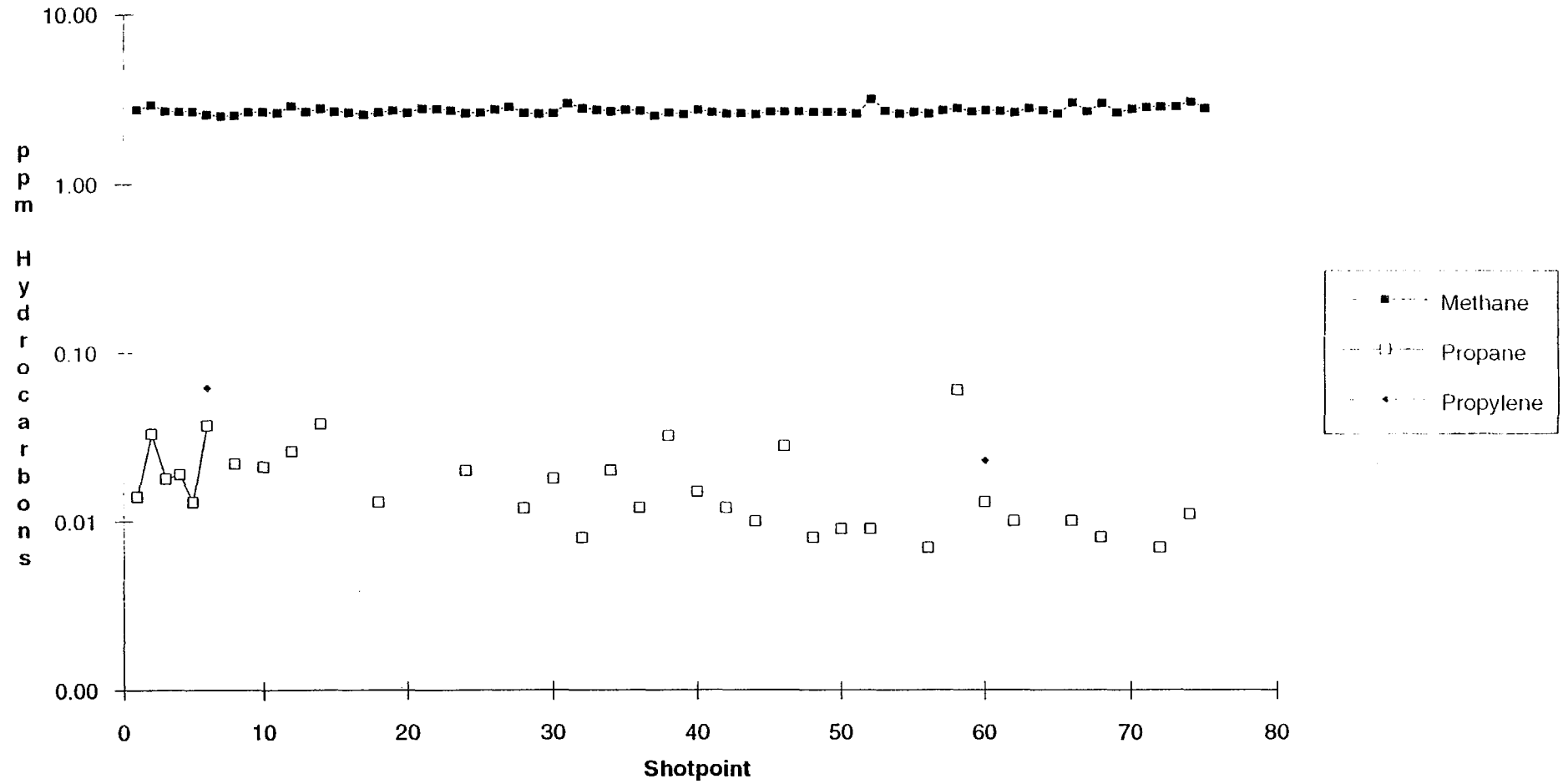
Line 104212 THC, Methane



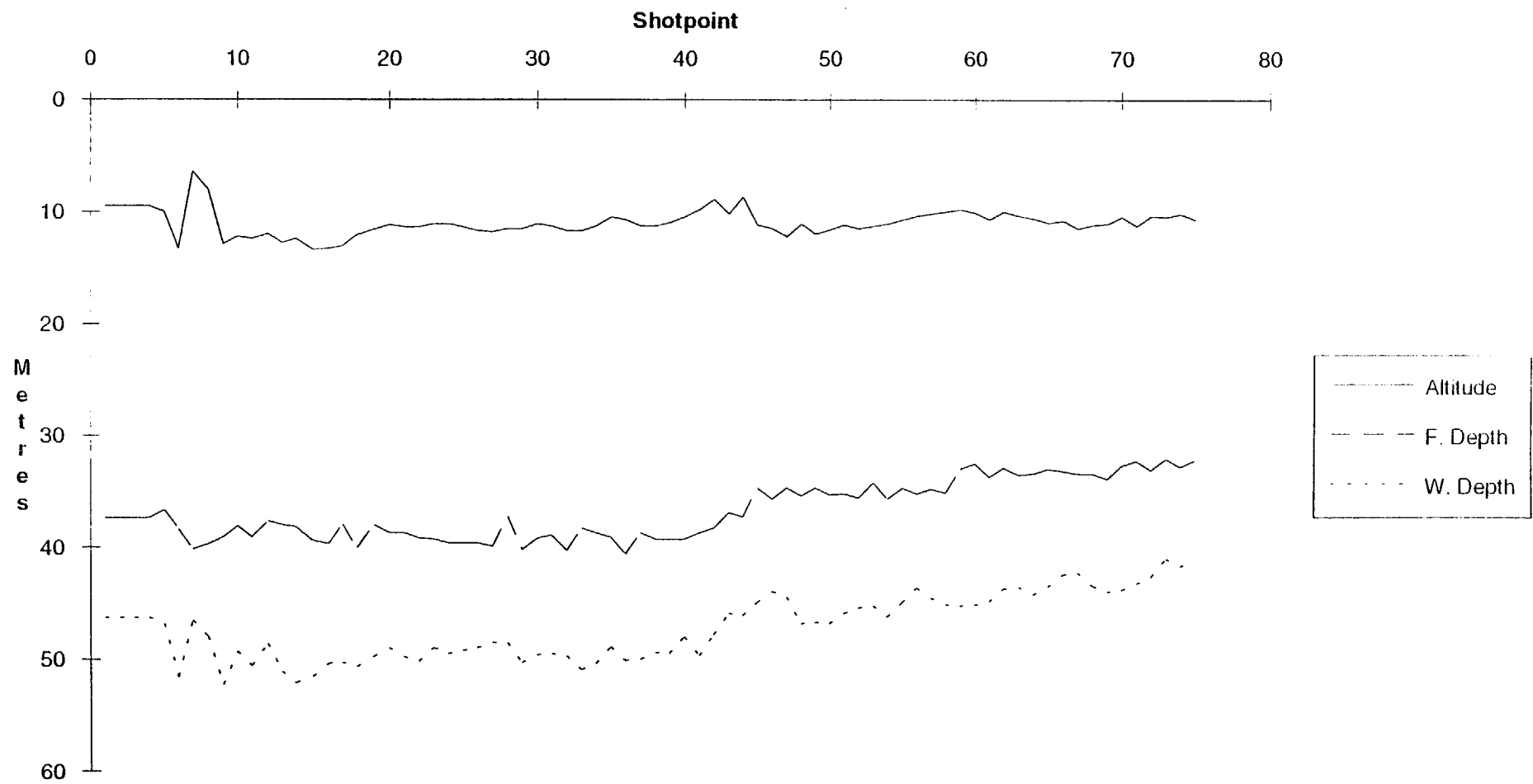
Line 104212 Methane, Ethane, Ethylene



Line 104212 Methane, Propane, Propylene



Line 104212 Depths, Altitude



Line Summary

Line Number 104213B
No. of Shotpoints 60

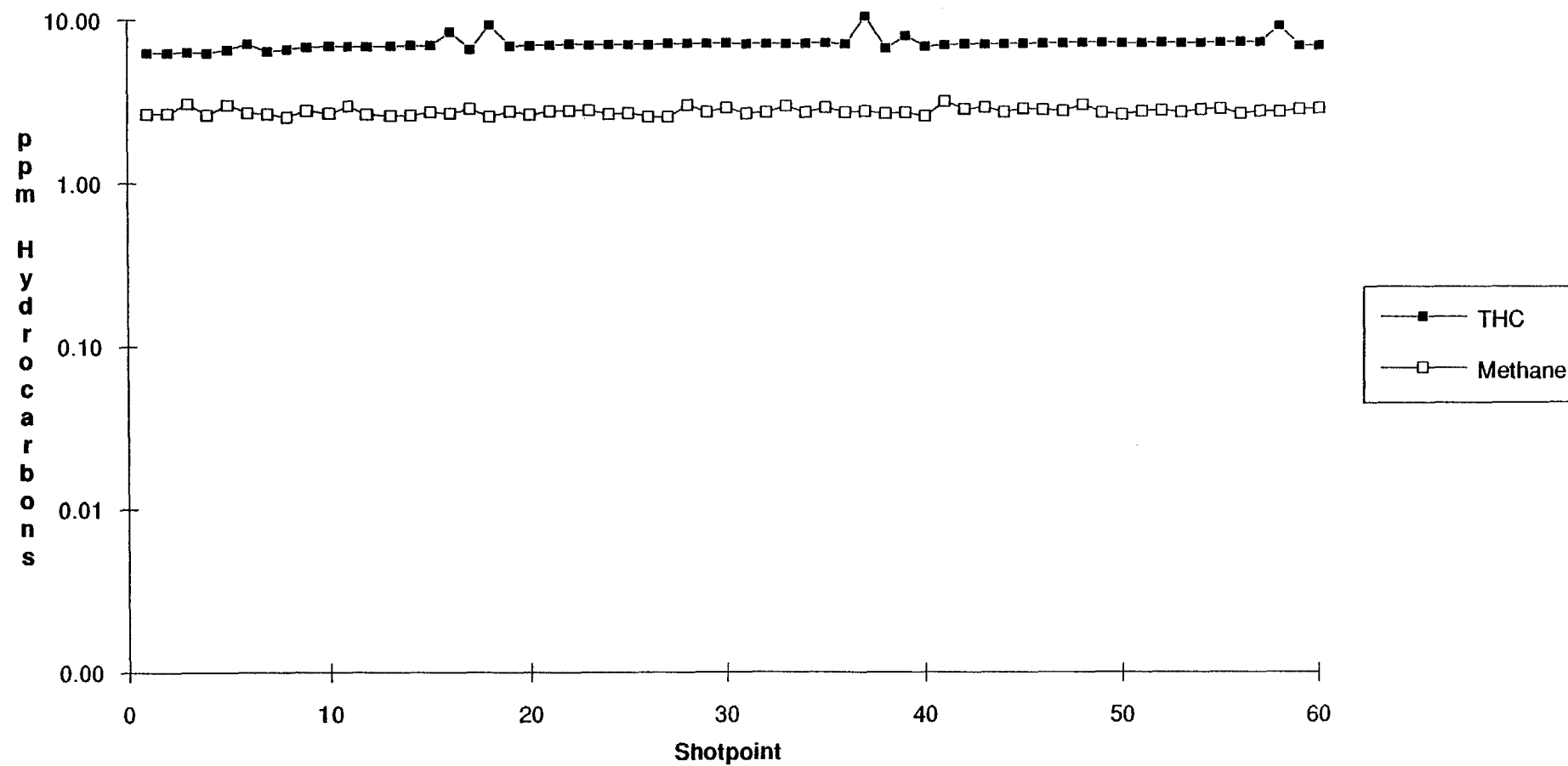
	Shotpoint	Date	Time	Latitude	Longitude	
Start	2	22/09/91	04:45:59	40	34.418 147	30.463
End	62	22/09/91	06:48:45	40	28.668 147	41.301

	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	7.140	2.742	0.000	0.025	0.005	0.000	0.000	0.000	0.014	0.063	0.000	0.000	0.187
Std. Dev.	0.684	0.134	0.000	0.020	0.015	0.000	0.000	0.000	0.010	0.025	0.000	0.000	0.506
Minimum	6.266	2.524	0.000	0.014	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Maximum	10.419	3.143	0.000	0.164	0.099	0.000	0.000	0.000	0.028	0.107	0.000	0.002	3.362

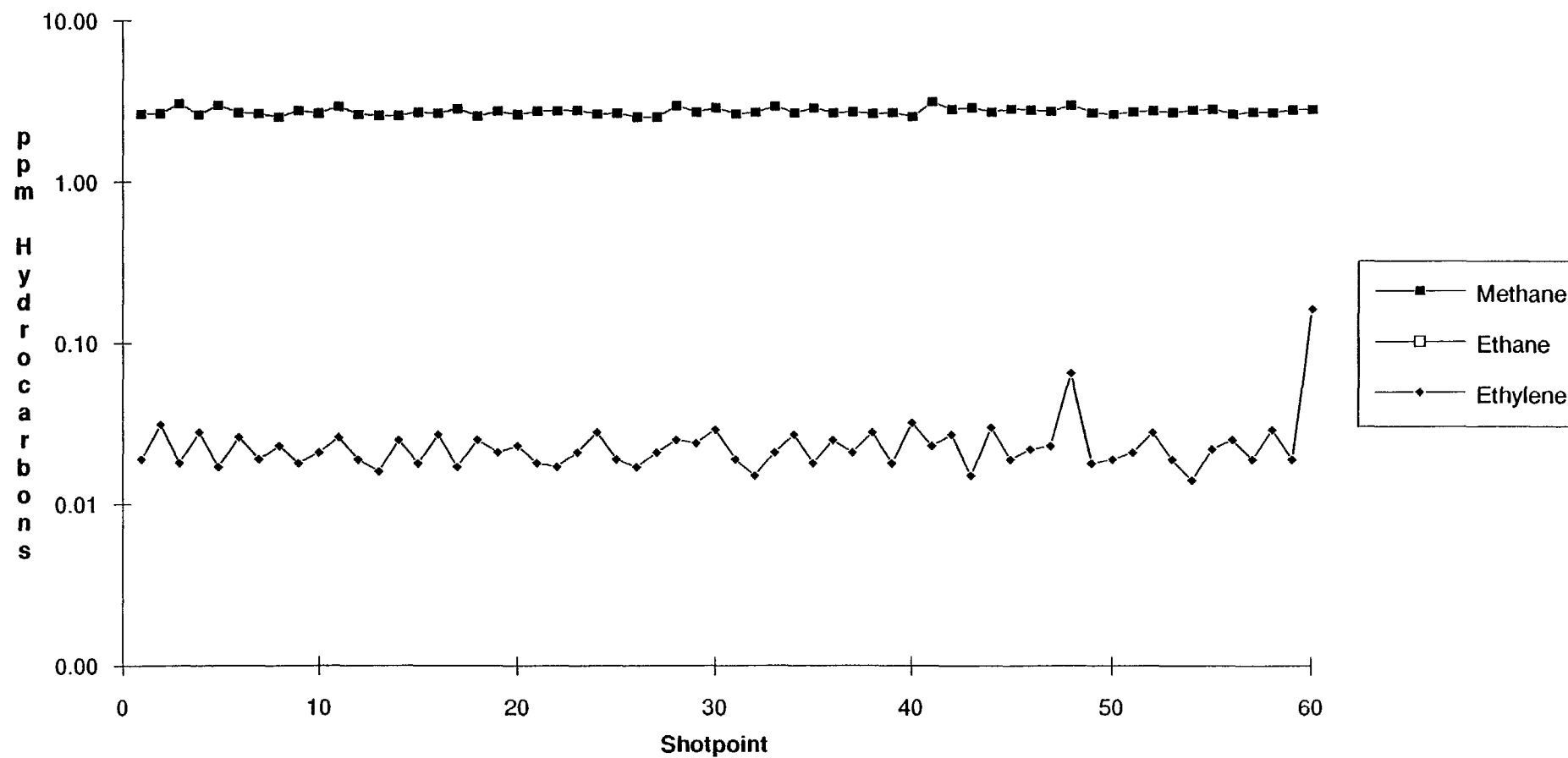
	Cond.	Temp.	Altitude	F. Depth	W.Depth
Mean	45.311	15.238	10.413	36.291	46.435
Std. Dev.	0.333	1.164	0.747	3.181	2.687
Minimum	44.880	13.310	8.900	30.400	41.000
Maximum	45.820	16.460	14.300	40.600	51.100

Notes
No hydrocarbon anomalies detected.

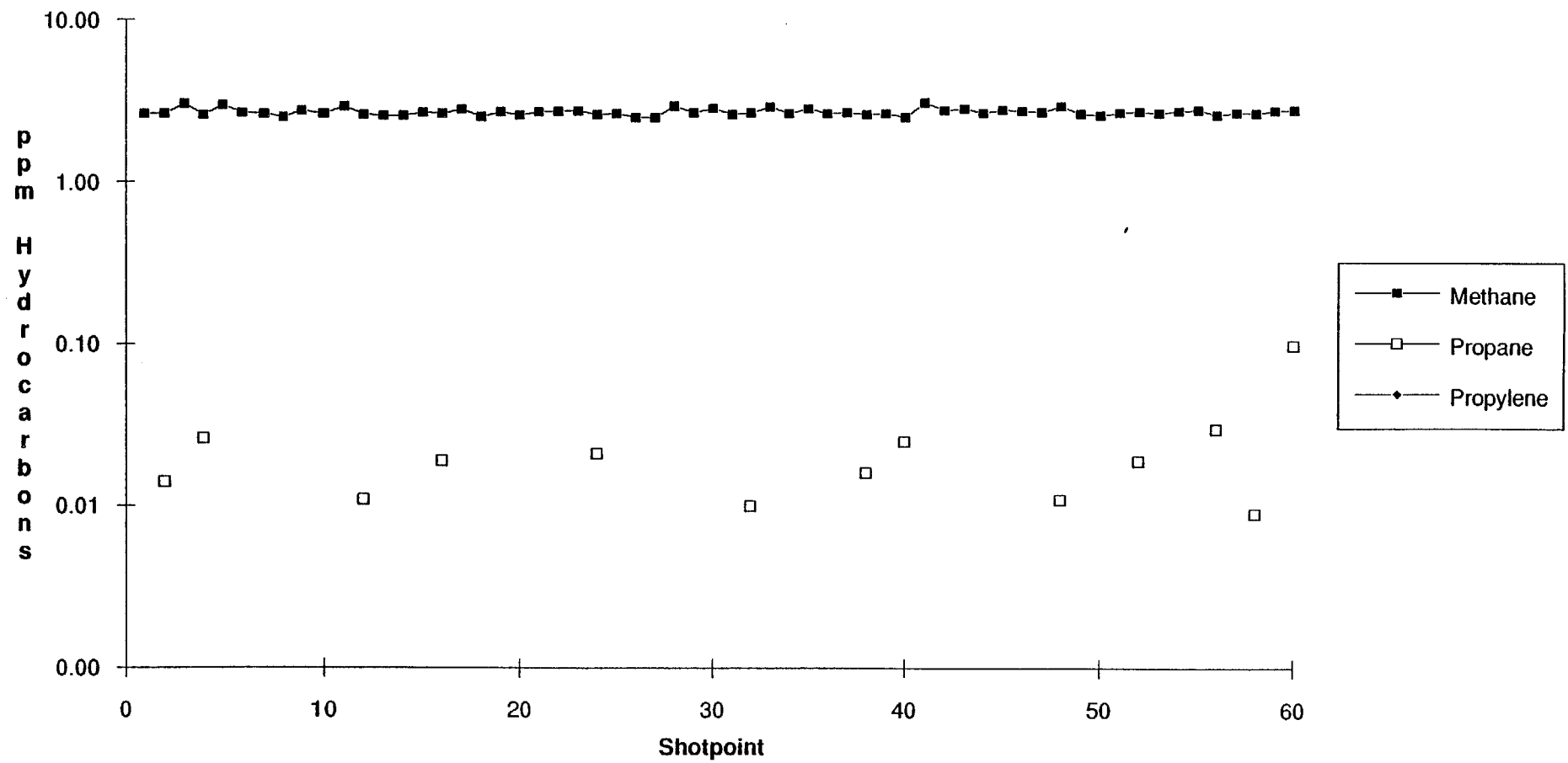
Line 104213B THC, Methane



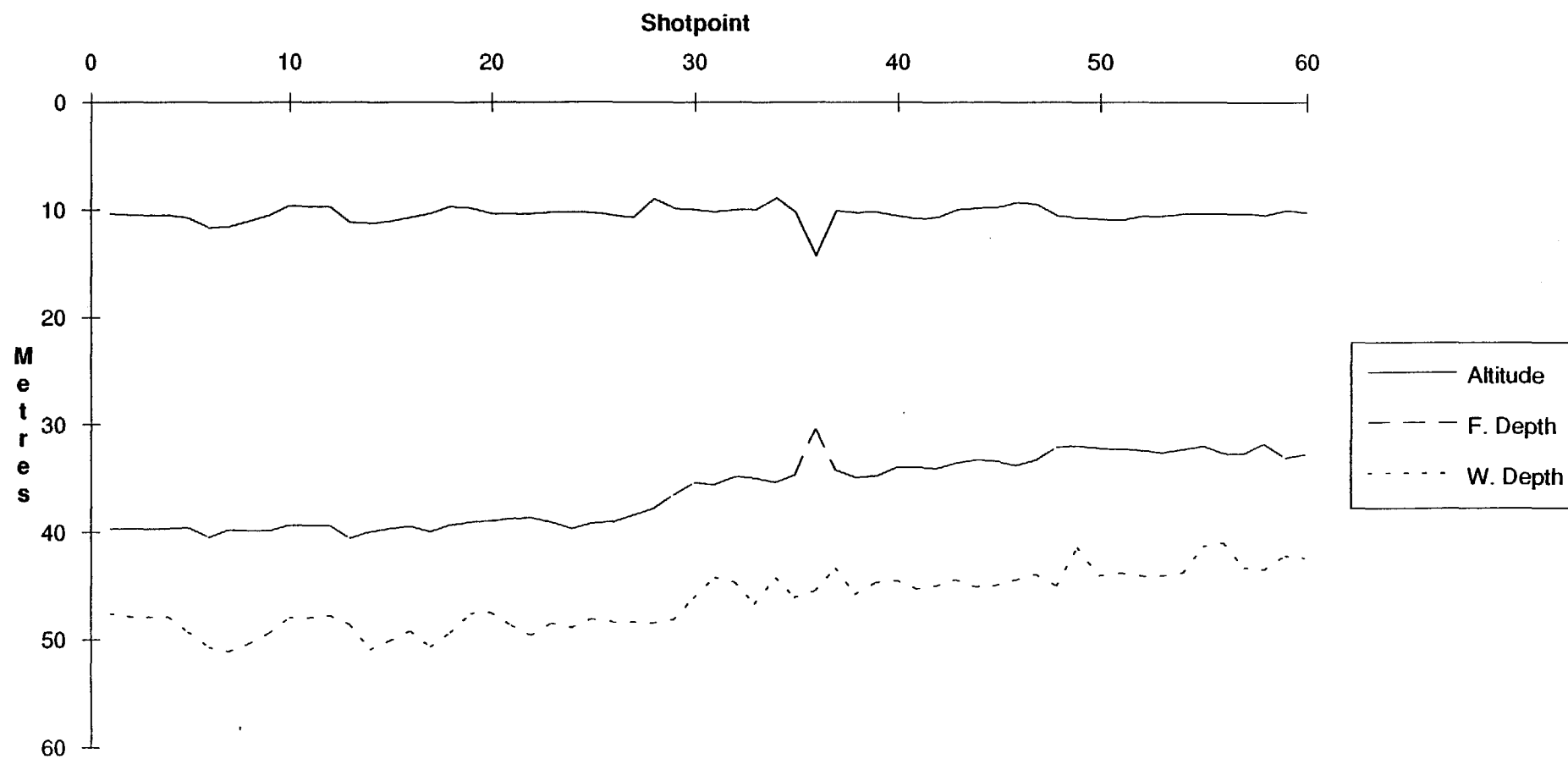
Line 104213B Methane, Ethane, Ethylene



Line 104213B Methane, Propane, Propylene



Line 104213B Depths, Altitude



Line Summary

Line Number 104214
No. of Shotpoints 38

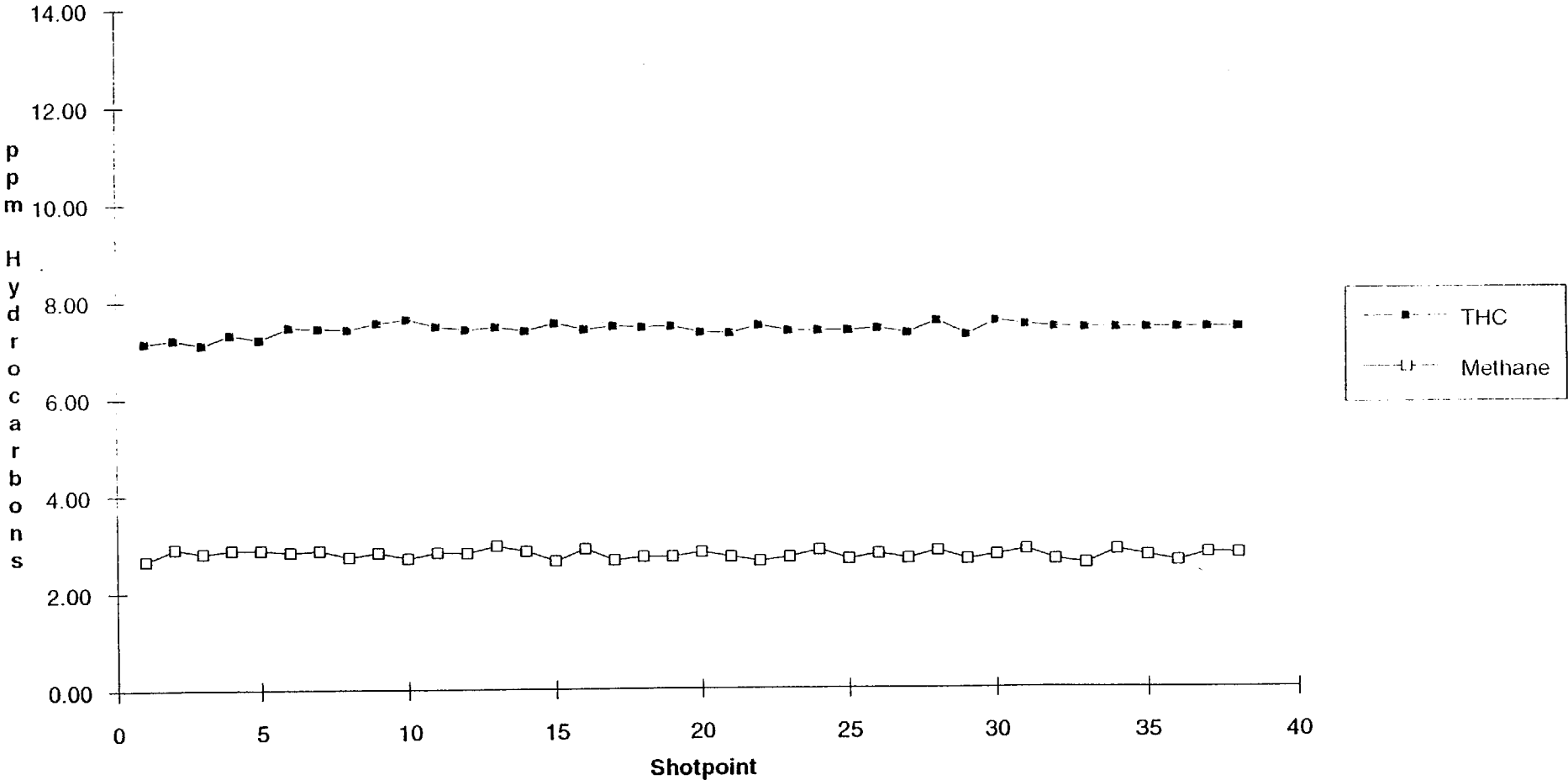
	Shotpoint	Date	Time	Latitude	Longitude		
Start	1	21/09/91	08:28:21	40	30.222	147	42.040
End	38	21/09/91	09:42:20	40	33.727	147	35.555

	THC	Methane	Ethane	Ethylene	Propane	Propylene	I-Butane	n-Butane	I-Pentane	n-Pentane	I-Hexane	n-Hexane	%Wetness
Mean	7.394	2.757	0.000	0.019	0.006	0.000	0.000	0.000	0.017	0.071	0.000	0.000	0.217
Std. Dev.	0.108	0.096	0.000	0.023	0.015	0.000	0.000	0.000	0.012	0.033	0.000	0.000	0.510
Minimum	7.102	2.560	0.000	0.013	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Maximum	7.624	2.953	0.000	0.154	0.089	0.000	0.000	0.000	0.033	0.108	0.000	0.000	2.973

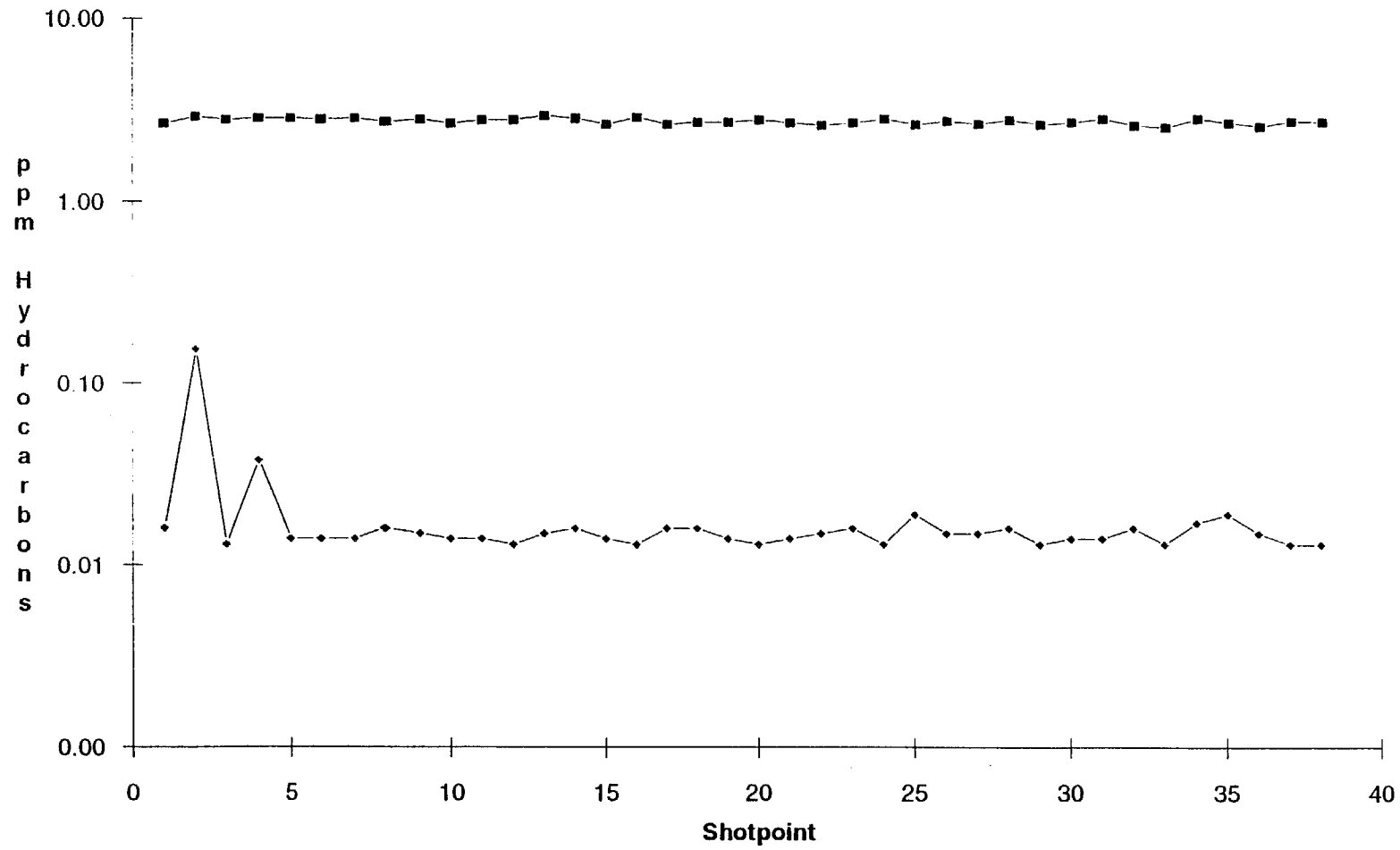
	Cond.	Temp.	Altitude	F. Depth	W.Depth
Mean	43.665	12.971	11.161	34.666	45.266
Std. Dev.	0.028	0.060	0.959	3.143	3.260
Minimum	43.620	12.840	9.800	30.400	40.400
Maximum	43.730	13.140	13.300	39.100	50.400

Notes
No hydrocarbon anomalies detected.

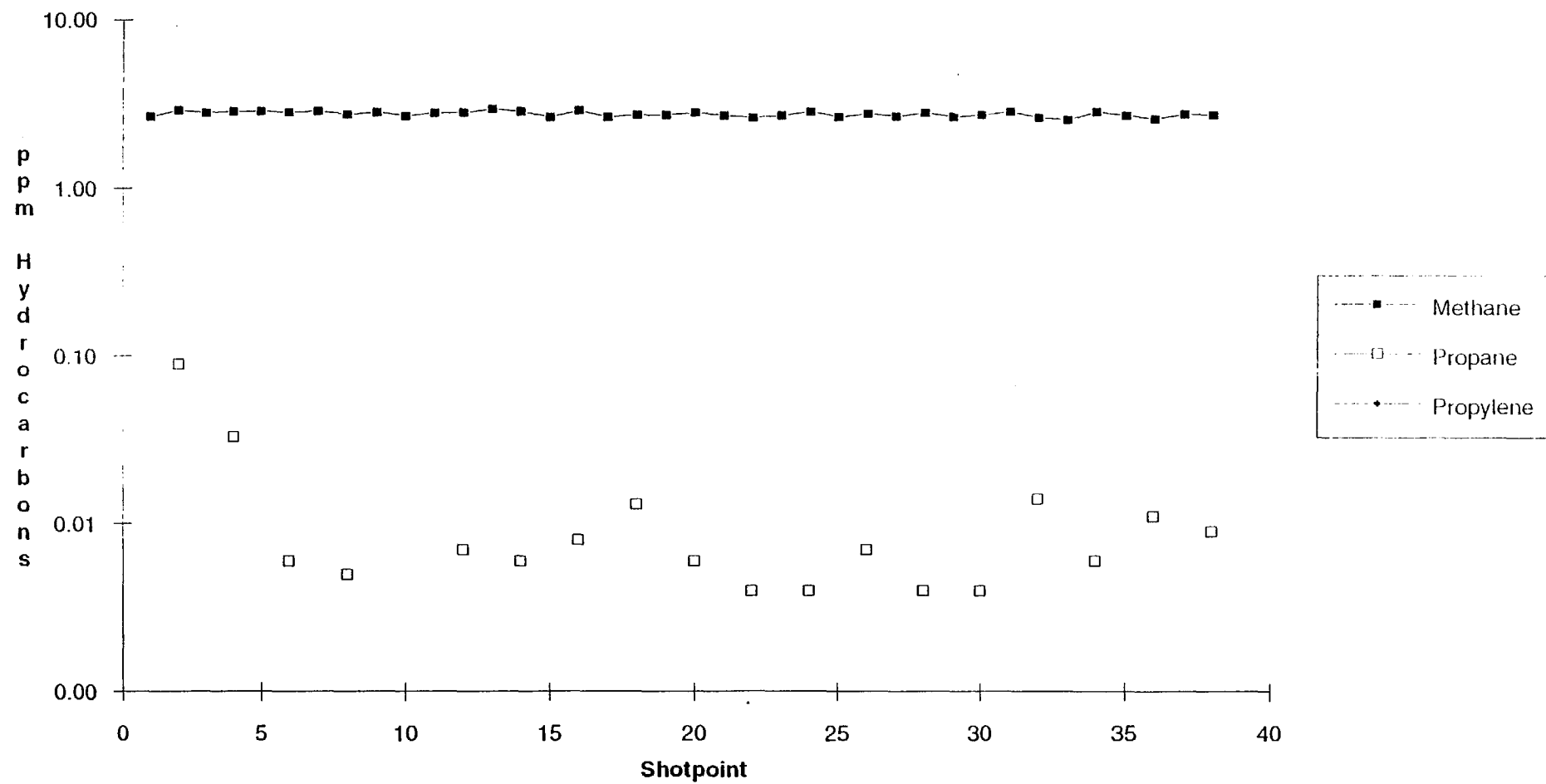
Line 104214 THC, Methane



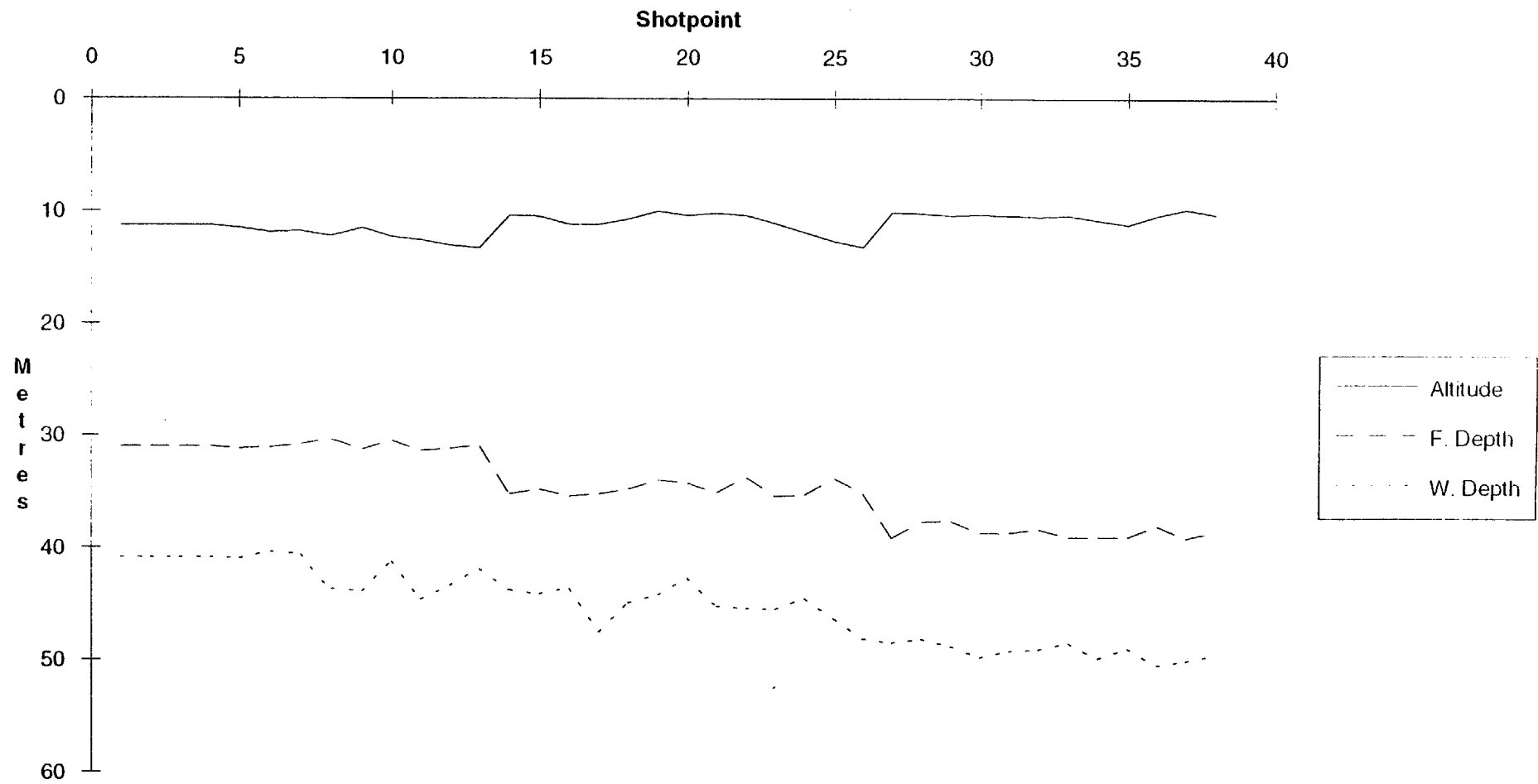
Line 104214 Methane, Ethane, Ethylene



Line 104214 Methane, Propane, Propylene



Line 104214 Depths, Altitude



Line Summary

Line Number 104216
No. of Shotpoints 63

	Shotpoint	Date	Time	Latitude	Longitude	
Start	1	22/09/91	11:45:56	40	35.445	147 37.852
End	63	22/09/91	13:50:08	40	29.508	147 48.845

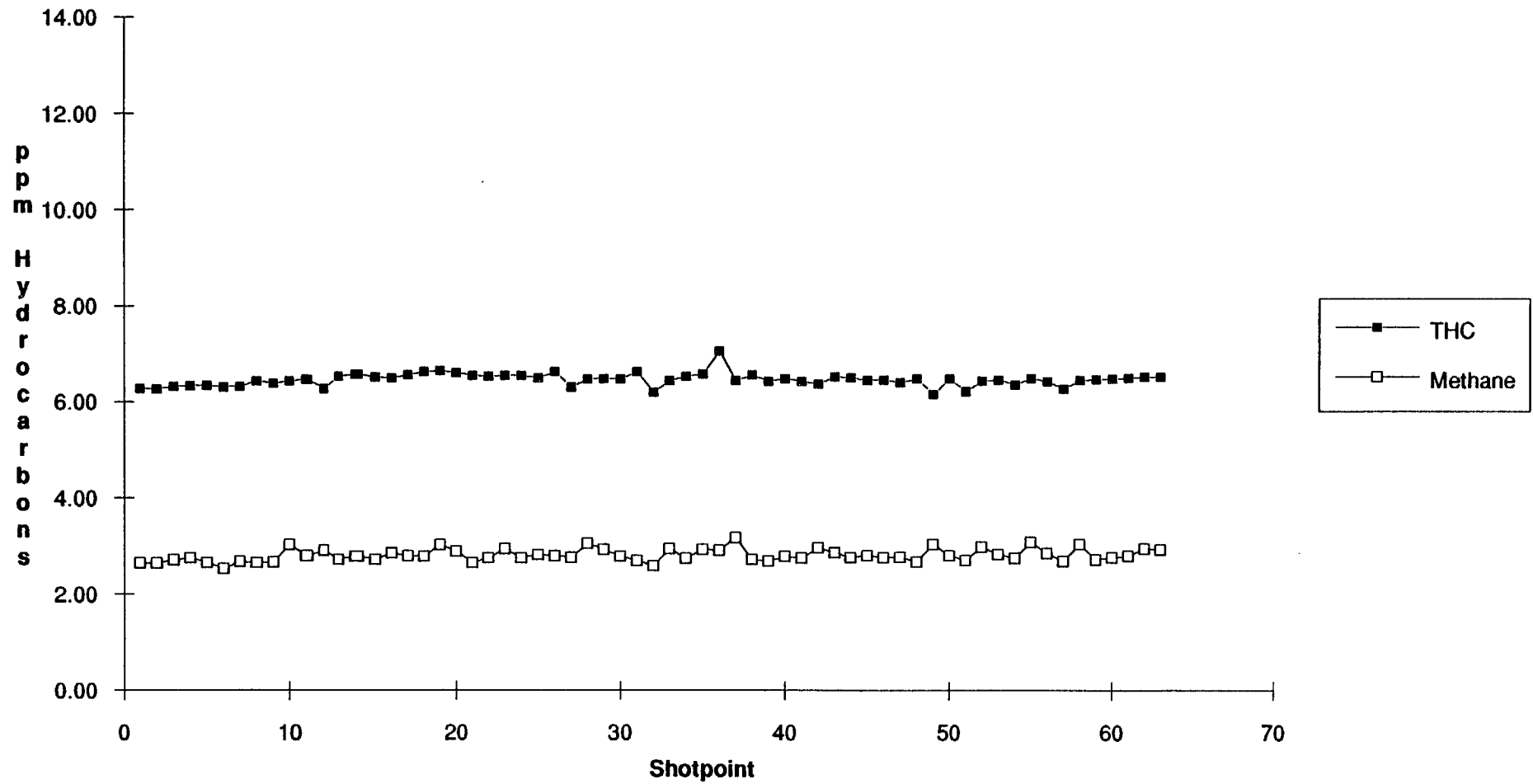
	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	6.462	2.810	0.000	0.016	0.011	0.000	0.000	0.000	0.000	0.034	0.000	0.000	0.373
Std. Dev.	0.134	0.133	0.000	0.003	0.009	0.000	0.000	0.000	0.000	0.021	0.000	0.000	0.330
Minimum	6.168	2.537	0.000	0.009	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Maximum	7.062	3.175	0.000	0.023	0.030	0.000	0.000	0.000	0.000	0.078	0.000	0.000	1.040

	Cond.	Temp.	Altitude	F. Depth	W.Depth
Mean	44.146	14.301	9.952	31.113	40.573
Std. Dev.	0.097	0.044	0.476	2.323	2.560
Minimum	43.950	14.150	8.600	28.200	37.700
Maximum	44.290	14.380	10.900	35.500	45.900

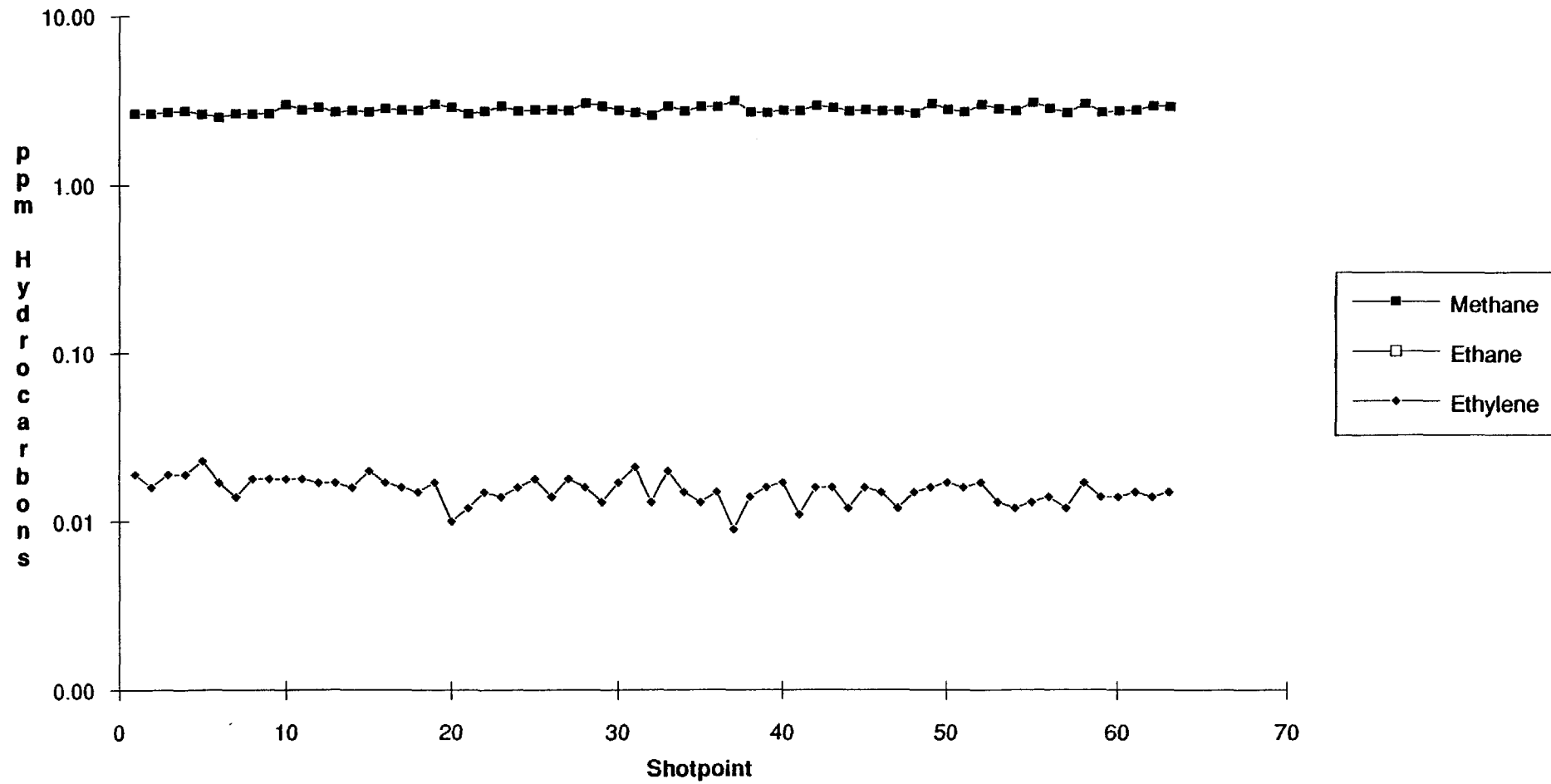
Notes

No hydrocarbon anomalies detected.

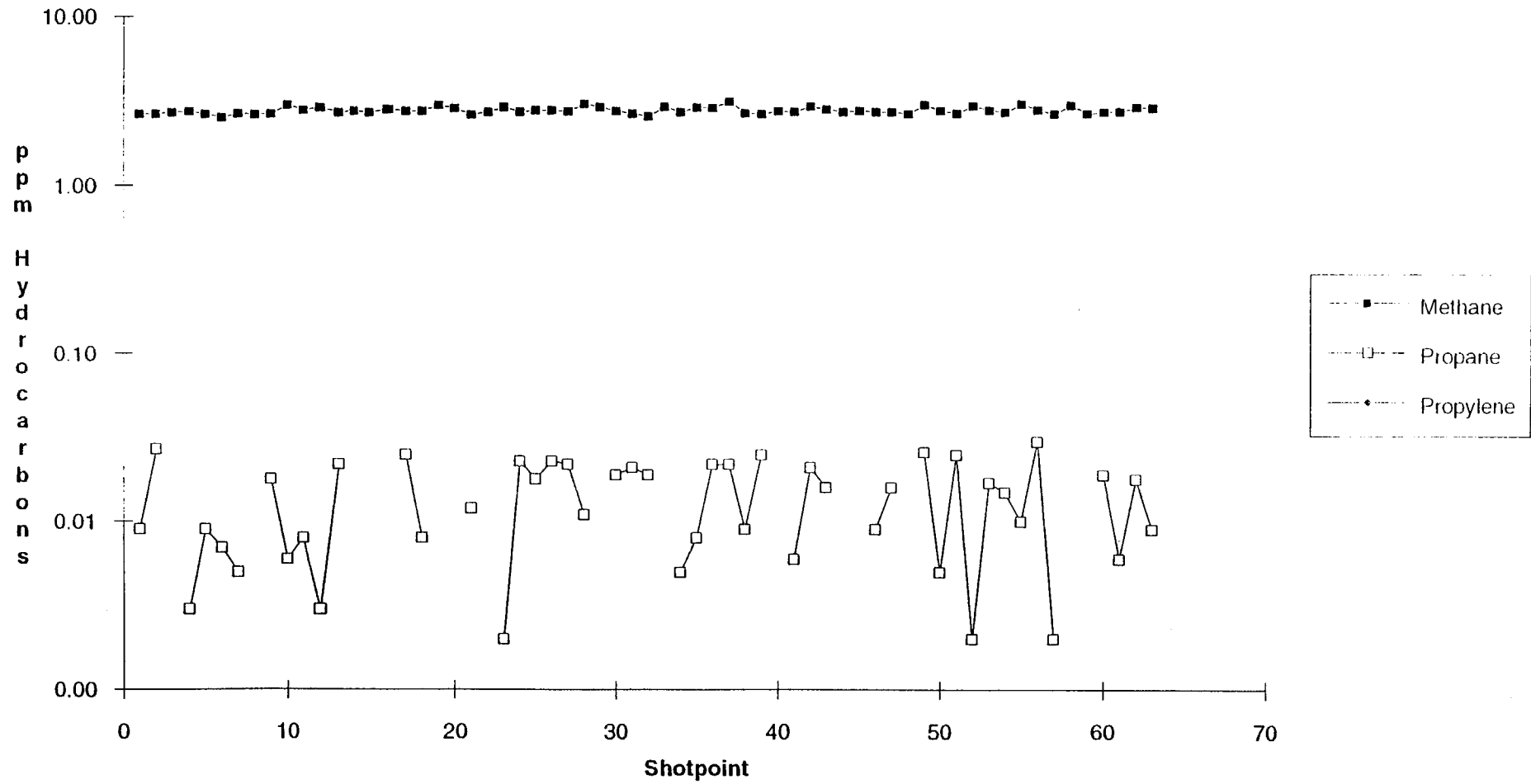
Line 104216 THC, Methane



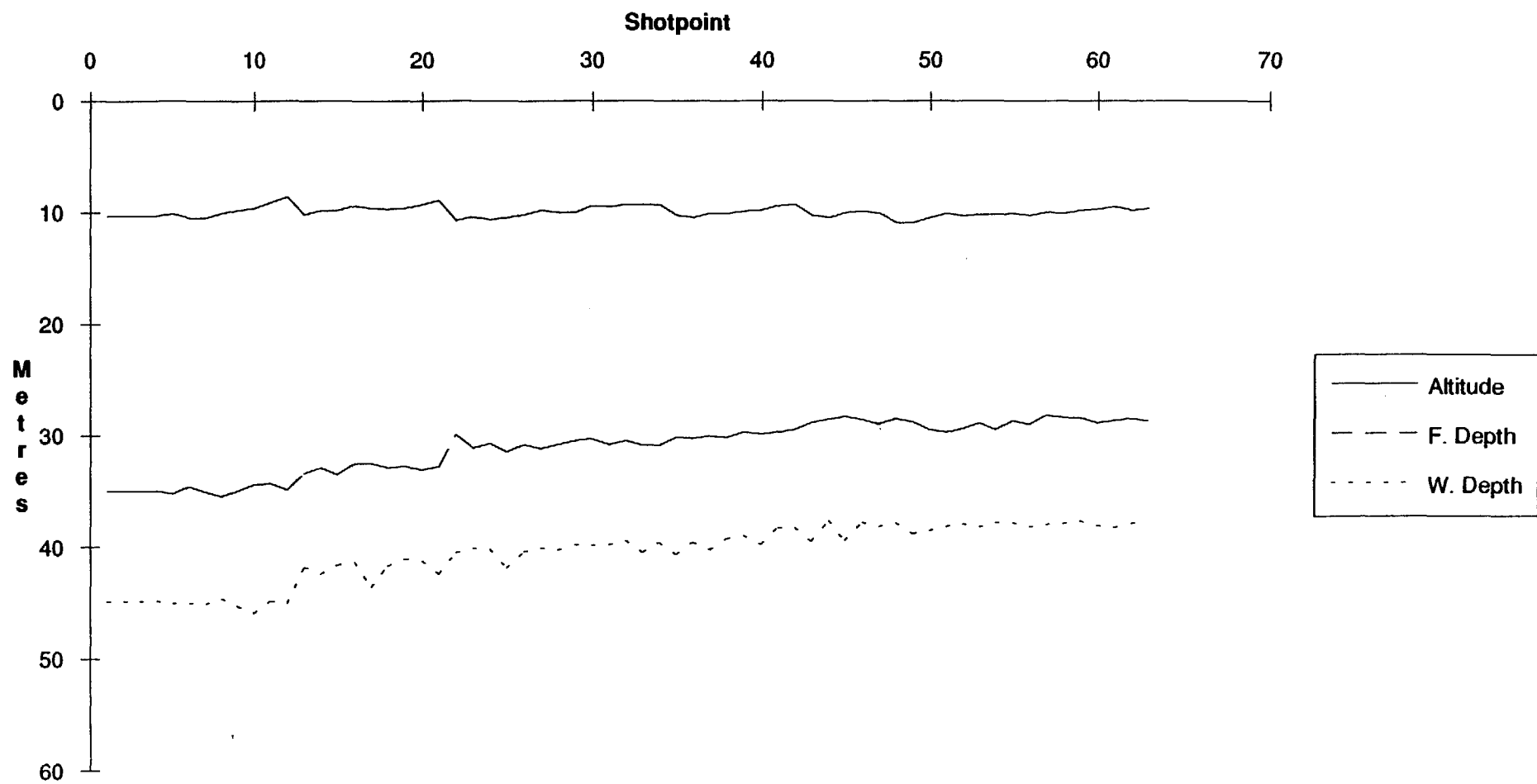
Line 104216 Methane, Ethane, Ethylene



Line 104216 Methane, Propane, Propylene



Line 104216 Depths, Altitude



Line Summary

Line Number 104217
No. of Shotpoints 78

	Shotpoint	Date	Time	Latitude	Longitude	
Start	1	24/09/91	23:41:09	40	36.352	147 38.739
End	78	25/09/91	02:15:07	40	29.470	147 50.922

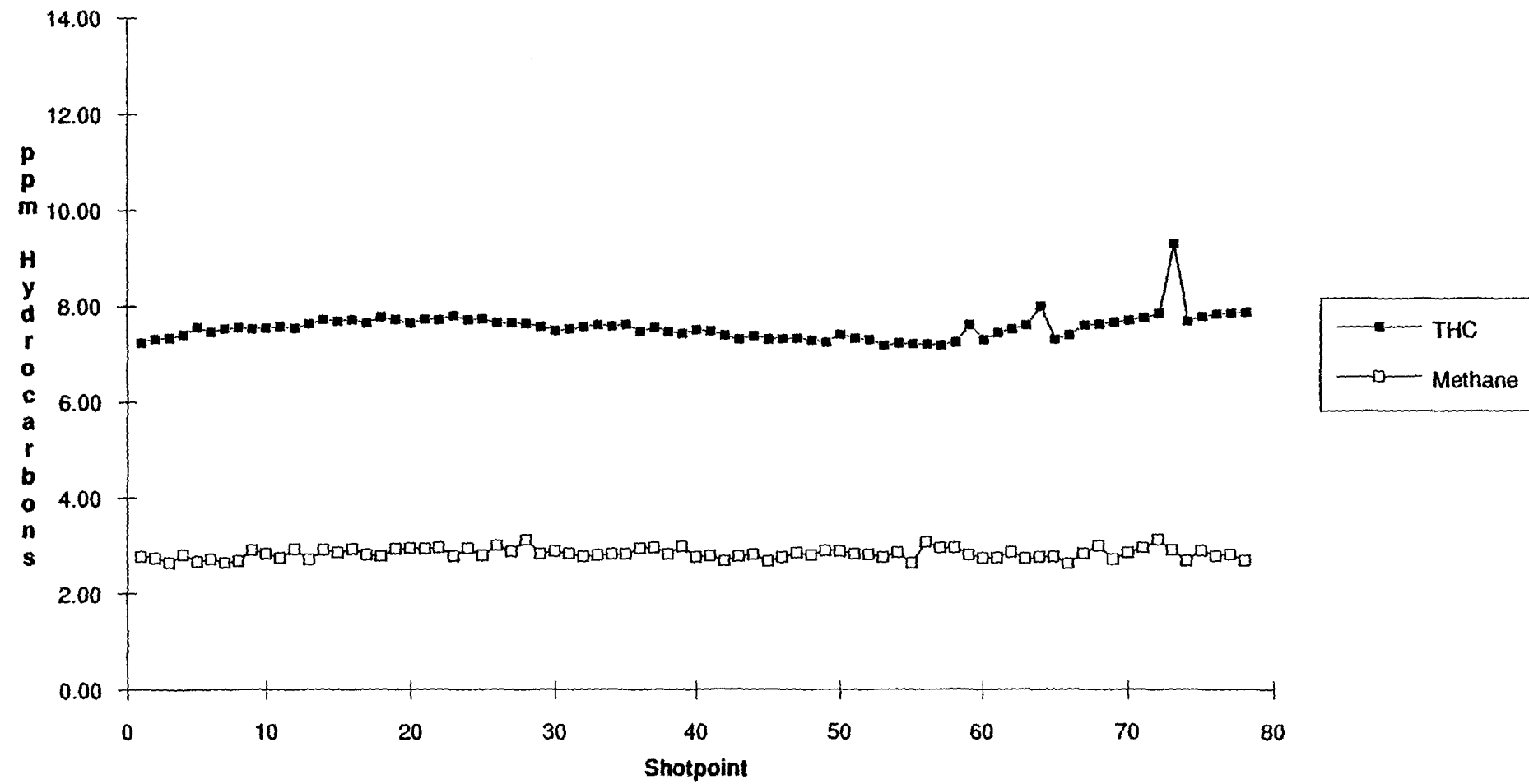
	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	7.547	2.829	0.000	0.017	0.003	0.000	0.001	0.000	0.021	0.031	0.000	0.000	0.162
Std. Dev.	0.278	0.109	0.000	0.003	0.005	0.000	0.009	0.000	0.014	0.015	0.000	0.003	0.366
Minimum	7.173	2.617	0.000	0.012	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Maximum	9.299	3.128	0.000	0.038	0.014	0.000	0.081	0.000	0.059	0.069	0.000	0.024	3.002

	Cond.	Temp.	Altitude	F. Depth	W.Depth
Mean	45.582	15.641	13.234	26.502	39.727
Std. Dev.	0.171	0.123	1.198	2.318	1.978
Minimum	45.170	15.230	10.300	24.000	37.000
Maximum	45.800	15.870	16.000	29.500	45.500

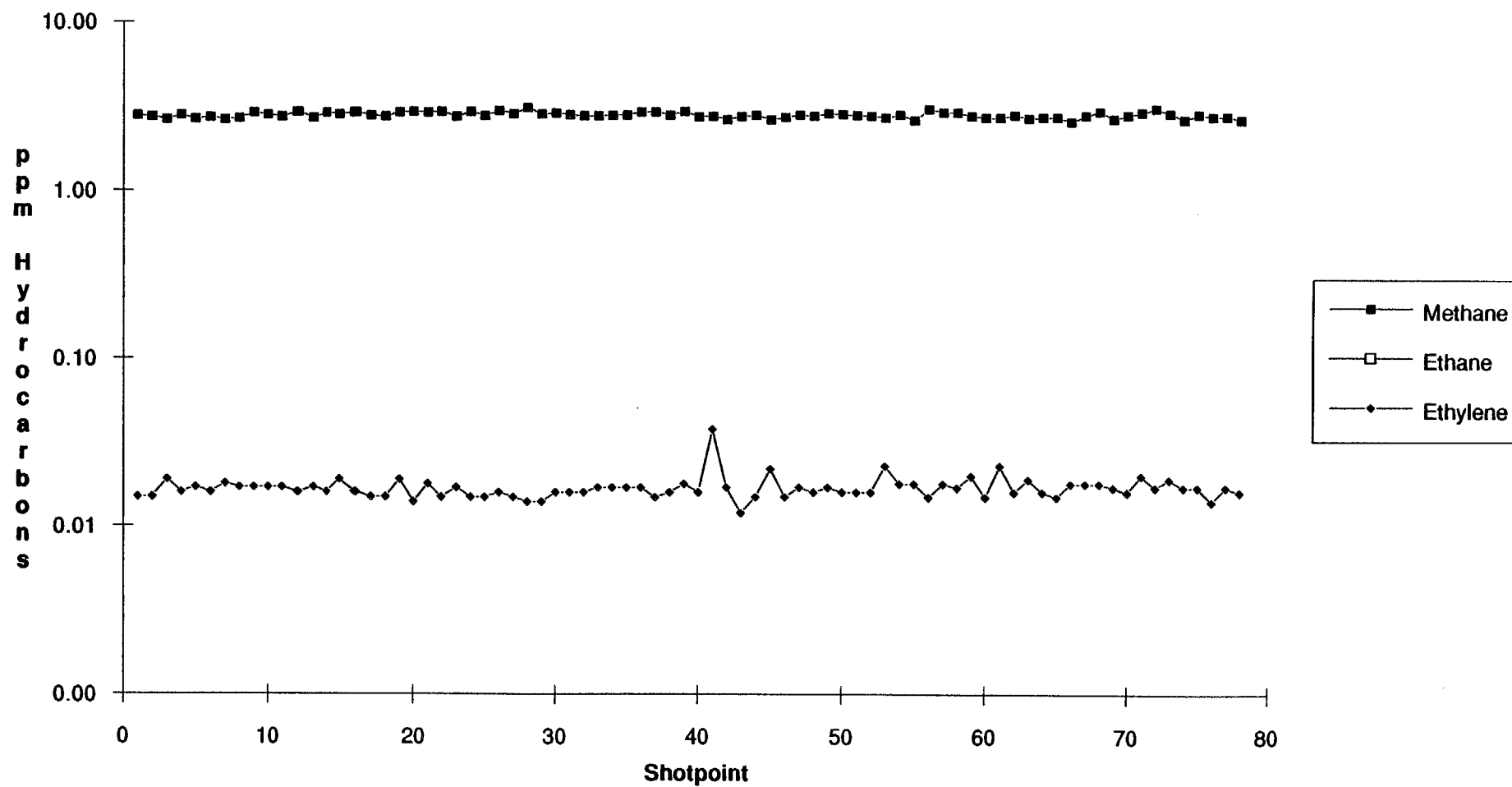
Notes

No hydrocarbon anomalies detected.

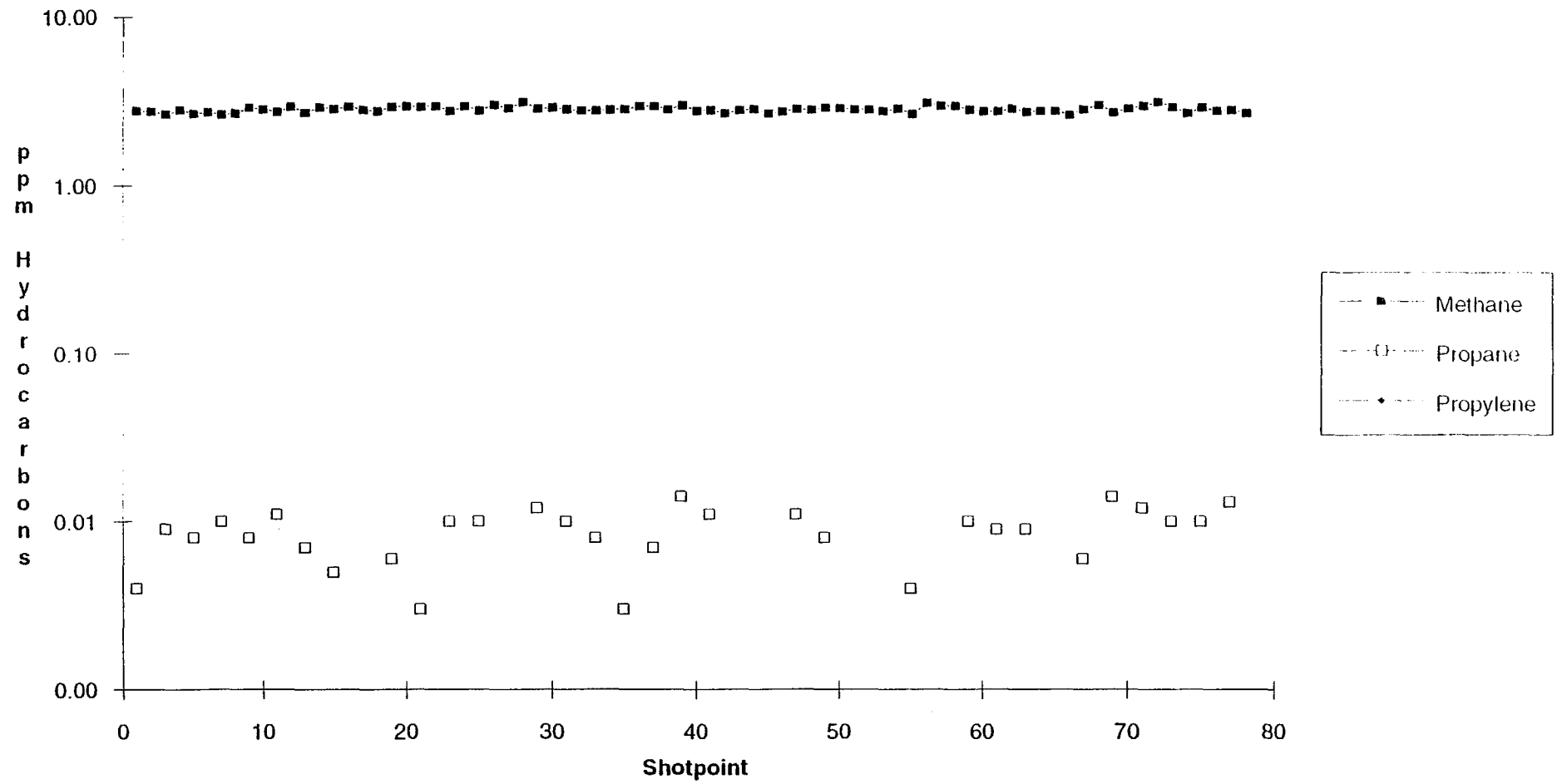
Line 104217 THC, Methane



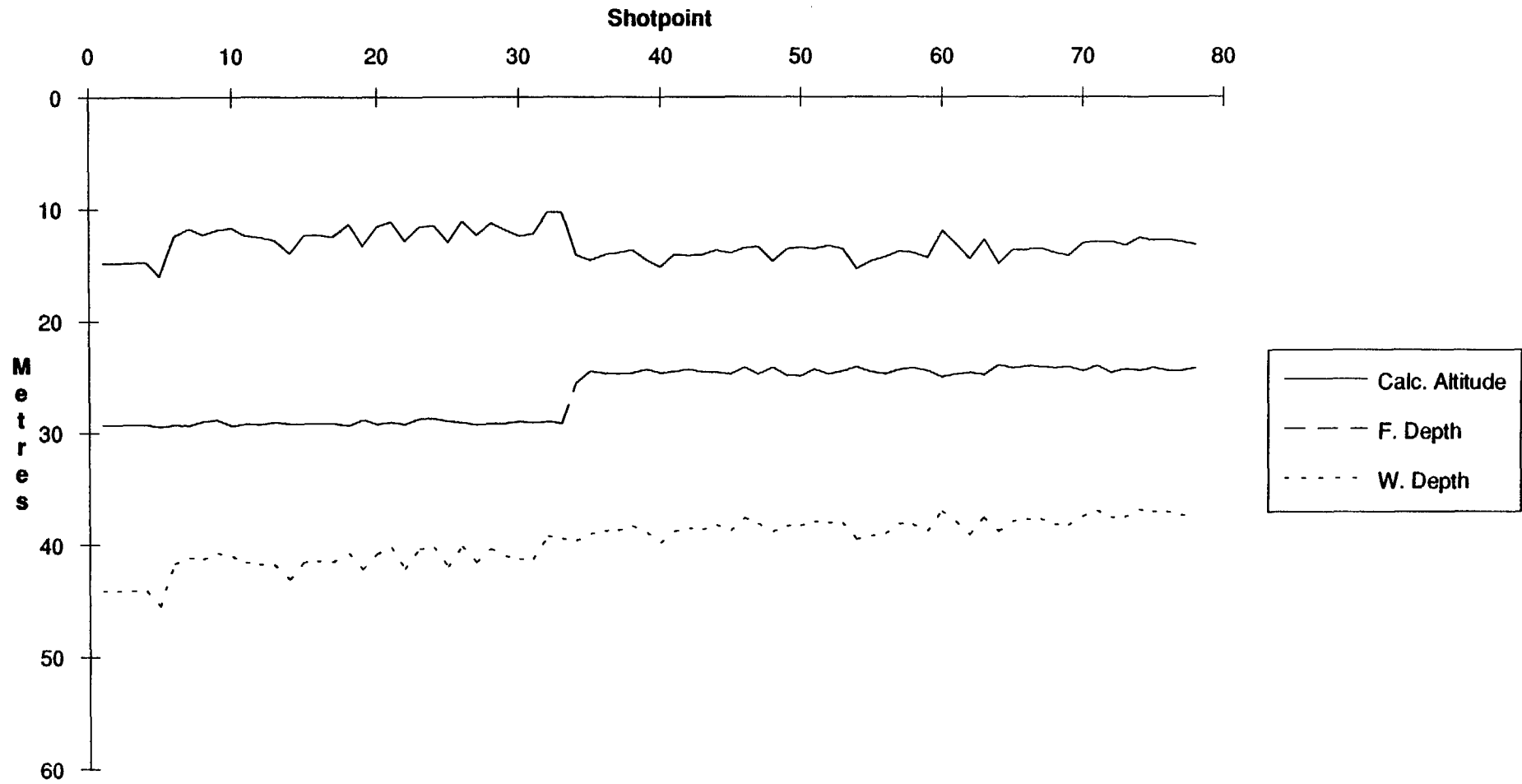
Line 104217 Methane, Ethane, Ethylene



Line 104217 Methane, Propane, Propylene



Line 104217 Depths, Altitude



Line Summary

Line Number 104219
No. of Shotpoints 60

	Shotpoint	Date	Time	Latitude	Longitude
Start	1	22/09/91	15:52:05	40	32.920 147 50.223
End	60	22/09/91	17:50:04	40	39.041 147 40.238

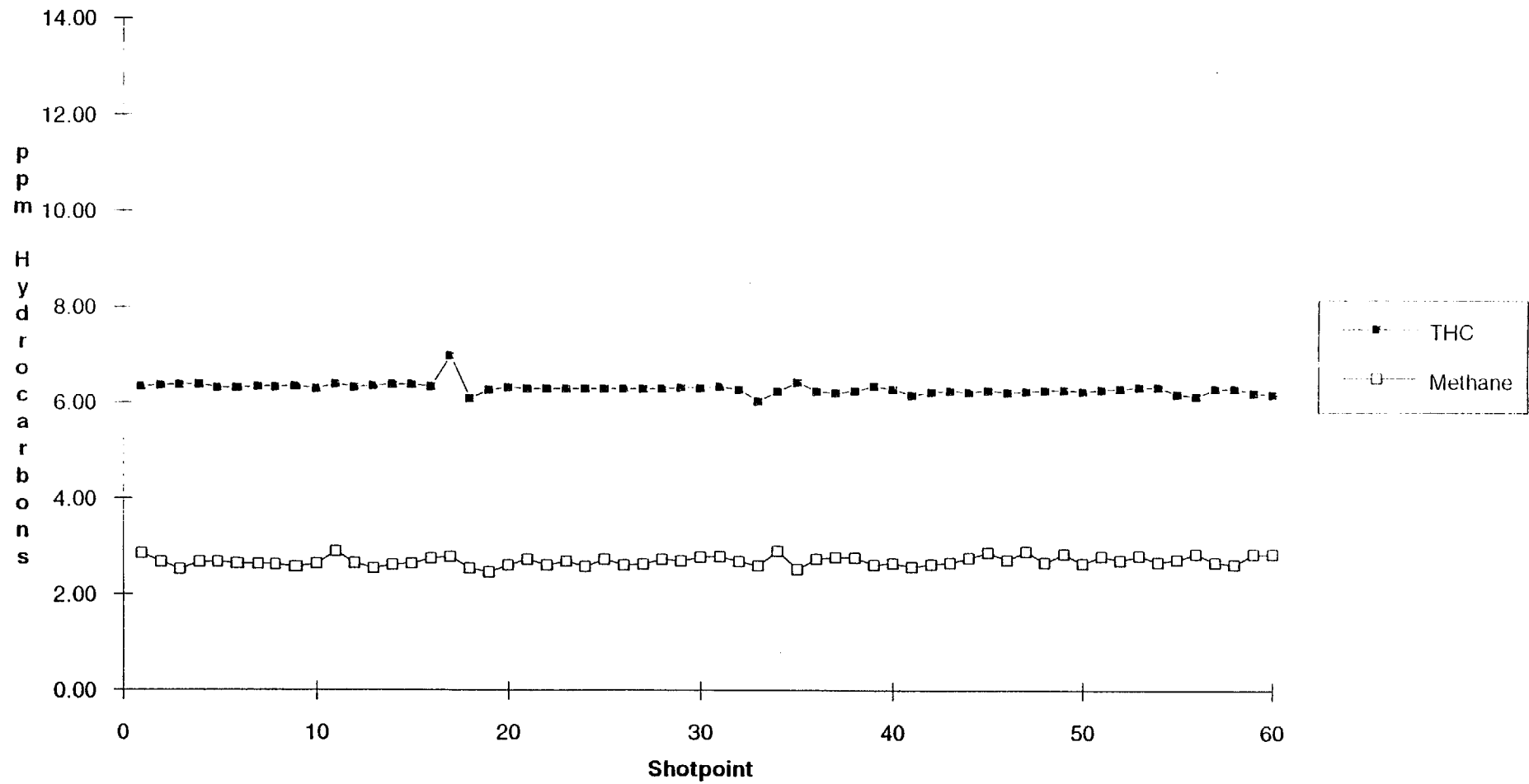
	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	6.300	2.698	0.000	0.015	0.011	0.000	0.001	0.000	0.002	0.031	0.000	0.000	0.469
Std. Dev.	0.115	0.104	0.000	0.006	0.010	0.000	0.010	0.000	0.005	0.021	0.000	0.000	0.479
Minimum	6.035	2.467	0.000	0.009	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Maximum	6.983	2.915	0.000	0.056	0.038	0.000	0.075	0.000	0.023	0.089	0.000	0.000	2.745

	Cond.	Temp.	Altitude	F. Depth	W.Depth
Mean	43.919	15.655	11.467	26.802	37.440
Std. Dev.	0.018	0.345	1.296	2.415	1.828
Minimum	43.890	15.120	8.000	23.600	34.600
Maximum	43.960	16.170	13.900	30.100	40.500

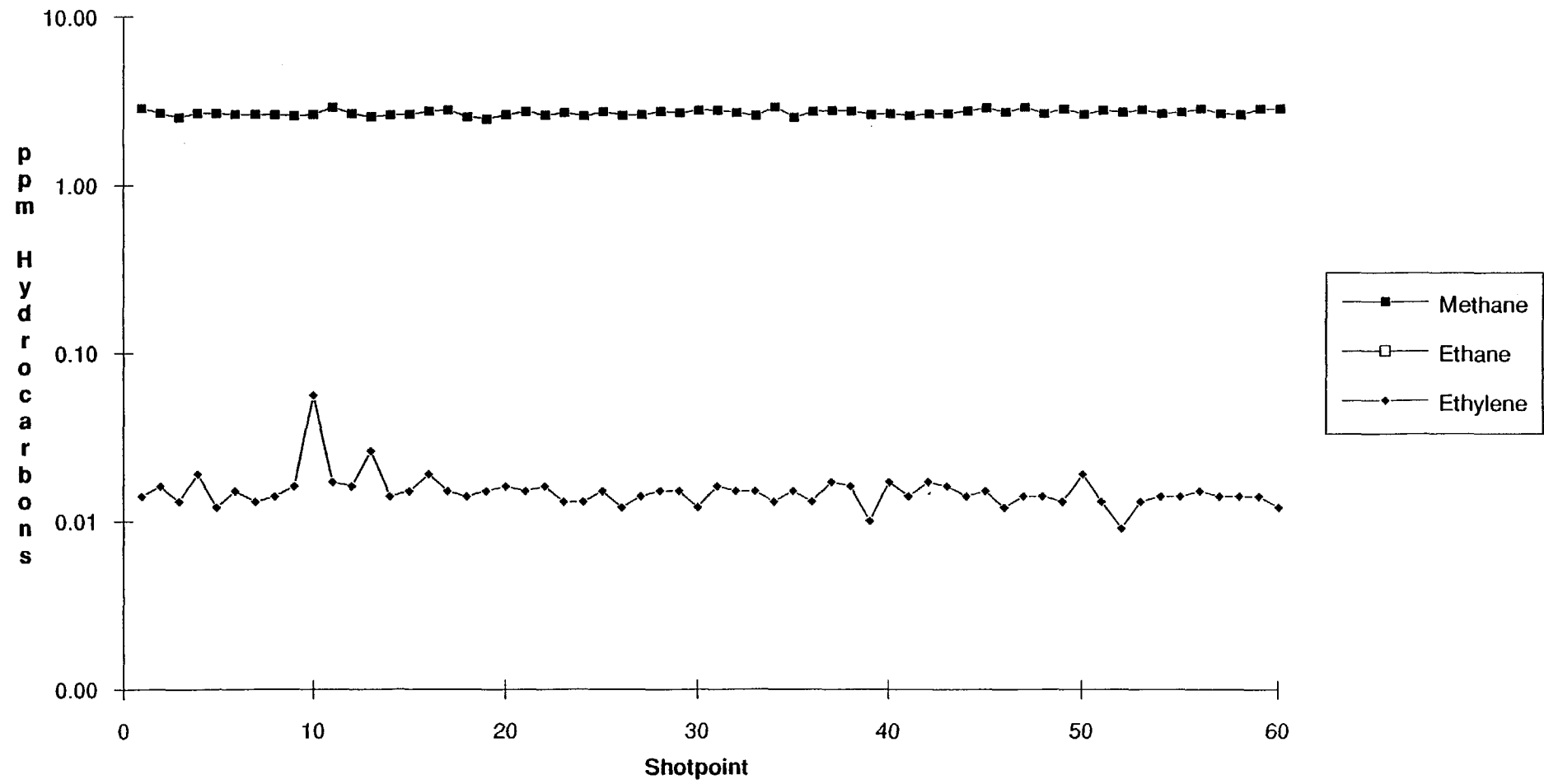
Notes

No hydrocarbon anomalies detected.

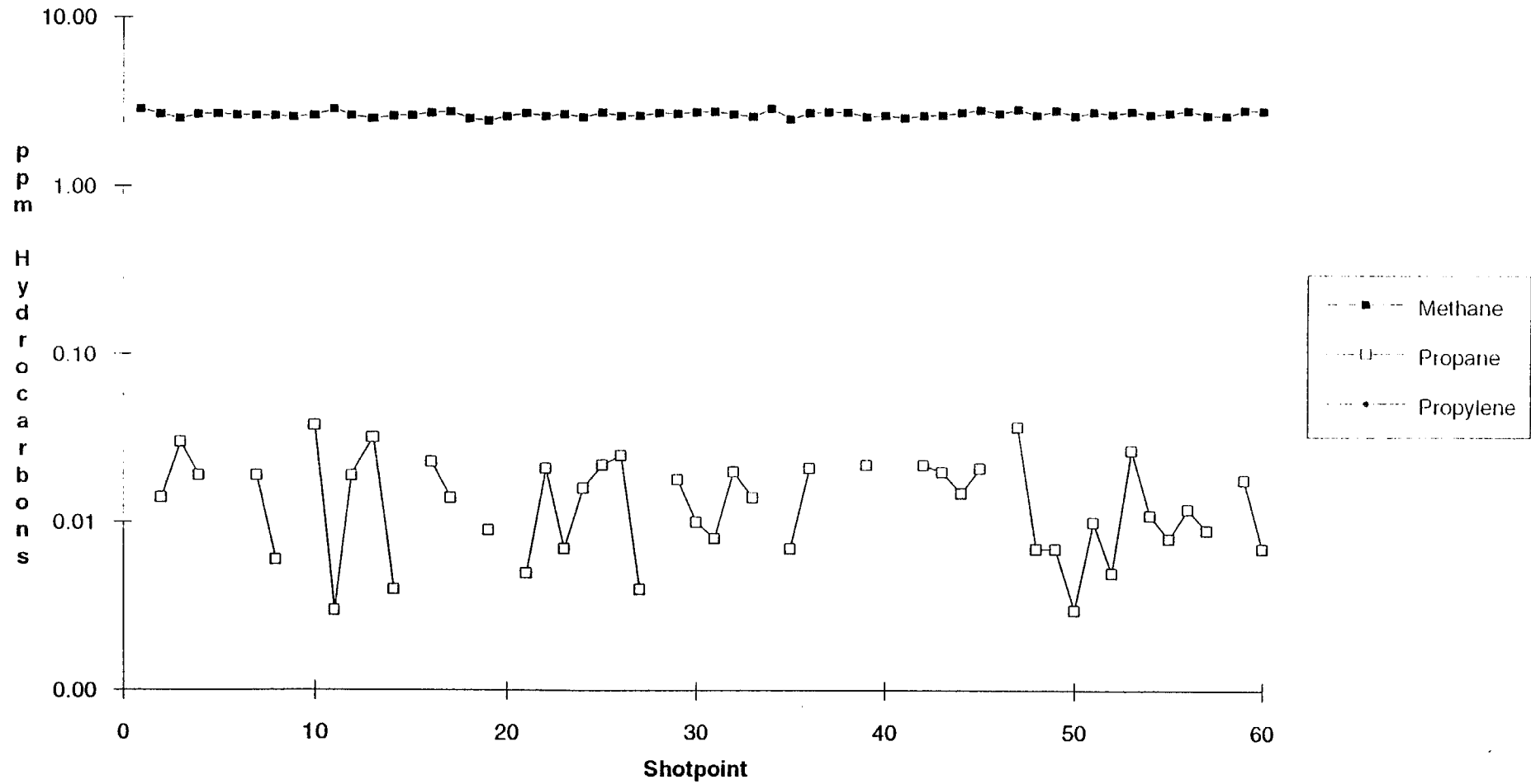
Line 104219 THC, Methane



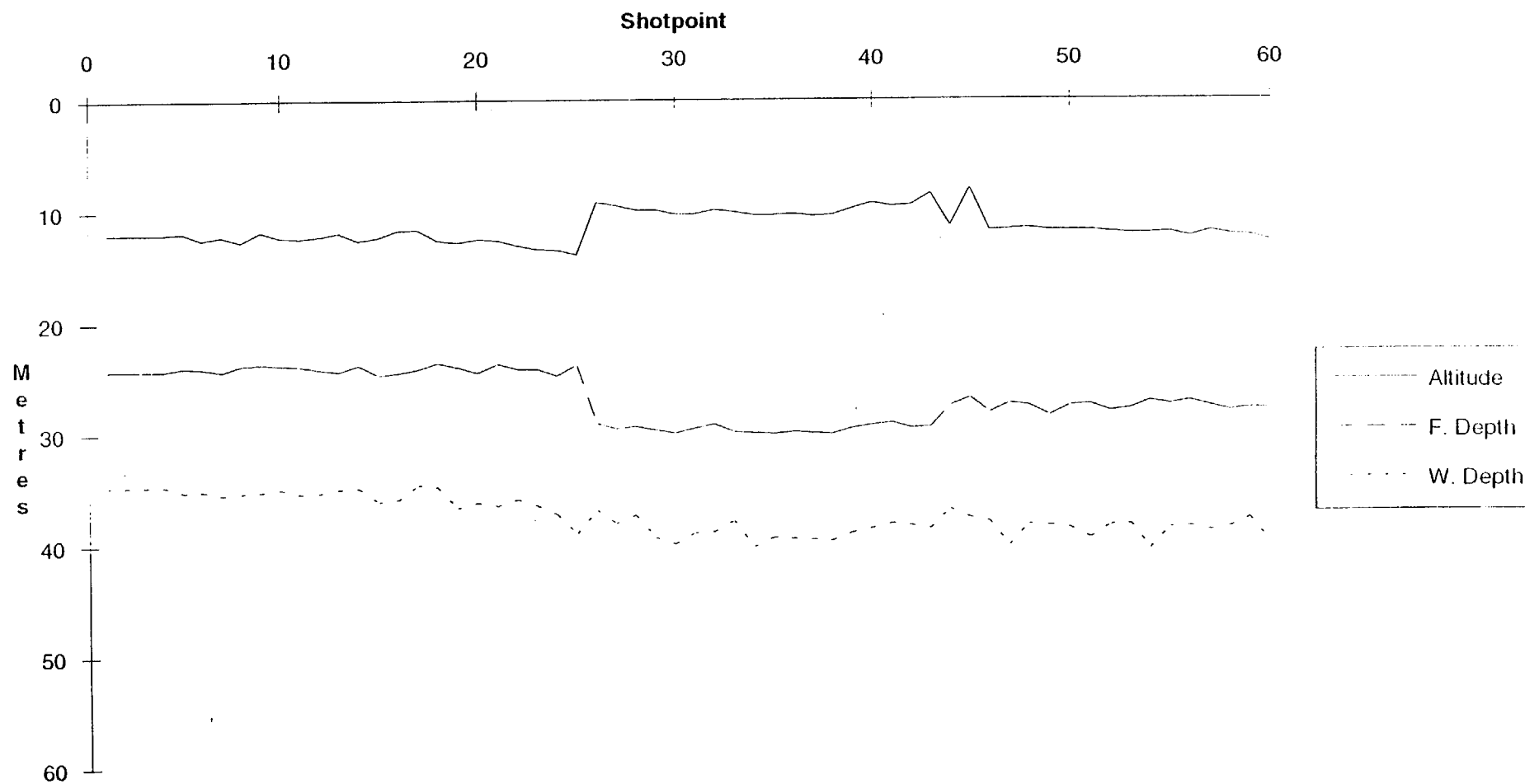
Line 104219 Methane, Ethane, Ethylene



Line 104219 Methane, Propane, Propylene



Line 104219 Depths, Altitude



Line Summary

Line Number 104220
No. of Shotpoints 48

	Shotpoint	Date	Time	Latitude	Longitude	
Start	1	25/09/91	08:47:58	40	34.483	147 50.219
End	49	25/09/91	10:36:31	40	40.183	147 41.447

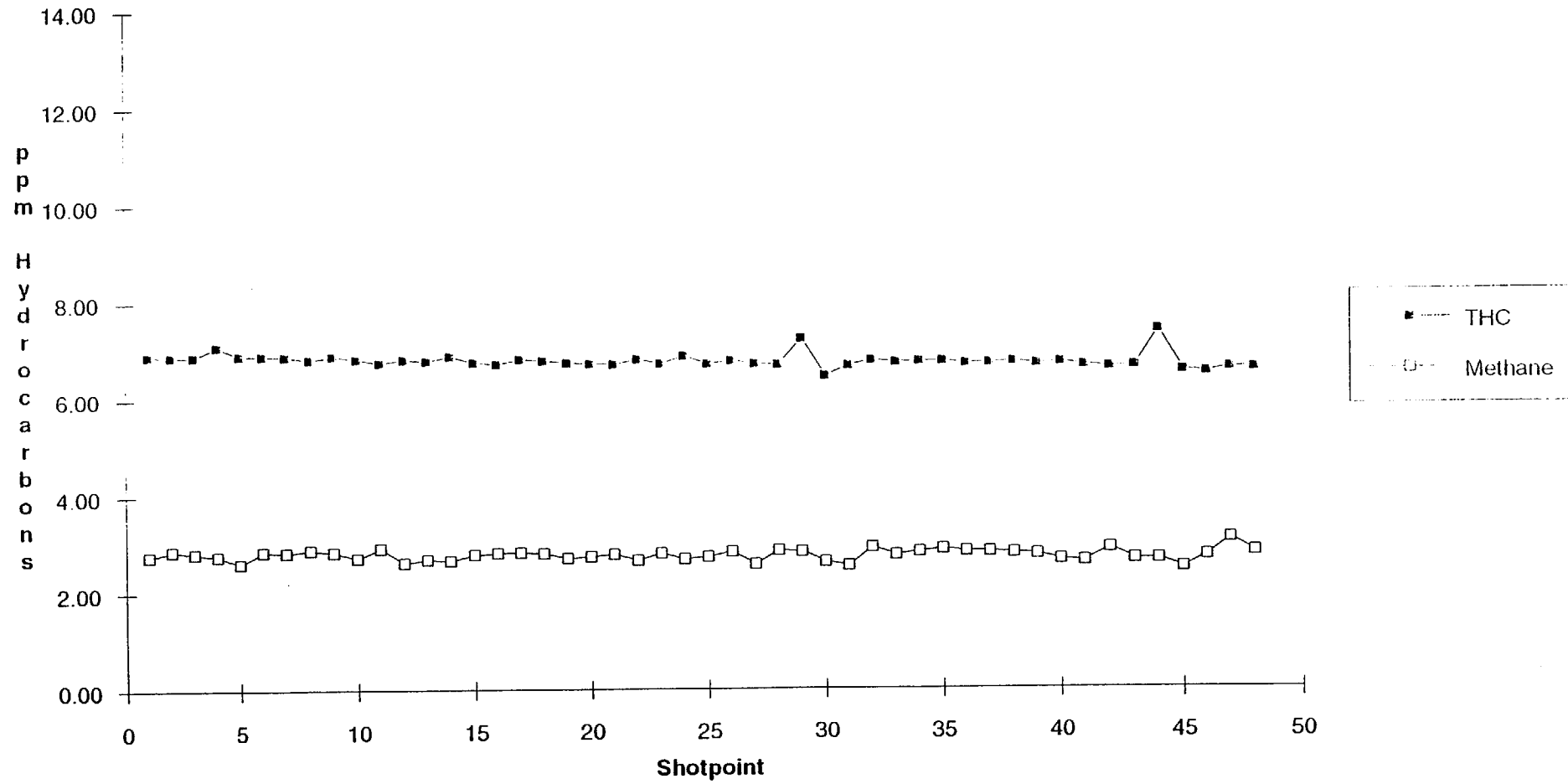
	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	6.775	2.764	0.000	0.018	0.003	0.000	0.002	0.000	0.005	0.028	0.002	0.000	0.163
Std. Dev.	0.160	0.112	0.000	0.004	0.004	0.000	0.008	0.000	0.007	0.014	0.005	0.000	0.292
Minimum	6.448	2.487	0.000	0.013	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Maximum	7.392	3.090	0.000	0.038	0.012	0.000	0.036	0.000	0.022	0.075	0.022	0.000	1.400

	Cond.	Temp.	Altitude	F. Depth	W.Depth
Mean	44.376	13.826	12.840	24.131	36.958
Std. Dev.	0.032	0.036	1.988	2.754	2.821
Minimum	44.320	13.760	10.100	21.900	32.300
Maximum	44.440	13.890	17.000	28.700	41.600

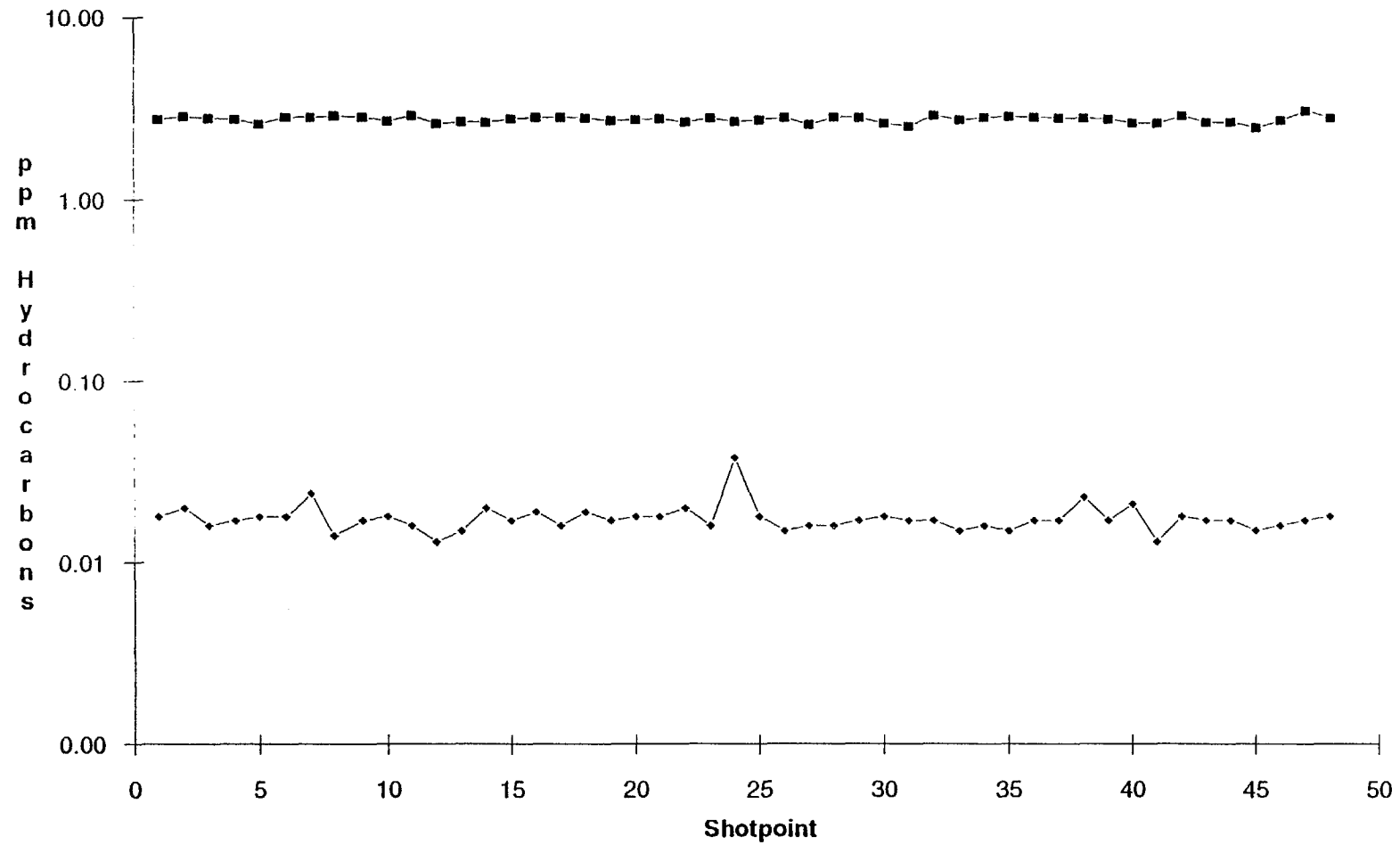
Notes

No hydrocarbon anomalies detected.

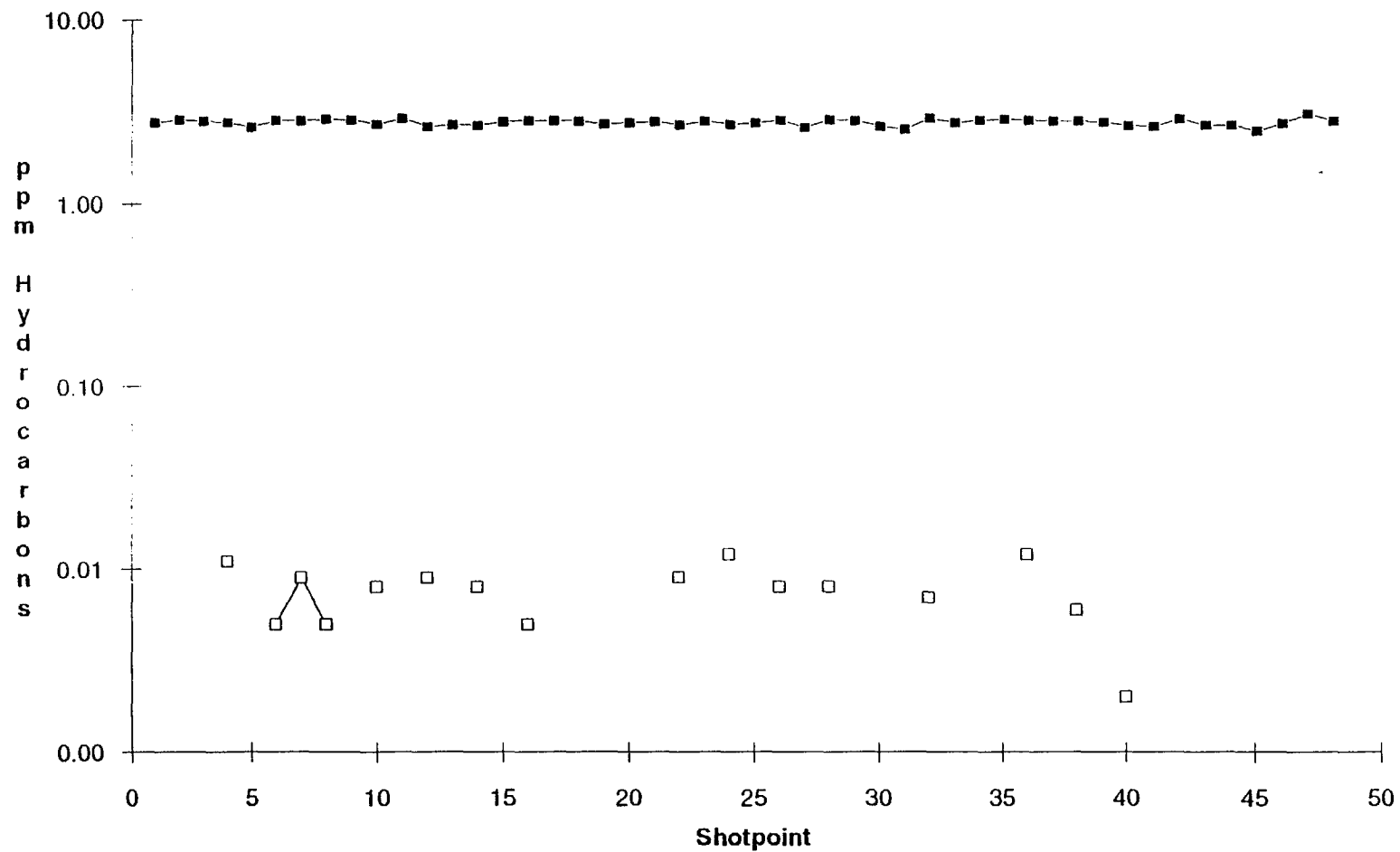
Line 104220 THC, Methane



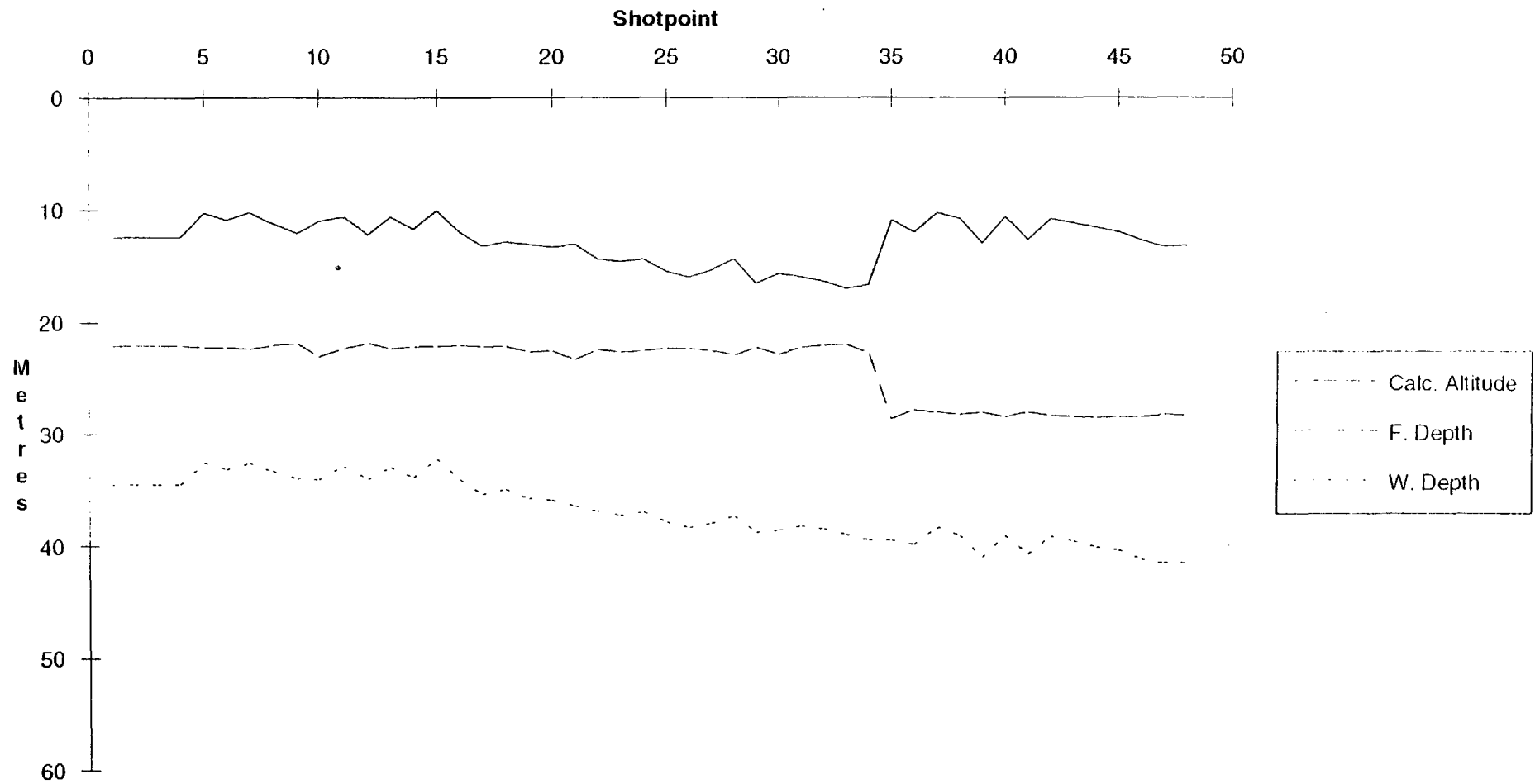
Line 104220 Methane, Ethane, Ethylene



Line 104220 Methane, Propane, Propylene



Line 104220 Depths, Altitude



Line Summary

Line Number 104221A
No. of Shotpoints 50

	Shotpoint	Date	Time	Latitude	Longitude	
Start	1	24/09/91	19:51:24	40	36.331 147	50.184
End	50	24/09/91	21:29:23	40	41.598 147	41.957

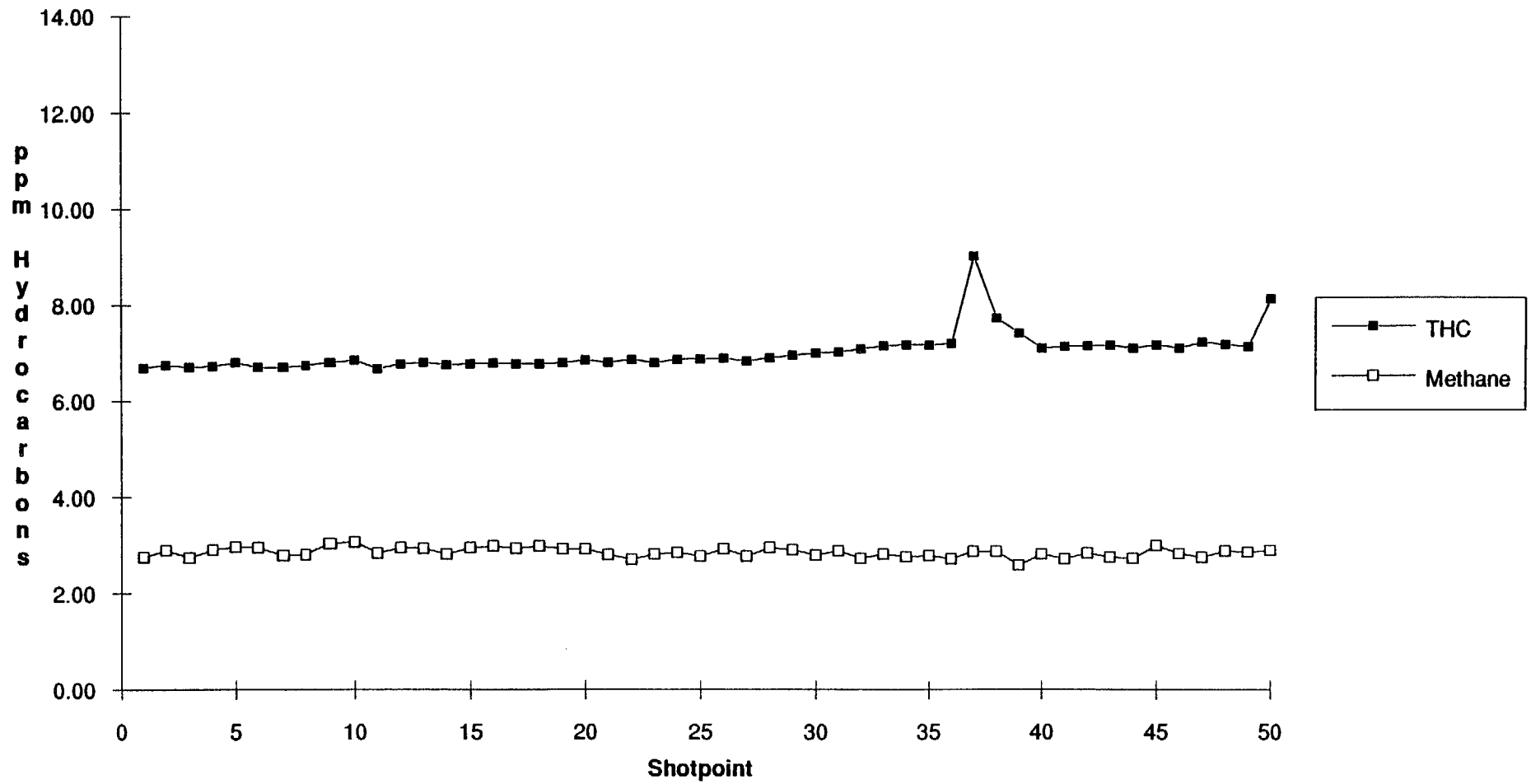
	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	7.018	2.854	0.000	0.017	0.004	0.000	0.000	0.000	0.003	0.027	0.000	0.000	0.166
Std. Dev.	0.399	0.099	0.000	0.002	0.006	0.000	0.002	0.000	0.008	0.013	0.000	0.000	0.204
Minimum	6.684	2.587	0.000	0.011	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Maximum	9.029	3.075	0.000	0.026	0.026	0.000	0.016	0.000	0.039	0.066	0.000	0.000	0.914

	Cond.	Temp.	Altitude	F. Depth	W.Depth
Mean	44.303	13.486	13.202	24.450	37.654
Std. Dev.	0.141	0.158	1.308	2.005	1.534
Minimum	44.150	13.310	10.200	20.800	35.200
Maximum	44.550	13.740	15.400	26.200	40.300

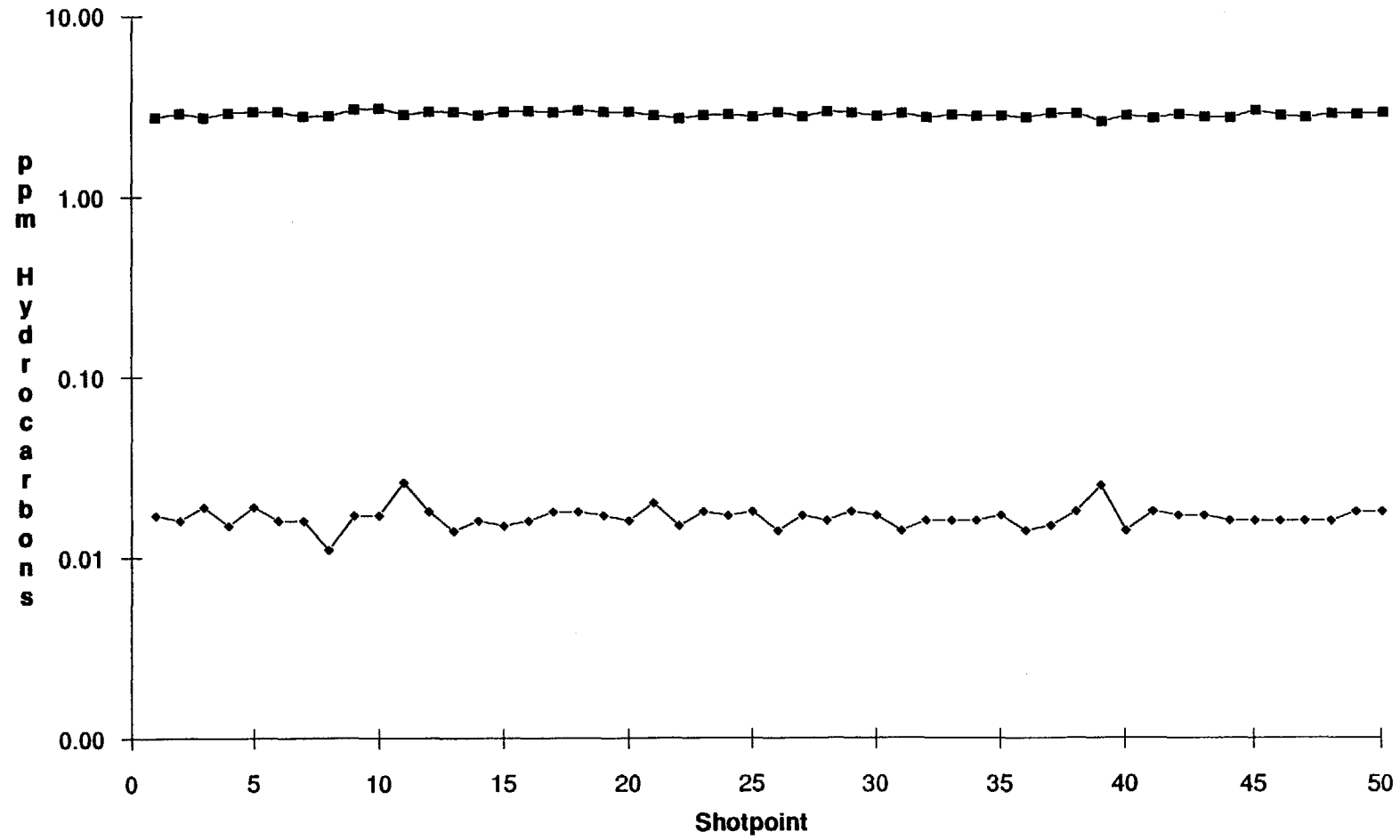
Notes

THC anomaly at shotpoint 37

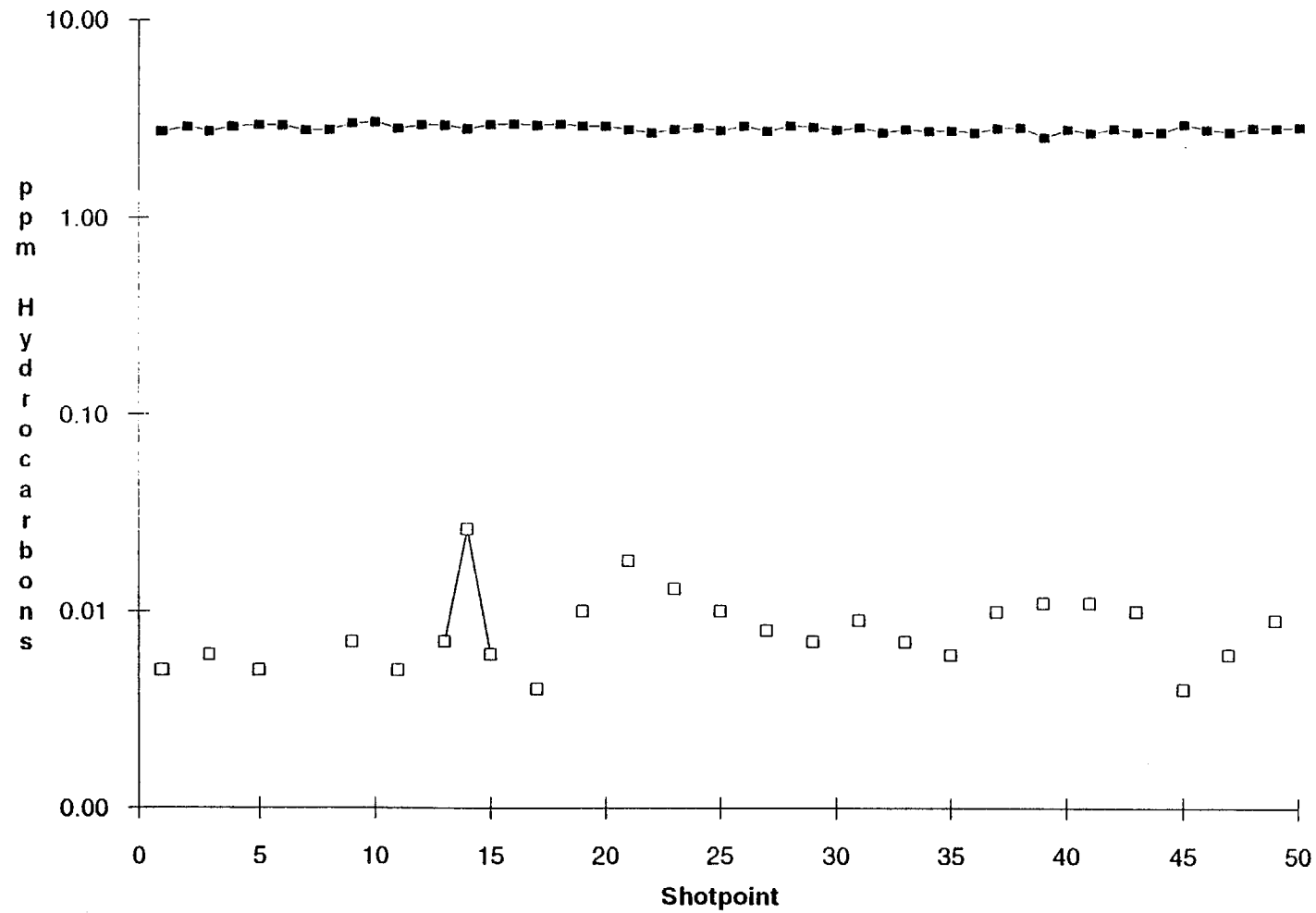
Line 104221 THC, Methane



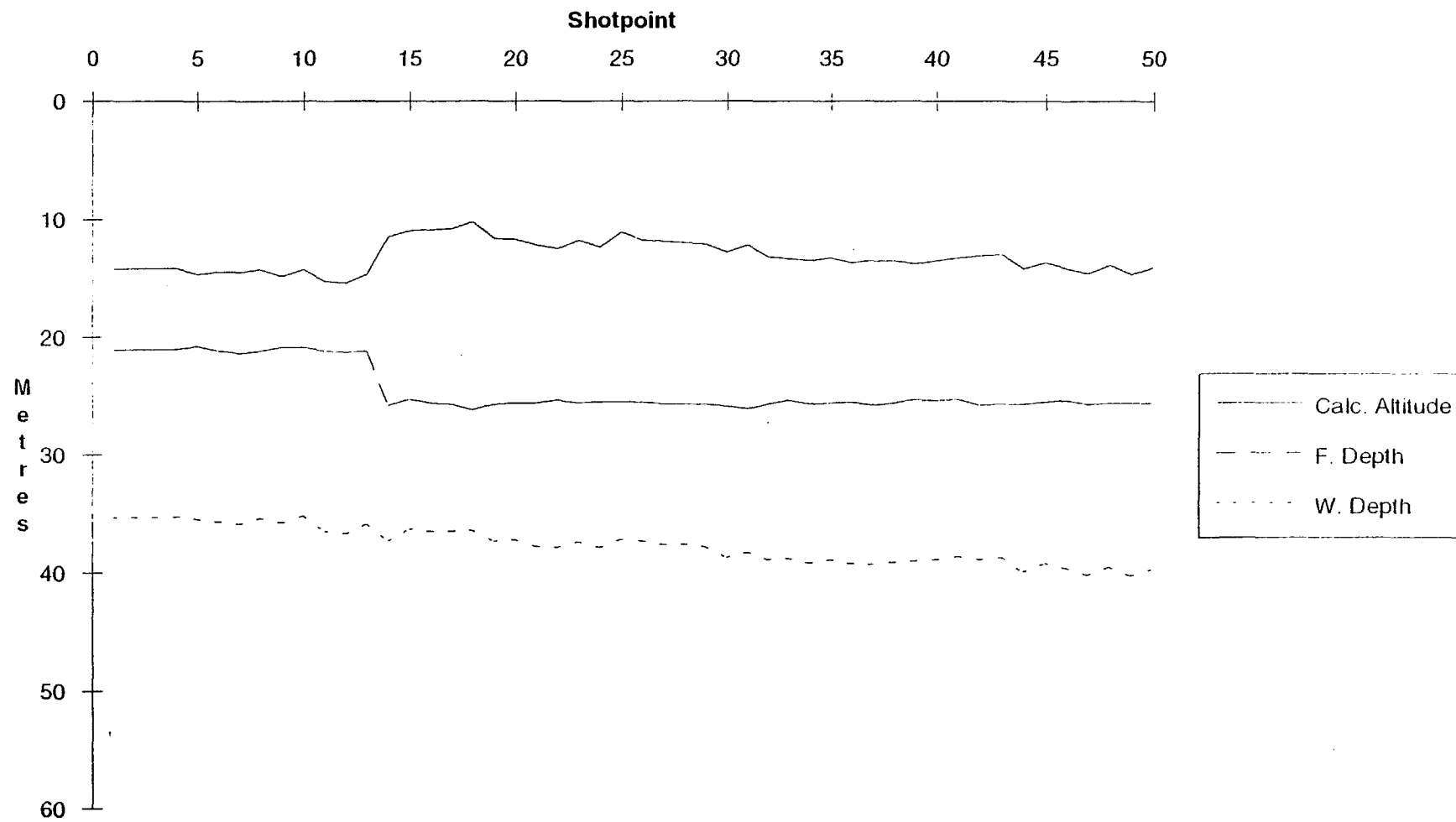
Line 104221 Methane, Ethane, Ethylene



Line 104221 Methane, Propane, Propylene



Line 104221 Depths, Altitudes



Line Summary

Line Number 104222
No. of Shotpoints 48

	Shotpoint	Date	Time	Latitude	Longitude
Start	1	22/09/91	20:00:18	40	42.799 147 44.128
End	48	22/09/91	21:34:17	40	37.983 147 51.932

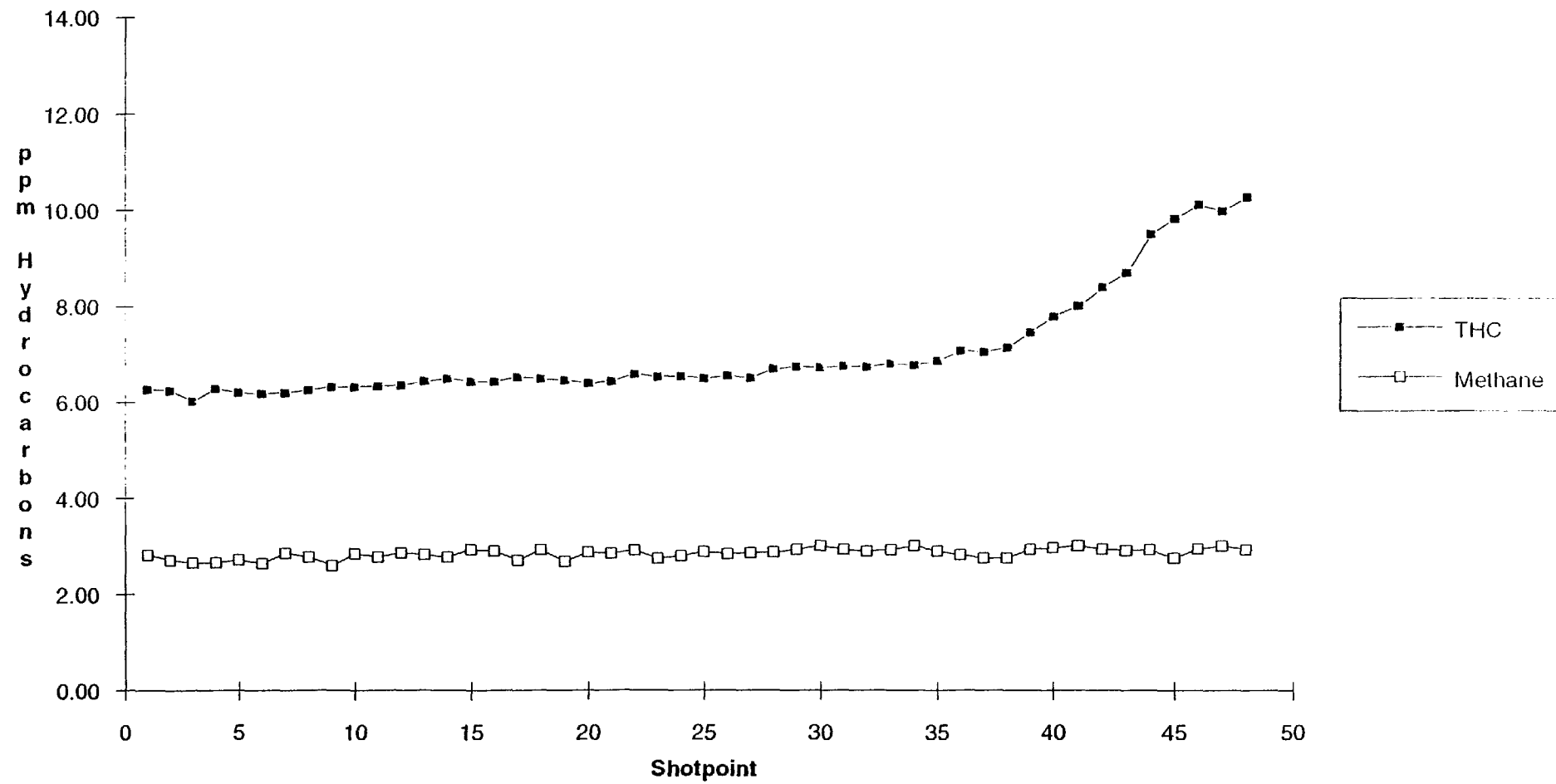
	THC	Methane	Ethane	Ethylene	Propane	Propylene	I-Butane	n-Butane	I-Pentane	n-Pentane	I-Hexane	n-Hexane	%Wetness
Mean	7.036	2.845	0.000	0.015	0.010	0.000	0.000	0.000	0.000	0.030	0.000	0.000	0.364
Std. Dev.	1.146	0.105	0.000	0.003	0.009	0.000	0.000	0.000	0.000	0.017	0.000	0.000	0.303
Minimum	6.016	2.600	0.000	0.009	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Maximum	10.281	3.013	0.000	0.024	0.027	0.000	0.000	0.000	0.000	0.065	0.000	0.000	0.928

	Cond.	Temp.	Altitude	F. Depth	W.Depth
Mean	43.376	16.145	11.202	27.381	38.179
Std. Dev.	0.097	0.125	1.800	3.973	3.048
Minimum	43.270	15.690	8.600	20.300	33.500
Maximum	43.620	16.390	17.300	32.300	44.100

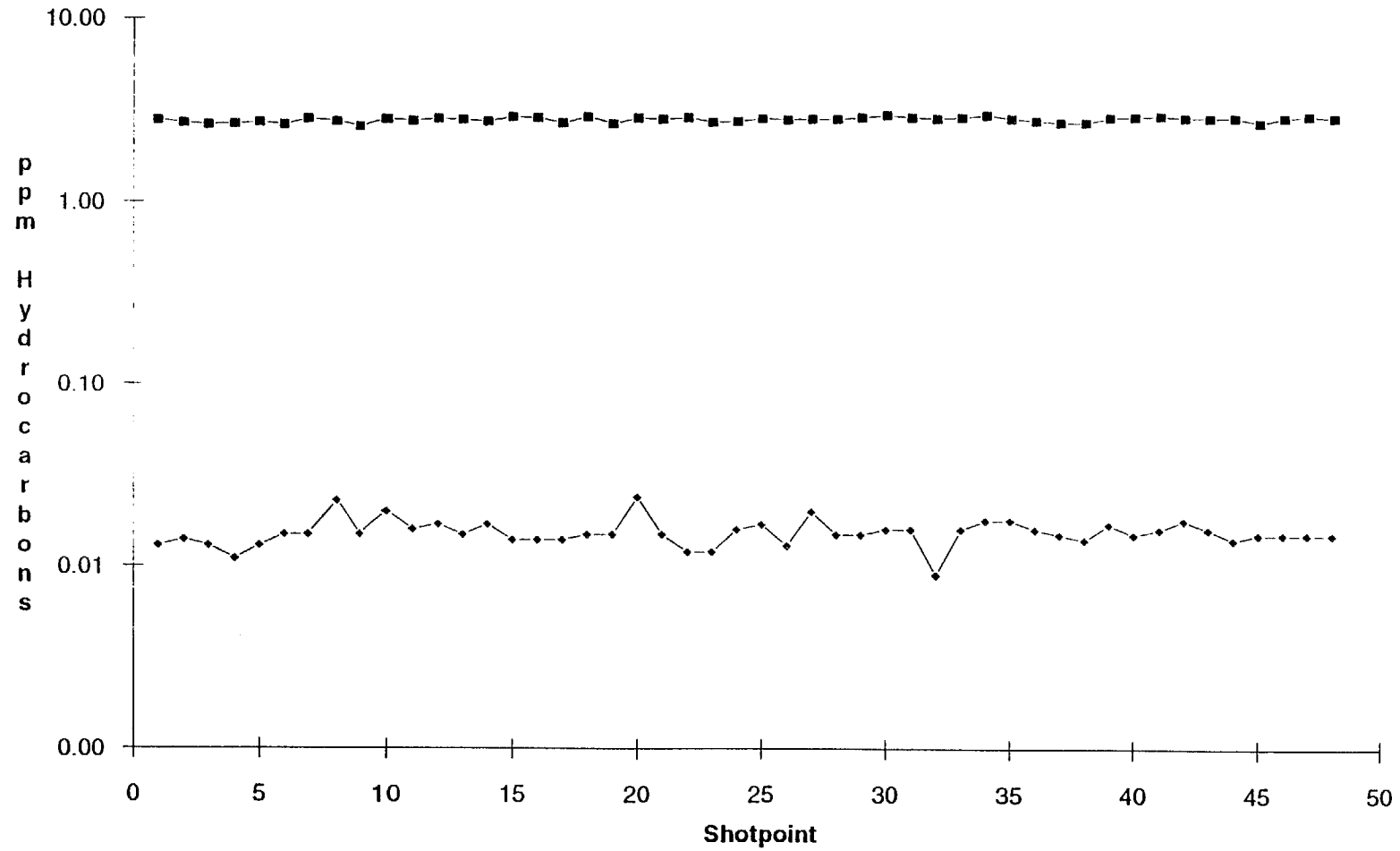
Notes

Slight increase in THC towards end of line.

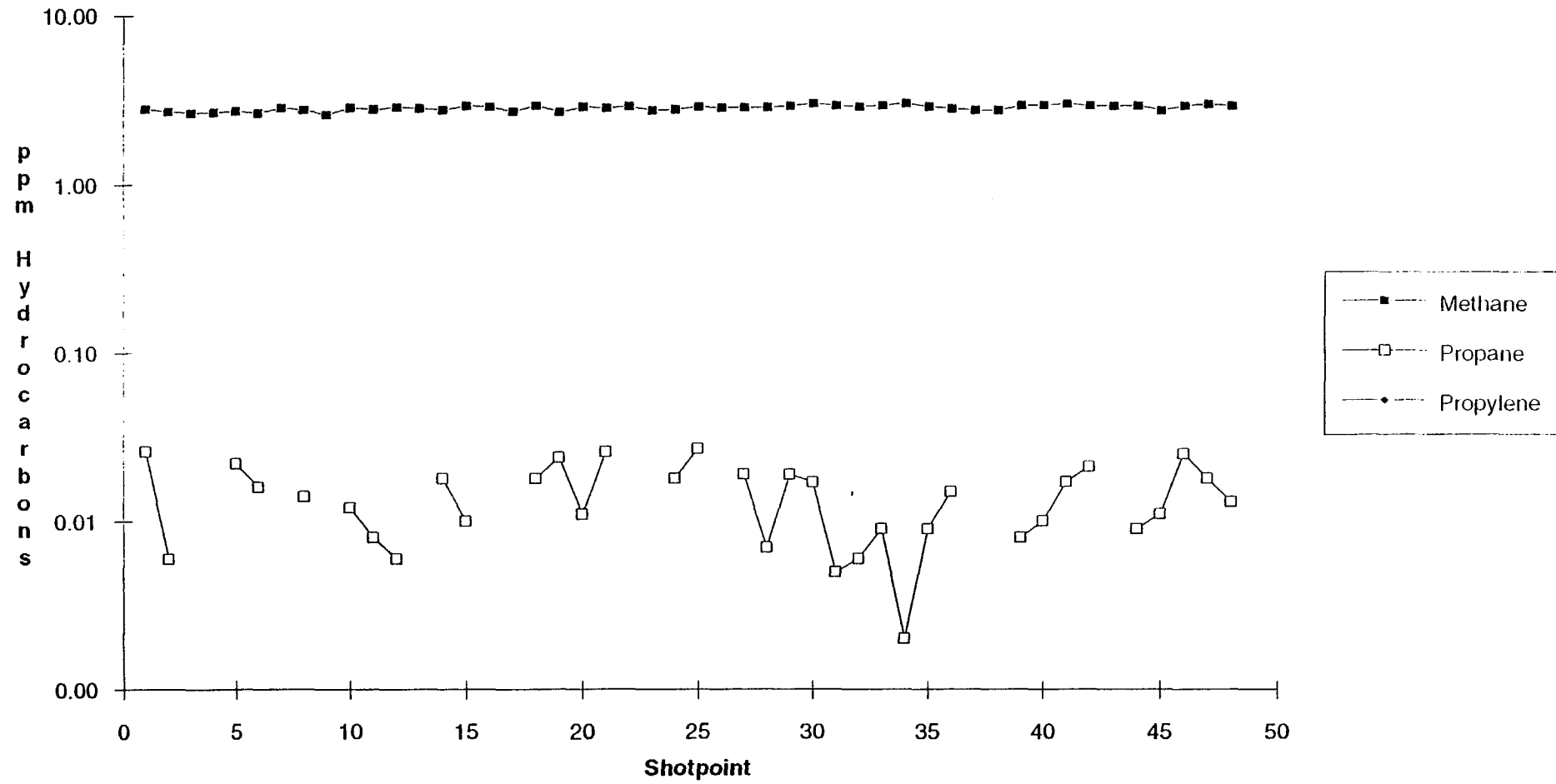
Line 104222 THC, Methane



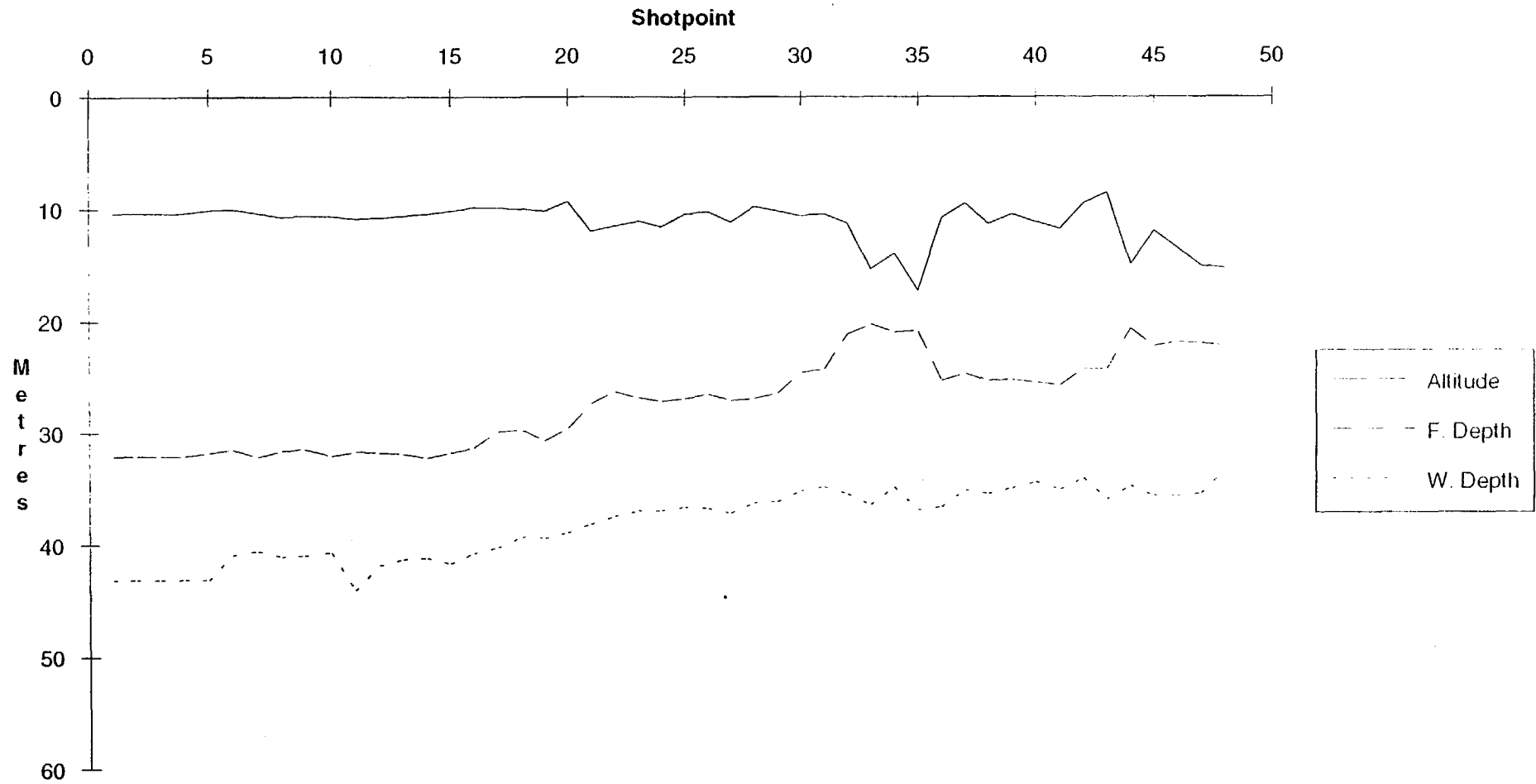
Line 104222 Methane, Ethane, Ethylene



Line 104222 Methane, Propane, Propylene



Line 104222 Depths, Altitude



Otway Basin: Individual line plots and line summary sheets

Line Summary

Line Number 104001
No. of Shotpoints 186

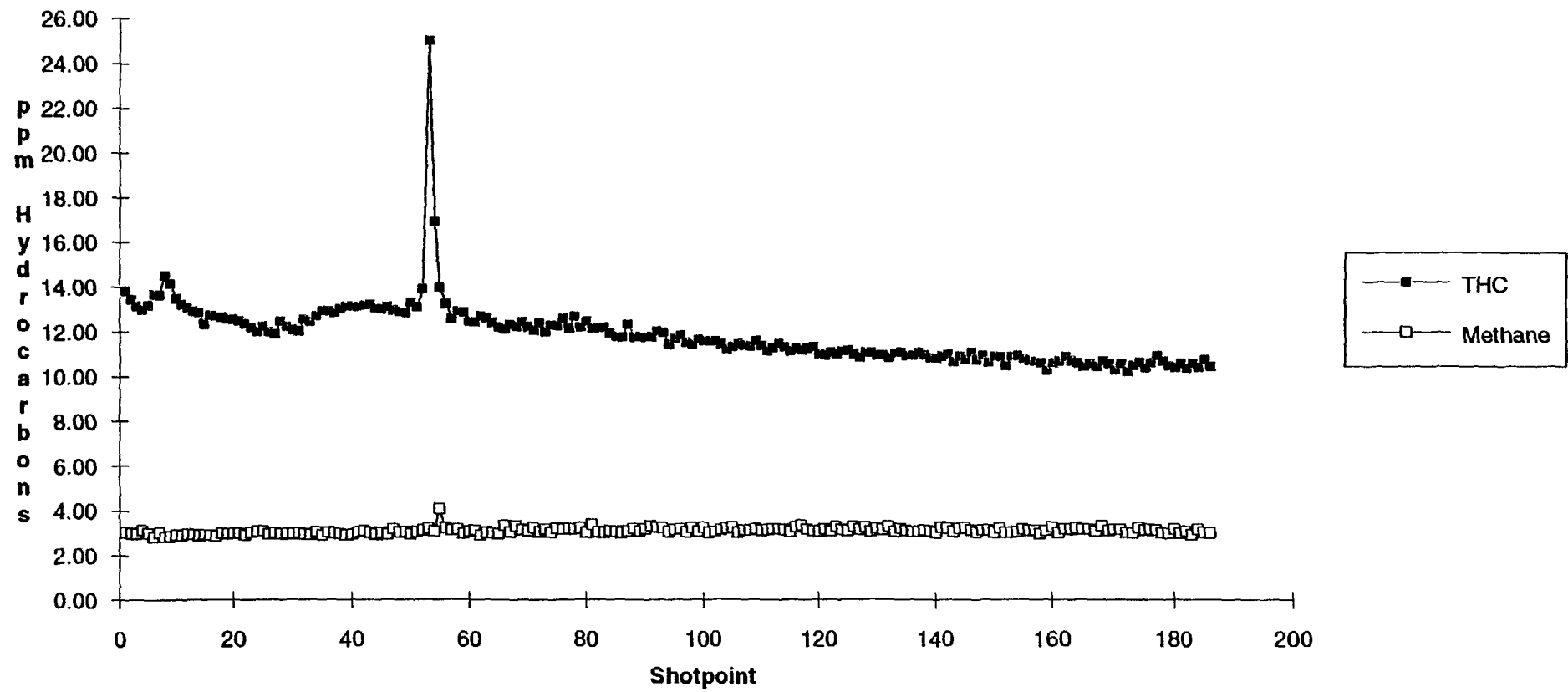
	Shotpoint	Date	Time	Latitude	Longitude
Start	1	27-Sep-91	18:23:00	39 10.294	143 03.644
End	186	28-Sep-91	00:35:53	38 55.479	142 36.237

	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	11.878	3.084	0.008	0.049	0.010	0.016	0.003	0.001	0.018	0.059	0.034	0.002	0.694
Std. Dev.	1.432	0.135	0.017	0.077	0.034	0.086	0.020	0.014	0.011	0.031	0.021	0.004	1.460
Minimum	10.211	2.799	0.000	0.025	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Maximum	25.020	4.068	0.164	0.869	0.429	1.032	0.254	0.190	0.046	0.167	0.133	0.018	12.323

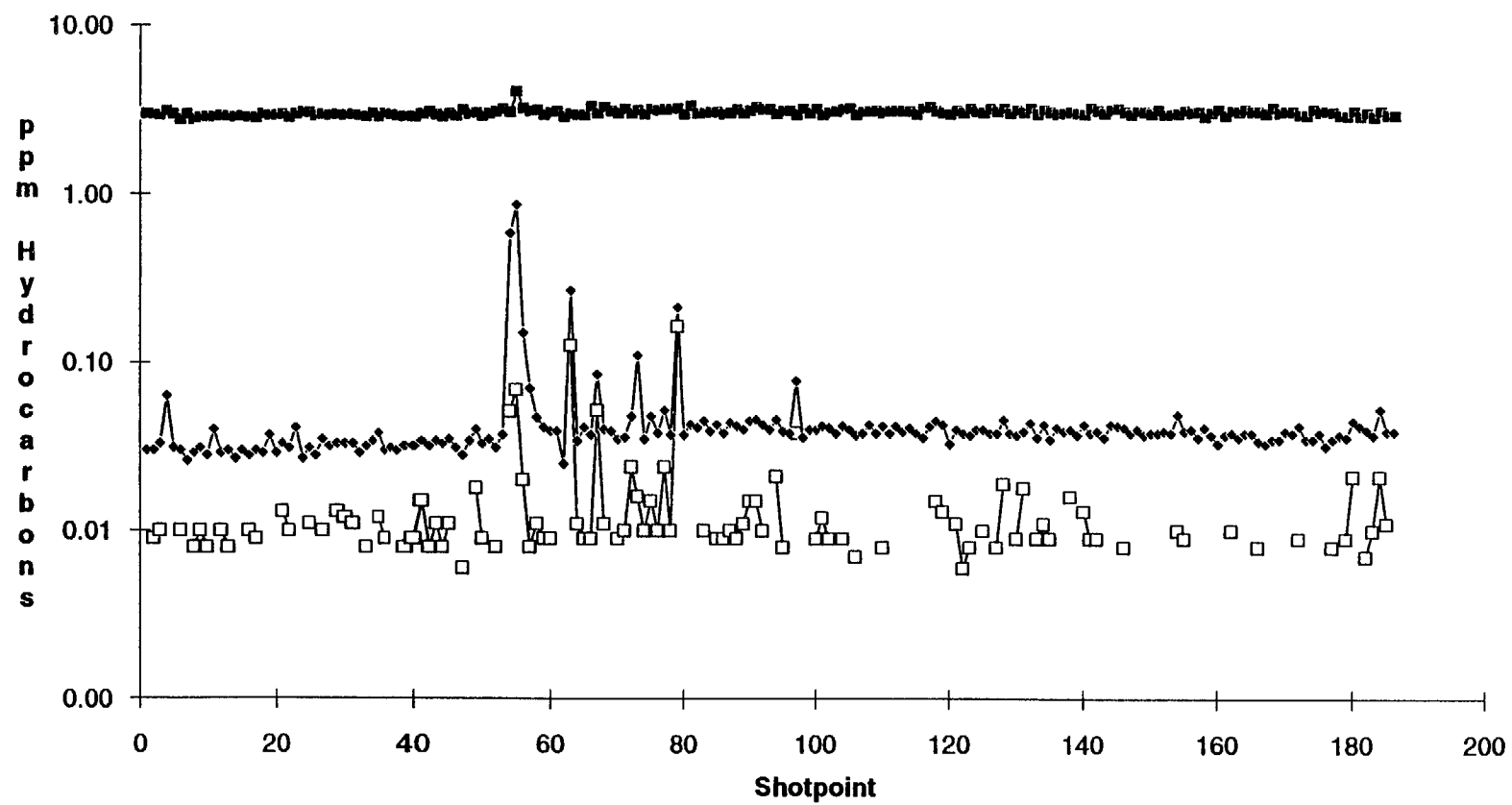
	Cond.	Temp.	Altitude	F. Depth	W.Depth
Mean	45.855	11.621	15.593	72.557	89.572
Std. Dev.	0.337	0.347	2.500	3.291	5.076
Minimum	45.220	10.980	10.700	64.200	73.000
Maximum	46.530	12.360	22.400	82.300	106.100

Notes Weak anomaly at shotpoints 53-56 comprising THC, and all C1-C4 hydrocarbons including ethylene and propylene.
Bad weather and sea conditions.

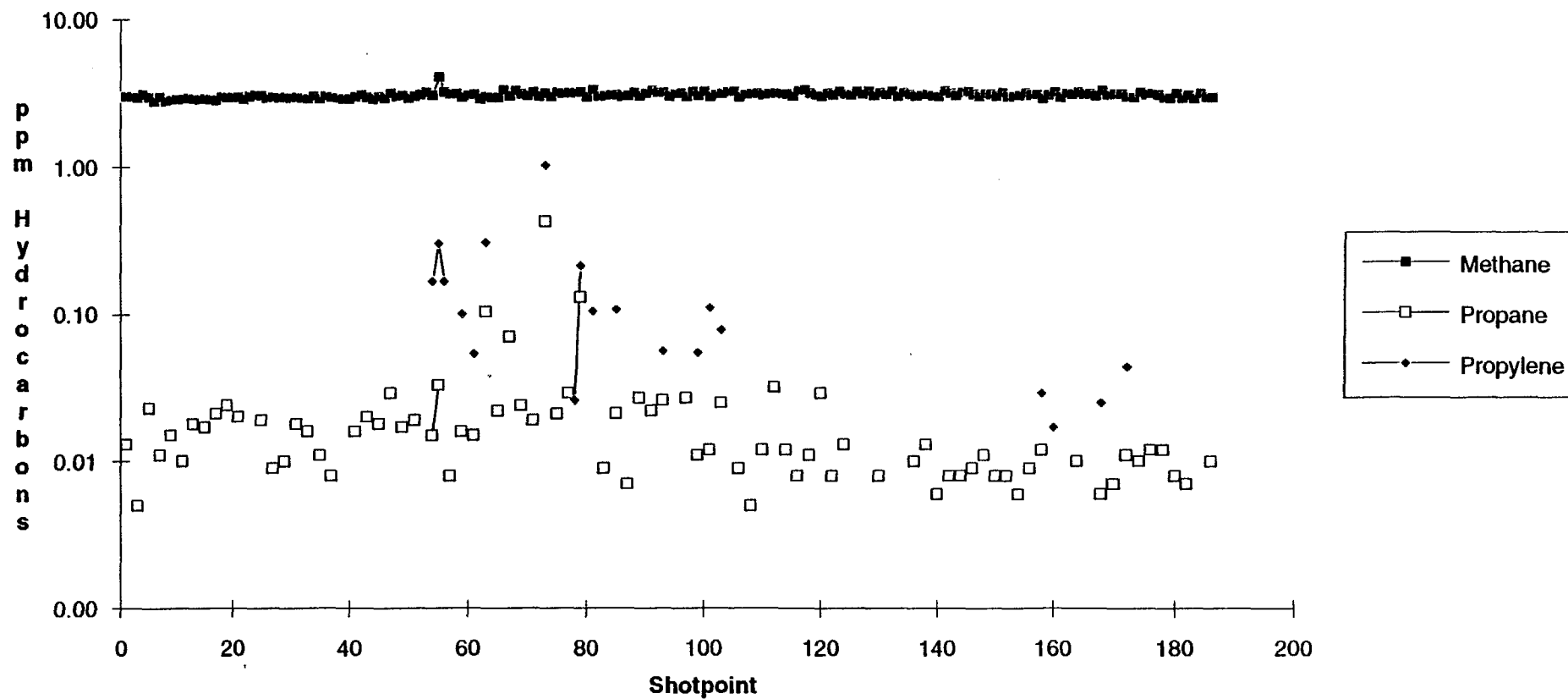
Line 104001 THC, Methane



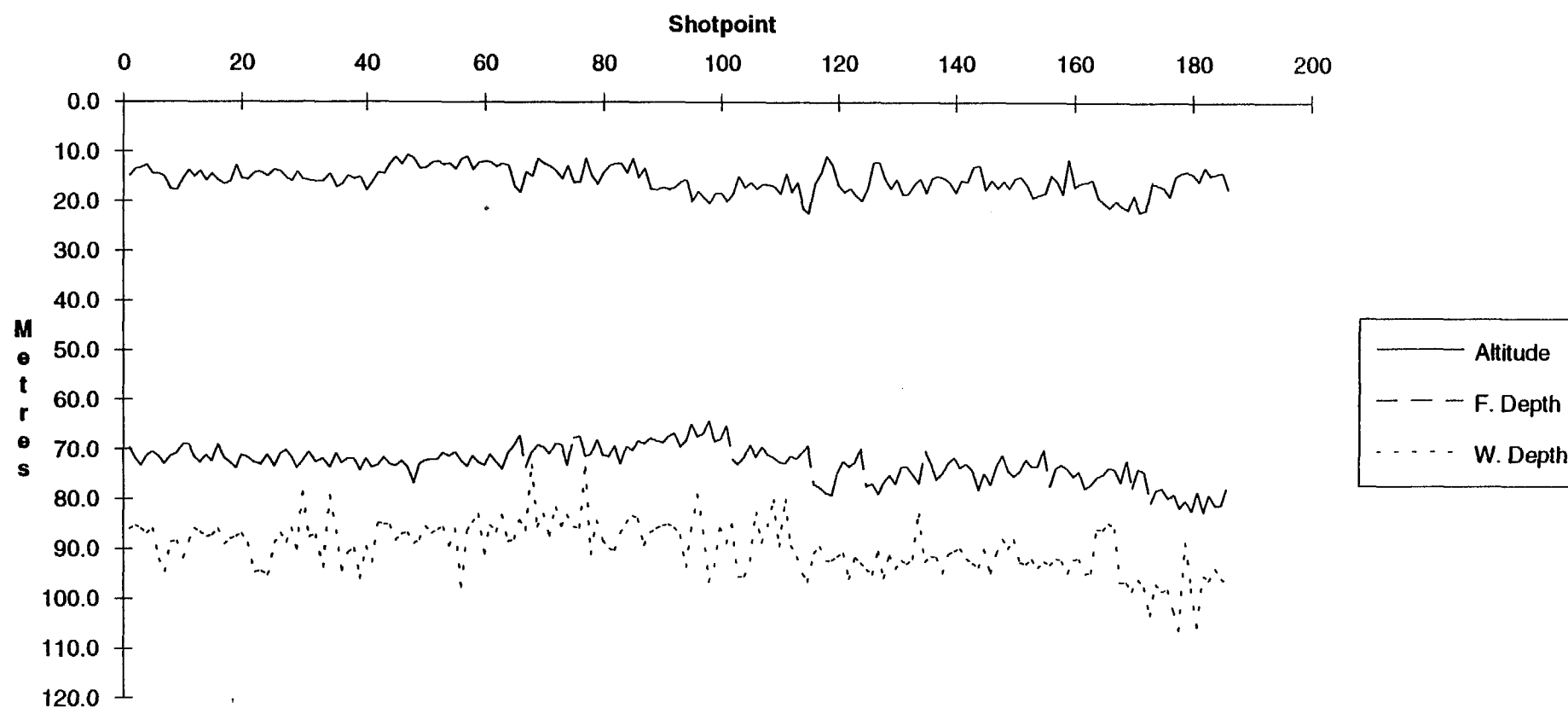
Line 104001 Methane, Ethane, Ethylene



Line 104001 Methane, Propane, Propylene



Line 104001 Depths, Altitude



Line Summary

Line Number 104002
No. of Shotpoints 220

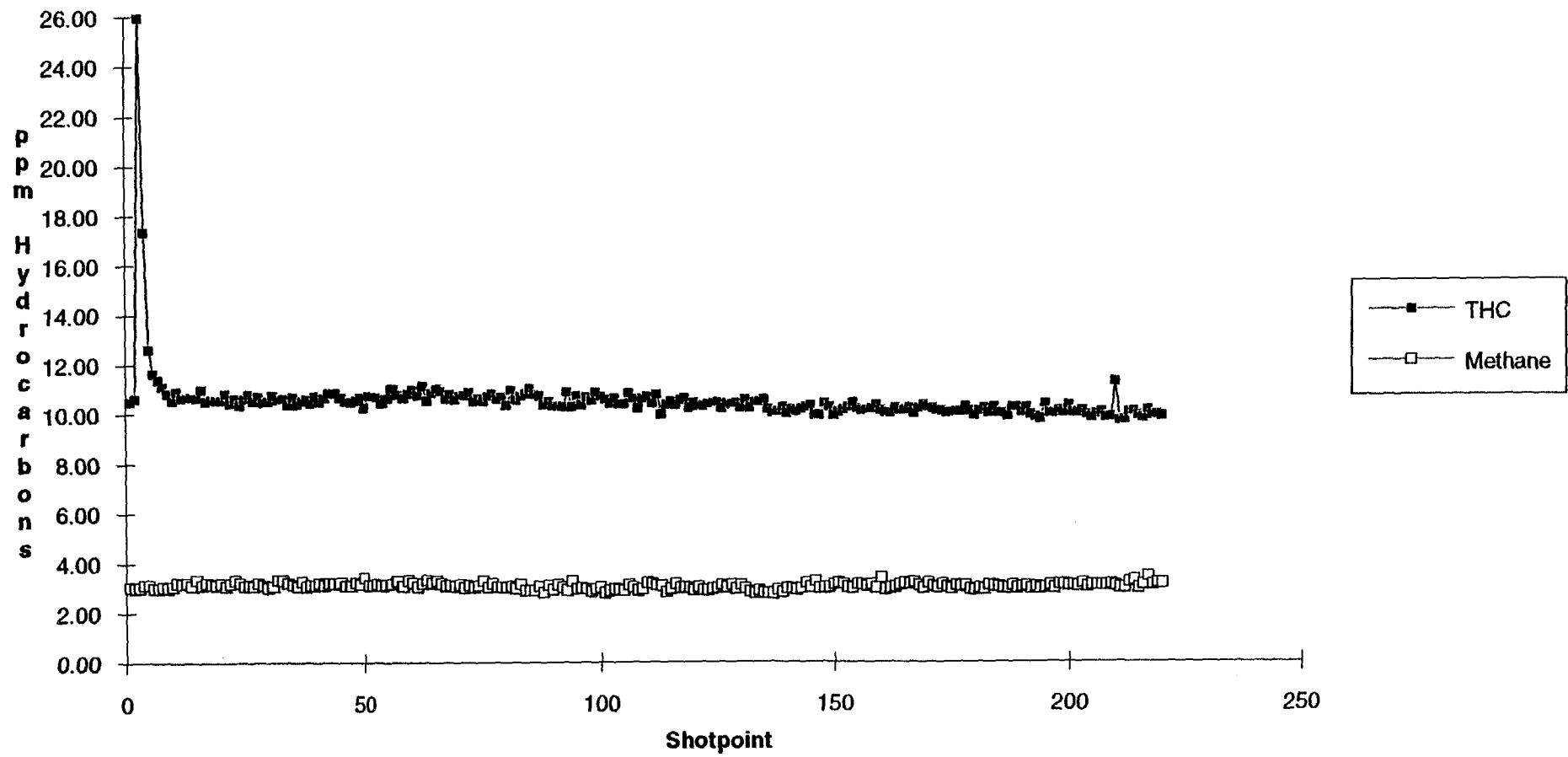
	Shotpoint	Date	Time	Latitude		Longitude	
Start	1	28/09/91	00:37:52	38	55.400	142	36.071
End	223	28/09/91	08:21:08	38	38.099	142	01.890

	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	10.523	3.058	0.006	0.042	0.004	0.003	0.001	0.000	0.013	0.052	0.034	0.003	0.373
Std. Dev.	1.202	0.120	0.011	0.010	0.005	0.010	0.009	0.005	0.009	0.020	0.015	0.004	0.495
Minimum	9.696	2.745	0.000	0.028	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Maximum	25.955	3.426	0.069	0.098	0.024	0.071	0.096	0.080	0.034	0.077	0.063	0.018	3.252

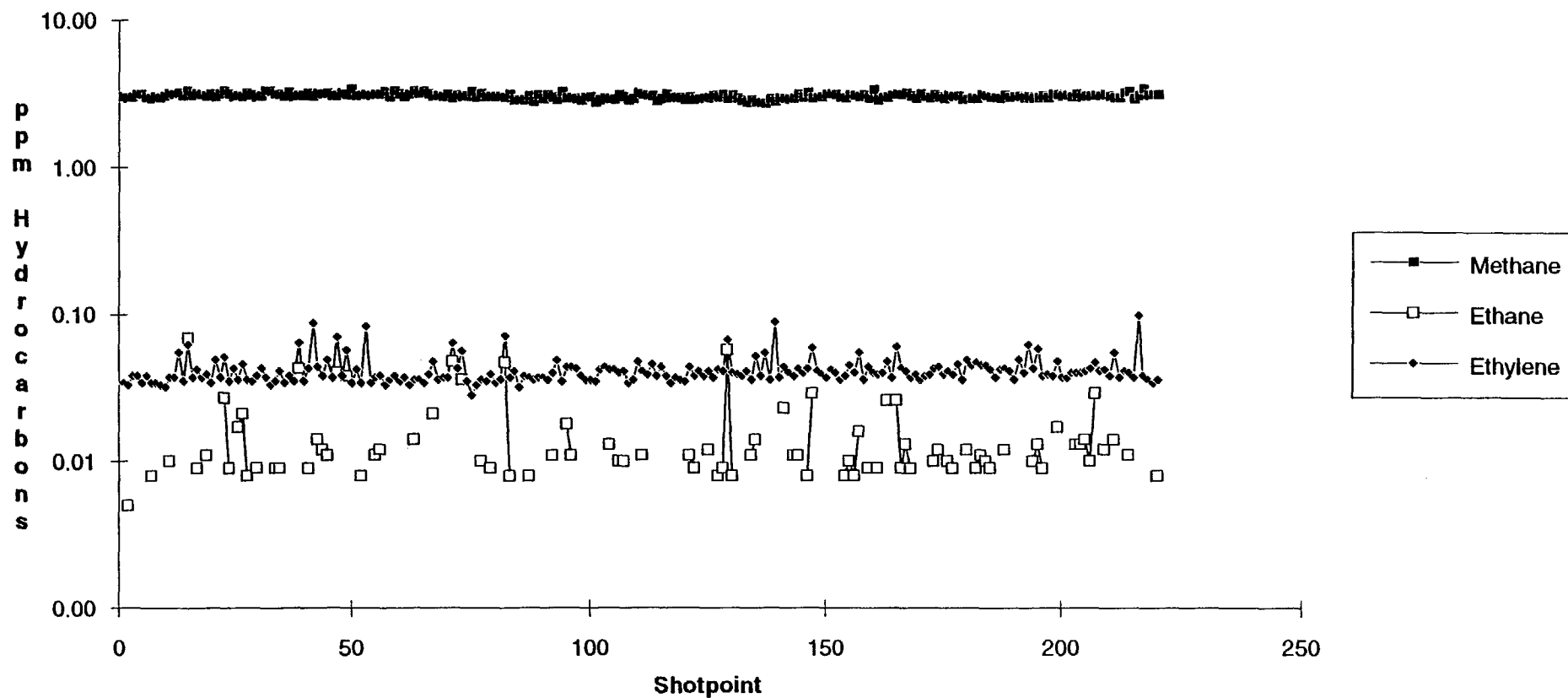
	Cond.	Temp.	Altitude	F. Depth	W.Depth
Mean	46.739	13.411	16.379	68.639	90.039
Std. Dev.	0.133	1.062	2.757	10.904	8.734
Minimum	46.390	12.290	10.600	41.300	72.700
Maximum	46.980	14.980	26.200	84.200	111.600

Notes Weak, but distinct, THC anomaly at start of line, shotpoints 3-5.
Bad weather and sea conditions.

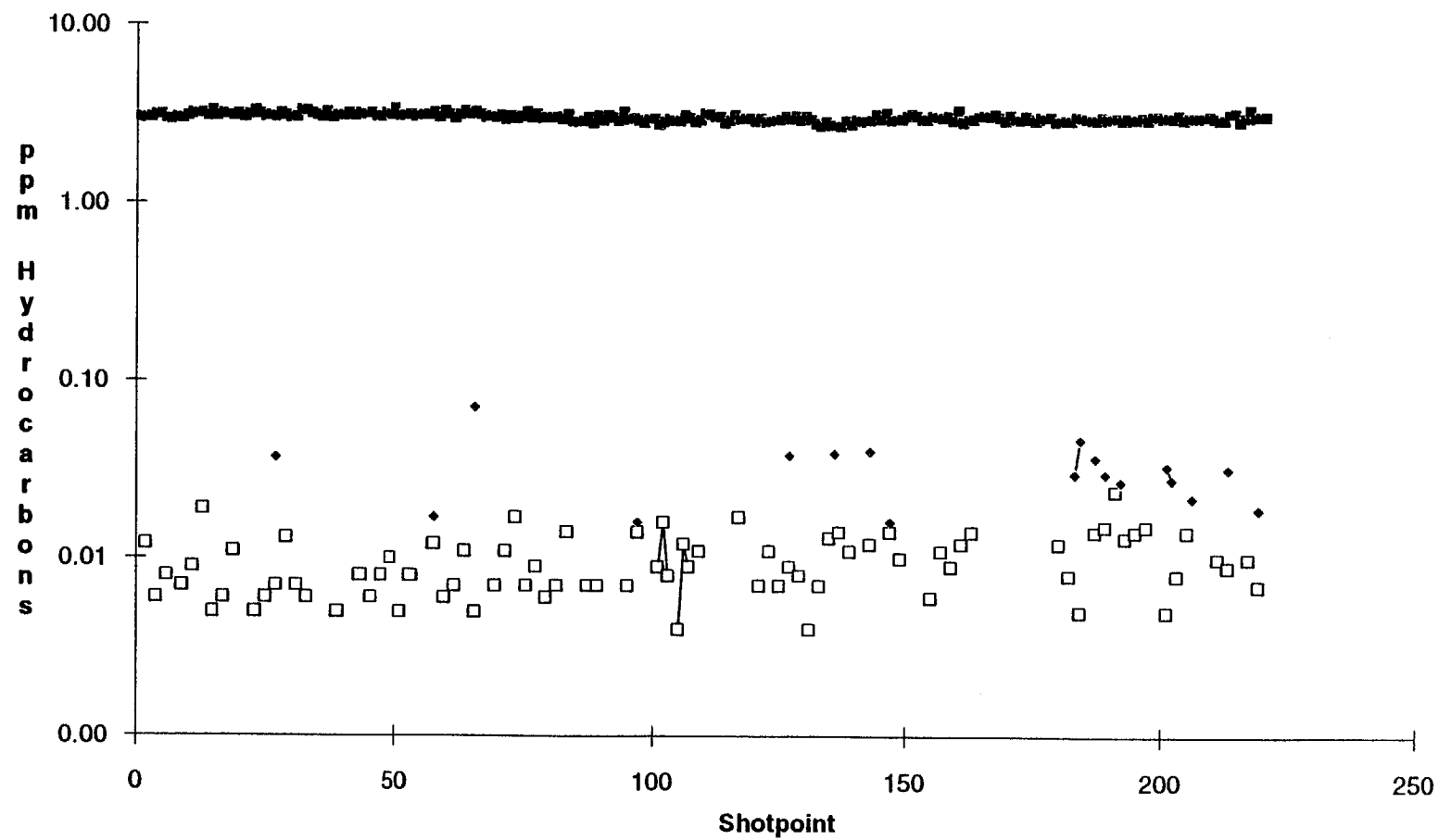
Line 104002 THC, Methane



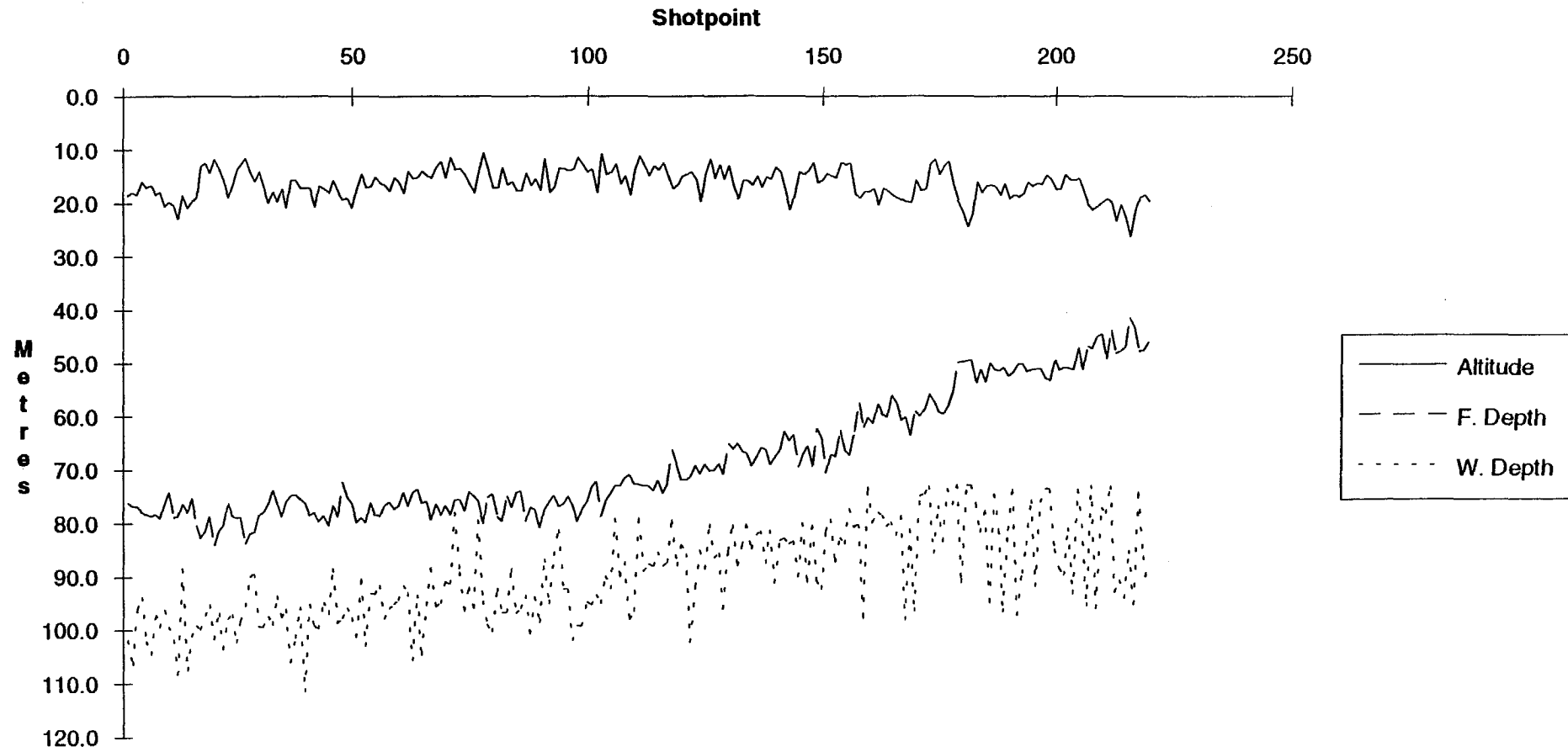
Line 104002 Methane, Ethane, Ethylene



Line 104002 Methane, Propane, Propylene



Line 104002 Depths, Altitude



Line Summary

Line Number 104003
No. of Shotpoints 85

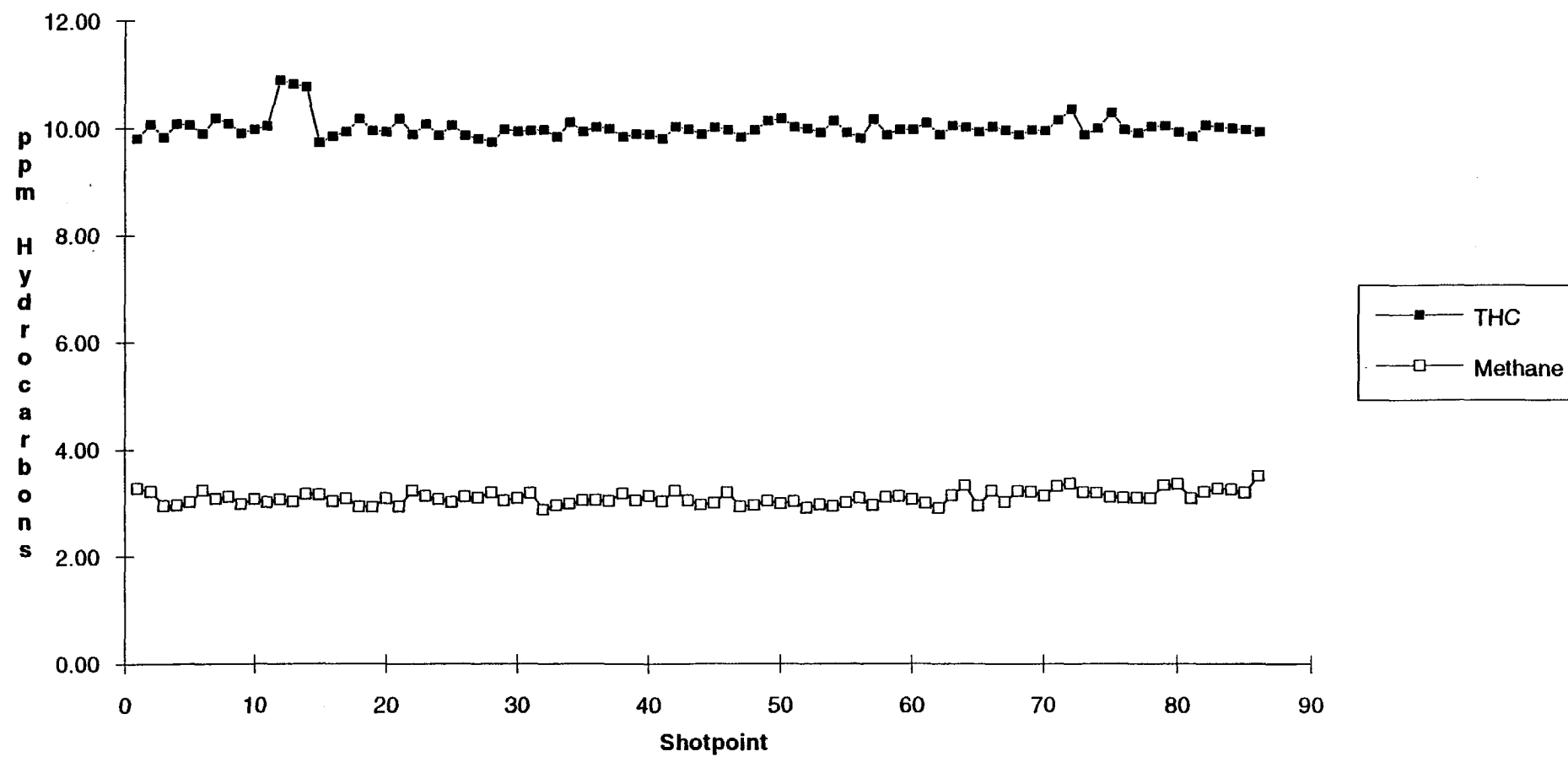
	Shotpoint	Date	Time	Latitude	Longitude
Start	1	28/09/91	08:24:13	38	142
End	88	28/09/91	11:44:36	38	142

	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	10.011	3.092	0.010	0.043	0.004	0.002	0.001	0.000	0.007	0.056	0.031	0.000	0.467
Std. Dev.	0.196	0.115	0.016	0.013	0.005	0.008	0.005	0.000	0.008	0.021	0.014	0.000	0.578
Minimum	9.742	2.876	0.000	0.034	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Maximum	10.900	3.362	0.097	0.129	0.017	0.056	0.046	0.000	0.026	0.080	0.069	0.000	3.640

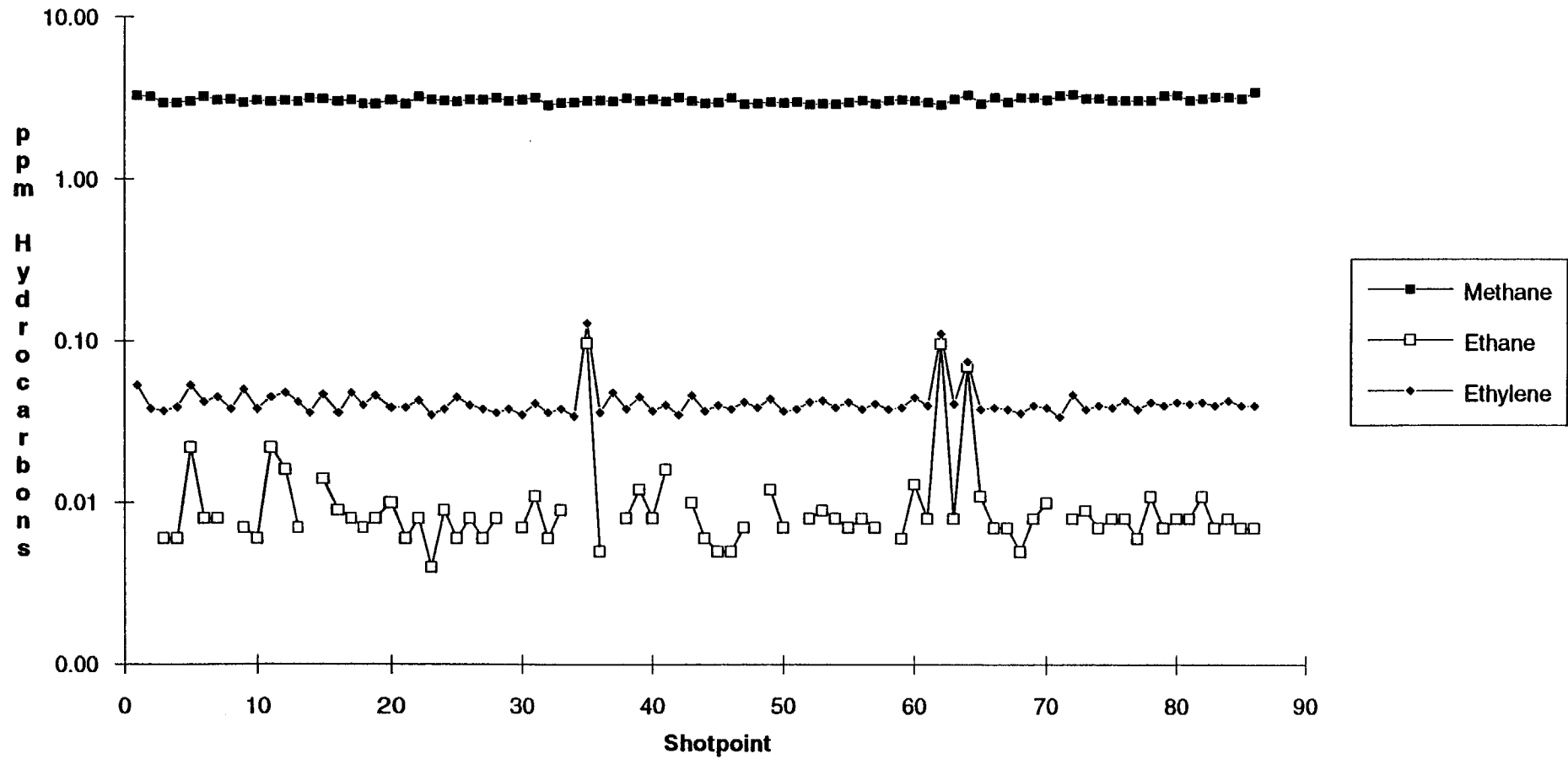
	Cond.	Temp.	Altitude	F. Depth	W. Depth
Mean	46.072	12.809	14.554	38.693	53.695
Std. Dev.	0.189	0.711	3.081	6.718	8.959
Minimum	45.780	12.340	10.300	23.100	44.800
Maximum	46.400	14.270	22.800	48.000	89.600

Notes No significant hydrocarbon anomalies.

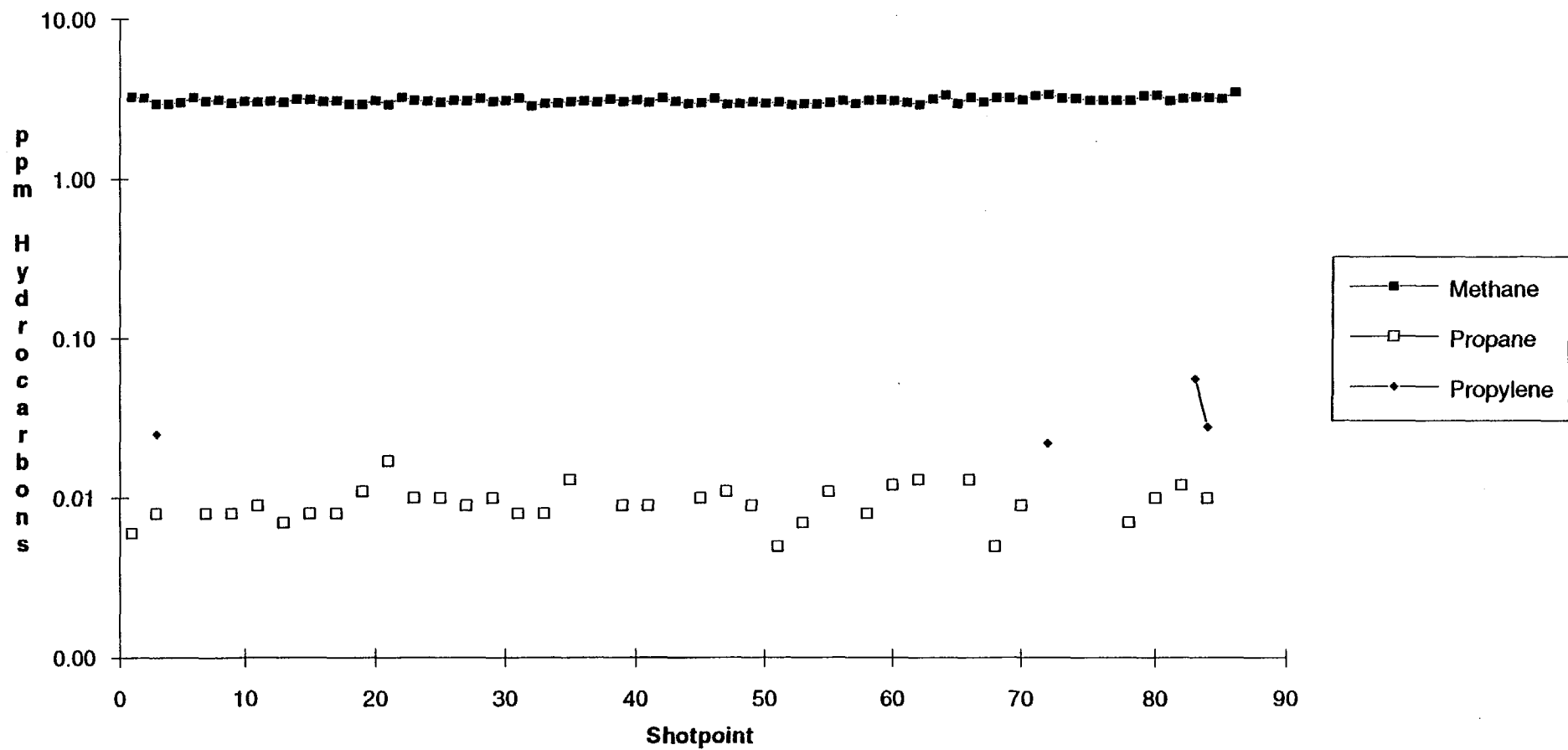
Line 104003 THC, Methane



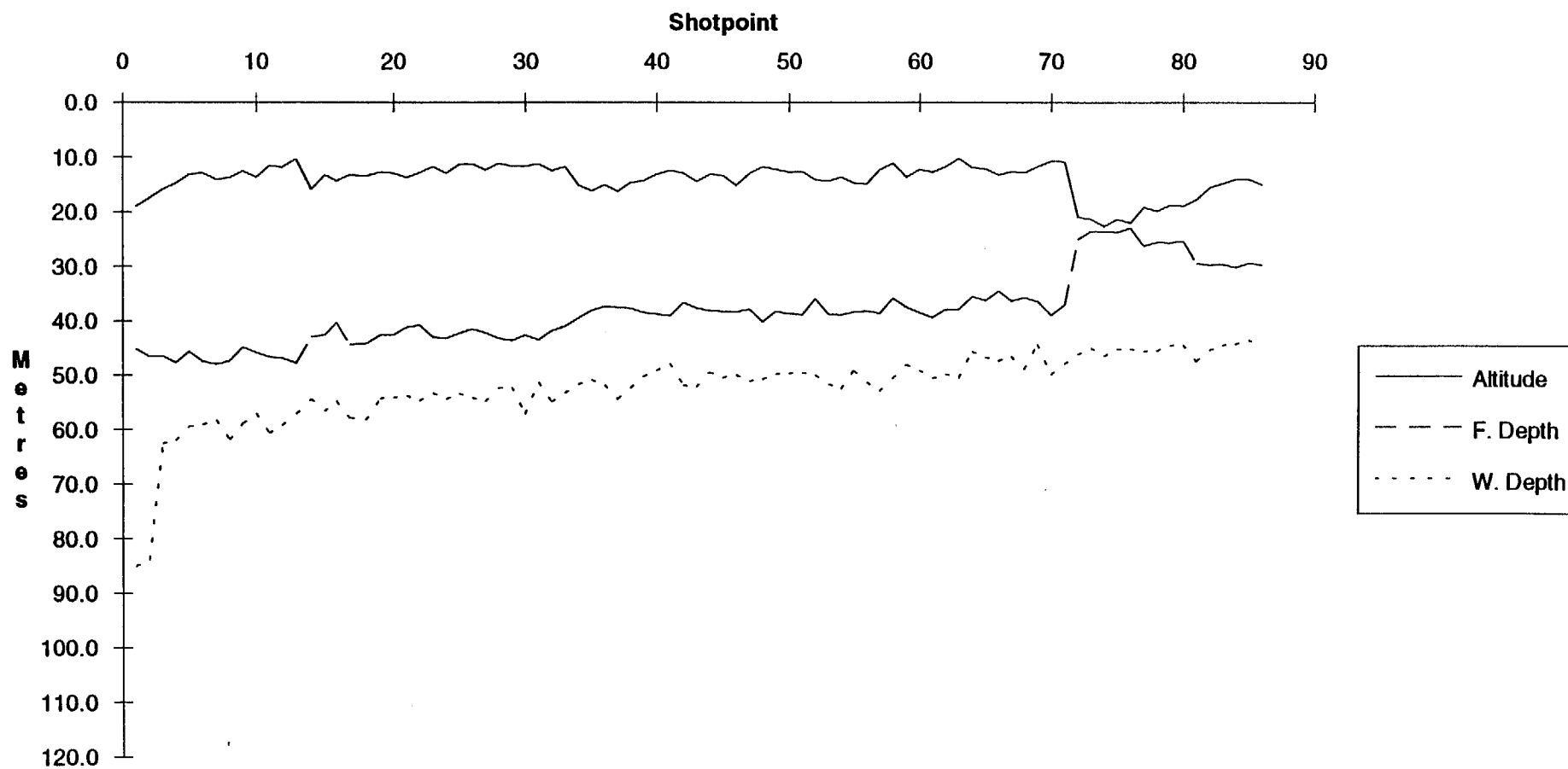
Line 104003 Methane, Ethane, Ethylene



Line 104003 Methane, Propane, Propylene



Line 104003 Depths, Altitude



Line Summary

Line Number 104004
No. of Shotpoints 157

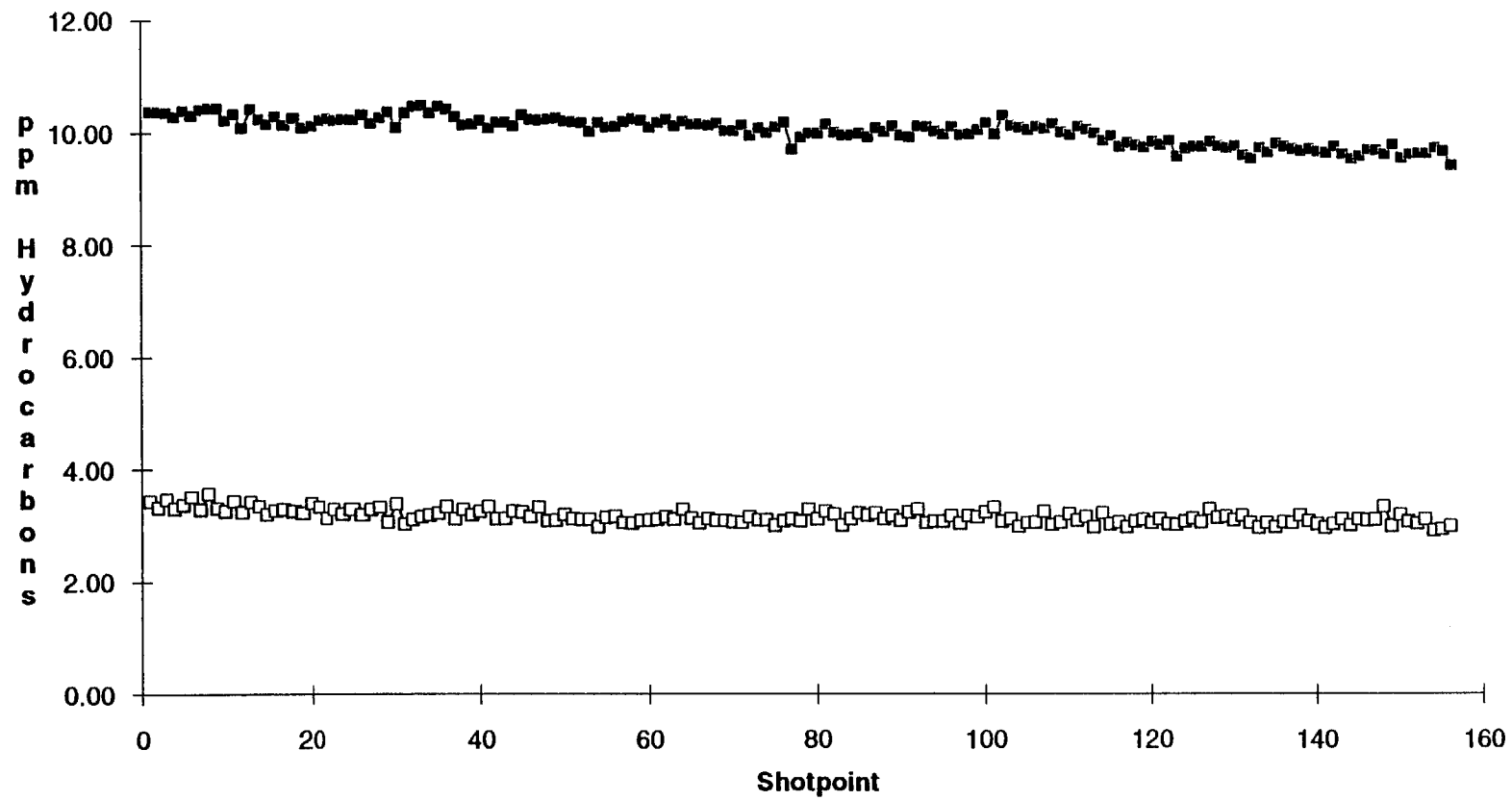
	Shotpoint	Date	Time	Latitude	Longitude	
Start	1	28/09/91	11:46:36	38	25.533 142	13.791
End	163	28/09/91	17:35:33	38	41.310 142	43.837

	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	10.039	3.156	0.010	0.043	0.004	0.010	0.004	0.002	0.007	0.066	0.026	0.001	0.616
Std. Dev.	0.246	0.126	0.004	0.006	0.006	0.022	0.014	0.013	0.008	0.024	0.012	0.004	0.652
Minimum	9.423	2.917	0.003	0.030	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.129
Maximum	10.504	3.561	0.033	0.064	0.031	0.148	0.148	0.147	0.029	0.100	0.058	0.023	5.207

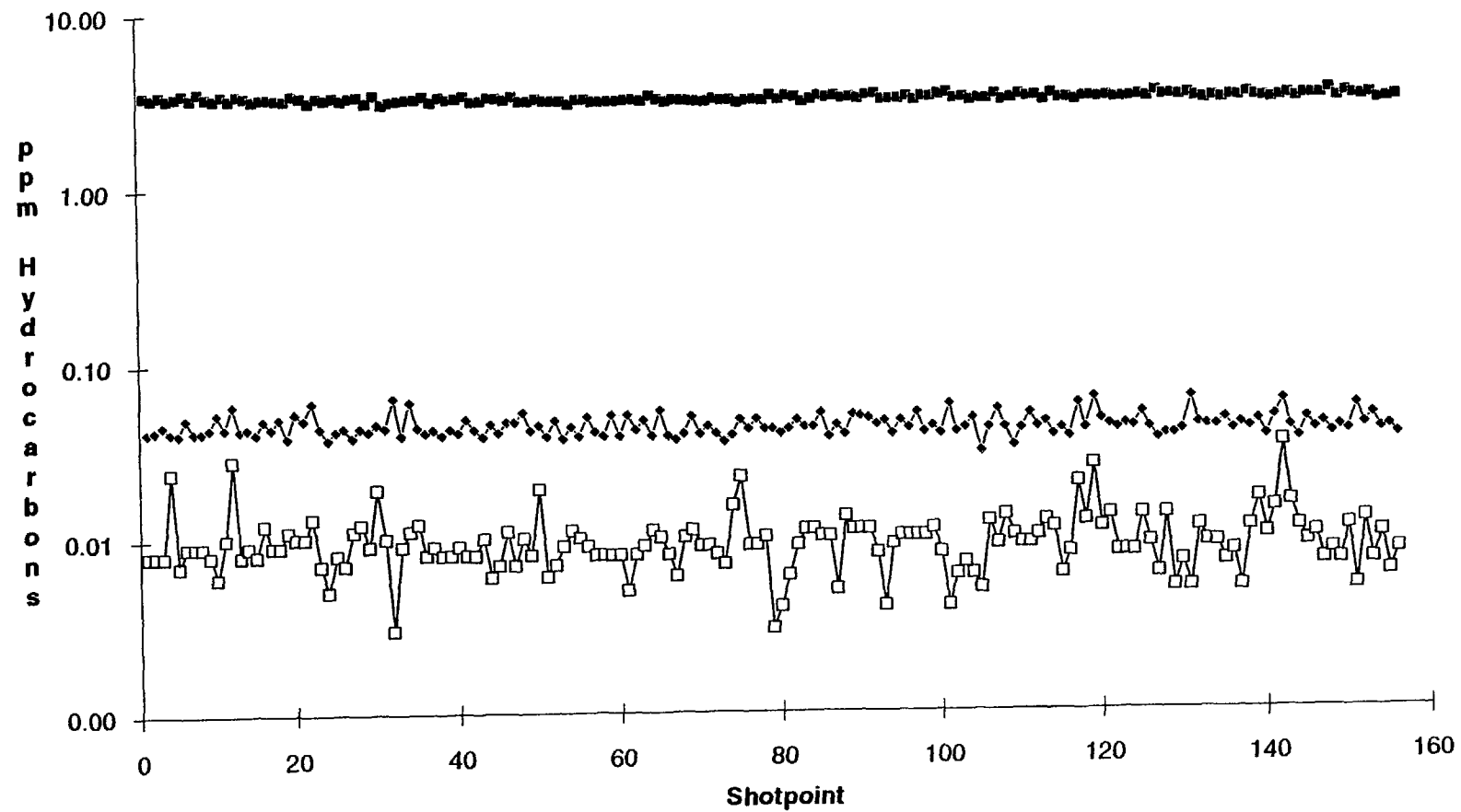
	Cond.	Temp.	Altitude	F. Depth	W.Depth
Mean	46.089	14.381	17.051	37.497	54.520
Std. Dev.	0.108	0.558	3.000	6.601	6.355
Minimum	45.760	12.380	10.200	25.100	41.500
Maximum	46.260	14.710	24.600	50.300	66.600

Notes No significant hydrocarbon anomalies.

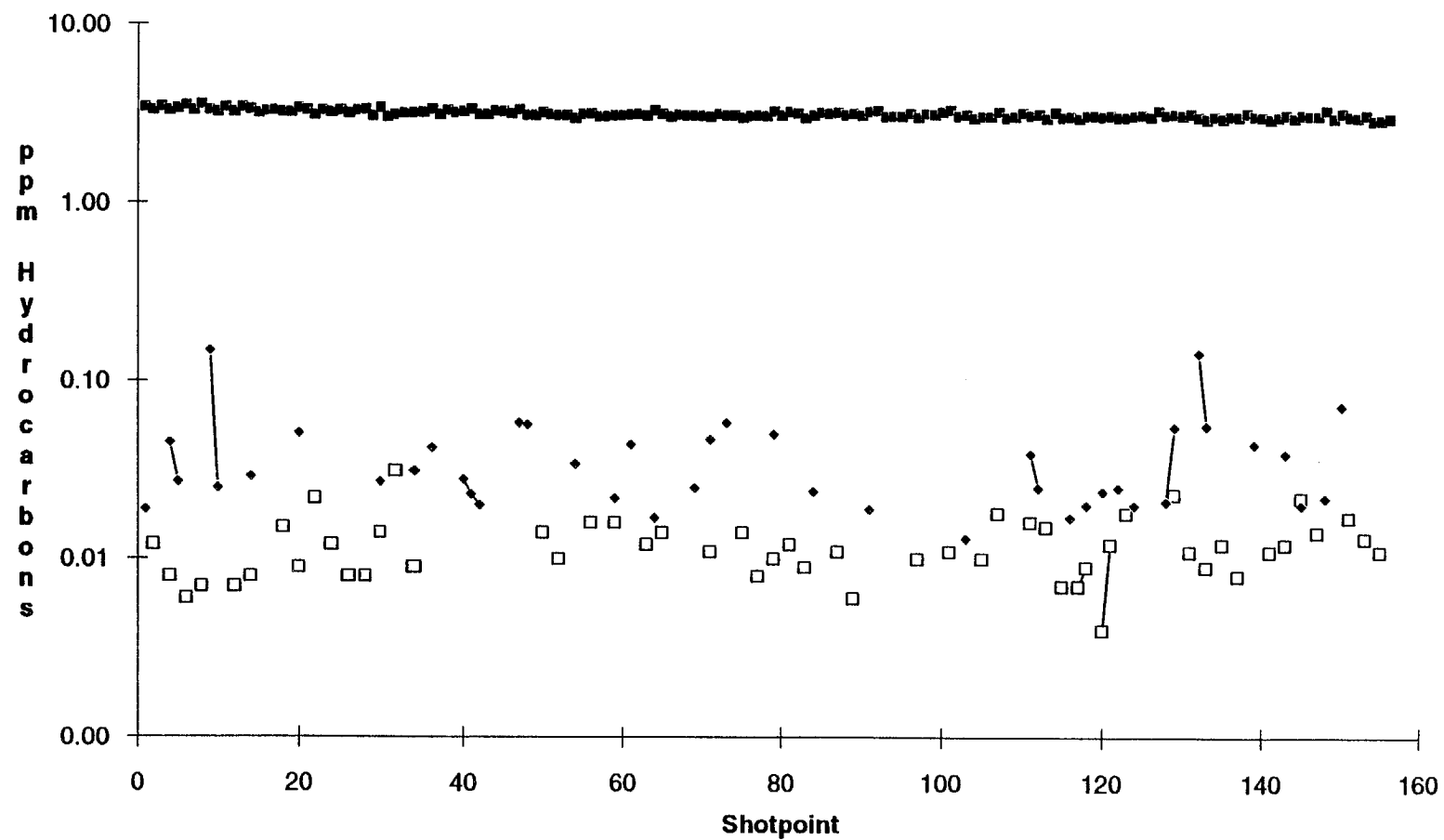
Line 104004 THC, Methane



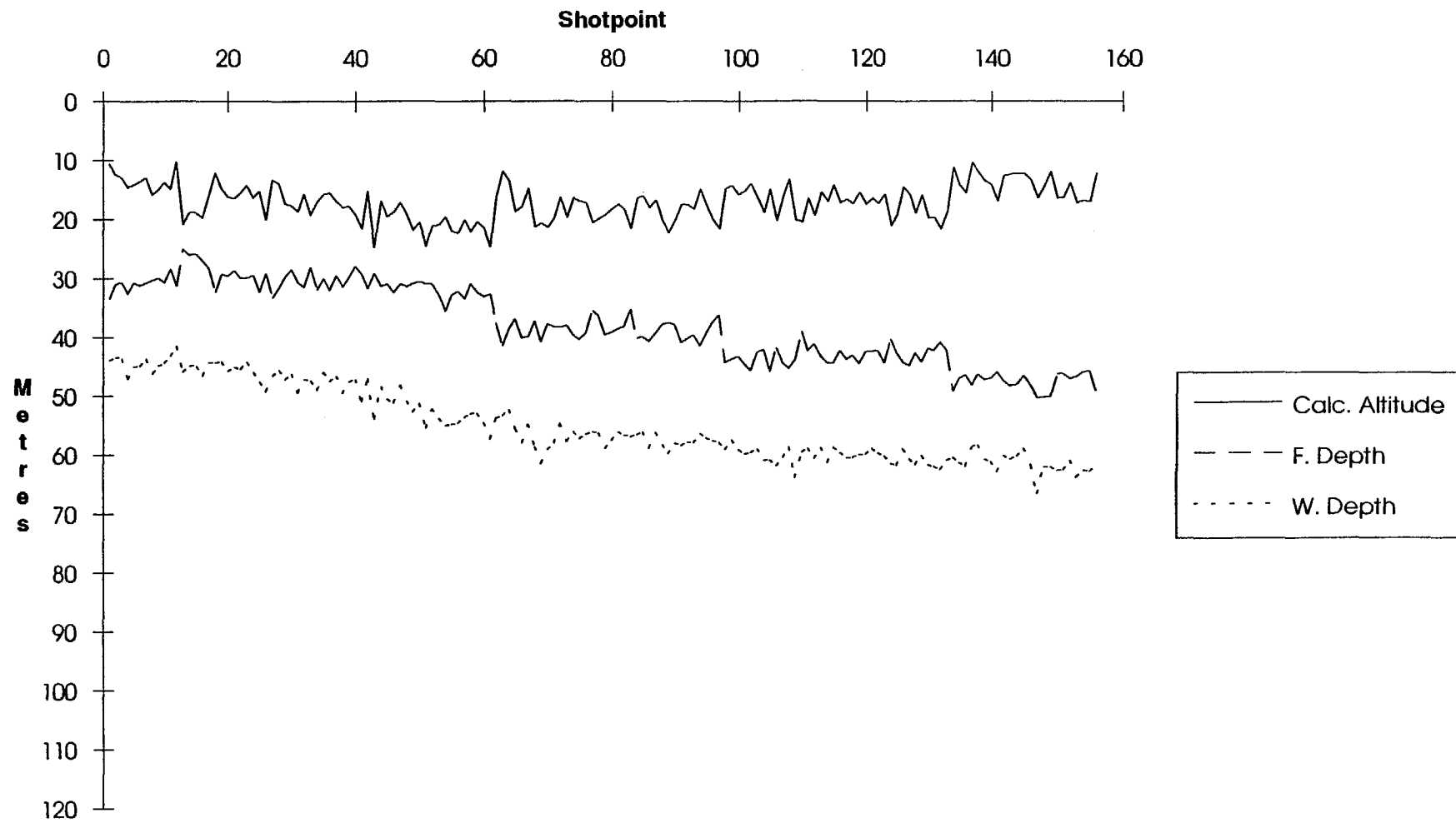
Line 104004 Methane, Ethane, Ethylene



Line 104004 Methane, Propane, Propylene



Line 10404 Depths, Altitude



Line Summary

Line Number 104005
No. of Shotpoints 33

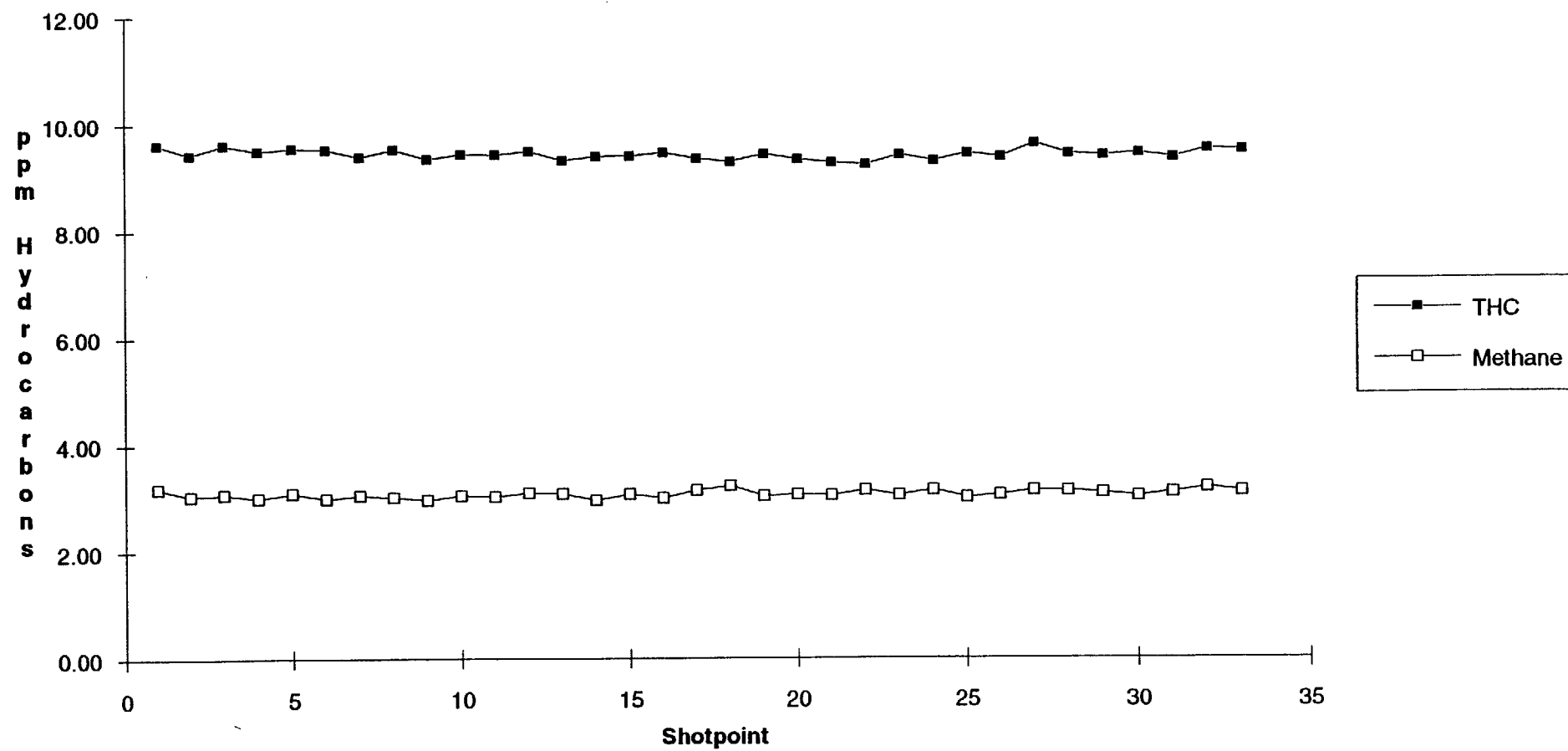
	Shotpoint	Date	Time	Latitude		Longitude	
Start	1	28/09/91	17:37:32	38	41.403	142	44.004
End	34	28/09/91	18:44:24	38	37.301	142	48.037

	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	9.426	3.068	0.008	0.038	0.003	0.001	0.000	0.000	0.004	0.059	0.029	0.000	0.353
Std. Dev.	0.099	0.062	0.002	0.003	0.005	0.005	0.000	0.000	0.007	0.021	0.013	0.000	0.174
Minimum	9.225	2.962	0.005	0.033	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.164
Maximum	9.619	3.220	0.013	0.046	0.018	0.029	0.000	0.000	0.022	0.078	0.059	0.000	0.839

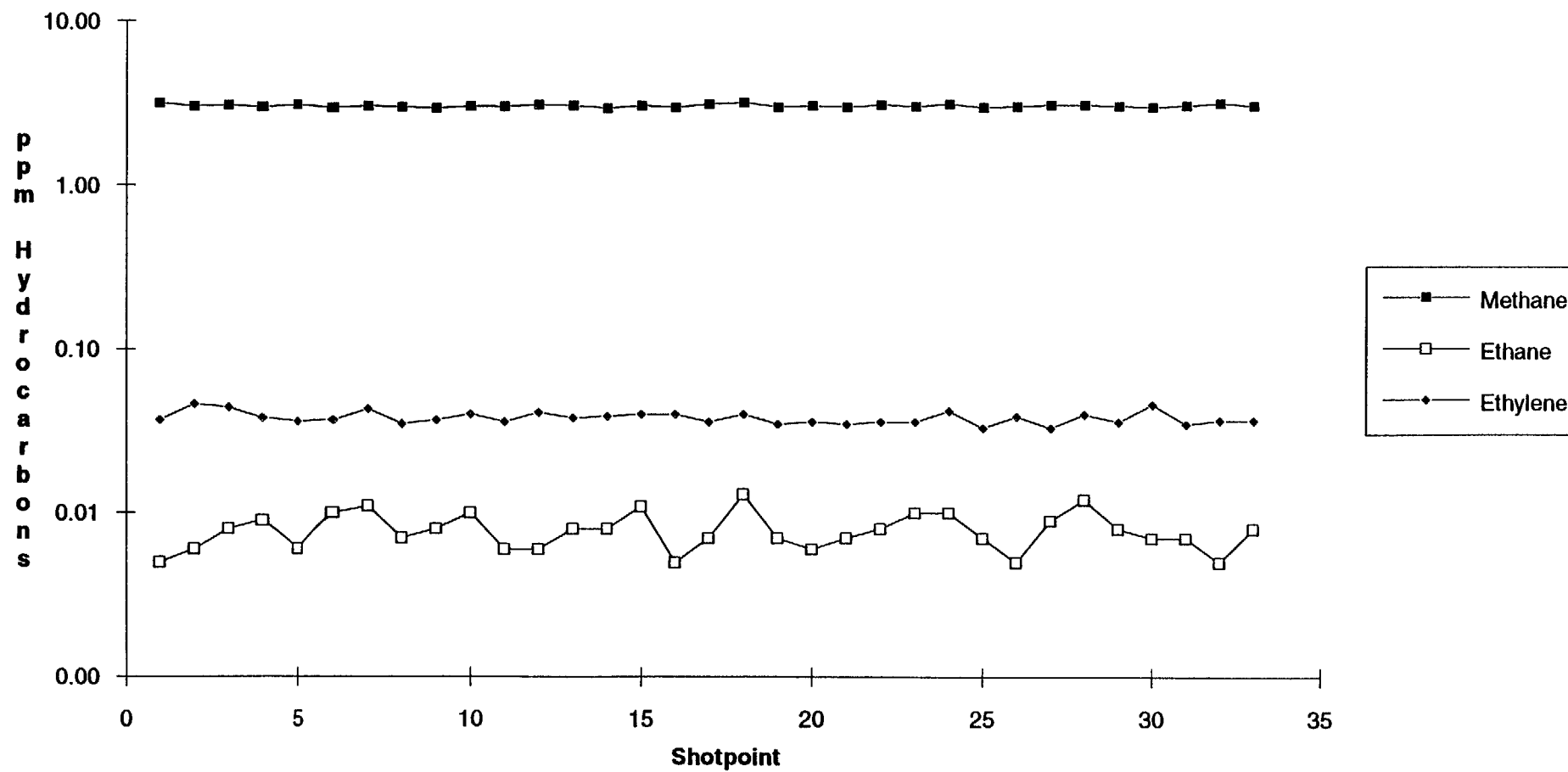
	Cond.	Temp.	Altitude	F. Depth	W.Depth
Mean	46.100	14.592	17.461	39.430	56.891
Std. Dev.	0.134	0.088	2.712	7.076	5.410
Minimum	45.820	14.410	12.900	27.600	47.000
Maximum	46.250	14.710	25.200	49.100	64.400

Notes No significant hydrocarbon anomalies.

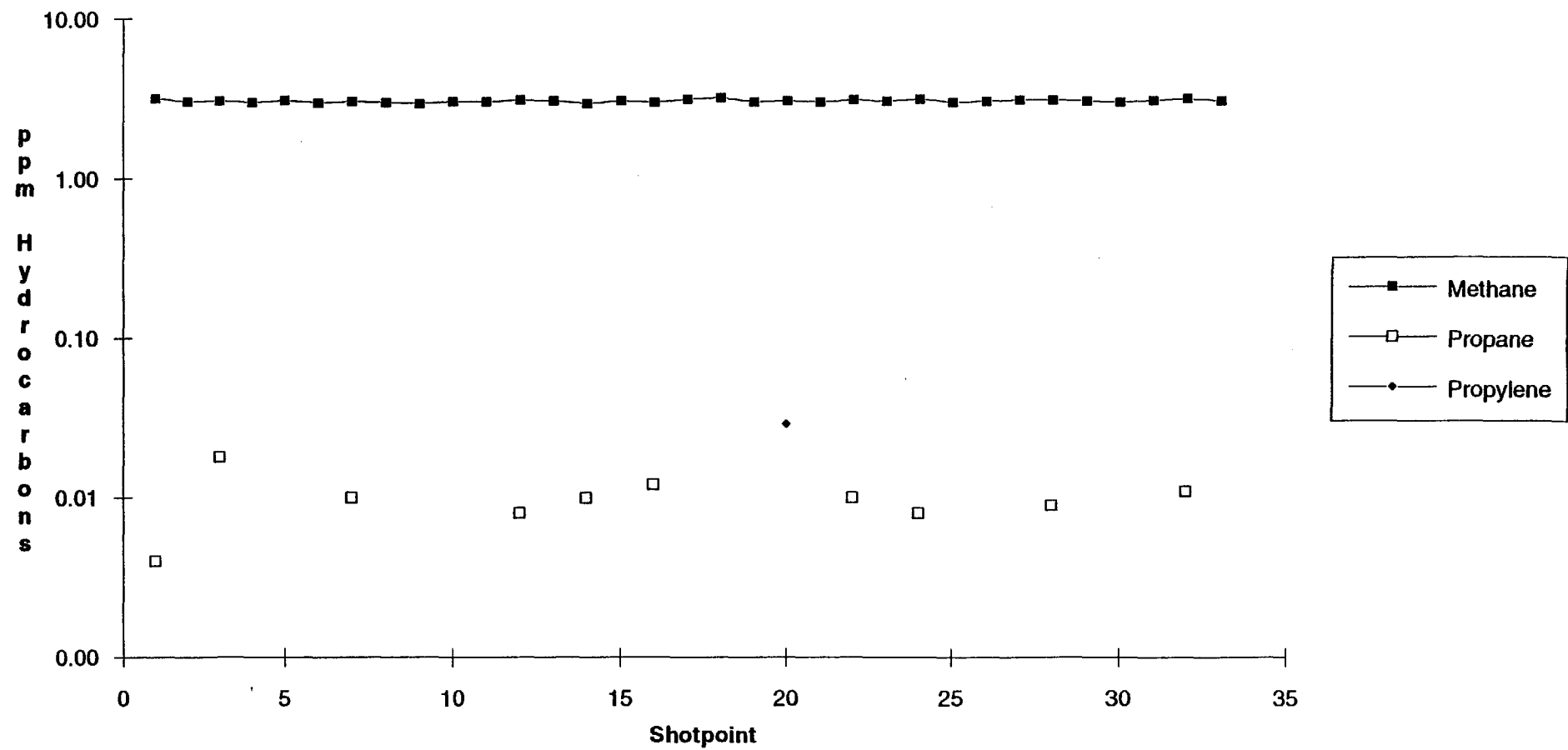
Line 104005 THC, Methane



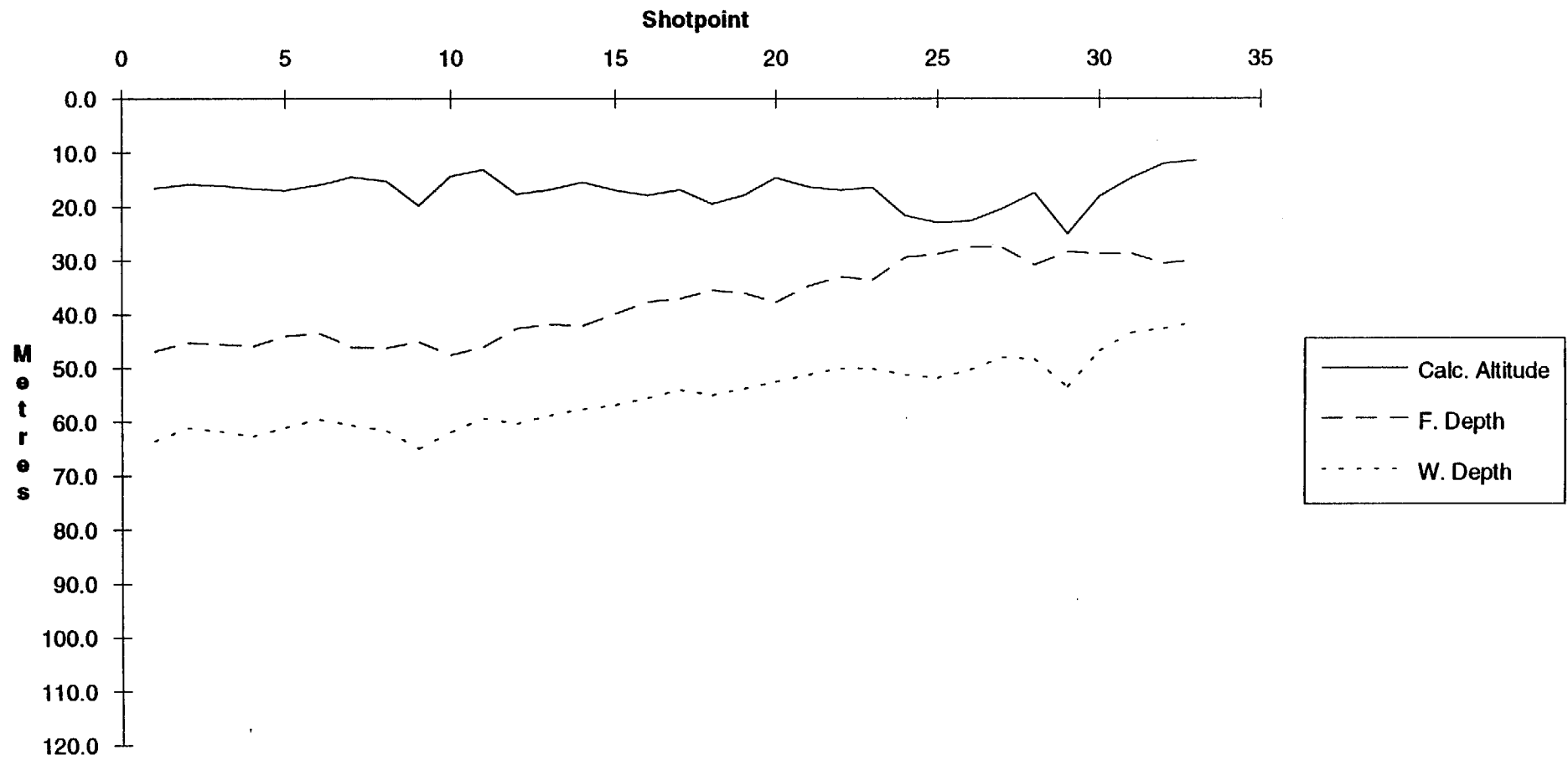
Line 104005 Methane, Ethane, Ethylene



Line 104005 Methane, Propane, Propylene



Line 104005 Depths, Altitude



Line Summary

Line Number 104006
No. of Shotpoints 61

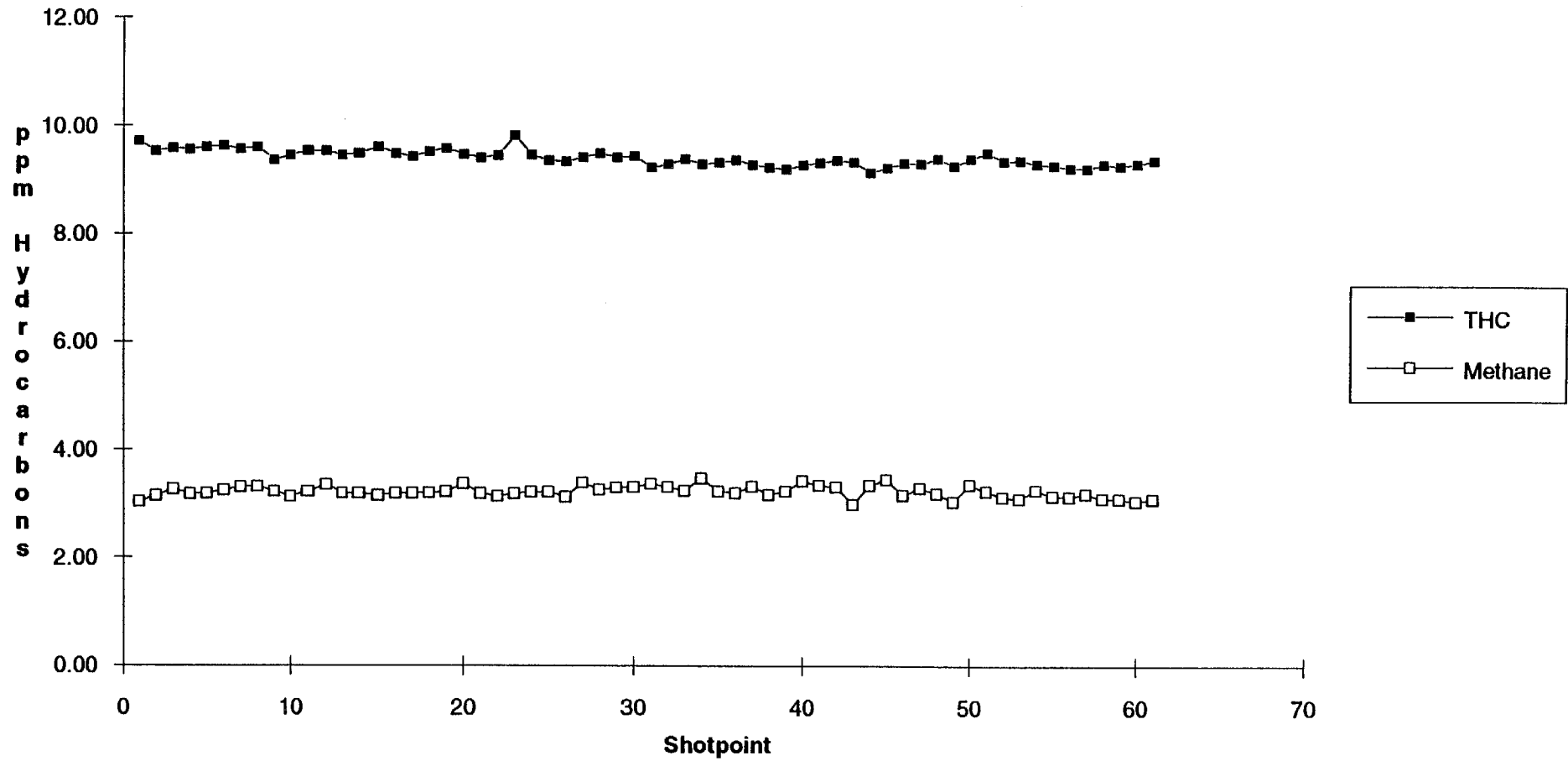
	Shotpoint	Date	Time	Latitude	Longitude	
Start	1	28/09/91	18:46:24	38	142	48.163
End	61	28/09/91	20:46:40	38	142	58.745

	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	9.411	3.221	0.009	0.040	0.004	0.008	0.001	0.001	0.004	0.056	0.027	0.001	0.469
Std. Dev.	0.138	0.105	0.006	0.006	0.007	0.016	0.005	0.004	0.007	0.022	0.013	0.003	0.275
Minimum	9.147	2.989	0.003	0.029	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.175
Maximum	9.834	3.474	0.040	0.058	0.023	0.063	0.033	0.032	0.026	0.083	0.054	0.013	1.236

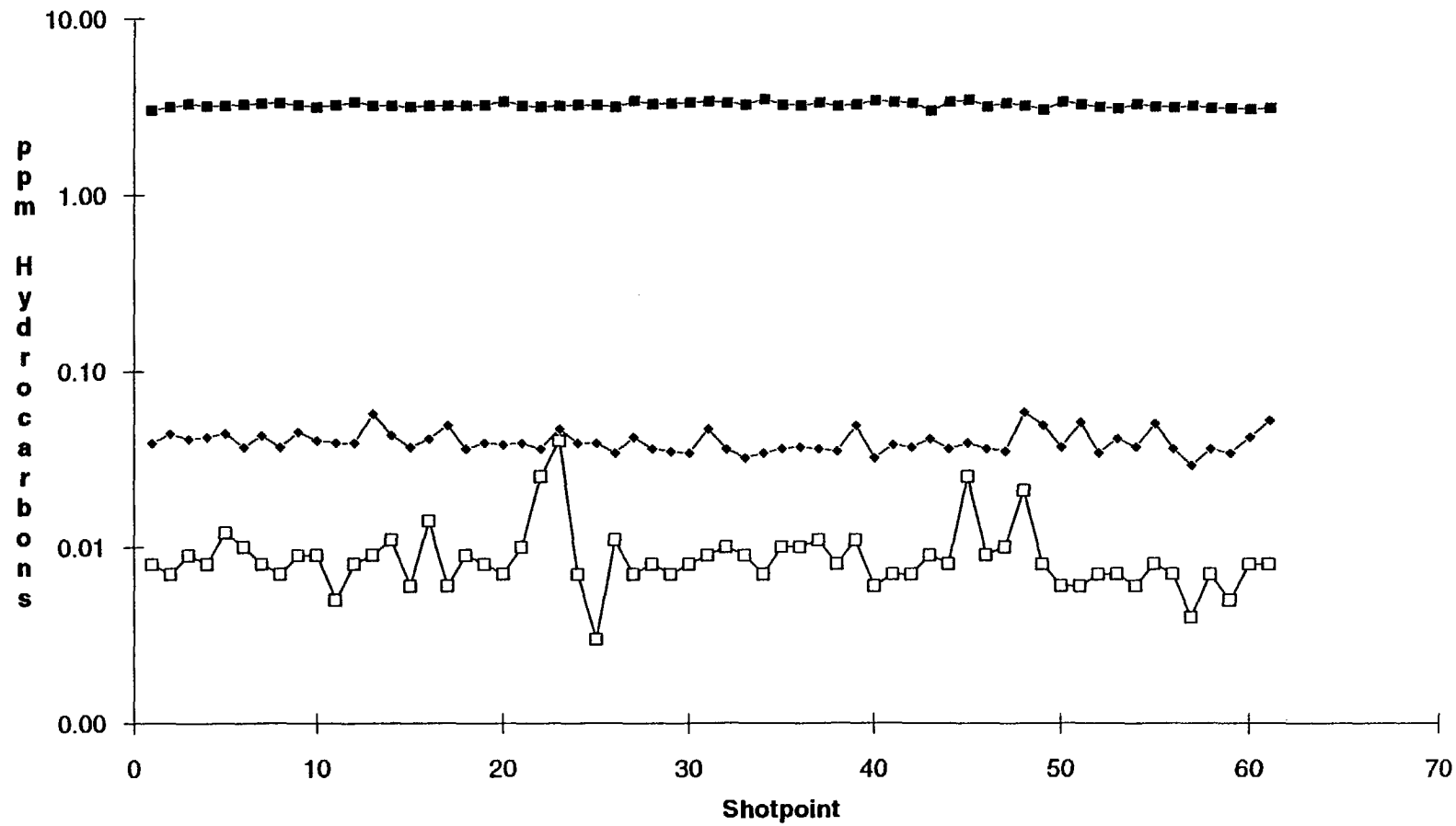
	Cond.	Temp.	Altitude	F. Depth	W.Depth
Mean	45.945	14.511	14.302	36.838	51.126
Std. Dev.	0.127	0.085	2.703	8.246	8.812
Minimum	45.690	14.380	8.000	24.500	37.600
Maximum	46.170	14.670	20.400	49.300	63.800

Notes Weak ethane anomaly, shotpoint 22-23.

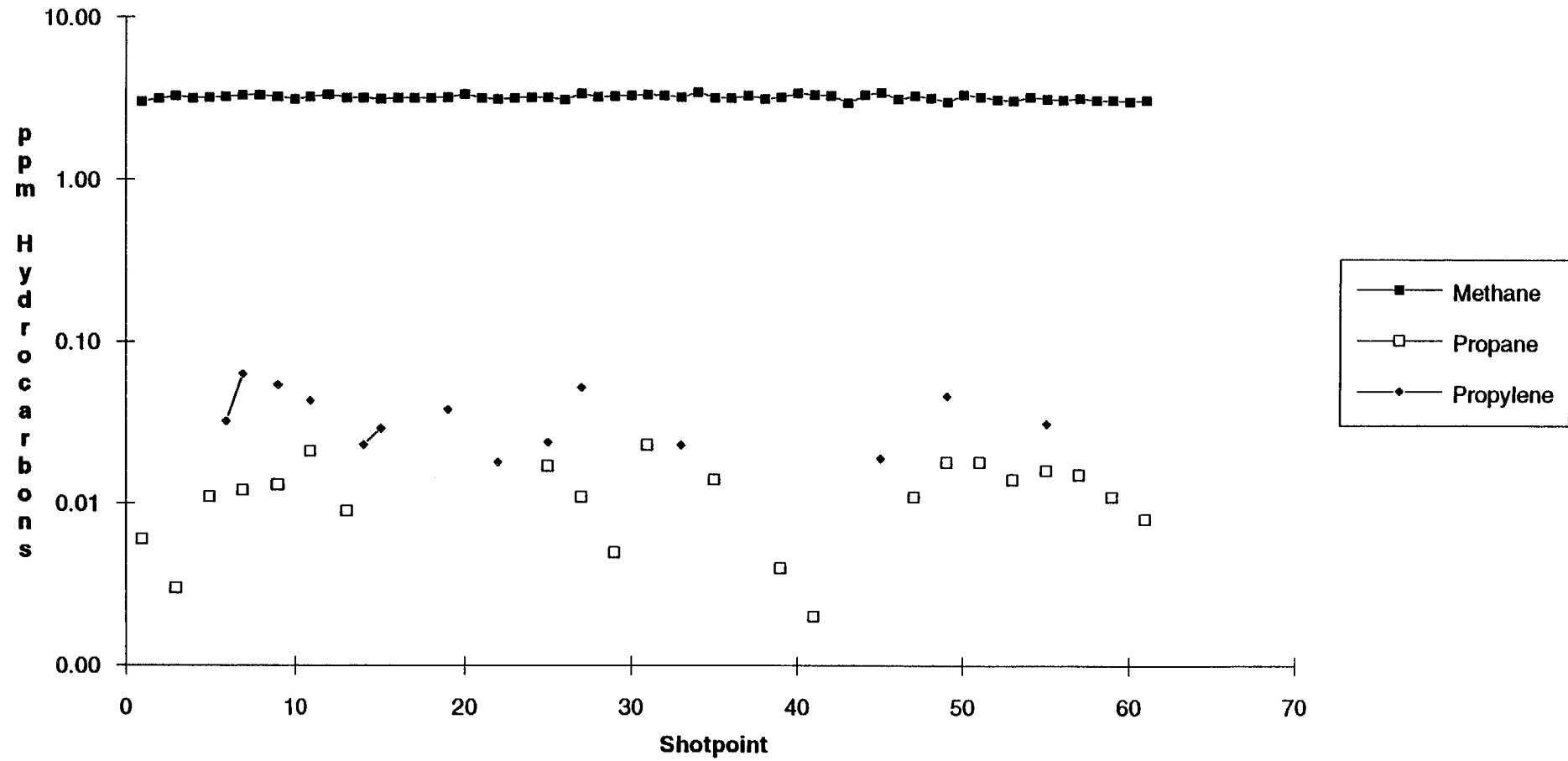
Line 104006 THC, Methane



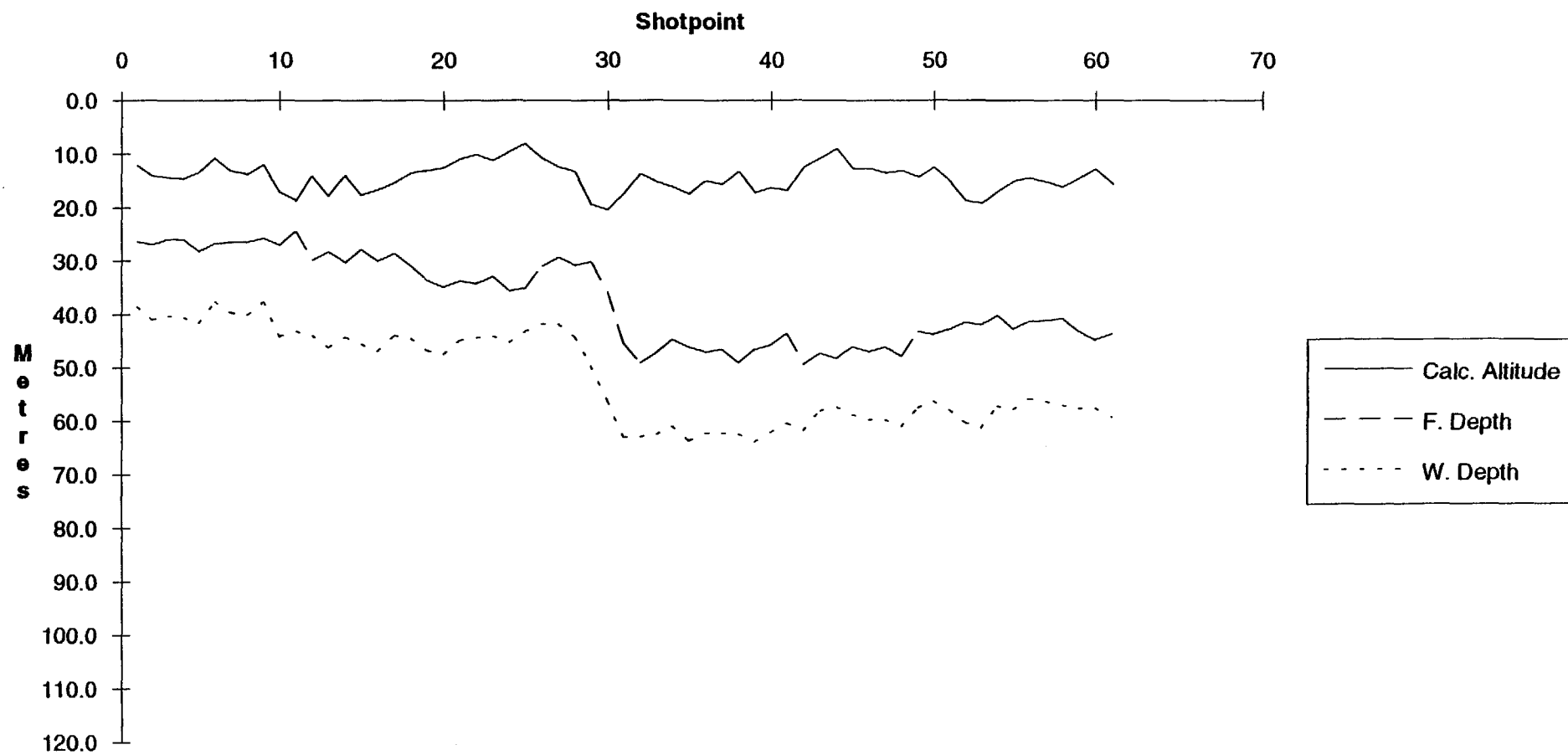
Line 104006 Methane, Ethane, Ethylene



Line 104006 Methane, Propane, Propylene



Line 104006 Depths, Altitude



Line Summary

Line Number 104007
No. of Shotpoints 50

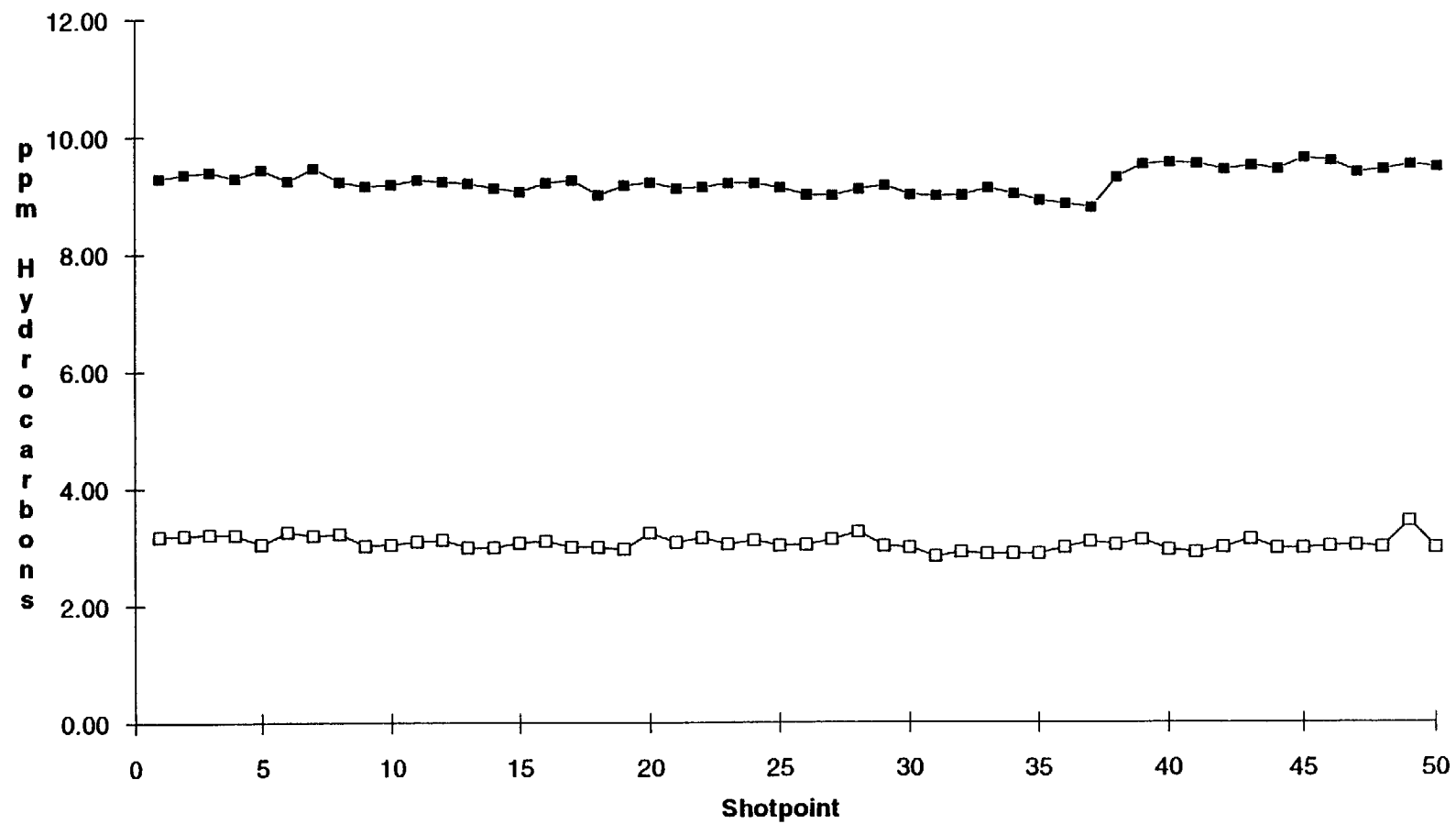
	Shotpoint	Date	Time	Latitude	Longitude
Start	1	28/09/91	20:48:39	38	42.695 142 58.918
End	50	28/09/91	22:26:52	38	49.094 142 53.540

	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	9.236	3.054	0.008	0.037	0.003	0.001	0.004	0.000	0.007	0.052	0.025	0.002	0.494
Std. Dev.	0.203	0.118	0.003	0.004	0.005	0.010	0.015	0.000	0.009	0.022	0.013	0.004	0.496
Minimum	8.782	2.826	0.004	0.030	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.132
Maximum	9.626	3.427	0.025	0.060	0.013	0.068	0.085	0.000	0.027	0.080	0.045	0.014	3.003

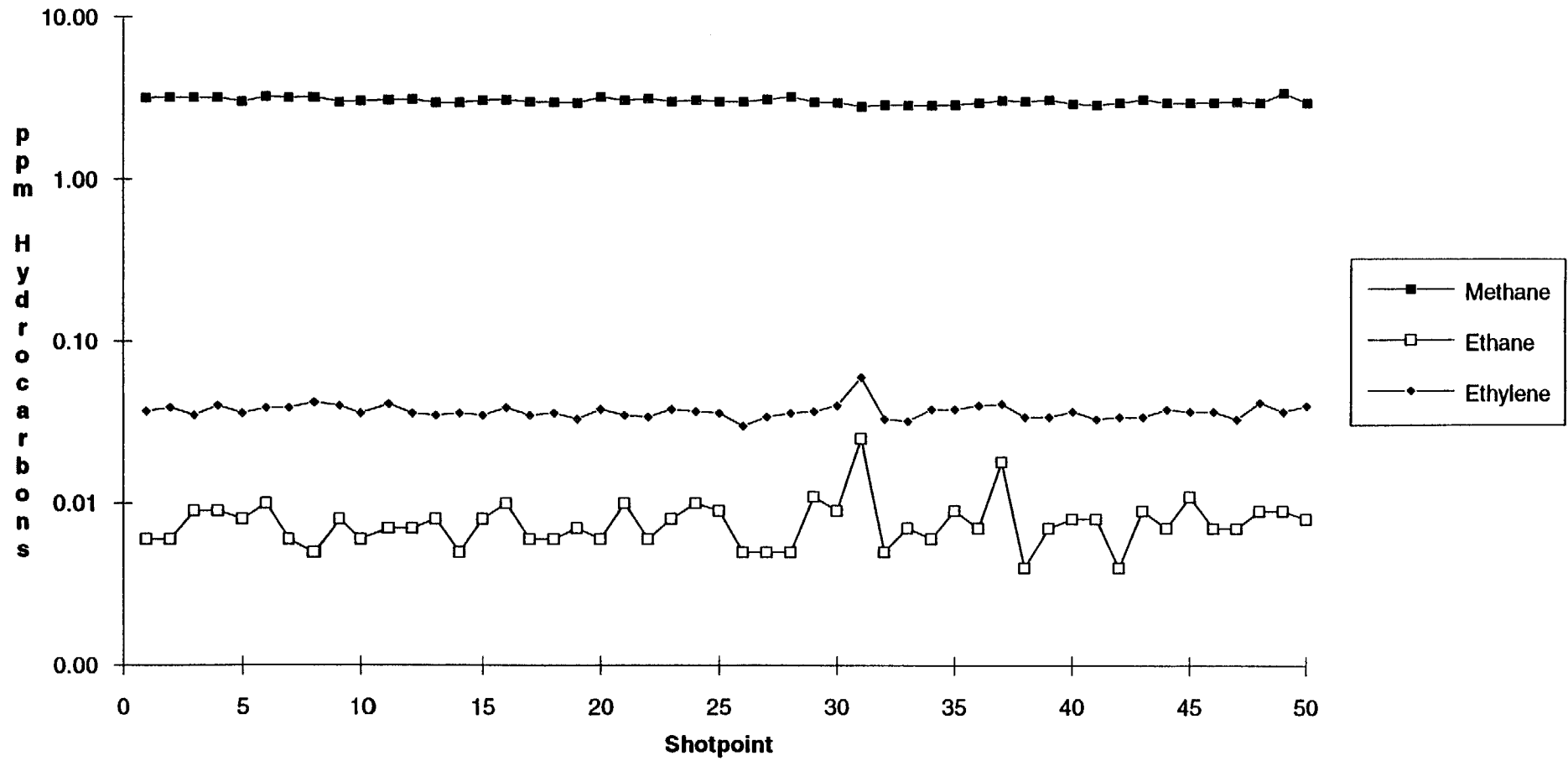
	Cond.	Temp.	Altitude	F. Depth	W. Depth
Mean	46.333	14.775	16.046	46.452	62.312
Std. Dev.	0.106	0.096	6.716	3.162	7.505
Minimum	46.160	14.640	4.300	40.500	46.800
Maximum	46.520	14.960	27.600	51.900	74.100

Notes No significant hydrocarbon anomalies.

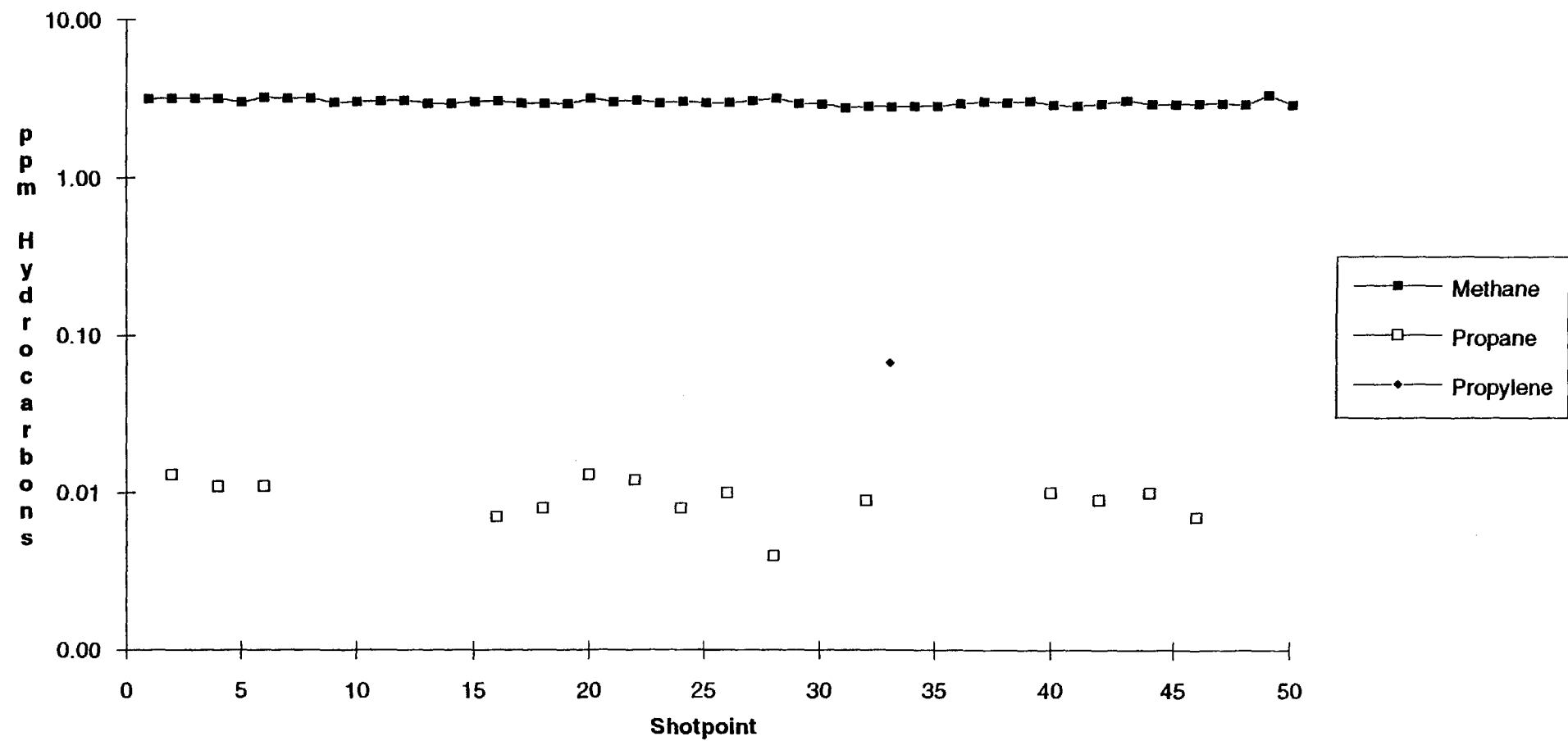
Line 104007 THC, Methane



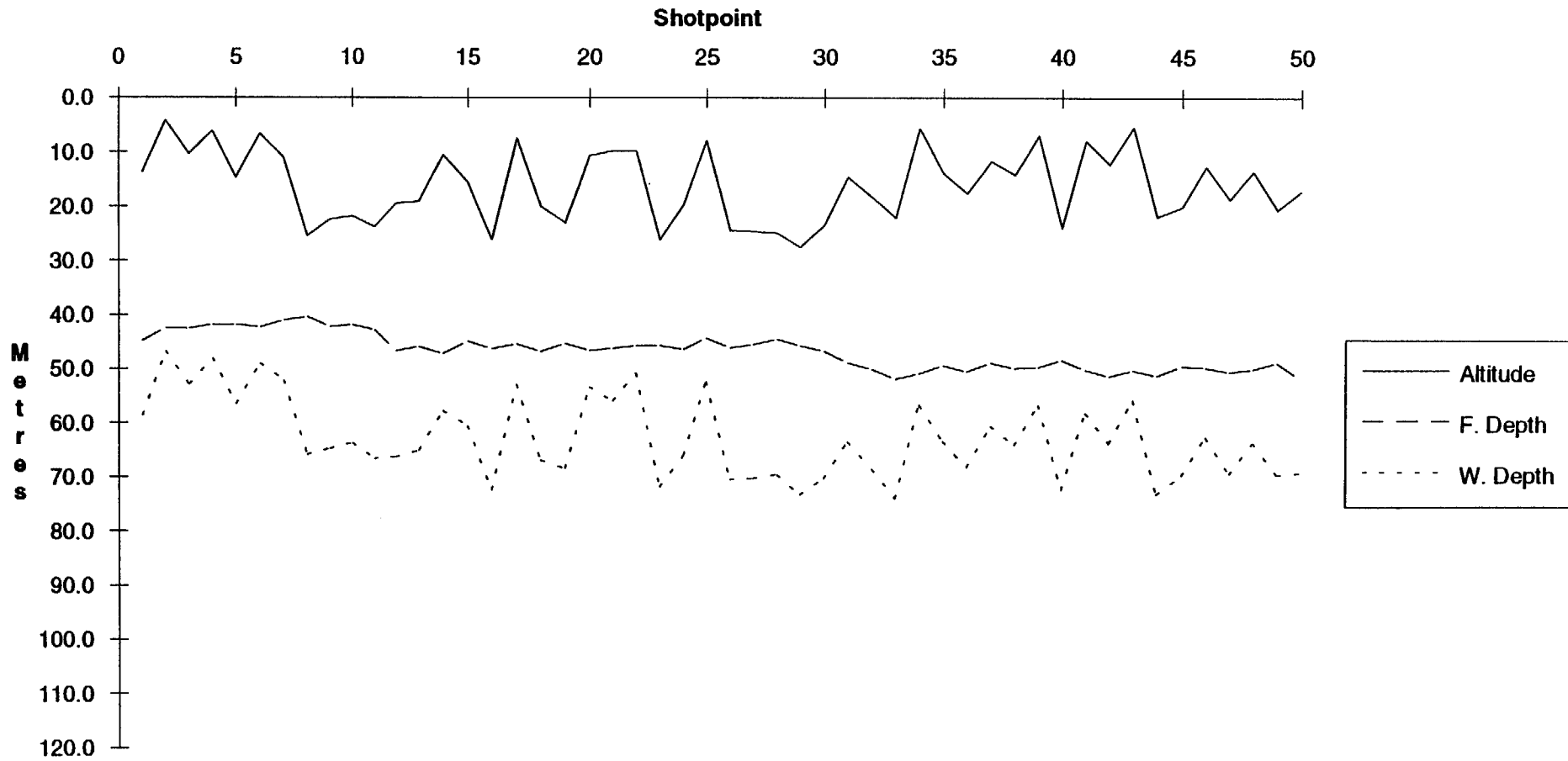
Line 104007 Methane, Ethane, Ethylene



Line 104007 Methane, Propane, Propylene



Line 104007 Depths, Altitude





* R 9 2 0 5 4 0 3 *

Line Summary

Line Number 104008
No. of Shotpoints 34

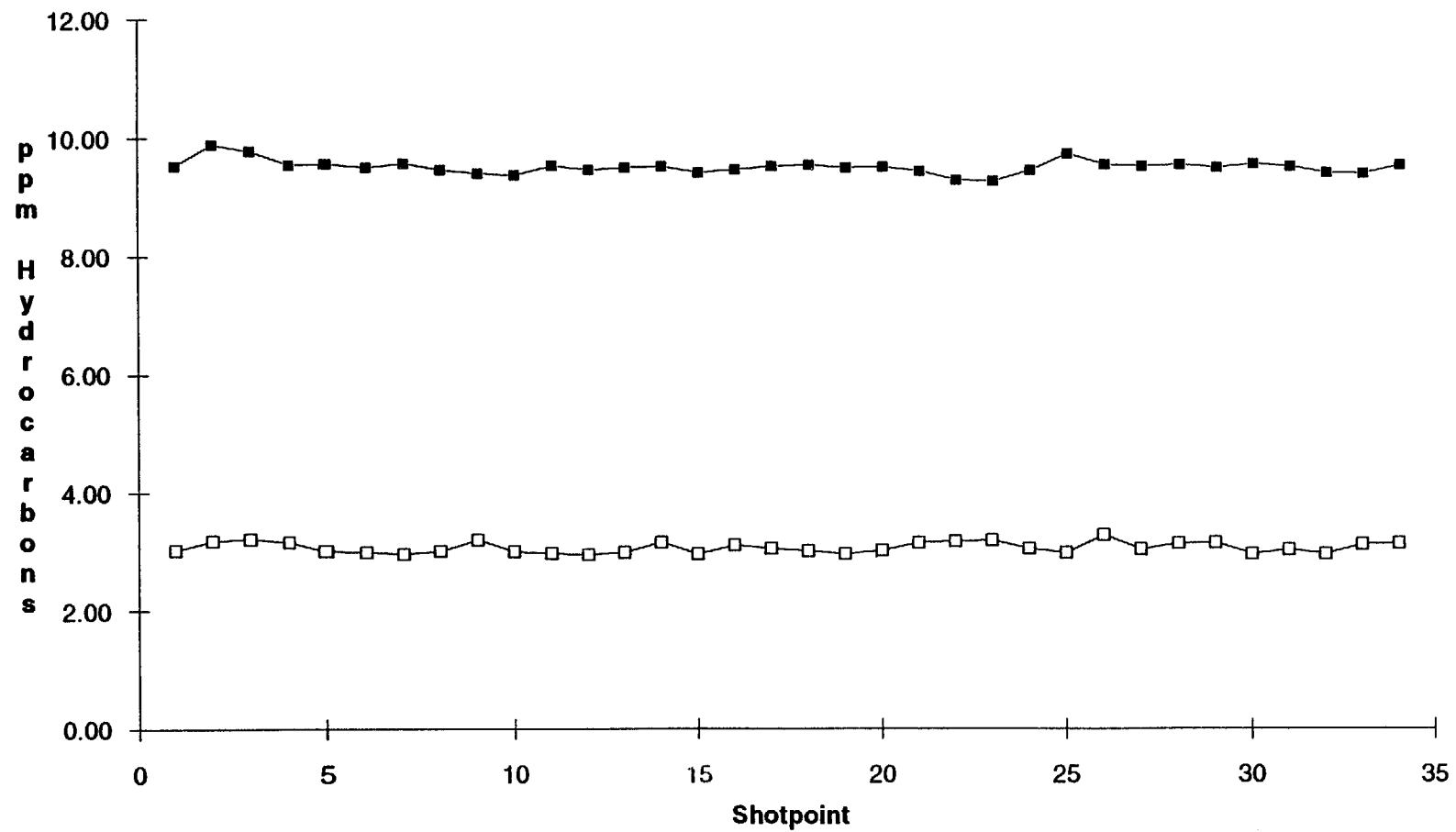
	Shotpoint	Date	Time	Latitude	Longitude
Start	1	28/09/91	22:28:51	38	49.218 142 53.417
End	34	28/09/91	23:35:12	38	52.540 142 58.782

	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	9.516	3.067	0.009	0.038	0.001	0.003	0.014	0.004	0.008	0.052	0.029	0.001	0.901
Std. Dev.	0.118	0.094	0.004	0.006	0.004	0.009	0.053	0.019	0.008	0.020	0.015	0.003	1.655
Minimum	9.272	2.947	0.005	0.029	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.166
Maximum	9.892	3.277	0.023	0.056	0.019	0.042	0.303	0.101	0.022	0.073	0.054	0.014	9.343

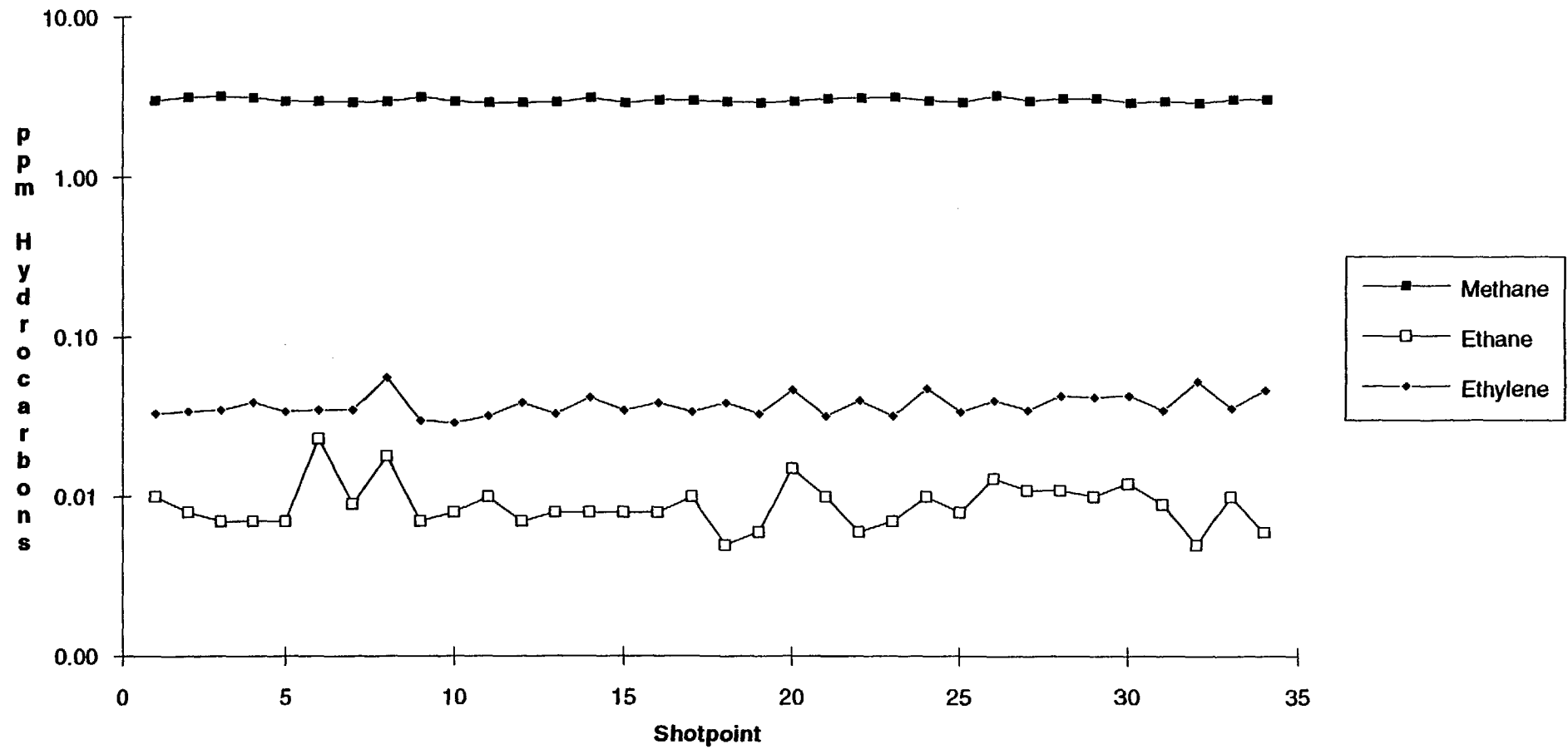
	Cond.	Temp.	Altitude	F. Depth	W.Depth
Mean	46.684	15.108	16.112	52.191	68.362
Std. Dev.	0.111	0.102	2.552	2.871	1.422
Minimum	46.490	14.930	11.500	46.500	63.700
Maximum	46.850	15.250	21.700	56.600	71.100

Notes No significant hydrocarbon anomalies.

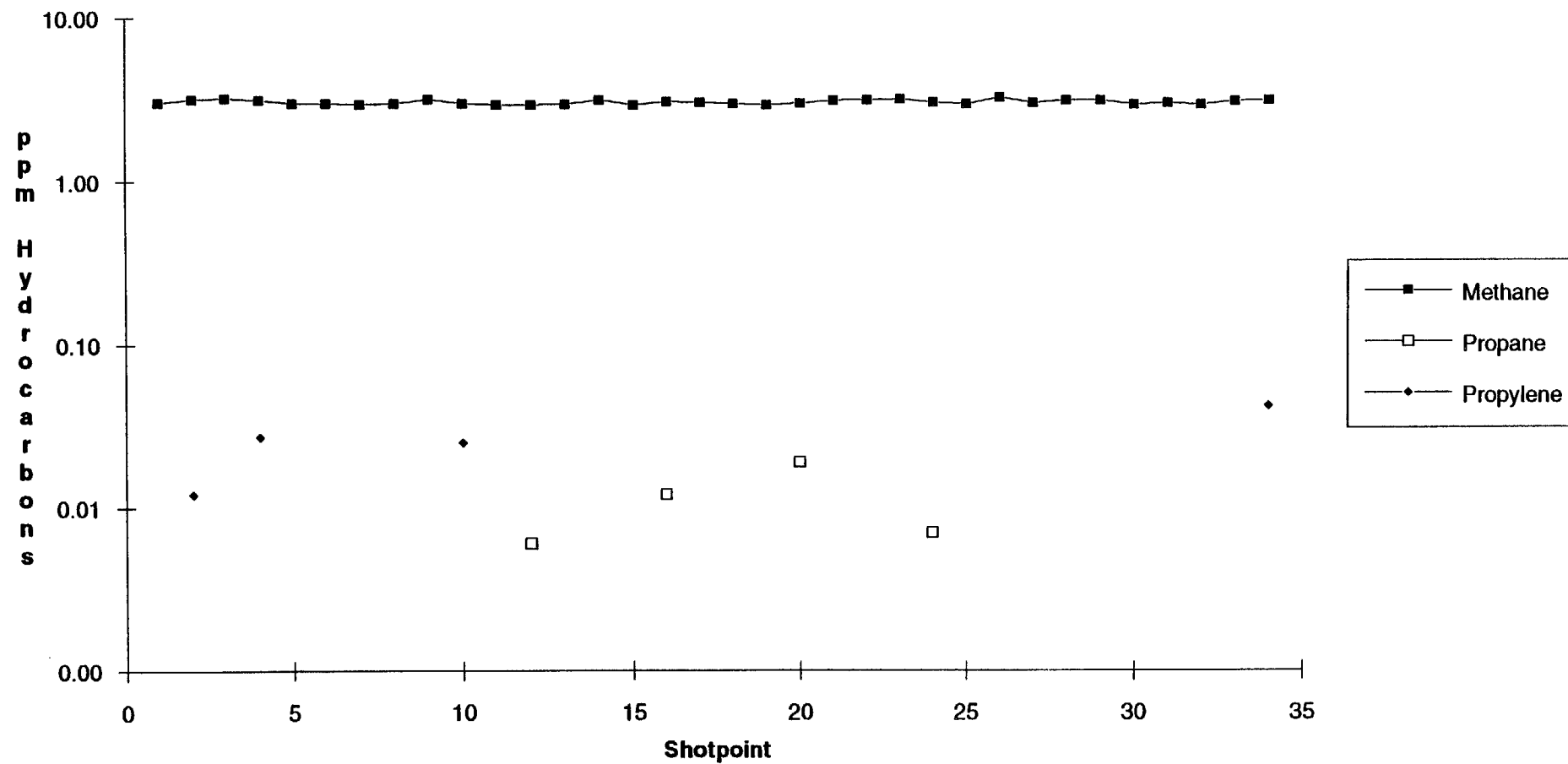
Line 104008 THC, Methane



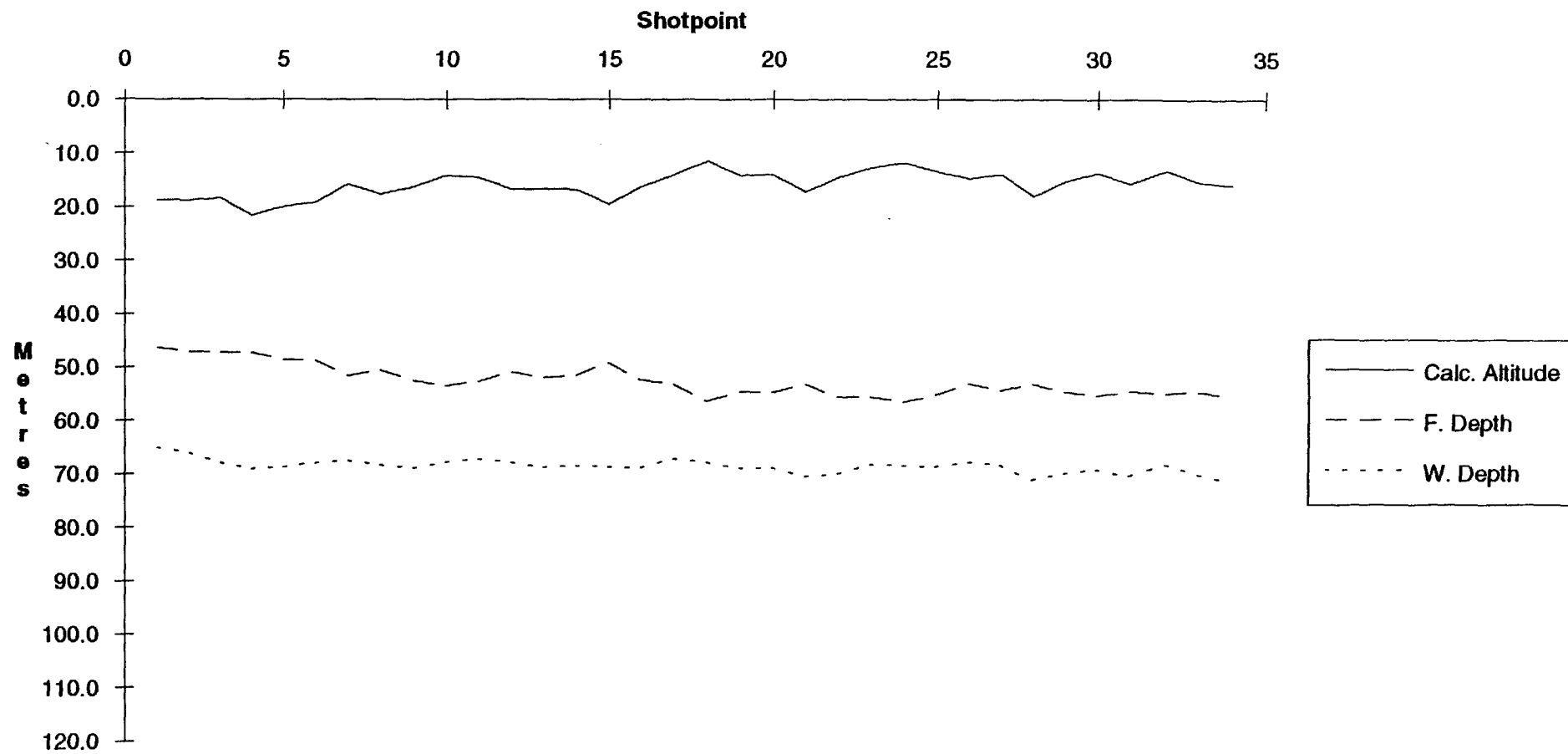
Line 104008 Methane, Ethane, Ethylene



Line 104008 Methane, Propane, Propylene



Line 104008 Depths, Altitude



Line Summary

Line Number 104009
No. of Shotpoints 47

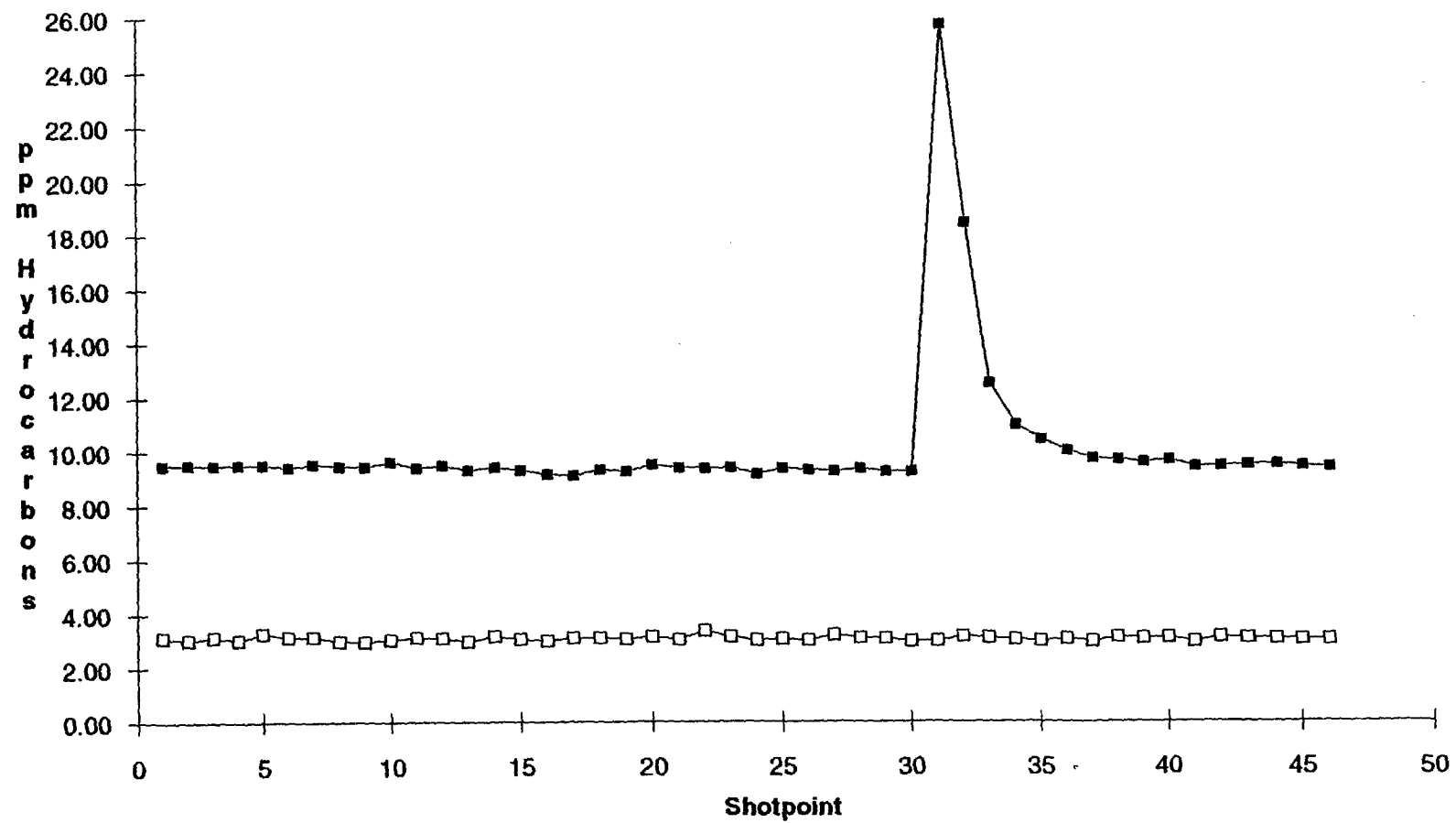
	Shotpoint	Date	Time	Latitude	Longitude
Start	1	28/09/91	23:49:06	38	53.001 142 00.369
End	48	29/09/91	01:31:35	38	53.134 143 12.216

	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	10.090	3.075	0.007	0.037	0.003	0.001	0.000	0.000	0.003	0.050	0.026	0.000	0.348
Std. Dev.	2.721	0.080	0.002	0.004	0.005	0.006	0.002	0.002	0.006	0.017	0.010	0.001	0.234
Minimum	9.115	2.954	0.003	0.031	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.098
Maximum	25.741	3.352	0.015	0.046	0.015	0.041	0.011	0.016	0.022	0.073	0.040	0.006	1.239

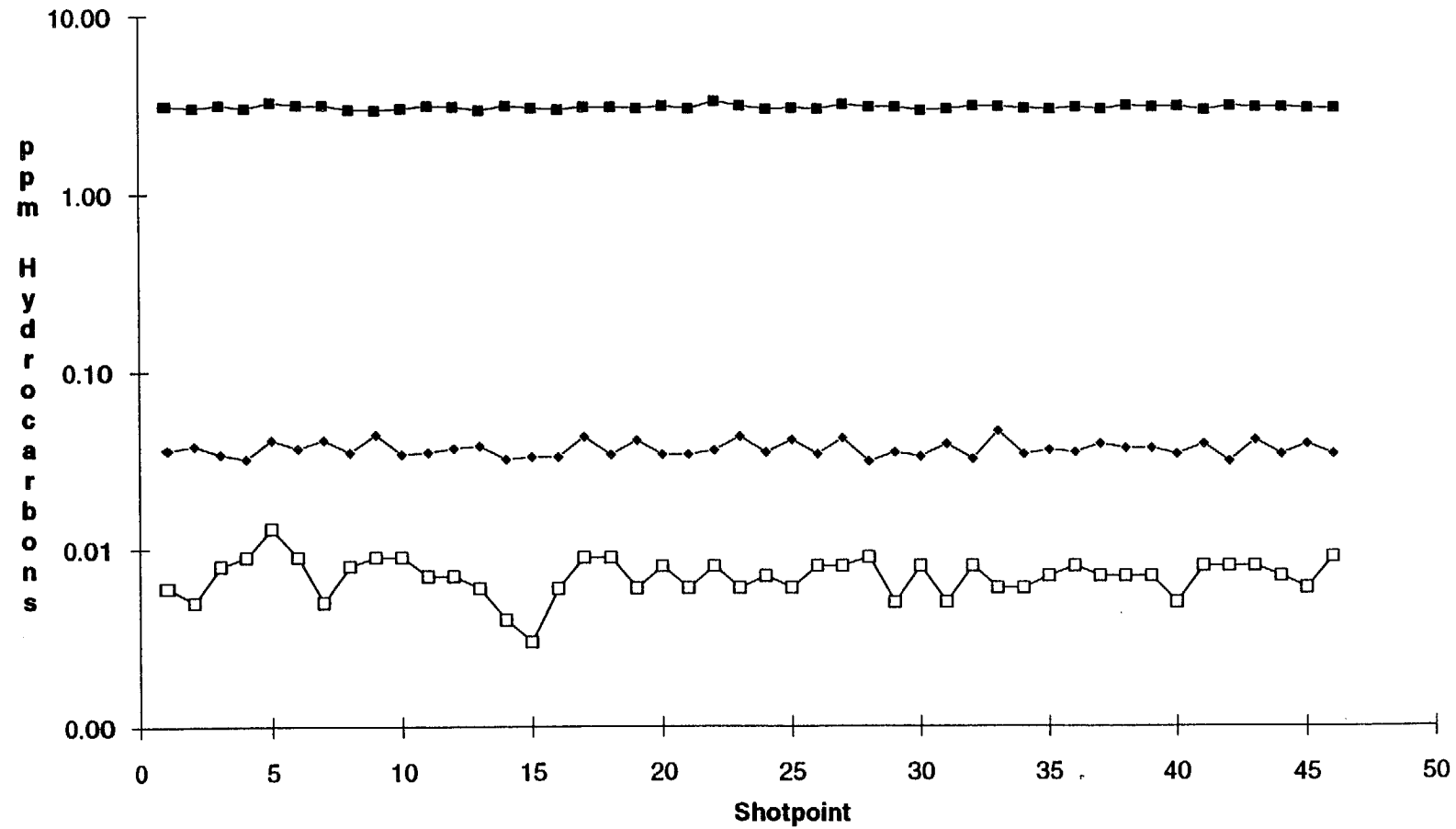
	Cond.	Temp.	Altitude	F. Depth	W.Depth
Mean	46.793	15.194	15.521	57.591	72.857
Std. Dev.	0.080	0.066	1.158	2.449	2.239
Minimum	46.660	15.090	12.600	53.400	68.100
Maximum	46.940	15.310	18.000	62.500	79.000

Notes Weak, but distinct, THC anomaly at shotpoints 32-35.

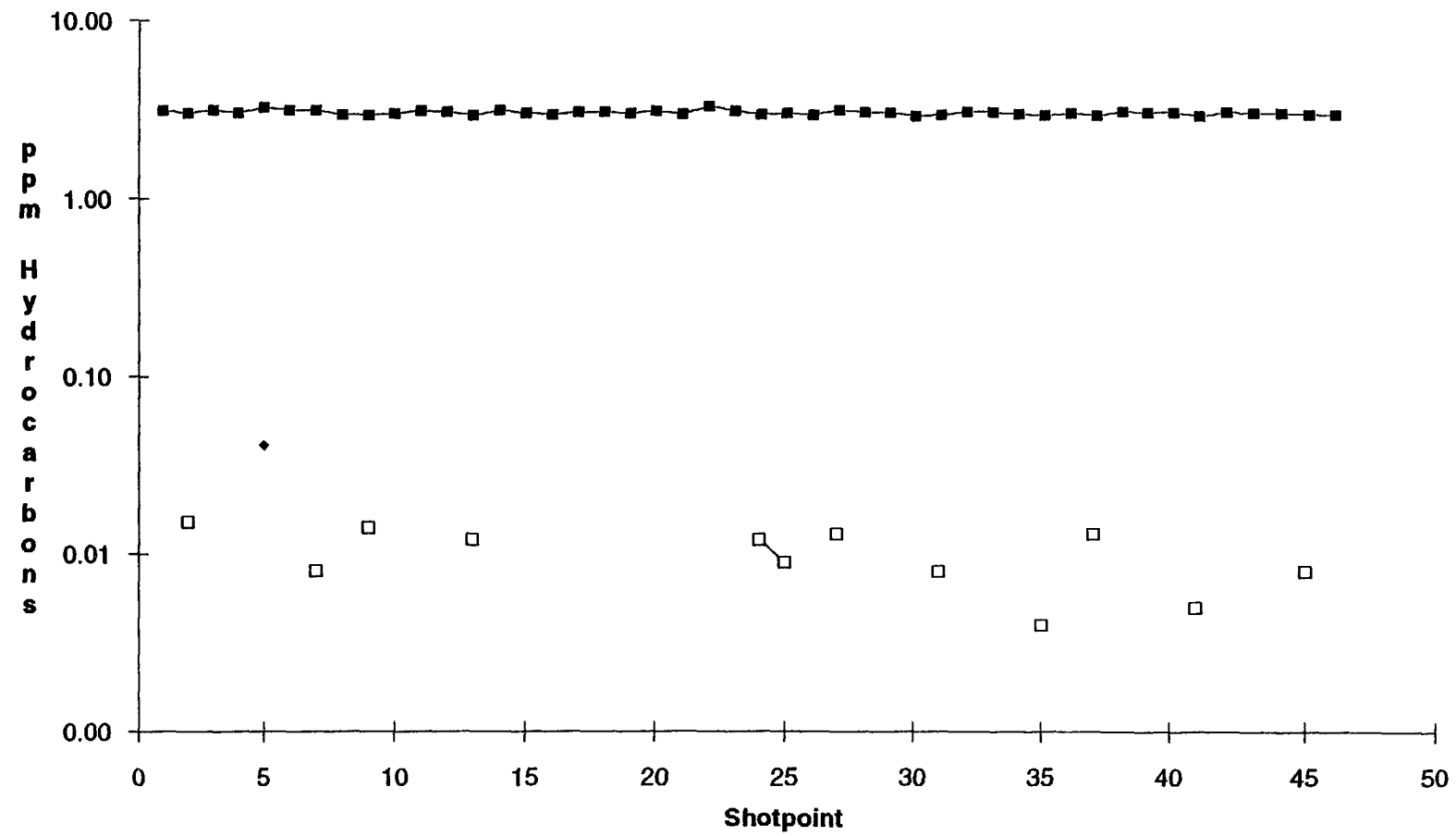
Line 104009 THC, Methane



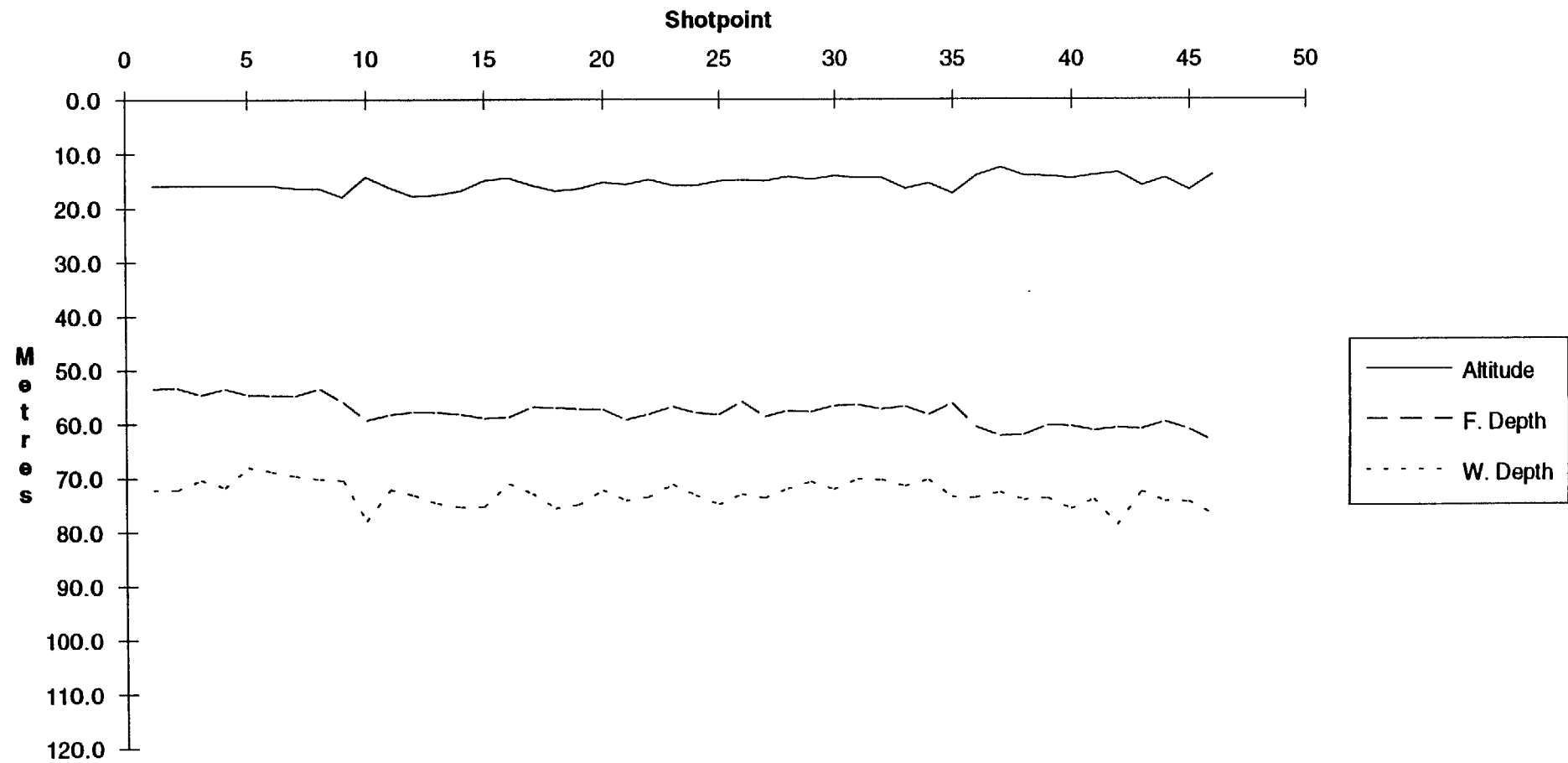
Line 104009 Methane, Ethane, Ethylene



Line 104009 Methane, Propane, Propylene



Line 104009 Depths, Altitude



Line Summary

Line Number 104010
No. of Shotpoints 44

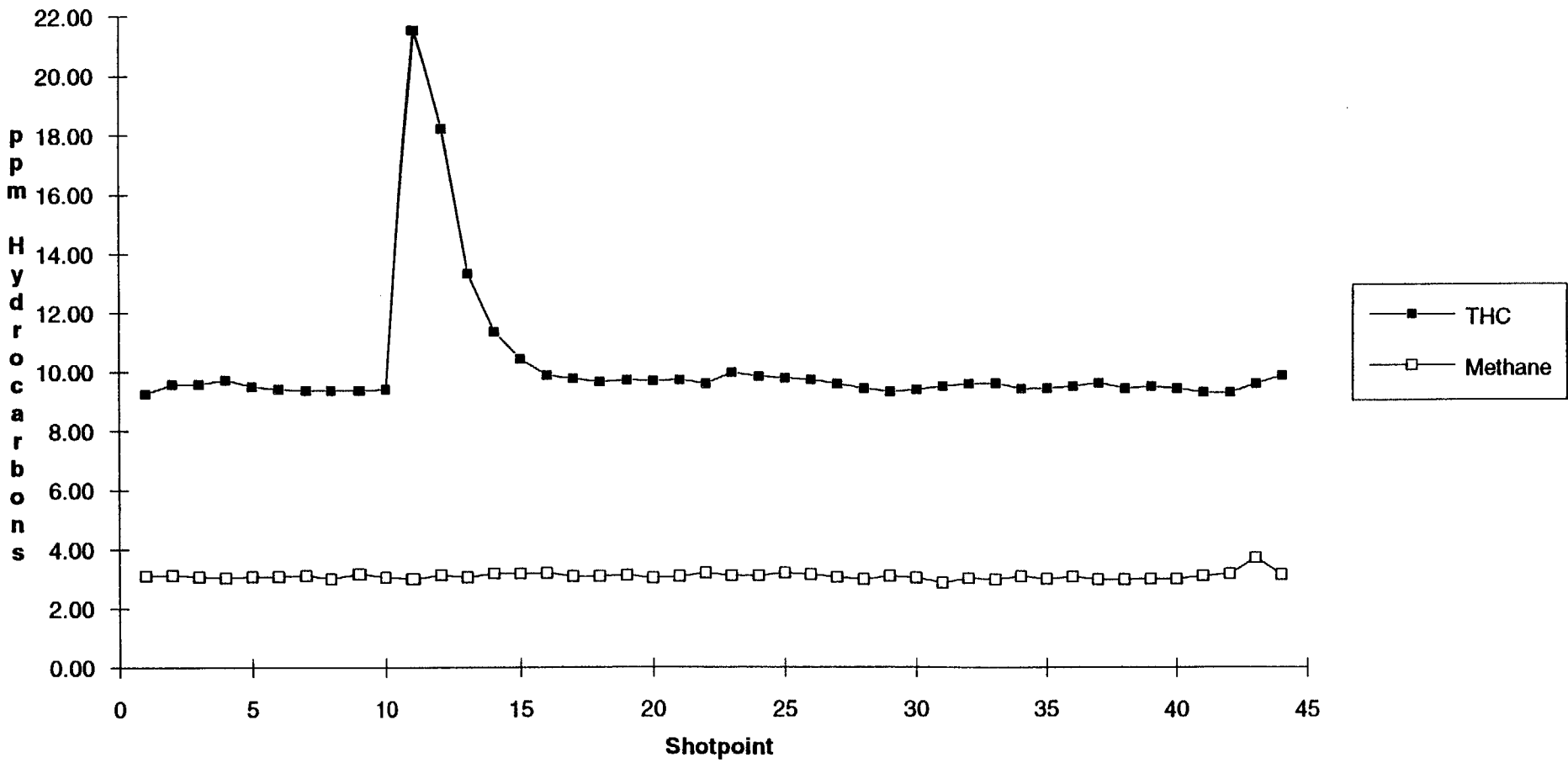
	Shotpoint	Date	Time	Latitude		Longitude	
Start	1	29/09/91	01:37:13	38	53.130	143	12.715
End	44	29/09/91	03:03:12	39	00.186	143	12.979

	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	10.183	3.082	0.009	0.036	0.003	0.006	0.000	0.000	0.007	0.051	0.022	0.001	0.389
Std. Dev.	2.270	0.120	0.003	0.004	0.005	0.030	0.001	0.000	0.008	0.023	0.013	0.004	0.192
Minimum	9.252	2.862	0.004	0.030	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.132
Maximum	21.549	3.703	0.020	0.047	0.018	0.193	0.008	0.000	0.024	0.079	0.044	0.014	0.929

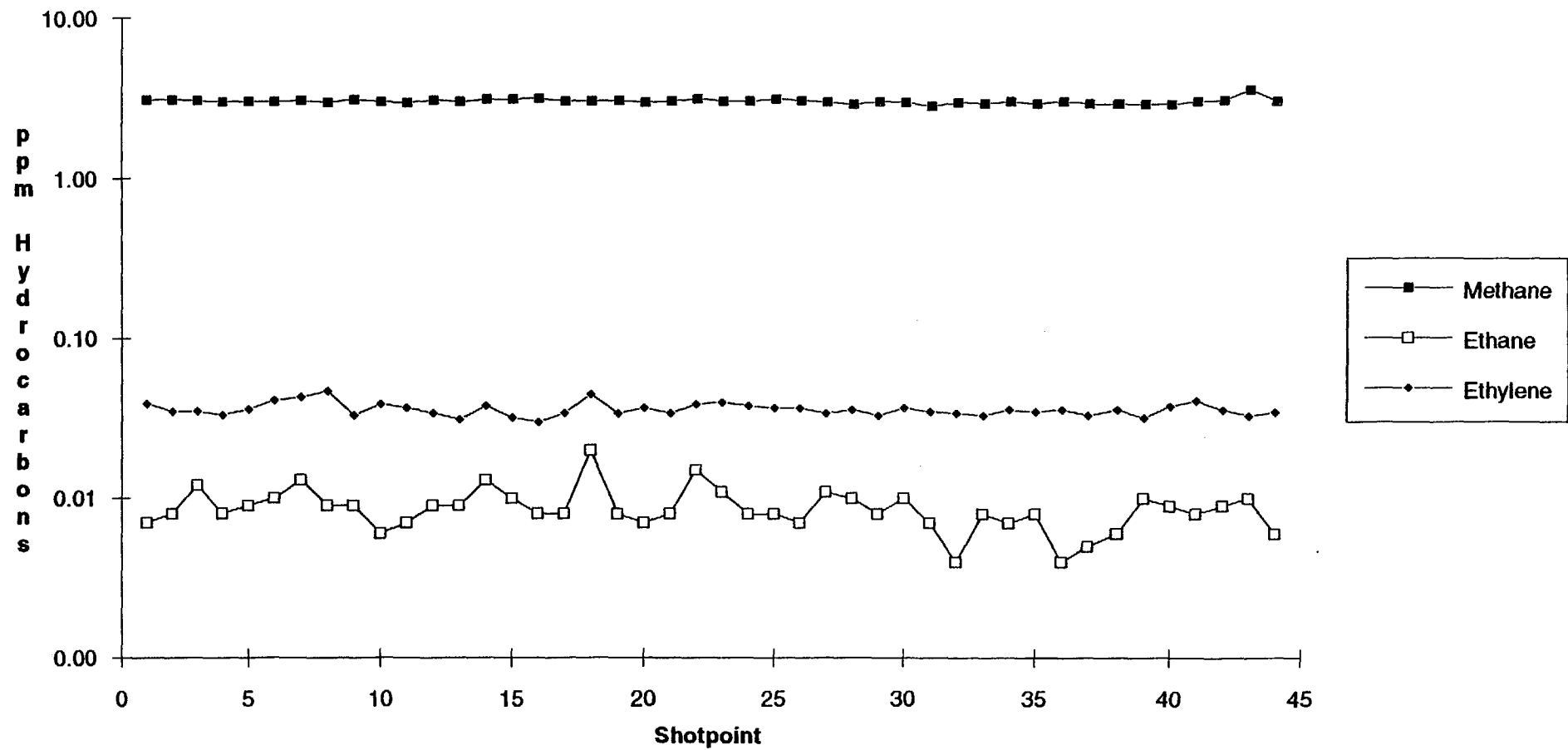
	Cond.	Temp.	Altitude	F. Depth	W.Depth
Mean	46.699	15.113	15.200	62.082	78.091
Std. Dev.	0.129	0.110	2.722	3.934	4.716
Minimum	46.540	14.960	9.900	53.300	65.400
Maximum	46.910	15.310	21.700	67.900	87.600

Notes Weak, but distinct, THC anomaly at shotpoints 11-15.

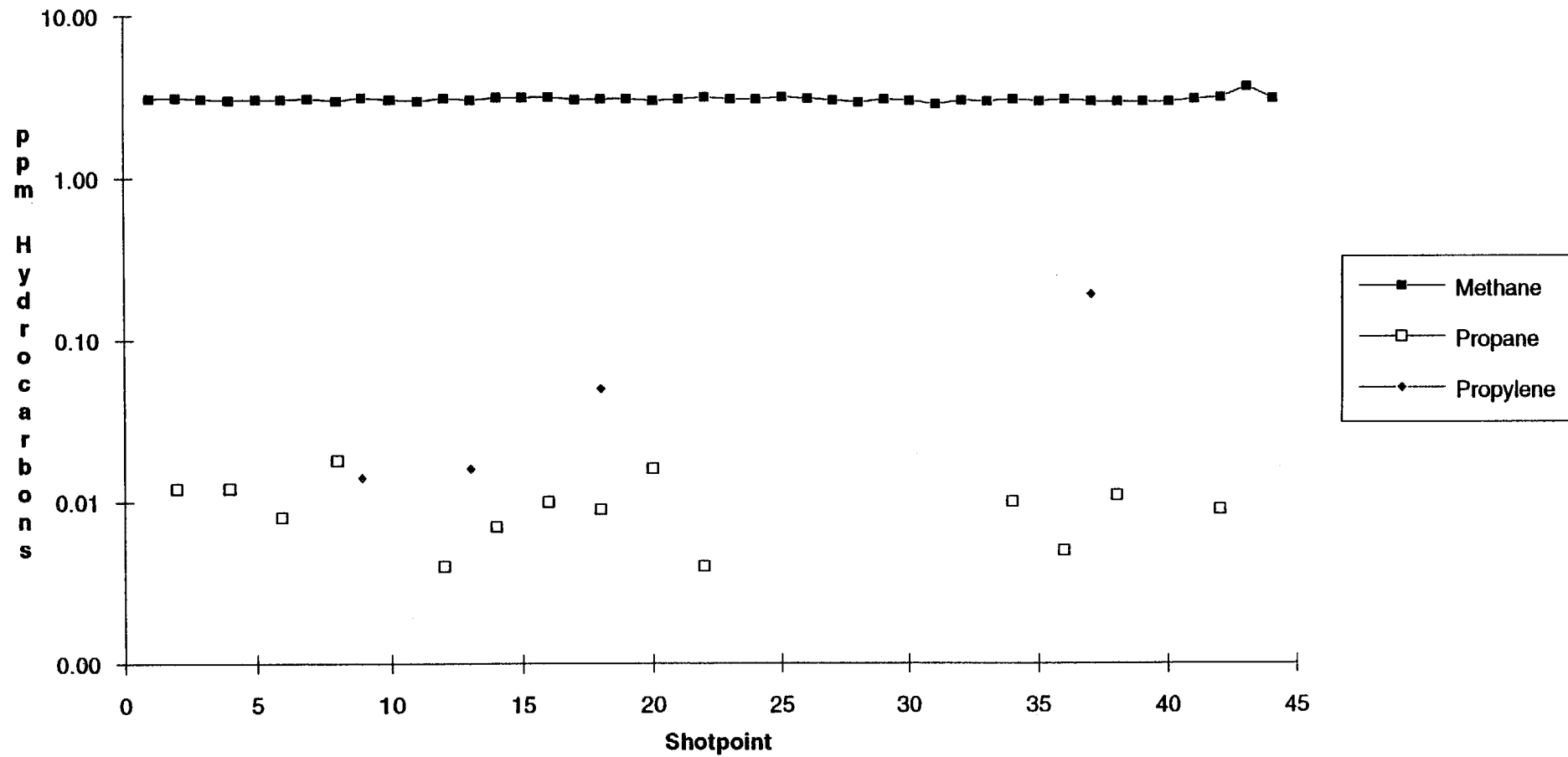
Line 104010 THC, Methane



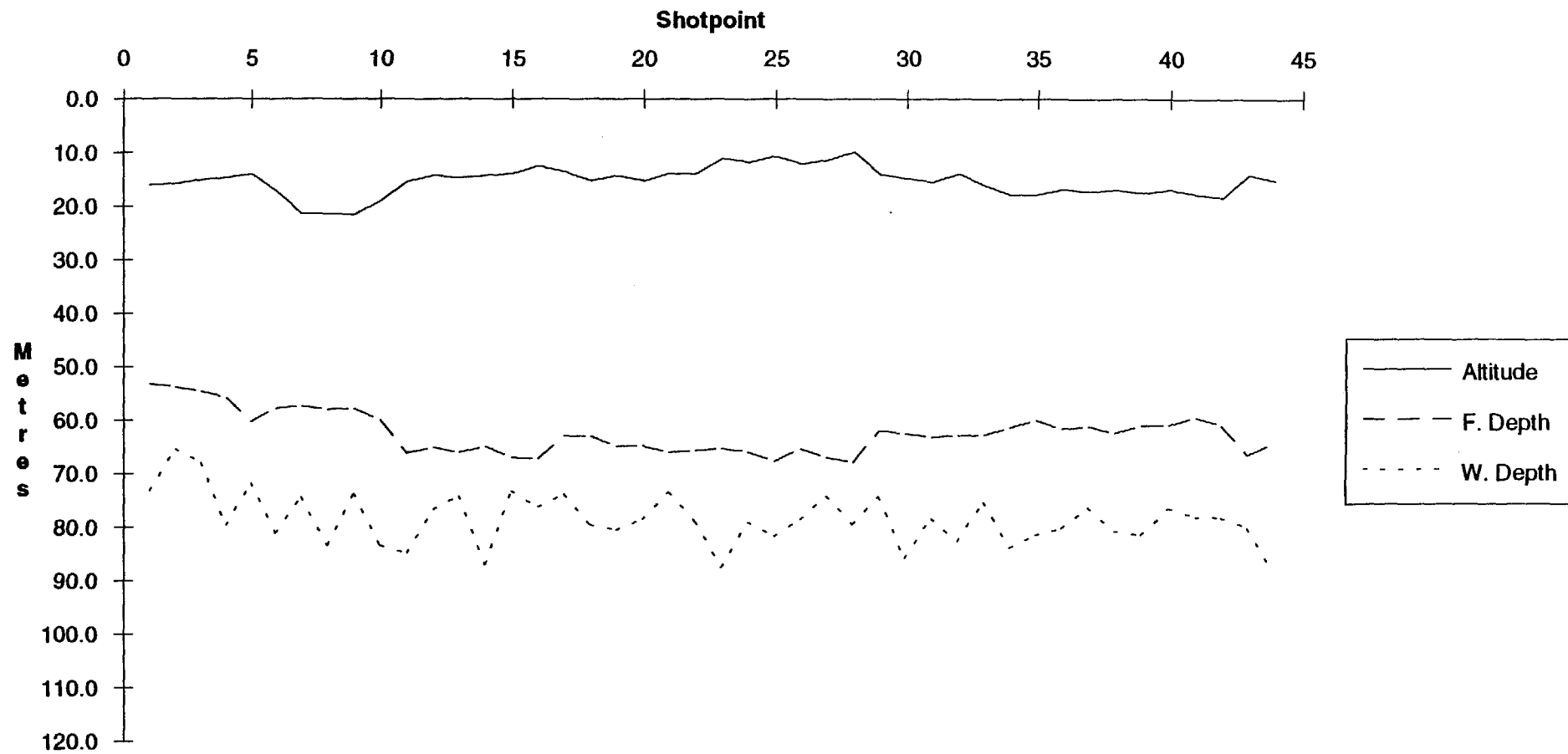
Line 104010 Methane, Ethane, Ethylene



Line 104010 Methane, Propane, Propylene



Line 104010 Depths, Altitude



Line Summary

Line Number 104011
No. of Shotpoints 32

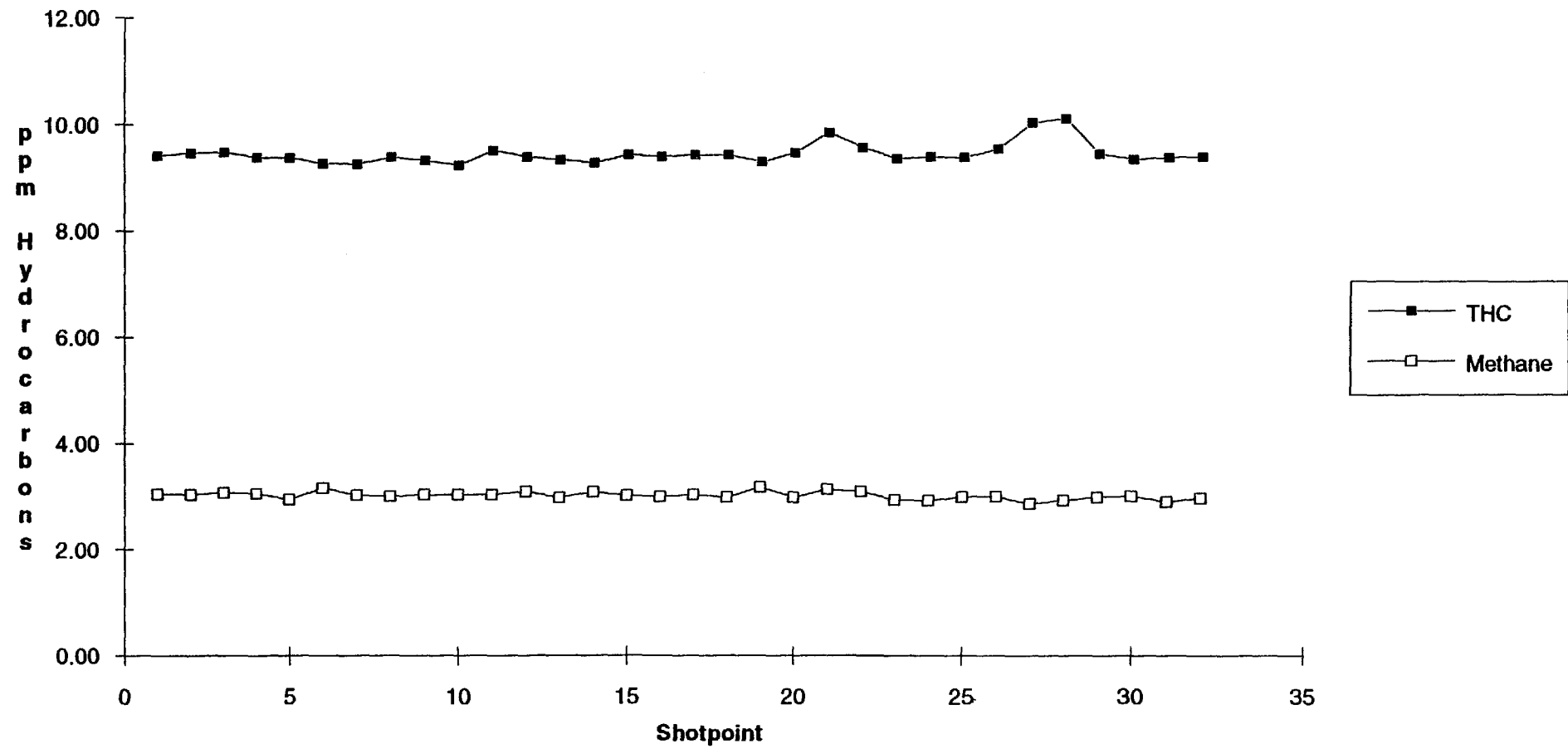
	Shotpoint	Date	Time	Latitude	Longitude	
Start	1	29/09/91	03:05:12	39	143	12.977
End	32	29/09/91	04:07:28	39	143	08.690

	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	9.454	3.013	0.009	0.034	0.003	0.000	0.000	0.000	0.005	0.048	0.023	0.000	0.392
Std. Dev.	0.201	0.070	0.002	0.004	0.005	0.002	0.000	0.000	0.007	0.020	0.011	0.002	0.156
Minimum	9.237	2.862	0.004	0.019	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.167
Maximum	10.125	3.172	0.011	0.041	0.014	0.010	0.000	0.000	0.020	0.070	0.037	0.008	0.710

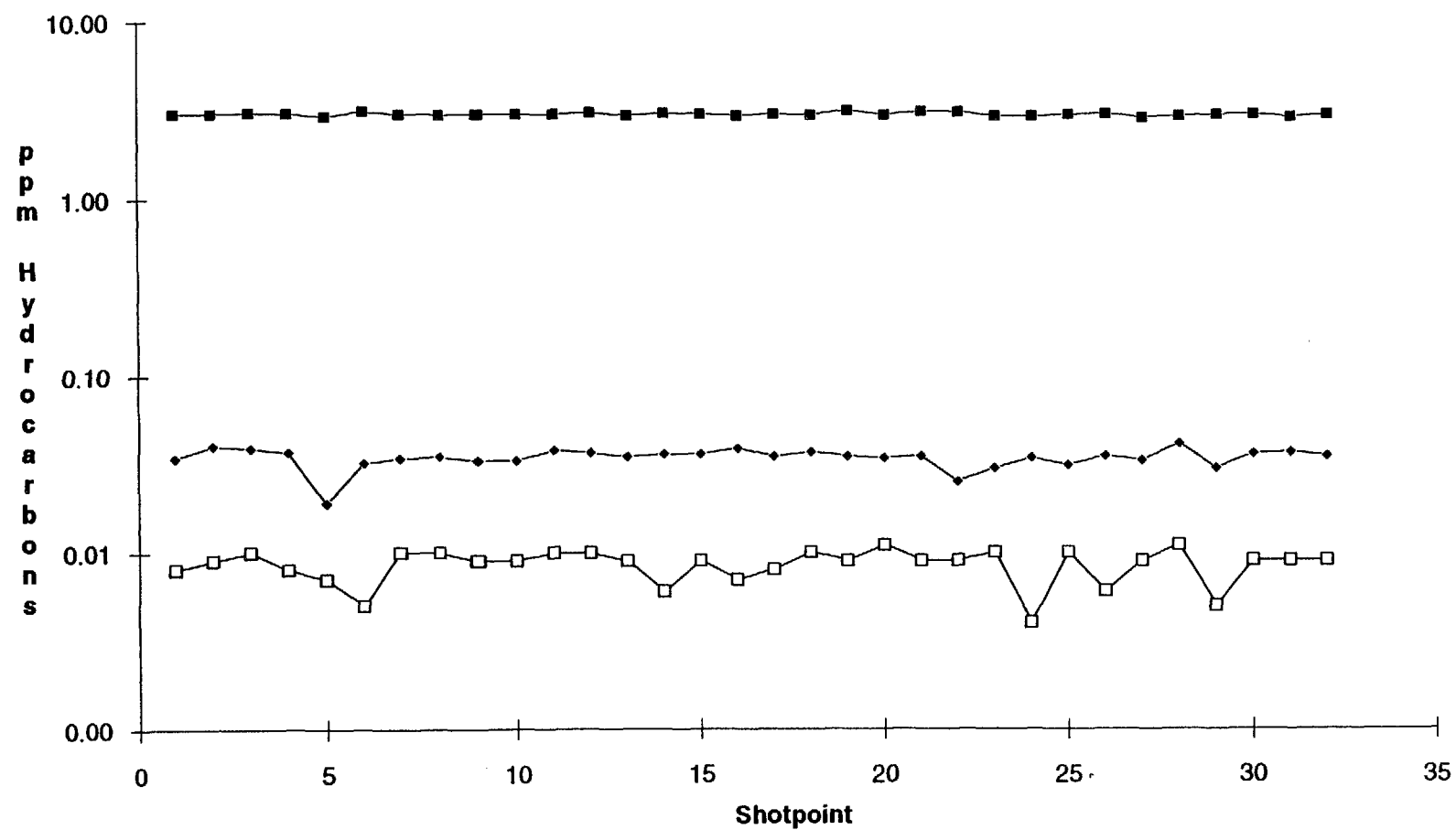
	Cond.	Temp.	Altitude	F. Depth	W.Depth
Mean	46.799	15.233	16.047	59.275	76.172
Std. Dev.	0.081	0.072	4.236	3.635	5.344
Minimum	46.660	15.120	7.400	52.600	65.500
Maximum	46.960	15.380	25.500	66.100	87.300

Notes No significant hydrocarbon anomalies.

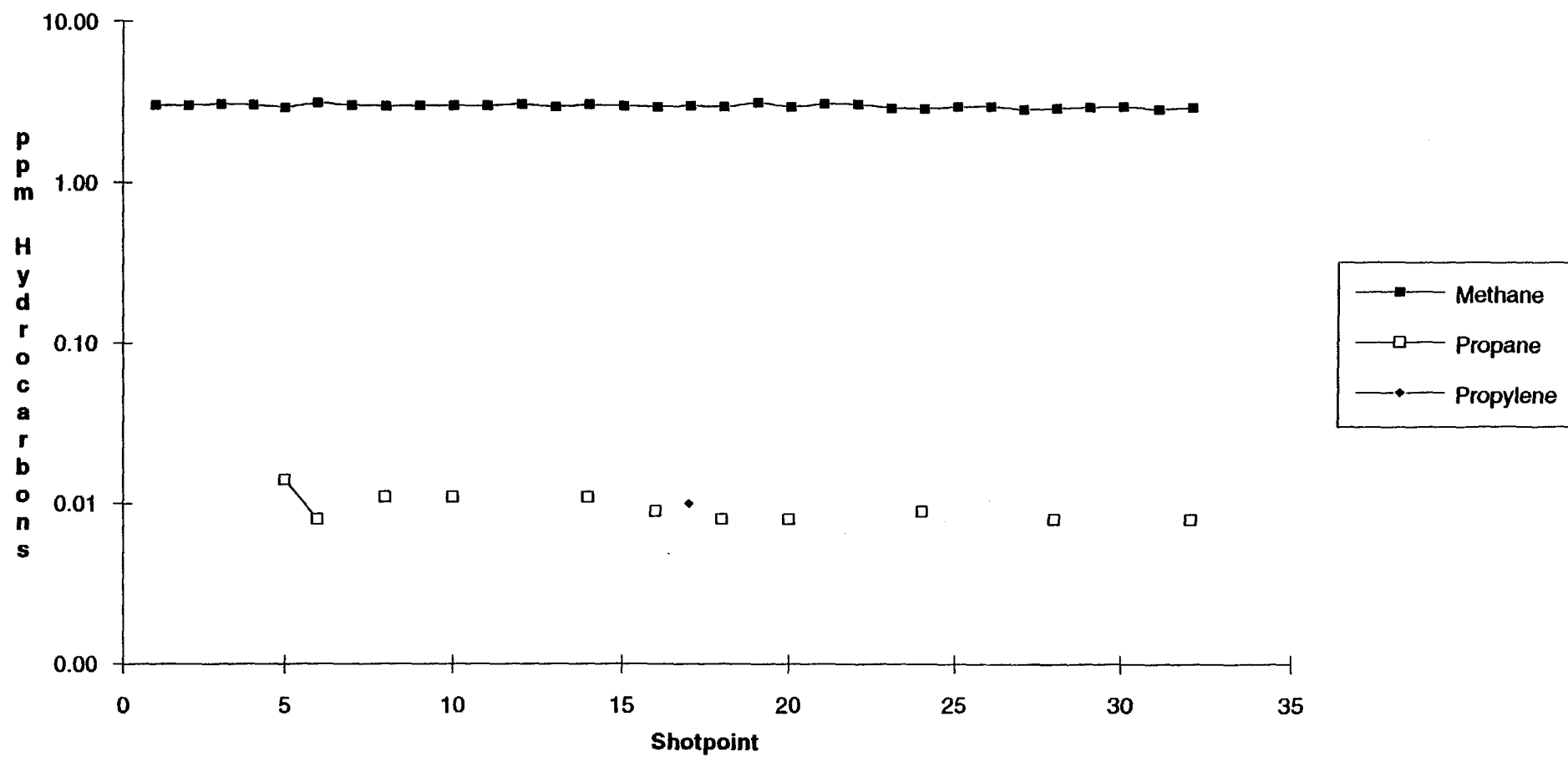
Line 104011 THC, Methane



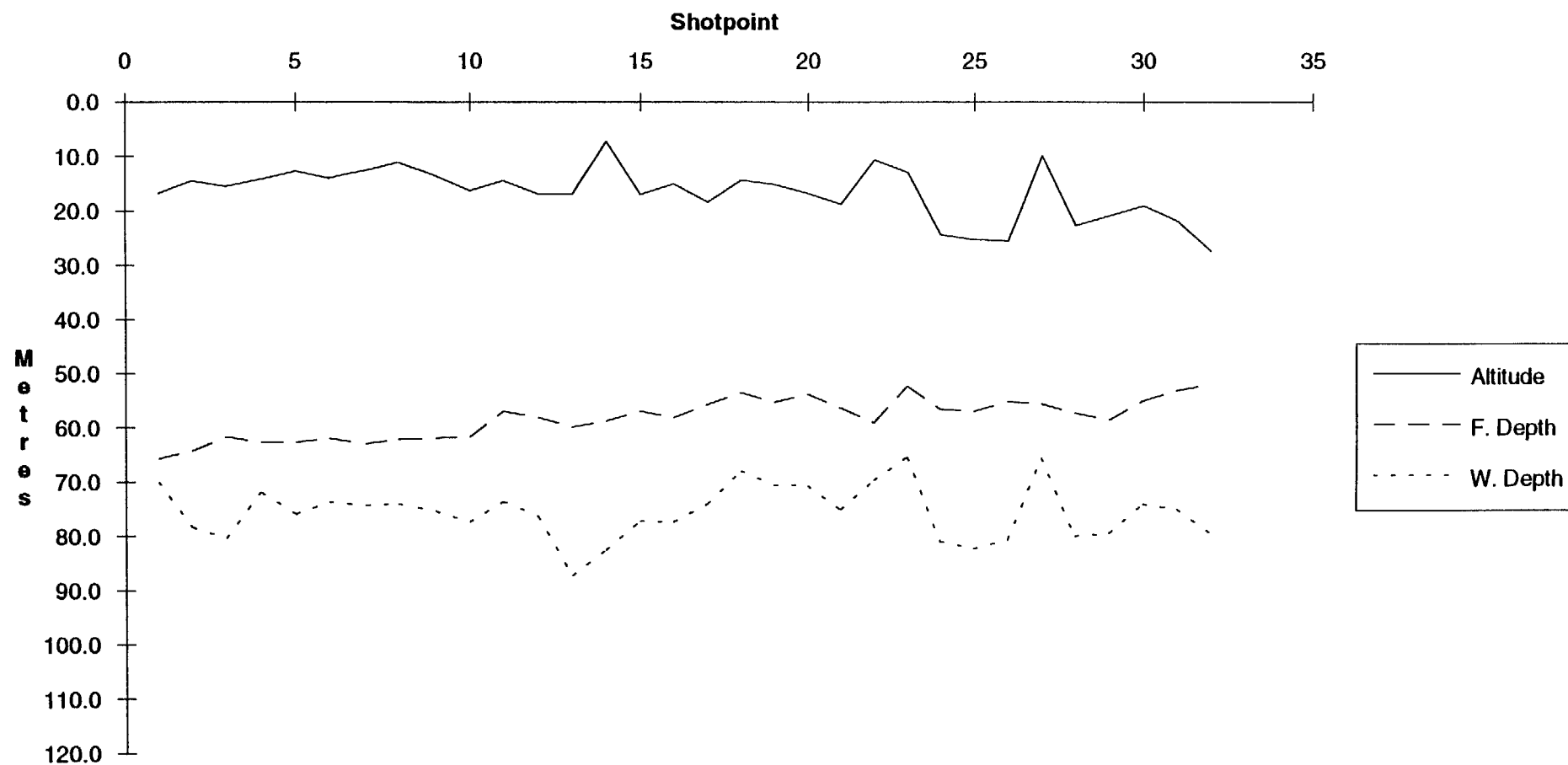
Line 104011 Methane, Ethane, Ethylene



Line 104011 Methane, Propane, Propylene



Line 104011 Depths, Altitude



Line Summary

Line Number 104012
No. of Shotpoints 81

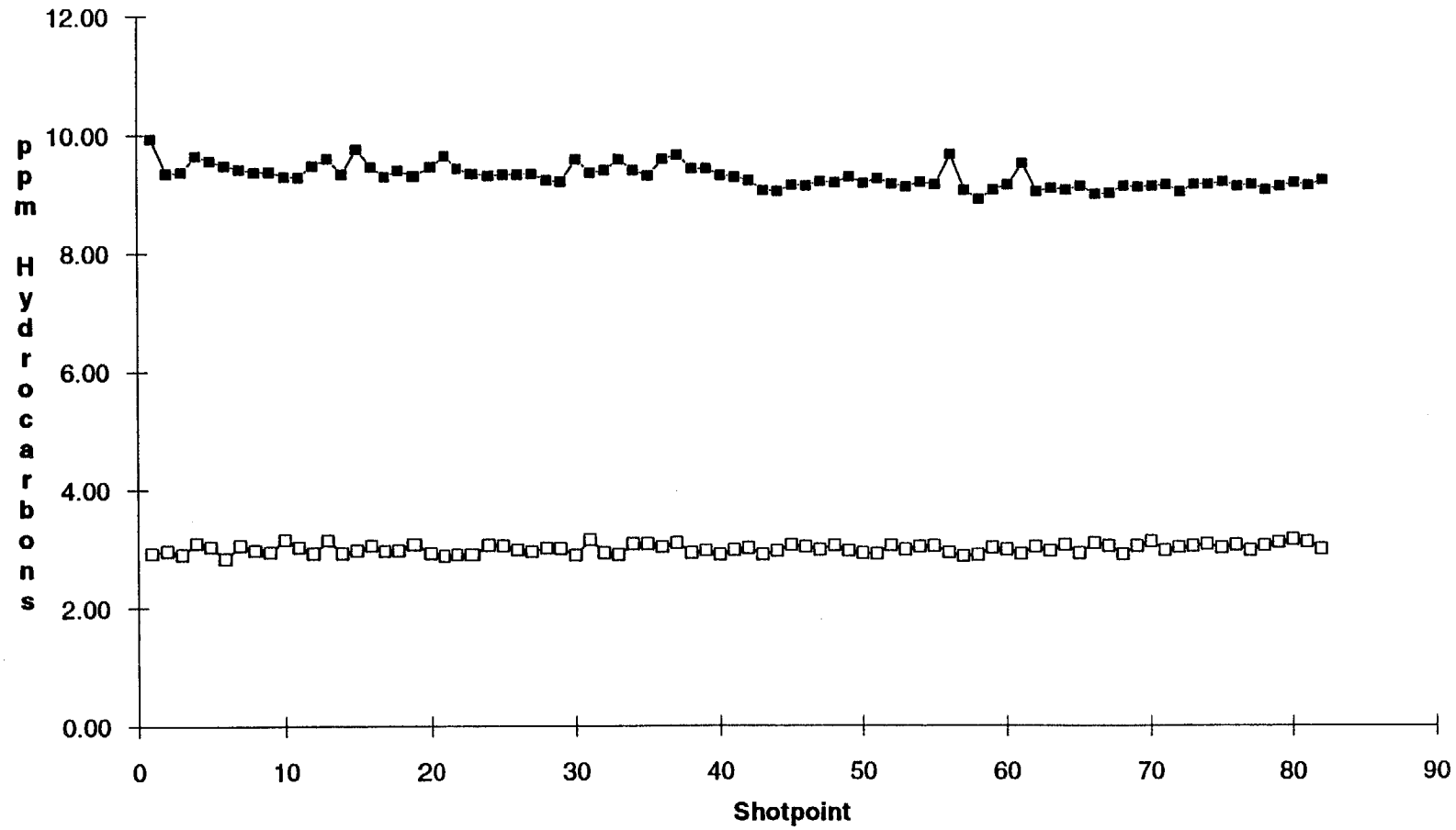
	Shotpoint	Date	Time	Latitude		Longitude	
Start	1	29/09/91	04:09:28	39	00.749	143	08.599
End	81	29/09/91	06:49:42	39	10.078	142	59.658

	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	9.297	2.995	0.009	0.036	0.003	0.001	0.000	0.000	0.007	0.047	0.025	0.002	0.374
Std. Dev.	0.198	0.076	0.005	0.007	0.004	0.007	0.001	0.000	0.007	0.018	0.012	0.004	0.208
Minimum	8.911	2.827	0.003	0.025	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.106
Maximum	9.935	3.156	0.035	0.070	0.015	0.063	0.010	0.000	0.019	0.069	0.051	0.017	1.226

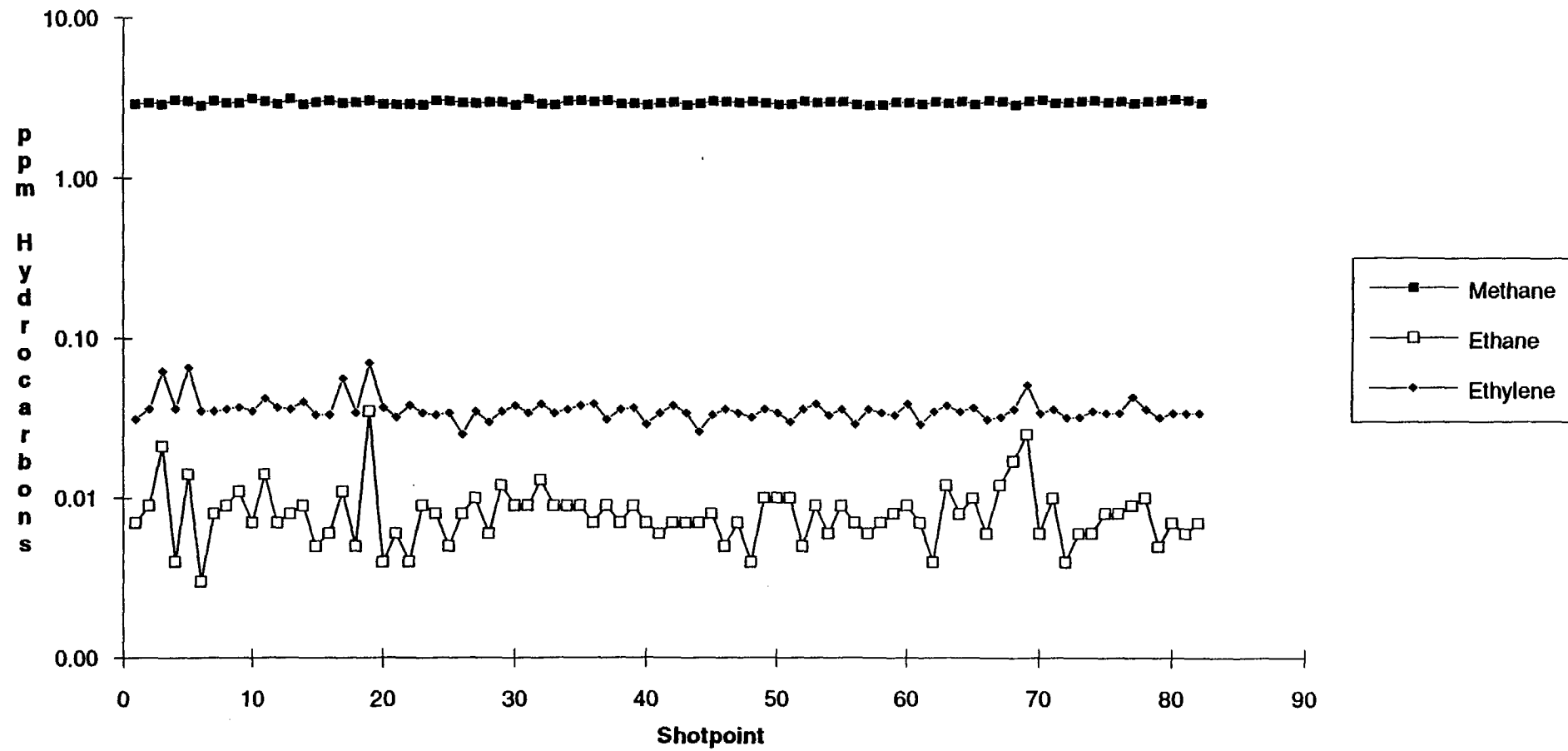
	Cond.	Temp.	Altitude	F. Depth	W.Depth
Mean	46.308	14.794	22.541	62.059	84.601
Std. Dev.	0.164	0.139	4.668	2.910	4.102
Minimum	46.120	14.640	15.400	52.300	74.300
Maximum	46.700	15.120	34.200	67.000	97.400

Notes No significant hydrocarbon anomalies.

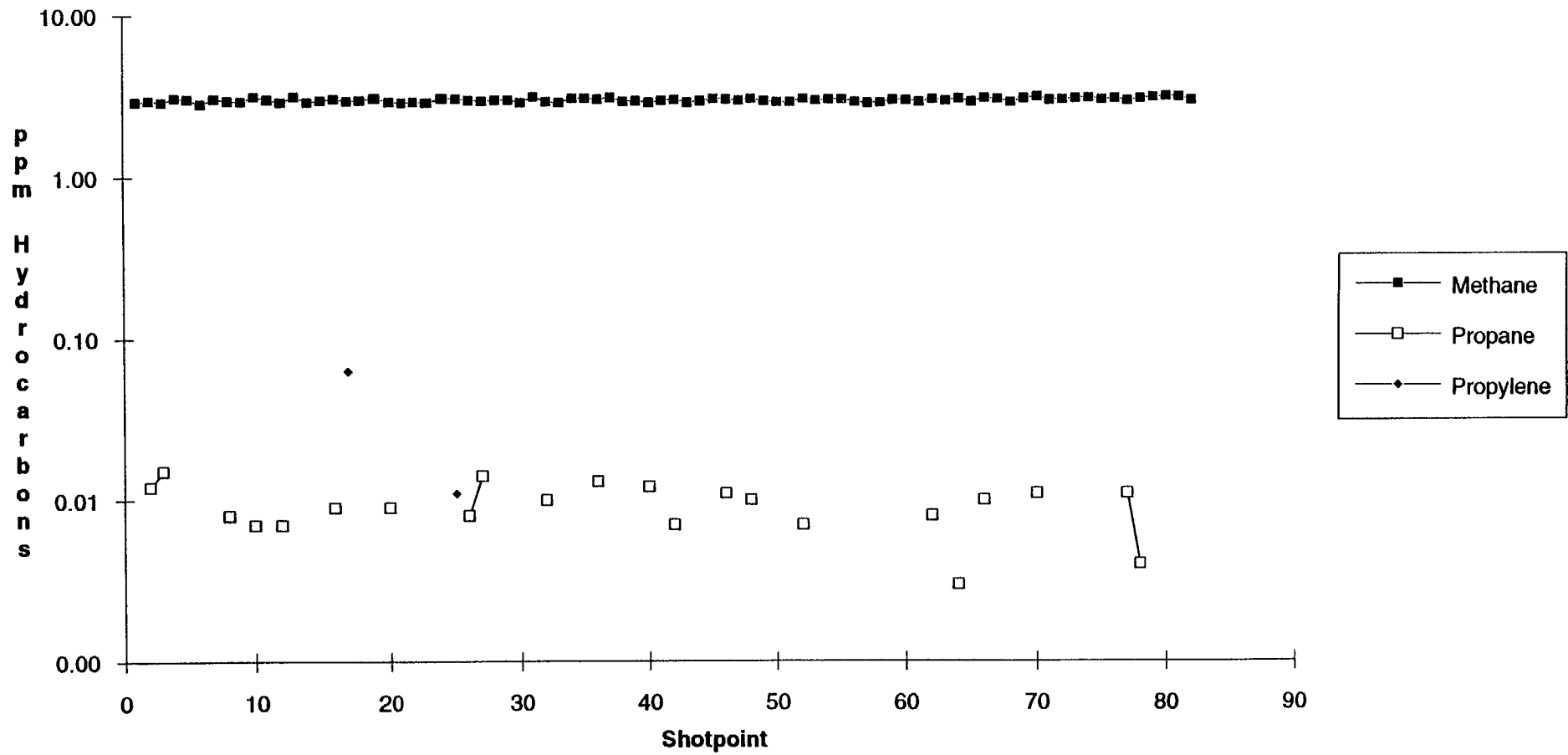
Line 104012 THC, Methane



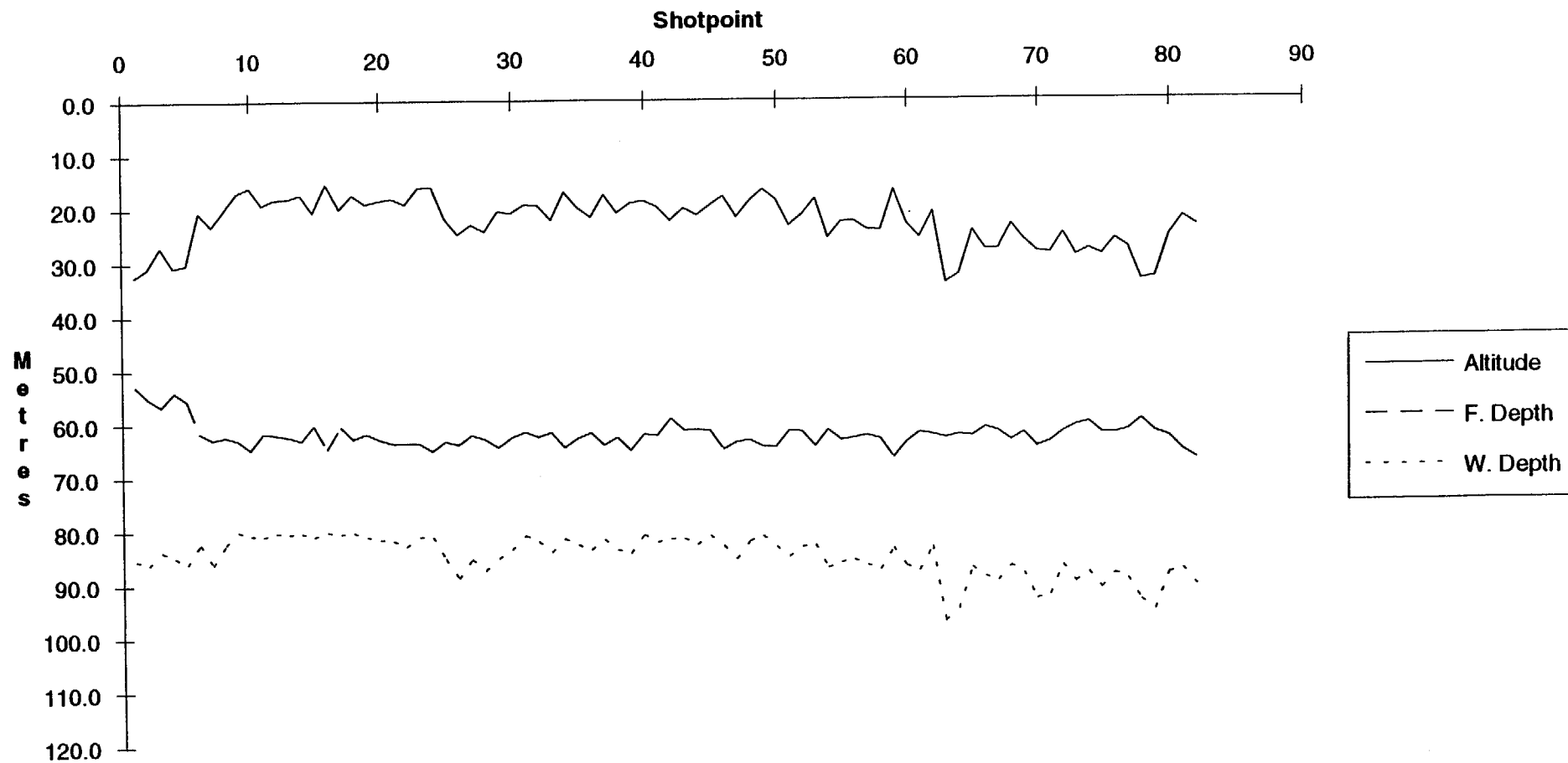
Line 104012 Methane, Ethane, Ethylene



Line 104012 Methane, Propane, Propylene



Line 104012 Depths, Altitude



Line Summary

Line Number 104SEEP1
No. of Shotpoints 119

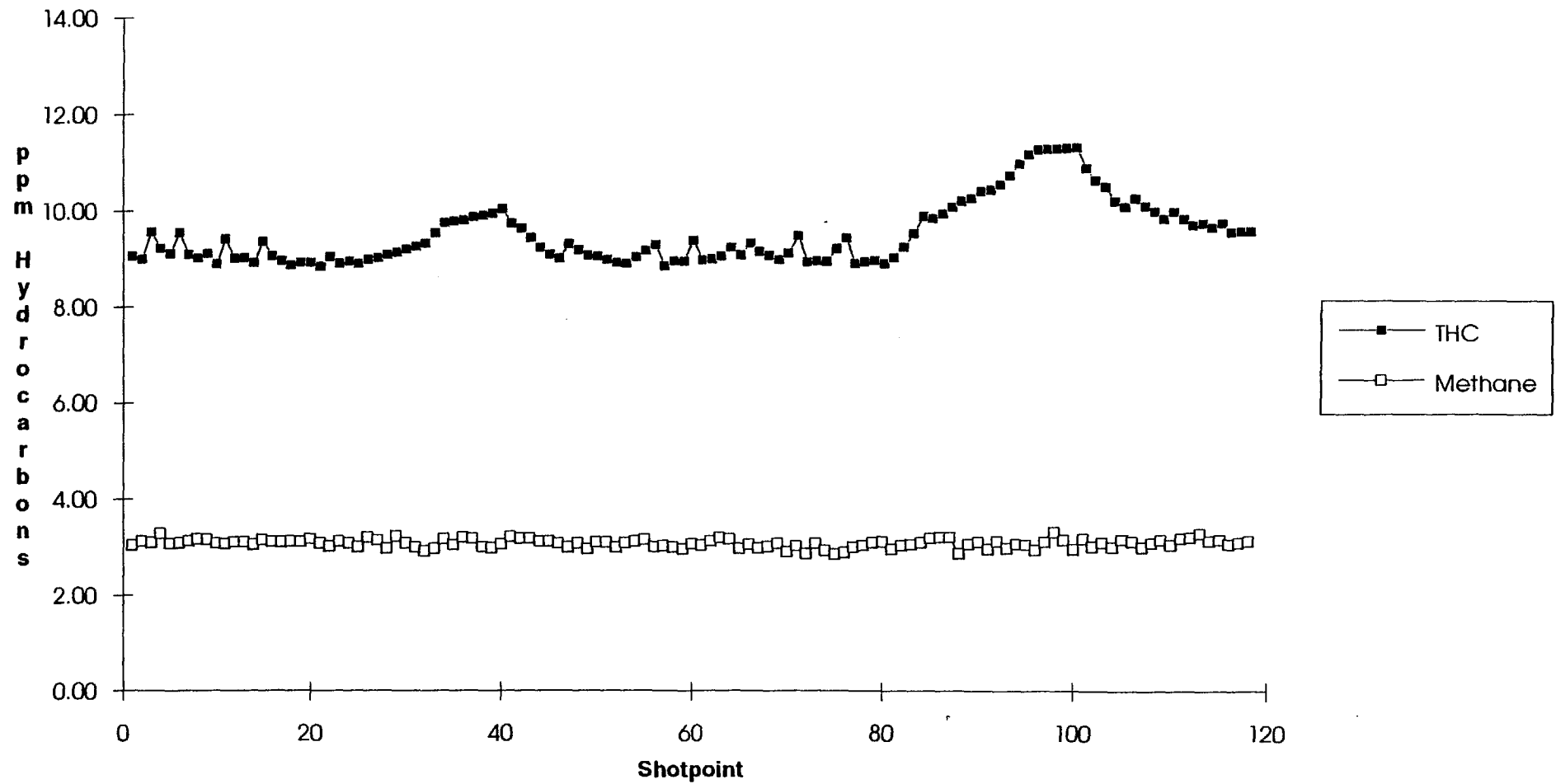
	Shotpoint	Date	Time	Latitude	Longitude	
Start	1	29/09/91	06:51:42	39	10.220 142	59.520
End	119	29/09/91	10:47:59	39	09.180 143	01.559

	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	9.531	3.077	0.008	0.037	0.004	0.001	0.000	0.001	0.006	0.044	0.025	0.001	0.418
Std. Dev.	0.653	0.091	0.003	0.006	0.007	0.004	0.003	0.005	0.008	0.020	0.013	0.003	0.315
Minimum	8.846	2.861	0.004	0.026	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.126
Maximum	11.347	3.323	0.027	0.059	0.047	0.041	0.019	0.045	0.034	0.075	0.052	0.016	1.855

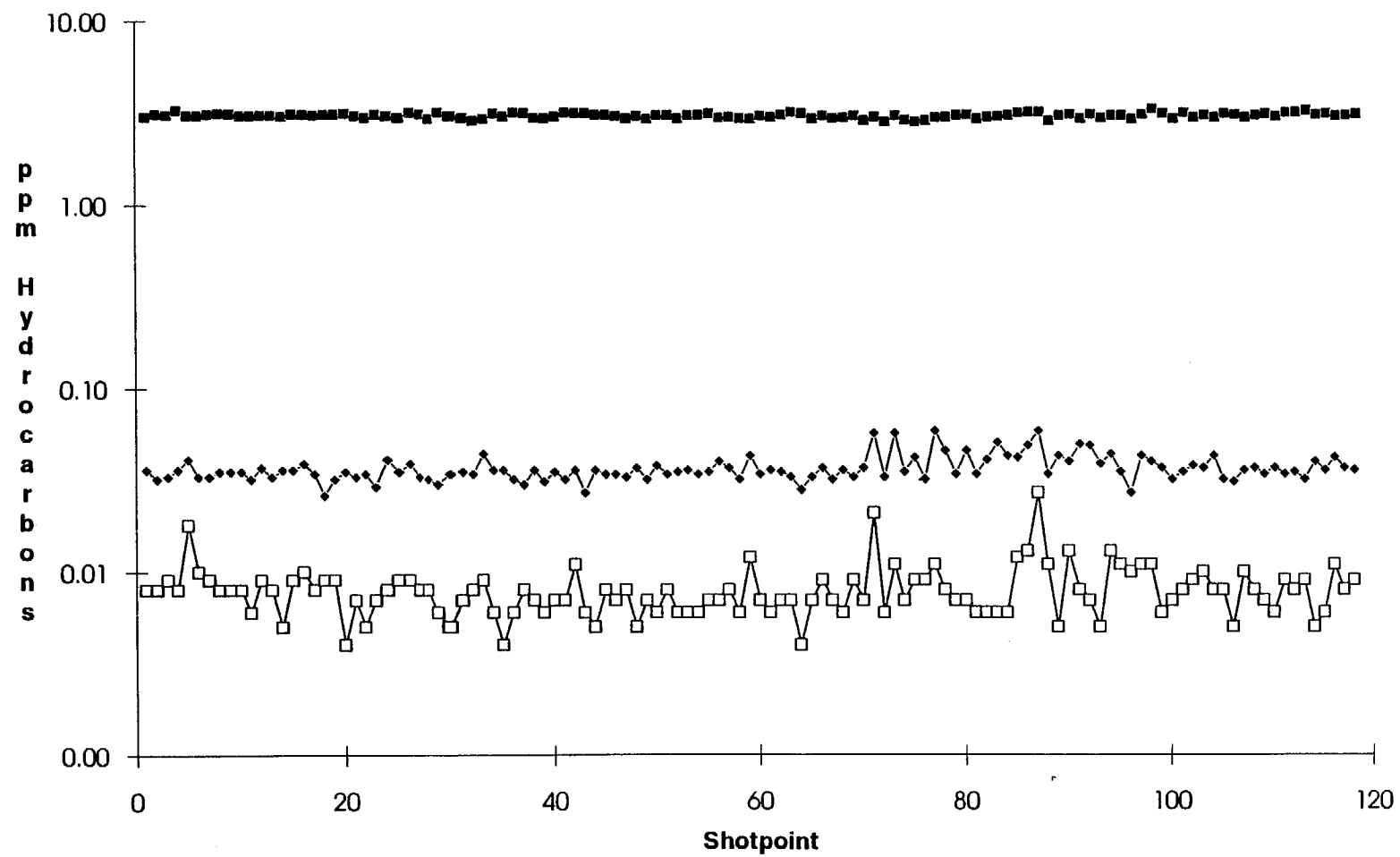
	Cond.	Temp.	Altitude	F. Depth	W.Depth
Mean	45.991	14.434	19.008	66.895	87.510
Std. Dev.	0.162	0.199	4.655	4.212	4.640
Minimum	45.700	14.180	5.500	58.100	78.900
Maximum	46.290	14.800	33.300	75.400	101.500

Notes Two very weak THC anomalies, maxima at shotpoints 41 and 101.

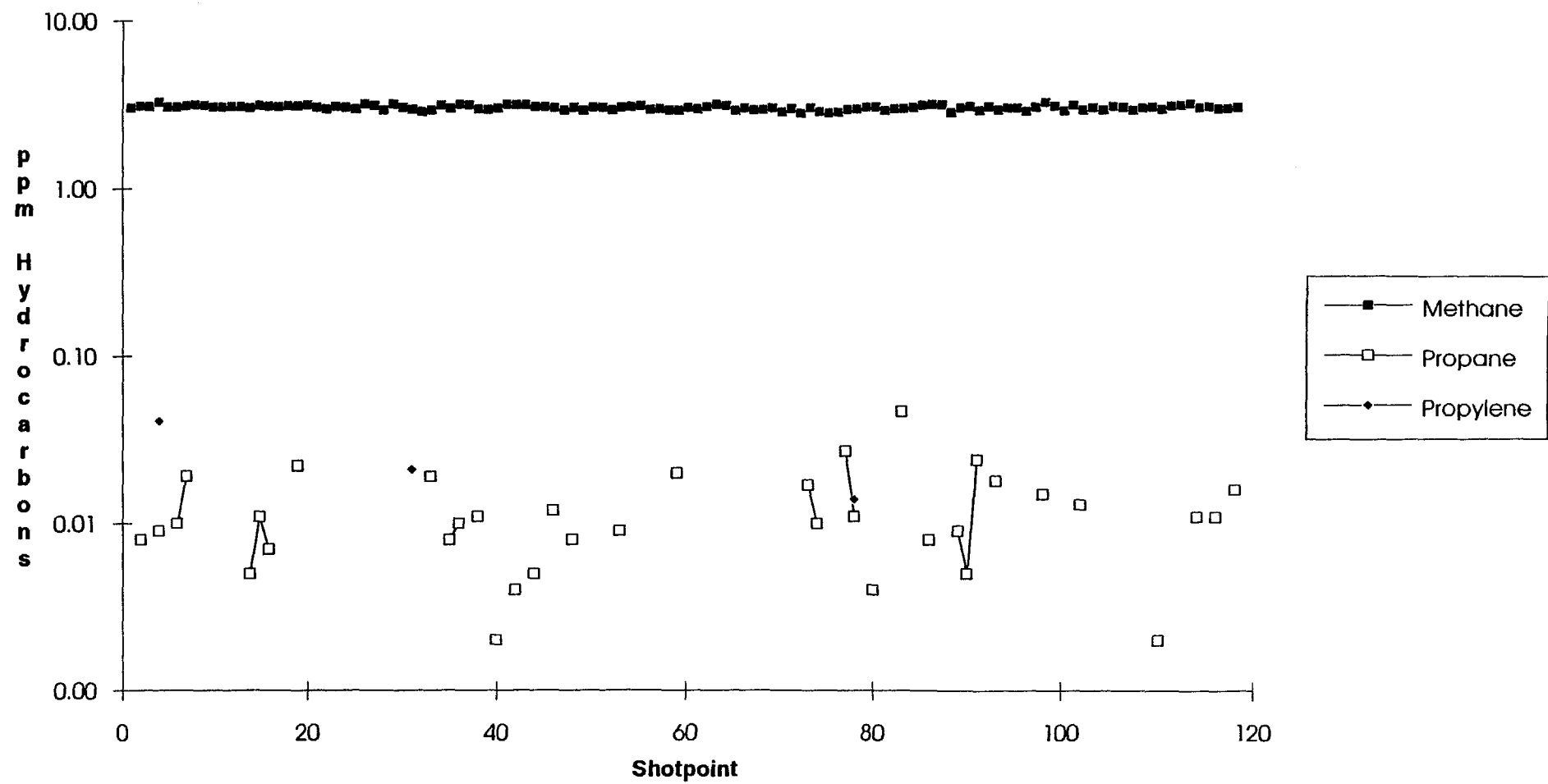
104 Seep1 THC, Methane



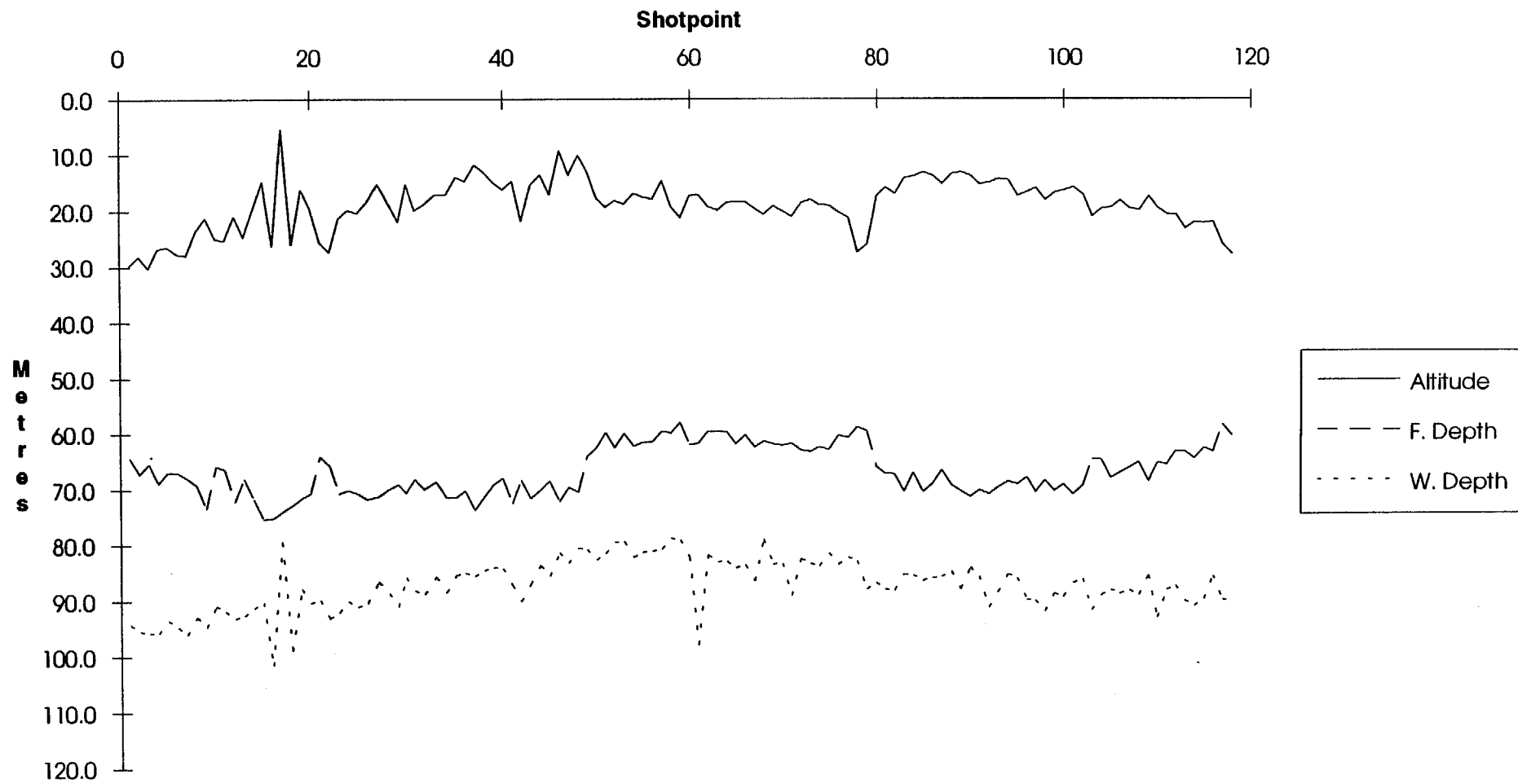
104 Seep1 Methane, Ethane, Ethylene



104 Seep1 Methane, Propane, Propylene



104 Seep1 Depths, Altitude



Torquay Sub-basin: Individual line plots and line summary sheets

Line Summary

Line Number 104013
No. of Shotpoints 9

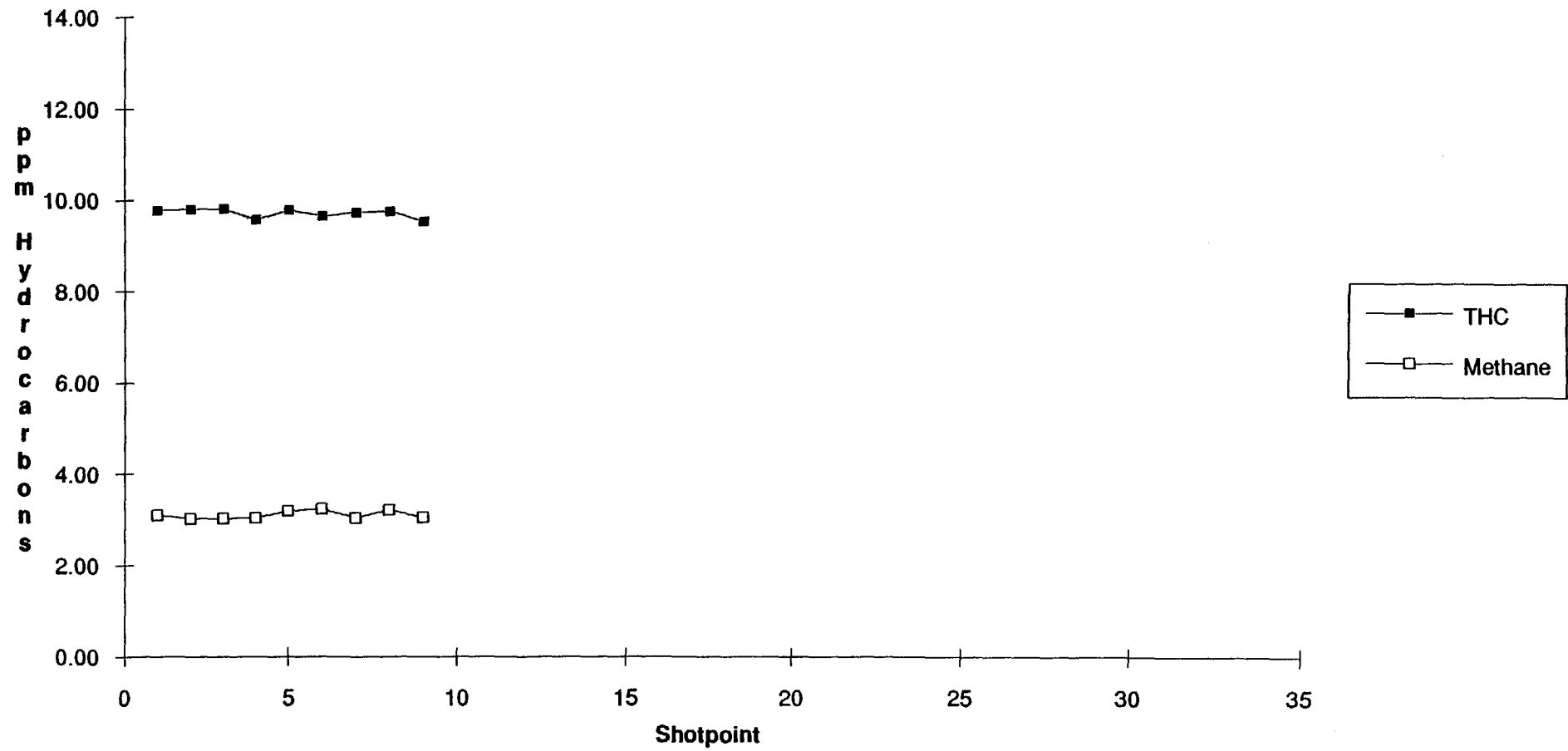
	Shotpoint	Date	Time	Latitude	Longitude	
Start	1	29/09/91	12:17:49	39	13.651	143 09.749
End	9	29/09/91	12:34:03	39	14.221	143 10.900

	THC	Methane	Ethane	Ethylene	Propane	Propylene	I-Butane	n-Butane	I-Pentane	n-Pentane	I-Hexane	n-Hexane	%Wetness
Mean	9.719	3.104	0.007	0.037	0.005	0.000	0.000	0.000	0.003	0.044	0.011	0.000	0.401
Std. Dev.	0.100	0.087	0.001	0.003	0.007	0.000	0.000	0.000	0.006	0.019	0.011	0.000	0.249
Minimum	9.546	3.022	0.005	0.031	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.155
Maximum	9.813	3.238	0.009	0.043	0.018	0.000	0.000	0.000	0.018	0.063	0.025	0.000	0.819

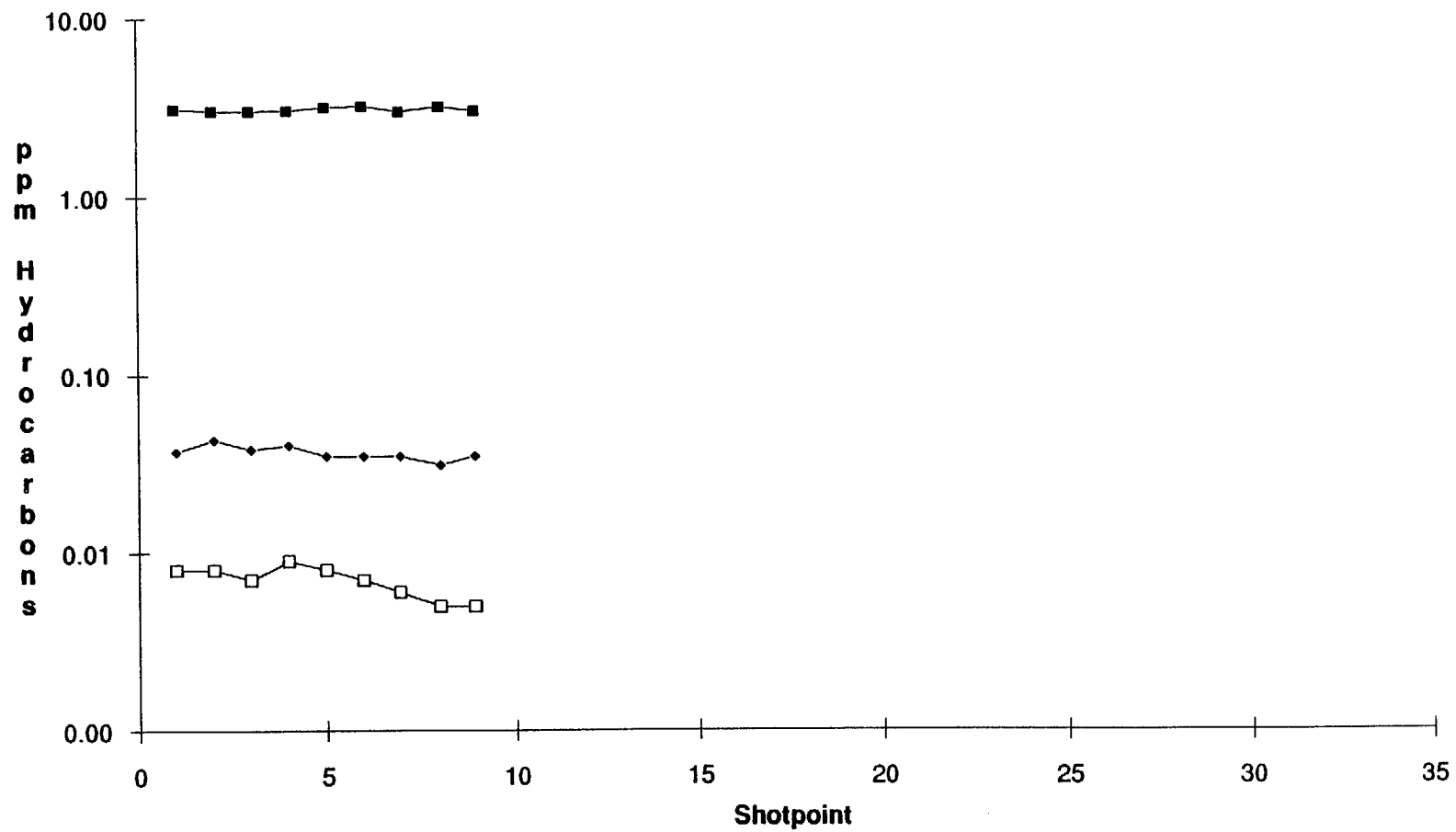
	Cond.	Temp.	Altitude	F. Depth	W.Depth
Mean	45.999	14.328	17.089	74.467	93.533
Std. Dev.	0.021	0.021	0.451	1.259	0.453
Minimum	45.950	14.310	16.200	71.600	92.700
Maximum	46.020	14.350	18.000	75.100	94.500

Notes
No hydrocarbon anomalies

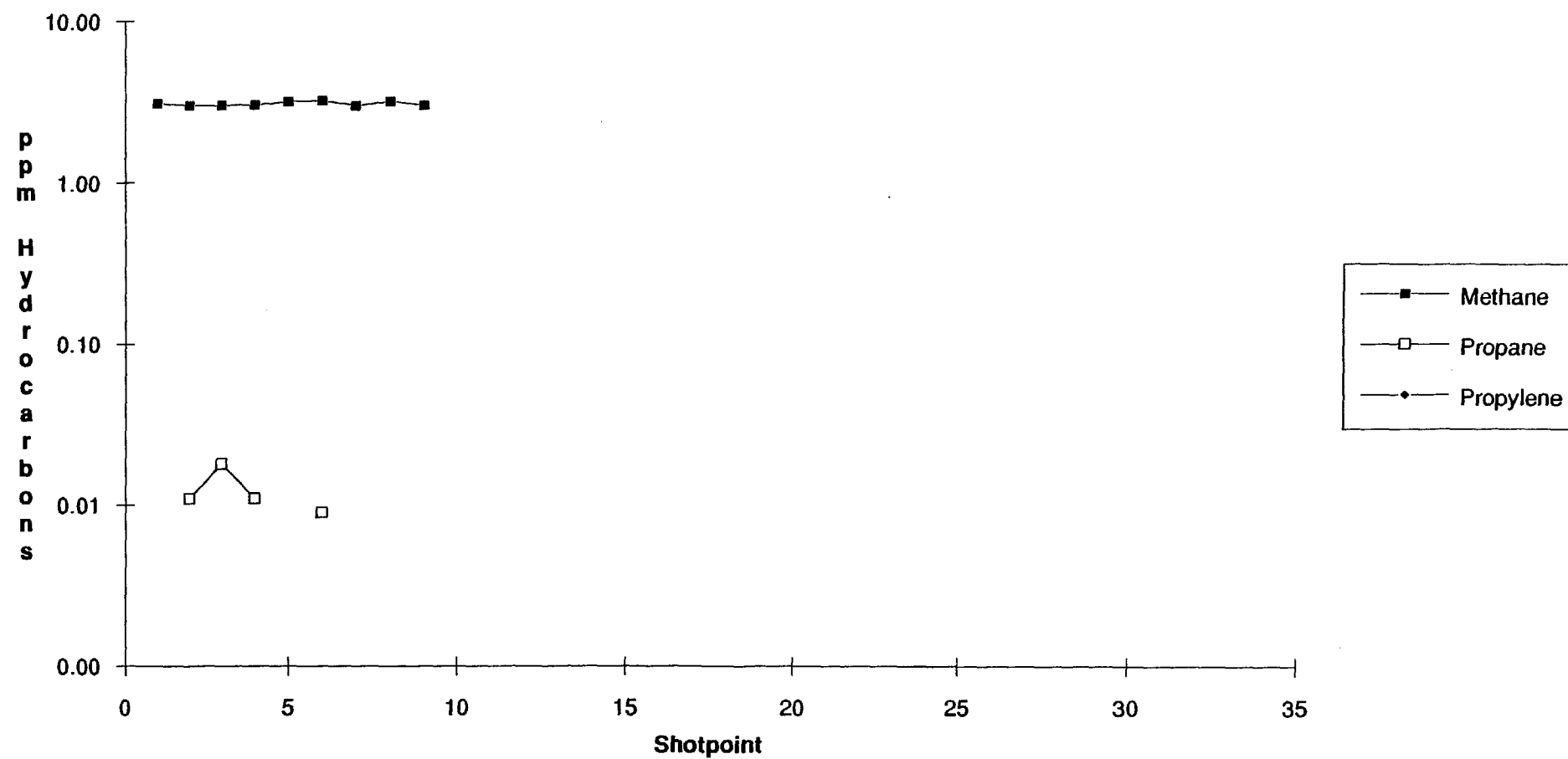
Line 104013 THC, Methane



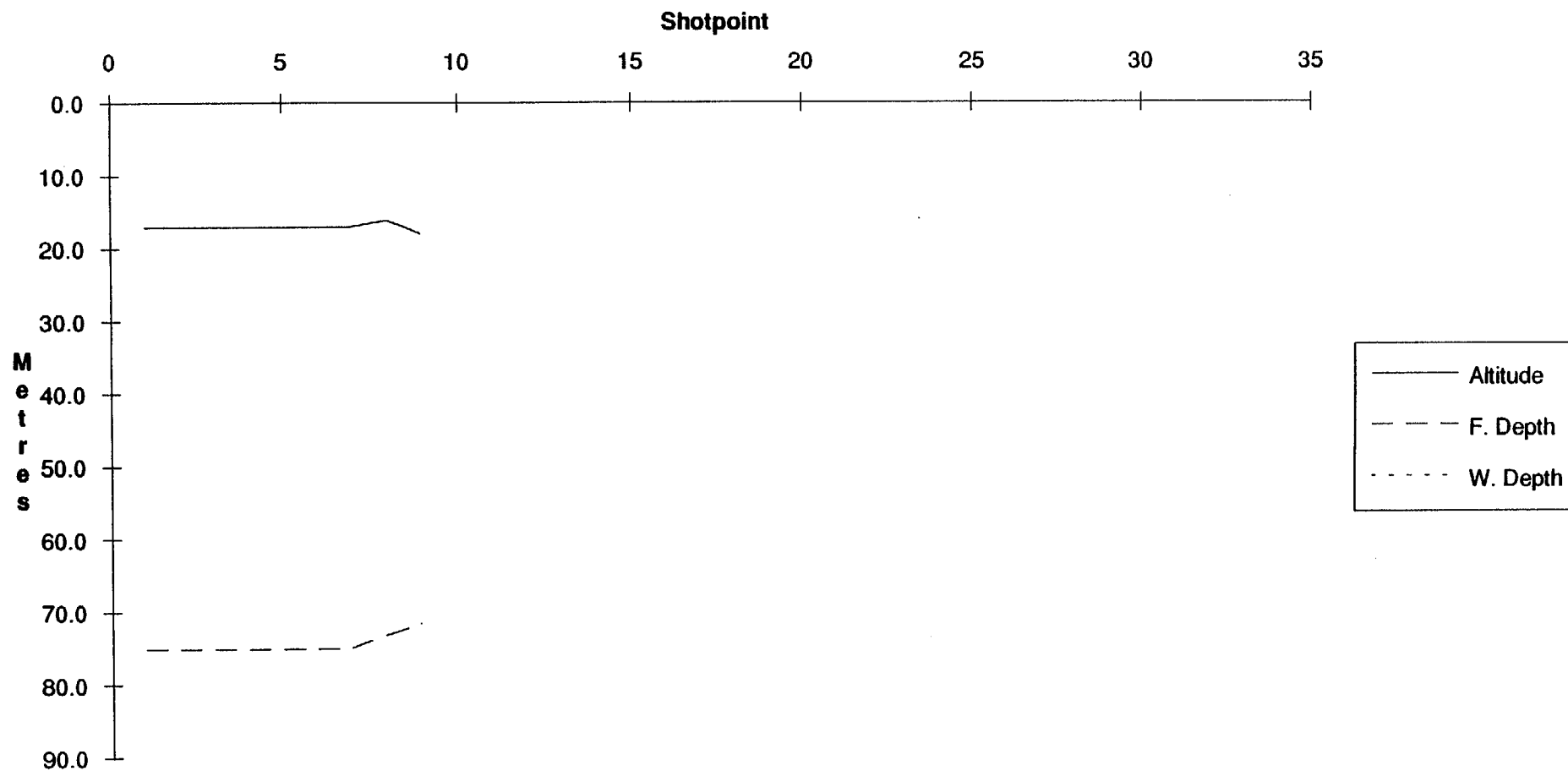
Line 104013 Methane, Ethane, Ethylene



Line 104013 Methane, Propane, Propylene



Line 104013 Depths, Altitude



Line Summary

Line Number 104014
No. of Shotpoints 285

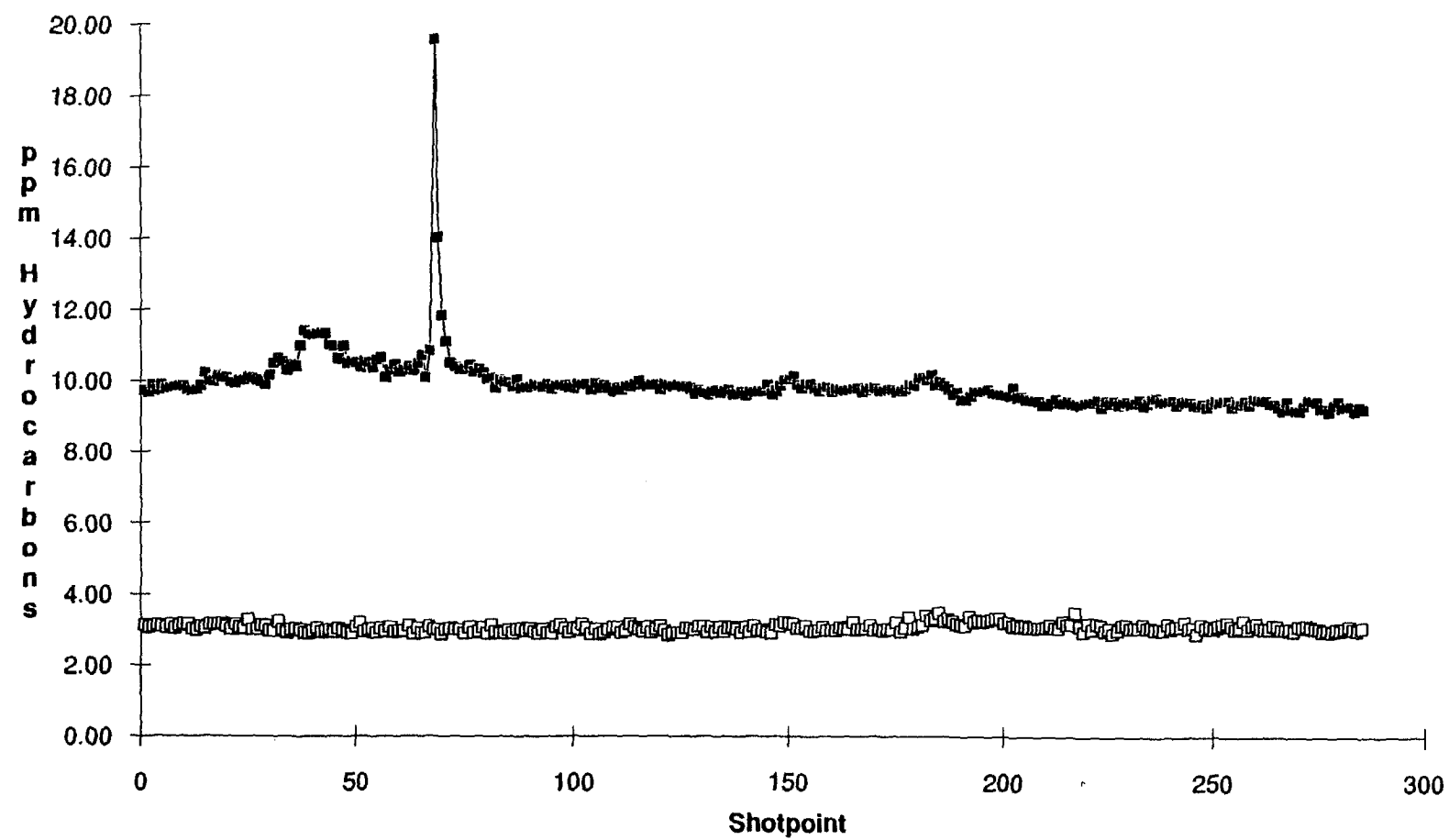
	Shotpoint	Date	Time	Latitude	Longitude
Start	1	29/09/91	12:36:03	39	14.554 143 11.148
End	285	29/09/91	22:08:47	38	45.989 143 59.460

	THC	Methane	Ethane	Ethylene	Propane	Propylene	I-Butane	n-Butane	I-Pentane	n-Pentane	I-Hexane	n-Hexane	%Wetness
Mean	9.898	3.056	0.008	0.037	0.003	0.000	0.000	0.000	0.001	0.052	0.016	0.000	0.362
Std. Dev.	0.774	0.110	0.002	0.004	0.004	0.001	0.000	0.000	0.003	0.020	0.013	0.003	0.156
Minimum	9.180	2.839	0.003	0.025	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.126
Maximum	19.628	3.504	0.021	0.066	0.019	0.014	0.000	0.000	0.022	0.101	0.054	0.051	0.891

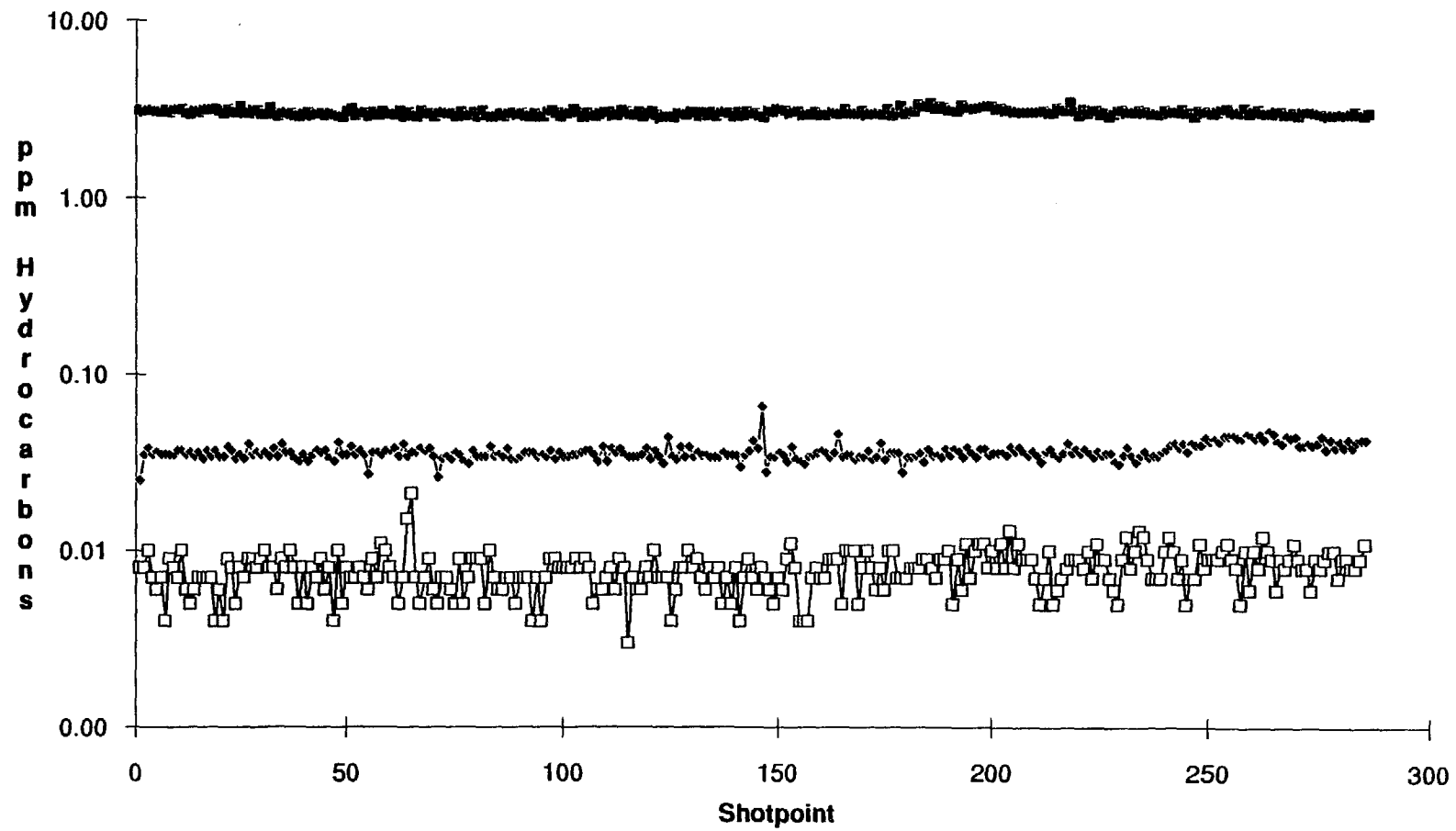
	Cond.	Temp.	Altitude	F. Depth	W.Depth
Mean	46.012	14.479	14.209	70.211	86.682
Std. Dev.	0.135	0.163	3.252	3.801	6.039
Minimum	45.800	14.120	9.200	62.500	77.800
Maximum	46.480	14.860	26.000	79.300	102.000

Notes
THC anomaly SP 68-72

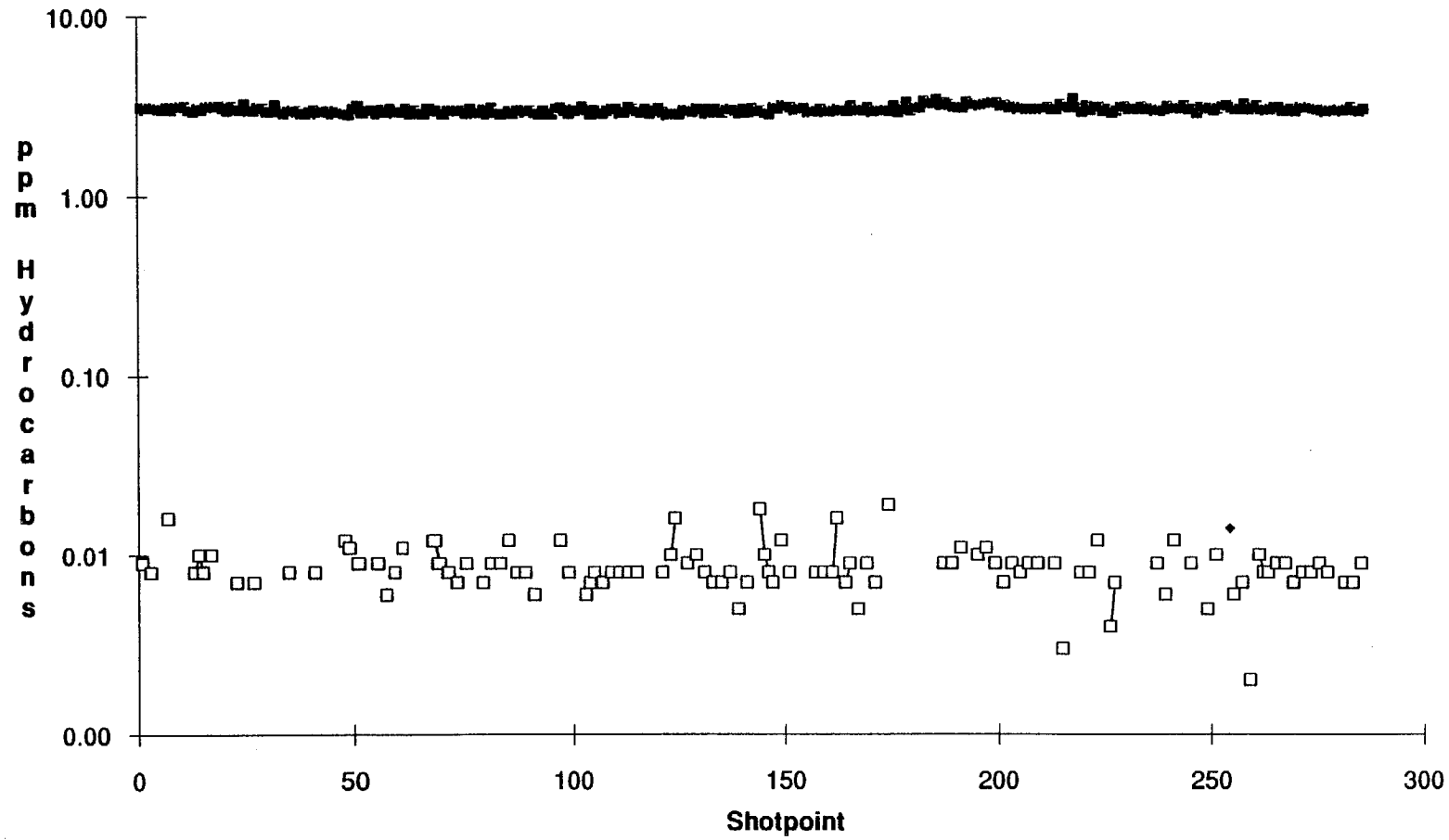
Line 104014 THC, Methane



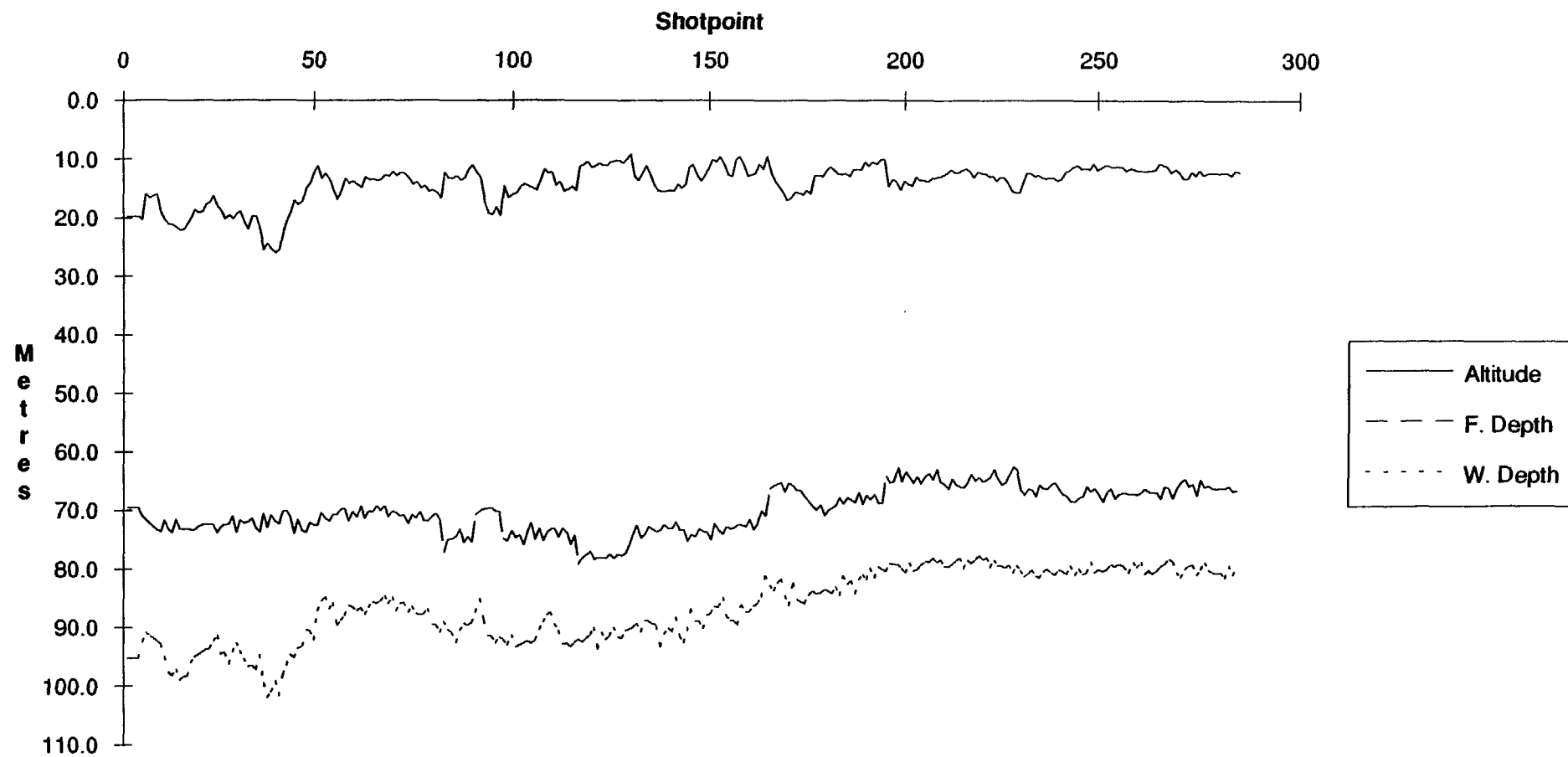
Line 104014 Methane, Ethane, Ethylene



Line 104014 Methane, Propane, Propylene



Line 104014 Depths, Altitude



Line Summary

Line Number 104015
No. of Shotpoints 30

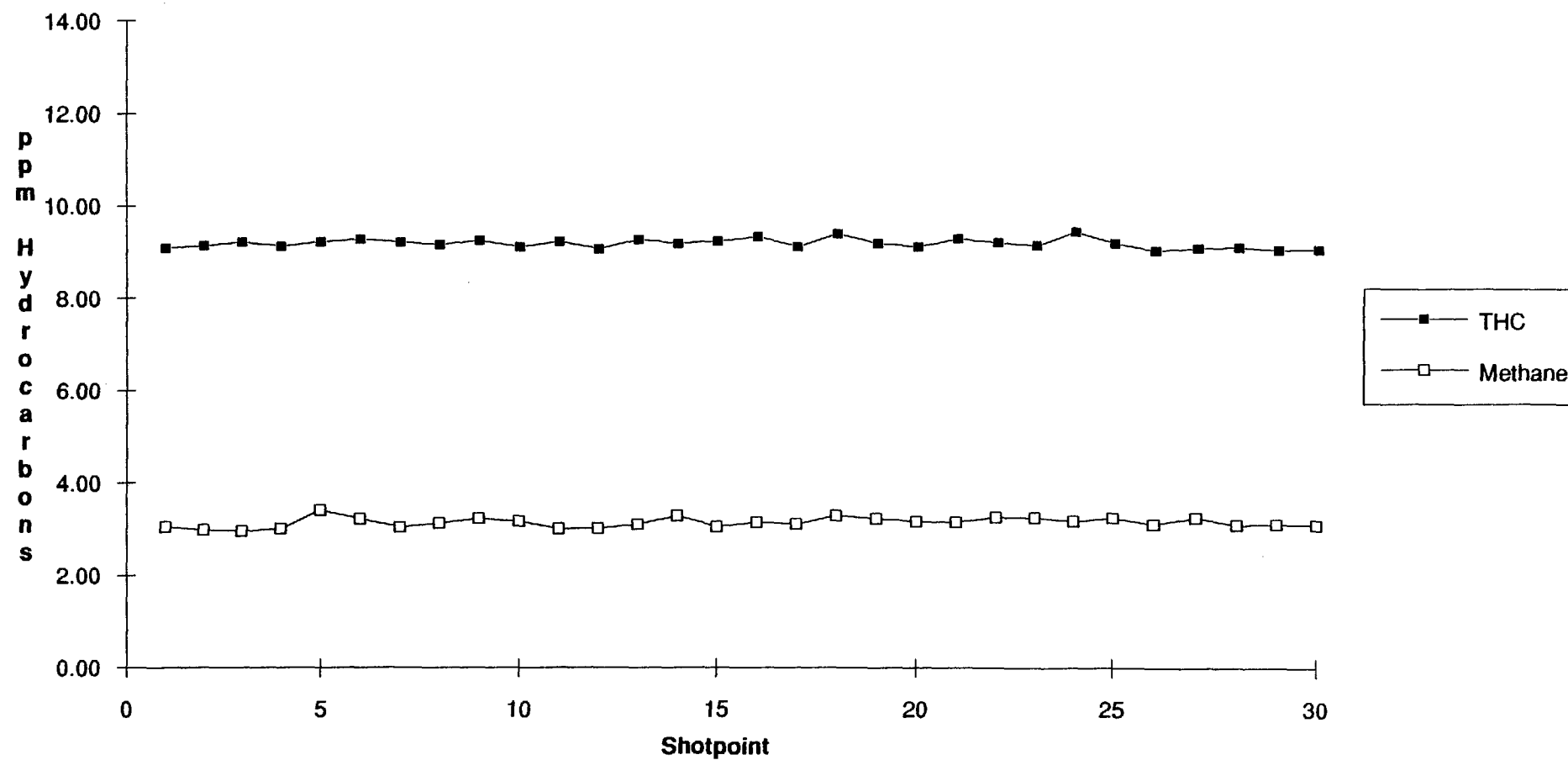
	Shotpoint	Date	Time	Latitude	Longitude	
Start	1	29/09/91	22:10:46	38	45.671 144	-00.068
End	31	29/09/91	23:11:03	38	49.104 144	04.239

	THC	Methane	Ethane	Ethylene	Propane	Propylene	I-Butane	n-Butane	I-Pentane	n-Pentane	I-Hexane	n-Hexane	%Wetness
Mean	9.200	3.146	0.011	0.044	0.004	0.002	0.000	0.000	0.003	0.046	0.016	0.003	0.482
Std. Dev.	0.099	0.108	0.003	0.010	0.005	0.008	0.002	0.000	0.007	0.018	0.013	0.006	0.202
Minimum	9.051	2.951	0.006	0.037	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.184
Maximum	9.463	3.399	0.020	0.090	0.012	0.036	0.010	0.000	0.030	0.067	0.045	0.020	0.943

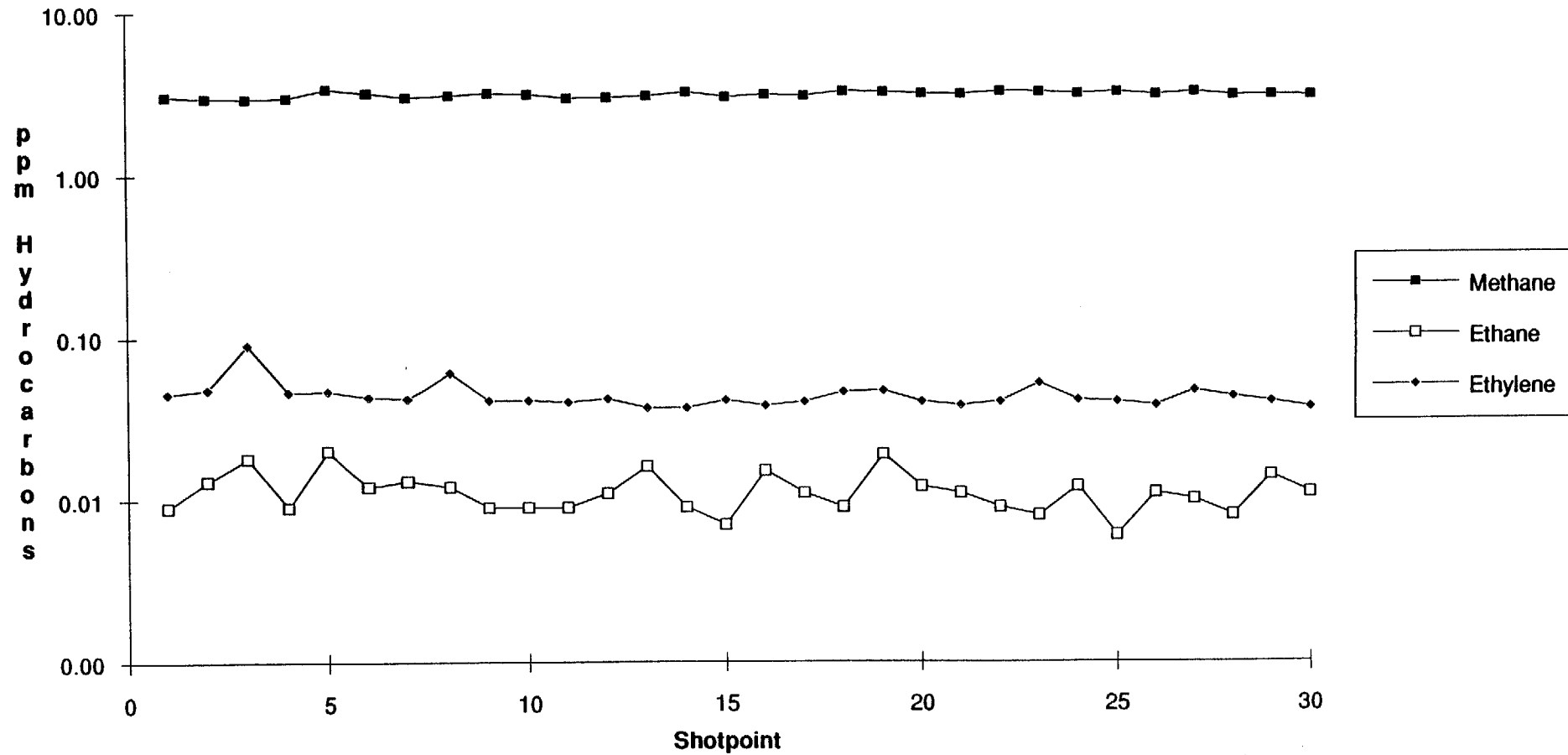
	Cond.	Temp.	Altitude	F. Depth	W. Depth
Mean	46.529	14.927	10.920	67.953	79.917
Std. Dev.	0.091	0.090	1.345	1.125	1.791
Minimum	46.410	14.830	8.400	66.000	76.500
Maximum	46.780	15.190	13.500	70.300	83.100

Notes
No hydrocarbon anomalies

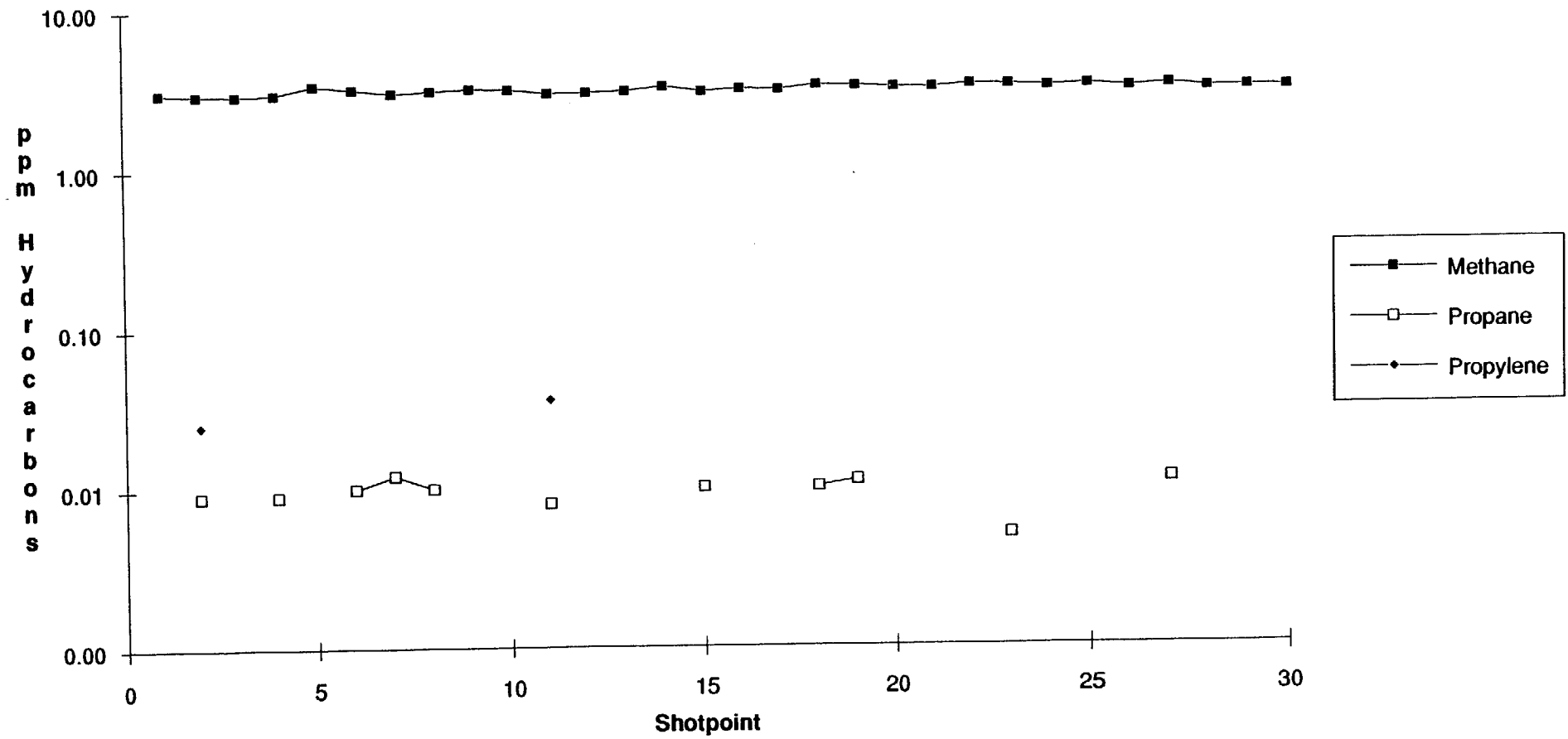
Line 104015 THC, Methane



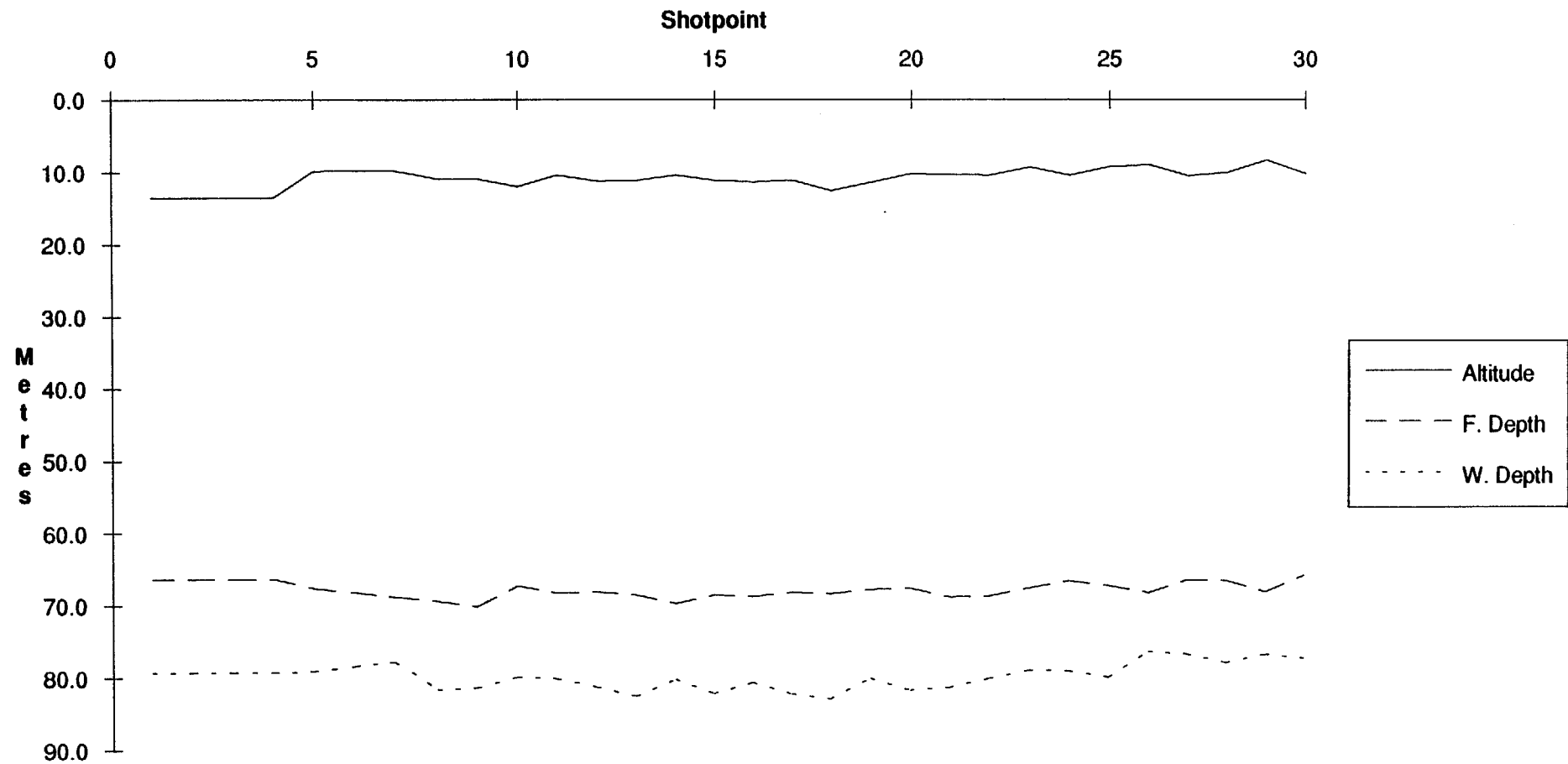
Line 104015 Methane, Ethane, Ethylene



Line 104015 Methane, Propane, Propylene



Line 104015 Depths, Altitude



Line Summary

Line Number
No. of Shotpoints

104016
24

	Shotpoint	Date	Time	Latitude	Longitude
Start	1	29/09/91	23:13:03	38 49.659	144 04.866
End	24	29/09/91	23:59:25	38 45.987	144 06.043

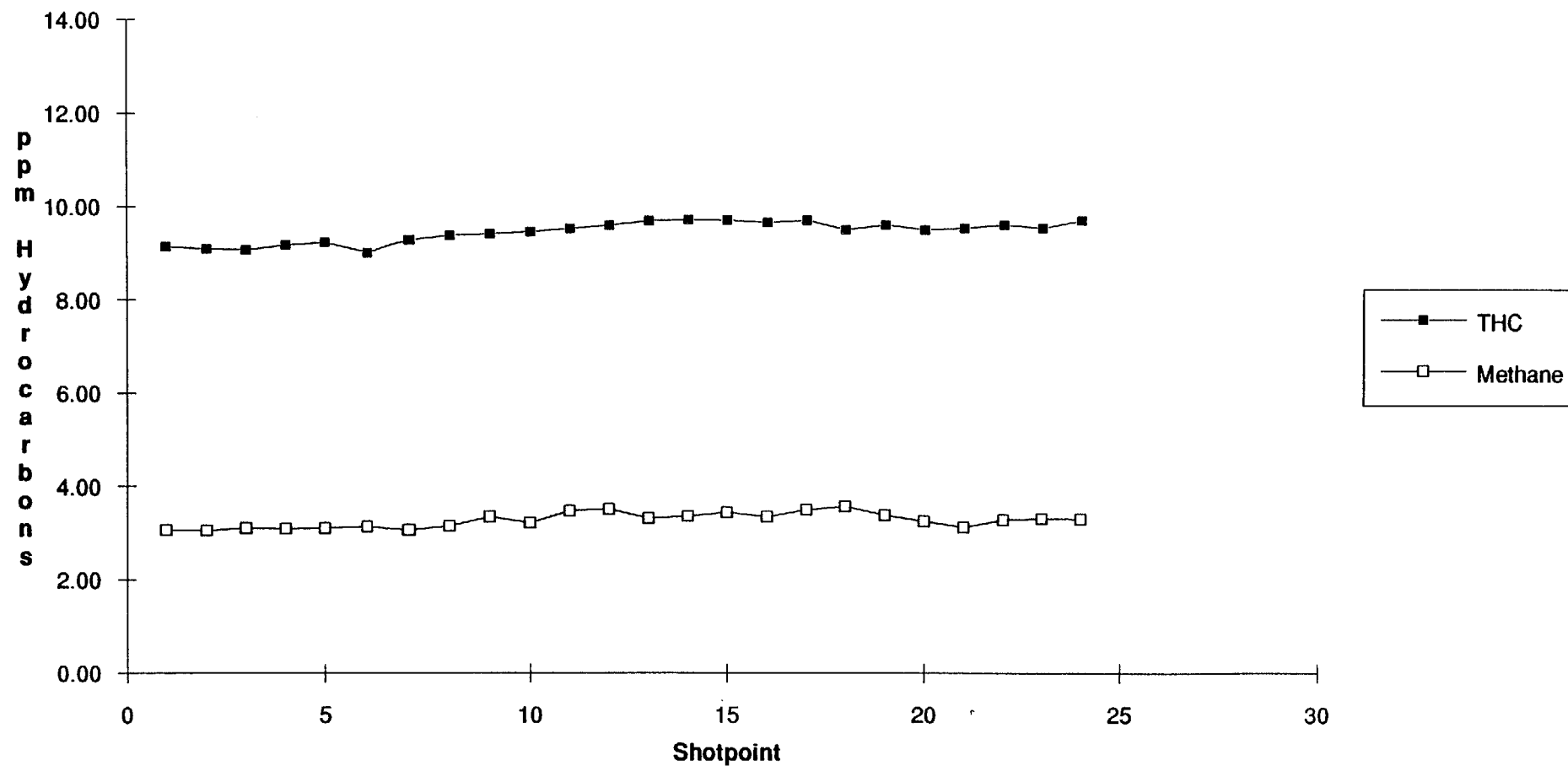
	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	9.465	3.271	0.009	0.040	0.002	0.000	0.000	0.000	0.000	0.040	0.012	0.000	0.331
Std. Dev.	0.230	0.159	0.002	0.002	0.003	0.000	0.000	0.000	0.000	0.017	0.011	0.000	0.115
Minimum	9.021	3.054	0.005	0.035	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.172
Maximum	9.729	3.567	0.013	0.045	0.011	0.000	0.000	0.000	0.000	0.058	0.032	0.000	0.588

	Cond.	Temp.	Altitude	F. Depth	W.Depth
Mean	46.986	15.350	11.413	67.104	79.392
Std. Dev.	0.171	0.161	0.755	0.940	1.285
Minimum	46.780	15.150	10.000	65.600	77.300
Maximum	47.270	15.630	13.400	68.900	81.900

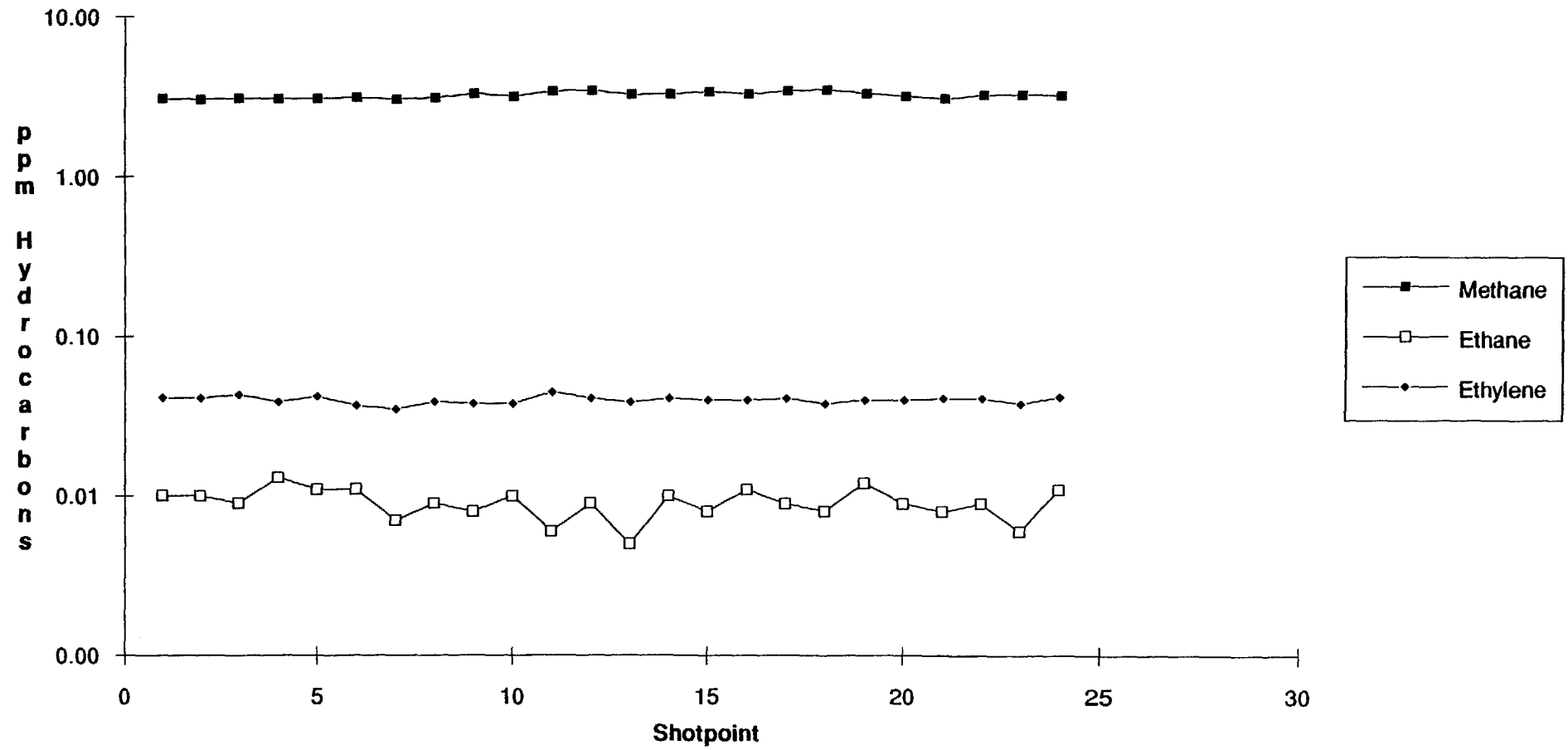
Notes

No hydrocarbon anomalies

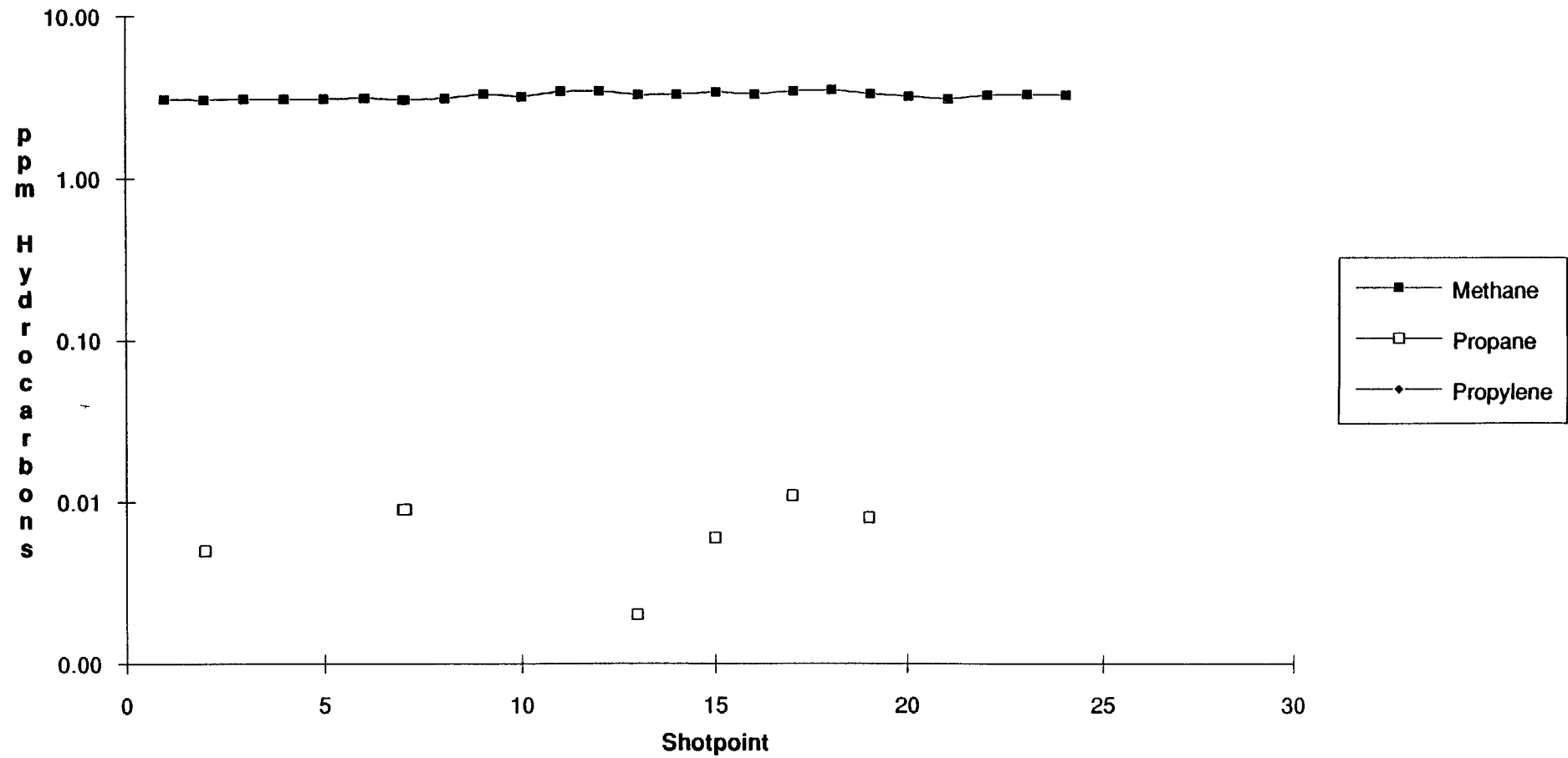
Line 104016 THC, Methane



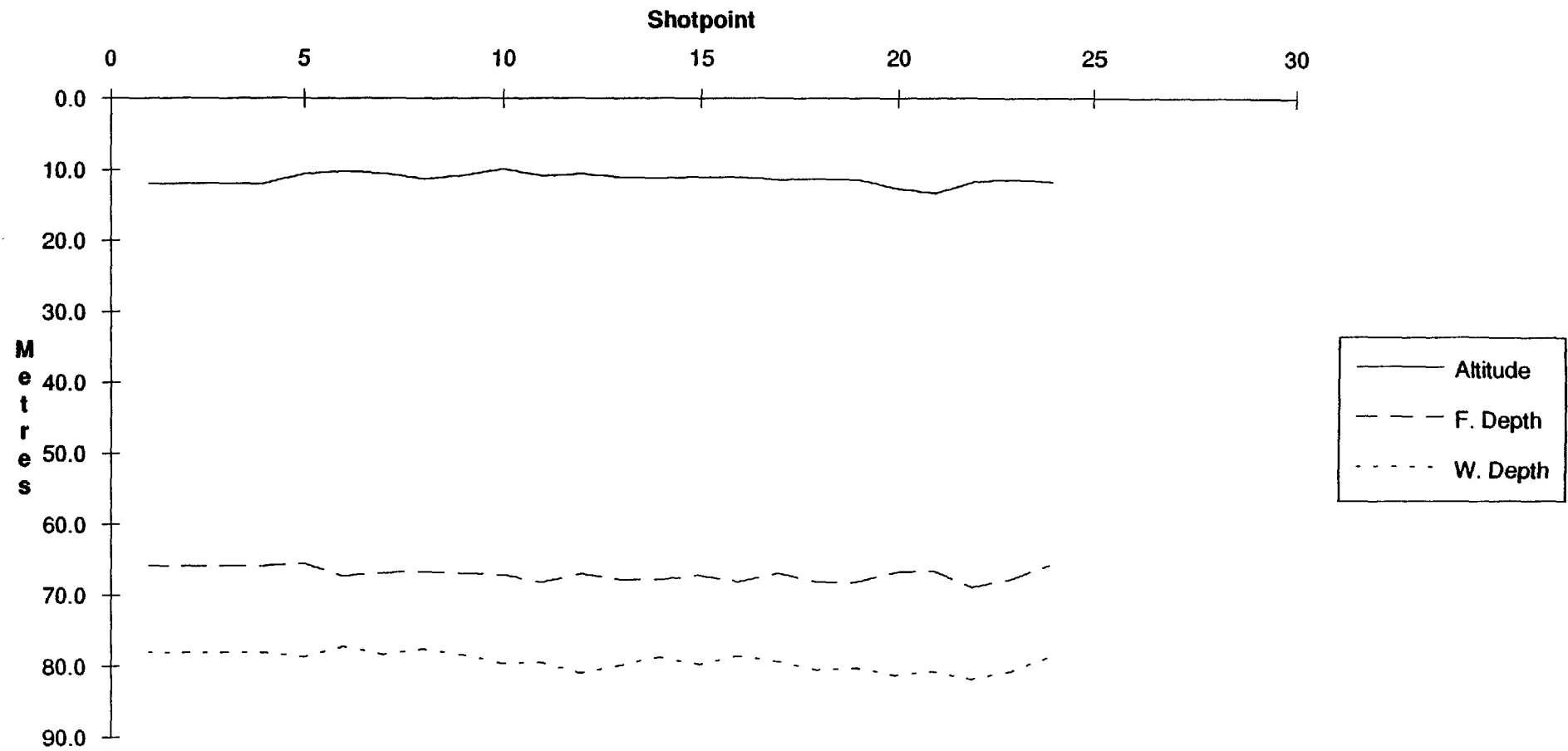
Line 104016 Methane, Ethane, Ethylene



Line 104016 Methane, Propane, Propylene



Line 104016 Depths, Altitude



Line Summary

Line Number 104017
No. of Shotpoints 26

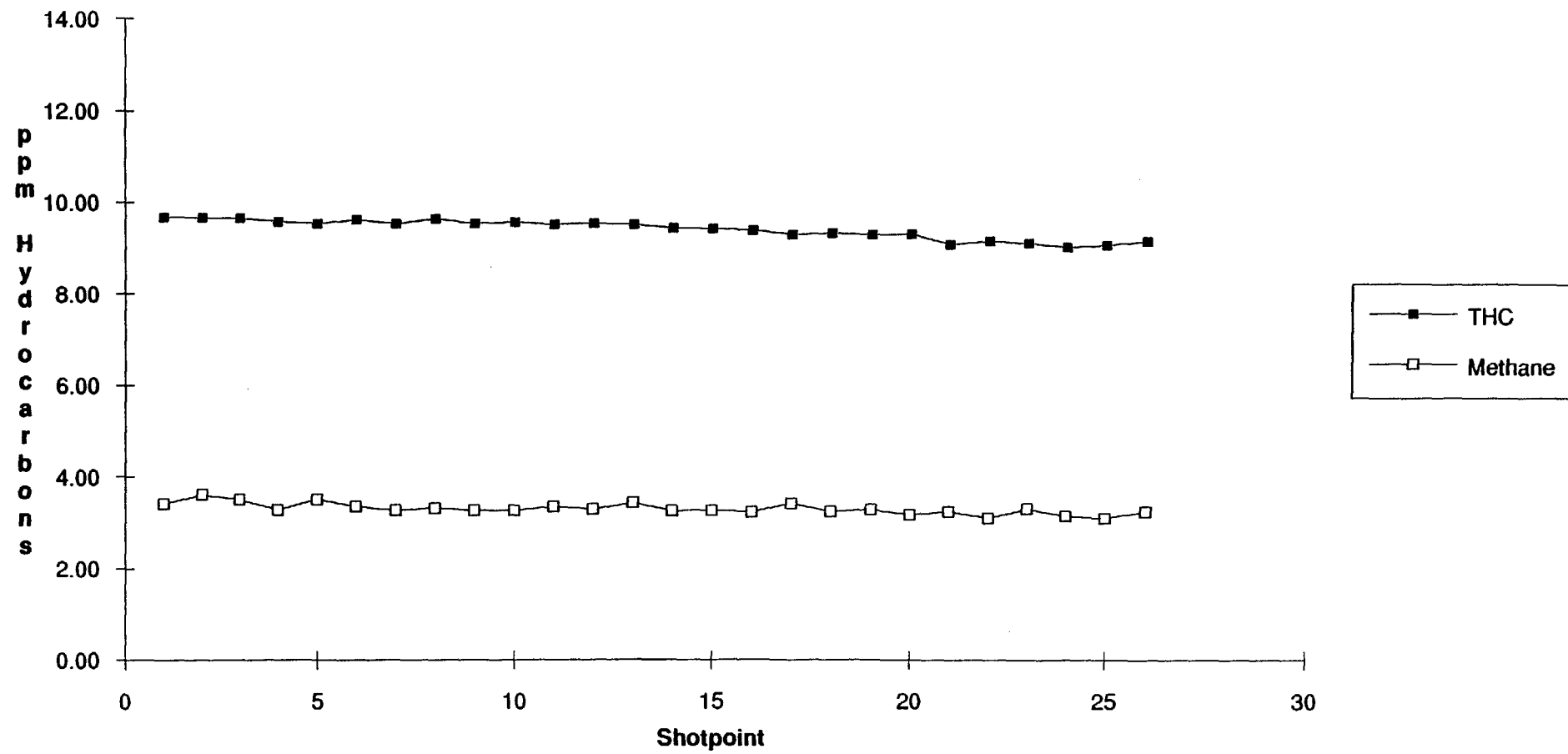
	Shotpoint	Date	Time	Latitude	Longitude	
Start	1	30/09/91	00:01:24	38	45.308 144	06.274
End	26	30/09/91	00:51:41	38	48.486 144	09.426

	THC	Methane	Ethane	Ethylene	Propane	Propylene	I-Butane	n-Butane	I-Pentane	n-Pentane	I-Hexane	n-Hexane	%Wetness
Mean	9.409	3.300	0.011	0.042	0.004	0.001	0.000	0.000	0.005	0.048	0.020	0.004	0.434
Std. Dev.	0.205	0.120	0.003	0.005	0.006	0.003	0.000	0.000	0.009	0.020	0.016	0.007	0.227
Minimum	9.024	3.104	0.007	0.033	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.213
Maximum	9.671	3.605	0.019	0.054	0.018	0.015	0.000	0.000	0.025	0.073	0.046	0.022	1.061

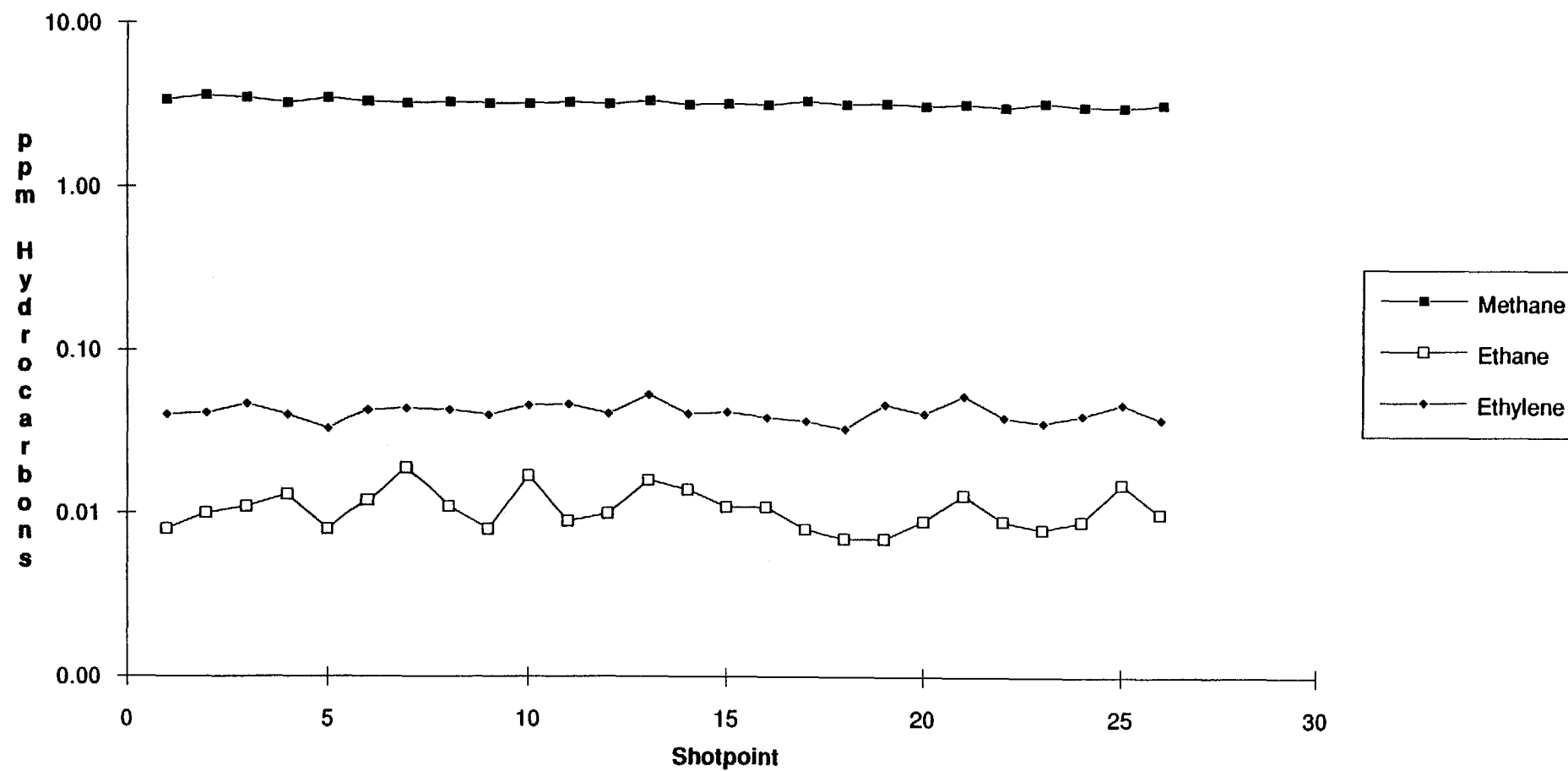
	Cond.	Temp.	Altitude	F. Depth	W.Depth
Mean	47.260	15.601	10.269	68.469	80.454
Std. Dev.	0.164	0.148	0.675	1.033	1.629
Minimum	46.990	15.340	9.300	67.000	77.500
Maximum	47.510	15.820	12.100	70.600	82.600

Notes
No hydrocarbon anomalies

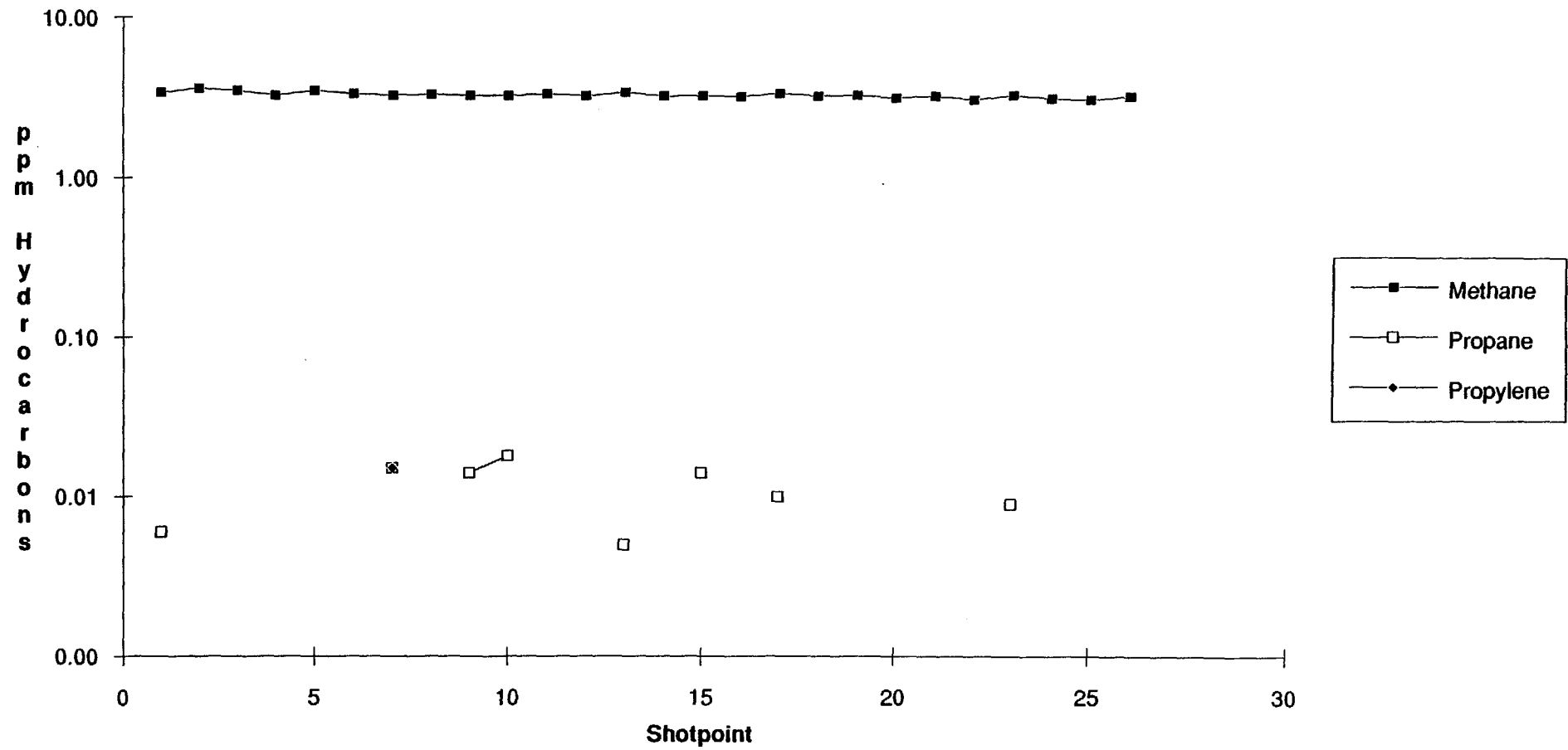
Line 104017 THC, Methane



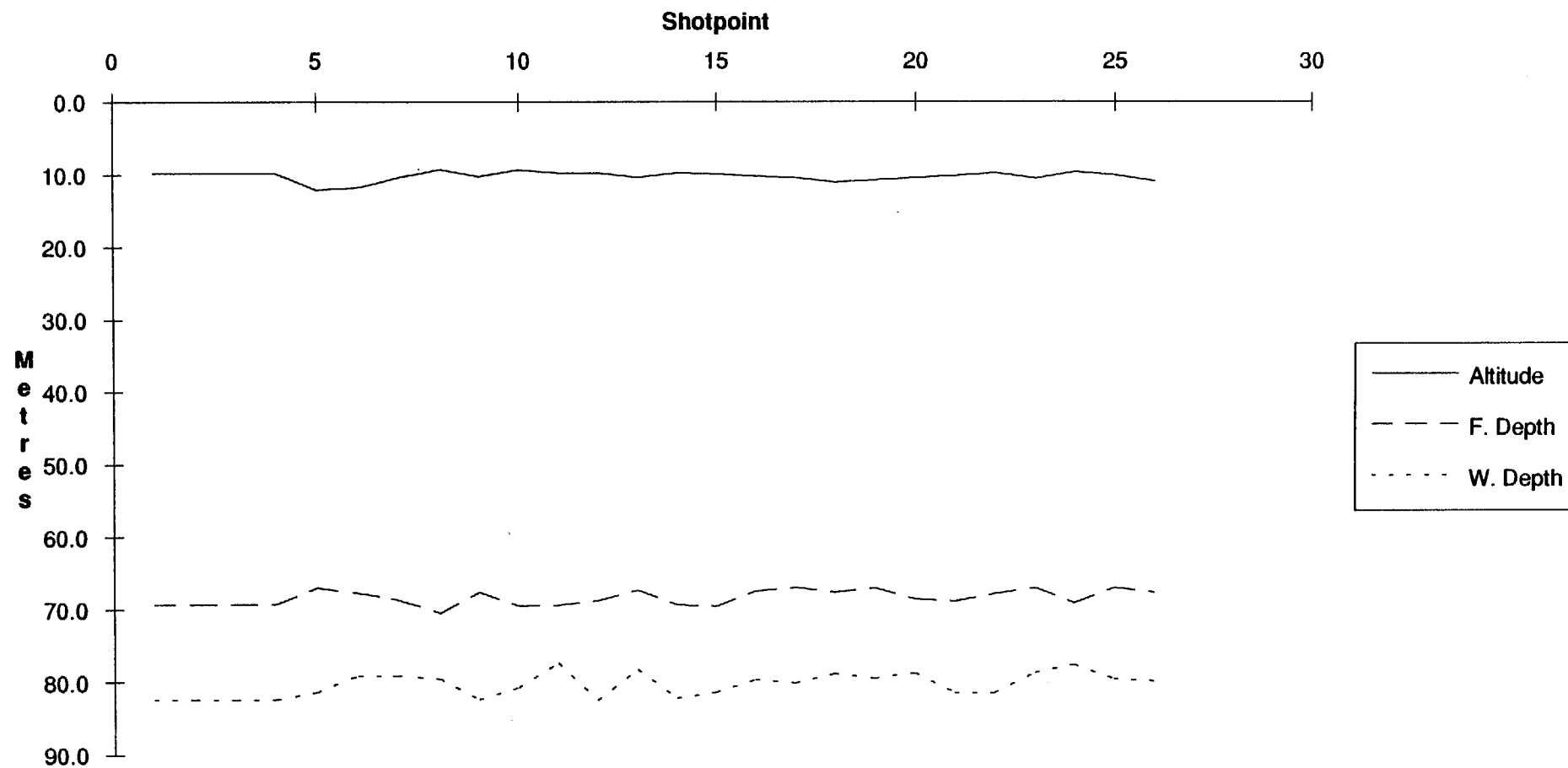
Line 104017 Methane, Ethane, Ethylene



Line 104017 Methane, Propane, Propylene



Line 104017 Depths, Altitude



Line Summary

Line Number 104018
No. of Shotpoints 44

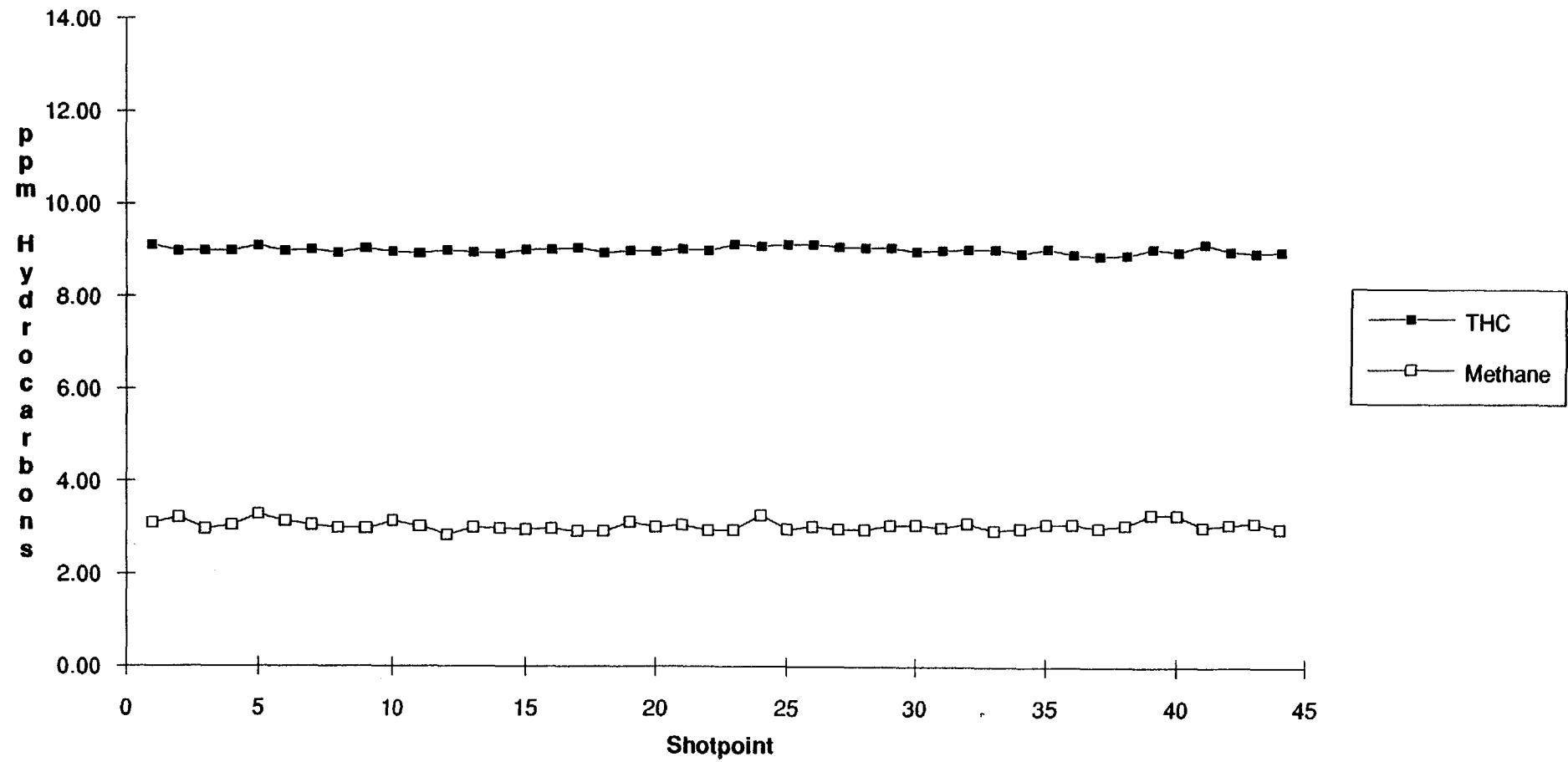
	Shotpoint	Date	Time	Latitude	Longitude
Start	1	30/09/91	00:53:41	38	49.053 144 09.865
End	44	30/09/91	02:19:57	38	43.324 144 14.923

	THC	Methane	Ethane	Ethylene	Propane	Propylene	I-Butane	n-Butane	I-Pentane	n-Pentane	I-Hexane	n-Hexane	%Wetness
Mean	9.032	3.049	0.008	0.039	0.003	0.000	0.000	0.000	0.000	0.040	0.016	0.000	0.347
Std. Dev.	0.065	0.105	0.002	0.003	0.005	0.000	0.000	0.000	0.002	0.016	0.015	0.000	0.159
Minimum	8.906	2.838	0.005	0.034	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.160
Maximum	9.175	3.300	0.012	0.045	0.013	0.000	0.000	0.000	0.013	0.059	0.050	0.000	0.736

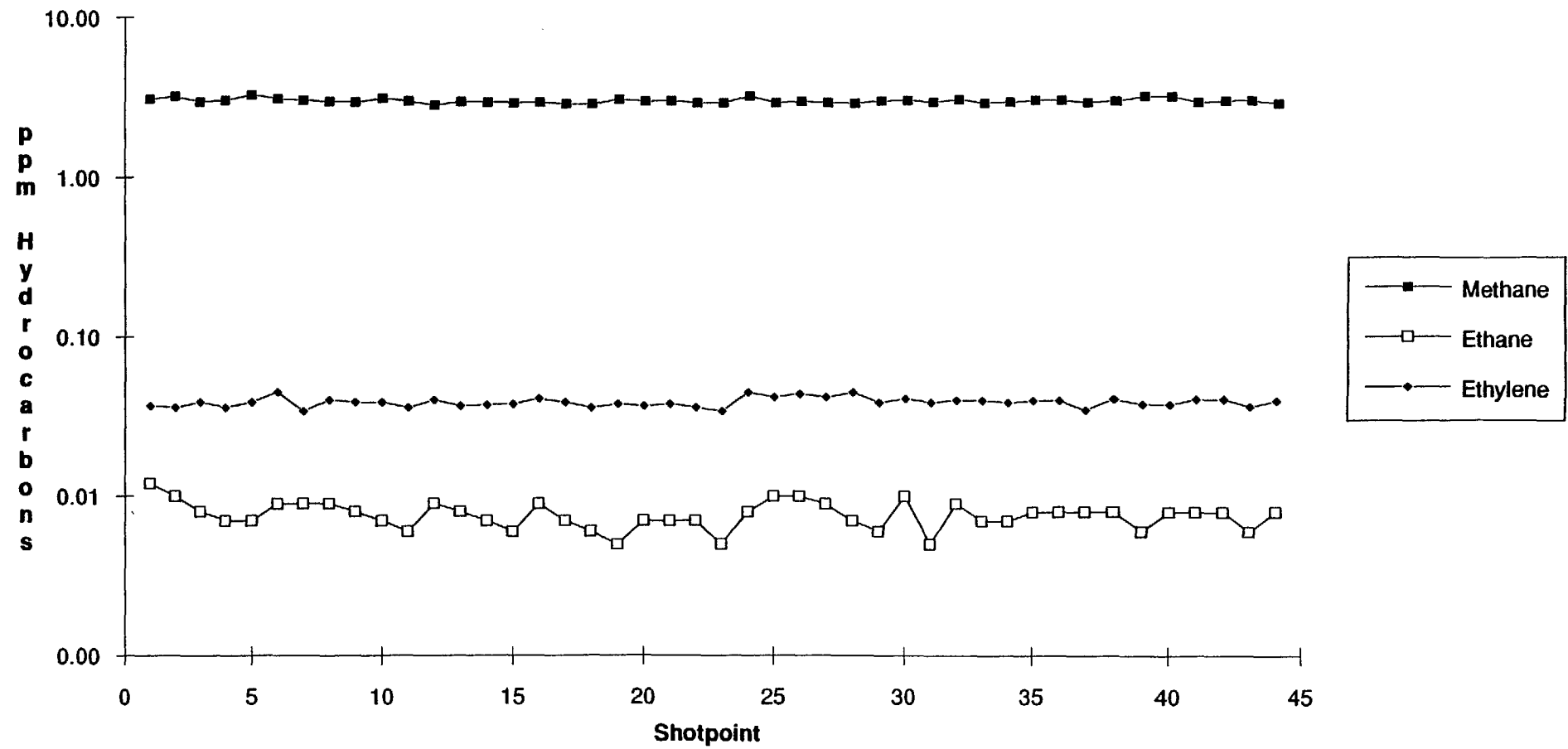
	Cond.	Temp.	Altitude	F. Depth	W.Depth
Mean	47.451	15.776	10.511	67.625	79.339
Std. Dev.	0.254	0.237	0.612	0.617	0.815
Minimum	46.990	15.340	8.000	66.500	77.300
Maximum	47.760	16.070	11.700	69.300	81.000

Notes
No hydrocarbon anomalies

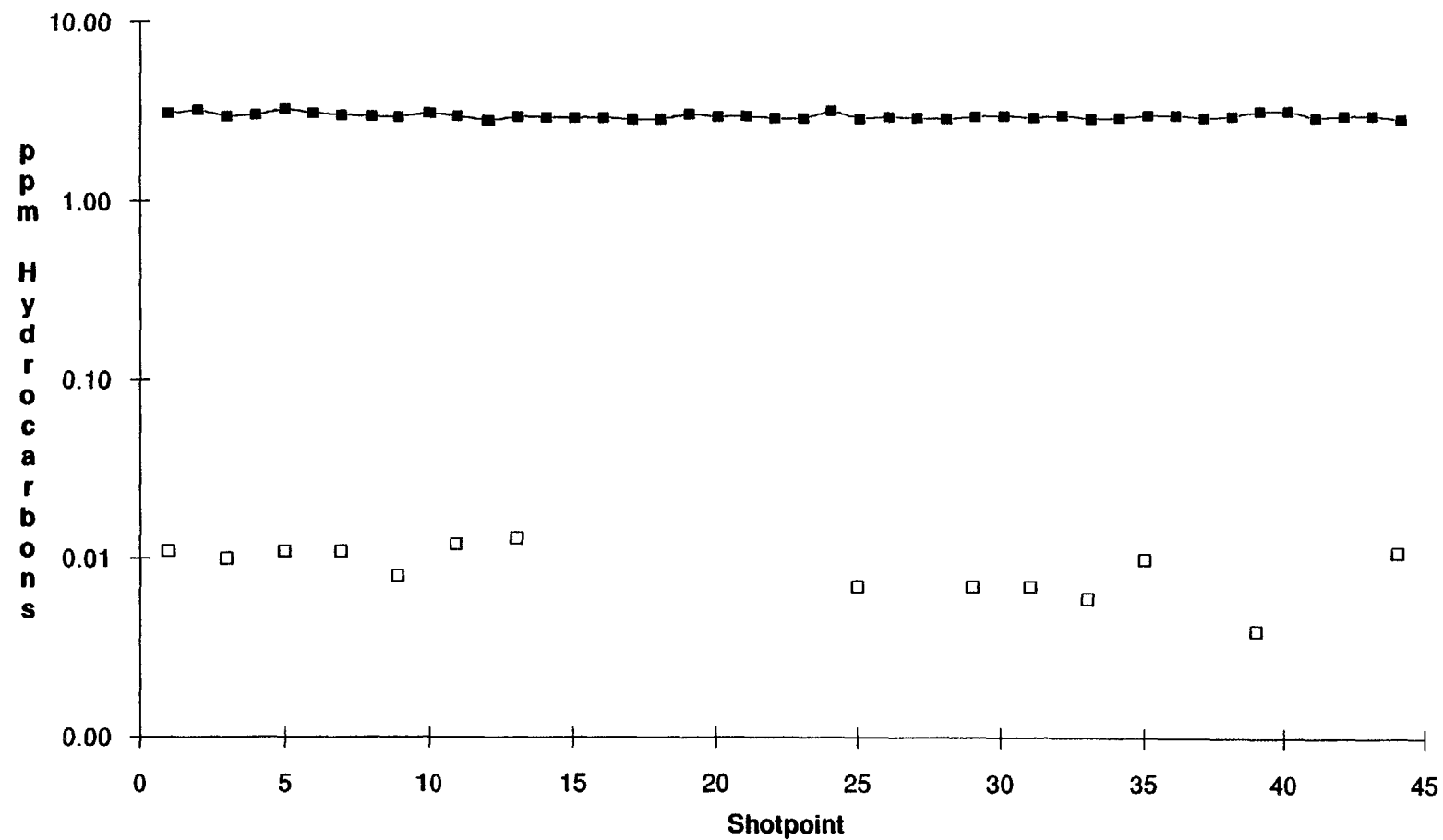
Line 104018 THC, Methane



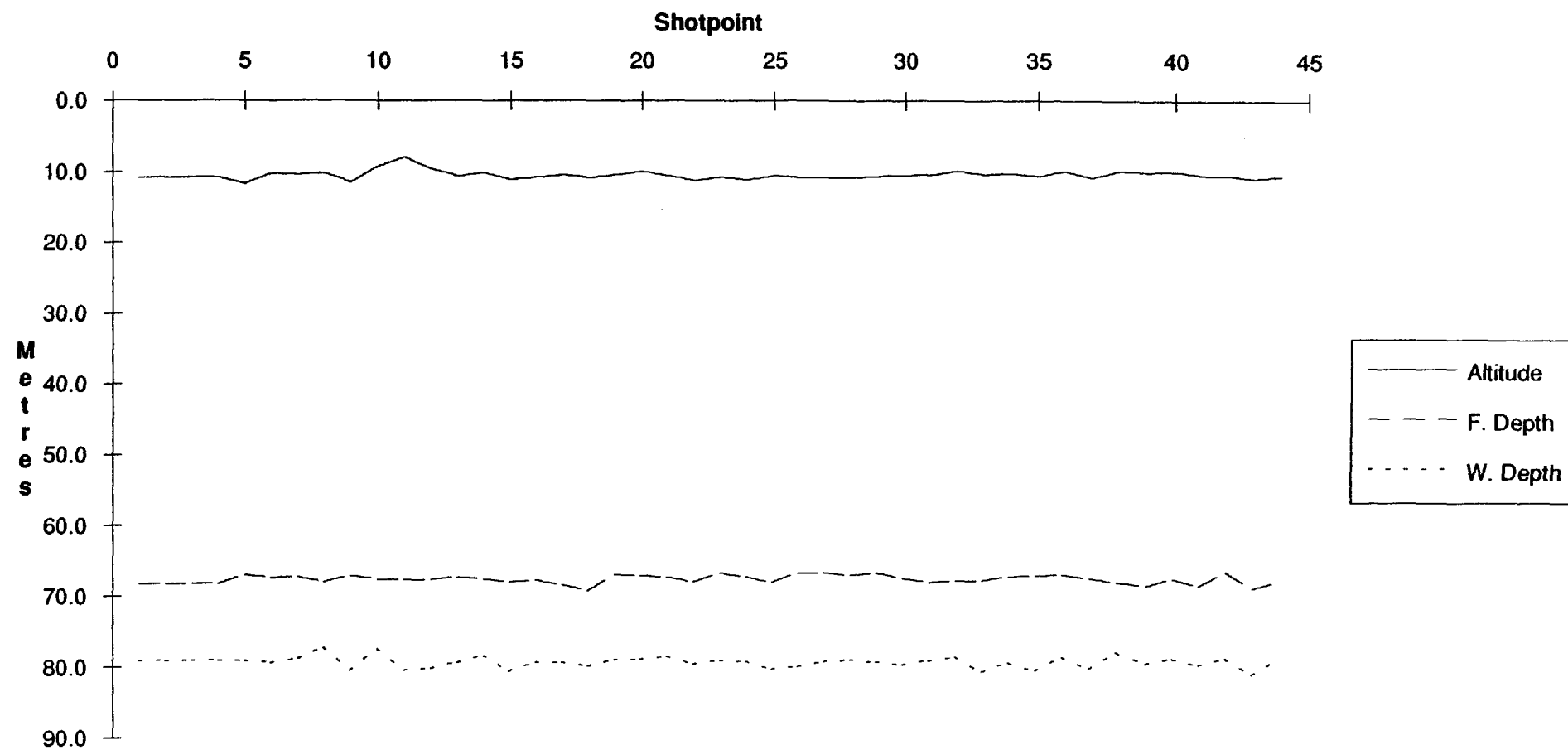
Line 104018 Methane, Ethane, Ethylene



Line 104018 Methane, Propane, Propylene



Line 104018 Depths, Altitude



Line Summary

Line Number 104019
No. of Shotpoints 41

	Shotpoint	Date	Time	Latitude	Longitude	
Start	1	30/09/91	02:21:57	38	42.946 144	15.123
End	41	30/09/91	03:42:16	38	44.724 144	22.563

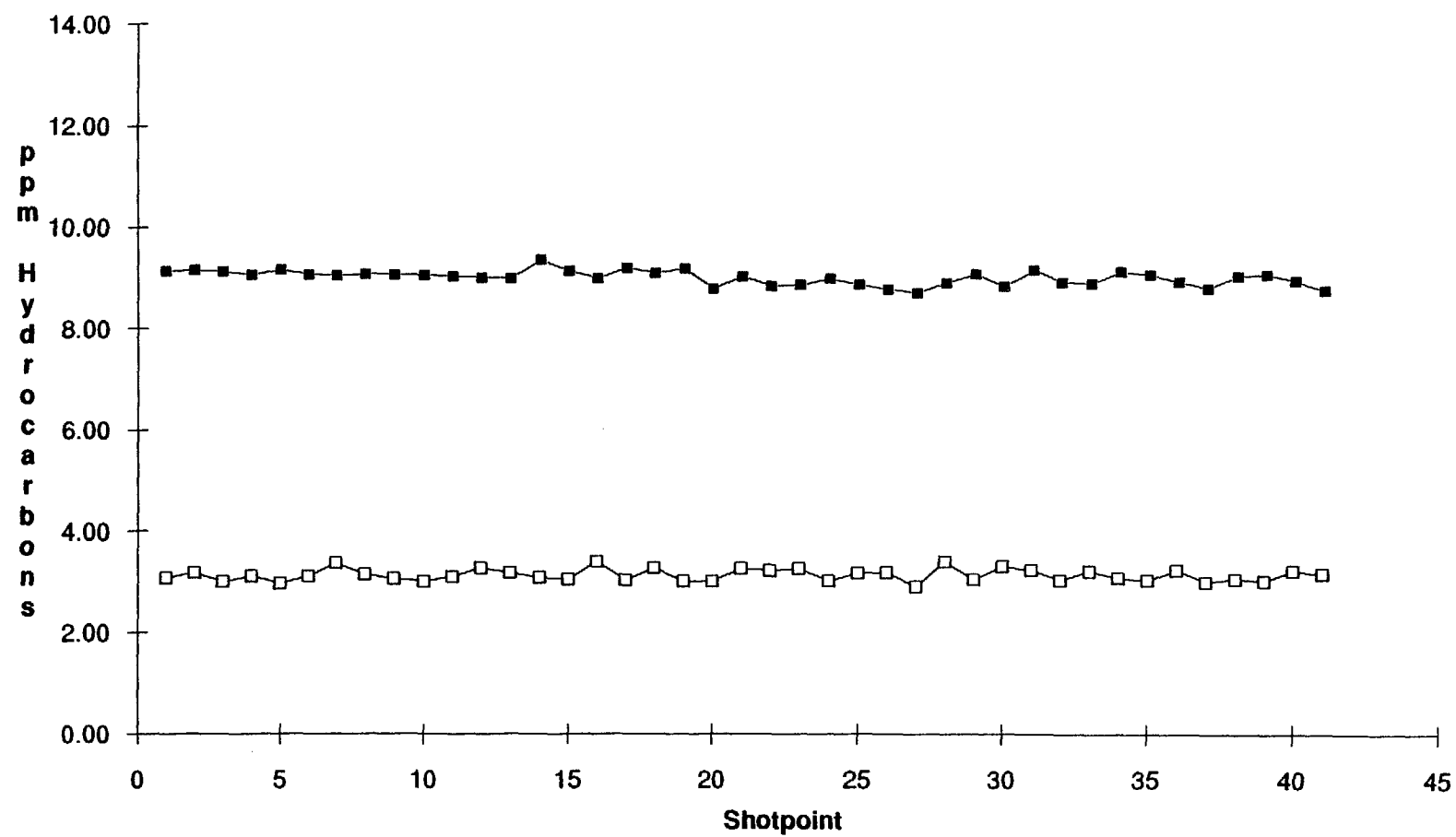
	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	% Wetness
Mean	9.021	3.140	0.009	0.041	0.005	0.000	0.000	0.000	0.002	0.039	0.007	0.000	0.440
Std. Dev.	0.140	0.122	0.003	0.003	0.005	0.000	0.000	0.000	0.005	0.015	0.010	0.002	0.159
Minimum	8.717	2.918	0.004	0.035	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.176
Maximum	9.369	3.404	0.016	0.048	0.012	0.000	0.000	0.000	0.015	0.062	0.031	0.015	0.797

	Cond.	Temp.	Altitude	F. Depth	W. Depth
Mean	47.687	15.994	10.929	67.820	79.768
Std. Dev.	0.102	0.100	1.261	1.459	1.099
Minimum	47.490	15.820	8.800	63.700	77.700
Maximum	47.860	16.170	13.000	70.500	82.200

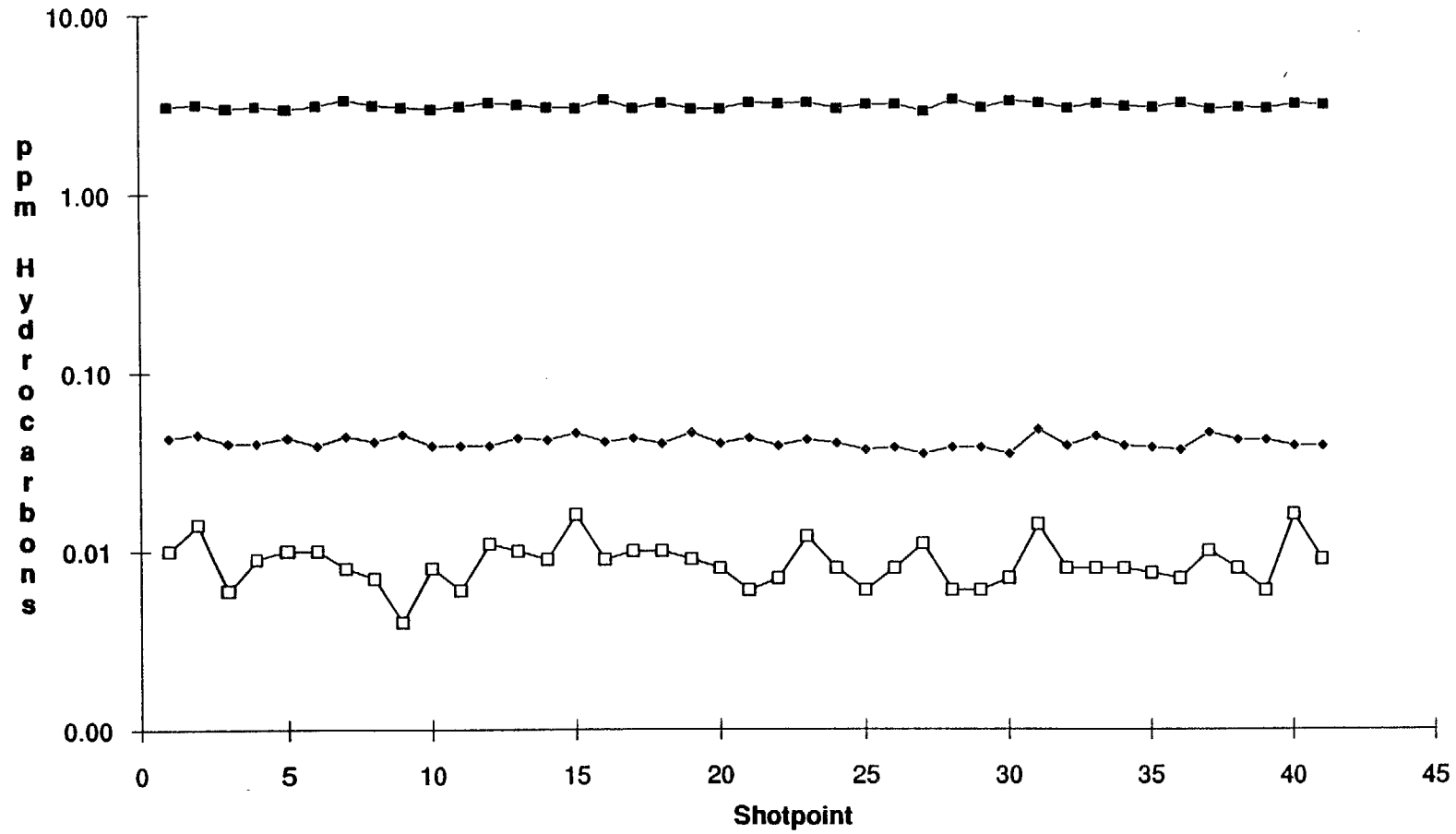
Notes

No hydrocarbon anomalies

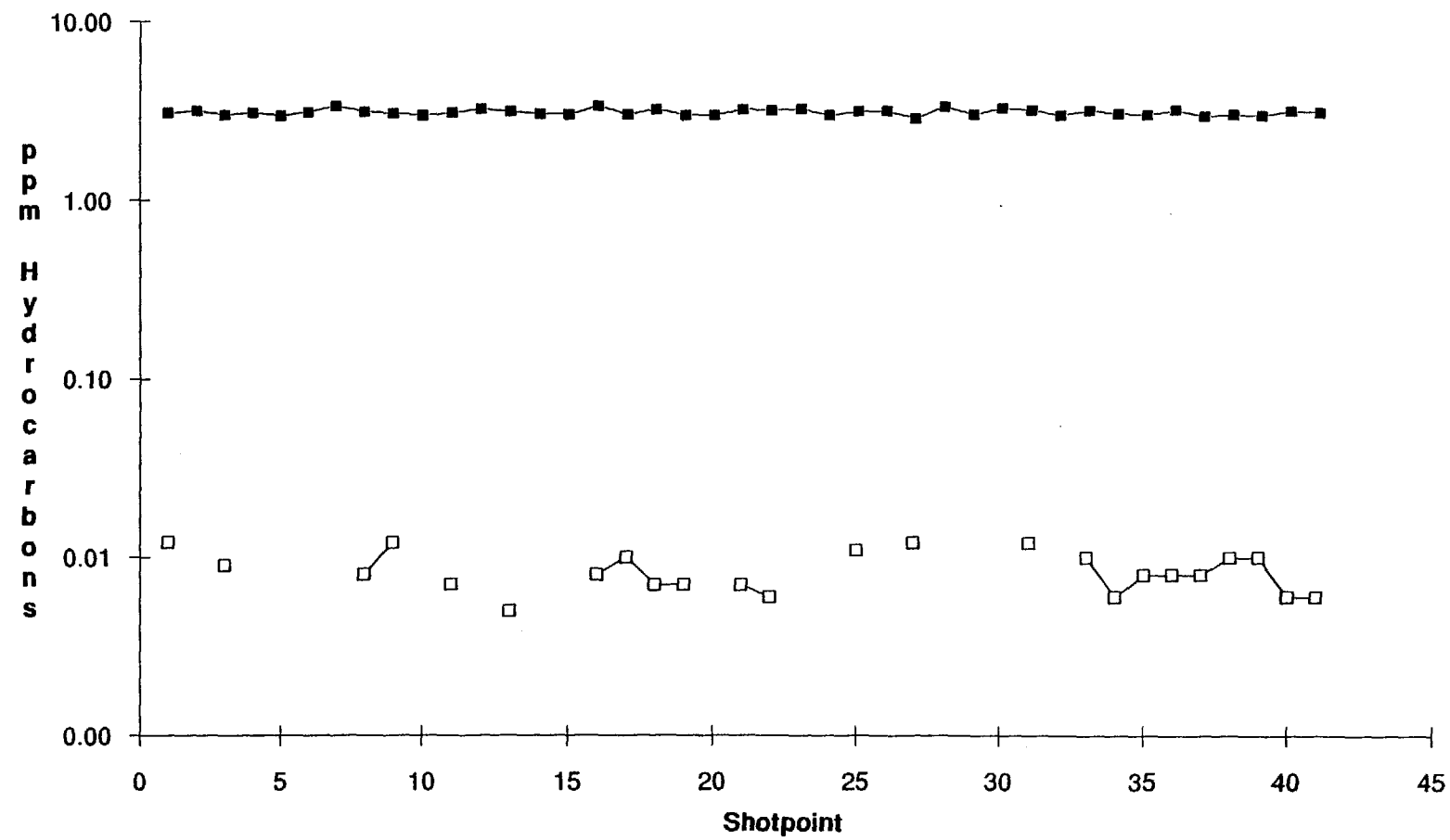
Line 104019 THC, Methane



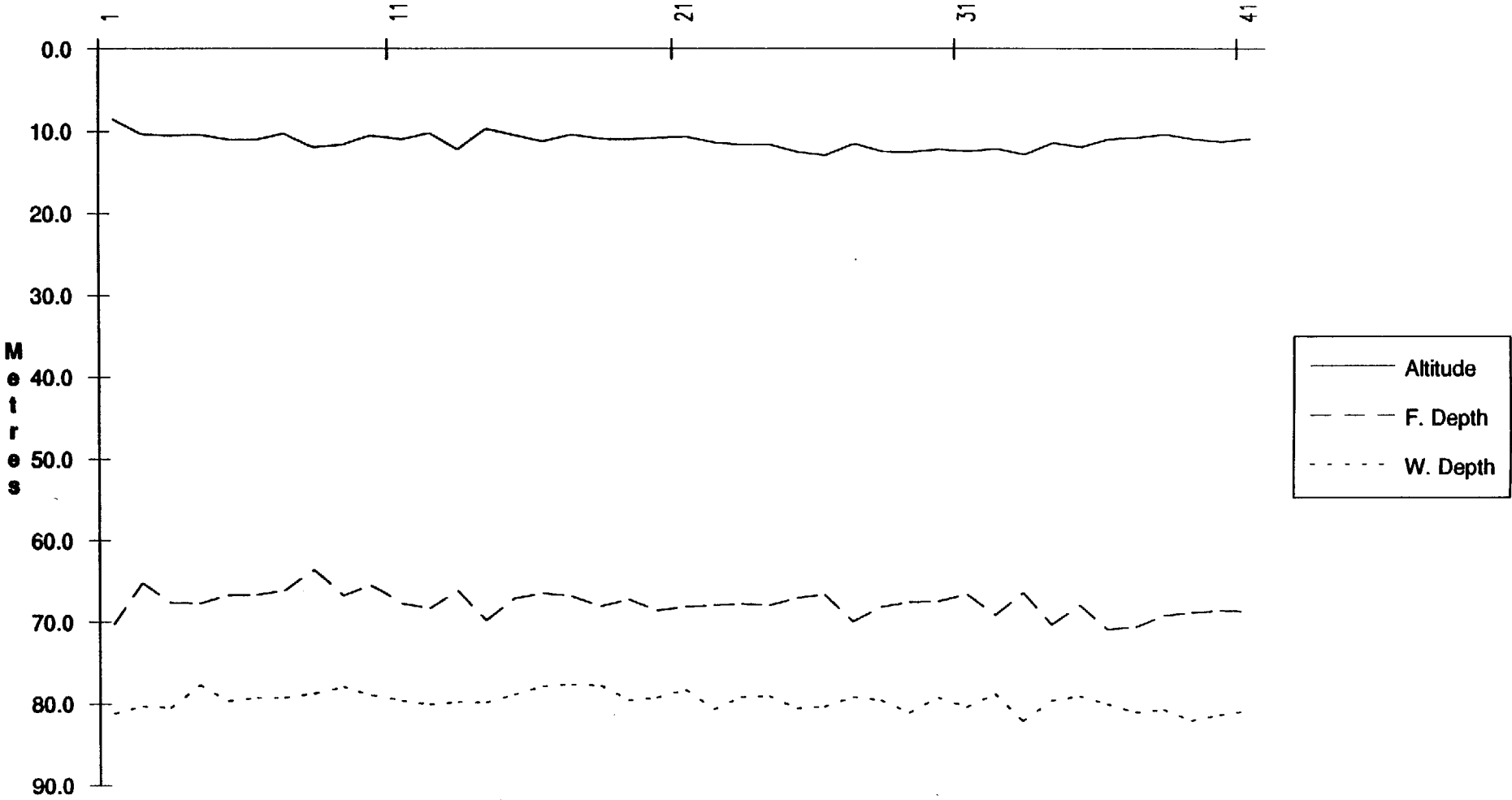
Line 104019 Methane, Ethane, Ethylene



Line 104019 Methane, Propane, Propylene



Line 104019 Depth, Altitude



Line Summary

Line Number 104020
No. of Shotpoints 77

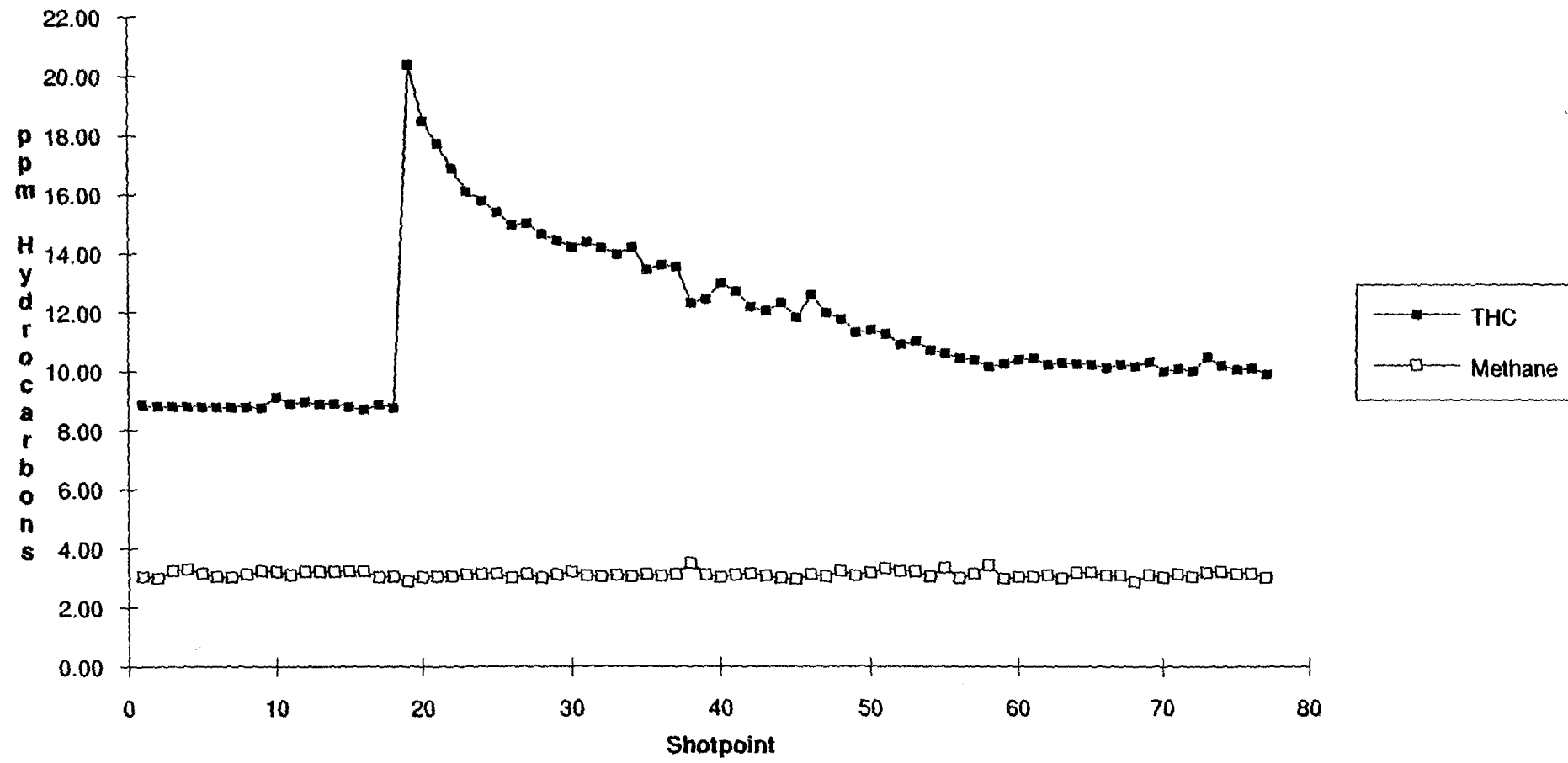
	Shotpoint	Date	Time	Latitude	Longitude	
Start	1	30/09/91	03:44:17	38	44.674	23.730
End	77	30/09/91	06:16:35	38	54.194	12.660

	THC	Methane	Ethane	Ethylene	Propane	Propylene	I-Butane	n-Butane	I-Pentane	n-Pentane	I-Hexane	n-Hexane	%Wetness
Mean	11.536	3.115	0.007	0.038	0.005	0.000	0.000	0.000	0.001	0.039	0.006	0.000	0.396
Std. Dev.	2.609	0.110	0.003	0.002	0.004	0.000	0.000	0.000	0.004	0.016	0.010	0.000	0.146
Minimum	8.717	2.857	0.000	0.034	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.162
Maximum	20.405	3.494	0.020	0.045	0.013	0.000	0.000	0.000	0.016	0.077	0.033	0.000	0.809

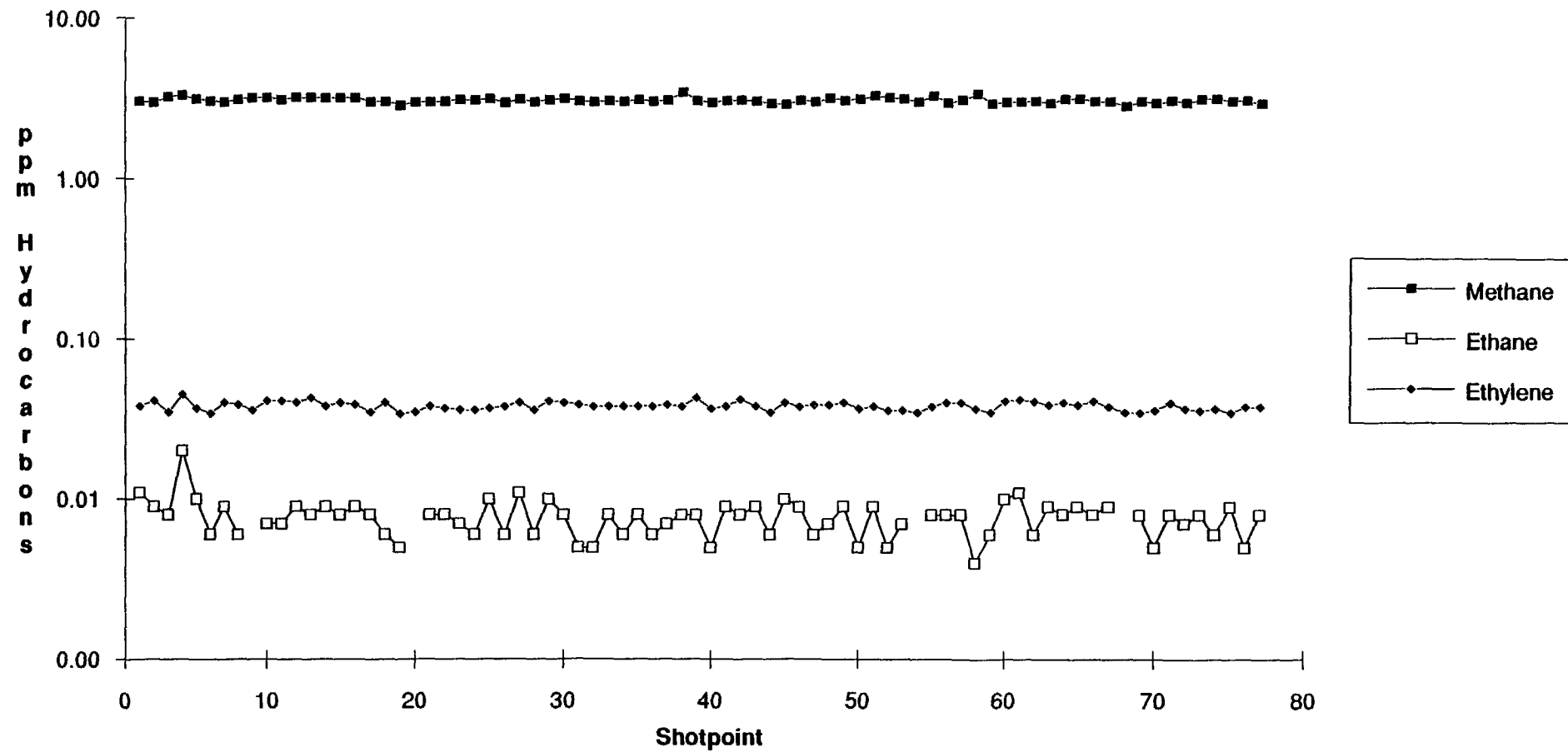
	Cond.	Temp.	Altitude	F. Depth	W.Depth
Mean	47.354	15.690	16.397	64.143	80.665
Std. Dev.	0.139	0.112	3.767	3.792	1.352
Minimum	47.090	15.470	7.200	58.400	77.800
Maximum	47.560	15.880	23.600	73.000	86.800

Notes
THC anomaly from SP 19-58

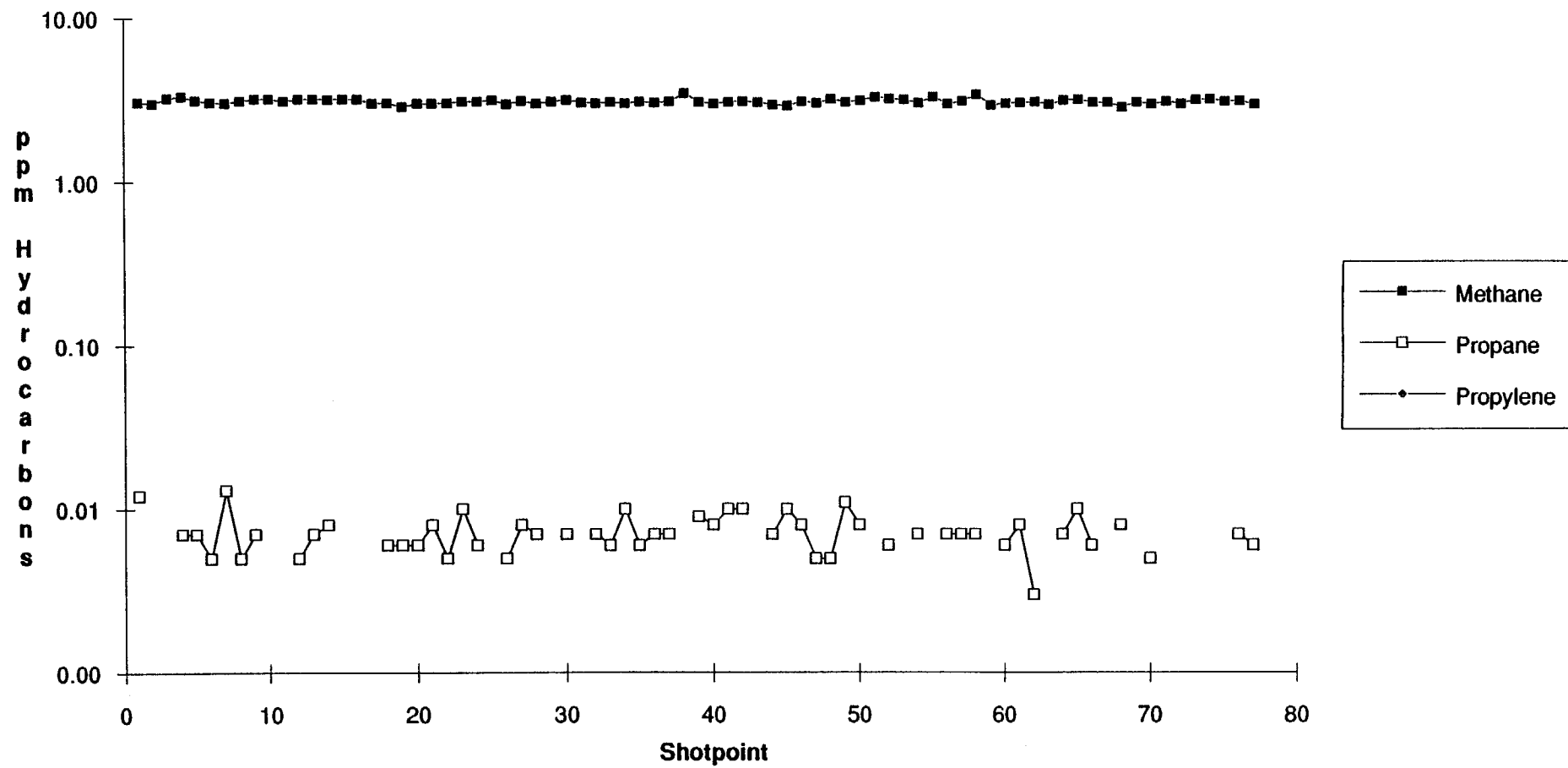
Line 104020 THC, Methane



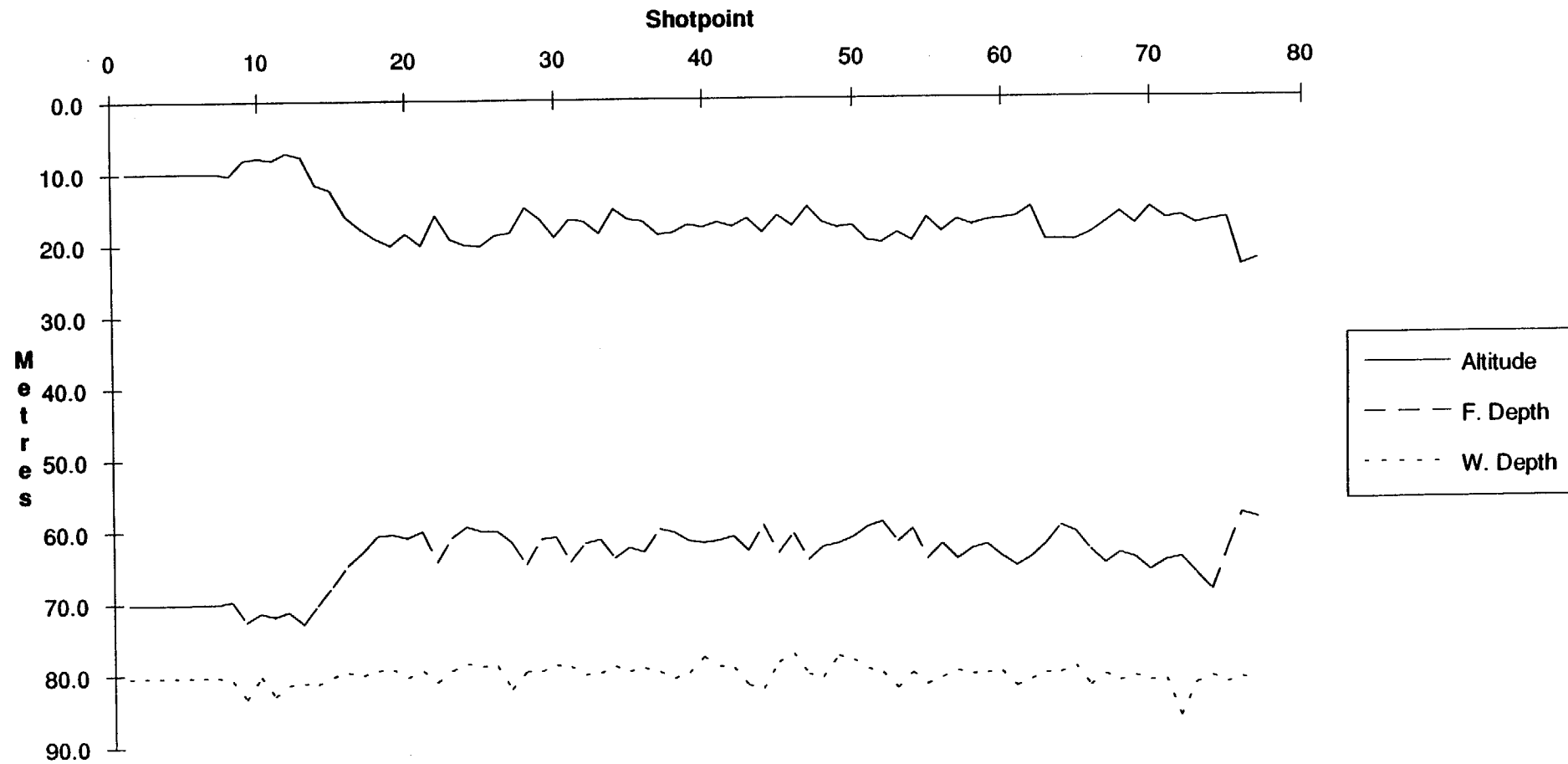
Line 104020 Methane, Ethane, Ethylene



Line 104020 Methane, Propane, Propylene



Line 104020 Depths, Altitude



Line Summary

Line Number 104021
No. of Shotpoints 115

	Shotpoint	Date	Time	Latitude	Longitude
Start	1	30/09/91	10:14:17	38	57.958 144 09.768
End	115	30/09/91	14:02:33	38	41.420 144 05.176

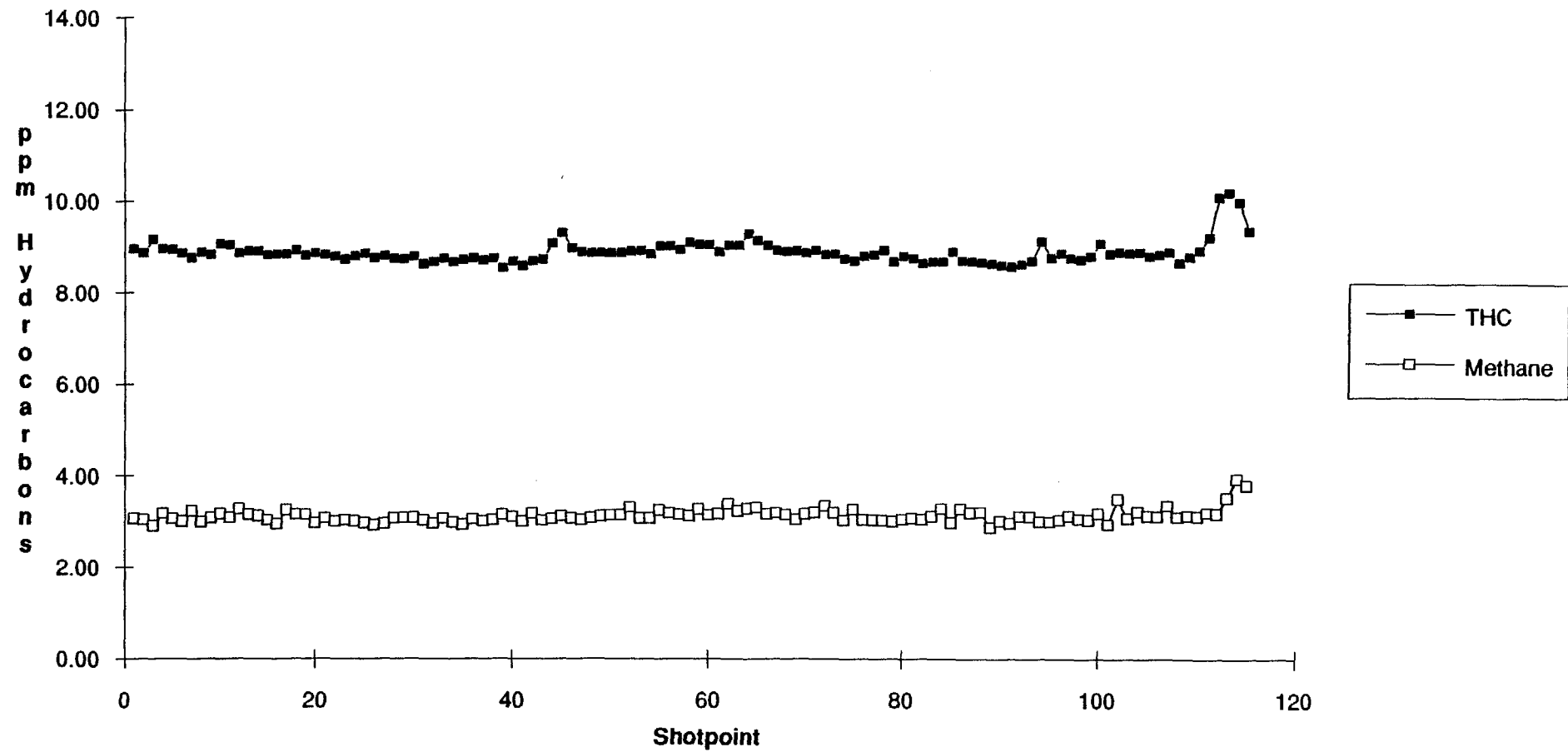
	THC	Methane	Ethane	Ethylene	Propane	Propylene	I-Butane	n-Butane	I-Pentane	n-Pentane	I-Hexane	n-Hexane	%Wetness
Mean	8.899	3.128	0.009	0.038	0.004	0.000	0.000	0.000	0.003	0.041	0.014	0.000	0.429
Std. Dev.	0.254	0.153	0.003	0.003	0.005	0.000	0.000	0.000	0.006	0.016	0.015	0.000	0.180
Minimum	8.557	2.872	0.004	0.033	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.115
Maximum	10.219	3.940	0.020	0.051	0.014	0.000	0.000	0.000	0.023	0.067	0.061	0.000	0.922

	Cond.	Temp.	Altitude	F. Depth	W.Depth
Mean	46.270	14.556	10.188	67.651	78.422
Std. Dev.	0.058	0.033	0.977	1.309	1.368
Minimum	46.160	14.480	8.100	63.400	75.700
Maximum	46.370	14.640	12.600	71.200	81.600

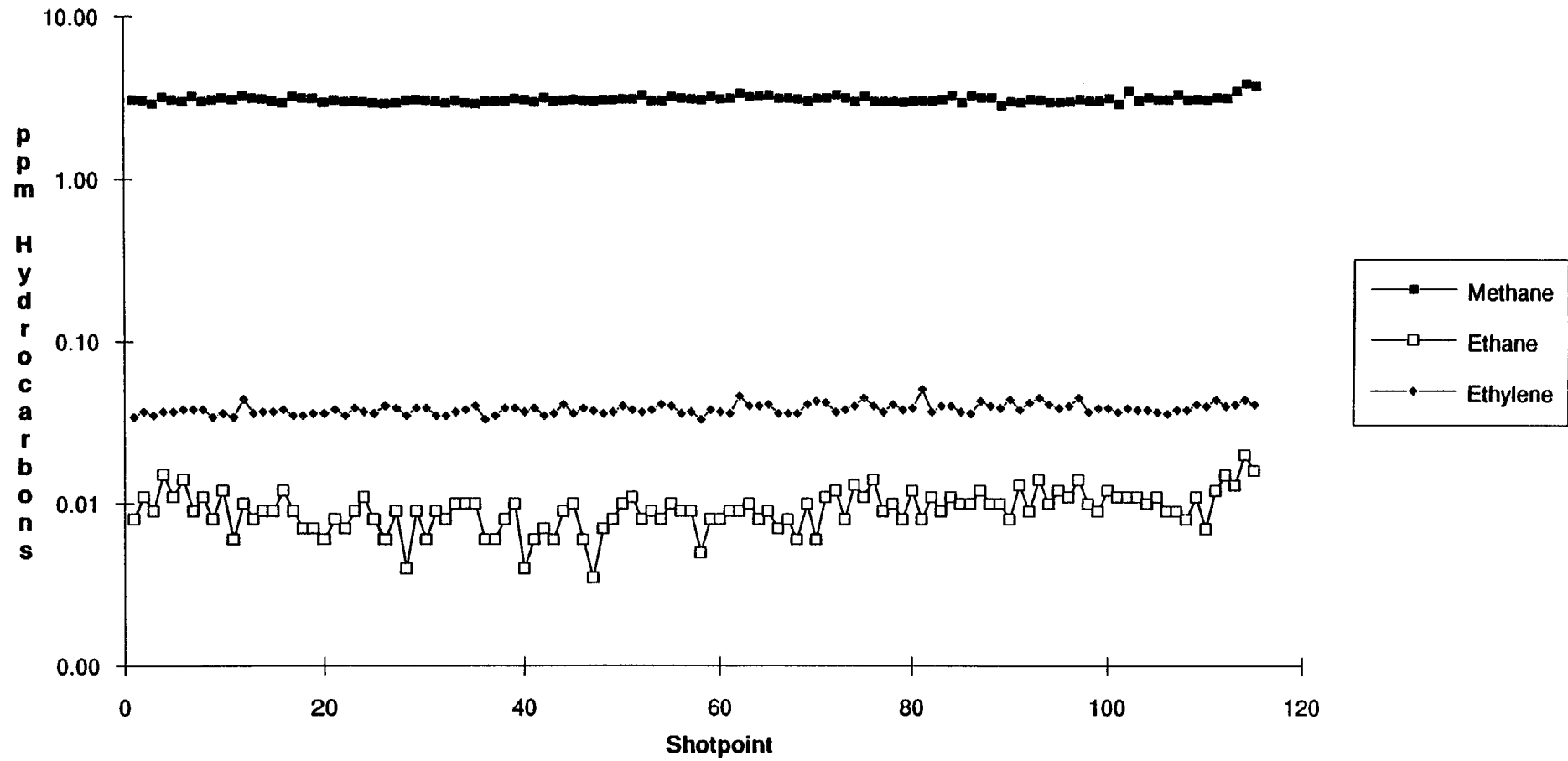
Notes

Slight increase in THC, methane and ethane at end of line

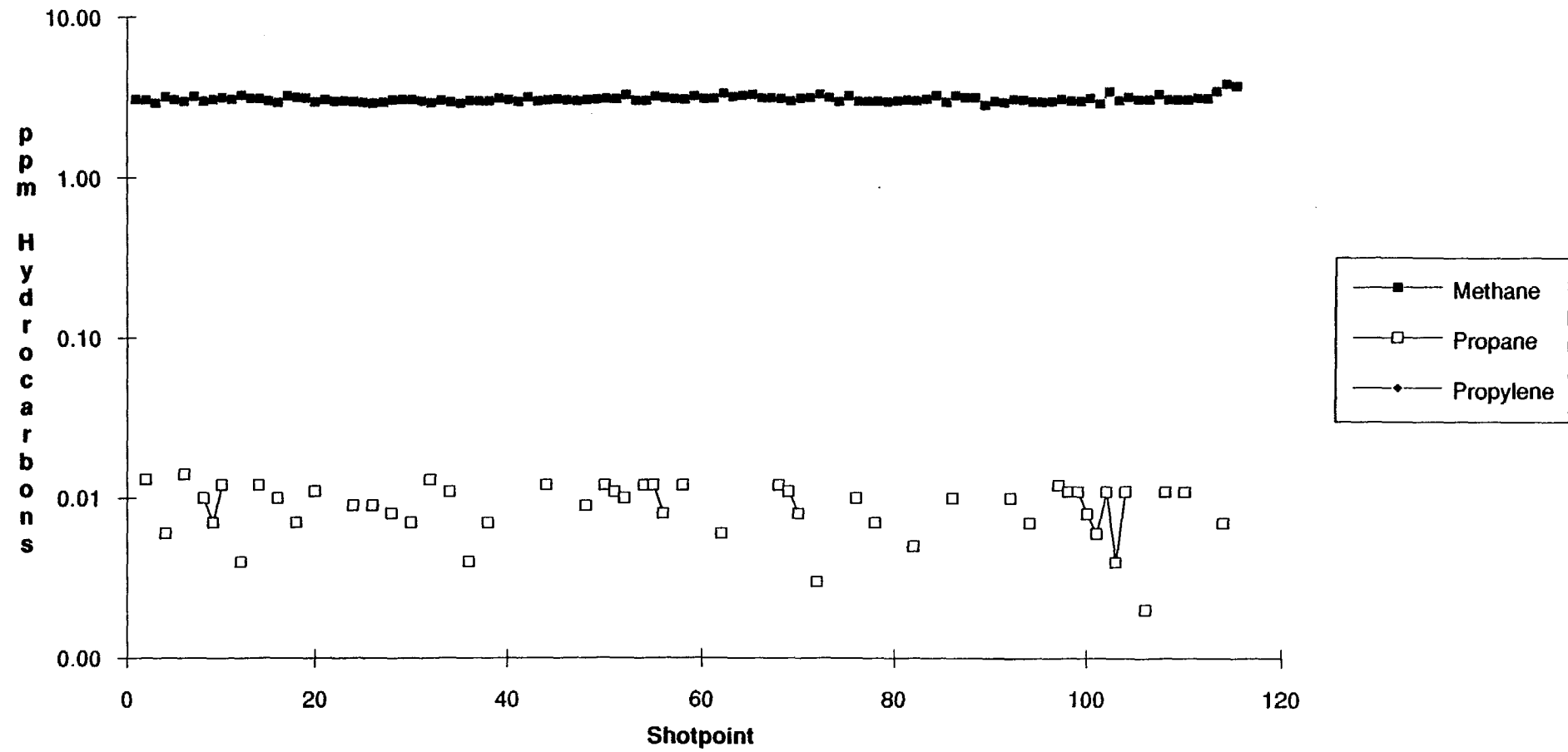
Line 104021 THC, Methane



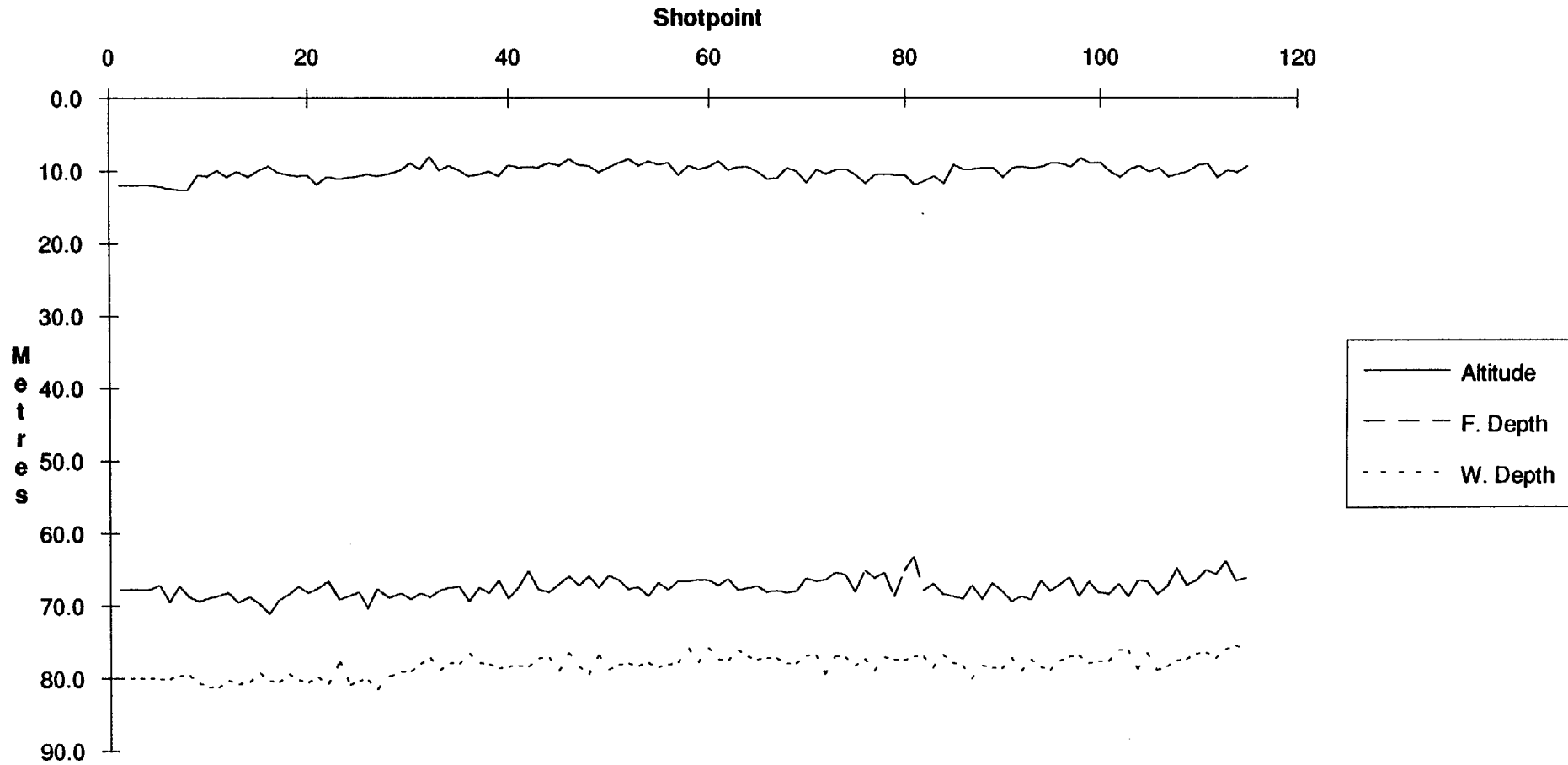
Line 104021 Methane, Ethane, Ethylene



Line 104021 Methane, Propane, Propylene



Line 104021 Depths, Altitude



Line Summary

Line Number 104022
No. of Shotpoints 143

	Shotpoint	Date	Time	Latitude	Longitude	
Start	1	30/09/91	15:06:55	38	41.743	05.034
End	146	30/09/91	20:02:11	38	28.668	27.678

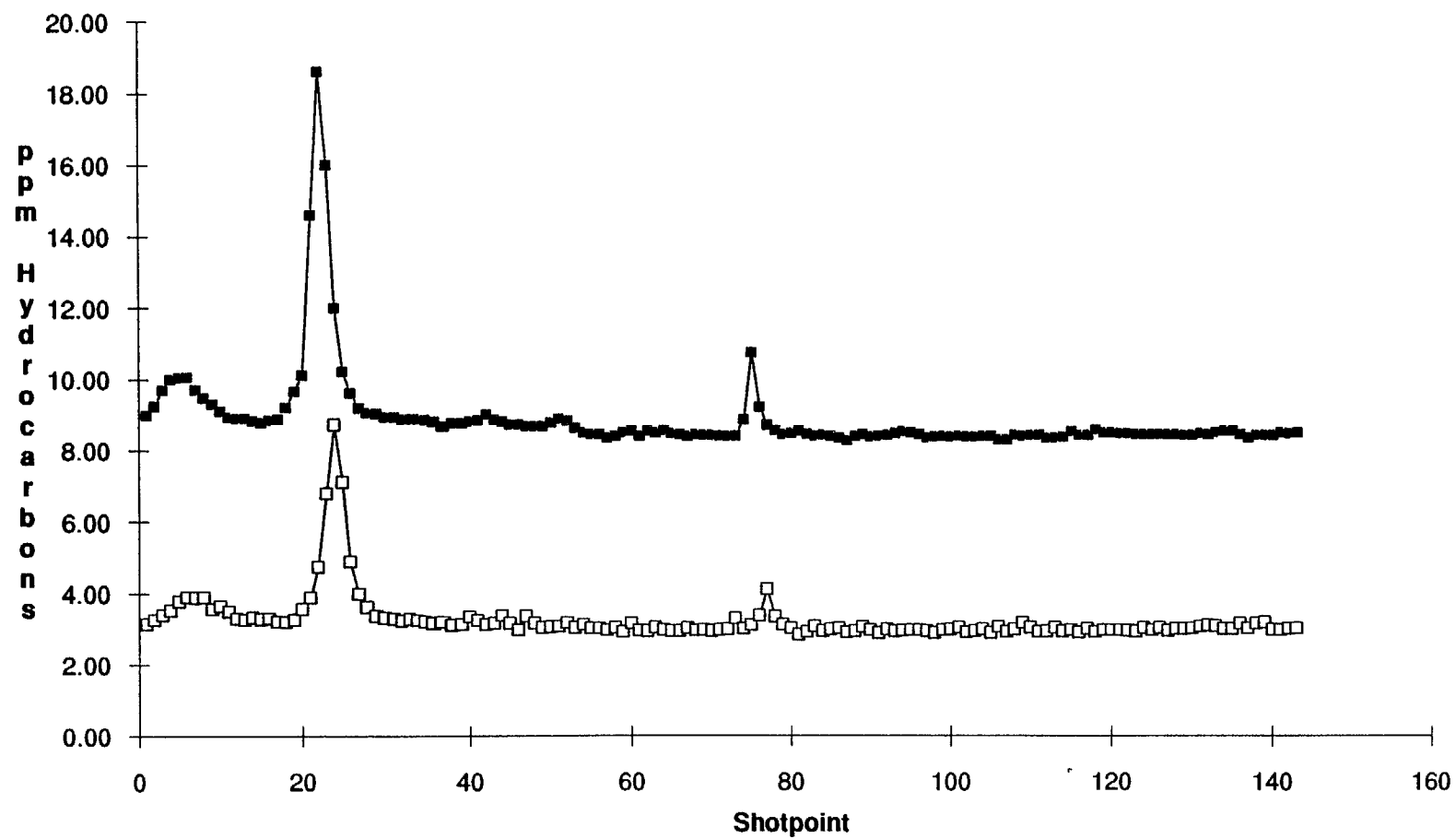
	THC	Methane	Ethane	Ethylene	Propane	Propylene	I-Butane	n-Butane	I-Pentane	n-Pentane	I-Hexane	n-Hexane	%Wetness
Mean	8.885	3.244	0.010	0.037	0.004	0.000	0.000	0.000	0.000	0.036	0.007	0.000	0.397
Std. Dev.	1.242	0.715	0.004	0.004	0.004	0.000	0.000	0.000	0.000	0.015	0.012	0.000	0.147
Minimum	8.286	2.831	0.005	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.165
Maximum	18.608	8.728	0.028	0.045	0.013	0.000	0.000	0.000	0.000	0.070	0.042	0.000	0.916

	Cond.	Temp.	Altitude	F. Depth	W.Depth
Mean	46.115	14.407	9.962	65.291	75.561
Std. Dev.	0.043	0.041	1.037	1.284	1.249
Minimum	46.040	14.350	8.000	61.400	71.700
Maximum	46.220	14.510	12.900	68.200	79.500

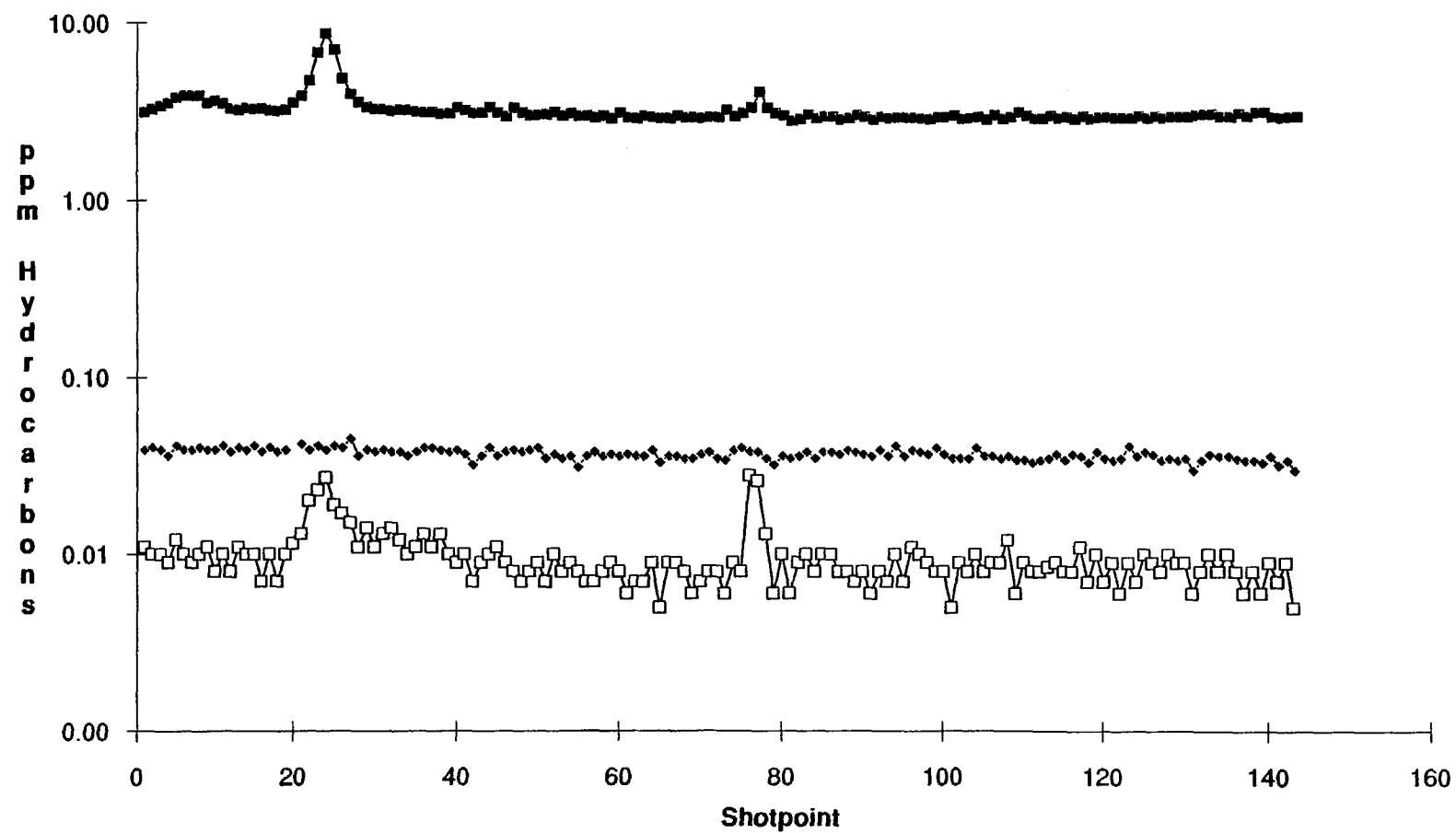
Notes

THC, methane and ethane anomaly at SP 20-29
THC, methane and ethane anomaly at SP 75-78

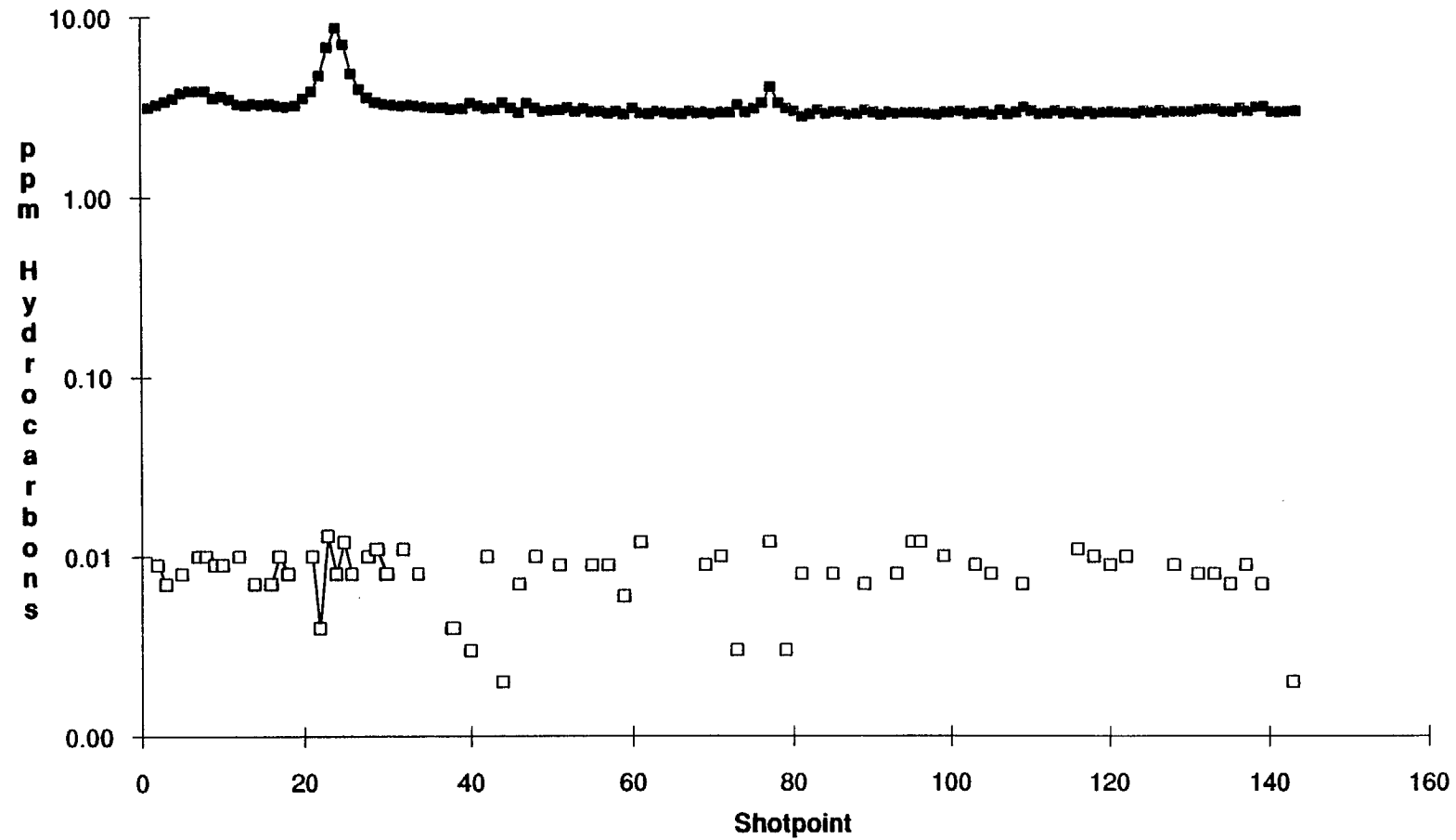
Line 104022 THC, Methane



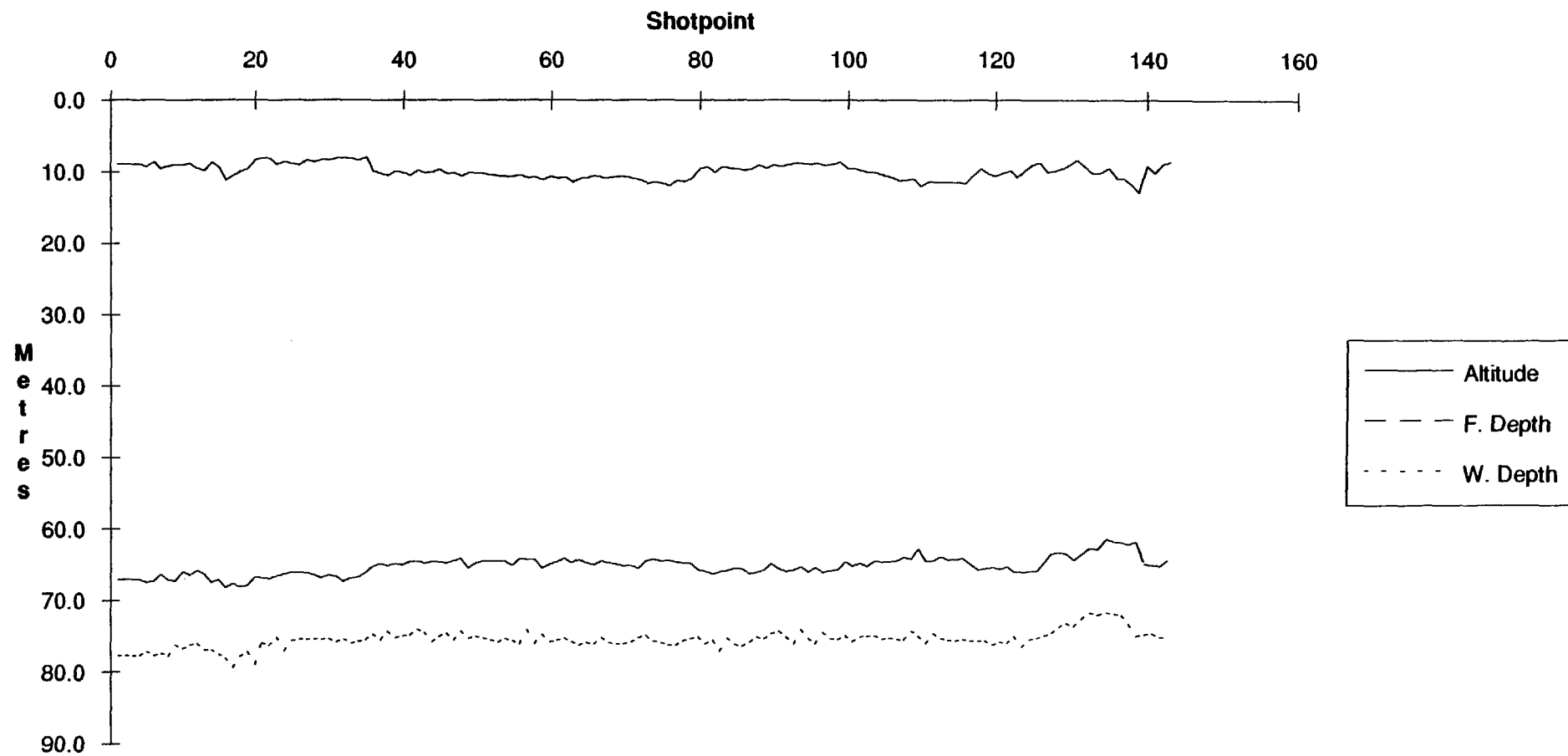
Line 104022 Methane, Ethane, Ethylene



Line 104022 Methane, Propane, Propylene



Line 104022 Depths, Altitude



Line Summary

Line Number 104023
No. of Shotpoints 108

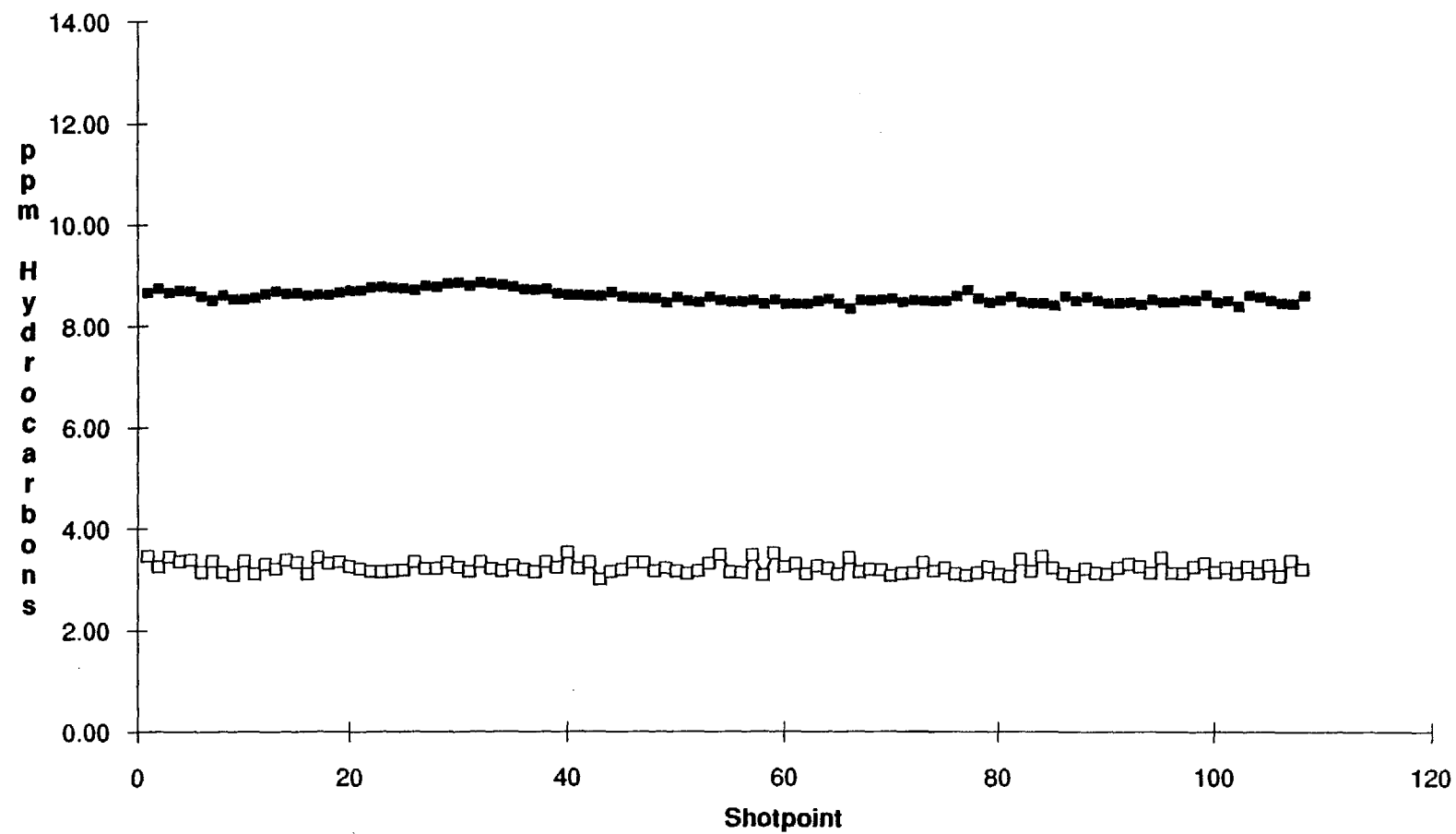
	Shotpoint	Date	Time	Latitude	Longitude
Start	1	30-Sep-91	20:45:20	38	28.987 144 27.205
End	108	1-Oct-91	00:19:18	38	45.082 144 27.343

	THC	Methane	Ethane	Ethylene	Propane	Propylene	I-Butane	n-Butane	I-Pentane	n-Pentane	I-Hexane	n-Hexane	%Wetness
Mean	8.589	3.235	0.008	0.039	0.005	0.000	0.000	0.000	0.000	0.038	0.002	0.000	0.409
Std. Dev.	0.115	0.116	0.001	0.002	0.004	0.000	0.000	0.000	0.001	0.015	0.006	0.000	0.138
Minimum	8.361	3.000	0.005	0.029	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.184
Maximum	8.858	3.539	0.011	0.046	0.015	0.000	0.000	0.000	0.013	0.063	0.025	0.000	0.776

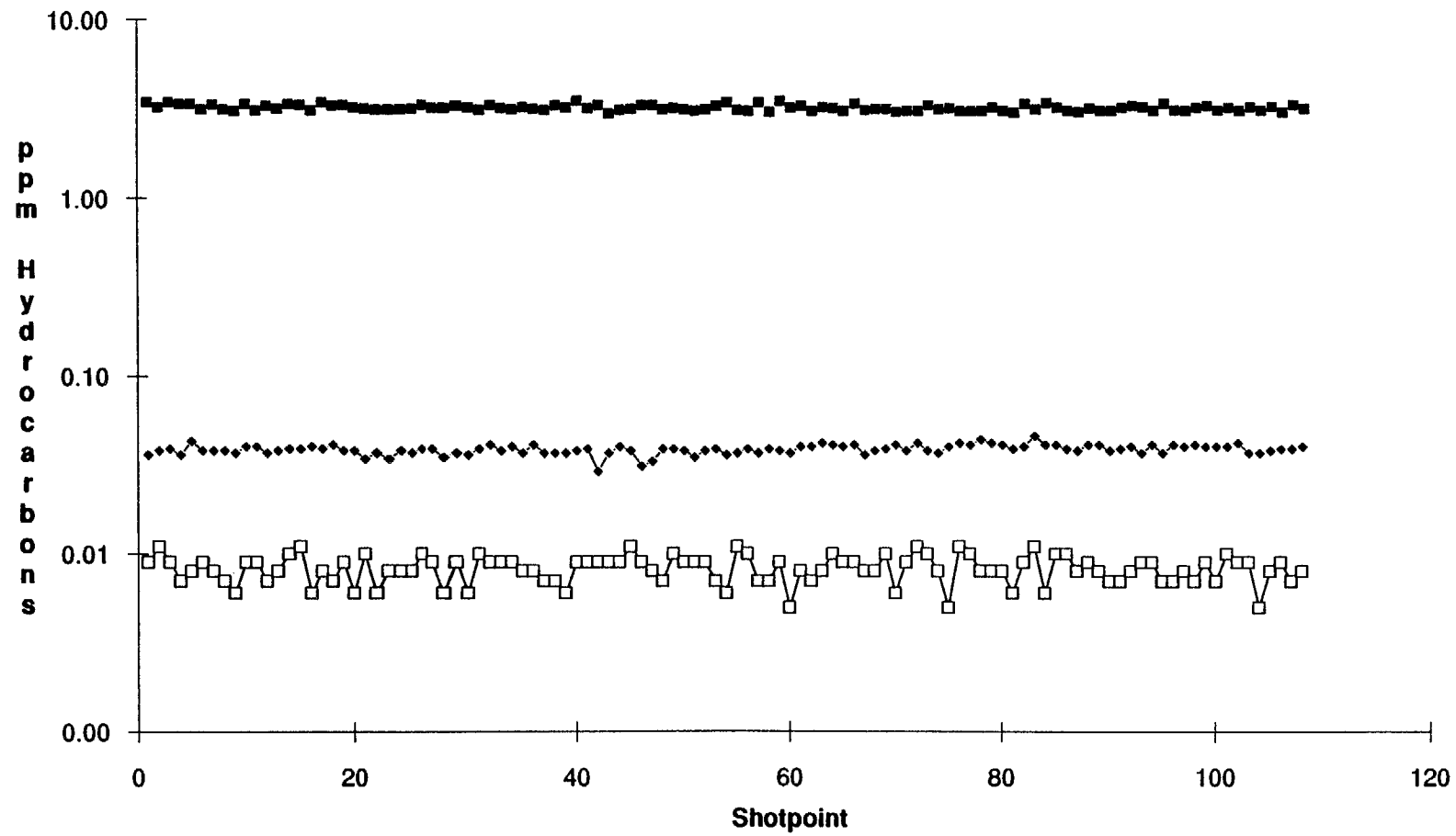
	Cond.	Temp.	Altitude	F. Depth	W.Depth
Mean	47.068	15.276	9.976	67.163	77.697
Std. Dev.	0.520	0.483	0.626	1.714	1.994
Minimum	46.270	14.570	8.200	62.600	72.600
Maximum	47.720	15.880	12.700	69.900	81.400

Notes
No hydrocarbon anomalies

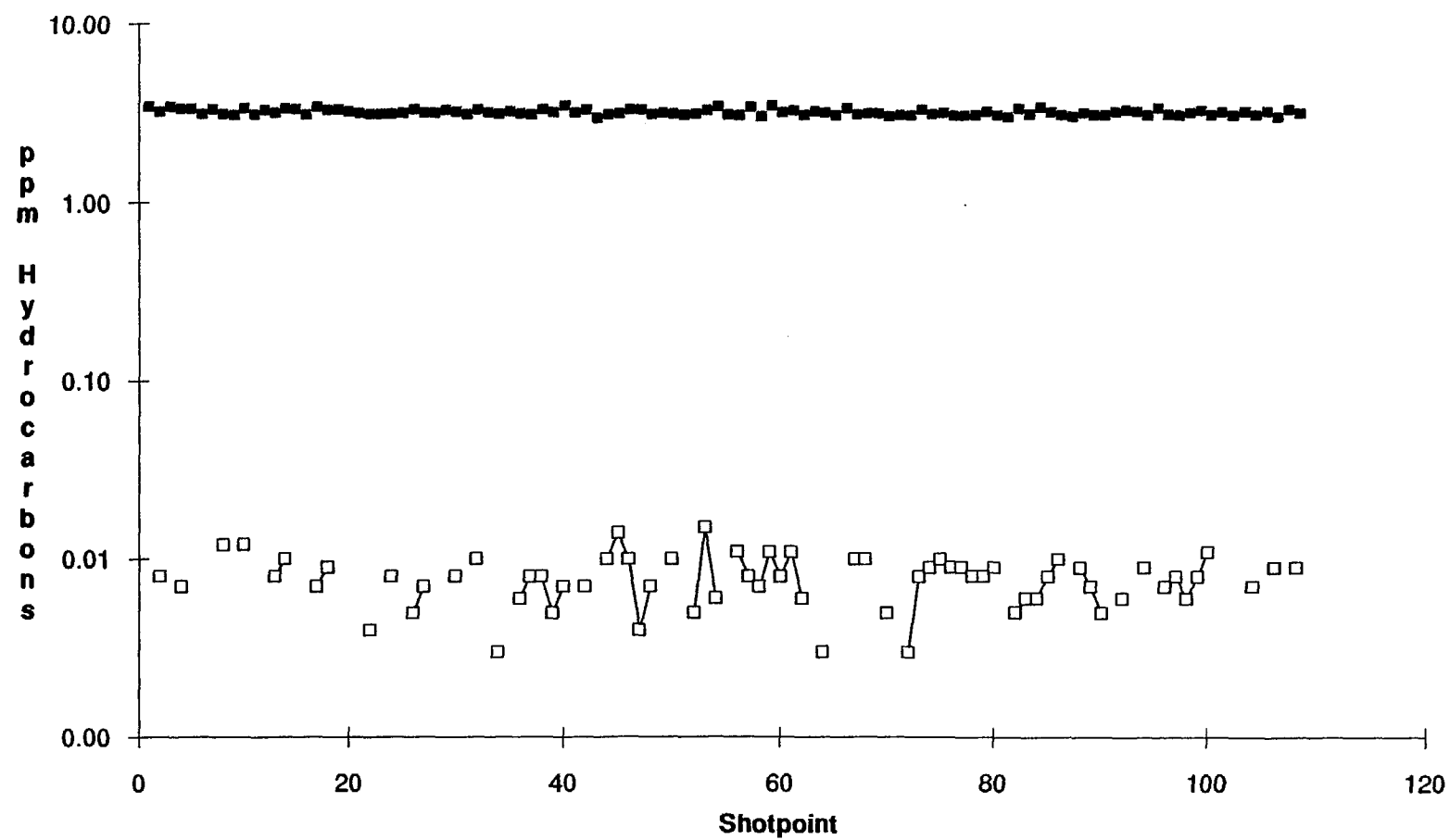
Line 104023 THC, Methane



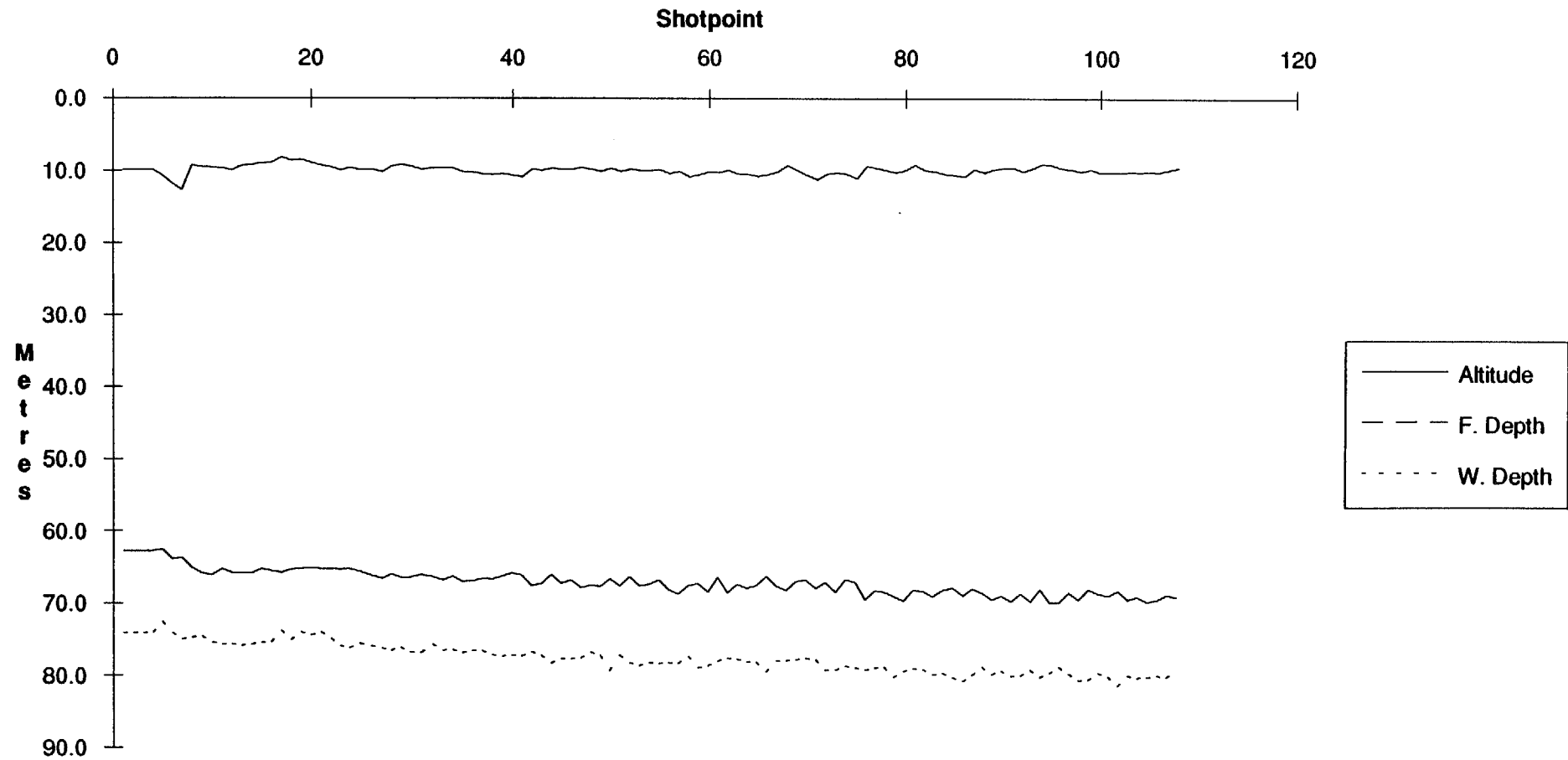
Line 104023 Methane, Ethane, Ethylene



Line 104023 Methane, Propane, Propylene



Line 104023 Depths, Altitude



Line Summary

Line Number 104024
No. of Shotpoints 100

	Shotpoint	Date	Time	Latitude	Longitude
Start	1	1-Oct-91	01:00:05	38 44.721	144 27.469
End	100	1-Oct-91	04:19:43	38 37.226	144 11.139

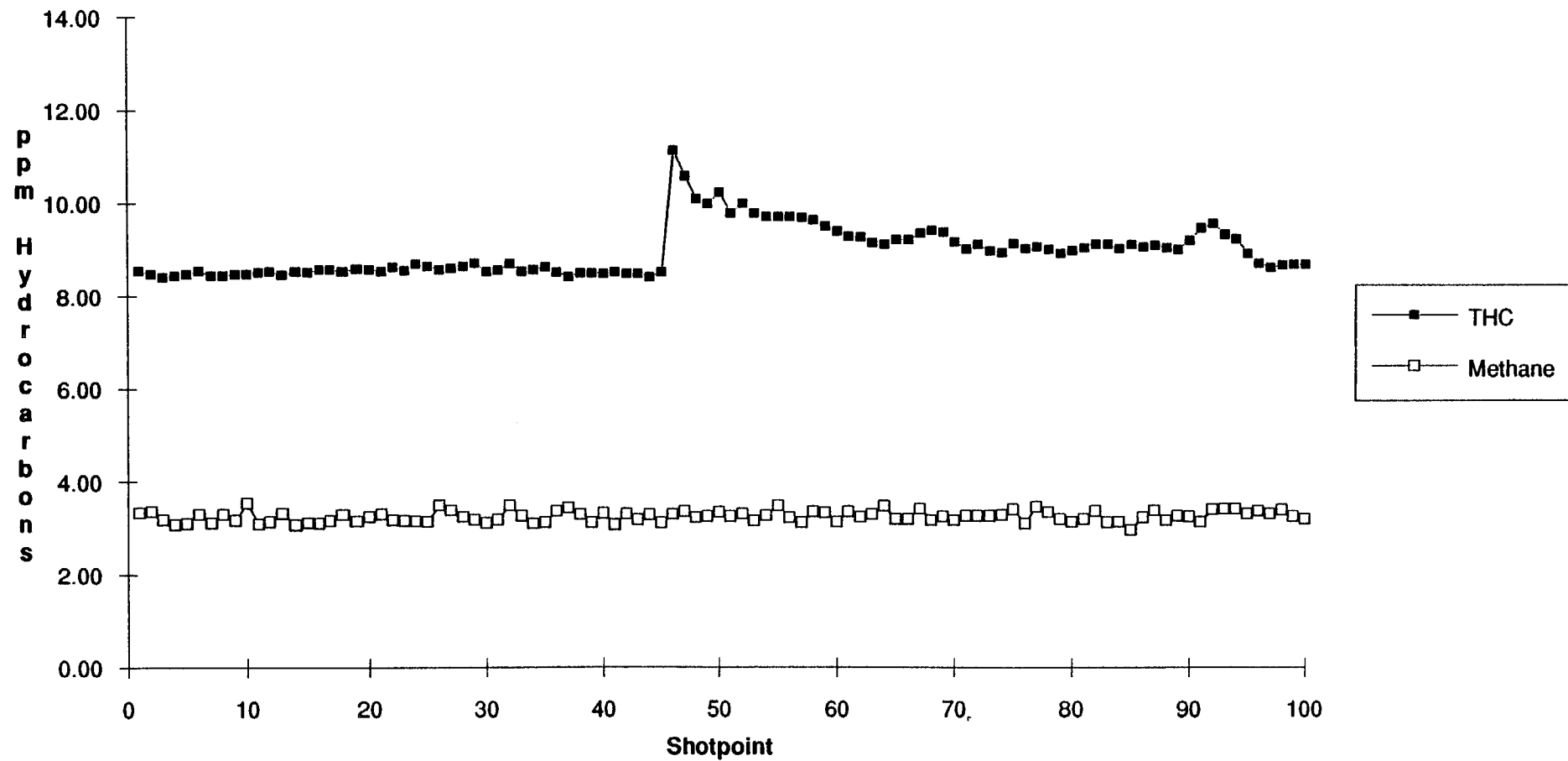
	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	8.975	3.251	0.008	0.039	0.004	0.000	0.000	0.000	0.000	0.035	0.001	0.000	0.362
Std. Dev.	0.533	0.117	0.002	0.005	0.004	0.000	0.000	0.000	0.002	0.014	0.004	0.001	0.143
Minimum	8.412	2.965	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.149
Maximum	11.152	3.539	0.011	0.047	0.025	0.000	0.000	0.000	0.015	0.057	0.024	0.006	0.935

	Cond.	Temp.	Altitude	F. Depth	W.Depth
Mean	48.119	16.241	10.340	67.462	78.472
Std. Dev.	0.151	0.138	0.823	1.945	2.016
Minimum	47.890	16.040	8.600	63.000	74.300
Maximum	48.450	16.540	12.300	71.000	81.600

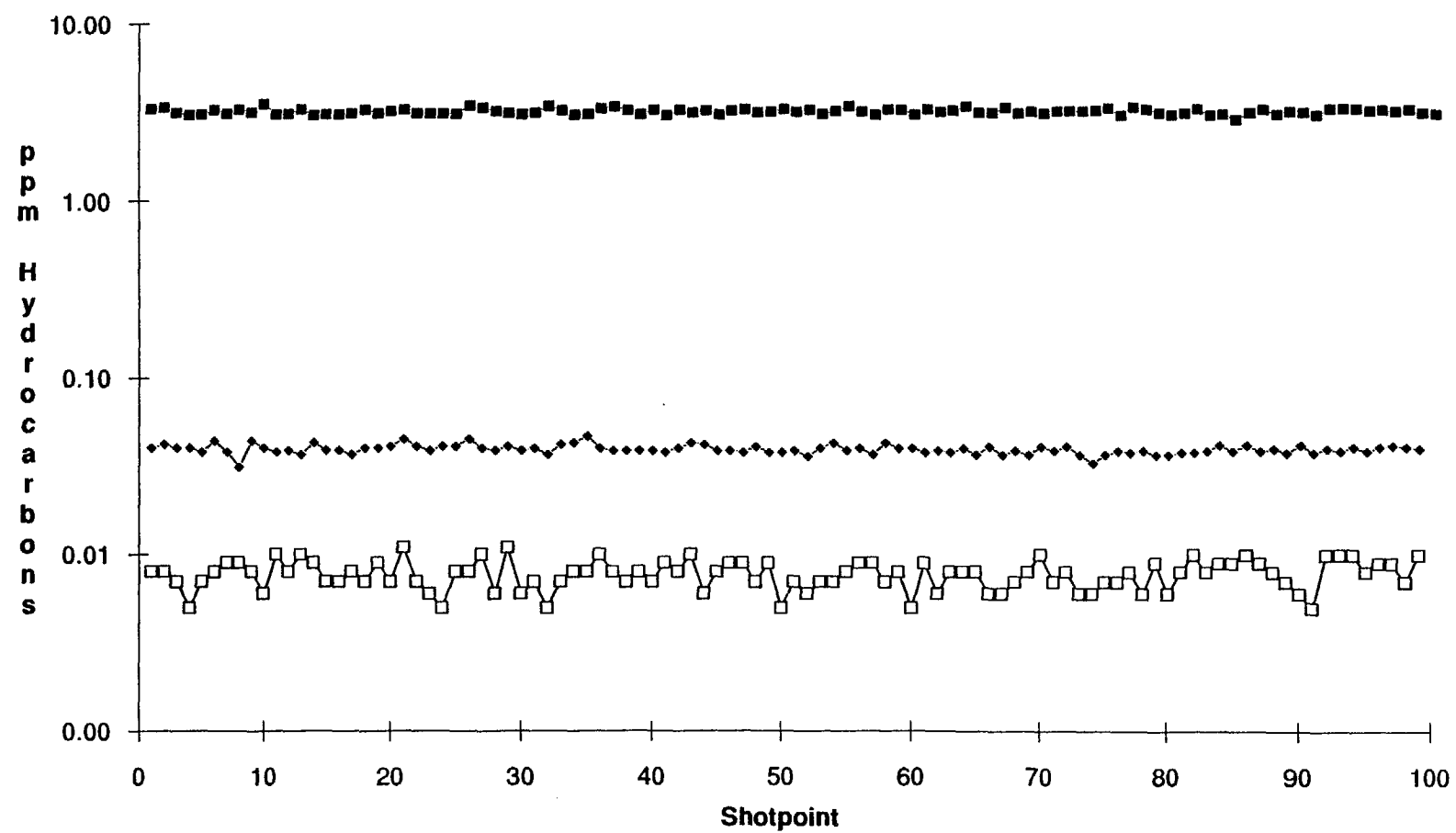
Notes

THC anomaly from SP 46 to end of line

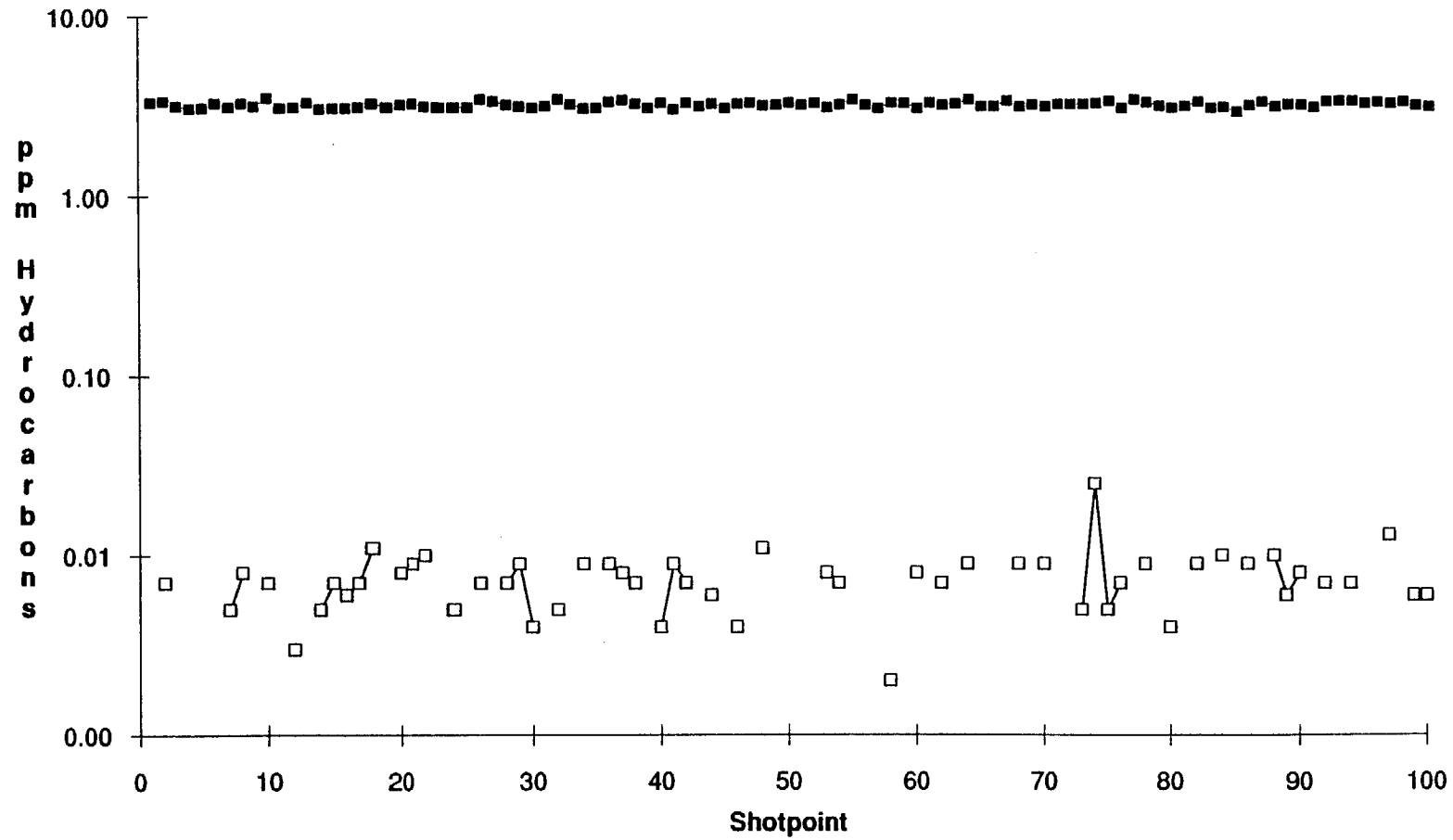
Line 104024 THC, Methane



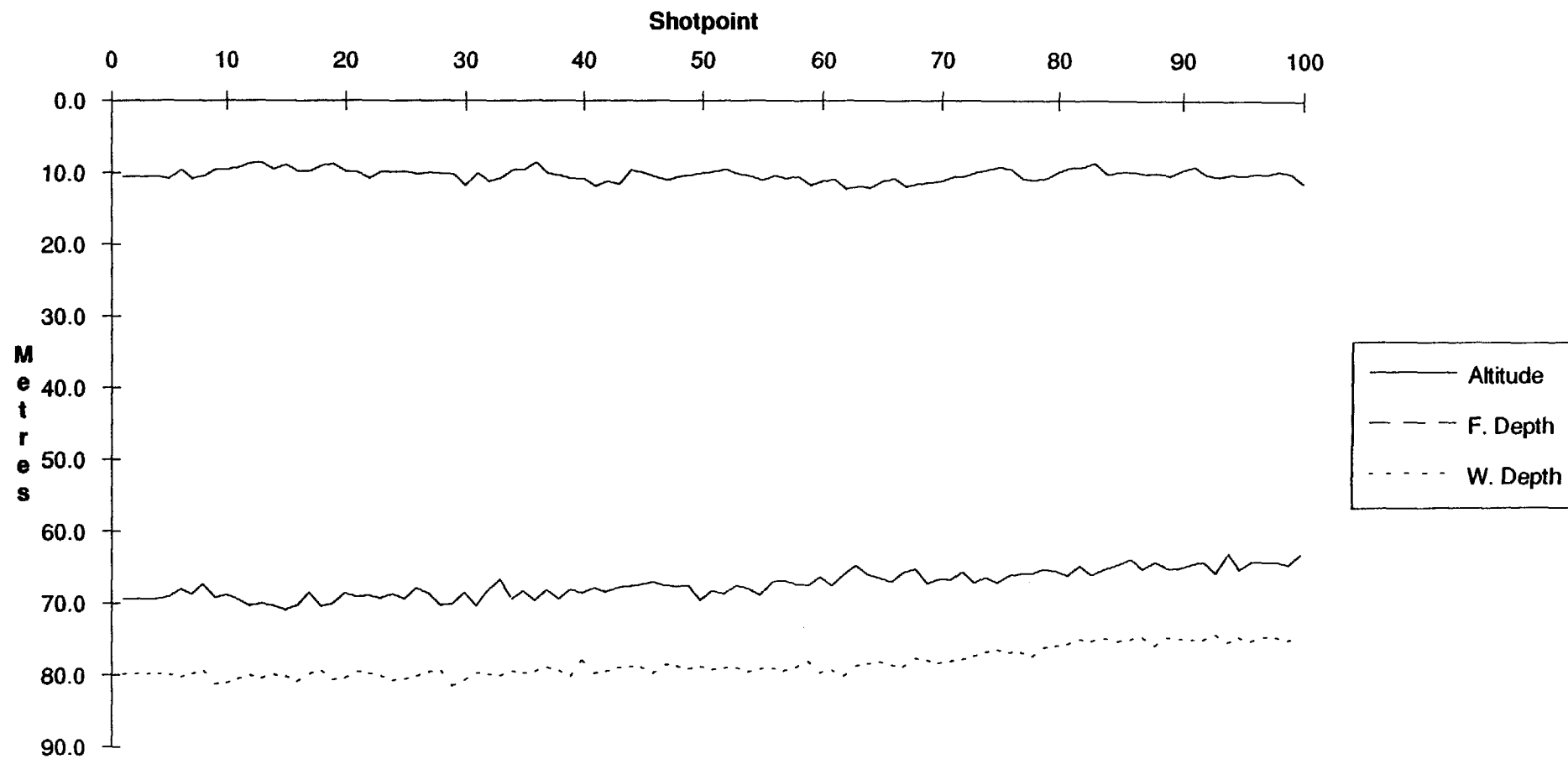
Line 104024 Methane, Ethane, Ethylene



Line 104024 Methane, Propane, Propylene



Line 104024 Depths, Altitude



Line Summary

Line Number 104025
No. of Shotpoints 17

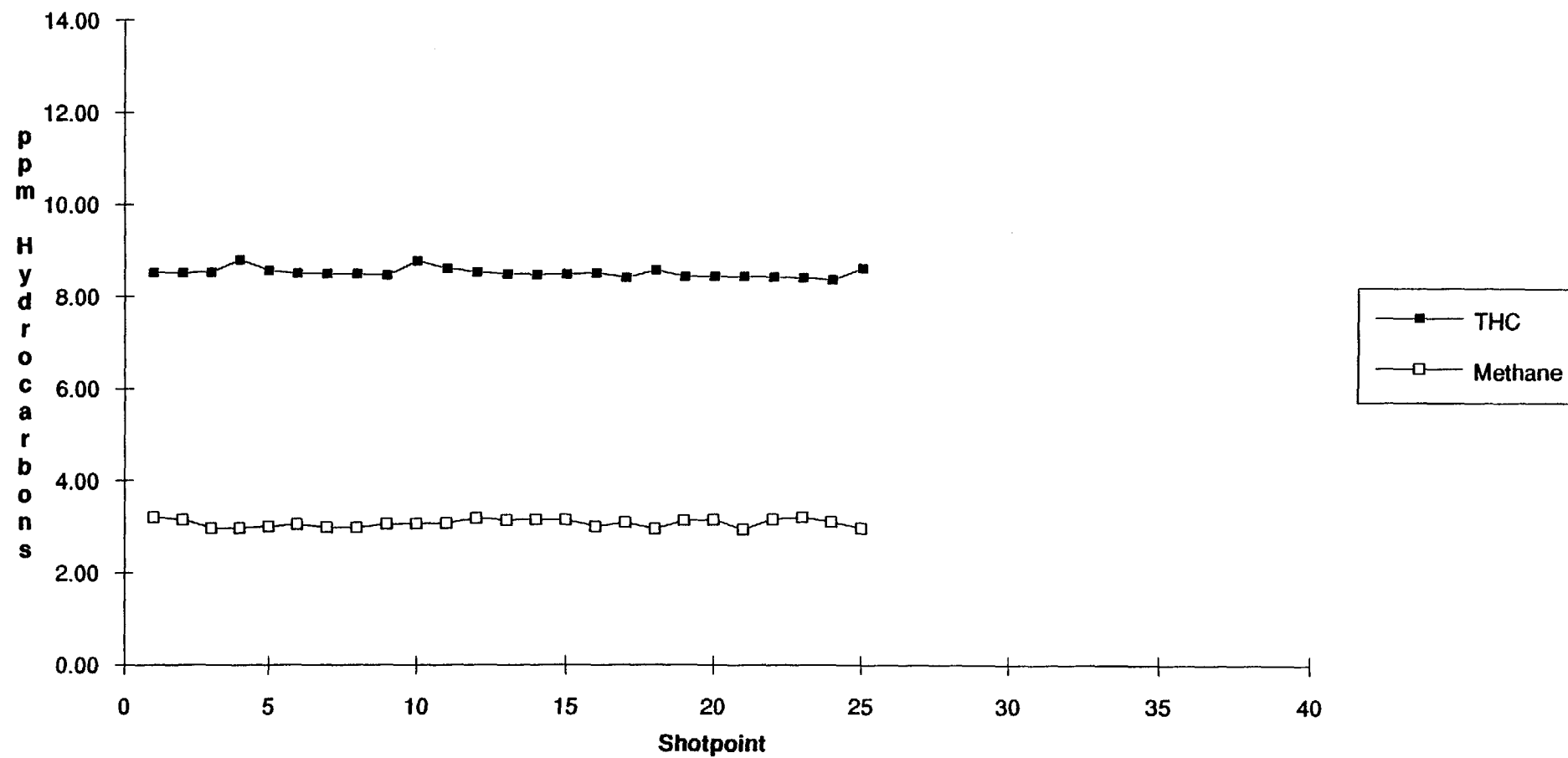
	Shotpoint	Date	Time	Latitude	Longitude
Start	1	1-Oct-91	9:49:32	38	33.378 144 16.438
End	17	1-Oct-91	10:23:31	38	34.764 144 16.631

	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	8.547	3.075	0.008	0.038	0.004	0.000	0.000	0.000	0.004	0.039	0.006	0.000	0.399
Std. Dev.	0.100	0.082	0.002	0.003	0.006	0.000	0.000	0.000	0.007	0.012	0.011	0.000	0.163
Minimum	8.426	2.969	0.005	0.034	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.235
Maximum	8.800	3.209	0.011	0.043	0.016	0.000	0.000	0.000	0.017	0.052	0.037	0.000	0.699

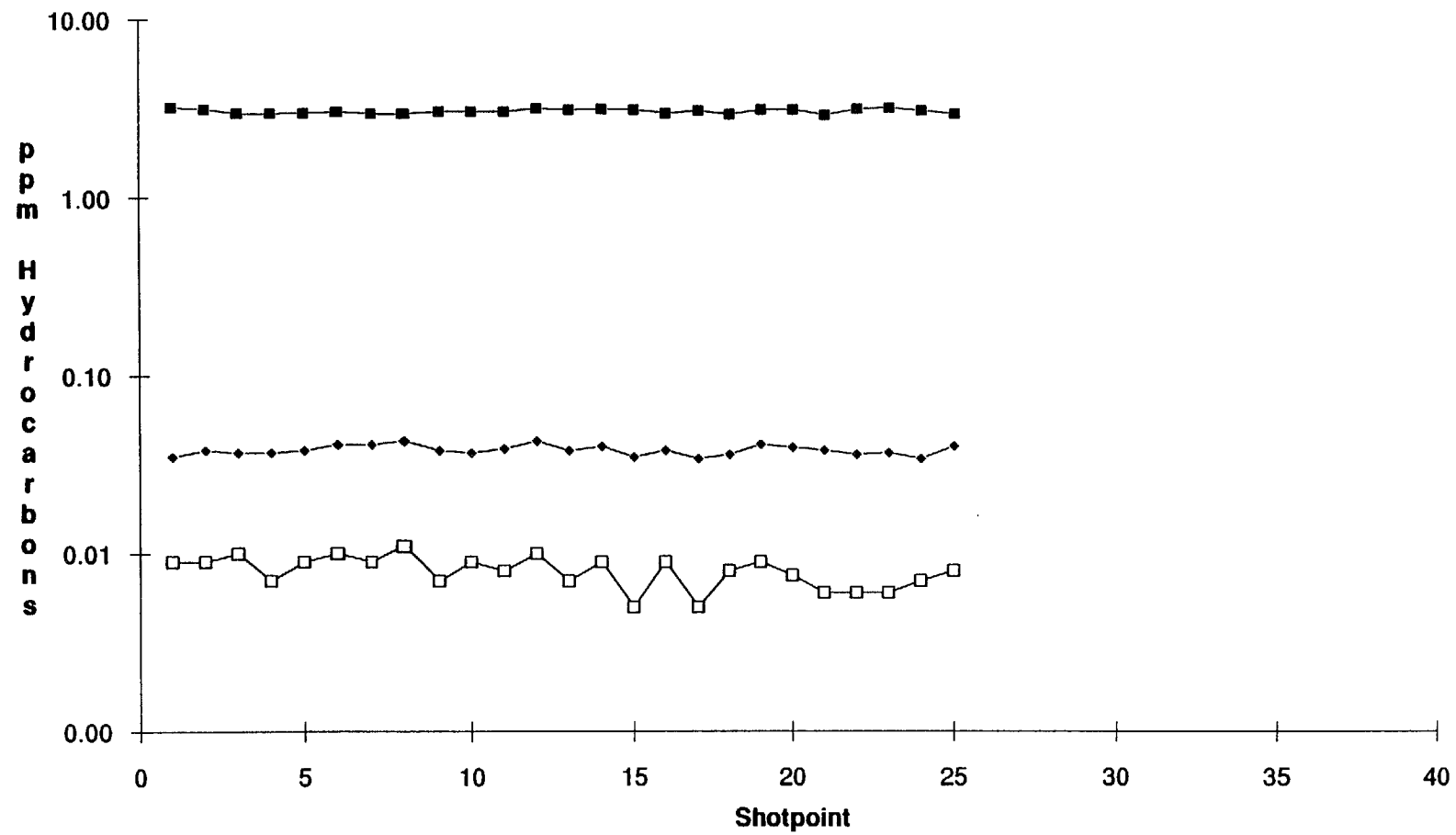
	Cond.	Temp.	Altitude	F. Depth	W.Depth
Mean	45.752	14.136	7.194	66.929	76.553
Std. Dev.	0.024	0.032	0.332	0.369	2.488
Minimum	45.710	14.080	6.600	66.200	74.100
Maximum	45.800	14.180	7.800	67.500	80.100

Notes
No hydrocarbon anomalies

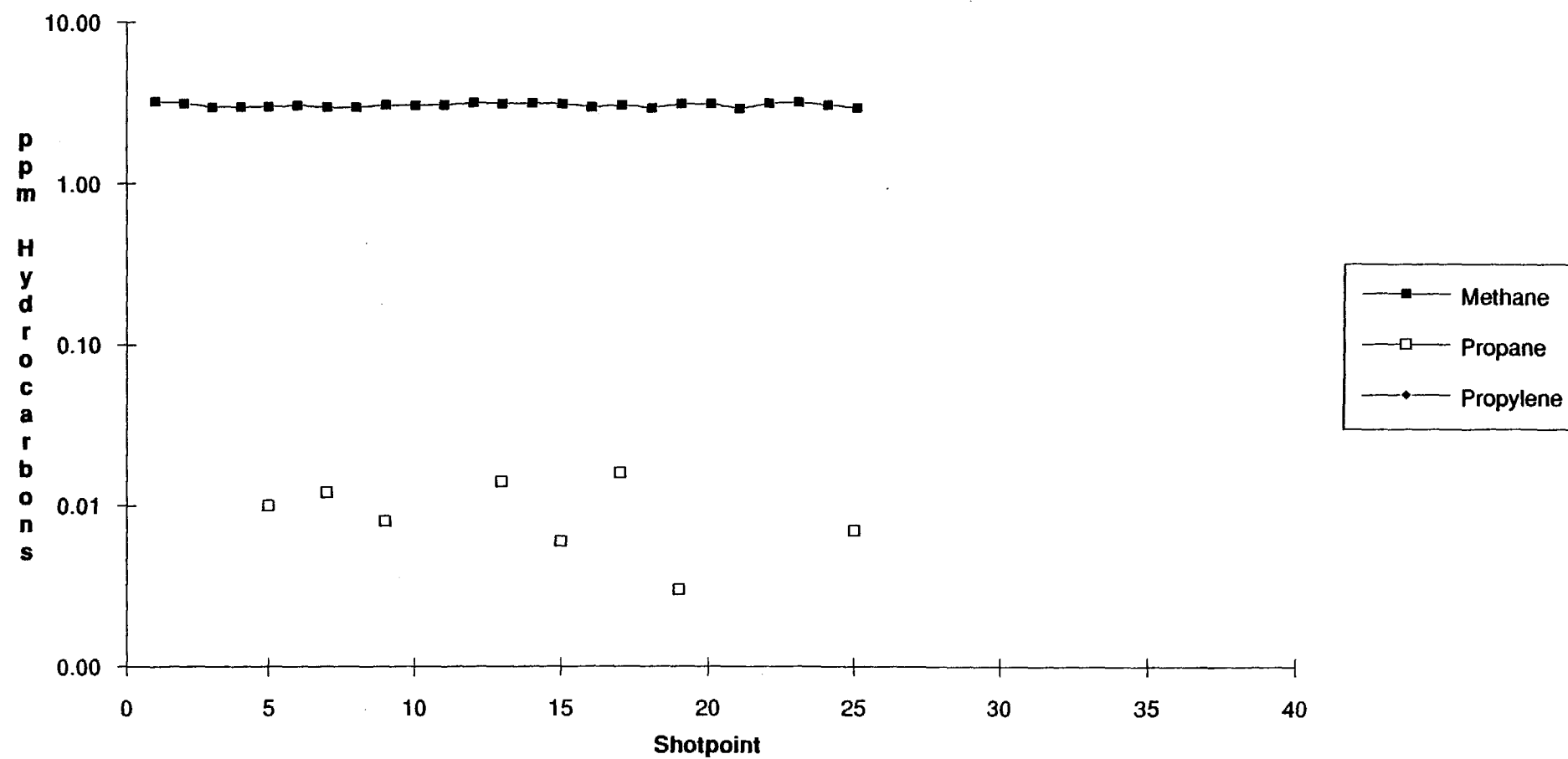
Line 104025 THC, Methane



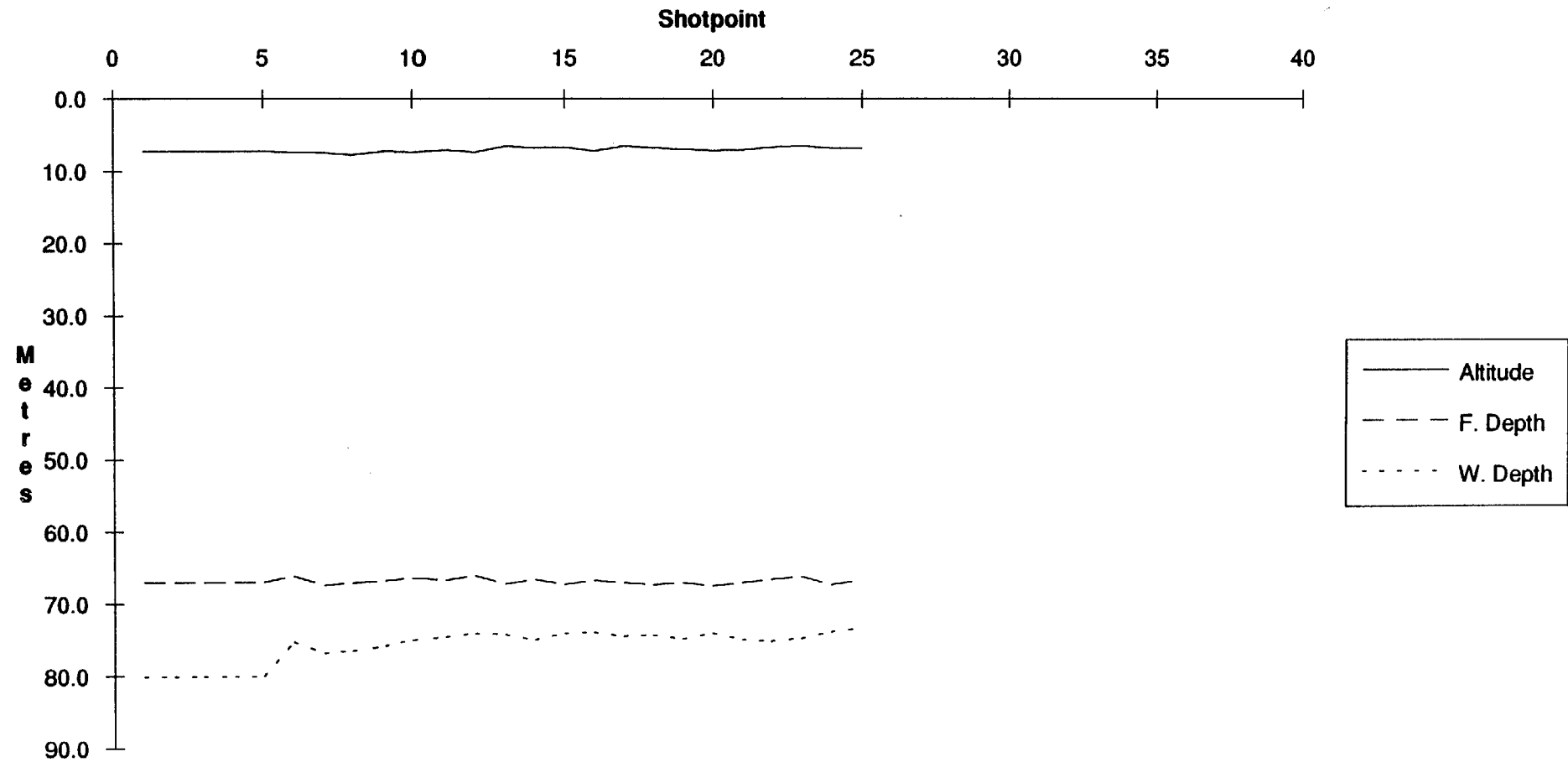
Line 104025 Methane, Ethane, Ethylene



Line 104025 Methane, Propane, Propylene



Line 104025 Depths, Altitude



Line Summary

Line Number 104026
No. of Shotpoints 8

	Shotpoint	Date	Time	Latitude	Longitude
Start	1	1-Oct-91	10:25:31	38	144
End	8	1-Oct-91	10:39:31	38	144

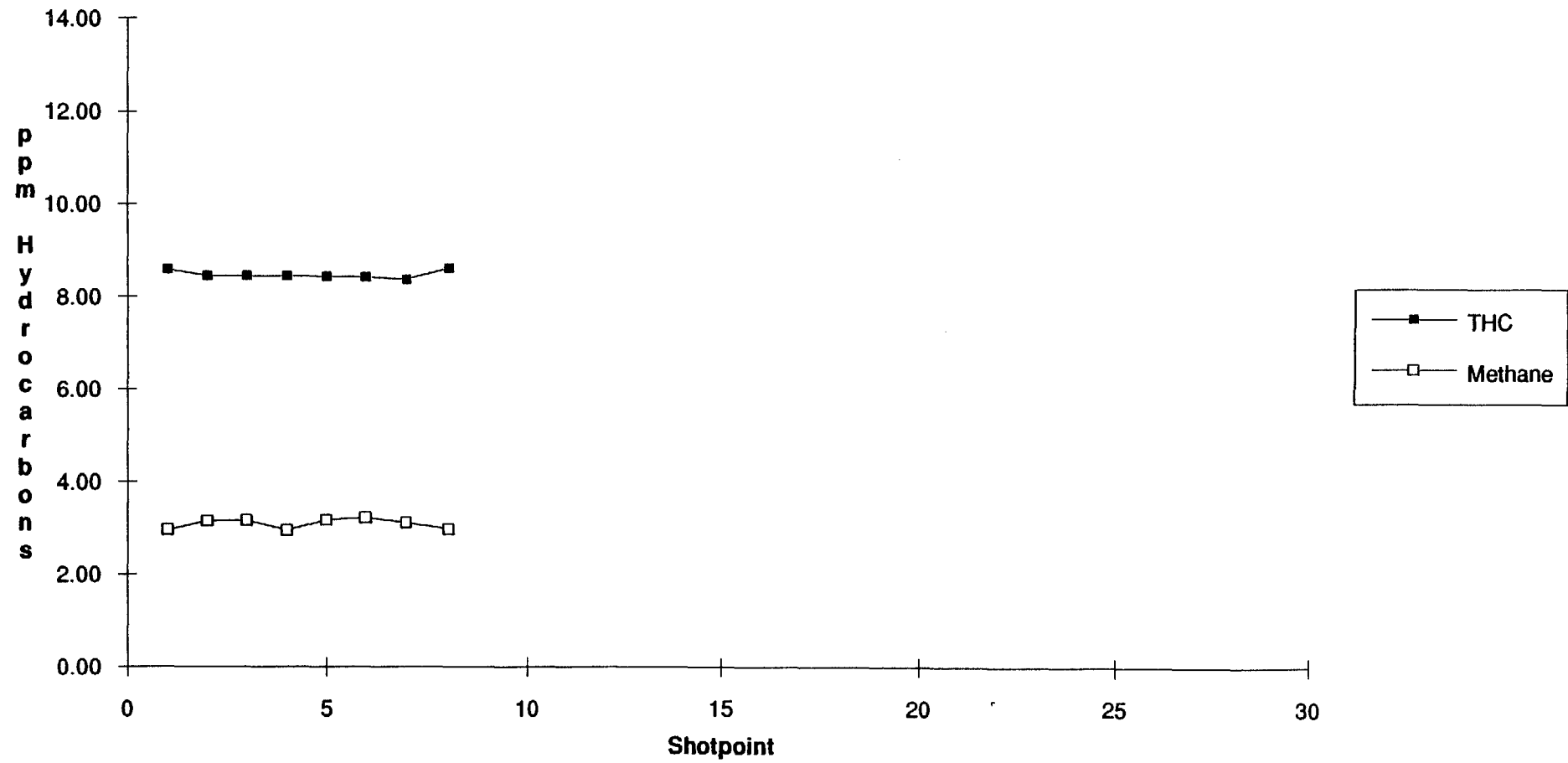
	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	8.475	3.086	0.012	0.041	0.001	0.000	0.000	0.000	0.001	0.039	0.008	0.000	0.416
Std. Dev.	0.085	0.108	0.013	0.009	0.003	0.000	0.000	0.000	0.003	0.017	0.015	0.000	0.403
Minimum	8.377	2.945	0.006	0.034	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.186
Maximum	8.622	3.215	0.044	0.062	0.007	0.000	0.000	0.000	0.009	0.059	0.042	0.000	1.375

	Cond.	Temp.	Altitude	F. Depth	W.Depth
Mean	45.819	14.158	6.938	67.025	74.775
Std. Dev.	0.027	0.021	0.200	0.377	0.620
Minimum	45.780	14.150	6.600	66.300	73.600
Maximum	45.870	14.210	7.100	67.500	75.300

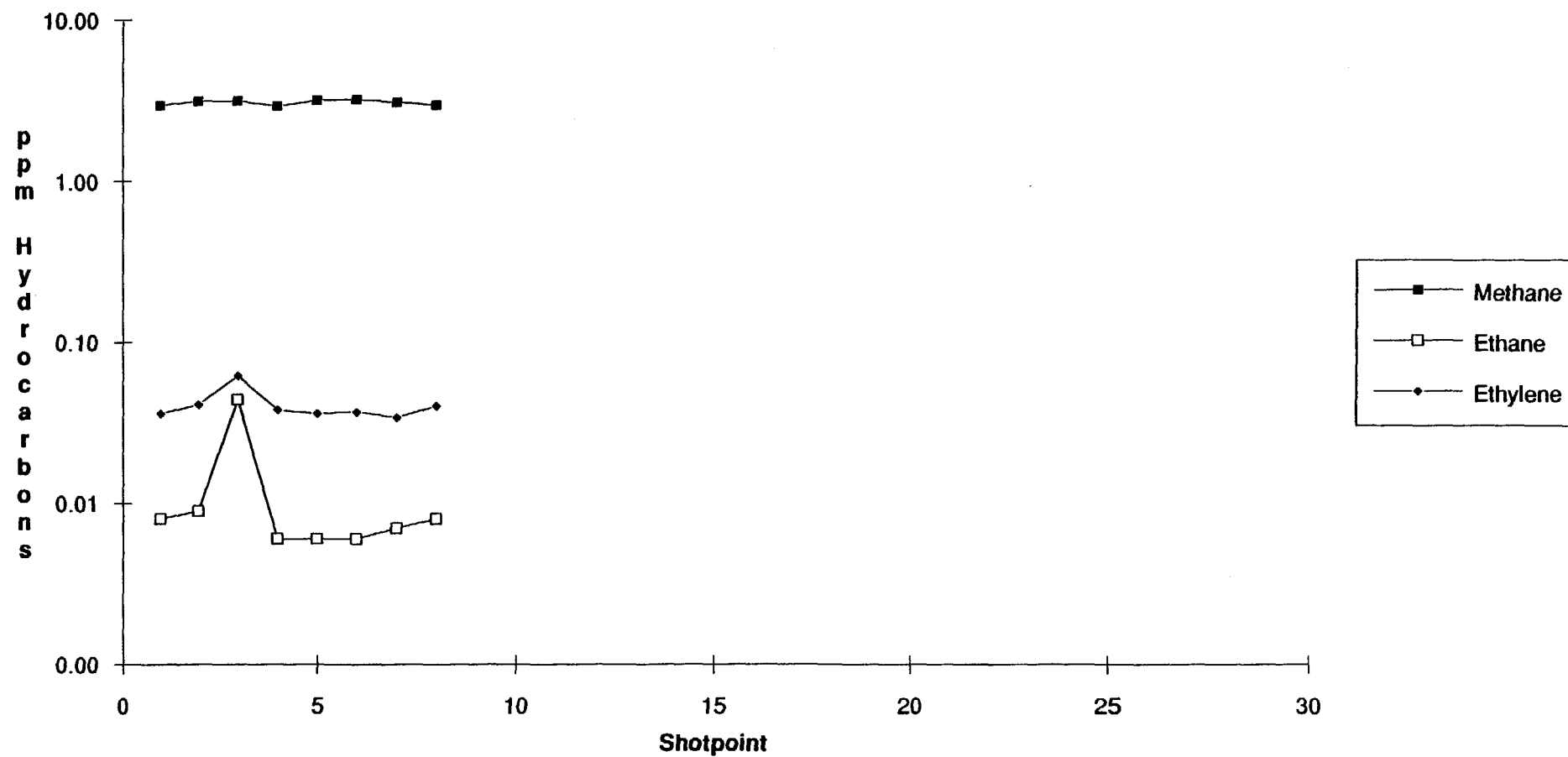
Notes

No hydrocarbon anomalies

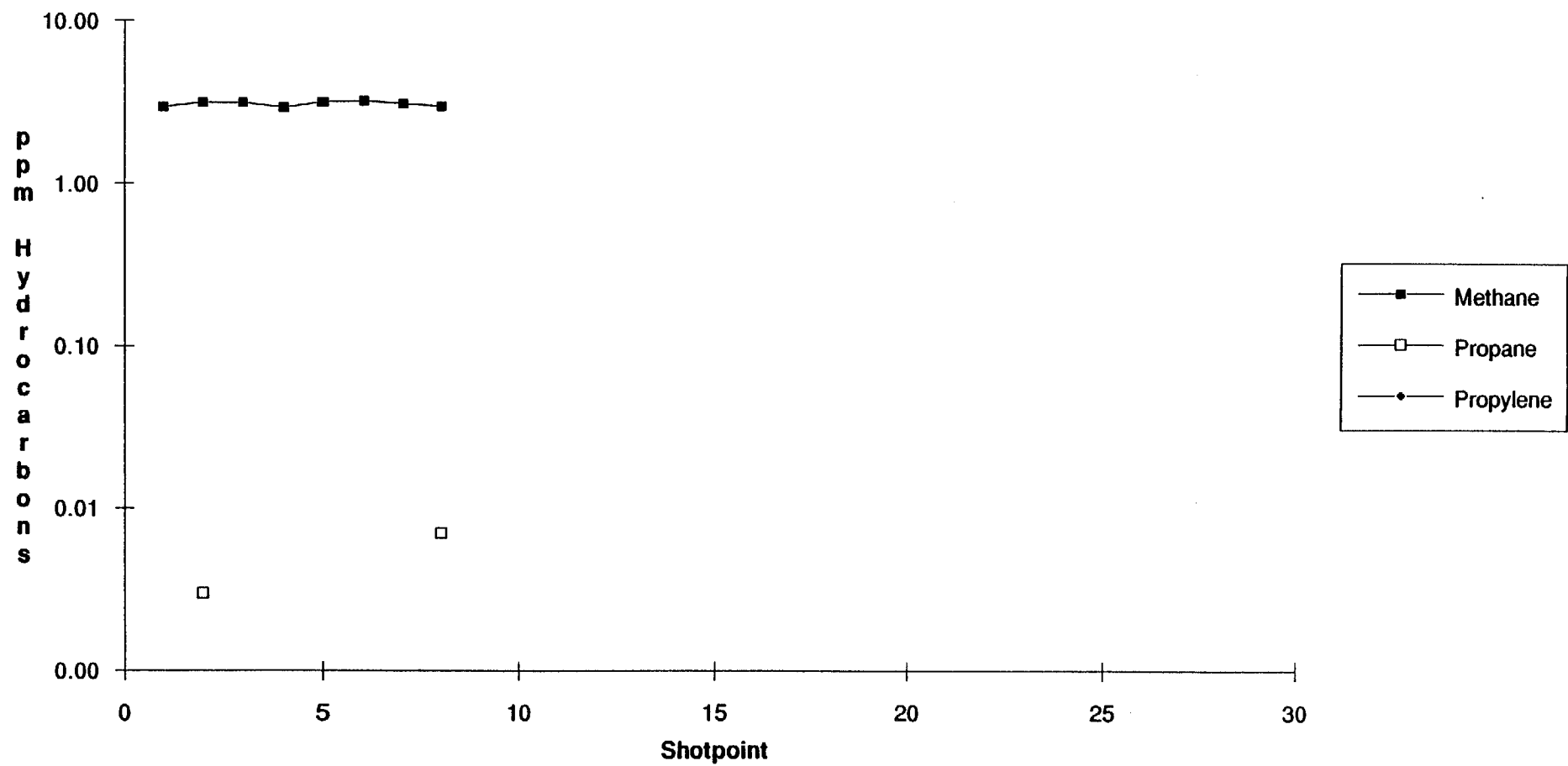
Line 104026 THC, Methane



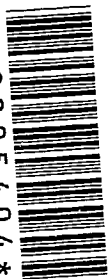
Line 104026 Methane, Ethane, Ethylene



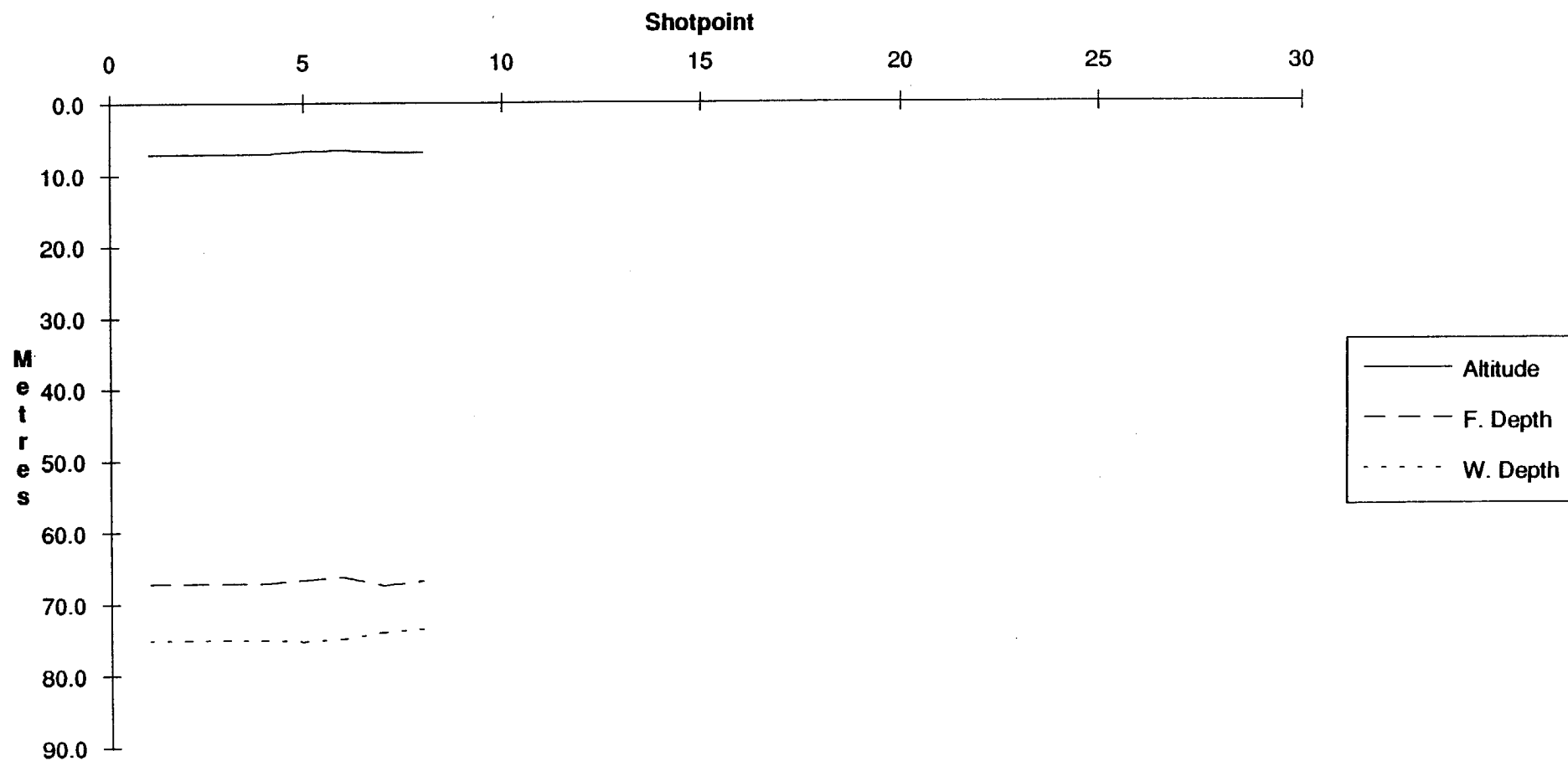
Line 104026 Methane, Propane, Propylene



* R 9 2 0 5 4 0 4 *



Line 104026 Depths, Altitude



Line Summary

Line Number 104027
No. of Shotpoints 22

	Shotpoint	Date	Time	Latitude	Longitude
Start	1	1-Oct-91	10:41:31	38	144
End	22	1-Oct-91	11:23:46	38	144

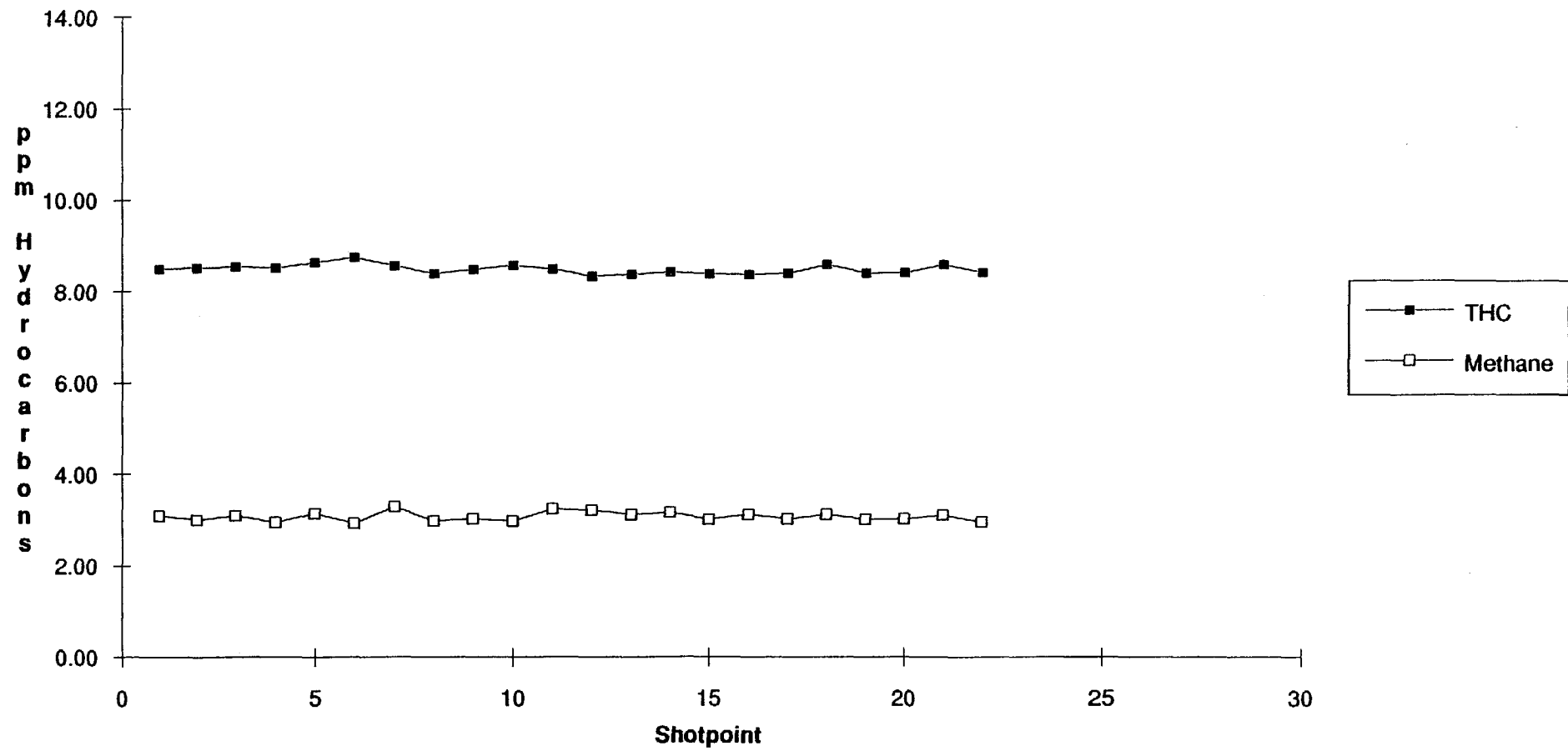
	THC	Methane	Ethane	Ethylene	Propane	Propylene	I-Butane	n-Butane	I-Pentane	n-Pentane	I-Hexane	n-Hexane	%Wetness
Mean	8.479	3.067	0.009	0.039	0.004	0.000	0.000	0.000	0.002	0.041	0.002	0.000	0.421
Std. Dev.	0.105	0.100	0.002	0.003	0.005	0.000	0.000	0.000	0.005	0.016	0.007	0.000	0.160
Minimum	8.321	2.929	0.006	0.031	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.194
Maximum	8.750	3.286	0.012	0.046	0.013	0.000	0.000	0.000	0.016	0.070	0.025	0.000	0.711

	Cond.	Temp.	Altitude	F. Depth	W.Depth
Mean	45.794	14.086	7.627	65.977	74.523
Std. Dev.	0.050	0.117	0.443	0.679	1.480
Minimum	45.730	13.620	7.000	64.800	72.600
Maximum	45.890	14.210	8.900	67.100	79.400

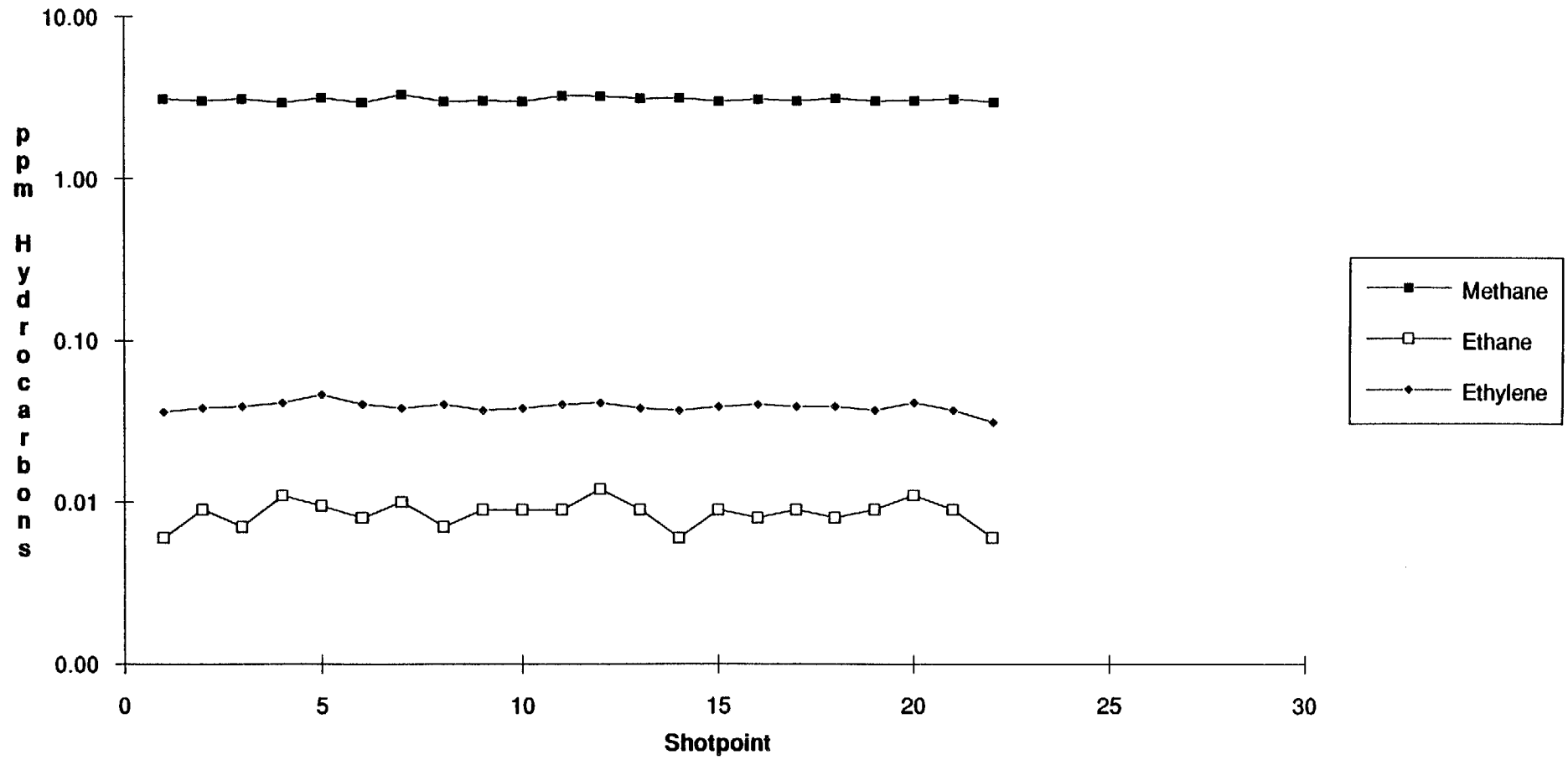
Notes

No hydrocarbon anomalies

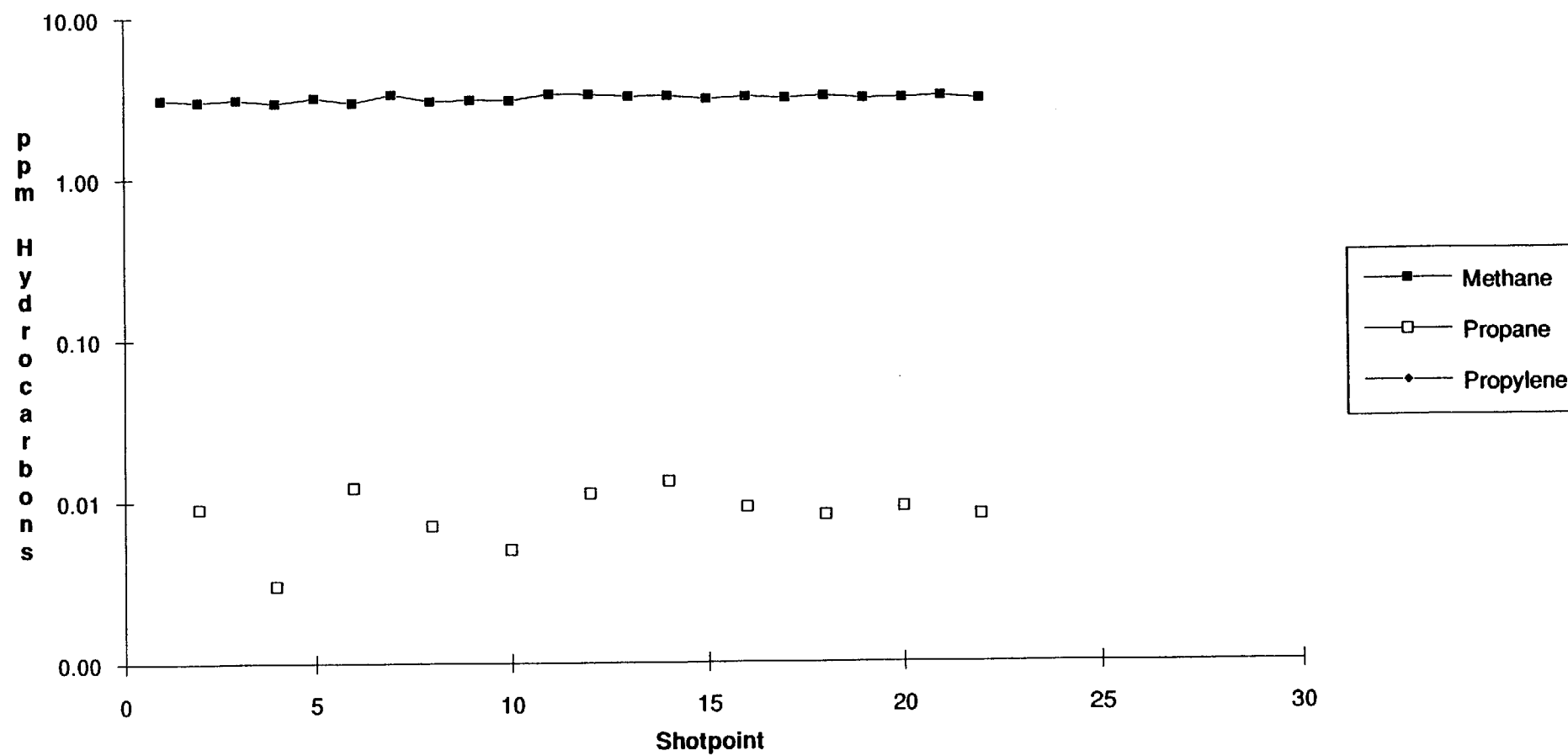
Line 104027 THC, Methane



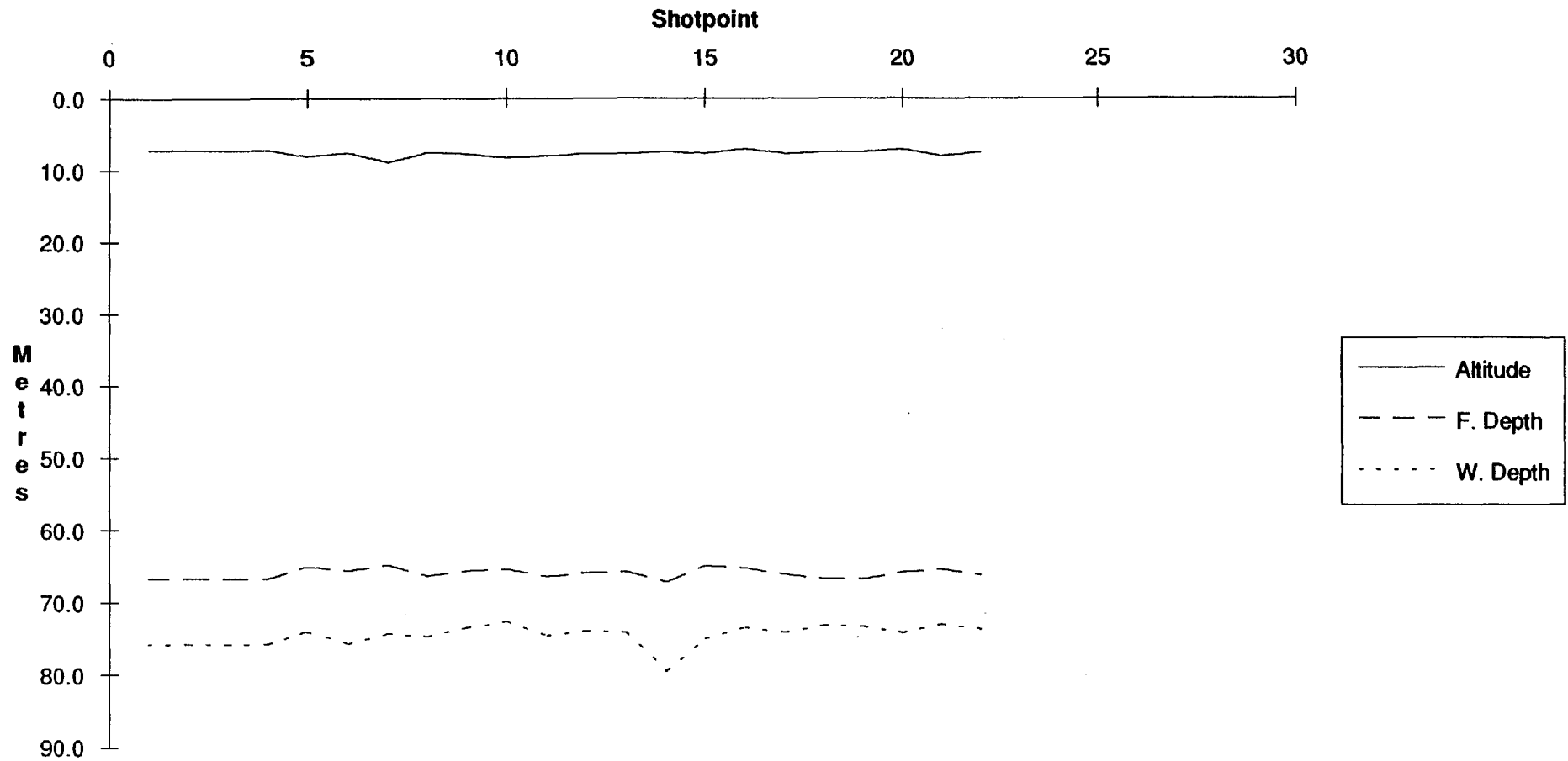
Line 104027 Methane, Ethane, Ethylene



Line 104027 Methane, Propane, Propylene



Line 104027 Depths, Altitude



Line Summary

Line Number 104028
No. of Shotpoints 70

	Shotpoint	Date	Time	Latitude	Longitude
Start	1	1-Oct-91	13:55:58	38	144
End	70	1-Oct-91	16:13:58	38	144

	THC	Methane	Ethane	Ethylene	Propane	Propylene	I-Butane	n-Butane	I-Pentane	n-Pentane	I-Hexane	n-Hexane	%Wetness
Mean	8.611	3.135	0.010	0.037	0.003	0.000	0.000	0.000	0.000	0.036	0.000	0.000	0.408
Std. Dev.	0.562	0.312	0.005	0.002	0.004	0.000	0.000	0.000	0.002	0.014	0.001	0.000	0.158
Minimum	8.168	2.796	0.005	0.030	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.173
Maximum	11.081	4.130	0.024	0.042	0.010	0.000	0.000	0.000	0.013	0.065	0.009	0.000	0.880

	Cond.	Temp.	Altitude	F. Depth	W.Depth
Mean	45.747	14.399	9.759	64.479	74.643
Std. Dev.	0.021	1.150	0.919	0.995	1.065
Minimum	45.710	11.320	7.400	63.000	73.100
Maximum	45.800	15.280	11.500	67.100	79.800

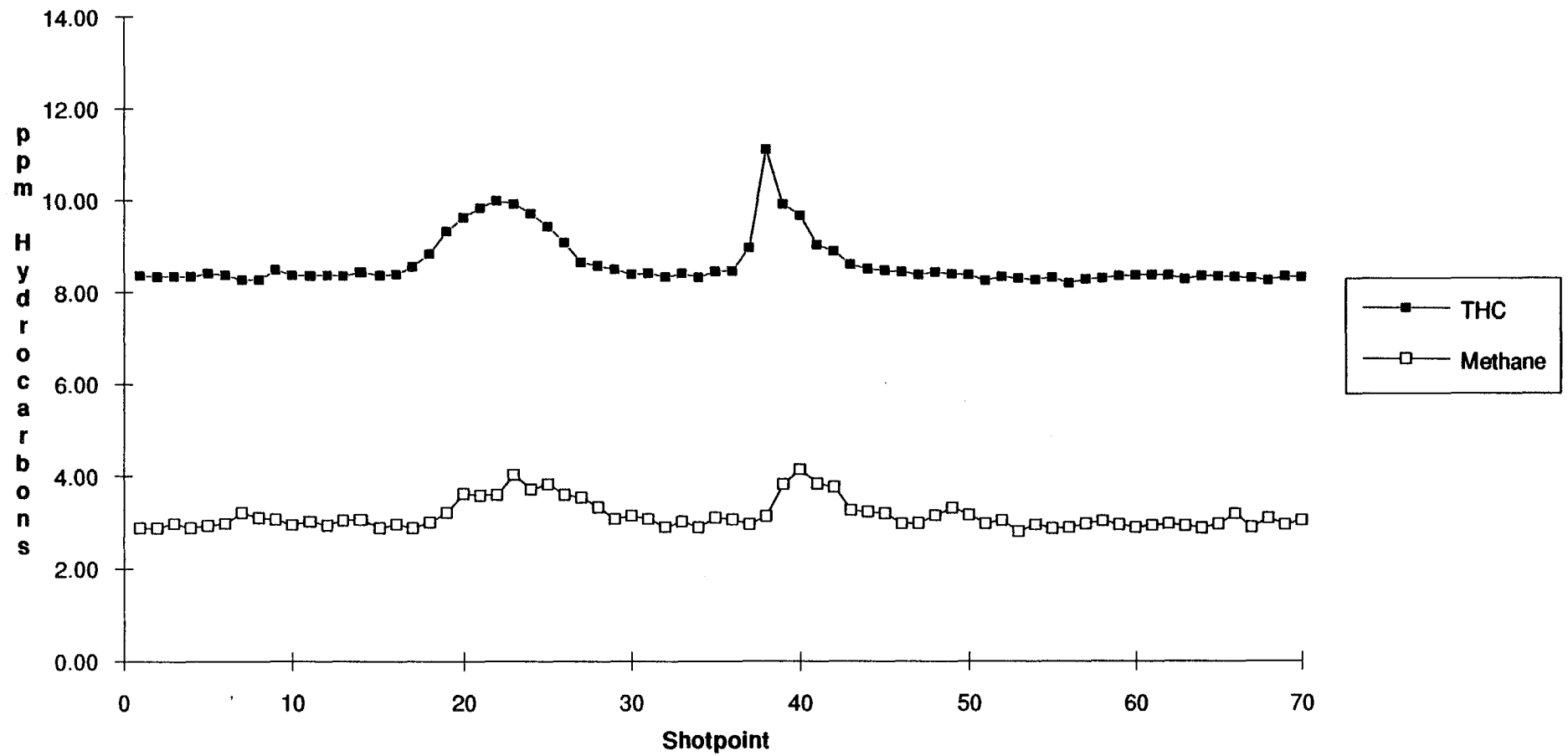
Notes

THC, methane and ethane anomaly SP35-45

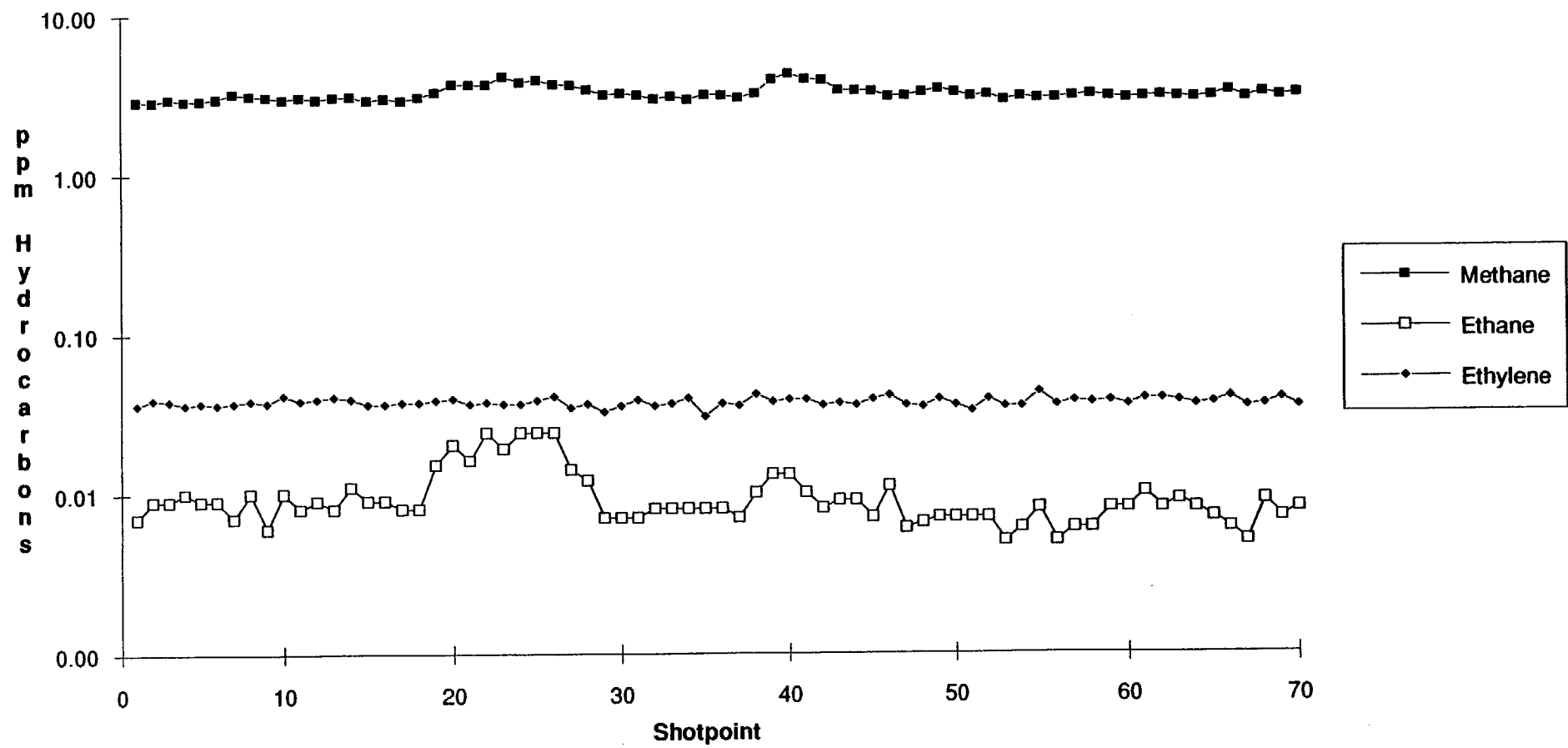
THC, methane and ethane anomaly SP17-30

Faulty temperature thermistor resulted in incorrect temperature values

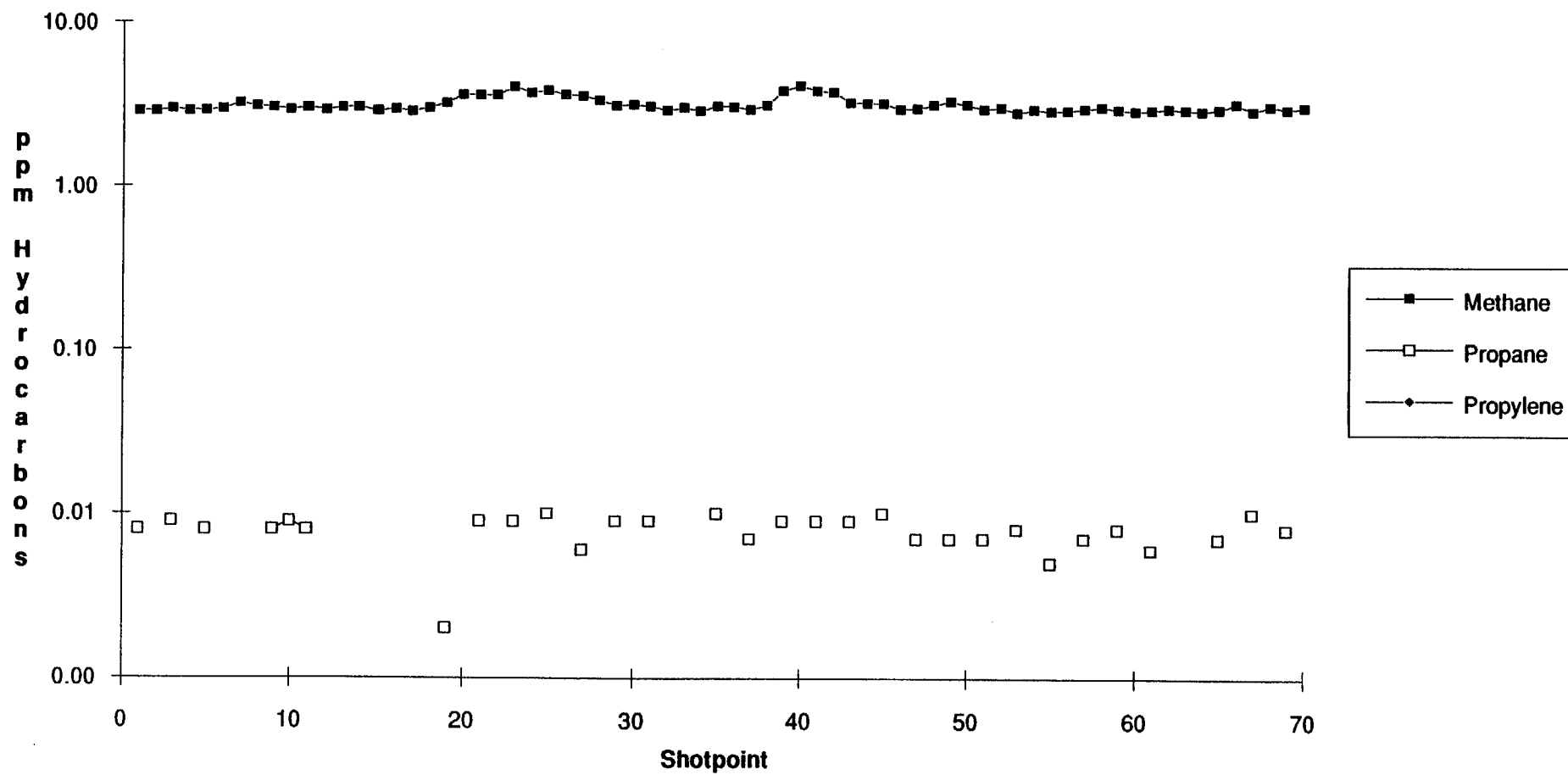
Line 104028 THC, Methane



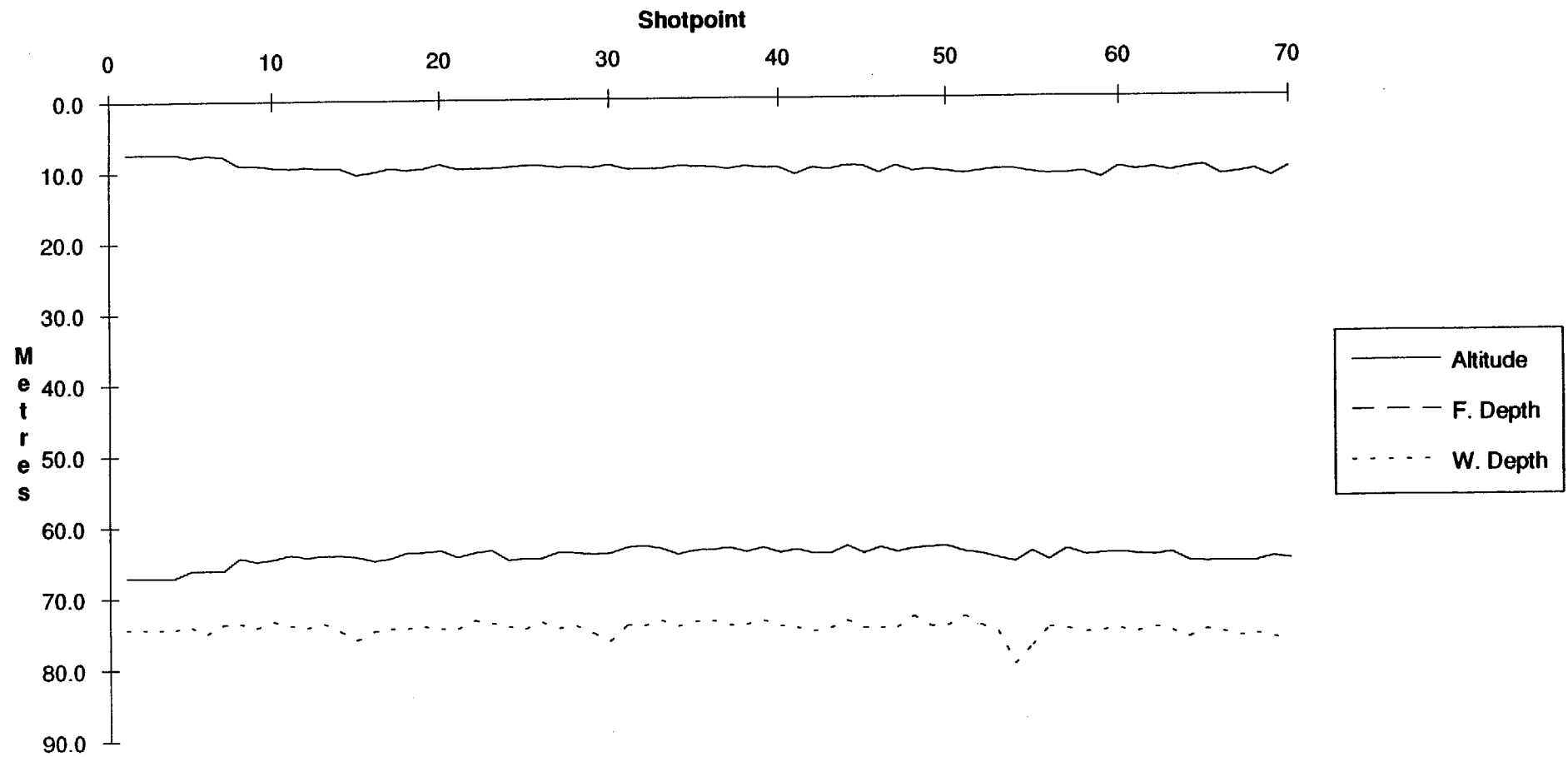
Line 104028 Methane, Ethane, Ethylene



Line 104028 Methane, Propane, Propylene



Line 104028 Depths, Altitude



Line Summary

Line Number 104029
No. of Shotpoints 57

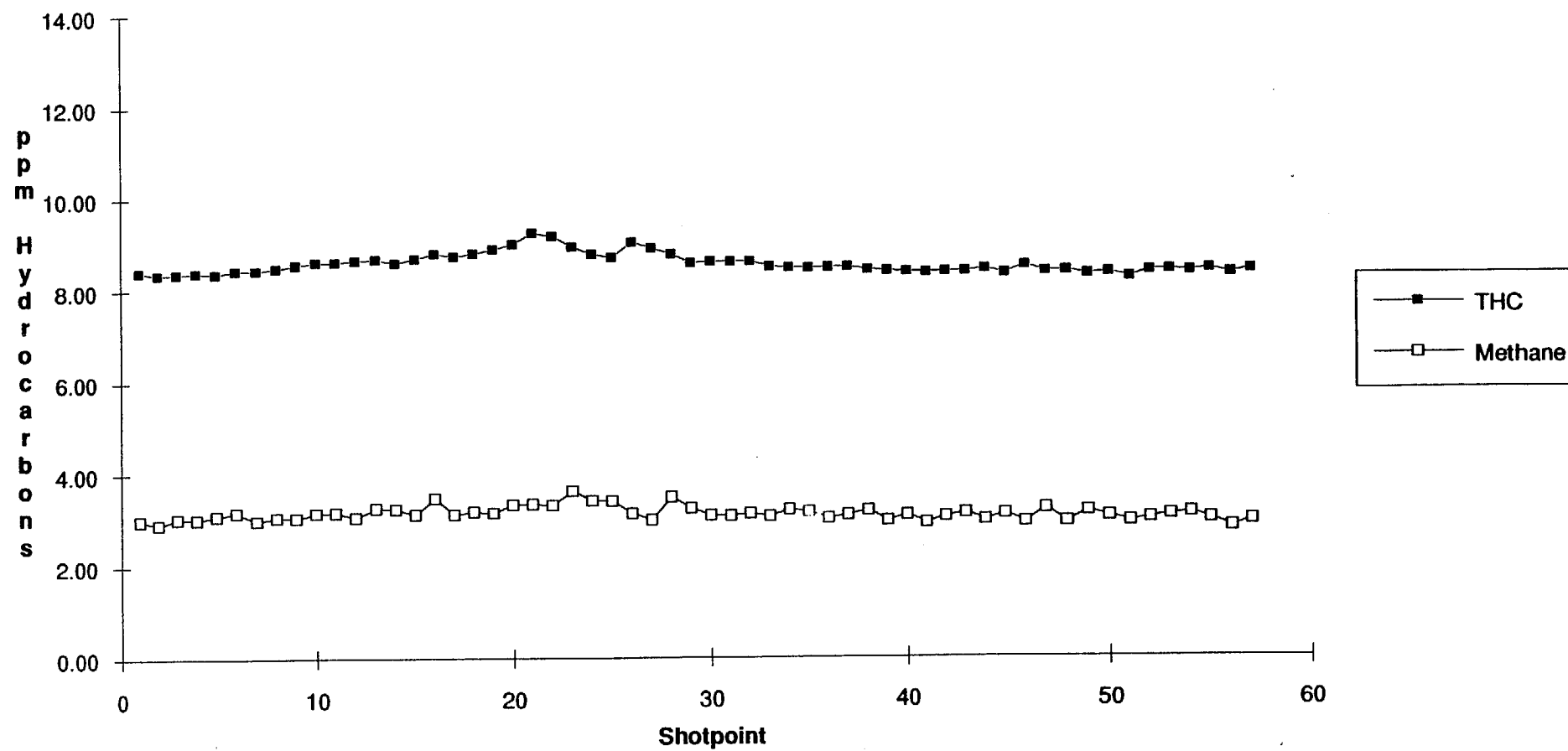
	Shotpoint	Date	Time	Latitude	Longitude
Start	1	1-Oct-91	16:15:57	38 40.518	144 10.871
End	57	1-Oct-91	18:08:08	38 40.346	144 03.306

	THC	Methane	Ethane	Ethylene	Propane	Propylene	I-Butane	n-Butane	I-Pentane	n-Pentane	I-Hexane	n-Hexane	%Wetness
Mean	8.538	3.112	0.009	0.038	0.004	0.000	0.000	0.000	0.001	0.038	0.001	0.000	0.405
Std. Dev.	0.230	0.159	0.002	0.002	0.004	0.000	0.000	0.000	0.005	0.014	0.005	0.000	0.138
Minimum	8.217	2.809	0.005	0.034	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.192
Maximum	9.232	3.620	0.014	0.044	0.012	0.000	0.000	0.000	0.023	0.056	0.028	0.000	0.749

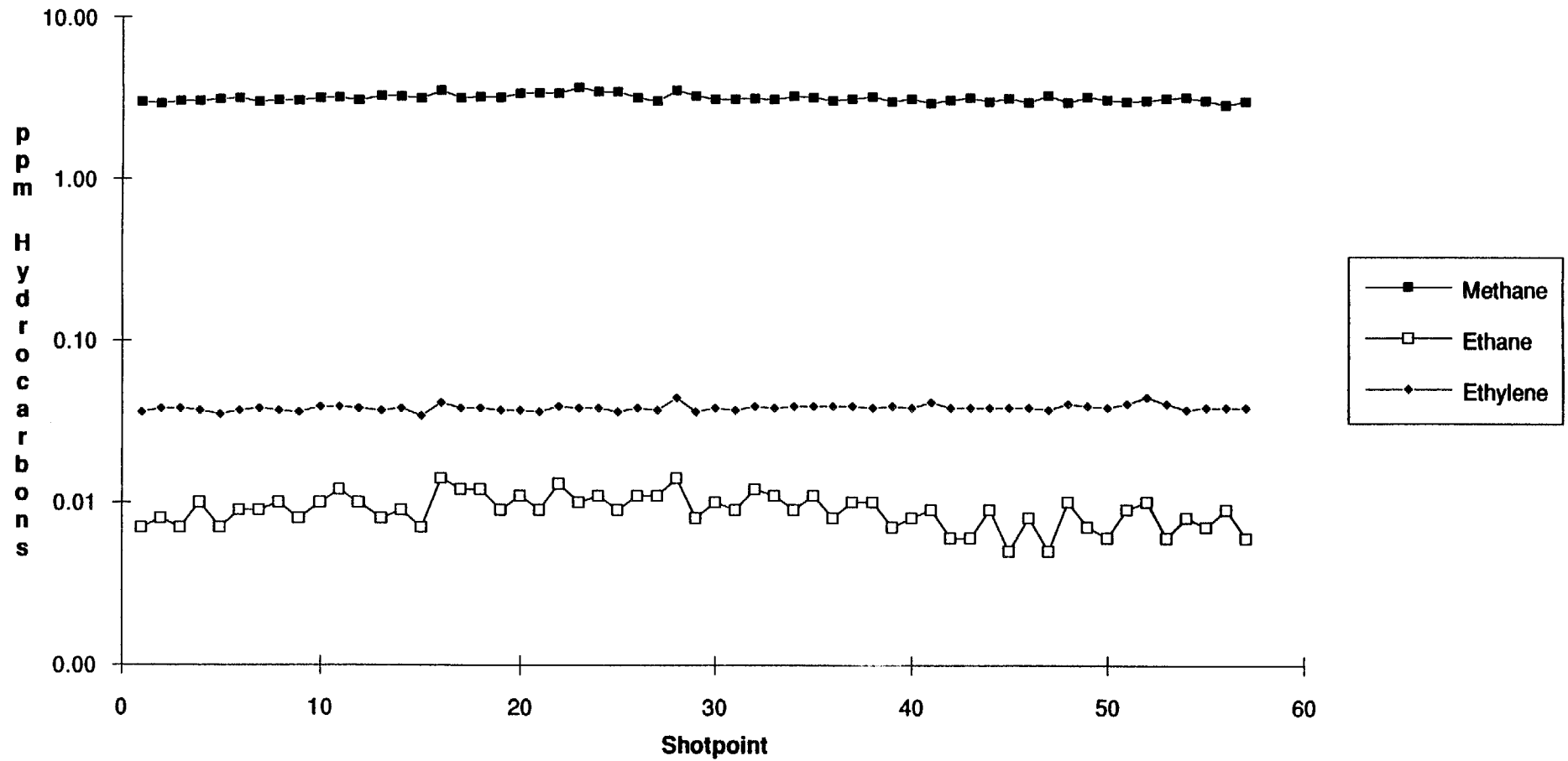
	Cond.	Temp.	Altitude	F. Depth	W.Depth
Mean	45.612	13.902	9.370	66.495	76.882
Std. Dev.	0.063	0.744	0.923	1.031	1.812
Minimum	45.500	11.290	7.800	64.400	71.000
Maximum	45.750	14.470	11.100	69.000	84.900

Notes
No hydrocarbon anomalies

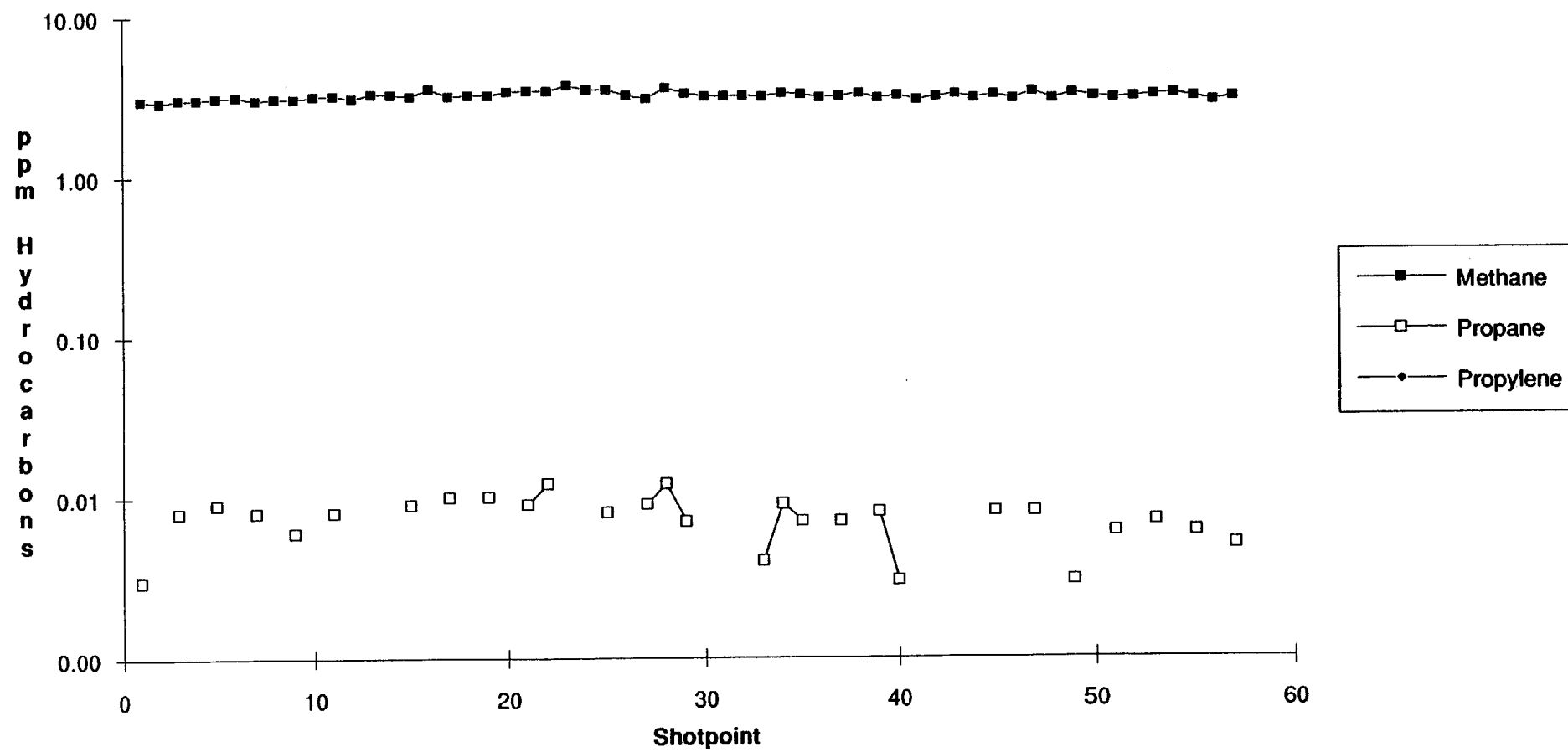
Line 104029 THC, Methane



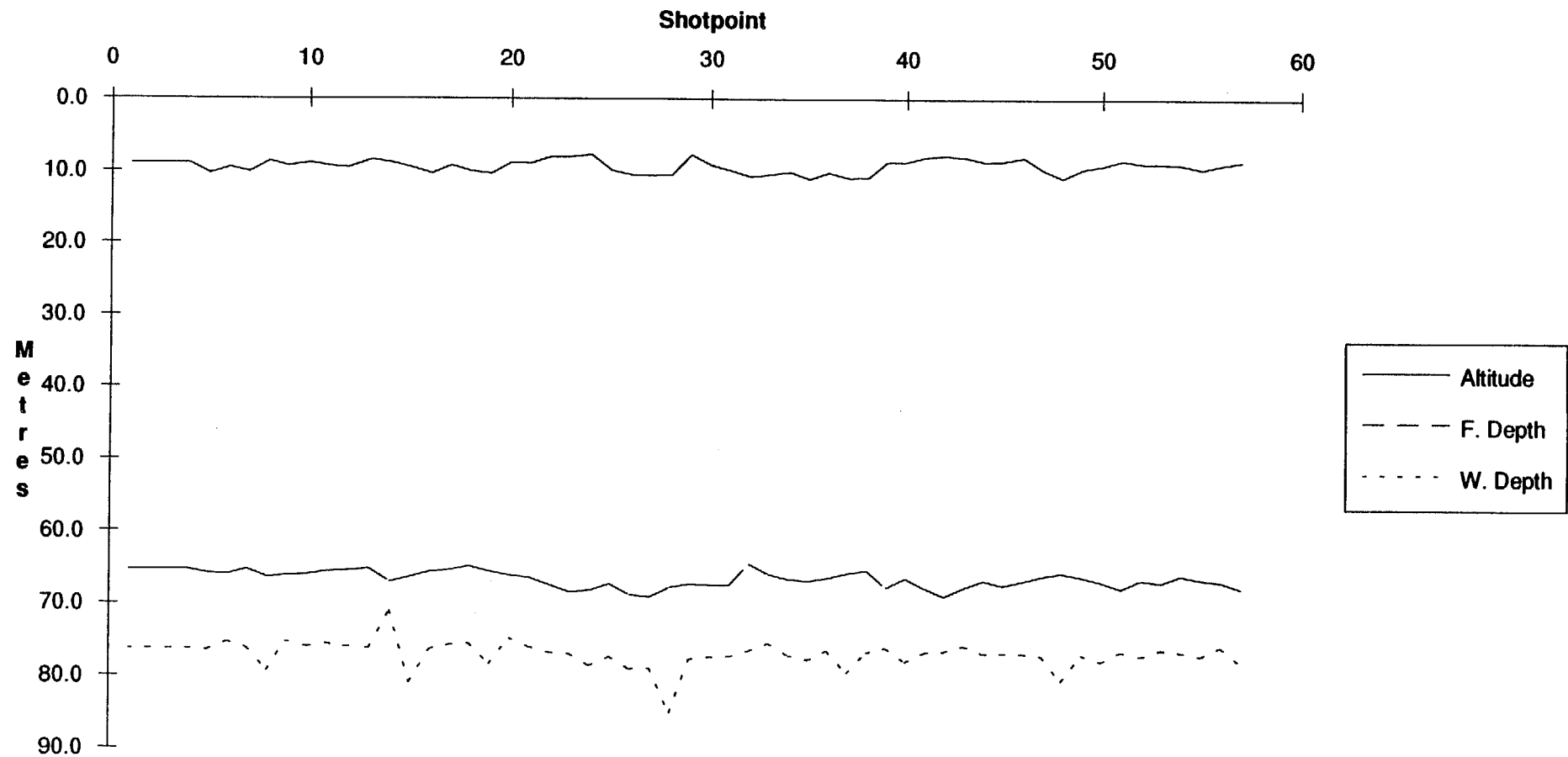
Line 104029 Methane, Ethane, Ethylene



Line 104029 Methane, Propane, Propylene



Line 104029 Depths, Altitude



Line Summary

Line Number 104030
No. of Shotpoints 45

	Shotpoint	Date	Time	Latitude	Longitude	
Start	1	1-Oct-91	18:58:32	38	40.352	03.110
End	45	1-Oct-91	20:26:49	38	39.797	08.666

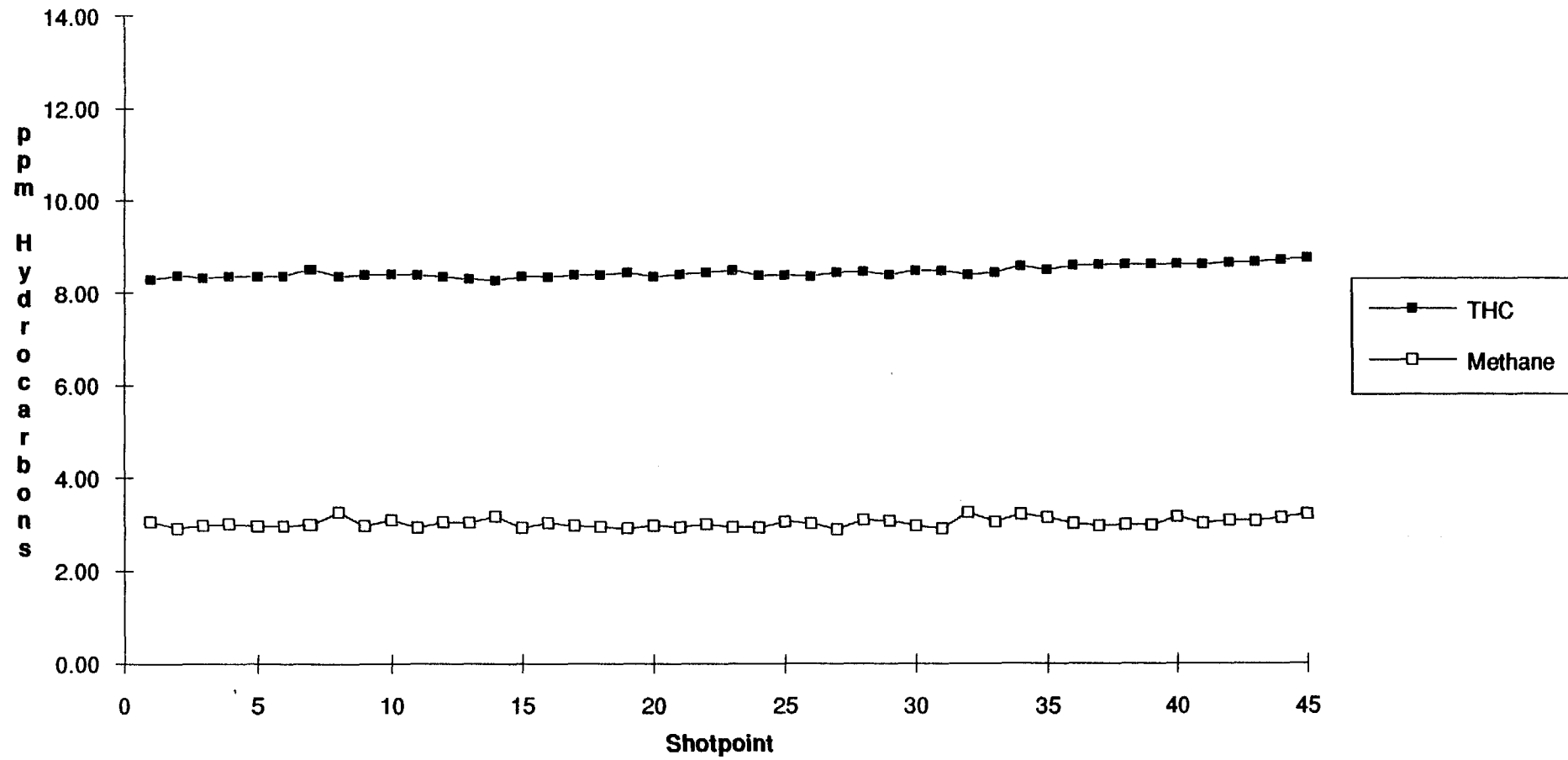
	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wellness
Mean	8.430	3.015	0.008	0.039	0.003	0.000	0.000	0.000	0.000	0.037	0.000	0.000	0.384
Std. Dev.	0.113	0.094	0.002	0.003	0.004	0.000	0.000	0.000	0.000	0.013	0.002	0.000	0.125
Minimum	8.255	2.877	0.006	0.032	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.229
Maximum	8.710	3.255	0.013	0.050	0.011	0.000	0.000	0.000	0.000	0.052	0.013	0.000	0.696

	Cond.	Temp.	Altitude	F. Depth	W.Depth
Mean	45.617	13.830	9.238	66.787	76.733
Std. Dev.	0.063	0.741	0.880	0.921	0.549
Minimum	45.500	11.740	7.800	65.100	75.200
Maximum	45.710	14.670	10.600	68.700	78.000

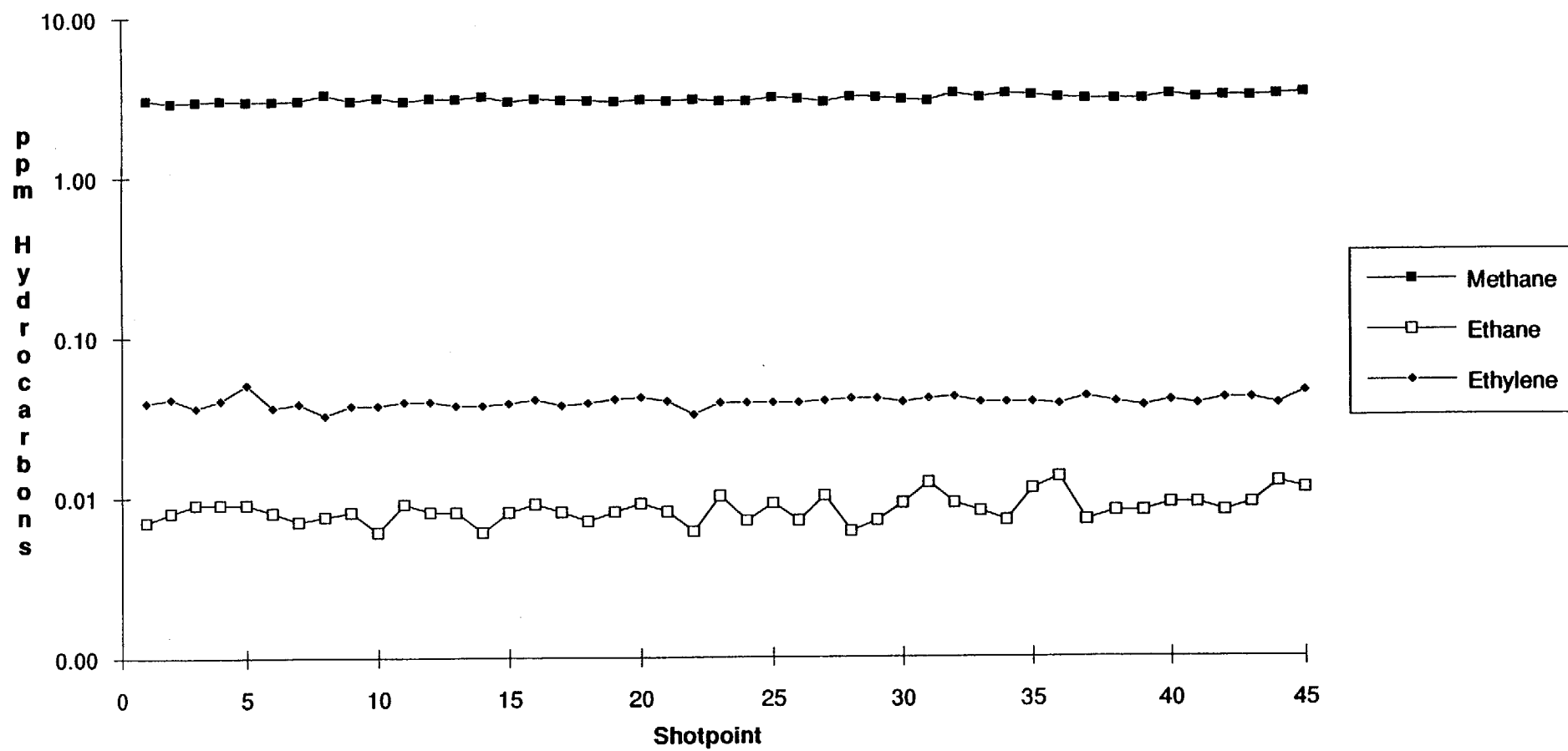
Notes

No hydrocarbon anomalies

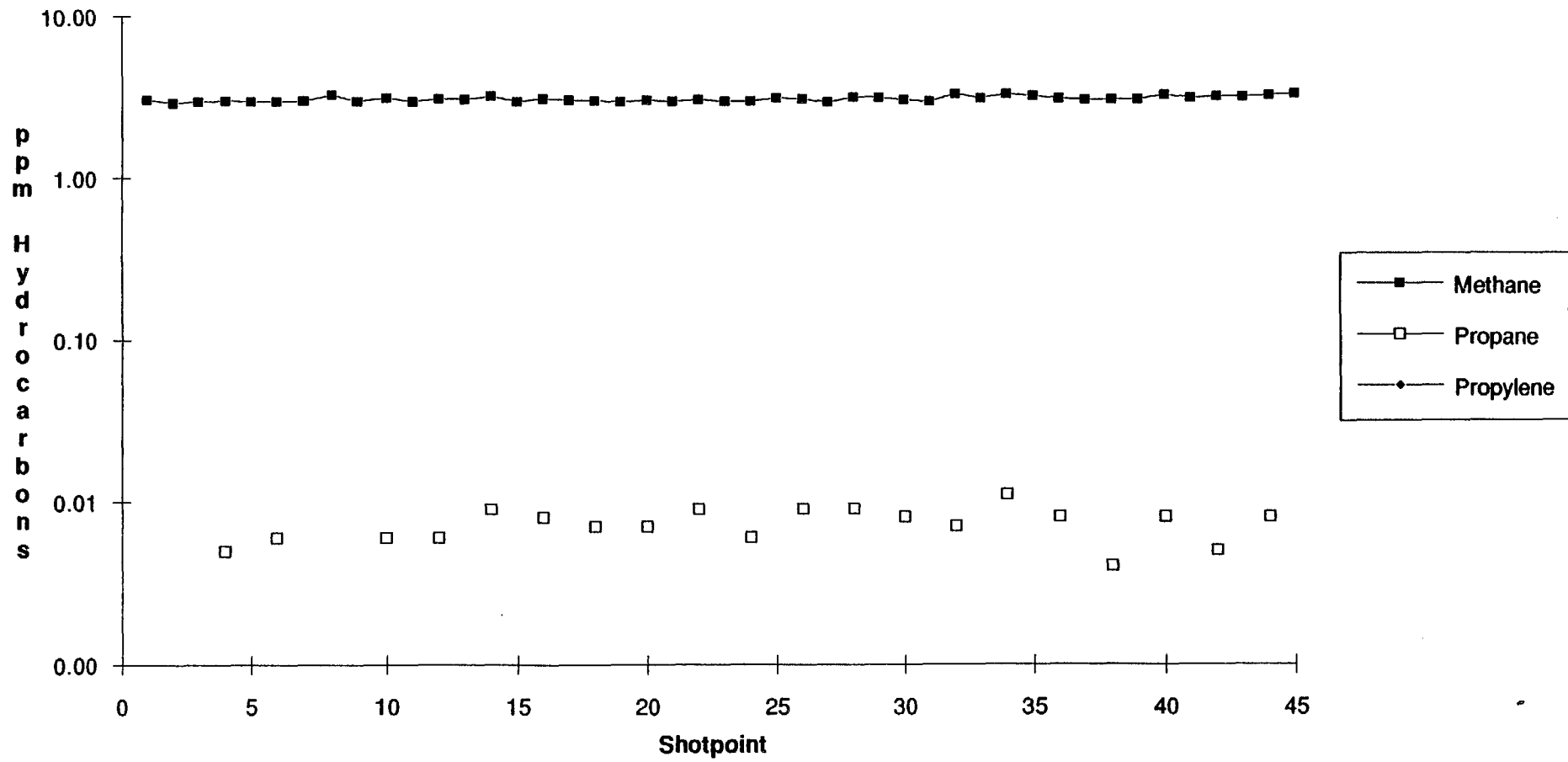
Line 104030 THC, Methane



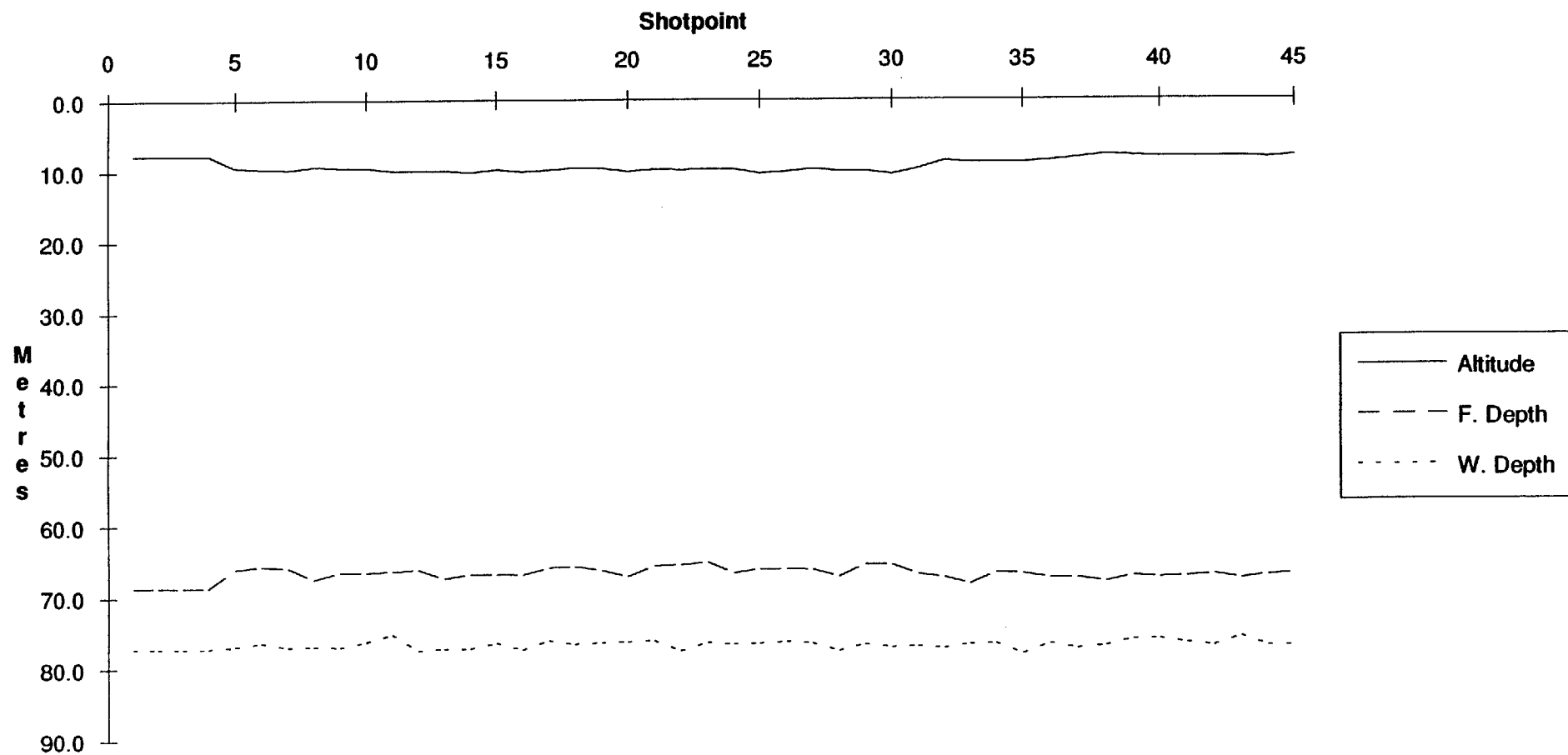
Line 104030 Methane, Ethane, Ethylene



Line 104030 Methane, Propane, Propylene



Line 104030 Depths, Altitude



Line Summary

Line Number 104040
No. of Shotpoints 33

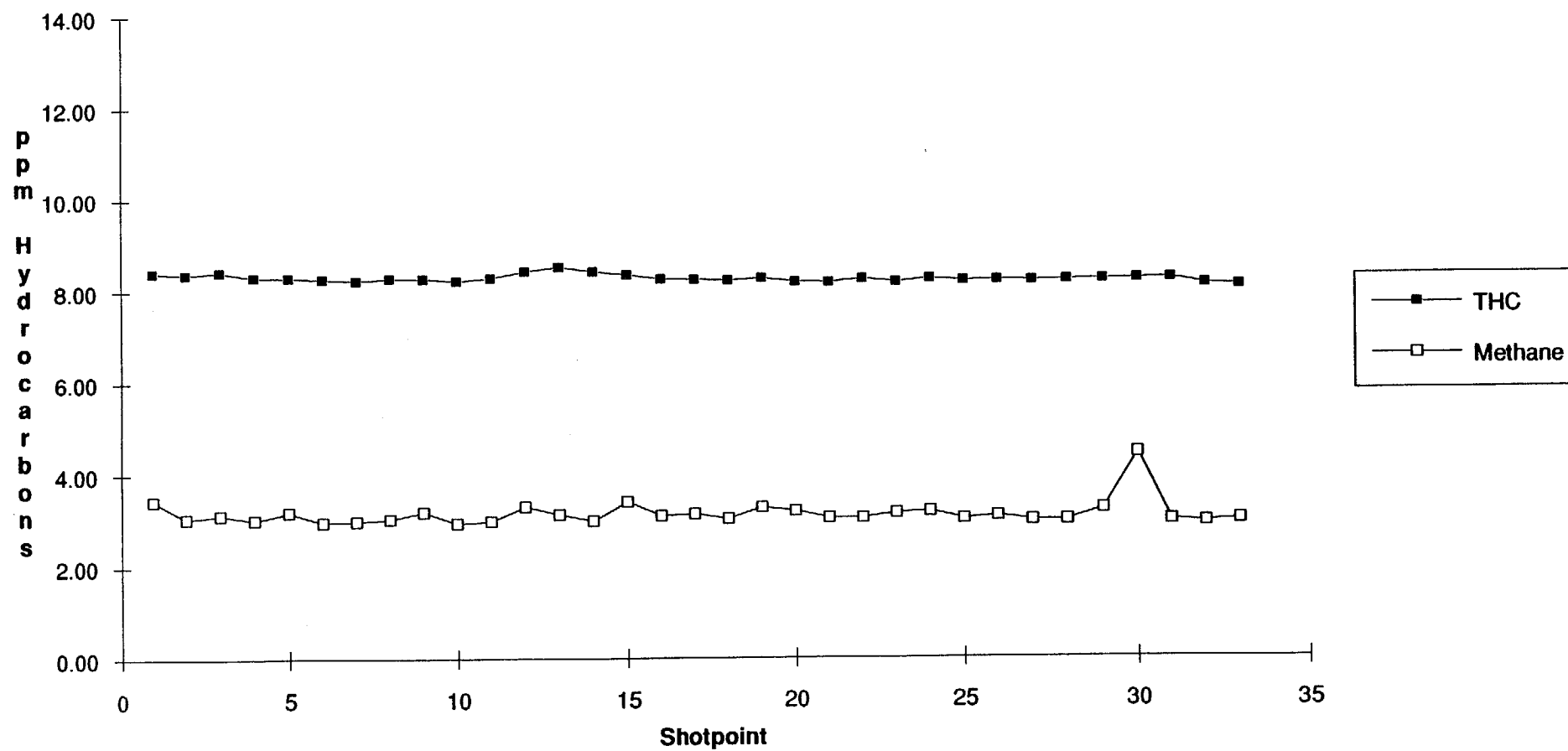
	Shotpoint	Date	Time	Latitude	Longitude
Start	1	4-Oct-91	12:16:40	38	27.760 144 24.921
End	33	4-Oct-91	13:20:56	38	31.808 144 29.432

	THC	Methane	Ethane	Ethylene	Propane	Propylene	I-Butane	n-Butane	I-Pentane	n-Pentane	I-Hexane	n-Hexane	%Wetness
Mean	8.233	3.118	0.008	0.029	0.004	0.000	0.000	0.000	0.005	0.035	0.046	0.000	0.382
Std. Dev.	0.099	0.266	0.002	0.005	0.005	0.000	0.000	0.000	0.009	0.015	0.023	0.000	0.183
Minimum	8.044	2.923	0.004	0.022	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.113
Maximum	8.491	4.418	0.015	0.043	0.015	0.000	0.000	0.000	0.029	0.052	0.088	0.000	0.966

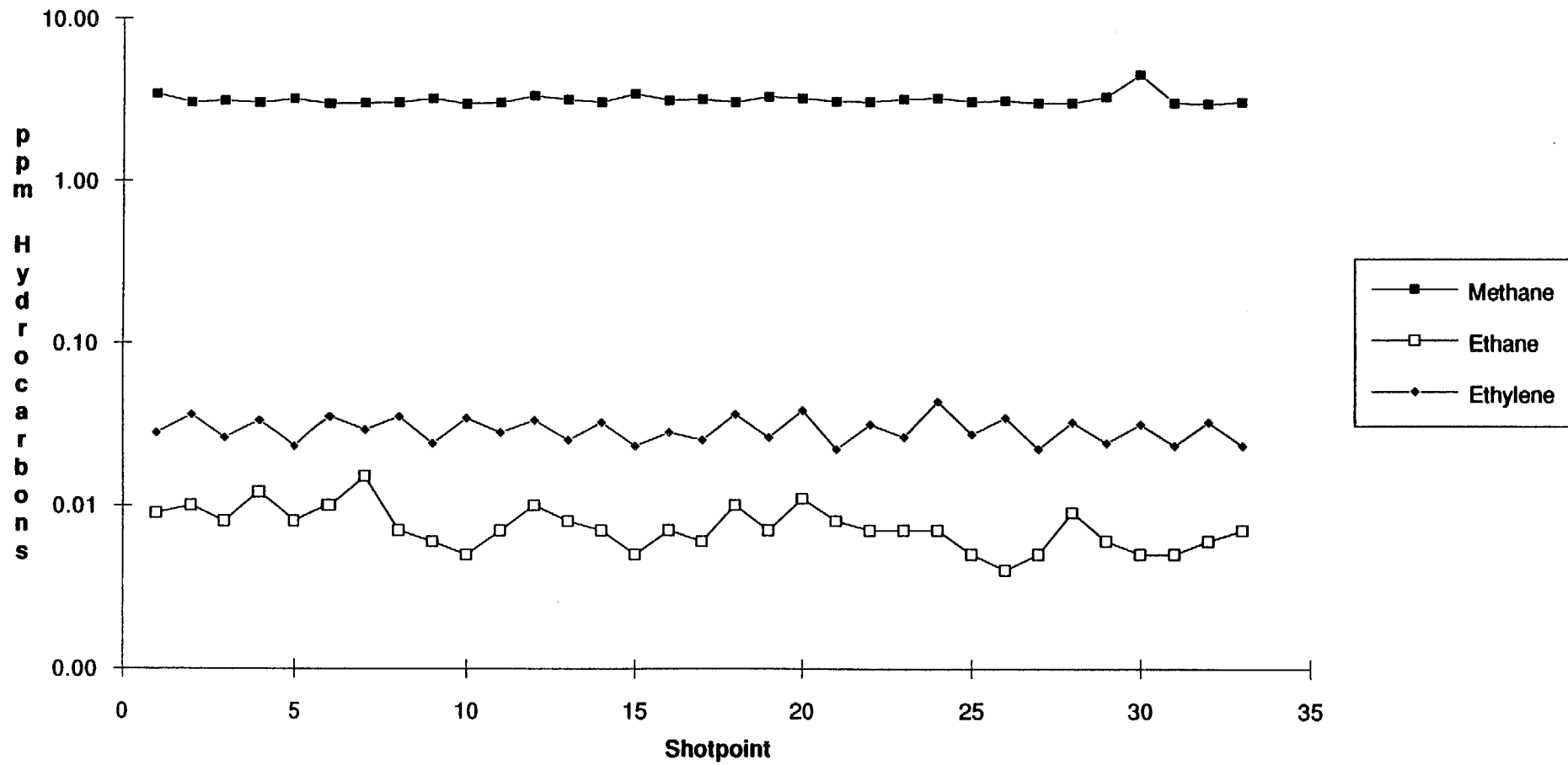
	Cond.	Temp.	Altitude	F. Depth	W.Depth
Mean	45.841	13.634	10.312	61.412	73.870
Std. Dev.	0.021	0.513	0.848	0.575	0.883
Minimum	45.790	13.160	8.100	60.400	72.300
Maximum	45.890	14.280	11.500	62.800	76.000

Notes
No hydrocarbon anomalies

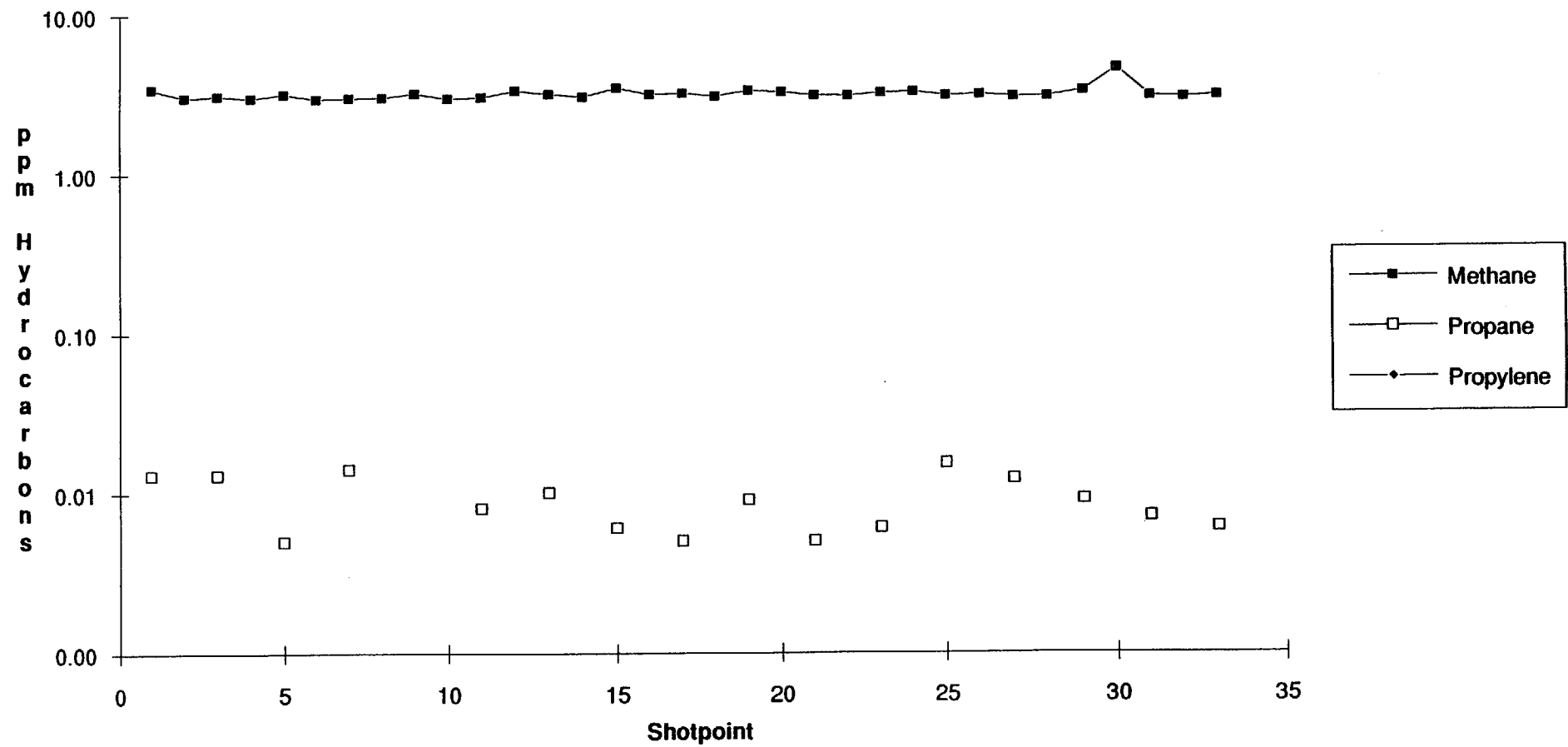
Line 104040 THC, Methane



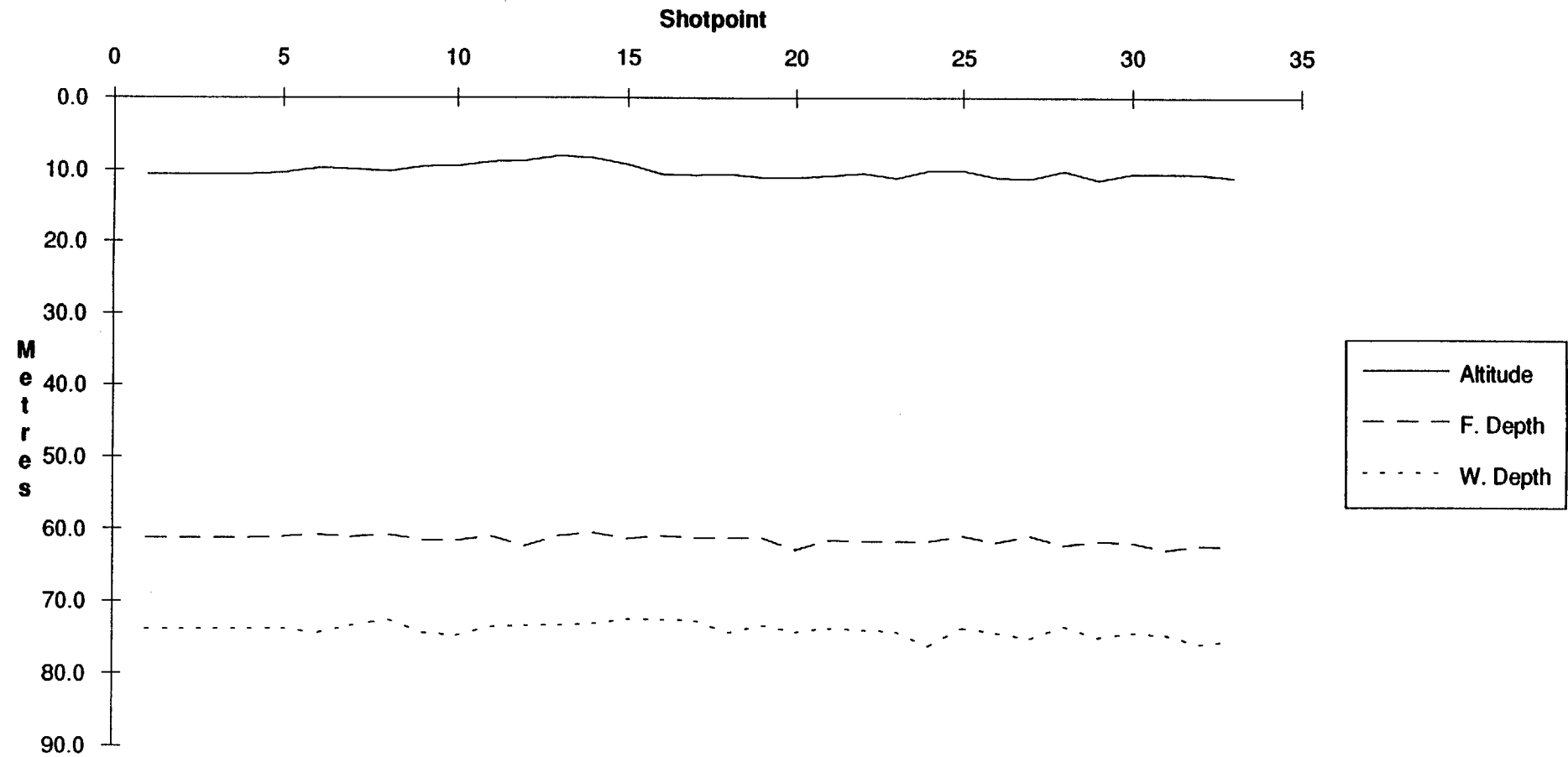
Line 104040 Methane, Ethane, Ethylene



Line 104040 Methane, Propane, Propylene



Line 104040 Depths, Altitude



Line Summary

Line Number 104041
No. of Shotpoints 72

	Shotpoint	Date	Time	Latitude	Longitude	
Start	1	4-Oct-91	13:20:56	38	144	29.680
End	73	4-Oct-91	15:47:19	38	144	29.615

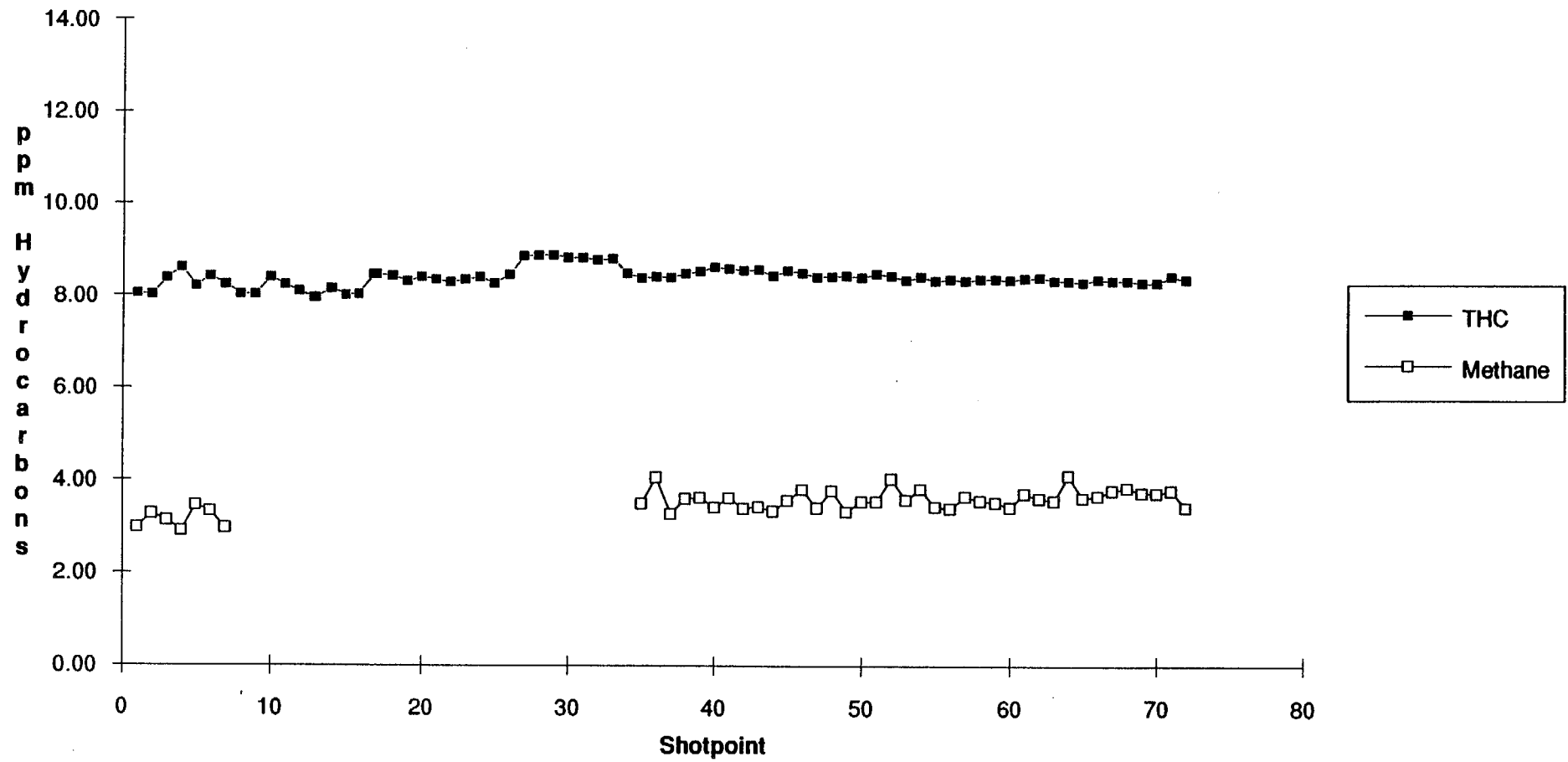
	THC	Methane	Ethane	Ethylene	Propane	Propylene	I-Butane	n-Butane	I-Pentane	n-Pentane	I-Hexane	n-Hexane	%Wetness
Mean	8.380	3.527	0.008	0.032	0.004	0.000	0.000	0.002	0.007	0.033	0.033	0.000	0.312
Std. Dev.	0.202	0.261	0.002	0.006	0.005	0.000	0.000	0.013	0.009	0.016	0.022	0.000	0.146
Minimum	7.947	2.903	0.005	0.023	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.131
Maximum	8.864	4.083	0.013	0.054	0.020	0.000	0.000	0.113	0.029	0.055	0.081	0.000	0.703

	Cond.	Temp.	Altitude	F. Depth	W.Depth
Mean	46.045	13.169	11.036	64.190	77.871
Std. Dev.	0.105	0.181	0.793	0.965	1.302
Minimum	45.840	12.860	8.900	61.700	74.900
Maximum	46.180	13.390	12.300	66.300	80.700

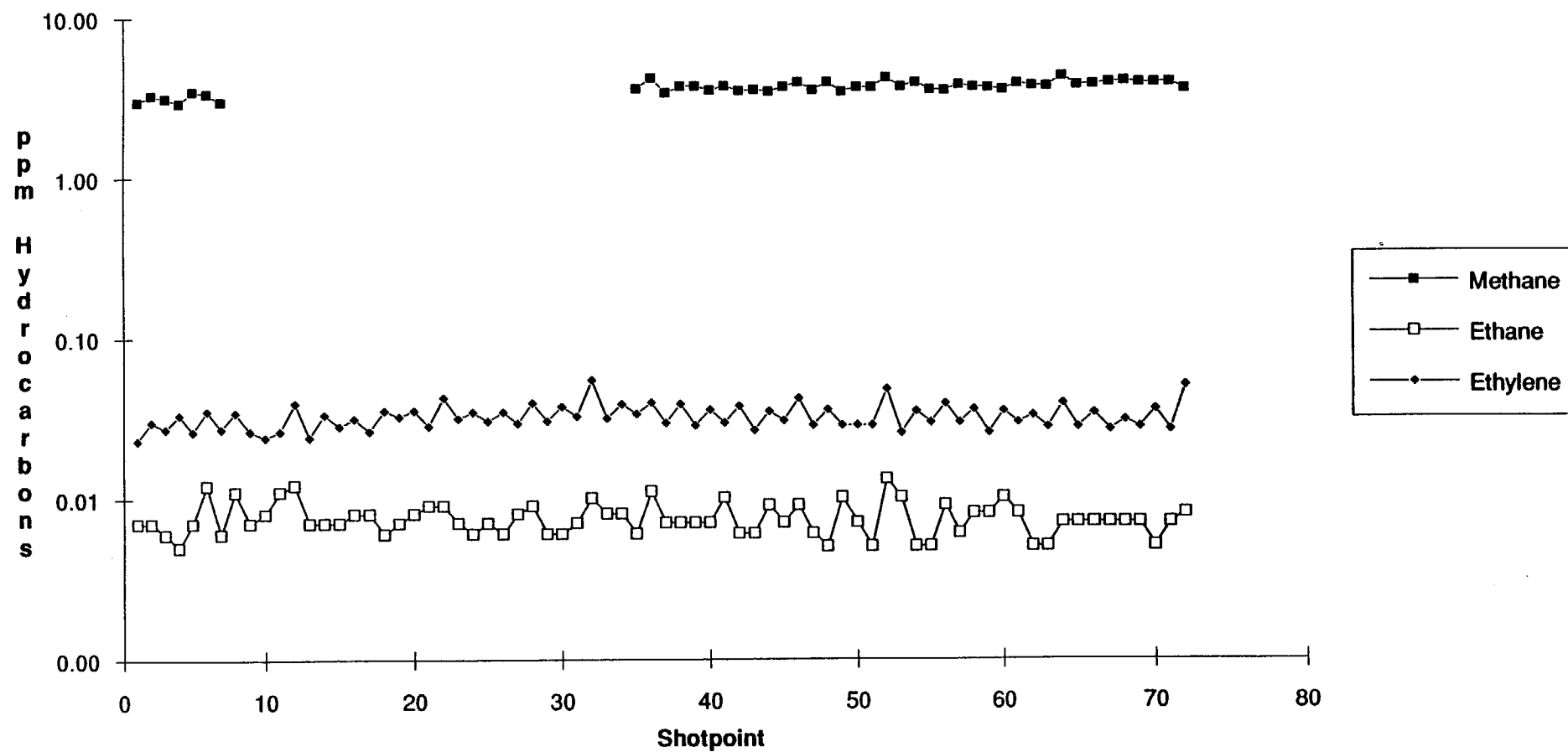
Notes

Methane was not analysed for SP 7-35

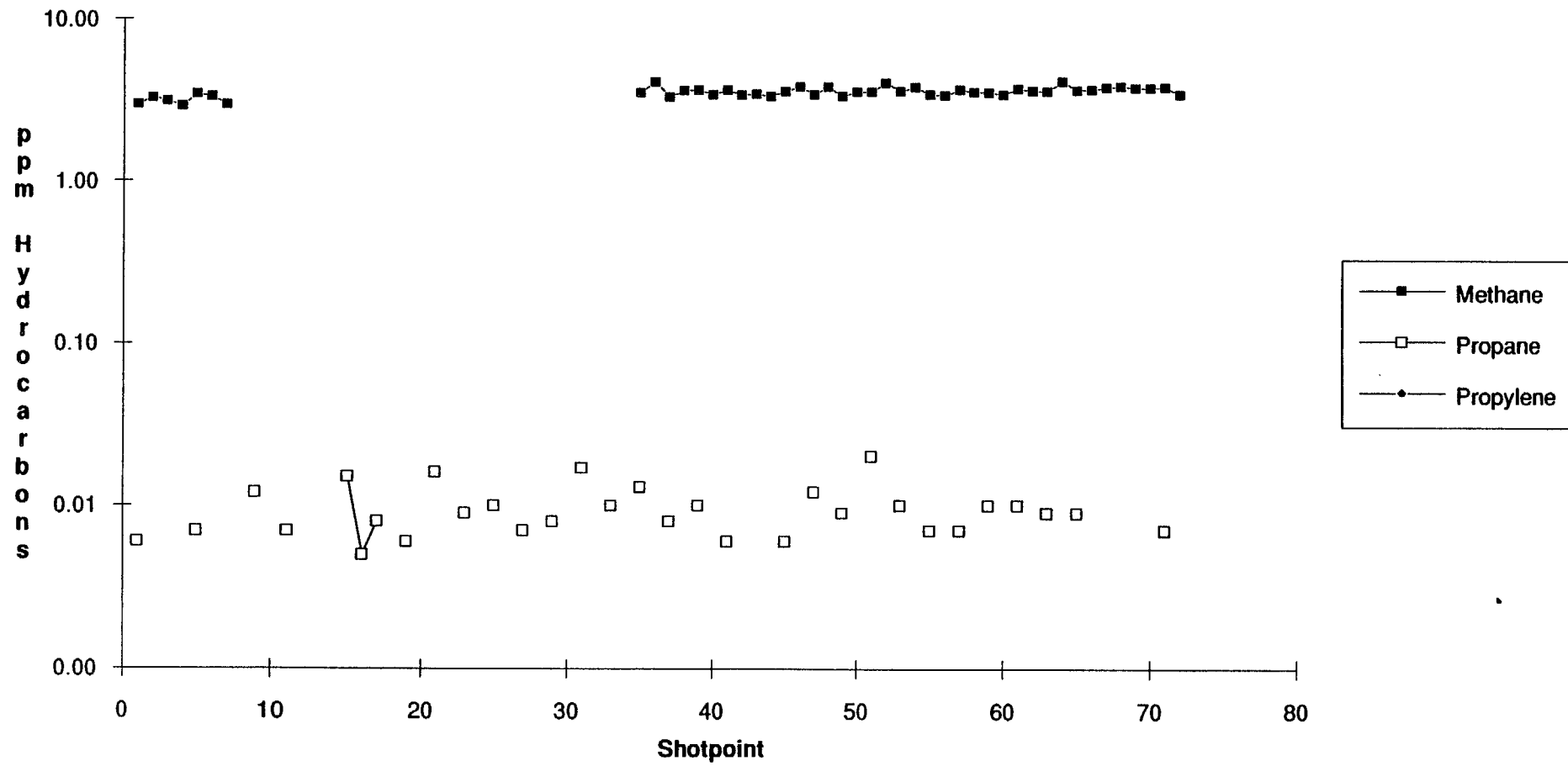
Line 104041 THC, Methane



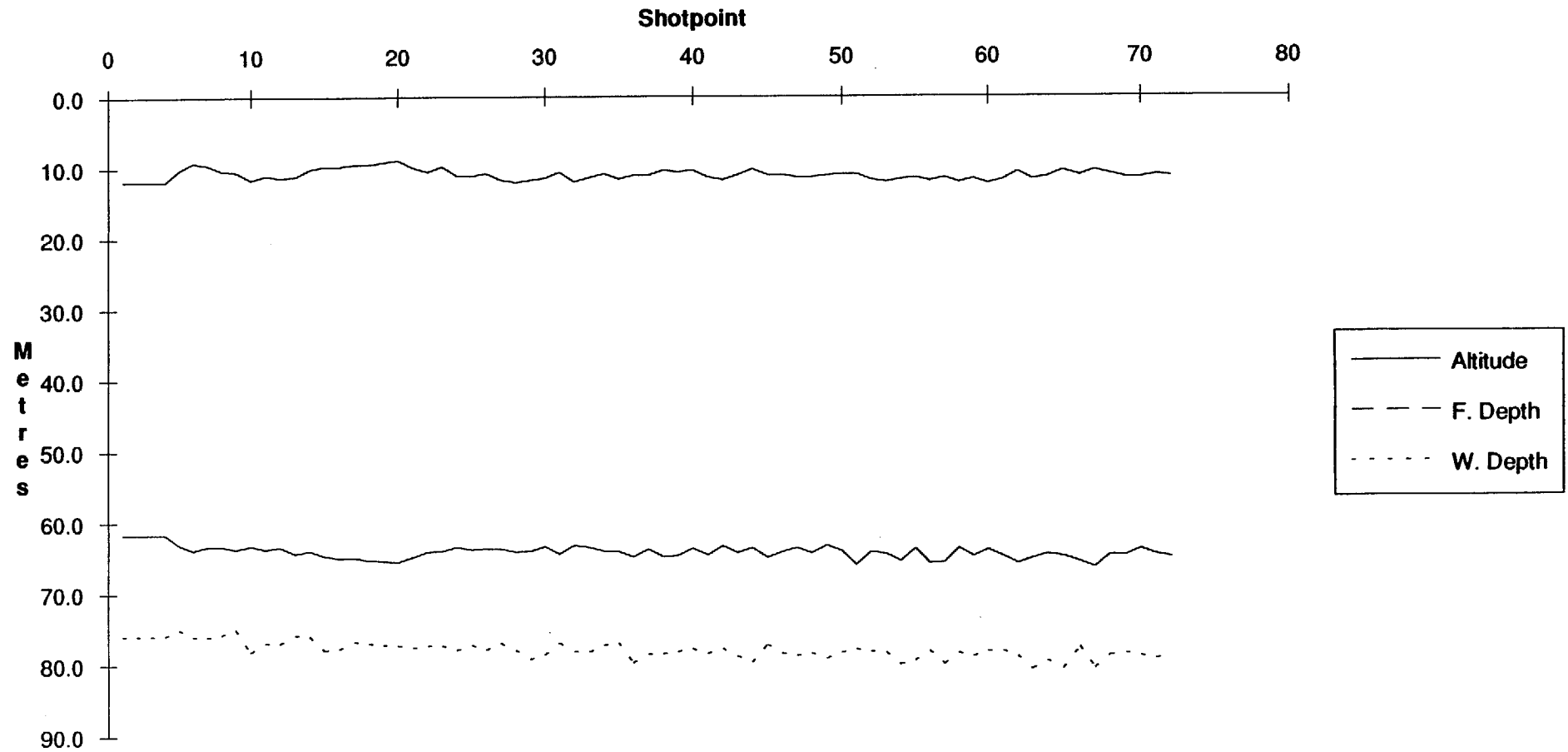
Line 104041 Methane, Ethane, Ethylene



Line 104041 Methane, Propane, Propylene



Line 104041 Depths, Altitude



Line Summary

Line Number 104042
No. of Shotpoints 30

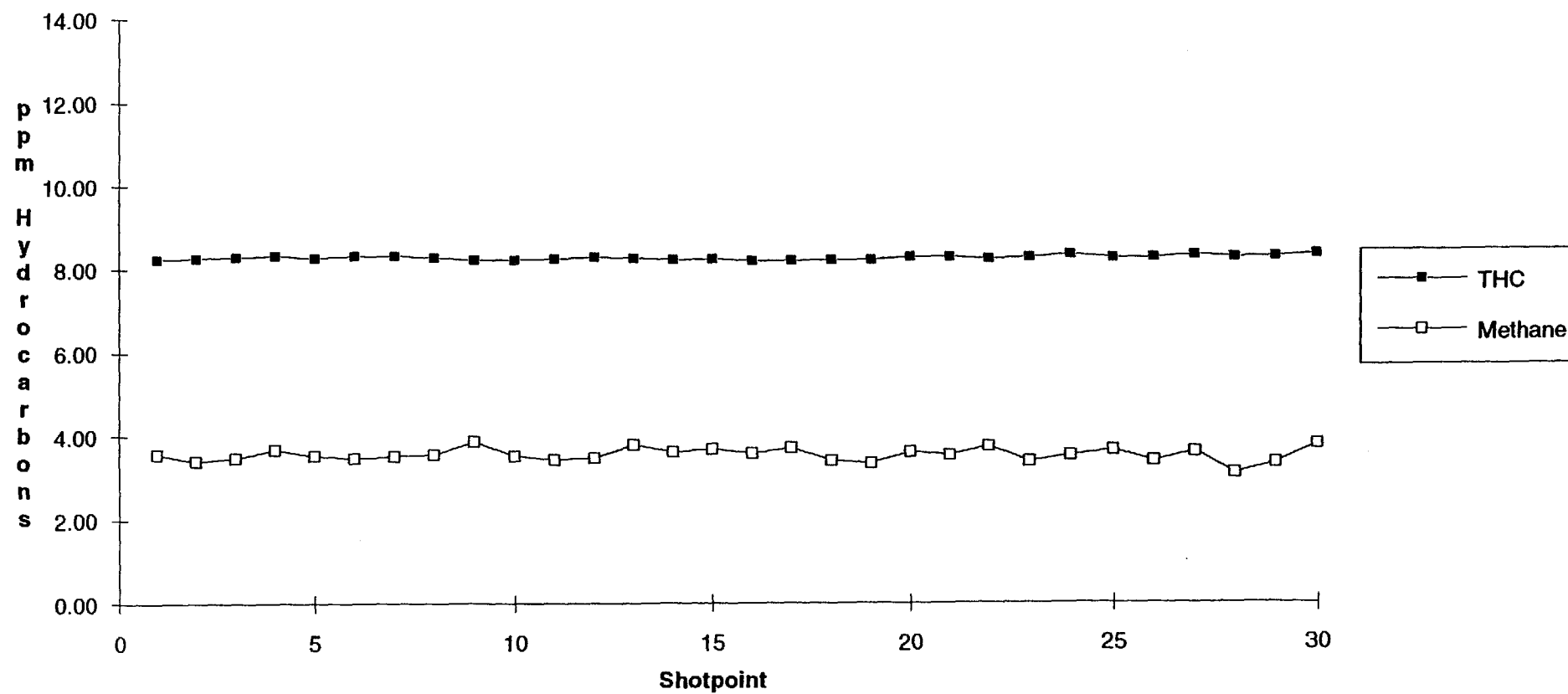
	Shotpoint	Date	Time	Latitude	Longitude
Start	1	4-Oct-91	15:49:18	38	44.040 144 29.577
End	31	4-Oct-91	16:49:38	38	45.032 144 23.683

	THC	Methane	Ethane	Ethylene	Propane	Propylene	I-Butane	n-Butane	I-Pentane	n-Pentane	I-Hexane	n-Hexane	%Wetness
Mean	8.237	3.530	0.007	0.031	0.003	0.000	0.000	0.000	0.005	0.033	0.030	0.000	0.283
Std. Dev.	0.045	0.160	0.002	0.004	0.004	0.000	0.000	0.000	0.007	0.015	0.019	0.000	0.122
Minimum	8.164	3.078	0.000	0.025	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.111
Maximum	8.319	3.856	0.011	0.040	0.012	0.000	0.000	0.000	0.023	0.053	0.076	0.000	0.568

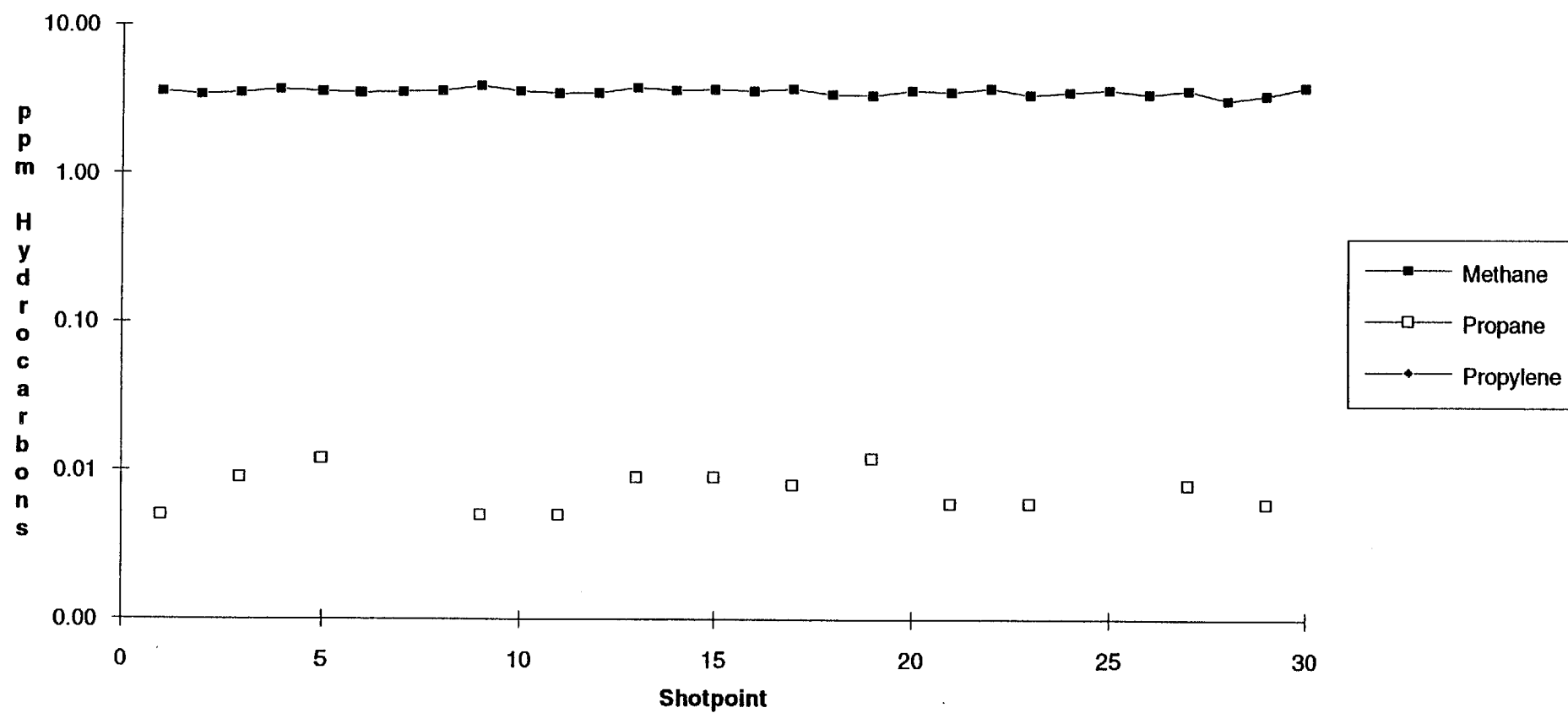
	Cond.	Temp.	Altitude	F. Depth	W.Depth
Mean	46.187	12.947	11.690	65.197	79.717
Std. Dev.	0.012	0.015	0.832	1.092	0.738
Minimum	46.160	12.930	10.200	62.500	78.500
Maximum	46.200	12.960	13.900	67.500	81.600

Notes
No hydrocarbon anomalies

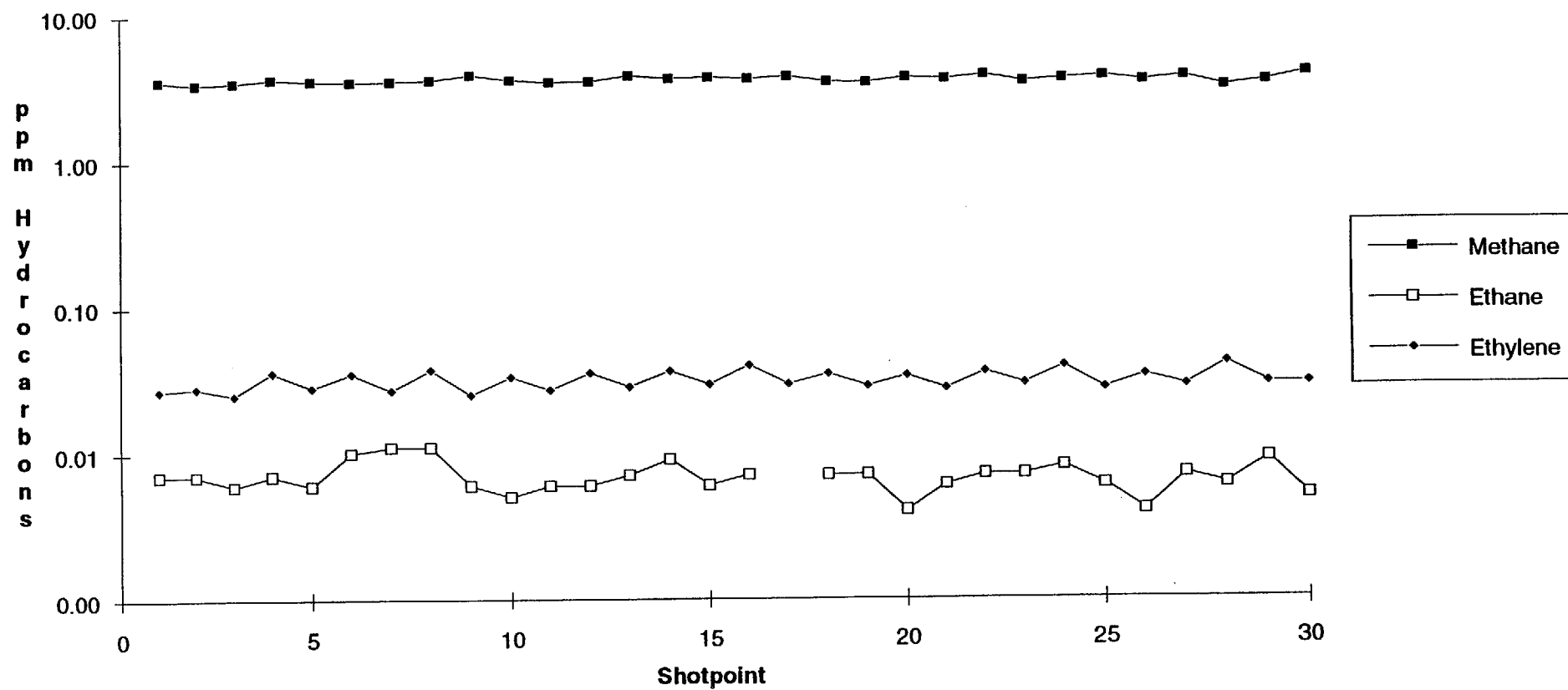
Line 104042 THC, Methane



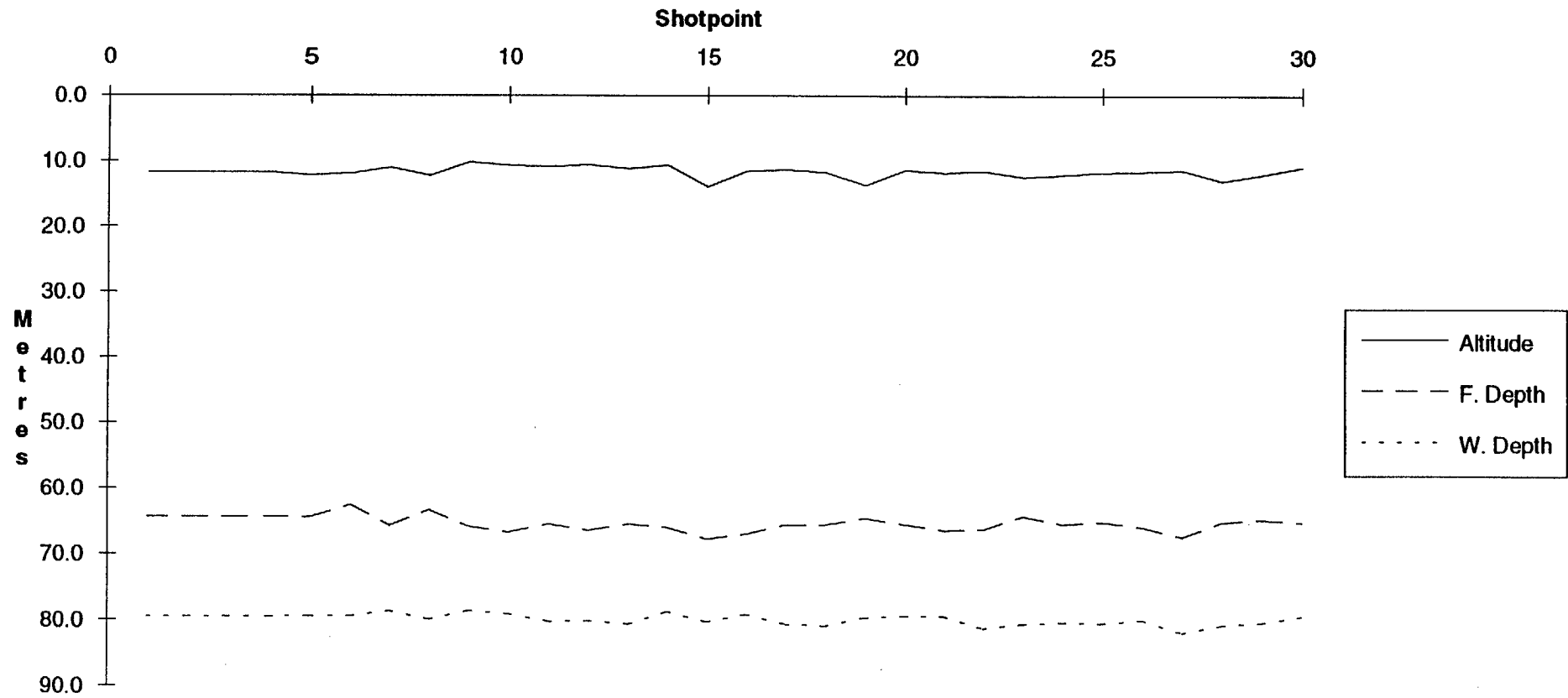
Line 104042 Methane, Propane, Propylene



Line 104042 Methane, Ethane, Ethylene



Line 104042 Depths, Altitude



Line Summary

Line Number 104043
No. of Shotpoints 57

	Shotpoint	Date	Time	Latitude	Longitude
Start	1	4-Oct-91	18:45:26	38 39.765	144 08.483
End	57	4-Oct-91	20:37:43	38 39.961	144 08.082

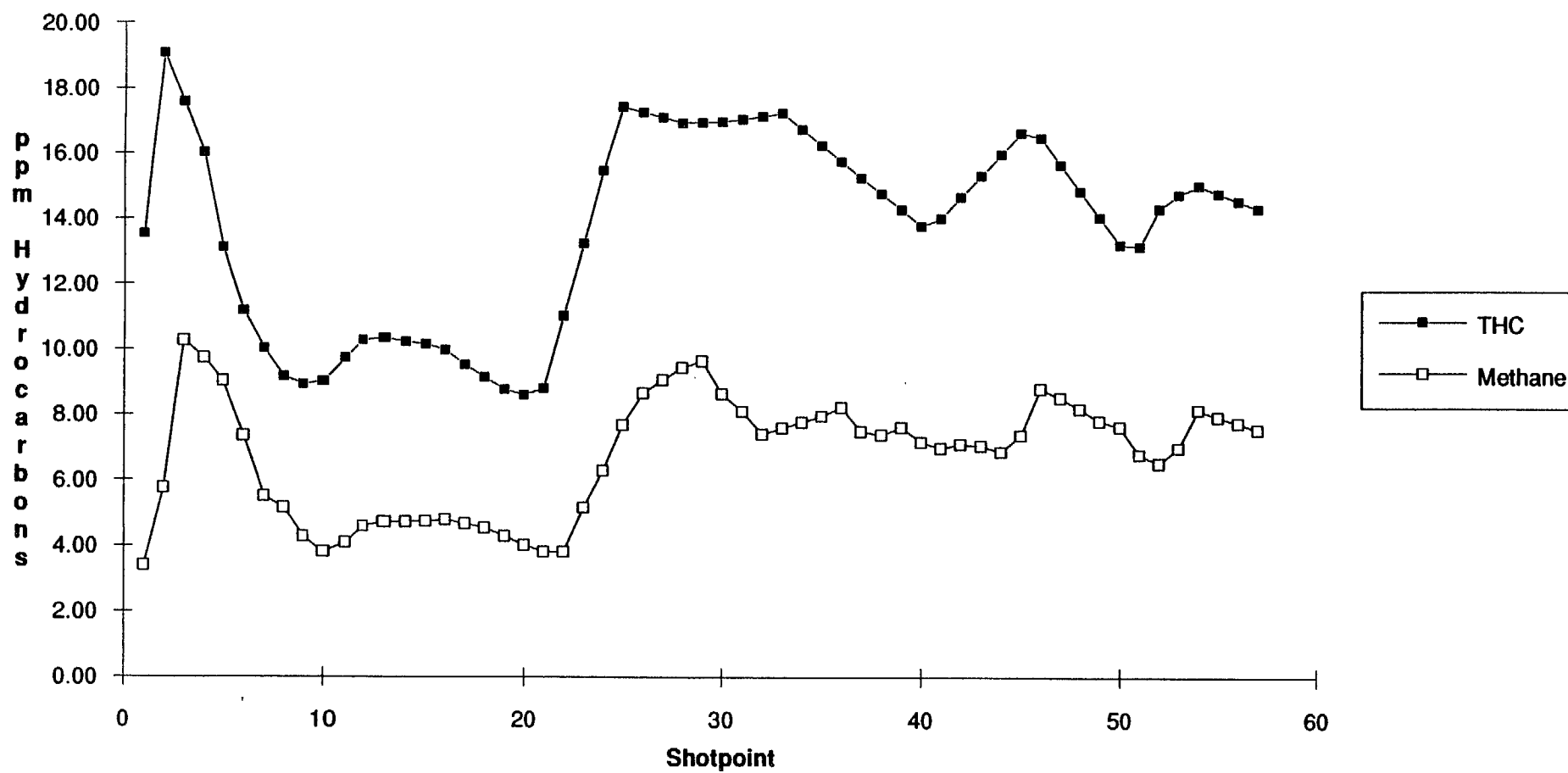
	THC	Methane	Ethane	Ethylene	Propane	Propylene	I-Butane	n-Butane	I-Pentane	n-Pentane	I-Hexane	n-Hexane	% Wetness
Mean	13.757	6.759	0.016	0.033	0.005	0.000	0.000	0.000	0.001	0.021	0.020	0.021	0.320
Std. Dev.	2.983	1.805	0.005	0.007	0.006	0.000	0.000	0.000	0.004	0.016	0.018	0.045	0.096
Minimum	8.579	3.386	0.007	0.014	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.146
Maximum	19.067	10.259	0.029	0.054	0.025	0.000	0.000	0.000	0.019	0.049	0.064	0.225	0.558

	Cond.	Temp.	Altitude	F. Depth	W. Depth
Mean	46.035	12.796	10.130	63.651	76.128
Std. Dev.	0.232	0.100	2.422	2.129	0.788
Minimum	45.910	12.690	5.800	60.000	74.500
Maximum	47.610	13.290	14.000	67.700	79.300

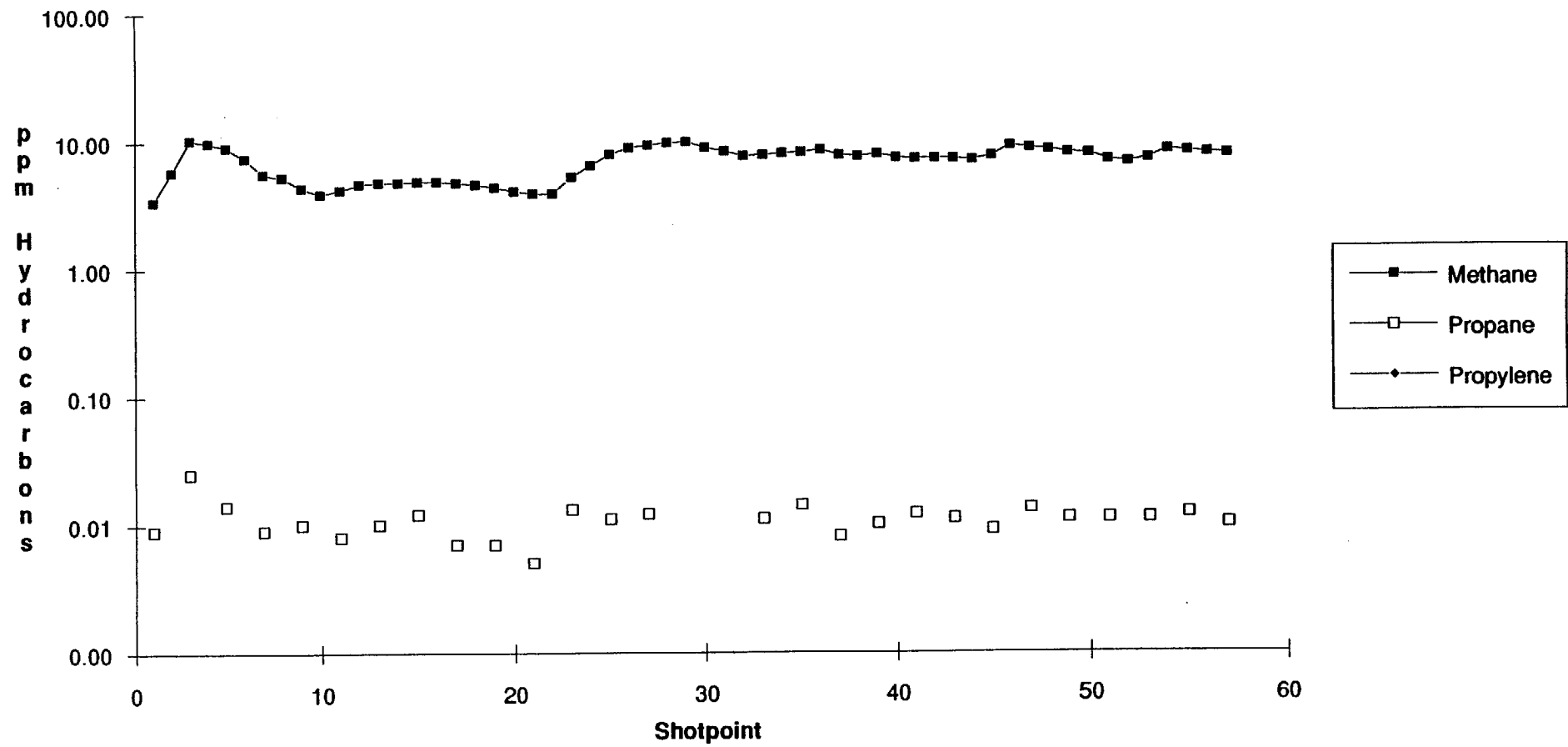
Notes

This survey line was conducted over a pockmark
THC, methane and ethane anomalies associated with pockmark

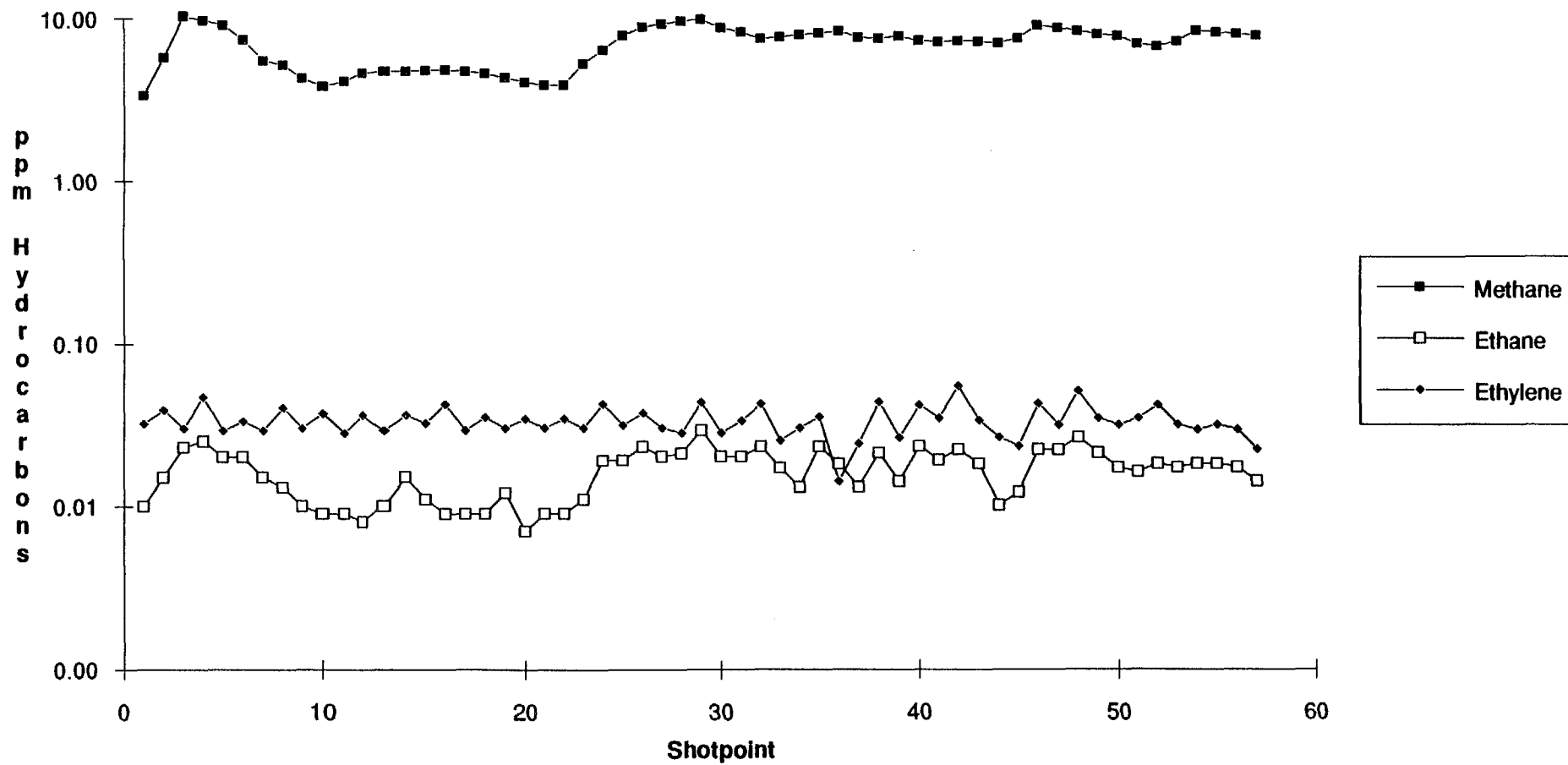
Line 104043 THC, Methane



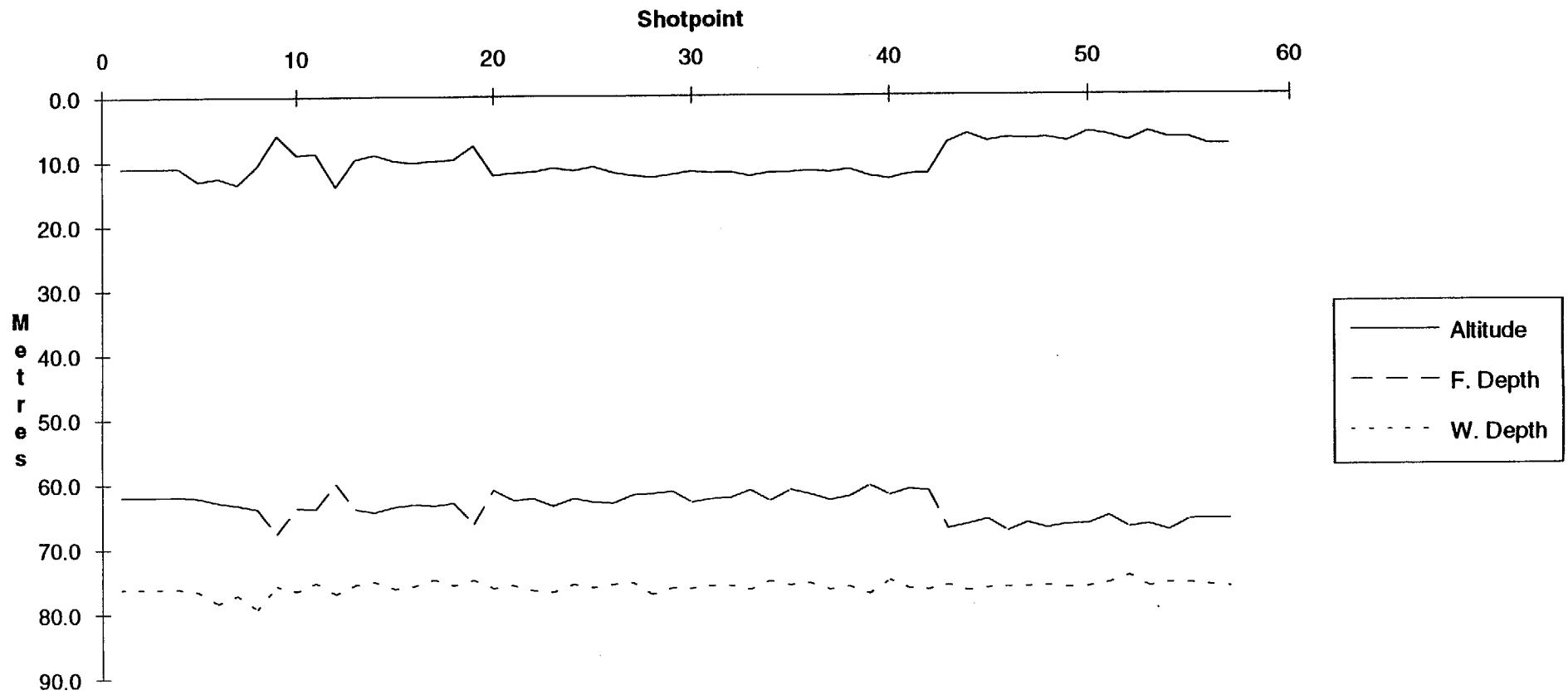
Line 104043 Methane, Propane, Propylene



Line 104043 Methane, Ethane, Ethylene



Line 104043 Depths, Altitude



Line Summary

Line Number 104SEEP2
No. of Shotpoints 75

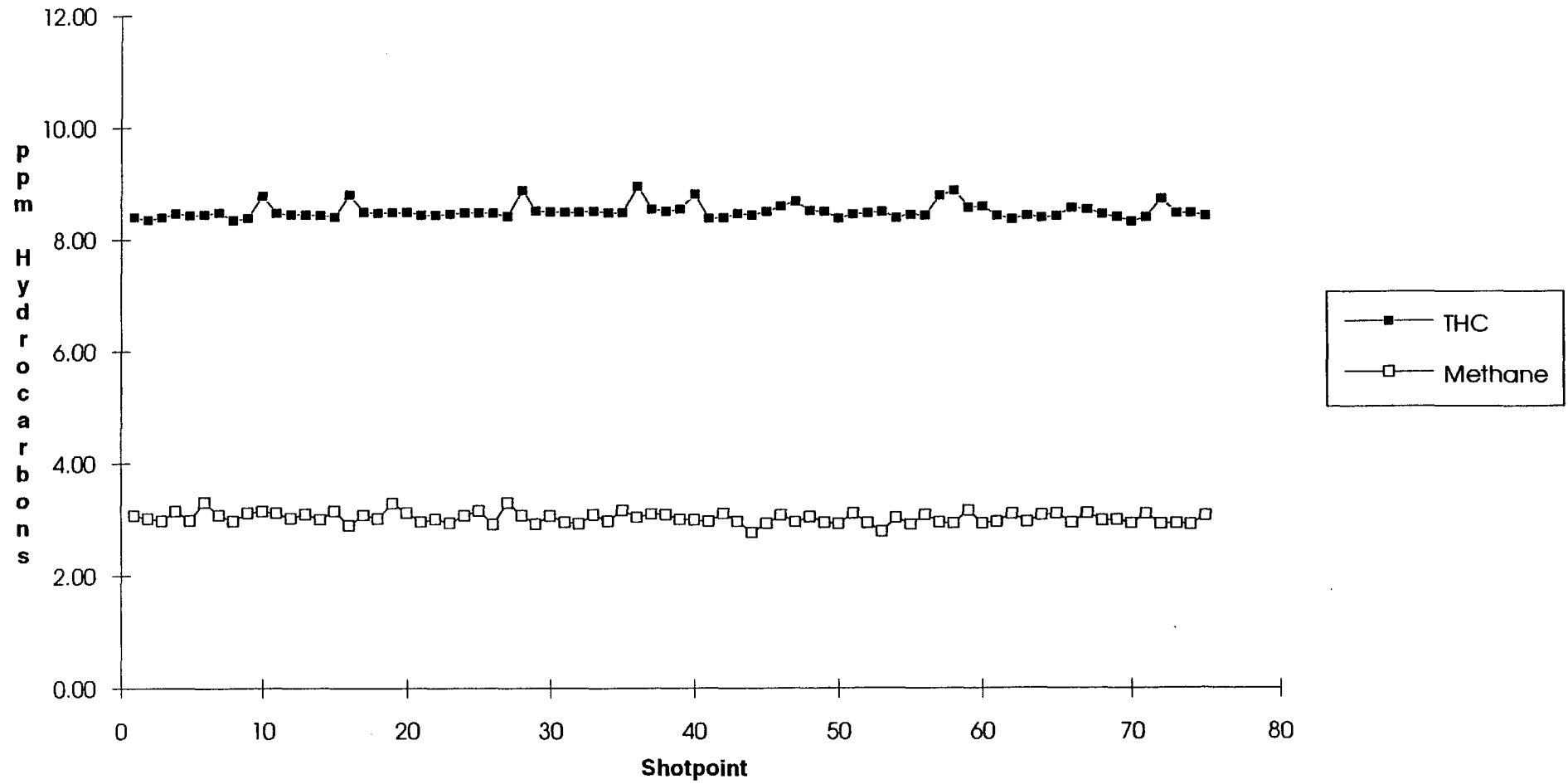
	Shotpoint	Date	Time	Latitude	Longitude
Start	1	01-Oct-91	11:31:46	38 35.497	144 13.574
End	75	01-Oct-91	13:59:59	38 35.149	144 16.533

	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	8.468	3.015	0.009	0.037	0.004	0.000	0.000	0.000	0.000	0.040	0.002	0.000	0.404
Std. Dev.	0.130	0.105	0.002	0.003	0.005	0.000	0.000	0.000	0.000	0.008	0.006	0.000	0.173
Minimum	8.272	2.751	0.005	0.032	0.000	0.000	0.000	0.000	0.000	0.024	0.000	0.000	0.204
Maximum	8.922	3.300	0.014	0.047	0.012	0.000	0.000	0.000	0.000	0.053	0.035	0.000	0.823

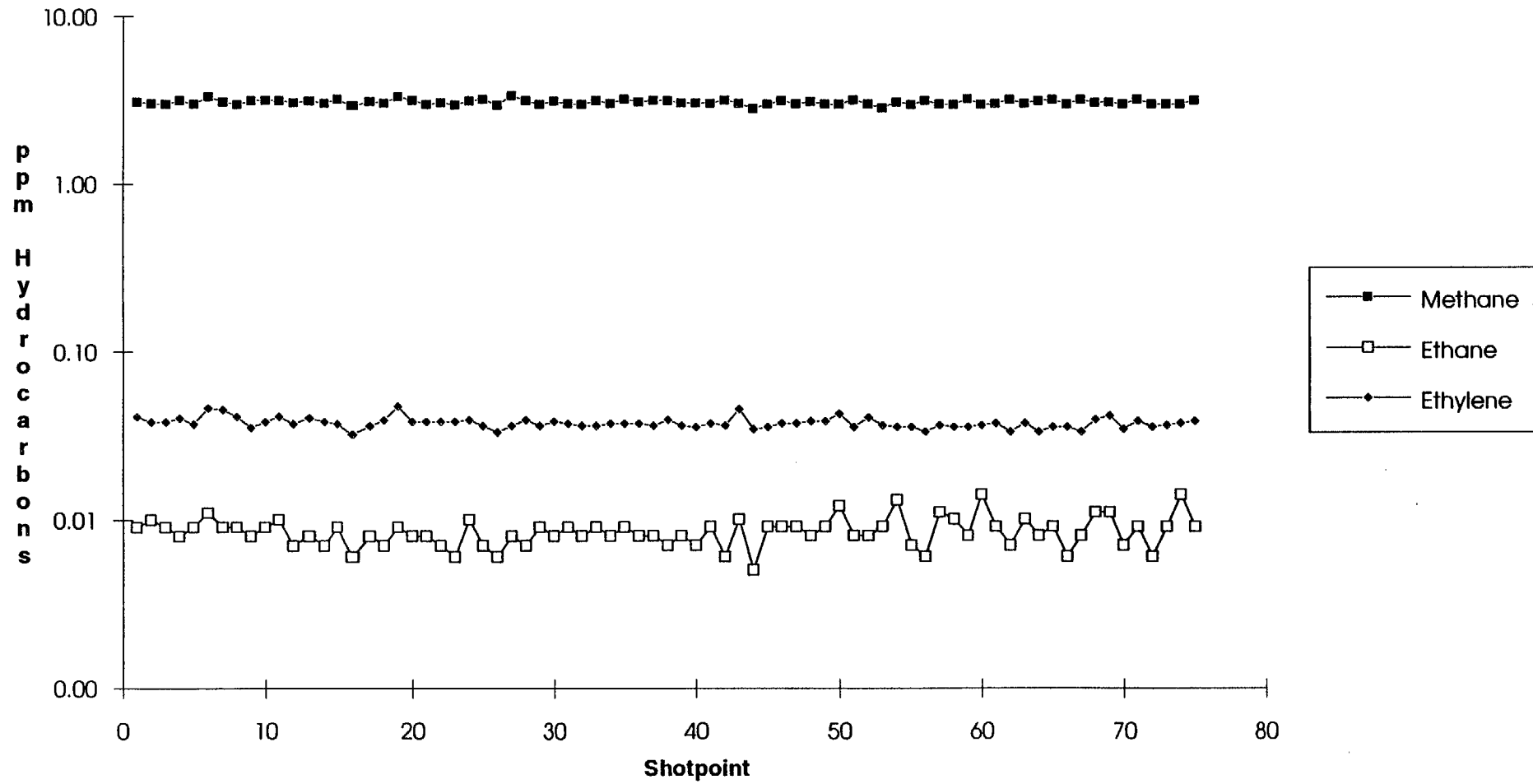
	Cond.	Temp.	Altitude	F. Depth	W.Depth
Mean	45.768	15.277	7.613	65.998	73.921
Std. Dev.	0.051	0.044	0.616	0.702	0.478
Minimum	45.680	15.180	6.380	63.320	73.100
Maximum	45.880	15.380	9.970	67.120	75.400

Notes
No hydrocarbon anomalies

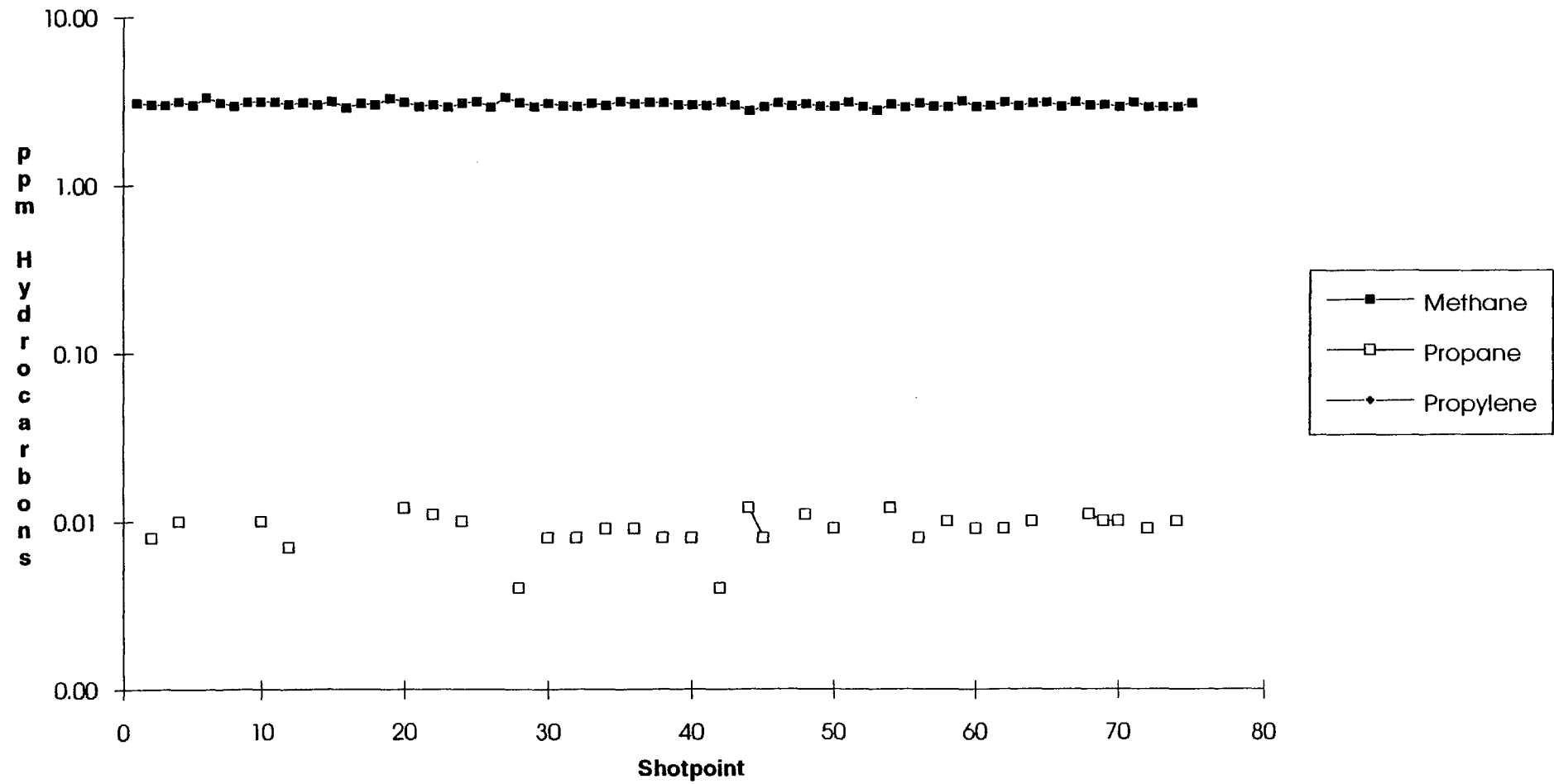
104Seep2 THC, Methane



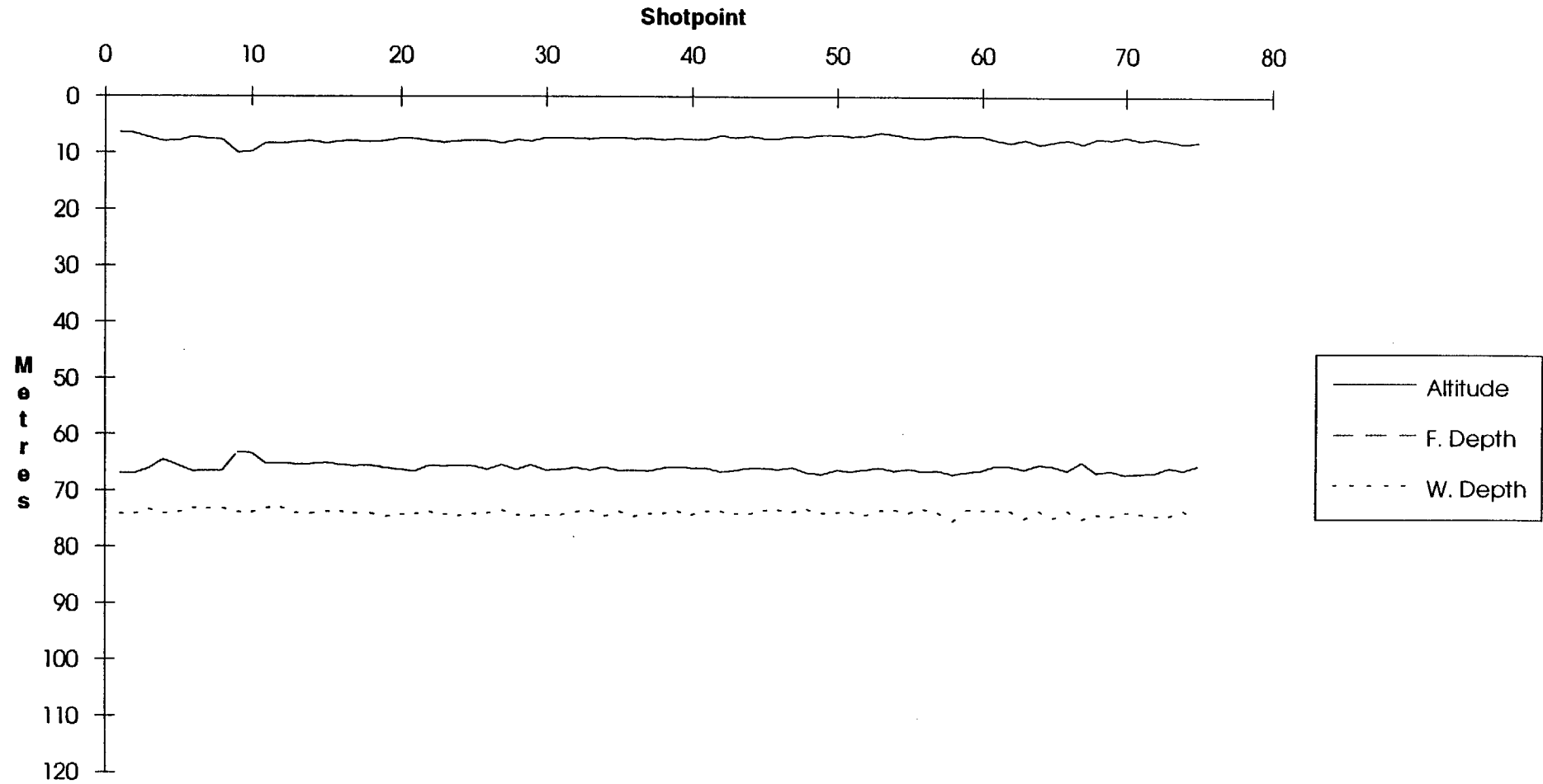
104Seep2 Methane, Ethane, Ethylene



104Seep2 Methane, Propane, Propylene



104Seep2 Depths, Altitude



Line Summary

Line Number 104SEEP3
No. of Shotpoints 210

	Shotpoint	Date	Time	Latitude	Longitude
Start	1	01-Oct-91	20:28:48	38	39.653 144 09.152
End	212	02-Oct-91	03:34:19	38	40.342 144 07.311

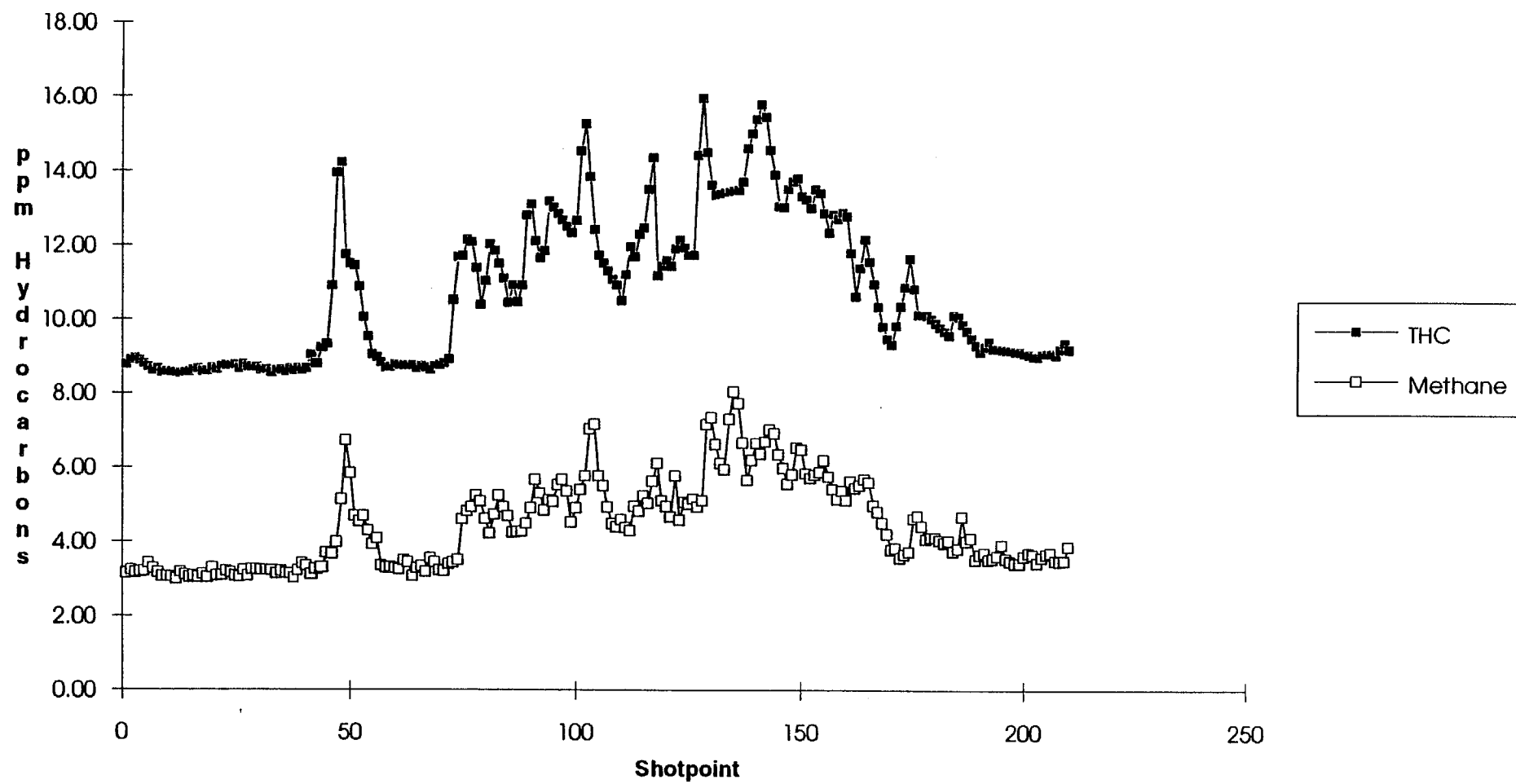
	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	10.769	4.439	0.015	0.045	0.007	0.000	0.000	0.000	0.001	0.036	0.003	0.000	0.472
Std. Dev.	2.001	1.197	0.004	0.005	0.005	0.000	0.000	0.000	0.003	0.016	0.008	0.001	0.116
Minimum	8.535	2.991	0.005	0.032	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.247
Maximum	15.973	8.052	0.026	0.065	0.023	0.000	0.000	0.000	0.025	0.069	0.031	0.008	0.763

	Cond.	Temp.	Altitude	F. Depth	W. Depth
Mean	47.078	15.386	4.953	72.160	78.017
Std. Dev.	0.621	0.940	1.476	1.957	1.299
Minimum	45.730	13.190	2.500	66.000	74.800
Maximum	47.990	16.630	9.400	74.700	80.800

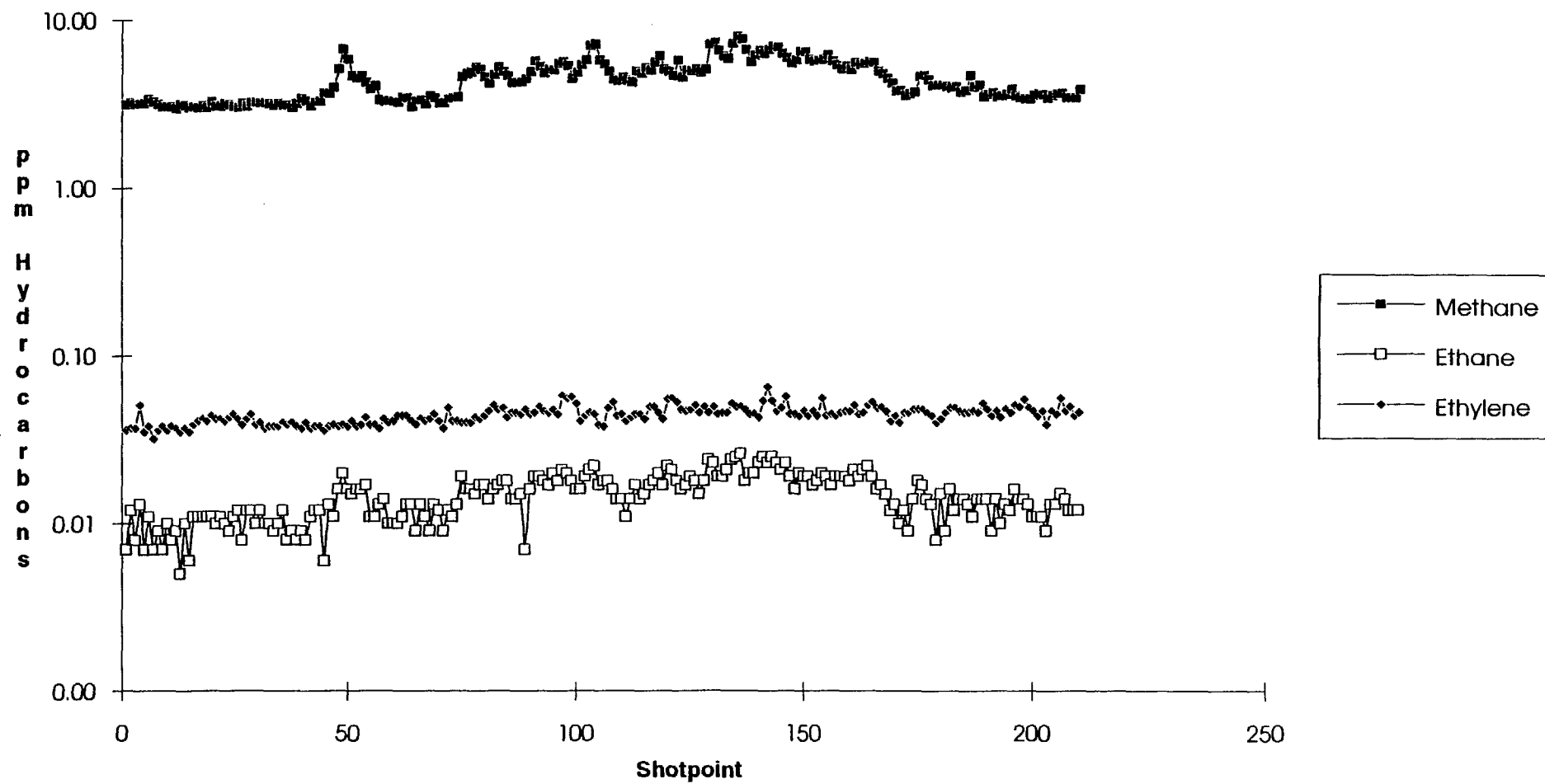
Notes

Weak THC, methane and ethane anomalies
Sampling conducted over pockmark area.

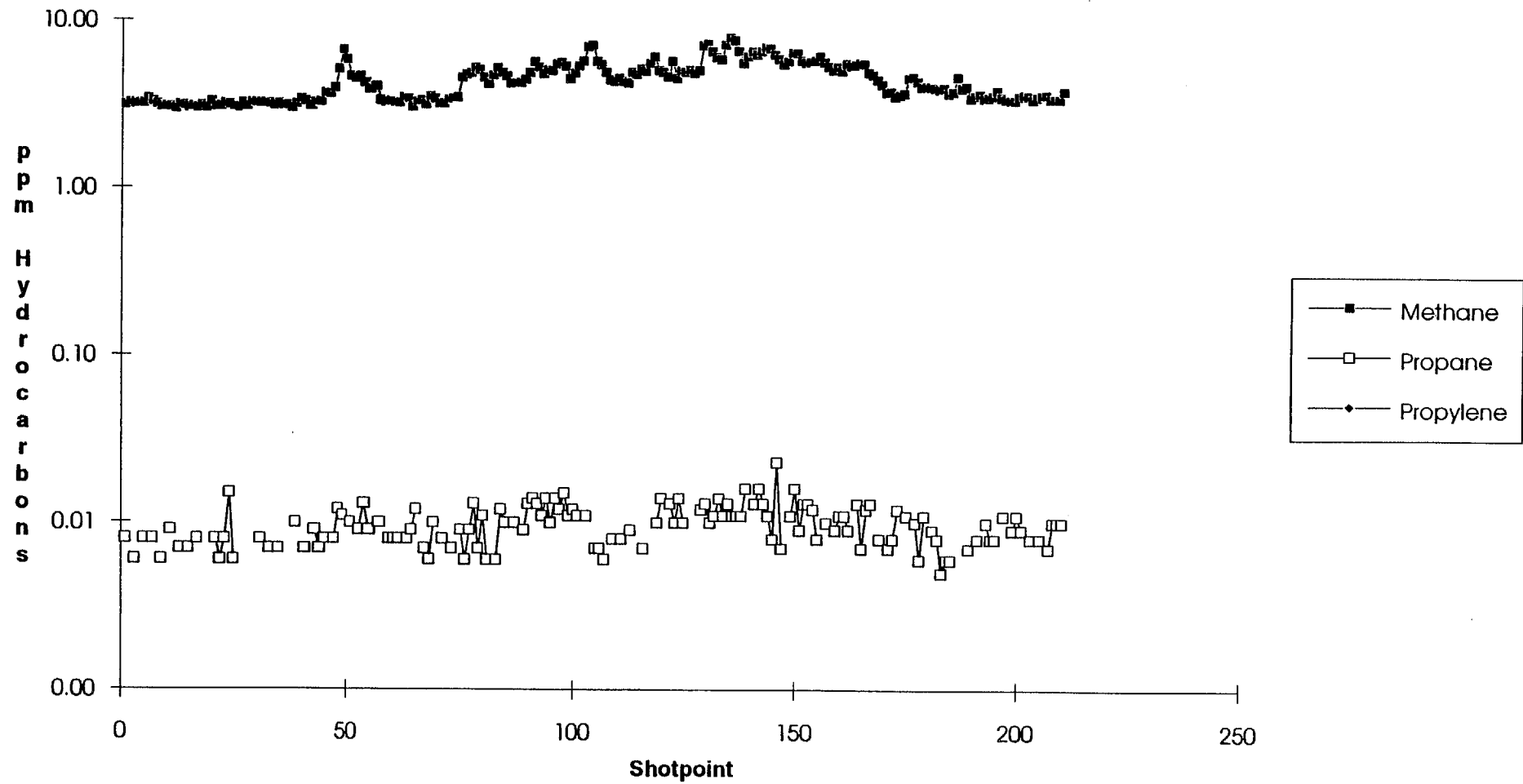
104Seep3 THC, Methane



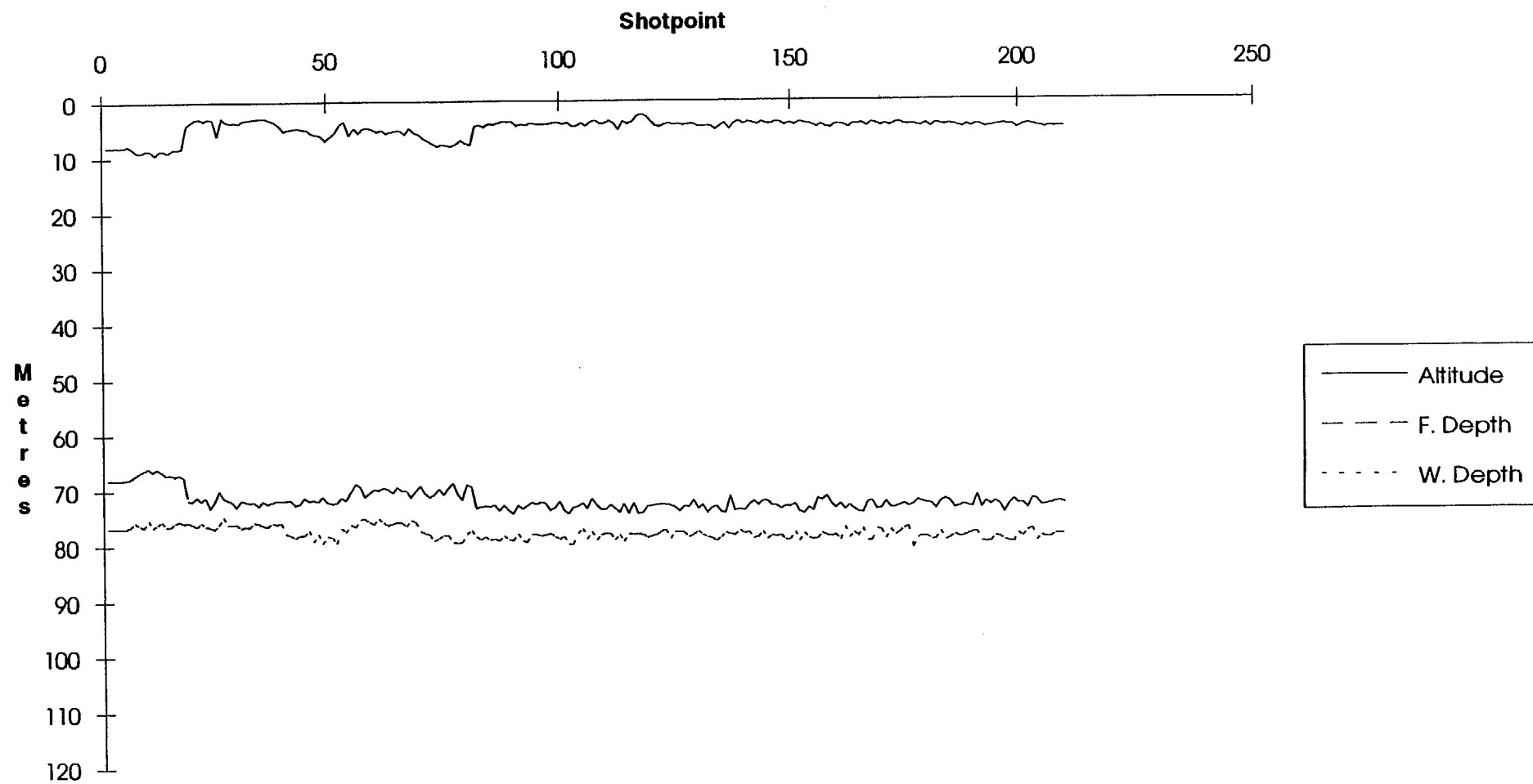
104Seep3 Methane, Ethane, Ethylene



104Seep3 Methane, Propane, Propylene



104Seep3 Depths, Altitude



Gippsland Basin: Individual line plots and line summary sheets

Line Summary

Line Number 104045
No. of Shotpoints 65

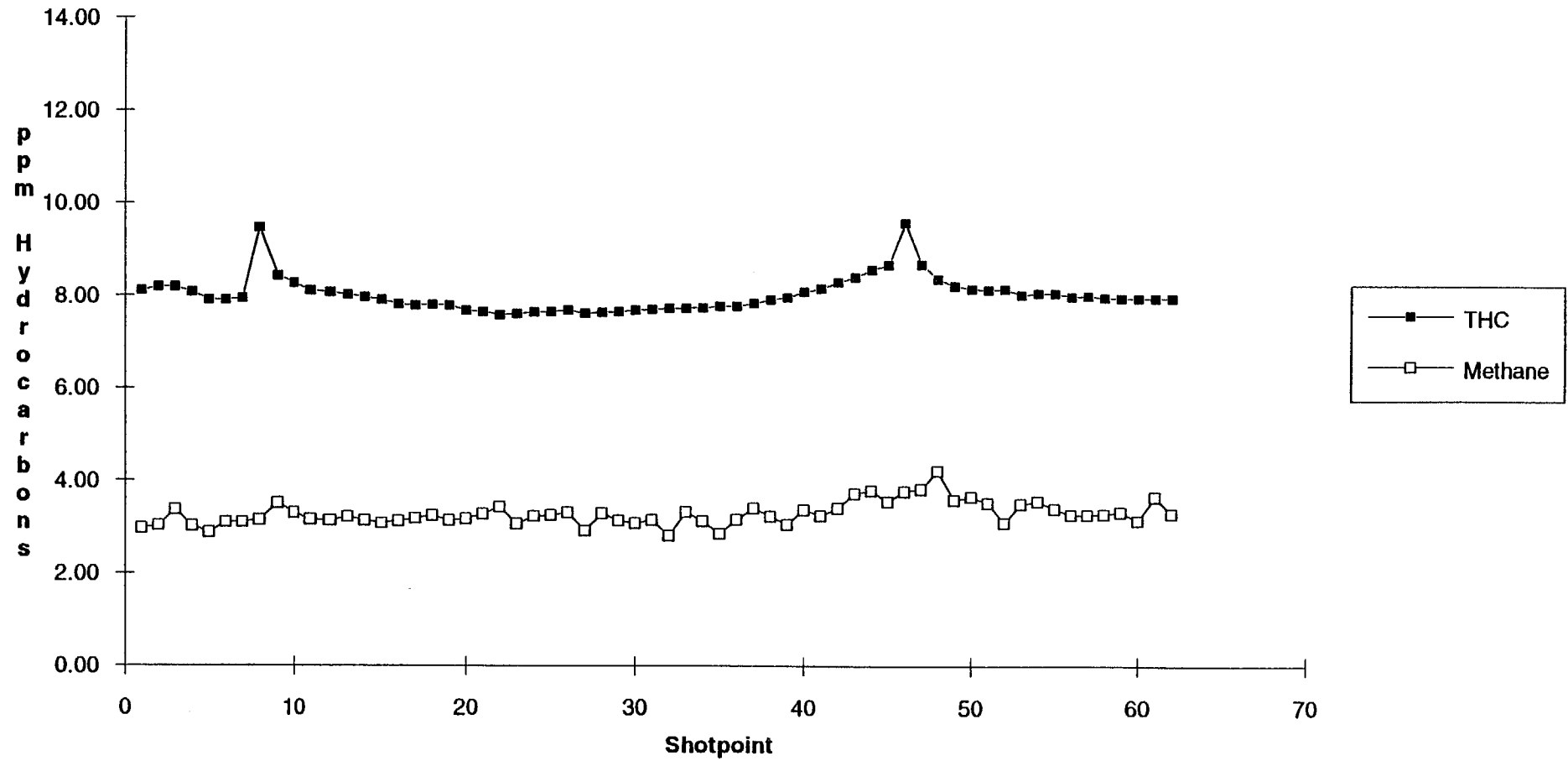
	Shotpoint	Date	Time	Latitude	Longitude
Start	1	05-Oct-91	21:48:18	38	20.497 147 38.738
End	70	06-Oct-91	00:09:56	38	08.257 147 41.004

	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	8.004	3.239	0.007	0.026	0.003	0.000	0.000	0.001	0.021	0.034	0.072	0.000	0.360
Std. Dev.	0.404	0.323	0.003	0.006	0.004	0.000	0.000	0.011	0.005	0.007	0.025	0.000	0.364
Minimum	6.766	2.003	0.004	0.012	0.000	0.000	0.000	0.000	0.010	0.008	0.022	0.000	0.118
Maximum	9.582	4.211	0.019	0.045	0.016	0.000	0.000	0.088	0.036	0.046	0.218	0.000	3.006

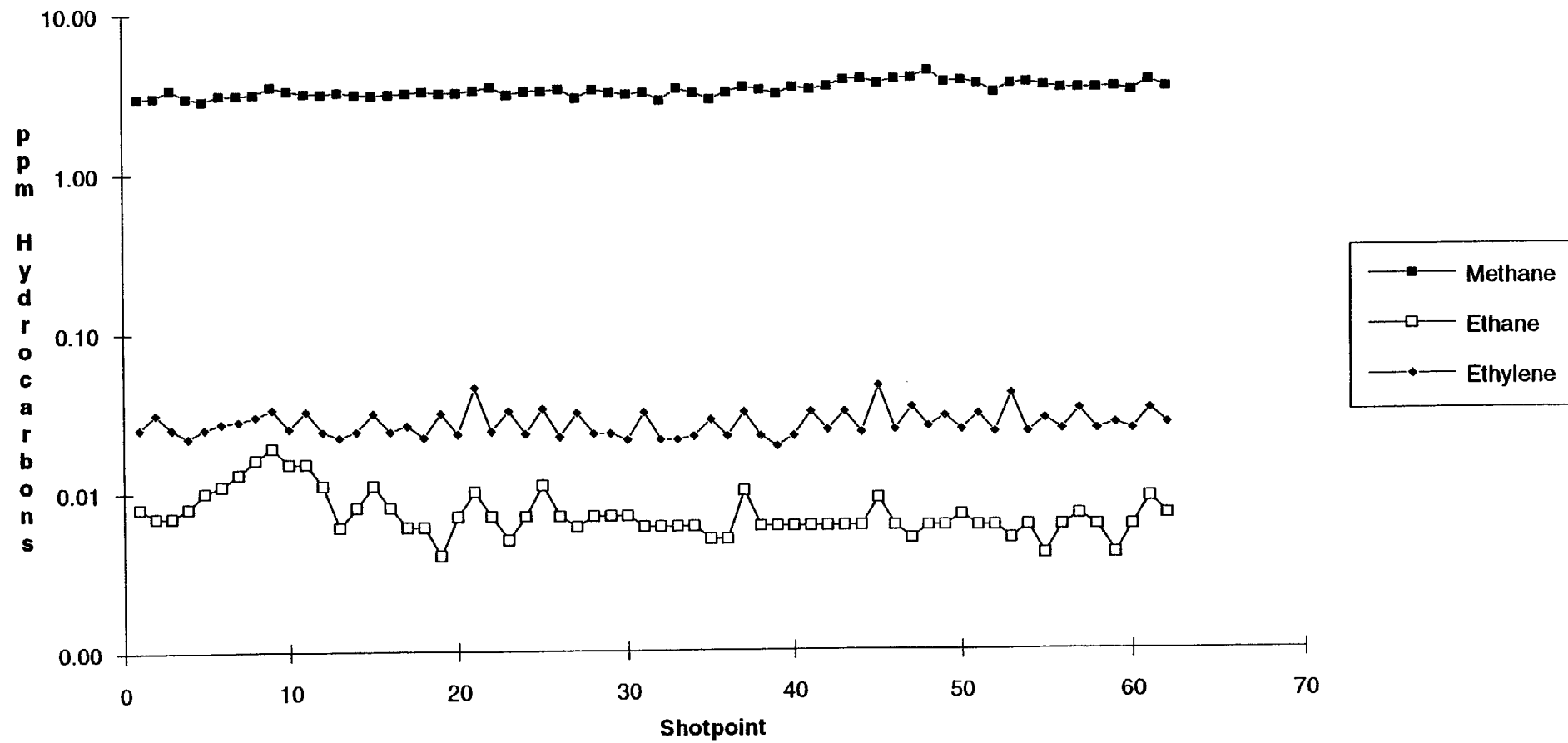
	Cond.	Temp.	Altitude	F. Depth	W.Depth
Mean	47.011	15.057	10.394	33.615	44.426
Std. Dev.	0.356	0.307	0.742	2.016	1.984
Minimum	46.480	14.650	9.140	29.450	40.400
Maximum	47.840	15.800	11.890	38.080	48.300

Notes
THC anomalies at shotpoints 12 and 50
No propylene detected

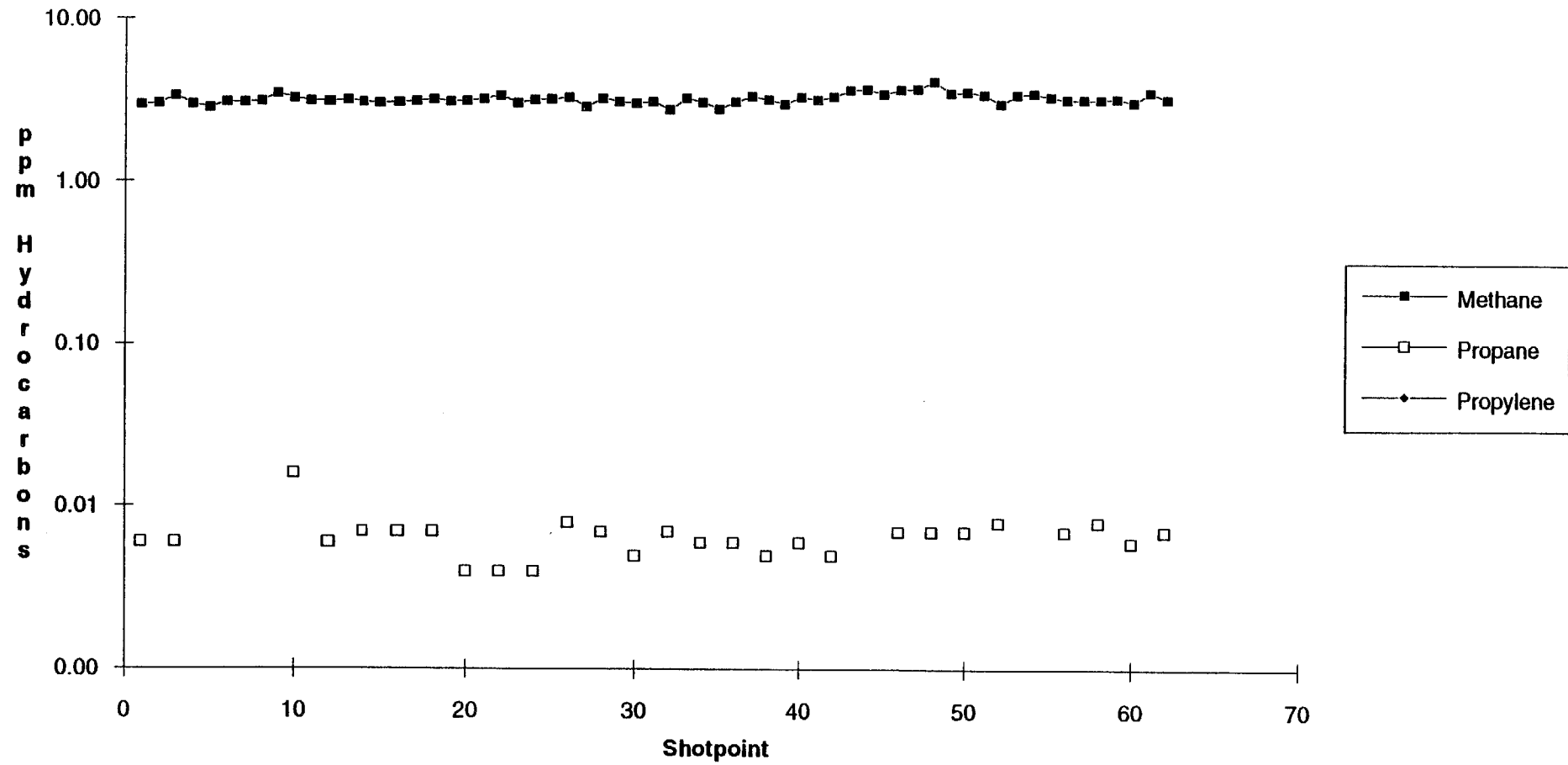
Line 104045 THC, Methane



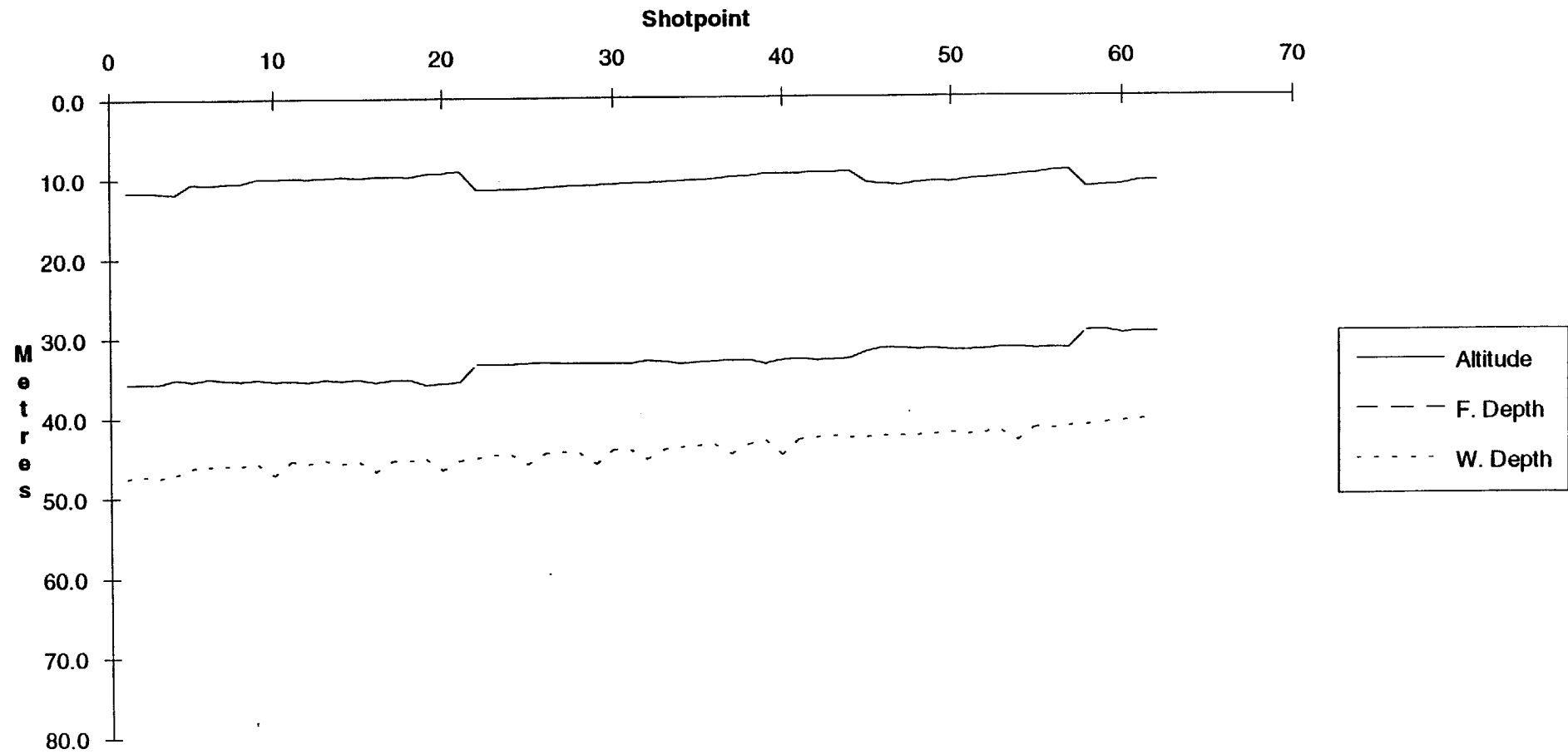
Line 104045 Methane, Ethane, Ethylene



Line 104045 Methane, Propane, Propylene



Line 104045 Depths, Altitude



Line Summary

Line Number 104046
No. of Shotpoints 43

	Shotpoint	Date	Time	Latitude	Longitude
Start	1	06-Oct-91	00:24:14	38	08.916 147 40.743
End	43	06-Oct-91	01:48:31	38	15.361 147 44.843

	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	7.960	2.784	0.001	0.017	0.000	0.000	0.000	0.000	0.016	0.021	0.096	0.000	0.050
Std. Dev.	1.086	0.211	0.002	0.009	0.001	0.000	0.000	0.000	0.006	0.014	0.024	0.000	0.095
Minimum	7.085	2.416	0.000	0.006	0.000	0.000	0.000	0.000	0.006	0.000	0.043	0.000	0.000
Maximum	12.686	3.357	0.010	0.042	0.006	0.000	0.000	0.000	0.030	0.042	0.145	0.000	0.365

	Cond.	Temp.	Altitude	F. Depth	W. Depth
Mean	46.517	14.609	10.872	33.558	44.909
Std. Dev.	0.078	0.057	1.468	2.311	2.175
Minimum	46.400	14.550	9.200	29.700	41.600
Maximum	46.670	14.710	14.100	36.400	49.100

Notes

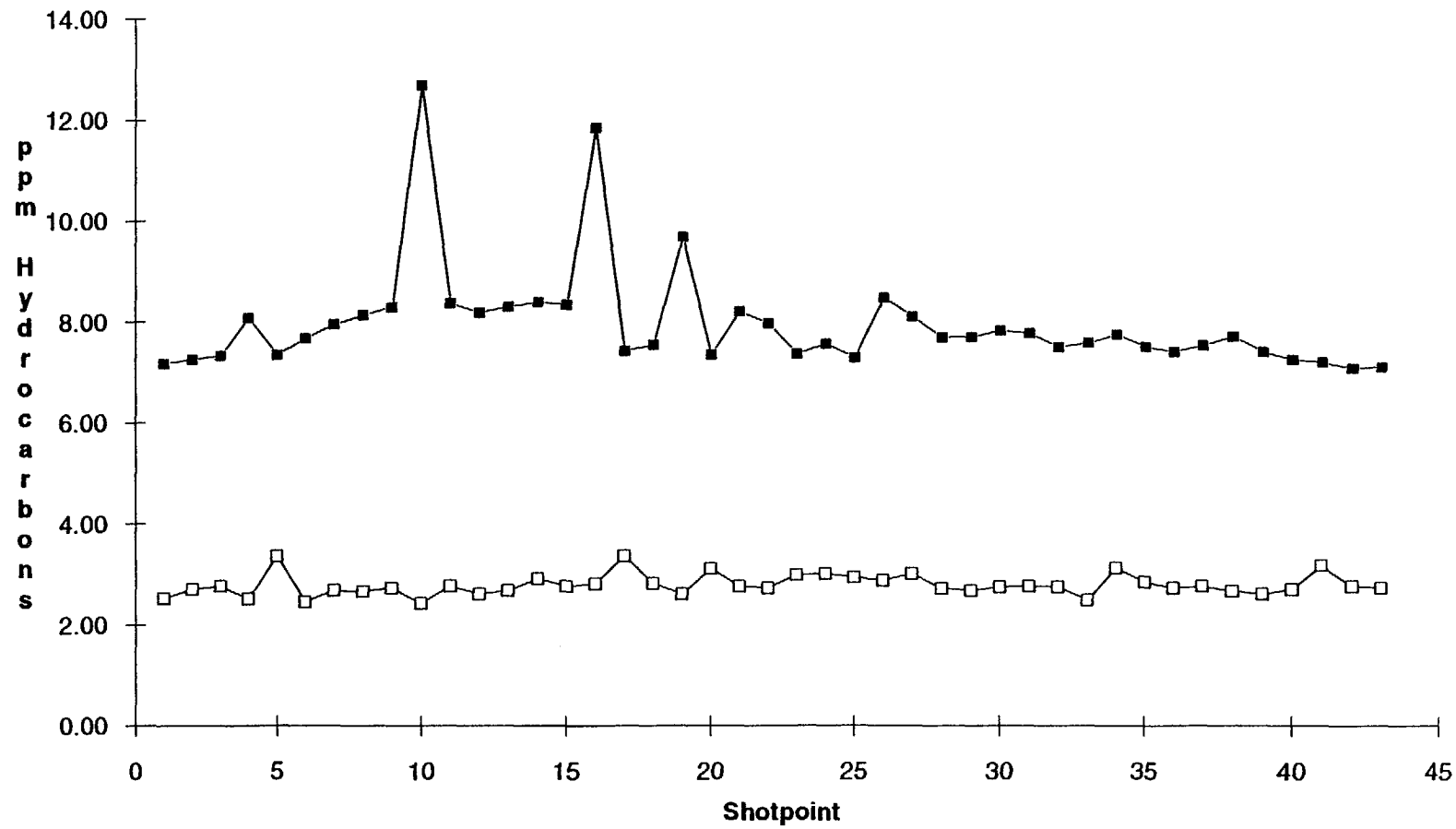
THC variations due to gas extractor problems.

No propylene detected

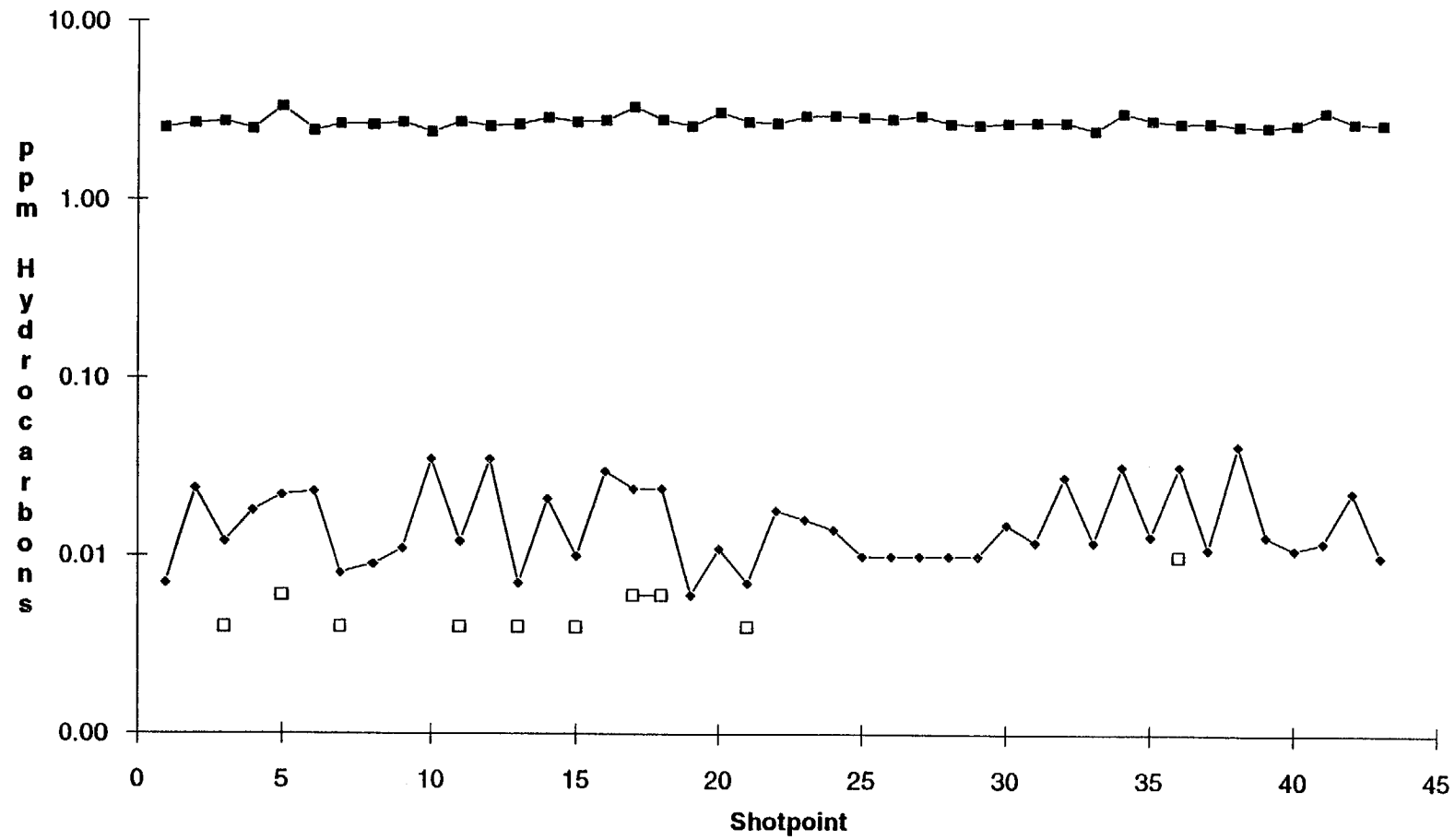
Due to gas extractor problems ethane was below the detection limit for much of the line.

No hydrocarbon anomalies detected.

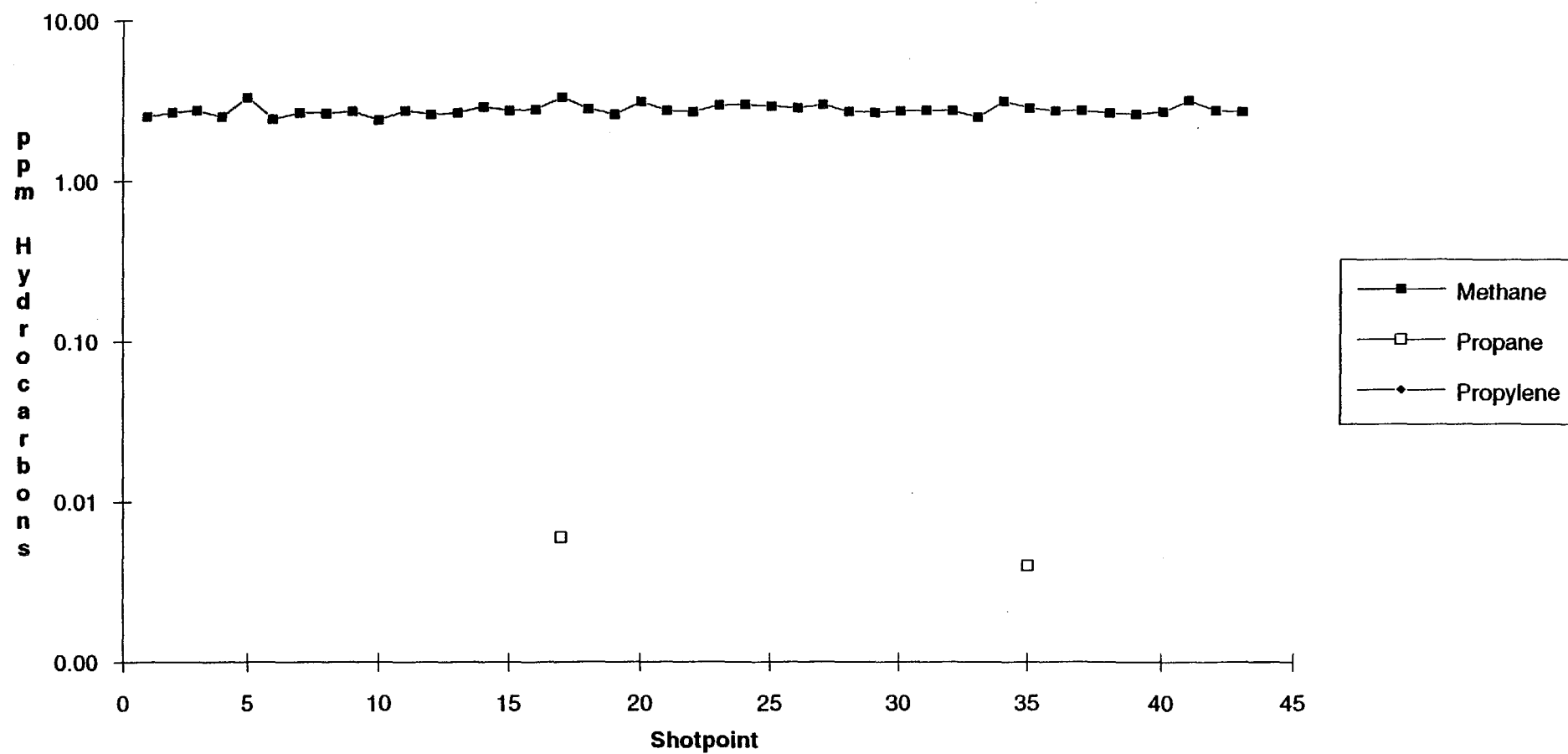
Line 104046 THC, Methane



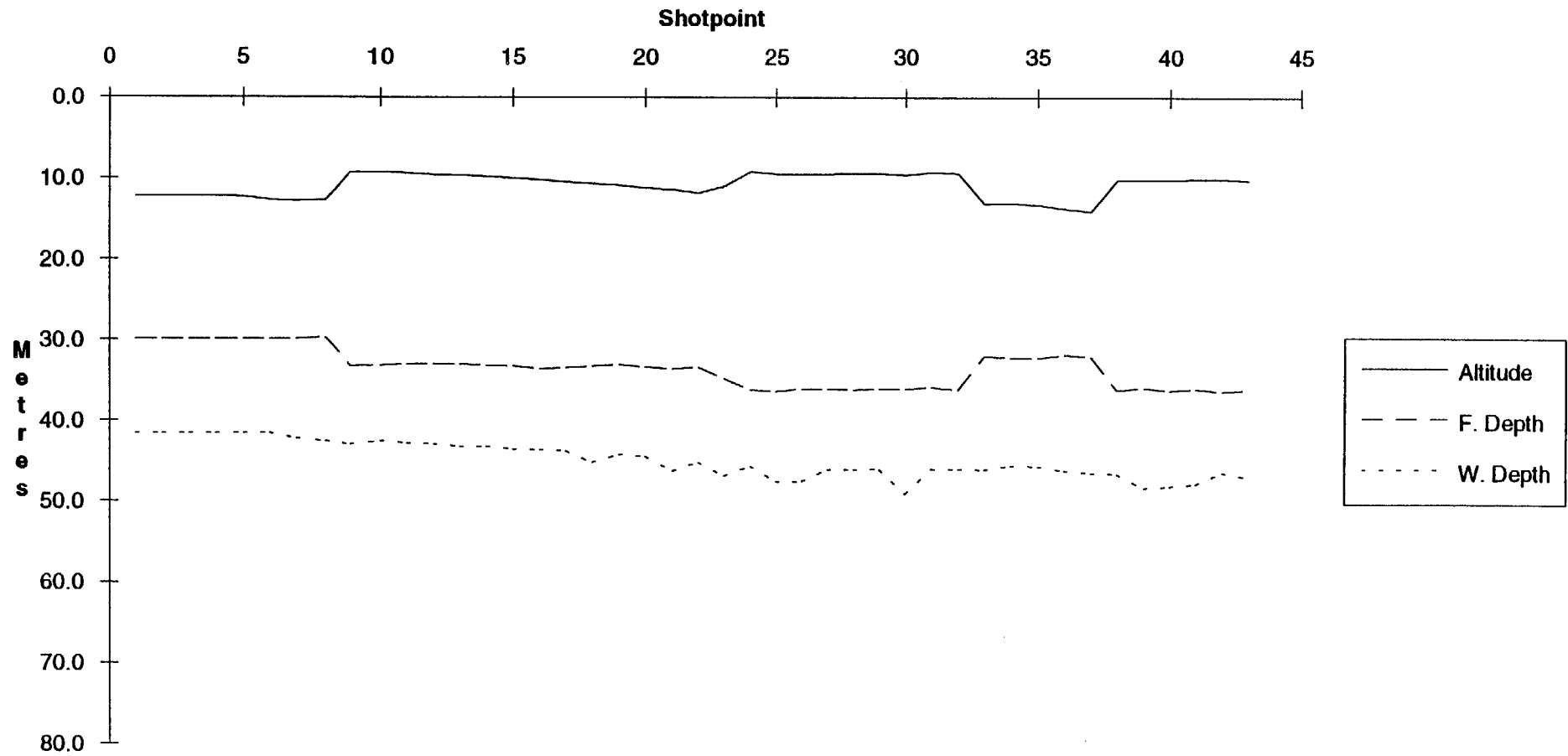
Line 104046 Methane, Ethane, Ethylene



Line 104046 Methane, Propane, Propylene



Line 104046 Depths, Altitude



Line Summary

Line Number 104047
No. of Shotpoints 39

	Shotpoint	Date	Time	Latitude		Longitude	
Start	1	06-Oct-91	05:08:44	38	15.929	147	45.063
End	40	06-Oct-91	06:31:09	38	08.165	147	45.062

	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	6.717	2.855	0.001	0.013	0.001	0.000	0.000	0.000	0.016	0.032	0.074	0.000	0.042
Std. Dev.	0.122	0.170	0.002	0.001	0.002	0.000	0.000	0.000	0.005	0.008	0.021	0.000	0.083
Minimum	6.491	2.591	0.000	0.009	0.000	0.000	0.000	0.000	0.007	0.021	0.028	0.000	0.000
Maximum	6.924	3.248	0.005	0.015	0.006	0.000	0.000	0.000	0.027	0.043	0.111	0.000	0.334

	Cond.	Temp.	Altitude	F. Depth	W. Depth
Mean	47.132	15.184	10.518	35.500	46.877
Std. Dev.	0.092	0.091	0.567	0.686	0.848
Minimum	46.930	14.970	9.600	34.400	45.200
Maximum	47.270	15.320	11.900	36.600	48.600

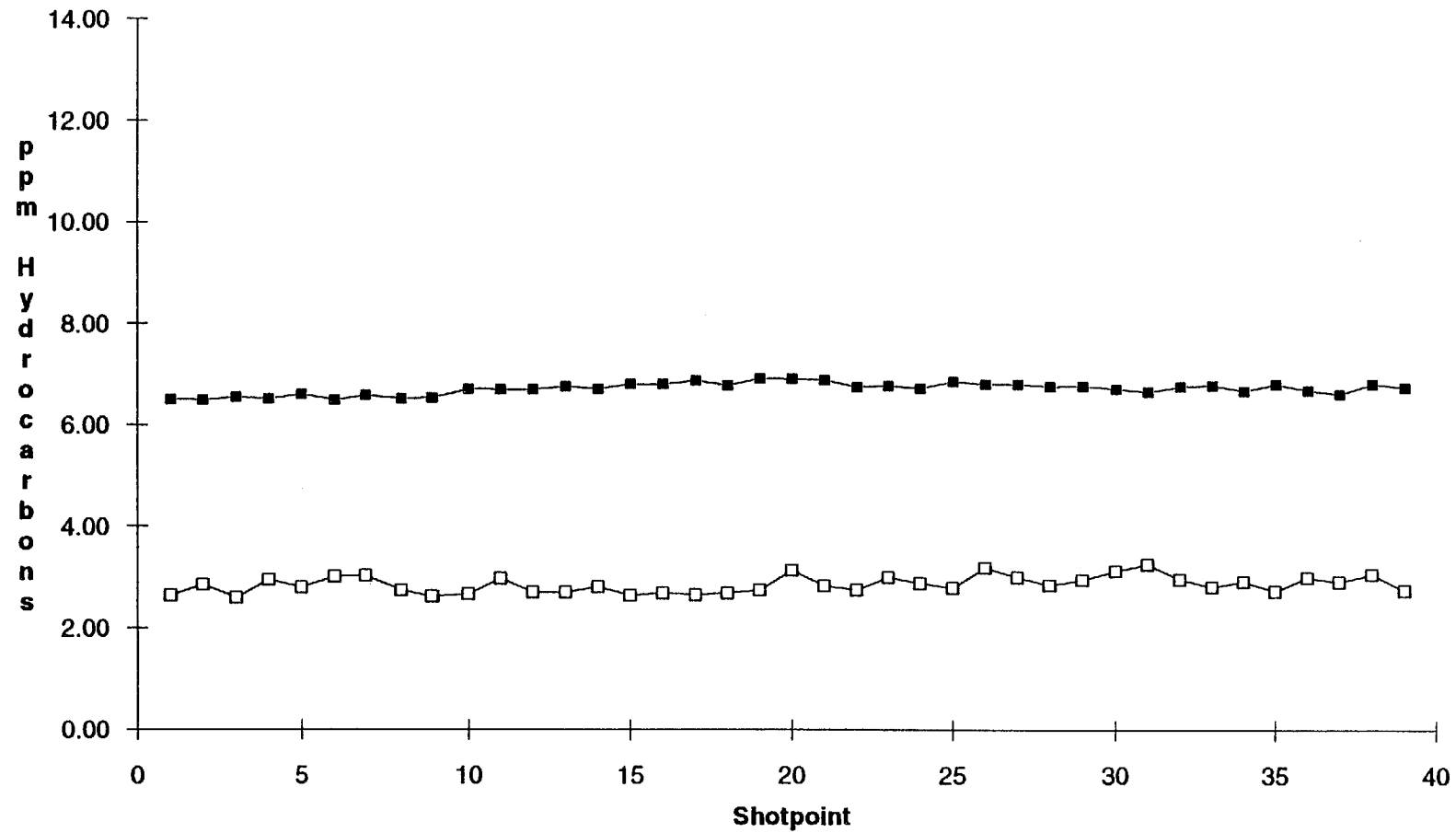
Notes

No hydrocarbon anomalies detected.

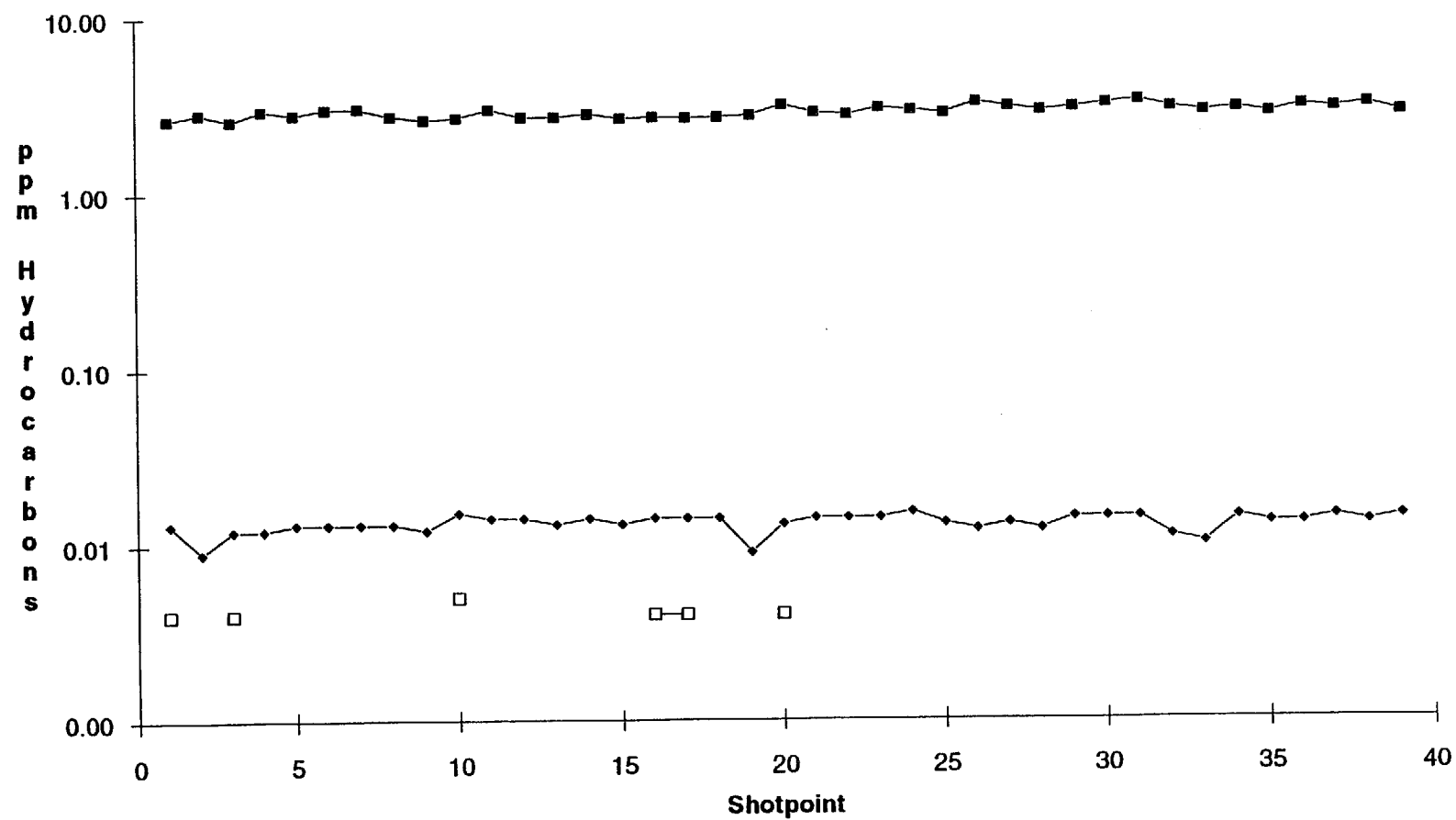
No propylene detected.

Due to gas extractor problems ethane was below the detection limit for much of the line.

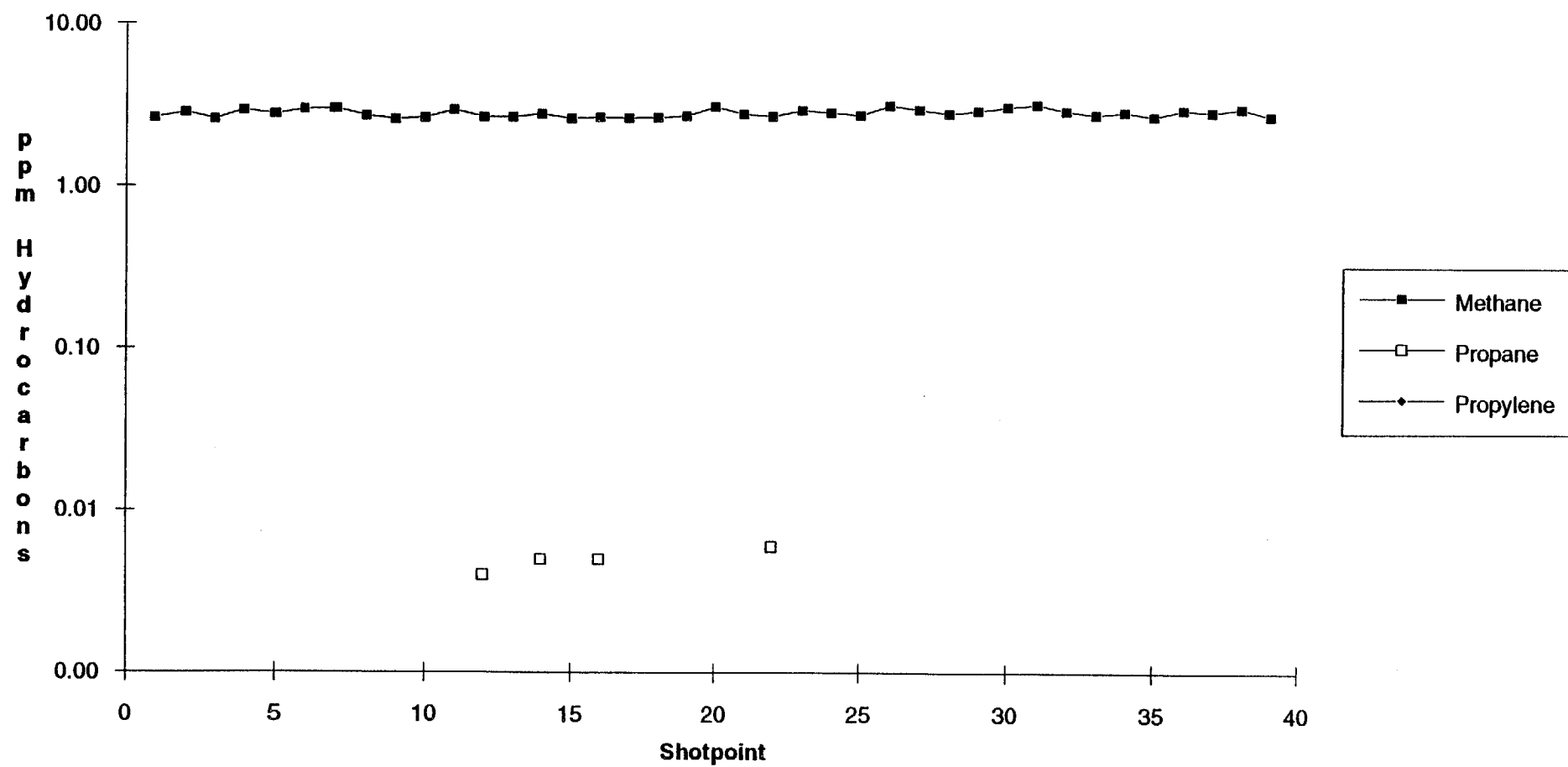
Line 104047 THC, Methane



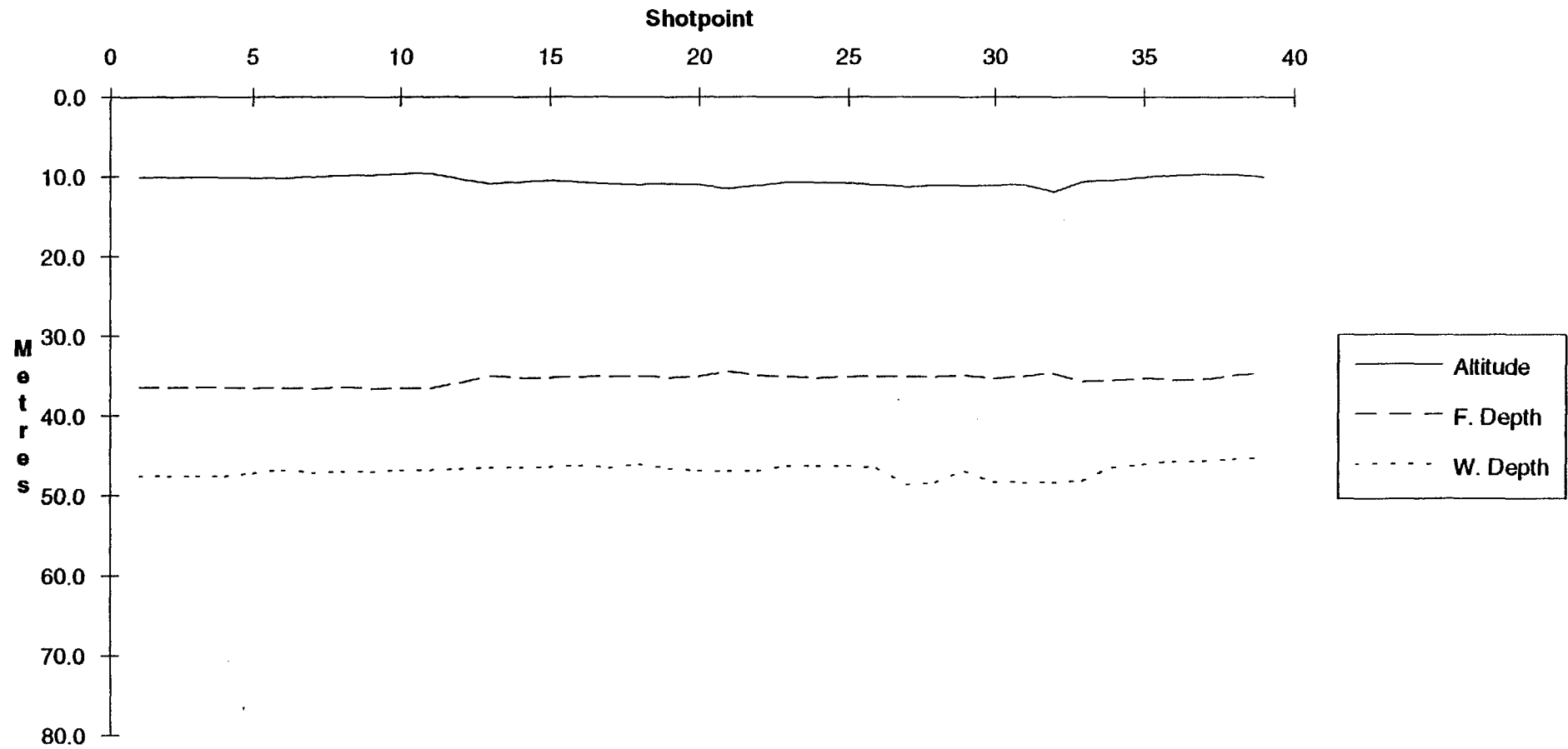
Line 104047 Methane, Ethane, Ethylene



Line 104047 Methane, Propane, Propylene



Line 104047 Depths, Altitude



Line Summary

Line Number 104048
No. of Shotpoints 75

	Shotpoint	Date	Time	Latitude	Longitude
Start	1	06-Oct-91	06:27:09	38	07.394 147 44.226
End	77	06-Oct-91	09:03:46	38	04.505 147 59.600

	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	6.899	2.798	0.001	0.013	0.000	0.000	0.000	0.000	0.021	0.036	0.074	0.000	0.030
Std. Dev.	0.253	0.172	0.001	0.002	0.001	0.000	0.000	0.000	0.005	0.007	0.022	0.000	0.069
Minimum	6.521	2.412	0.000	0.009	0.000	0.000	0.000	0.000	0.007	0.015	0.026	0.000	0.000
Maximum	7.580	3.278	0.005	0.020	0.005	0.000	0.000	0.000	0.036	0.051	0.114	0.000	0.339

	Cond.	Temp.	Altitude	F. Depth	W.Depth
Mean	46.418	14.561	13.775	34.791	48.581
Std. Dev.	0.257	0.249	2.551	3.461	2.714
Minimum	46.120	14.290	10.000	31.600	44.100
Maximum	47.120	15.230	17.500	41.700	53.100

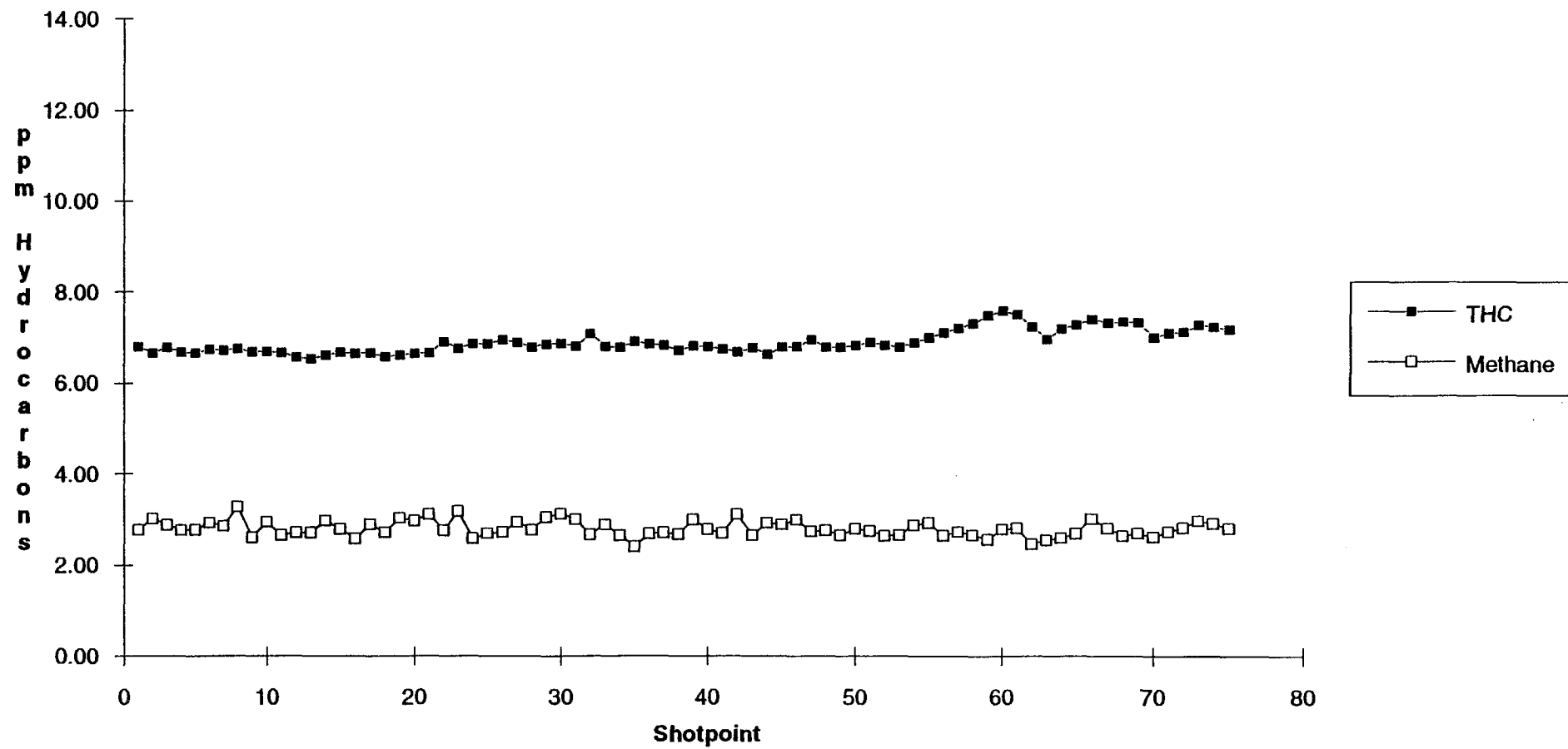
Notes

No hydrocarbon anomalies detected.

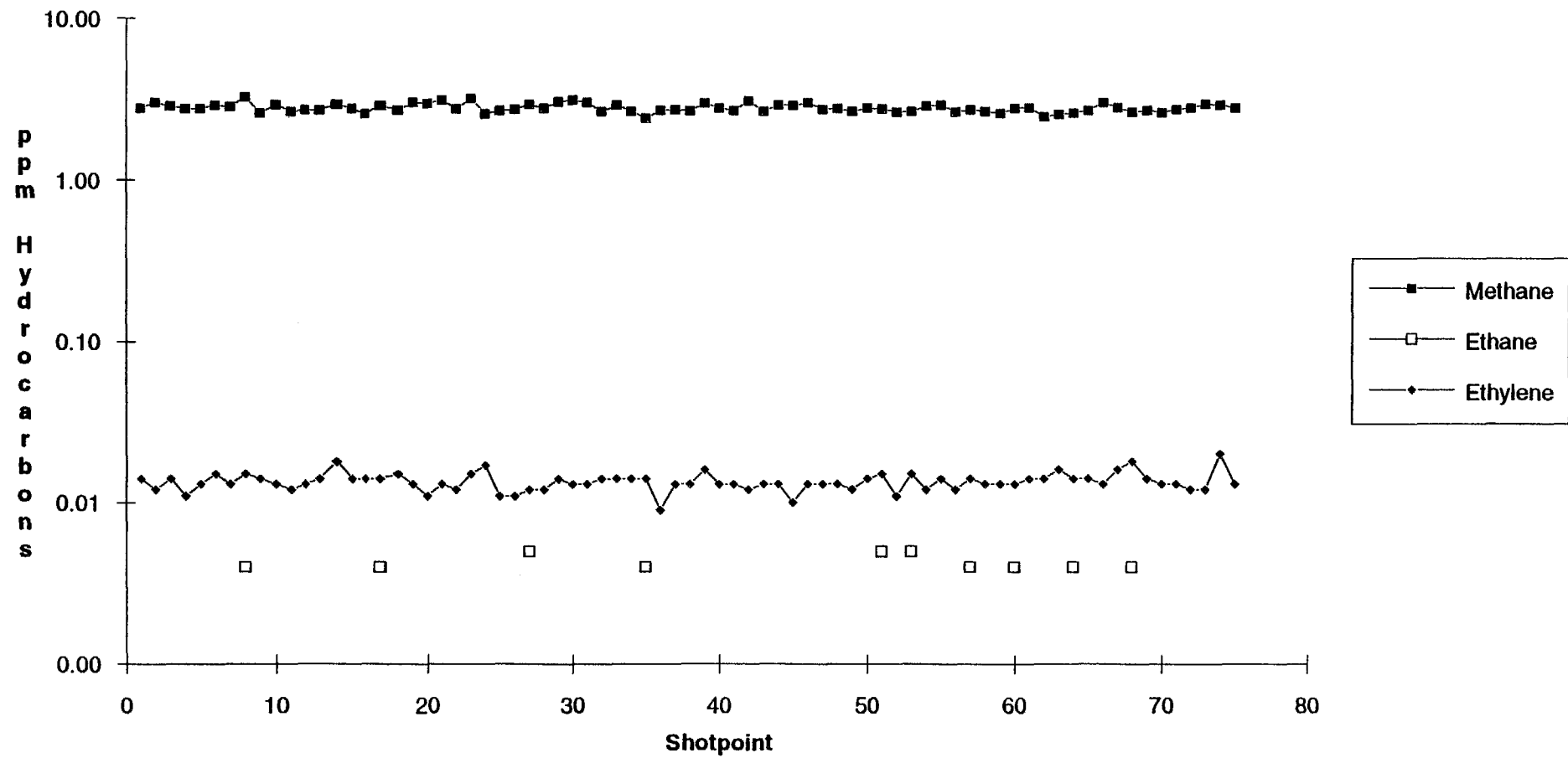
No propylene detected .

Due to gas extractor problems ethane was below the detection limit for much of the line.

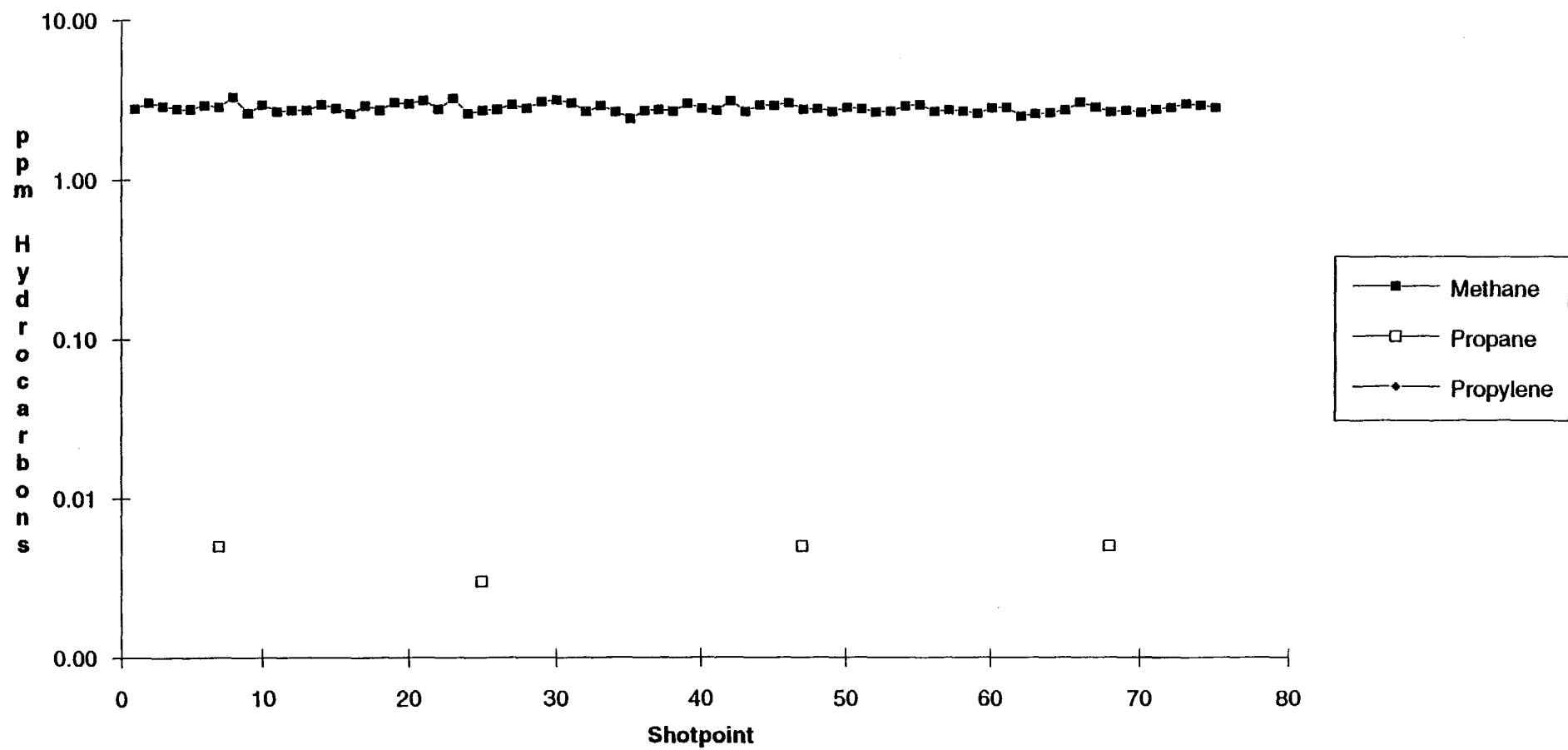
Line 104048 THC, Methane



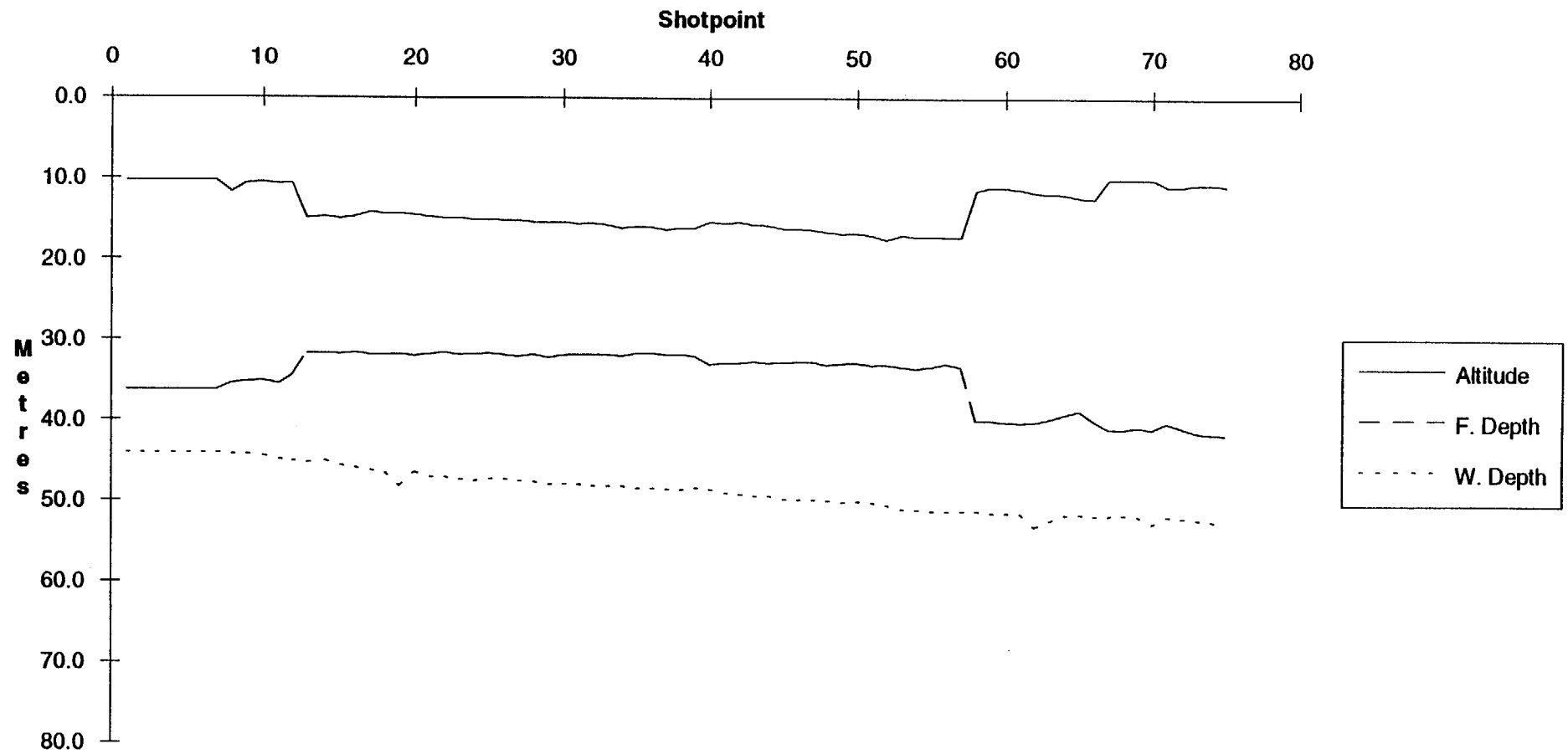
Line 104048 Methane, Ethane, Ethylene



Line 104048 Methane, Propane, Propylene



Line 104048 Depths, Altitude



Line Summary

Line Number 104049
No. of Shotpoints 39

	Shotpoint	Date	Time	Latitude	Longitude	
Start	1	06-Oct-91	09:11:45	38	04.230 148	01.198
End	40	06-Oct-91	10:34:51	38	09.131 148	05.665

	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	7.428	2.786	0.006	0.013	0.003	0.000	0.000	0.000	0.024	0.038	0.063	0.000	0.299
Std. Dev.	0.228	0.207	0.008	0.002	0.005	0.000	0.000	0.000	0.005	0.009	0.017	0.000	0.411
Minimum	7.131	2.401	0.000	0.008	0.000	0.000	0.000	0.000	0.012	0.017	0.023	0.000	0.000
Maximum	8.337	3.491	0.030	0.021	0.020	0.000	0.000	0.000	0.035	0.054	0.092	0.000	1.451

	Cond.	Temp.	Altitude	F. Depth	W.Depth
Mean	46.118	14.252	10.779	43.344	54.646
Std. Dev.	0.065	0.045	0.836	1.492	1.670
Minimum	45.920	14.130	9.300	41.500	52.600
Maximum	46.170	14.290	12.600	47.100	57.500

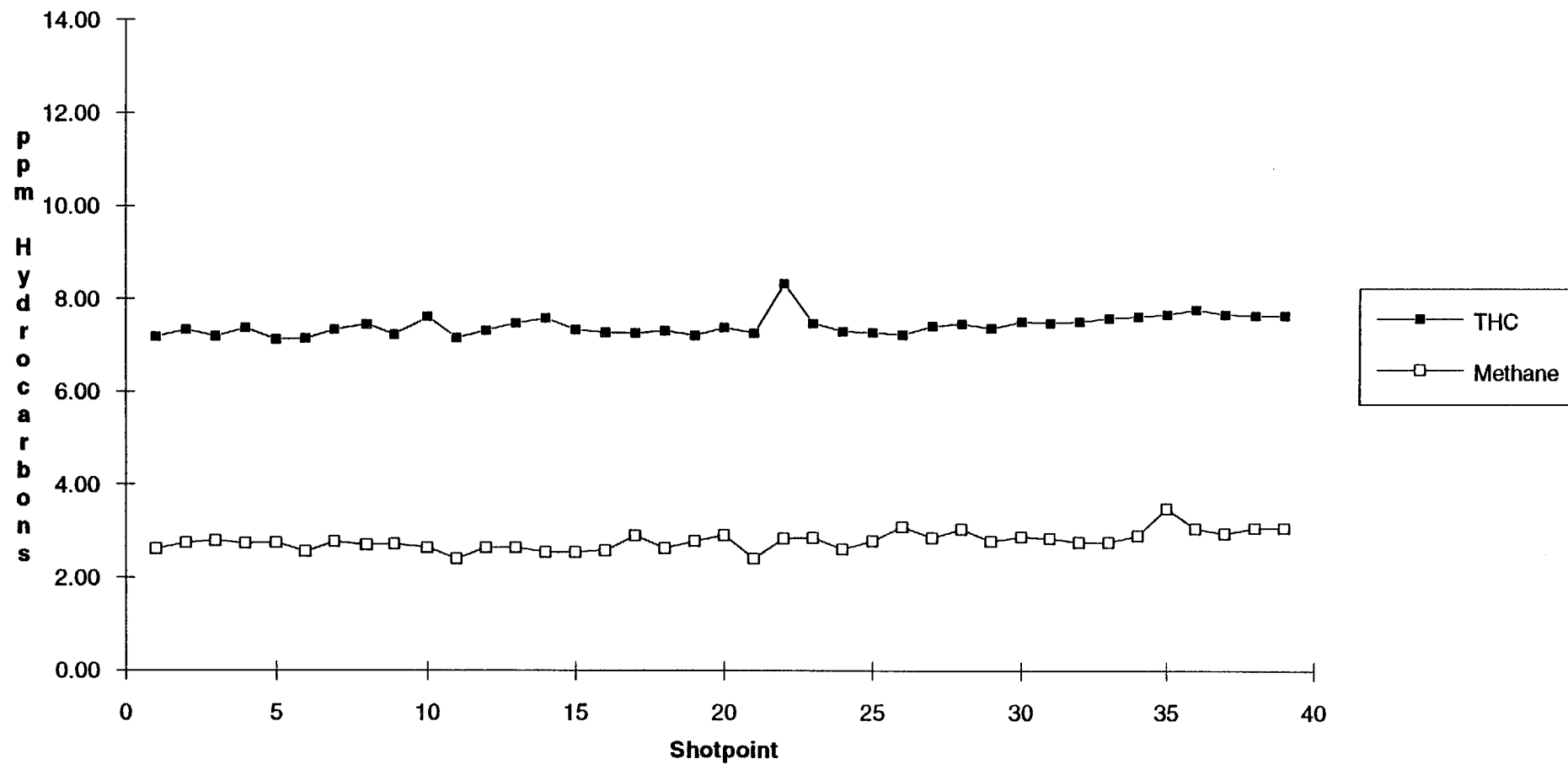
Notes

No propylene detected .

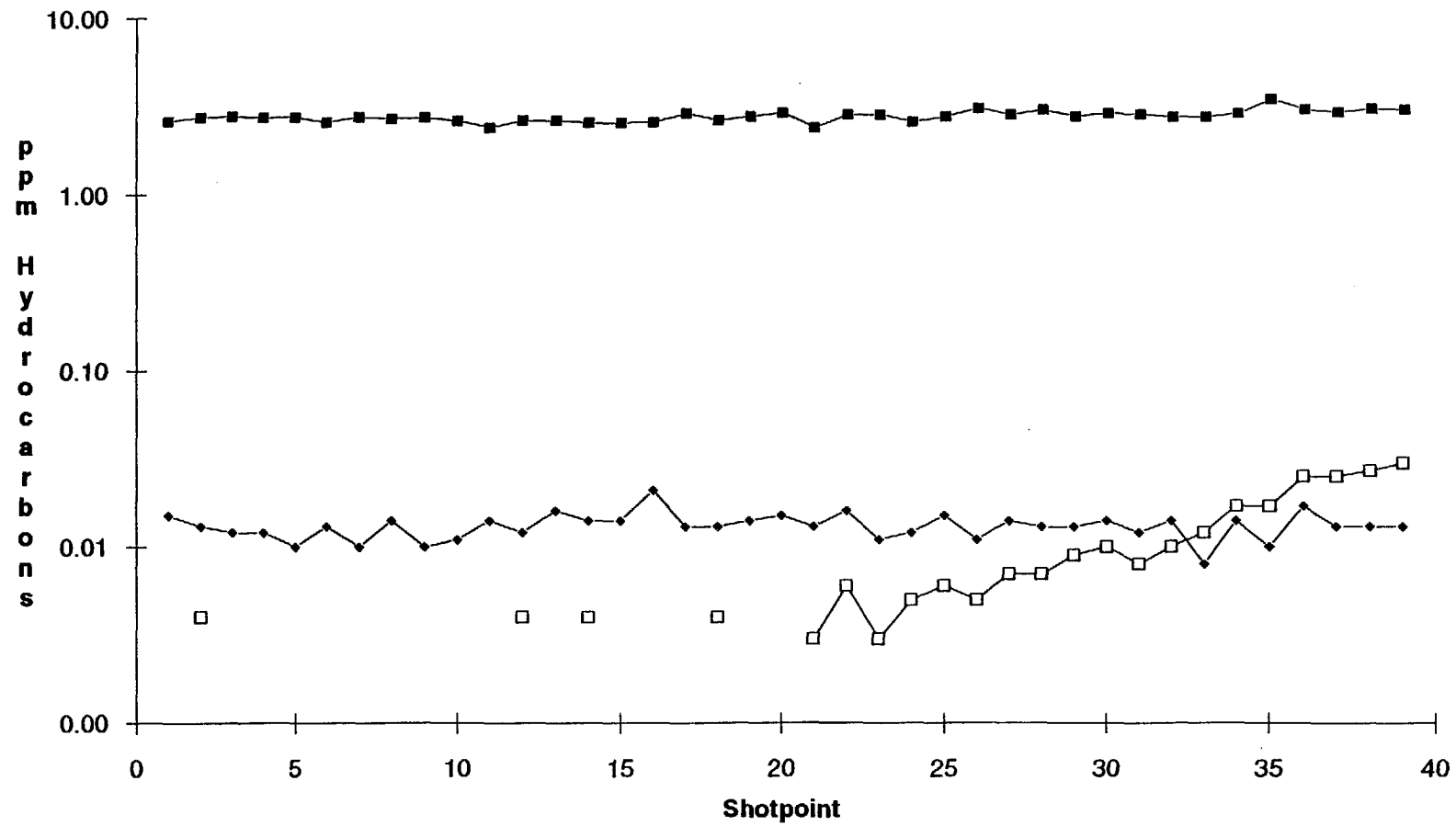
Due to gas extractor problems ethane was below the detection limit for much of the line.

Ethane increasing seven fold from shotpoint 22 to shotpoint 40

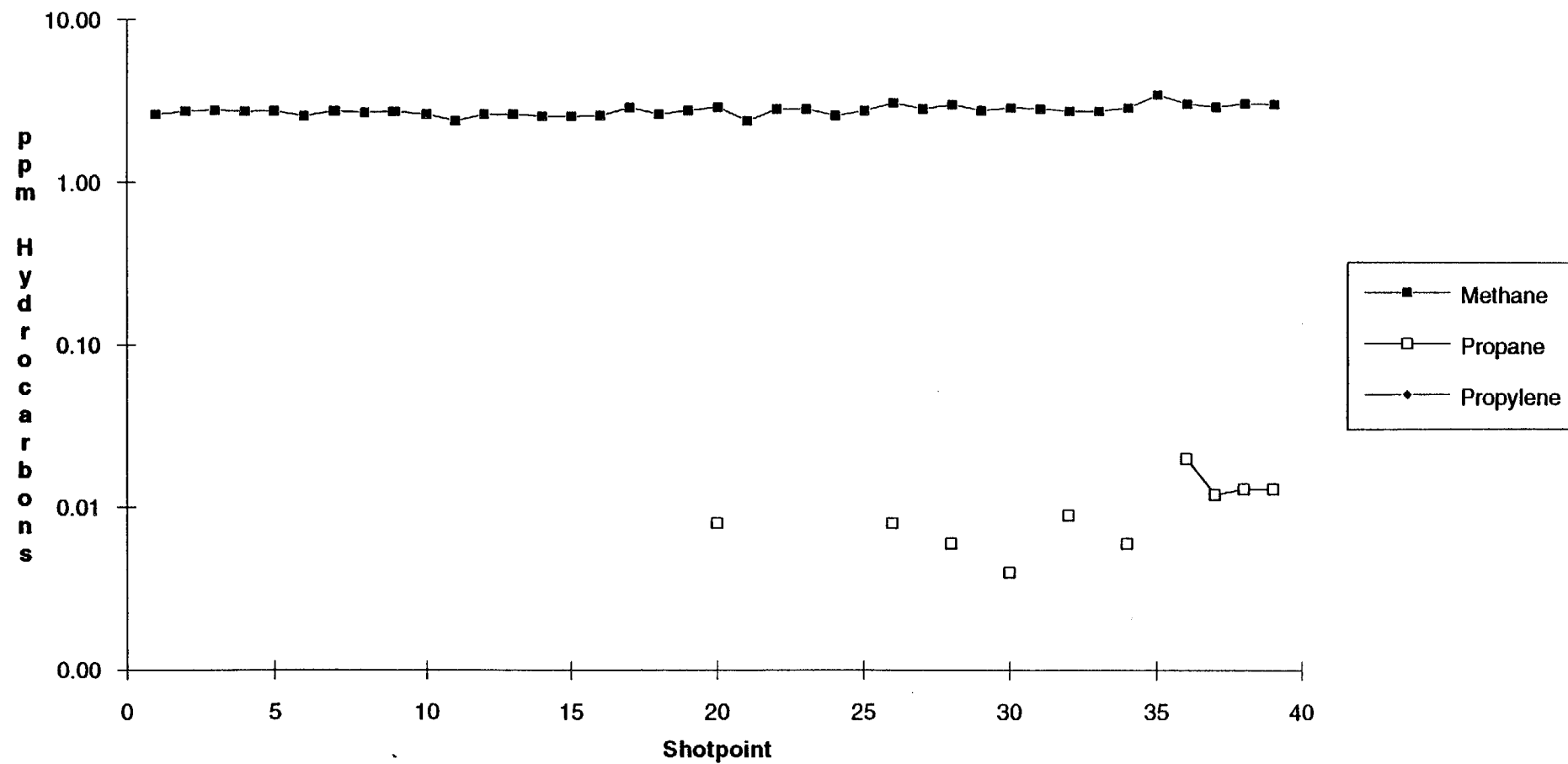
Line 104049 THC, Methane



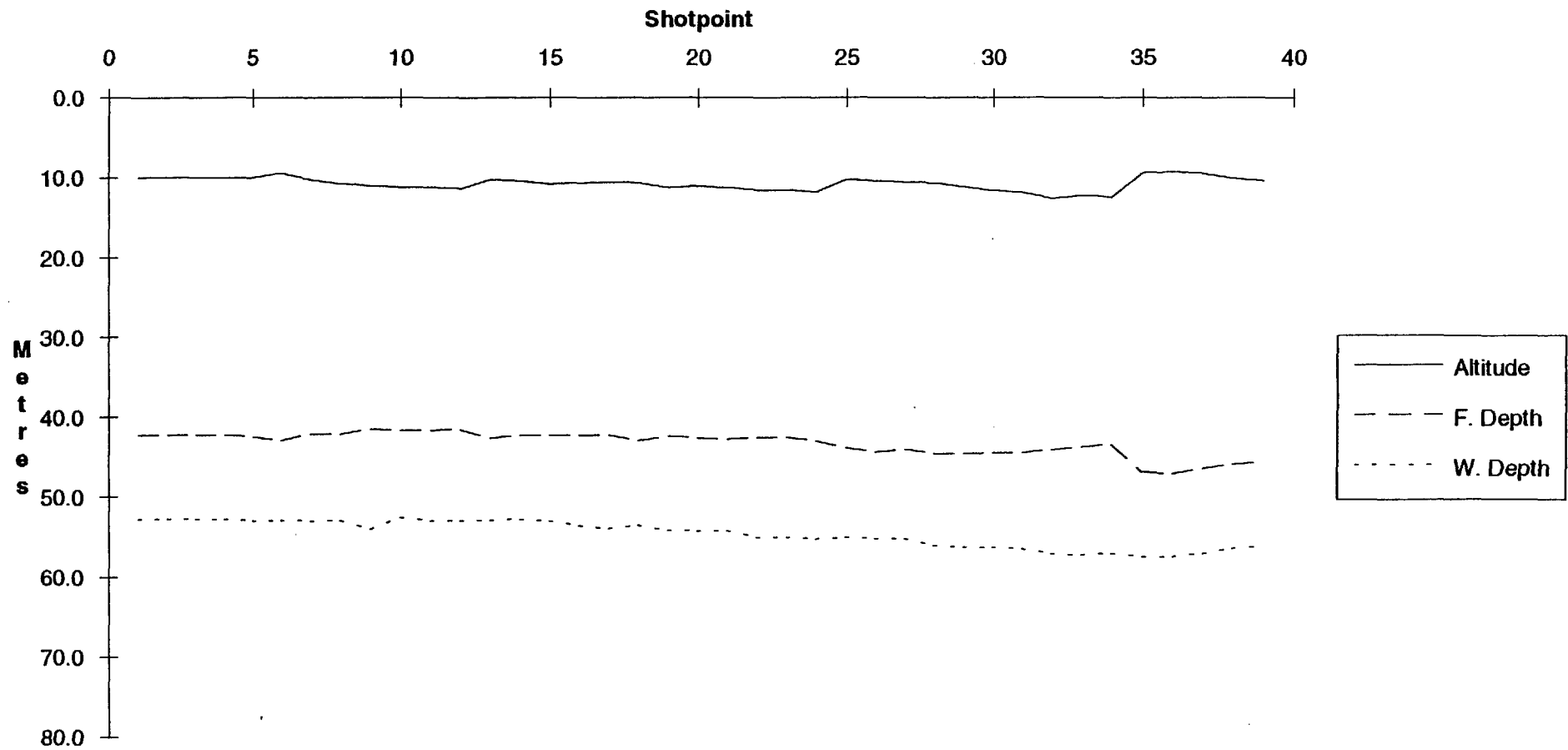
Line 104049 Methane, Ethane, Ethylene



Line 104049 Methane, Propane, Propylene



Line 104049 Depths, Altitude



Line Summary

Line Number 104050
No. of Shotpoints 18

	Shotpoint	Date	Time	Latitude		Longitude	
Start	1	06-Oct-91	10:40:05	38	09.888	148	06.113
End	18	06-Oct-91	11:14:03	38	09.912	148	09.655

	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	7.550	3.104	0.027	0.013	0.012	0.000	0.000	0.000	0.019	0.038	0.074	0.000	1.236
Std. Dev.	0.173	0.179	0.003	0.002	0.003	0.000	0.000	0.000	0.005	0.006	0.025	0.000	0.150
Minimum	7.270	2.774	0.022	0.010	0.008	0.000	0.000	0.000	0.010	0.025	0.025	0.000	1.074
Maximum	7.859	3.561	0.035	0.019	0.017	0.000	0.000	0.000	0.028	0.046	0.118	0.000	1.718

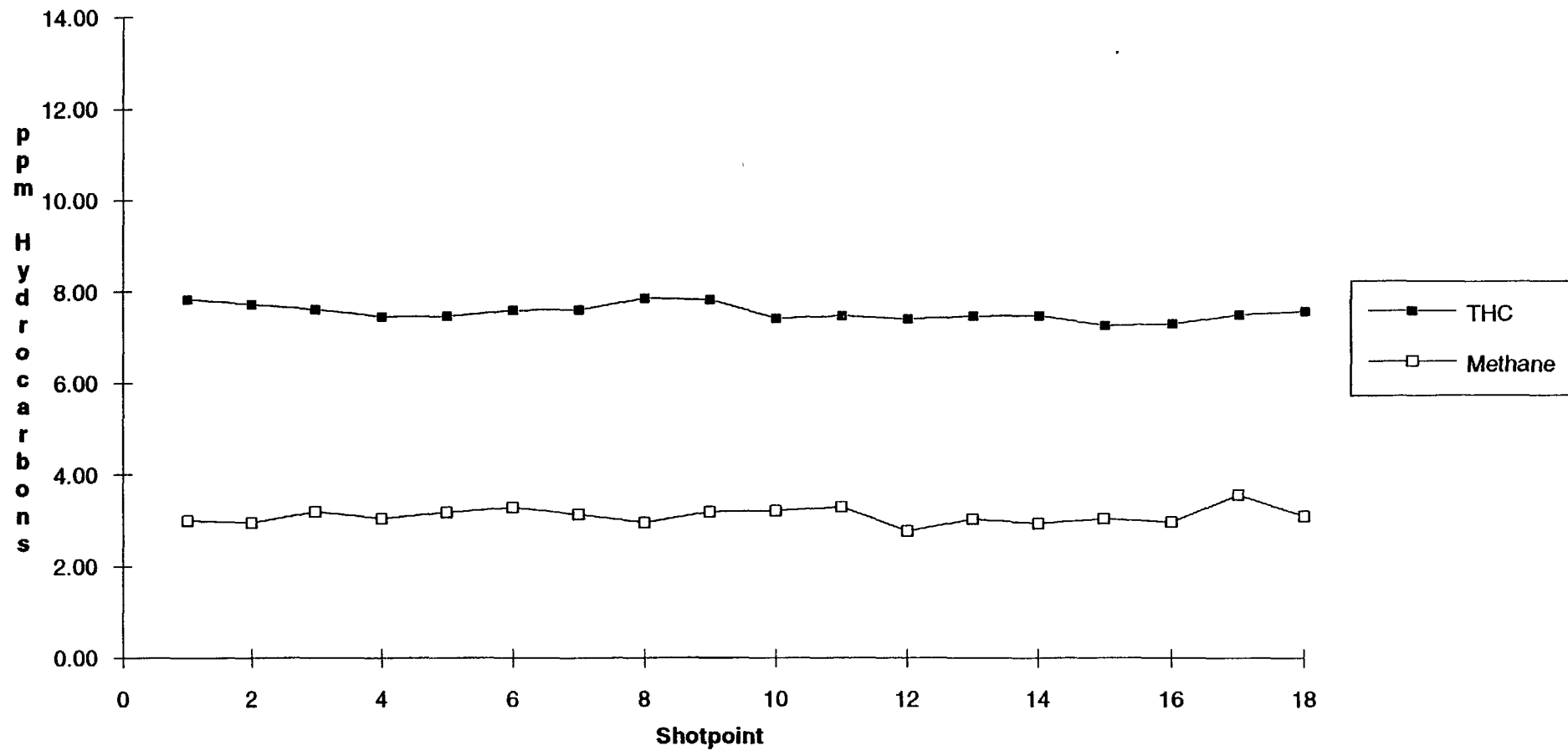
	Cond.	Temp.	Altitude	F. Depth	W.Depth
Mean	45.852	14.069	10.261	46.894	57.967
Std. Dev.	0.021	0.021	0.460	0.893	0.639
Minimum	45.820	14.030	9.500	46.000	57.200
Maximum	45.900	14.100	11.200	48.100	59.200

Notes

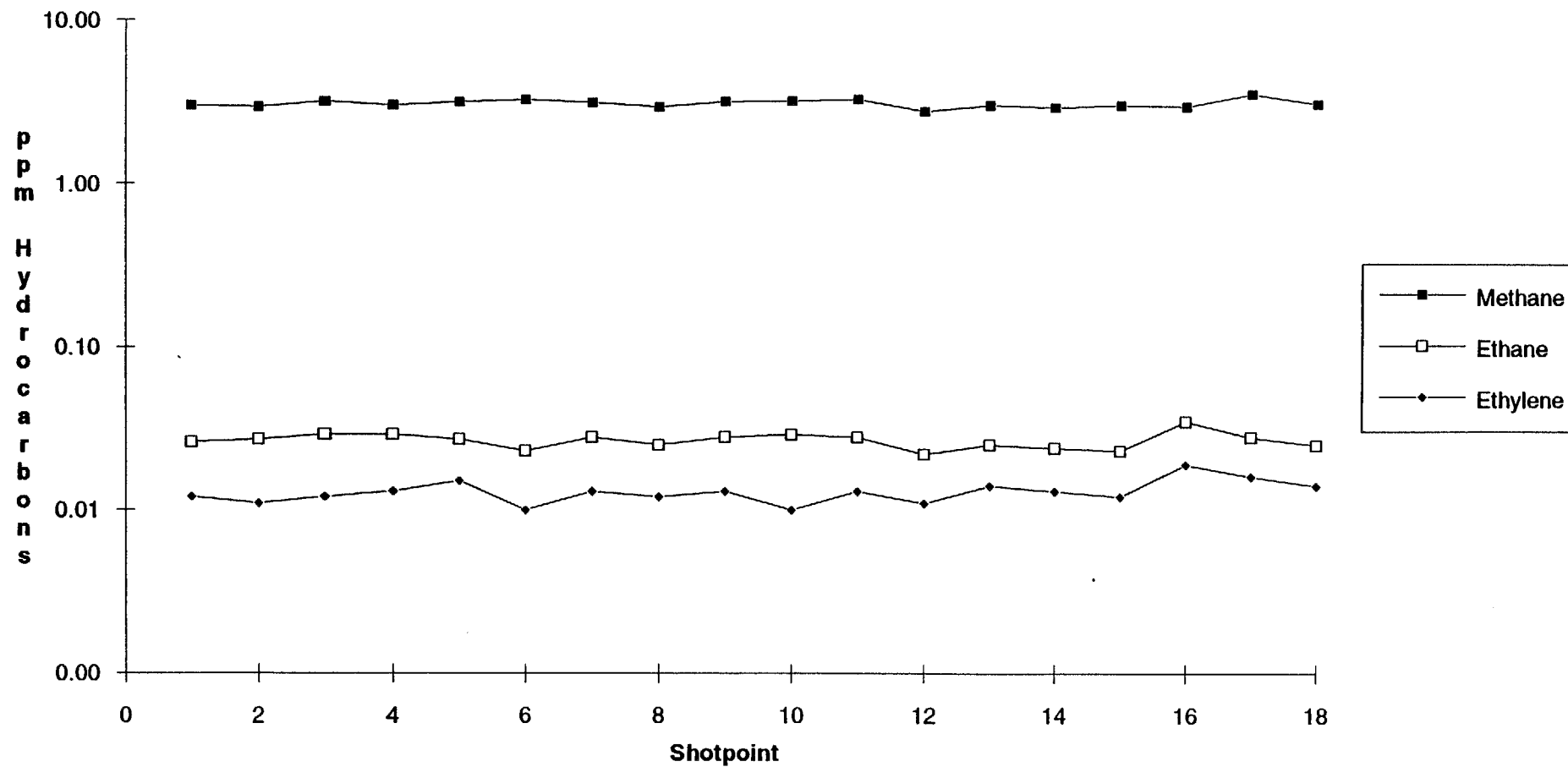
Ethane at elevated levels for this line.

No propylene detected .

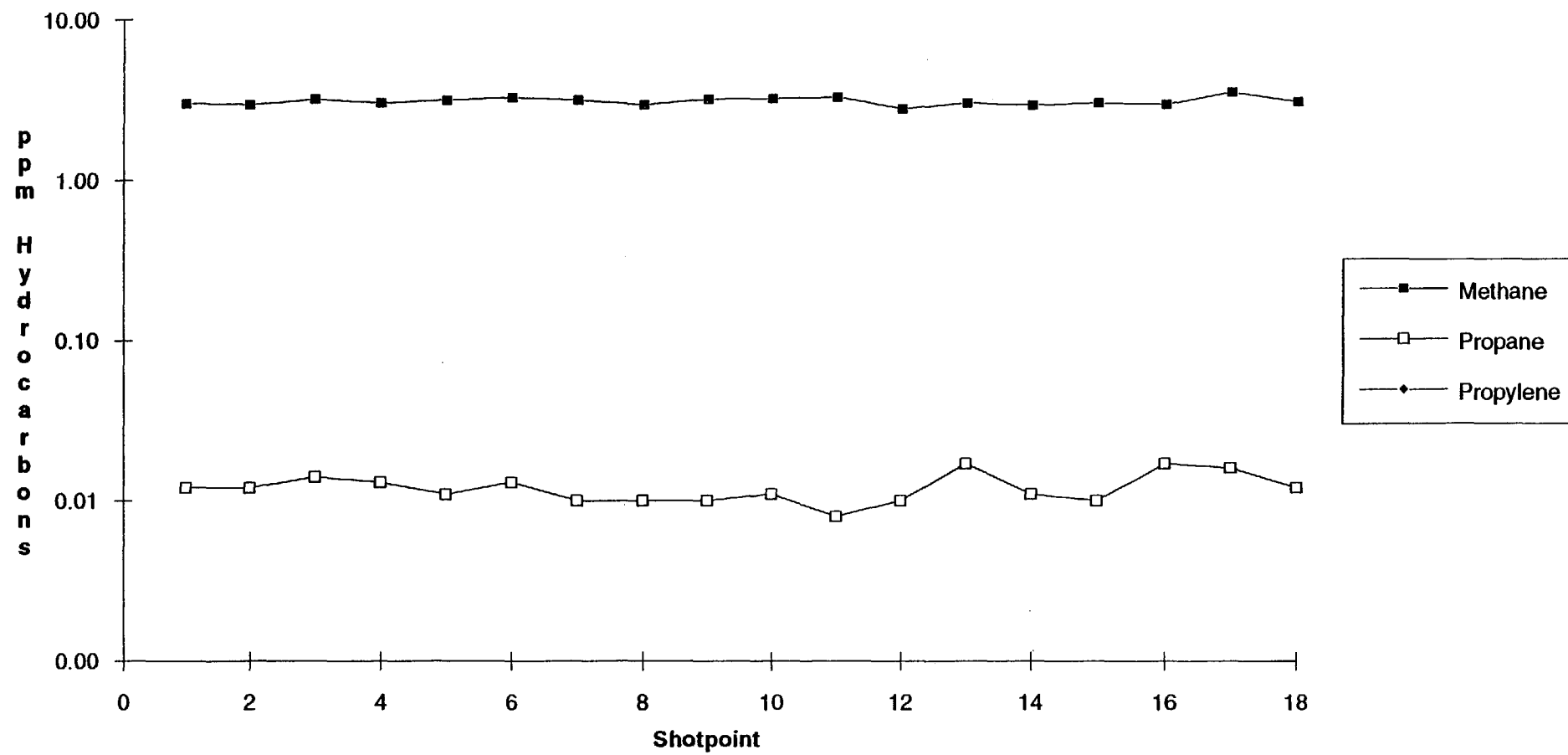
Line 104050 THC, Methane



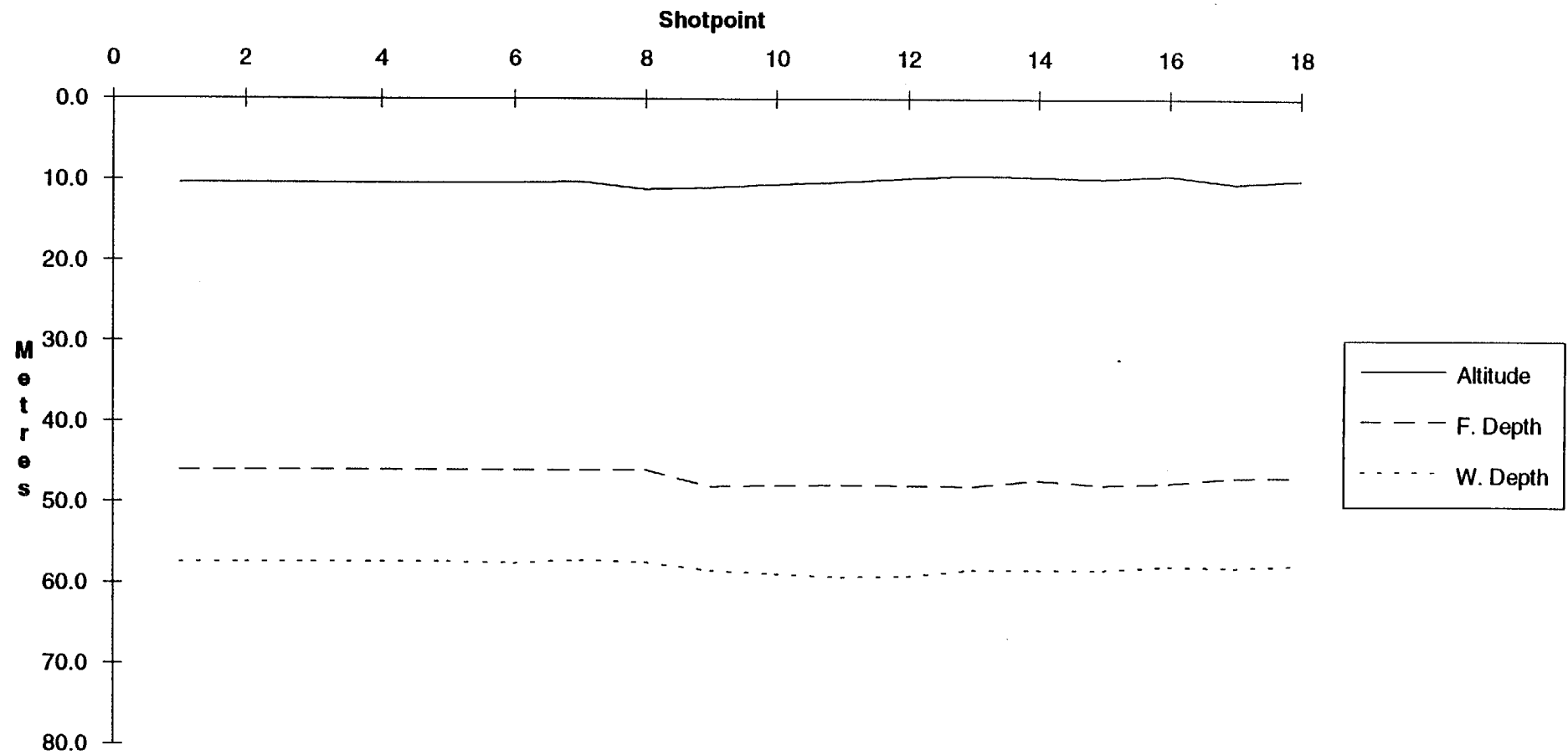
Line 104050 Methane, Ethane, Ethylene



Line 104050 Methane, Propane, Propylene



Line 104050 Depths, Altitude



Line Summary

Line Number 104051
No. of Shotpoints 29

	Shotpoint	Date	Time	Latitude	Longitude
Start	1	06-Oct-91	11:16:04	38	10.193 148 10.391
End	29	06-Oct-91	12:12:03	38	05.636 148 10.675

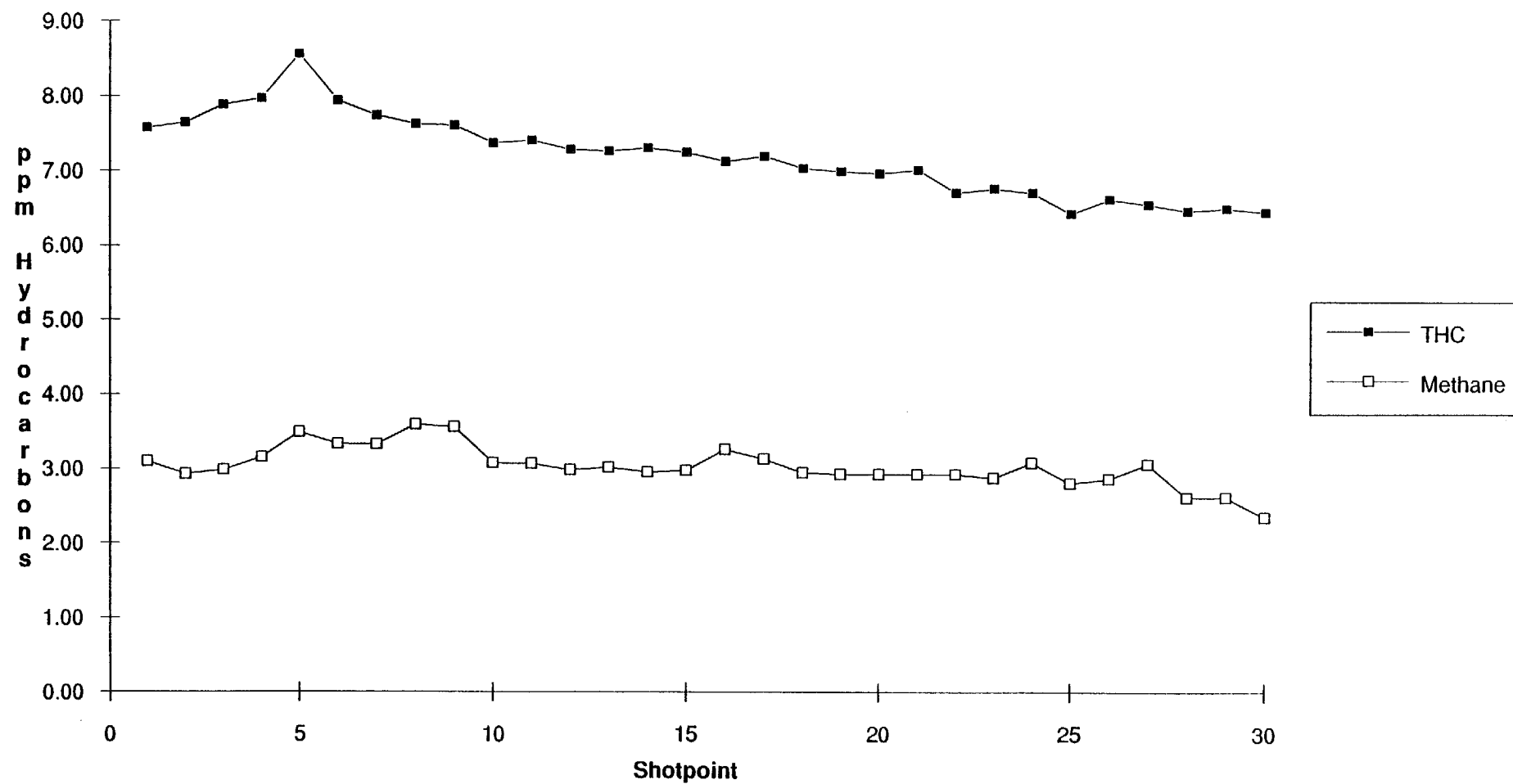
	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	7.187	3.026	0.025	0.014	0.015	0.000	0.001	0.002	0.018	0.035	0.067	0.000	1.345
Std. Dev.	0.538	0.271	0.012	0.002	0.007	0.000	0.004	0.007	0.005	0.007	0.019	0.000	0.547
Minimum	6.431	2.352	0.004	0.011	0.007	0.000	0.000	0.000	0.010	0.024	0.030	0.000	0.390
Maximum	8.560	3.592	0.049	0.020	0.032	0.000	0.021	0.033	0.028	0.045	0.100	0.000	2.540

	Cond.	Temp.	Altitude	F. Depth	W. Depth
Mean	45.897	14.079	10.121	45.931	57.076
Std. Dev.	0.093	0.048	0.547	0.345	0.540
Minimum	45.810	14.030	9.400	45.200	55.900
Maximum	46.080	14.190	11.000	46.700	57.700

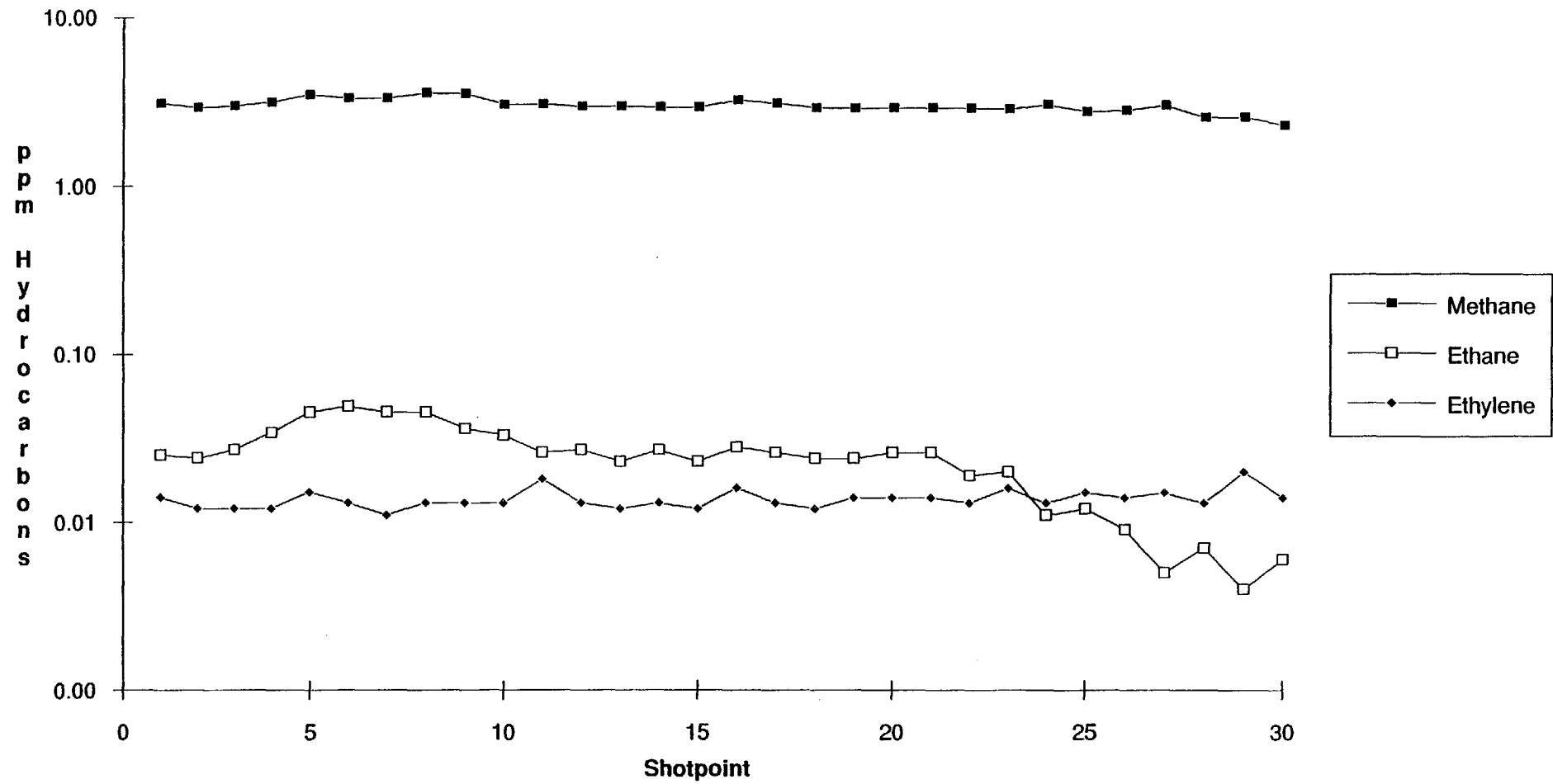
Notes

Weak methane, ethane, propane anomaly from SP 2 to 10.
No propylene detected.

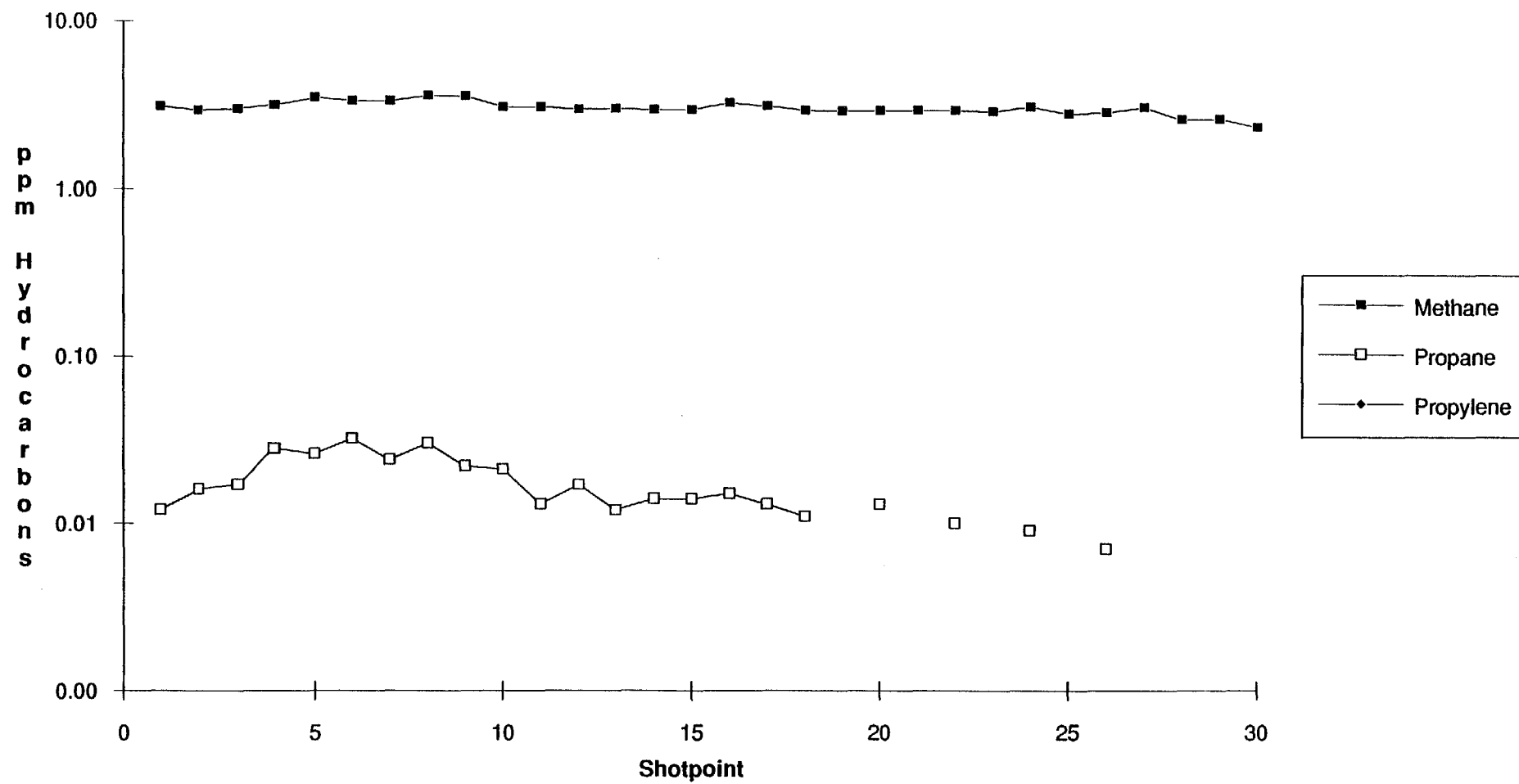
Line 104051 THC, Methane



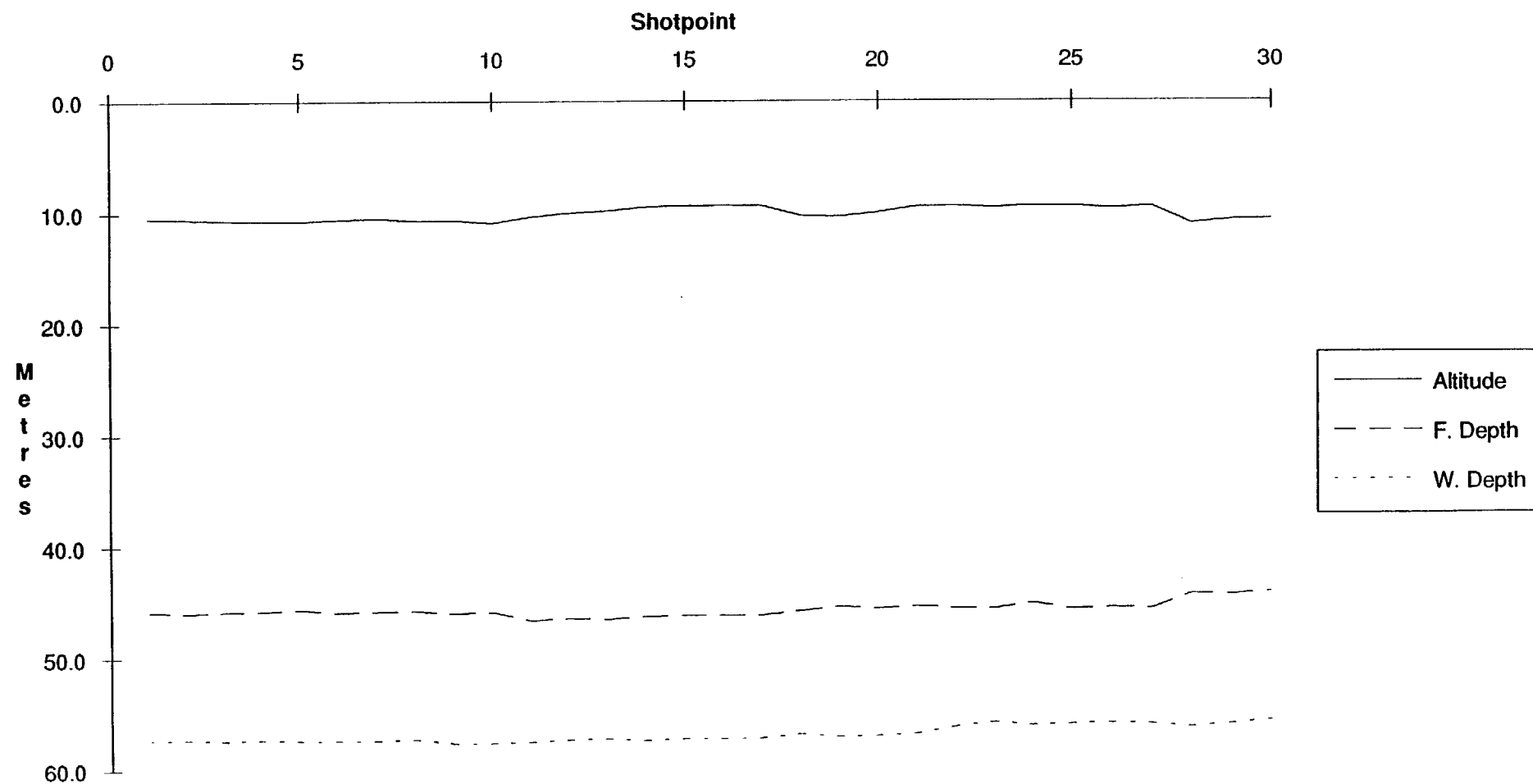
Line 104051 Methane, Ethane, Ethylene



Line 104051 Methane, Propane, Propylene



Line 104051 Depths, Altitude



Line Summary

Line Number 104052
No. of Shotpoints 28

	Shotpoint	Date	Time	Latitude	Longitude
Start	1	06-Oct-91	12:08:03	38	05.085 148 10.078
End	28	06-Oct-91	13:02:25	38	04.901 148 13.387

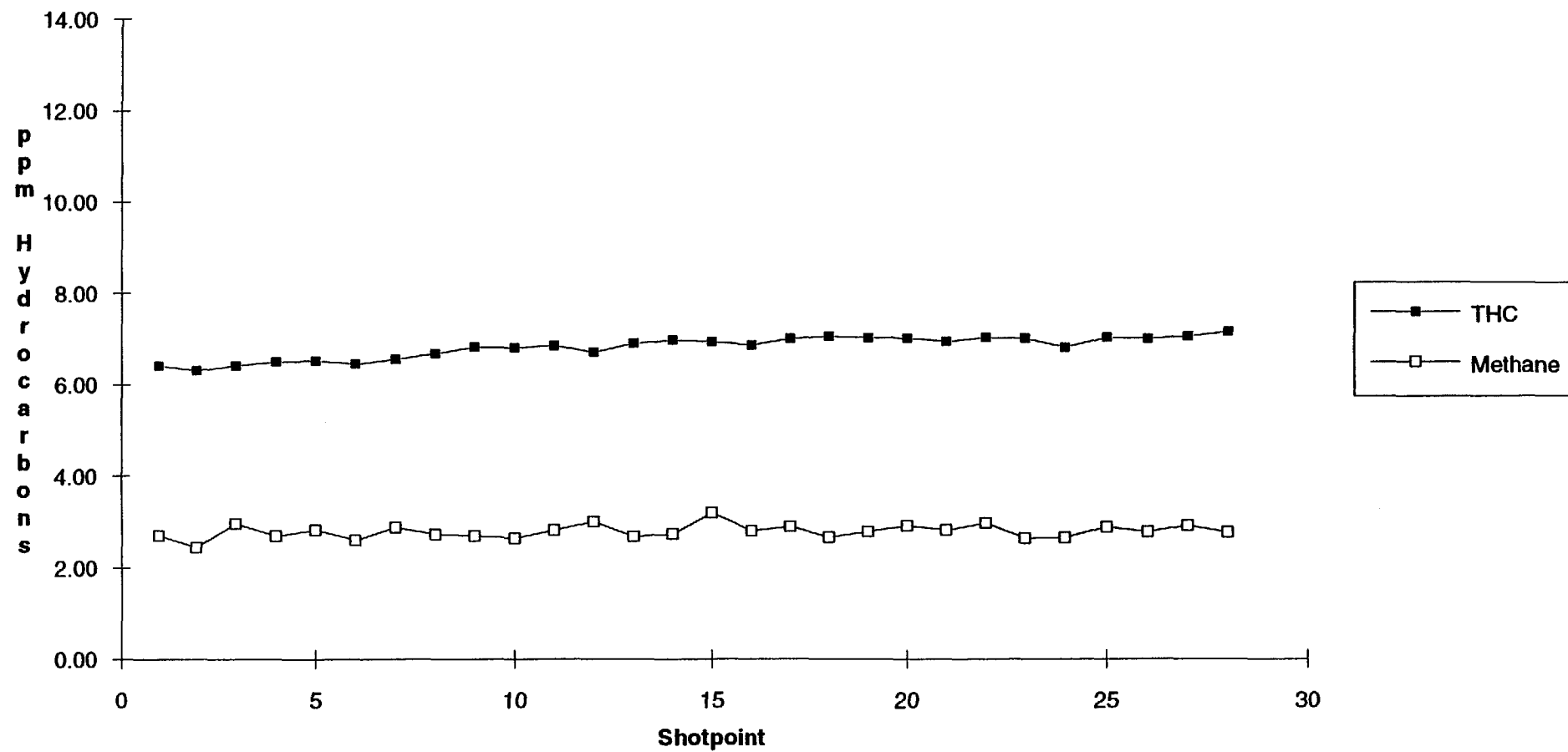
	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	6.814	2.788	0.009	0.017	0.002	0.000	0.001	0.000	0.020	0.037	0.072	0.000	0.379
Std. Dev.	0.243	0.153	0.003	0.004	0.003	0.000	0.003	0.000	0.007	0.008	0.026	0.000	0.182
Minimum	6.309	2.443	0.004	0.010	0.000	0.000	0.000	0.000	0.008	0.021	0.026	0.000	0.177
Maximum	7.161	3.200	0.015	0.026	0.010	0.000	0.016	0.000	0.033	0.049	0.117	0.000	0.821

	Cond.	Temp.	Altitude	F. Depth	W.Depth
Mean	46.060	14.189	10.768	44.275	55.964
Std. Dev.	0.031	0.022	1.103	1.086	0.231
Minimum	45.990	14.130	10.100	41.600	55.500
Maximum	46.100	14.230	13.700	45.000	56.500

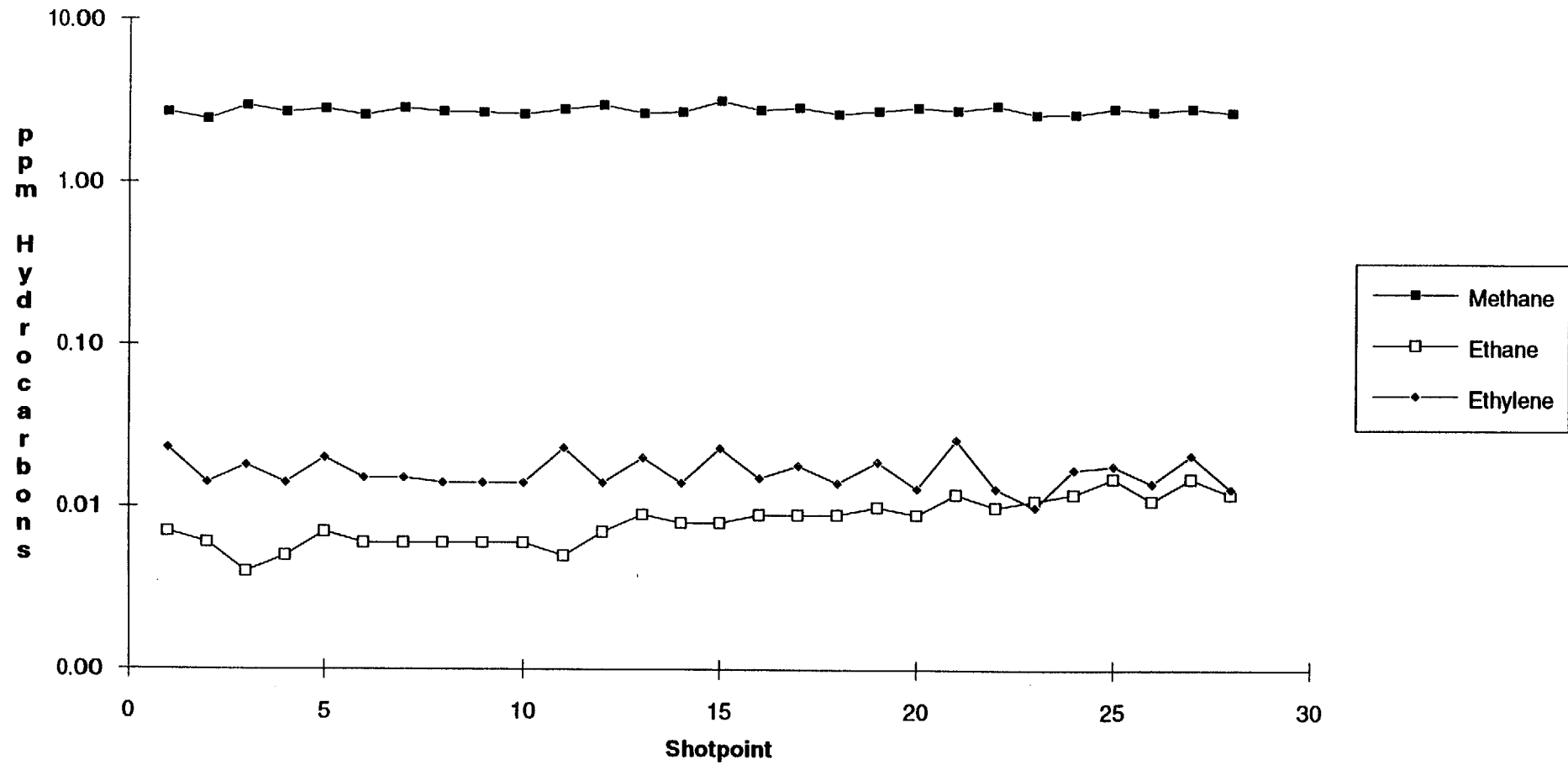
Notes

Ethane increasing to two times background by shotpoint 28.
No propylene detected.

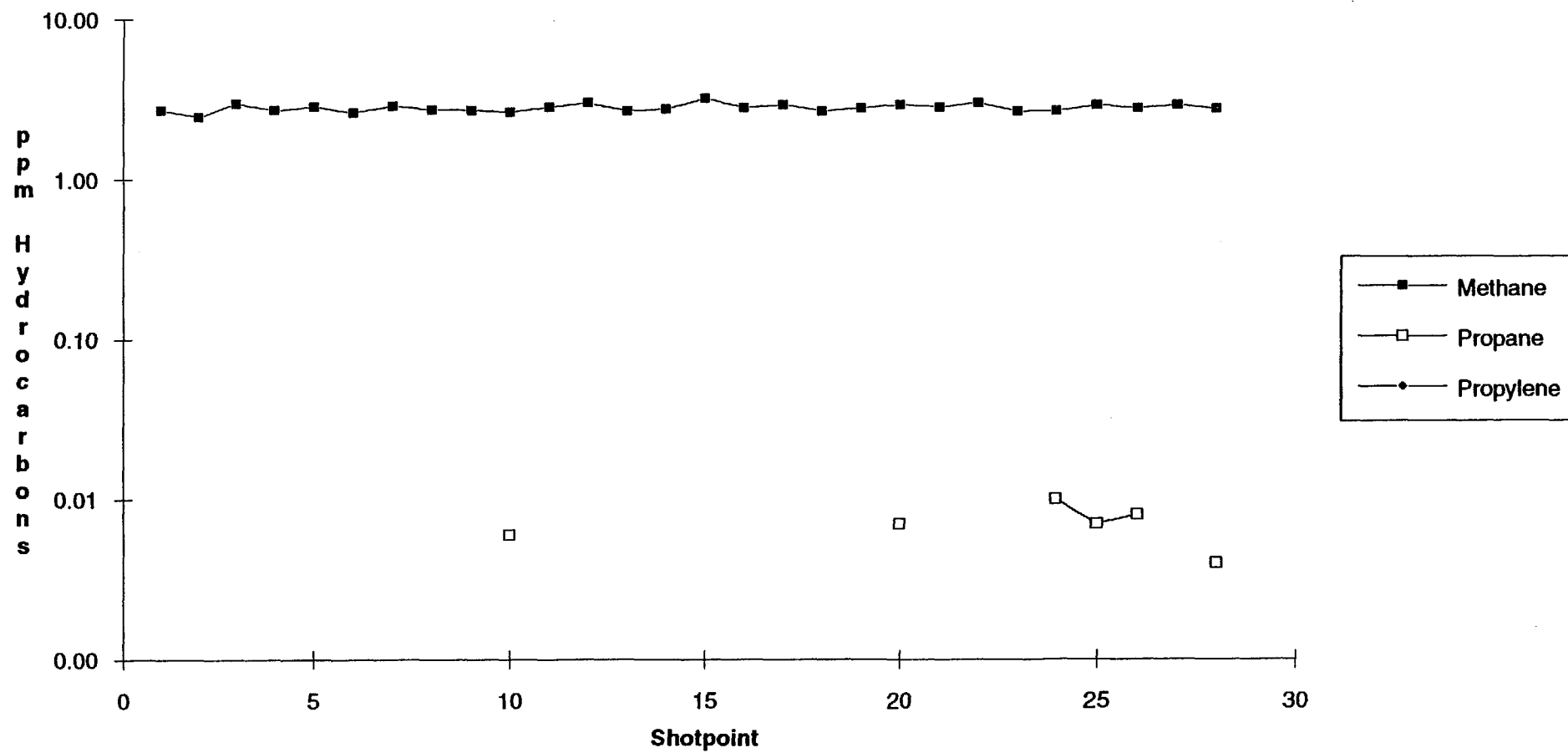
Line 104052 THC, Methane



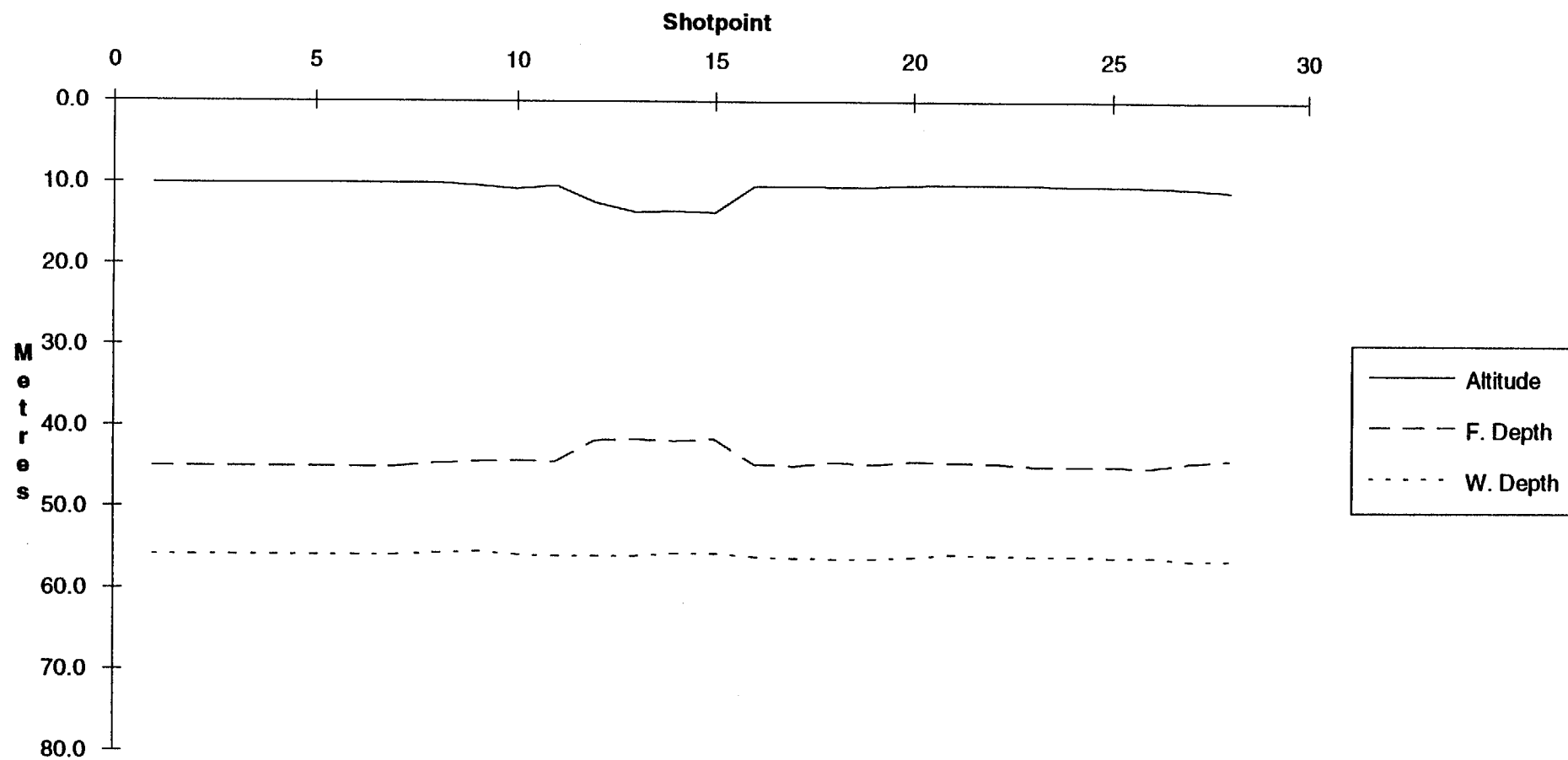
Line 104052 Methane, Ethane, Ethylene



Line 104052 Methane, Propane, Propylene



Line 104052 Depths, Altitude



Line Summary

Line Number 104053
No. of Shotpoints 33

	Shotpoint	Date	Time	Latitude	Longitude
Start	1	06-Oct-91	13:41:05	38 04.803	148 13.799
End	33	06-Oct-91	14:47:06	38 09.940	148 14.368

	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	13.577	5.502	0.259	0.016	0.157	0.000	0.027	0.051	0.035	0.051	0.080	0.000	5.740
Std. Dev.	6.861	2.703	0.294	0.004	0.193	0.000	0.040	0.065	0.017	0.015	0.025	0.000	4.885
Minimum	7.007	2.755	0.014	0.010	0.008	0.000	0.000	0.000	0.012	0.029	0.040	0.000	0.748
Maximum	31.273	11.263	0.940	0.028	0.623	0.000	0.138	0.187	0.060	0.074	0.138	0.000	15.706

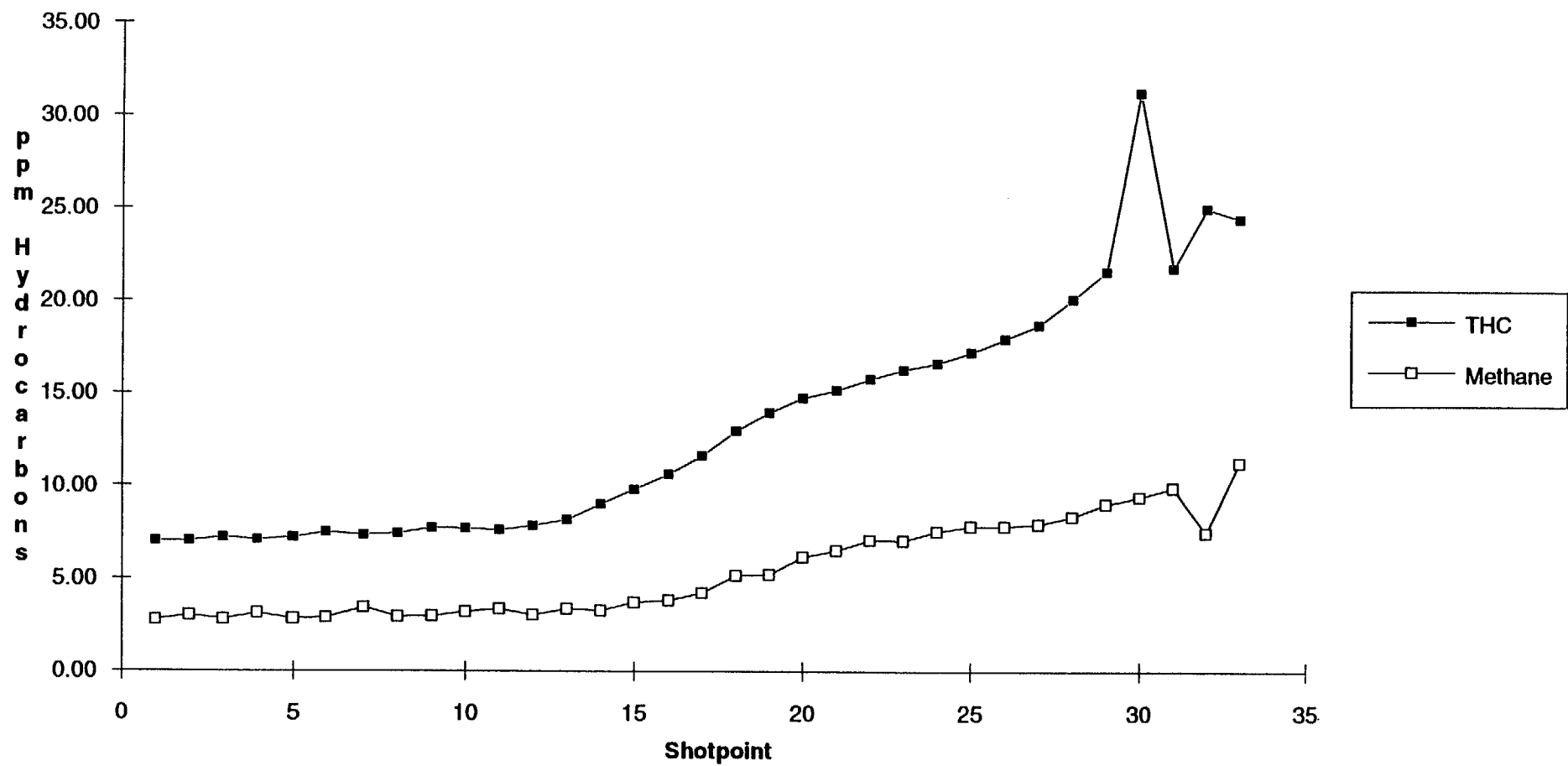
	Cond.	Temp.	Altitude	F. Depth	W.Depth
Mean	45.856	14.062	10.518	45.797	57.133
Std. Dev.	0.053	0.040	0.608	1.277	0.977
Minimum	45.790	14.000	9.400	44.000	55.800
Maximum	45.970	14.130	12.400	47.500	58.600

Notes

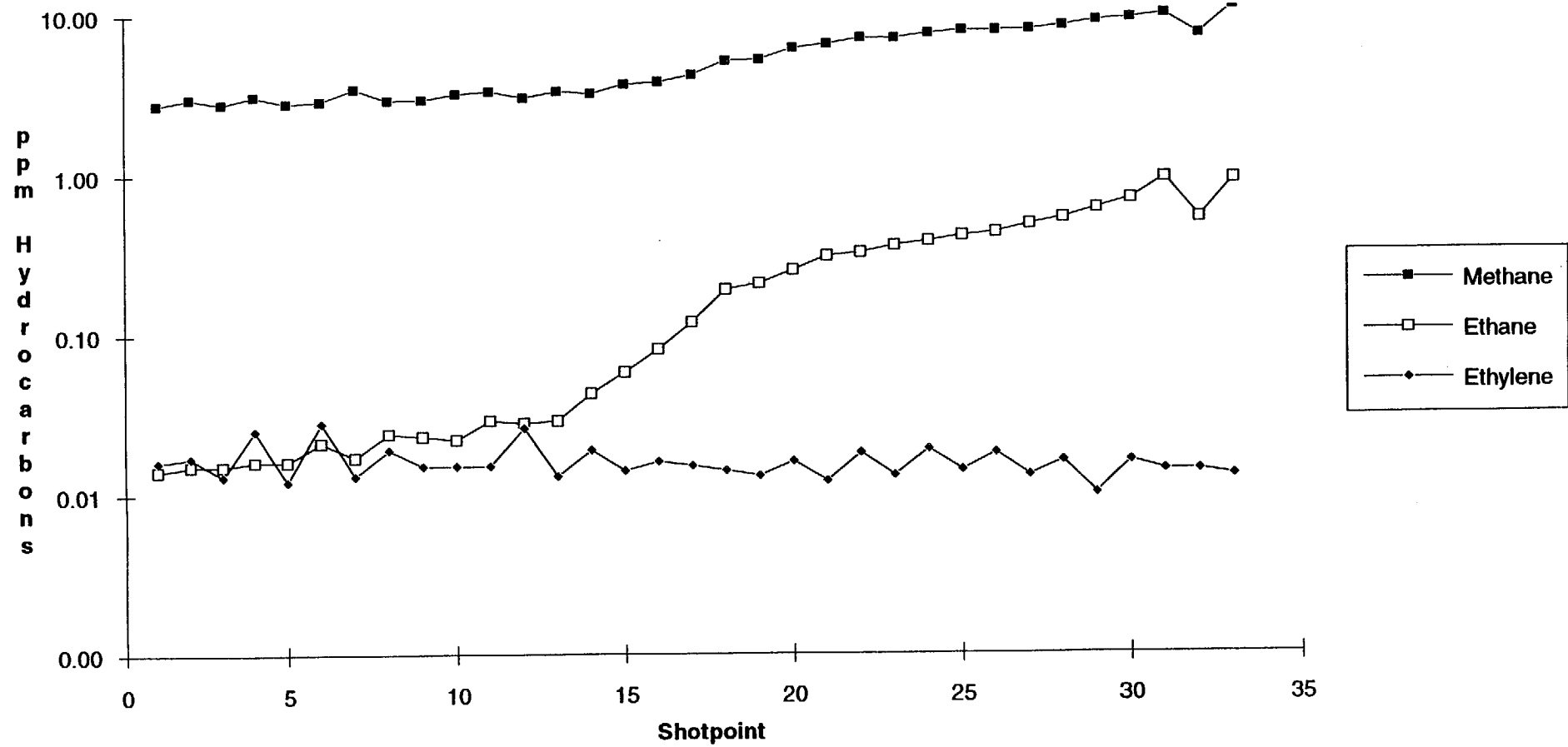
Strong THC, methane, ethane and propane anomaly increasing from shotpoint 7 to end of line.

No propylene detected

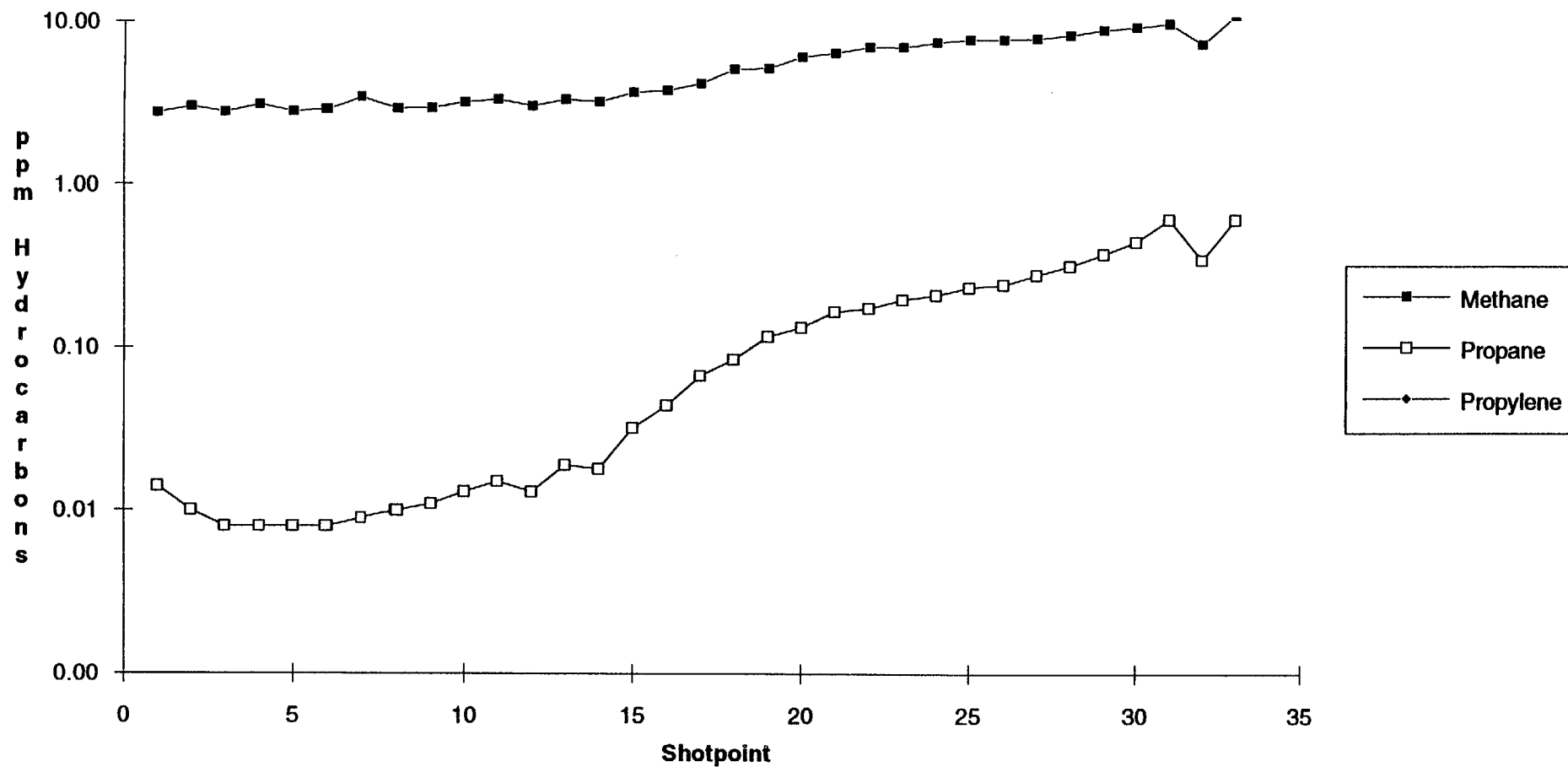
Line 104053 THC, Methane



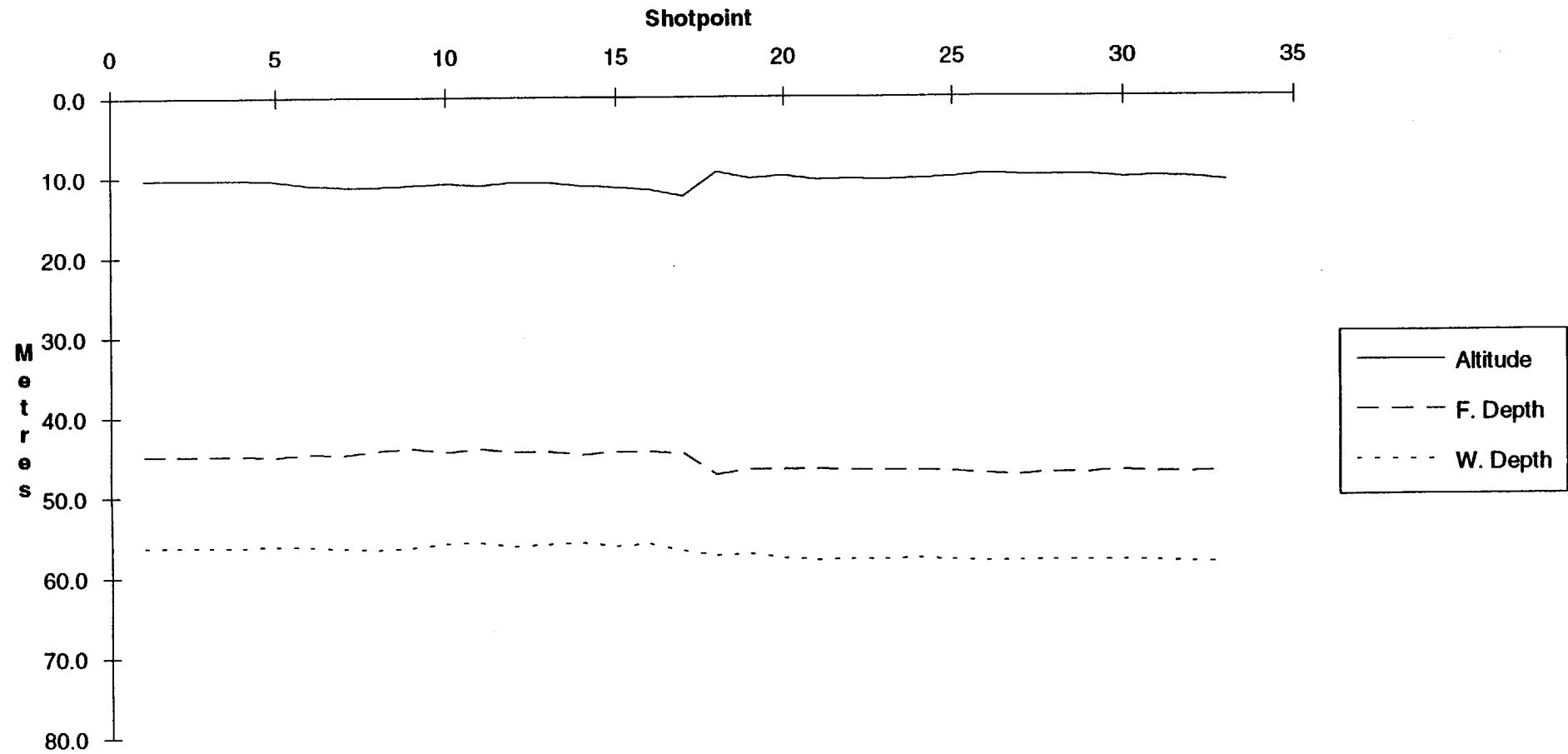
Line 104053 Methane, Ethane, Ethylene



Line 104053 Methane, Propane, Propylene



Line 104053 Depths, Altitude



Line Summary

Line Number 104055
No. of Shotpoints 35

	Shotpoint	Date	Time	Latitude		Longitude	
Start	1	06-Oct-91	14:49:19	38	10.015	148	14.989
End	35	06-Oct-91	15:59:54	38	04.905	148	16.058

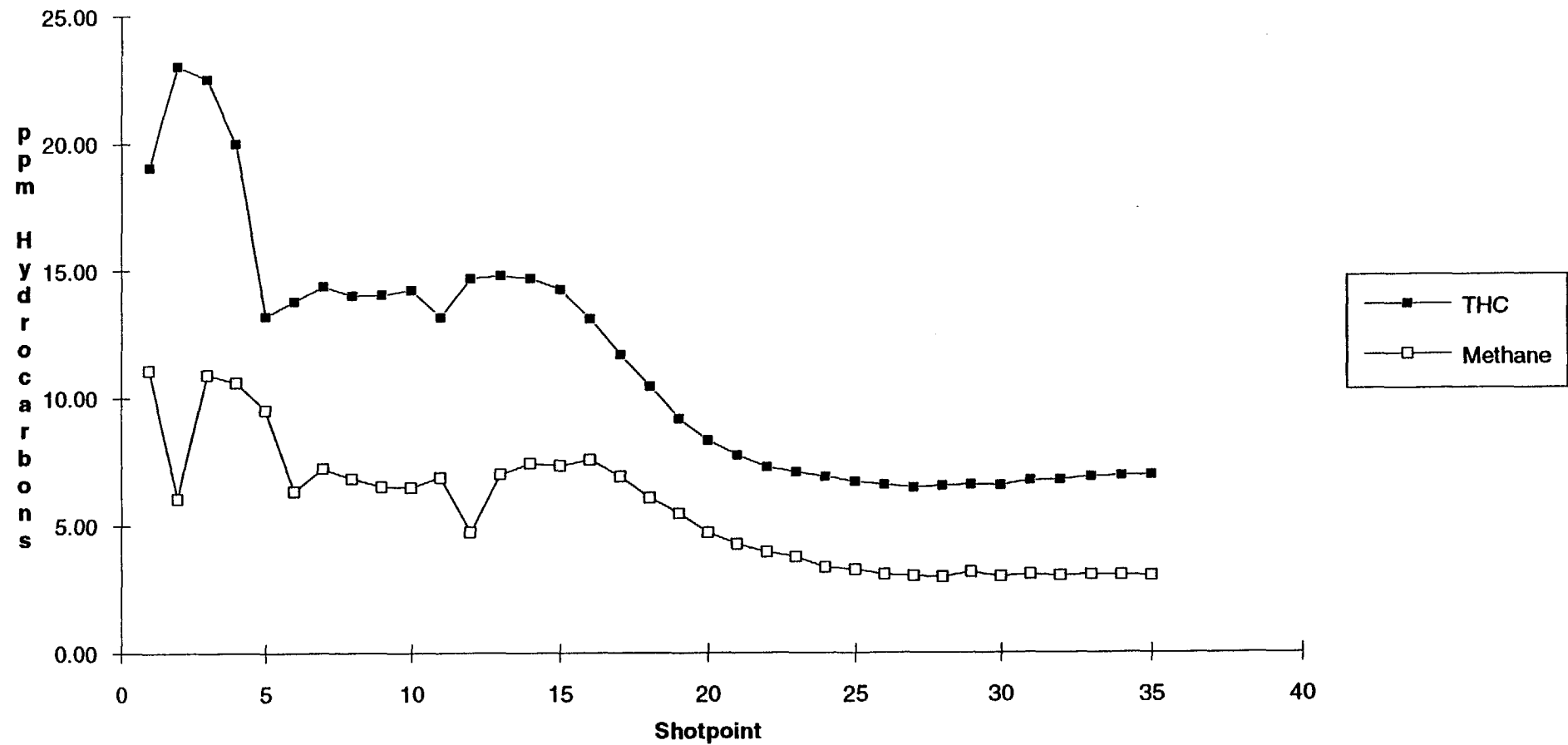
	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	11.384	5.812	0.266	0.016	0.160	0.000	0.020	0.038	0.029	0.052	0.082	0.000	5.782
Std. Dev.	4.952	2.663	0.258	0.005	0.163	0.000	0.027	0.054	0.015	0.015	0.027	0.000	4.057
Minimum	6.451	2.966	0.018	0.008	0.011	0.000	0.000	0.000	0.008	0.025	0.029	0.000	1.002
Maximum	23.025	11.079	0.872	0.030	0.579	0.000	0.089	0.192	0.063	0.088	0.136	0.000	13.520

	Cond.	Temp.	Altitude	F. Depth	Altitude
Mean	45.837	14.040	9.997	46.049	57.043
Std. Dev.	0.038	0.022	0.446	0.840	1.066
Minimum	45.780	14.000	9.100	44.800	55.500
Maximum	45.910	14.060	10.700	47.100	58.600

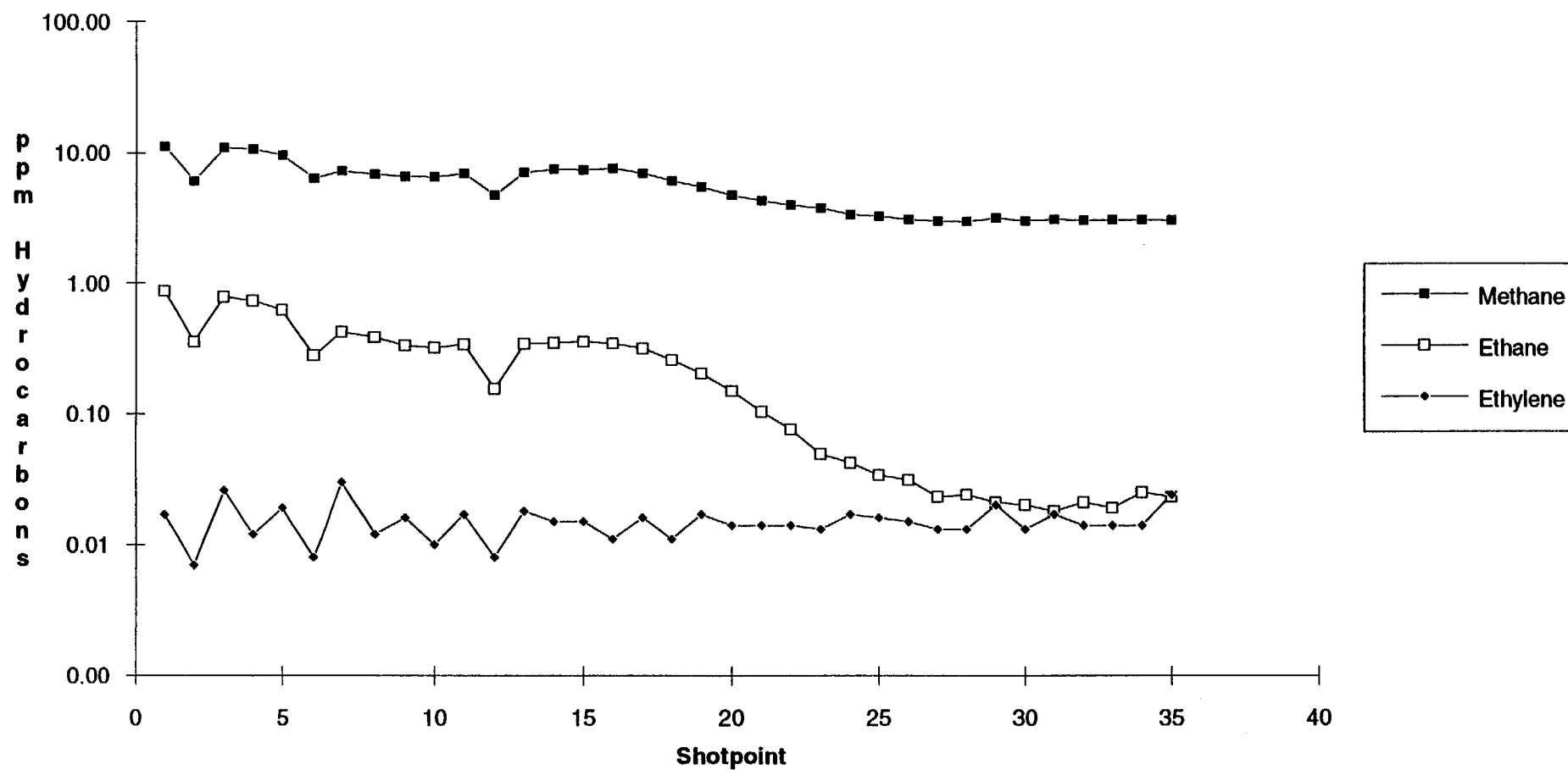
Notes

Strong THC, methane, ethane, propane, and butane anomaly at start of line, decreasing to background towards end of line.
No propylene detected

Line 104055 THC, Methane



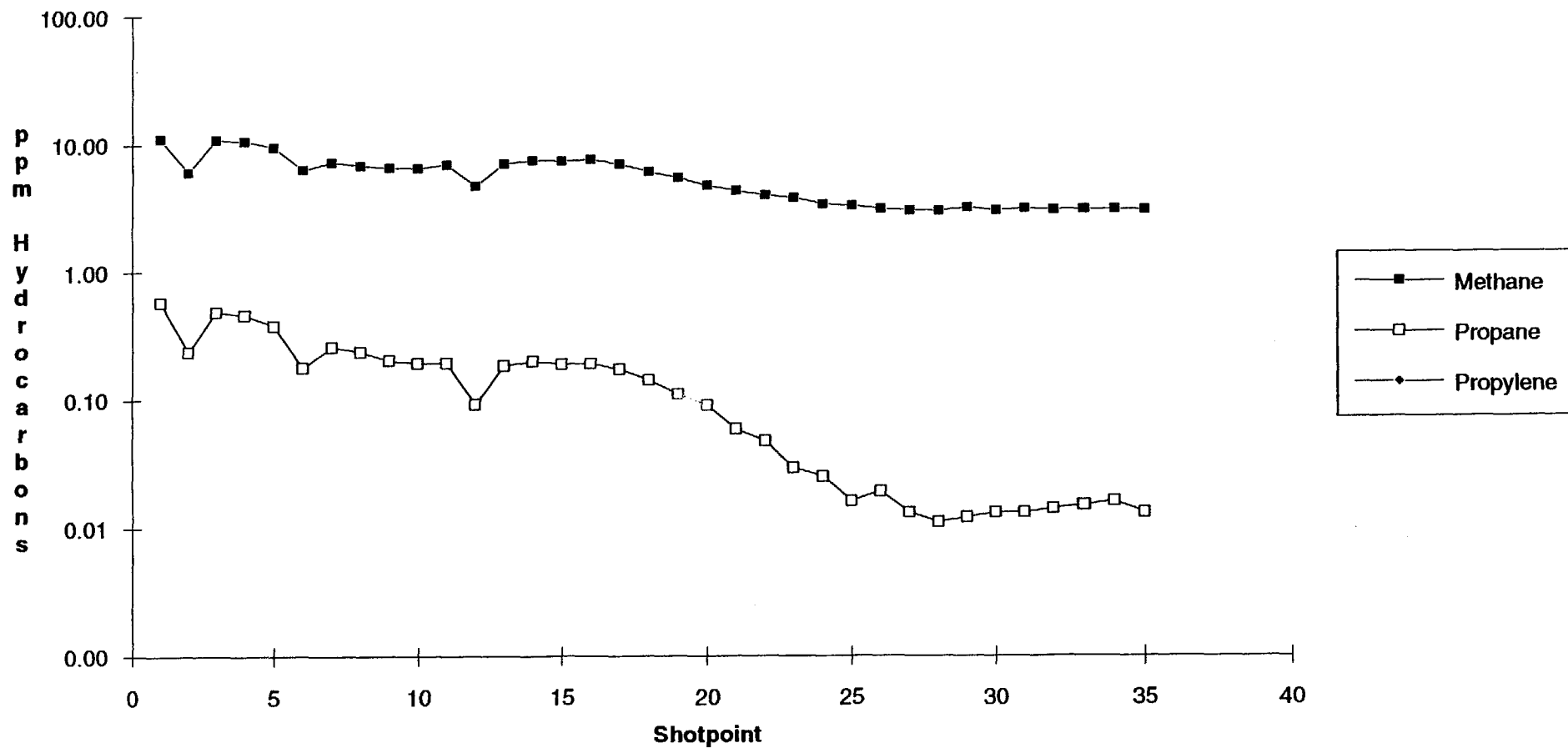
Line 104055 Methane, Ethane, Ethylene



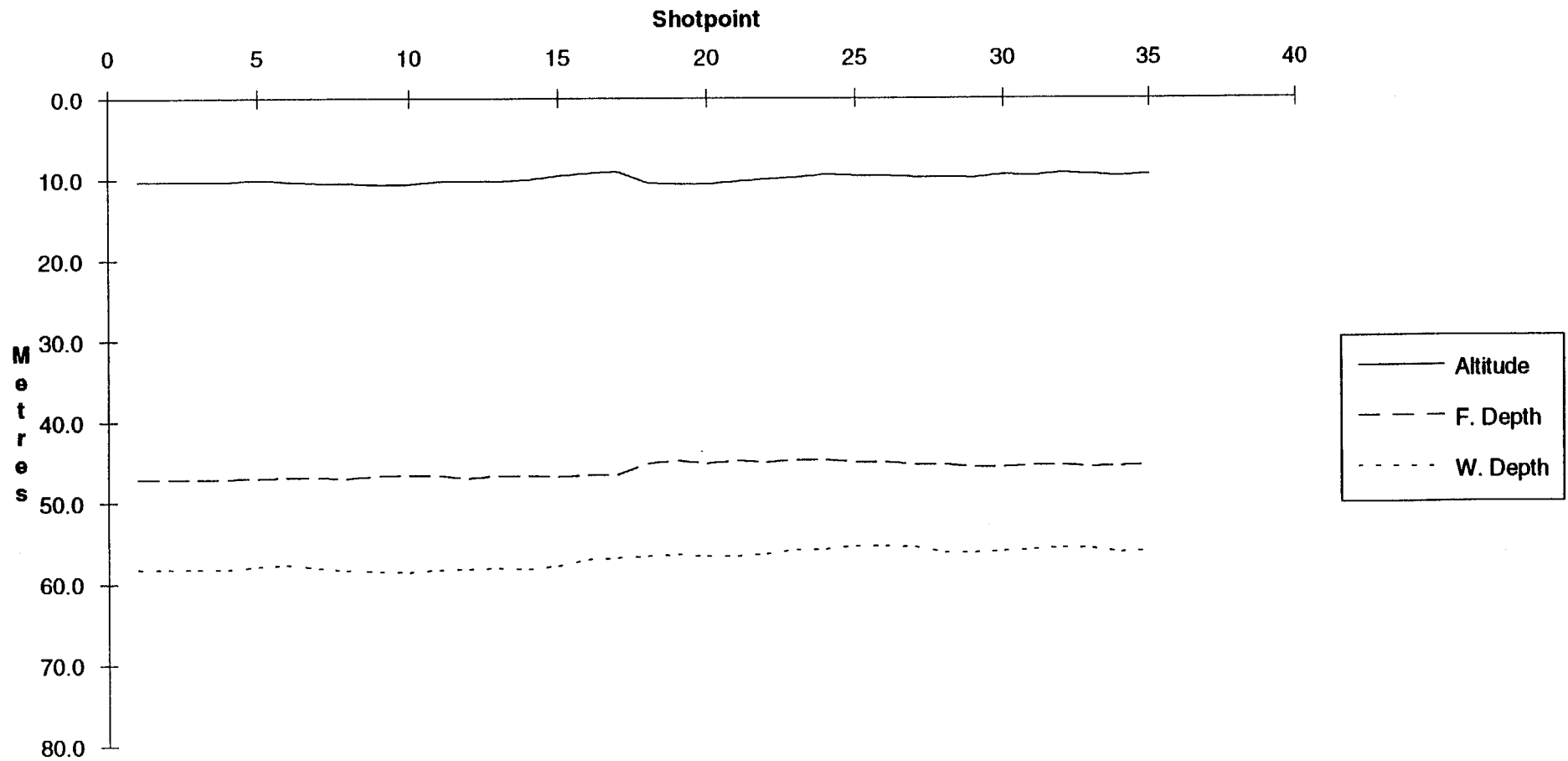
R9205405



Line 104055 Methane, Propane, Propylene



Line 104055 Depths, Altitude



Line Summary

Line Number 104057
No. of Shotpoints 33

	Shotpoint	Date	Time	Latitude	Longitude
Start	1	06-Oct-91	16:01:54	38 04.727	148 16.799
End	33	06-Oct-91	17:08:29	38 09.902	148 17.233

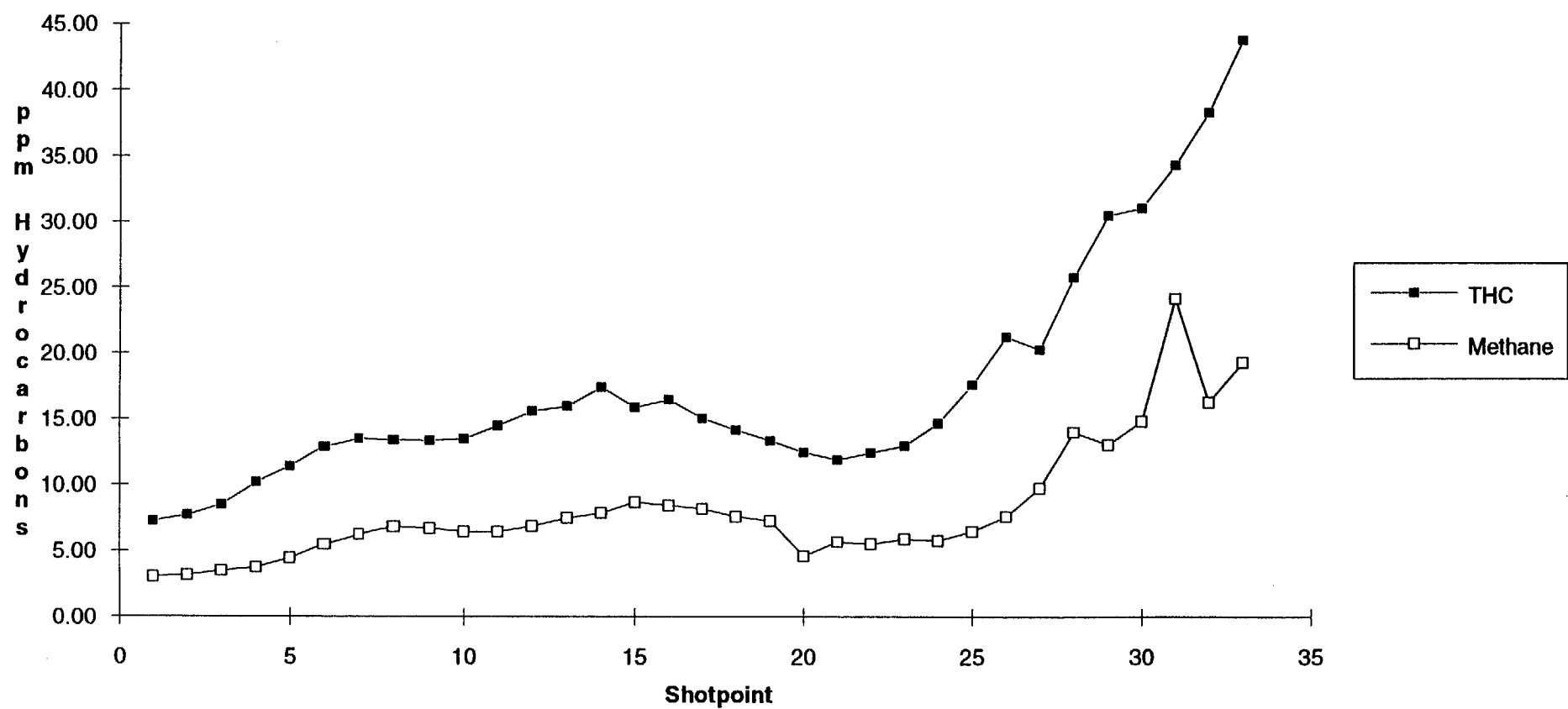
	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	17.471	8.429	0.459	0.016	0.252	0.000	0.038	0.065	0.040	0.080	0.077	0.007	7.459
Std. Dev.	8.795	5.078	0.442	0.004	0.245	0.000	0.040	0.079	0.021	0.056	0.039	0.017	2.565
Minimum	7.239	3.059	0.028	0.012	0.020	0.000	0.000	0.000	0.010	0.029	0.022	0.000	1.890
Maximum	43.801	24.143	1.812	0.026	1.001	0.000	0.148	0.285	0.093	0.223	0.151	0.059	12.273

	Cond.	Temp.	Altitude	F. Depth	W. Depth
Mean	45.783	13.996	9.709	46.748	57.461
Std. Dev.	0.025	0.032	0.600	0.900	0.772
Minimum	45.740	13.960	8.800	45.000	56.100
Maximum	45.830	14.060	11.500	47.800	58.600

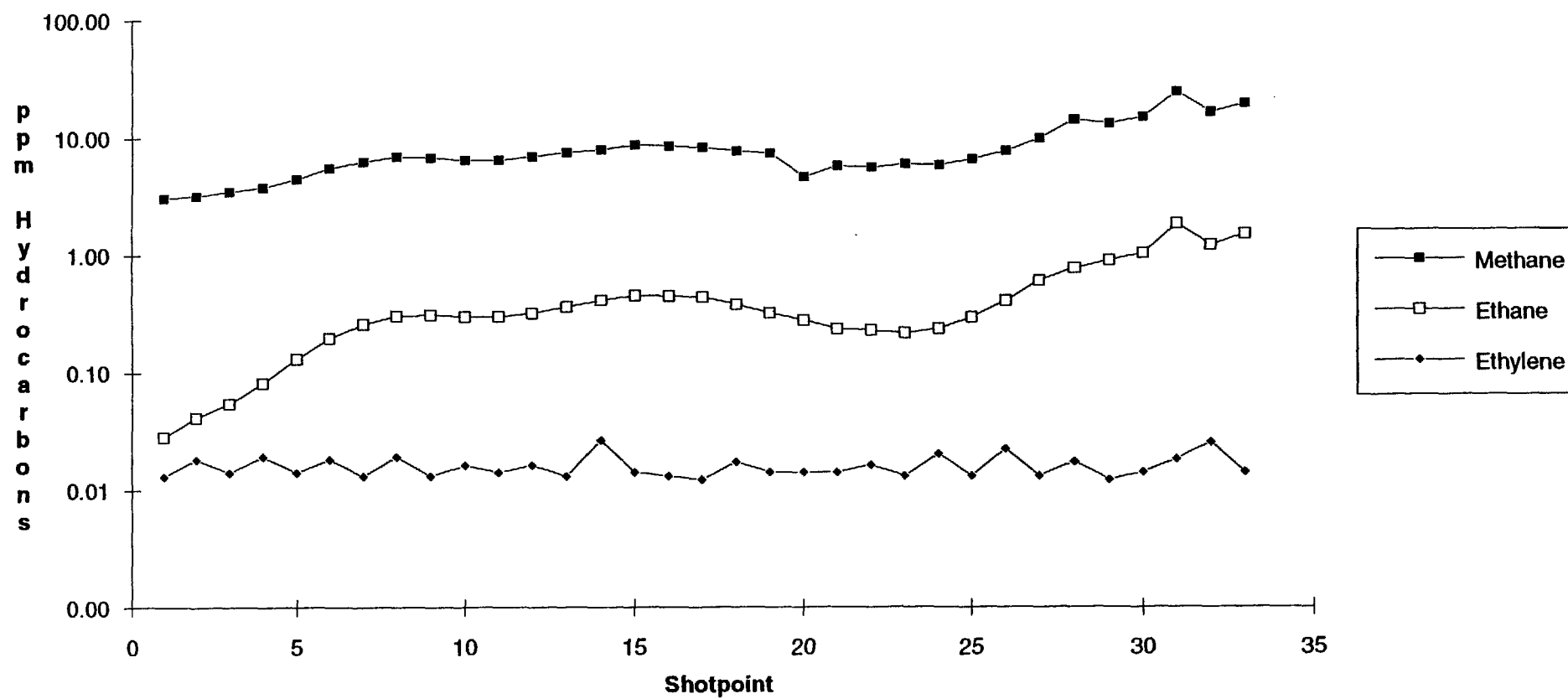
Notes

Strong THC, methane, ethane, propane, and butane anomaly detected from middle to end of line.
No propylene detected

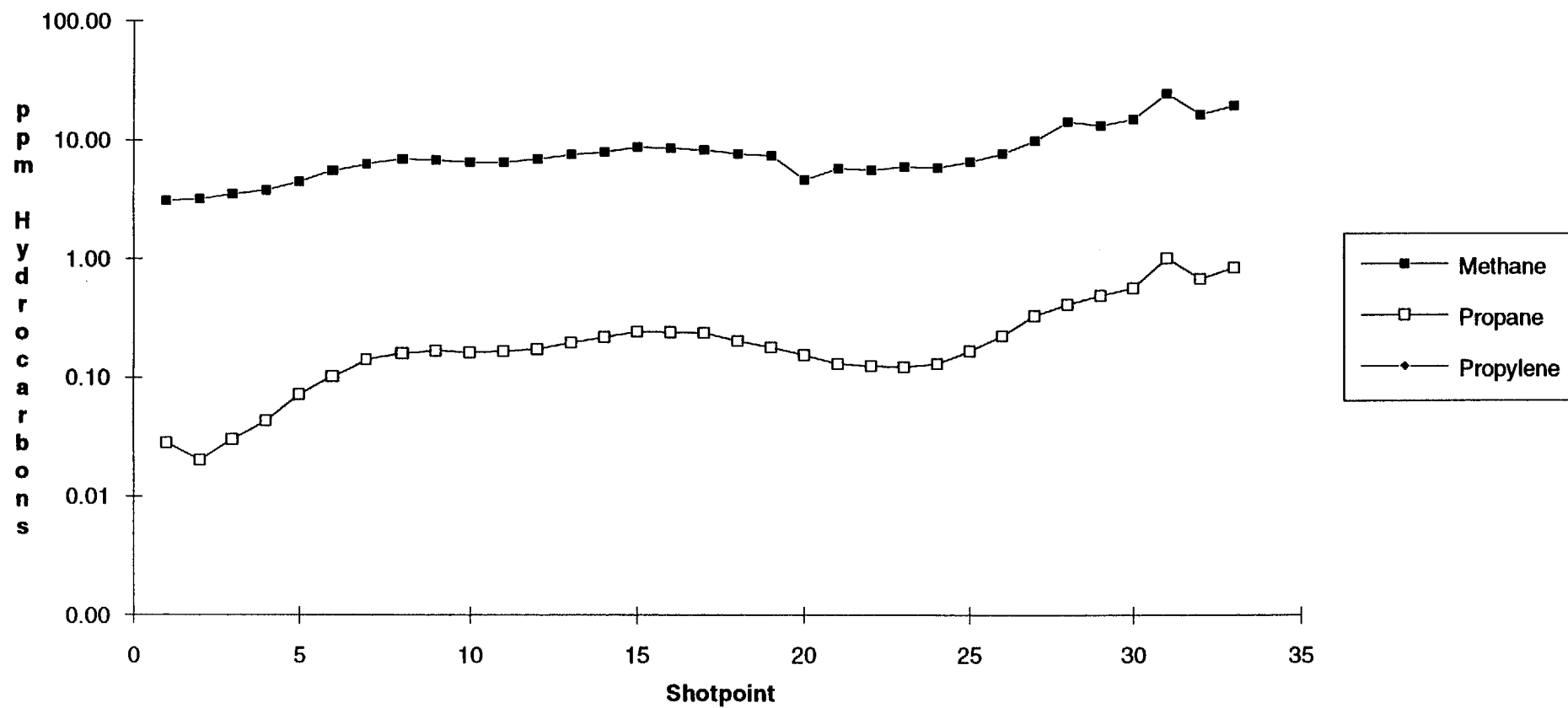
Line 104057 THC, Methane



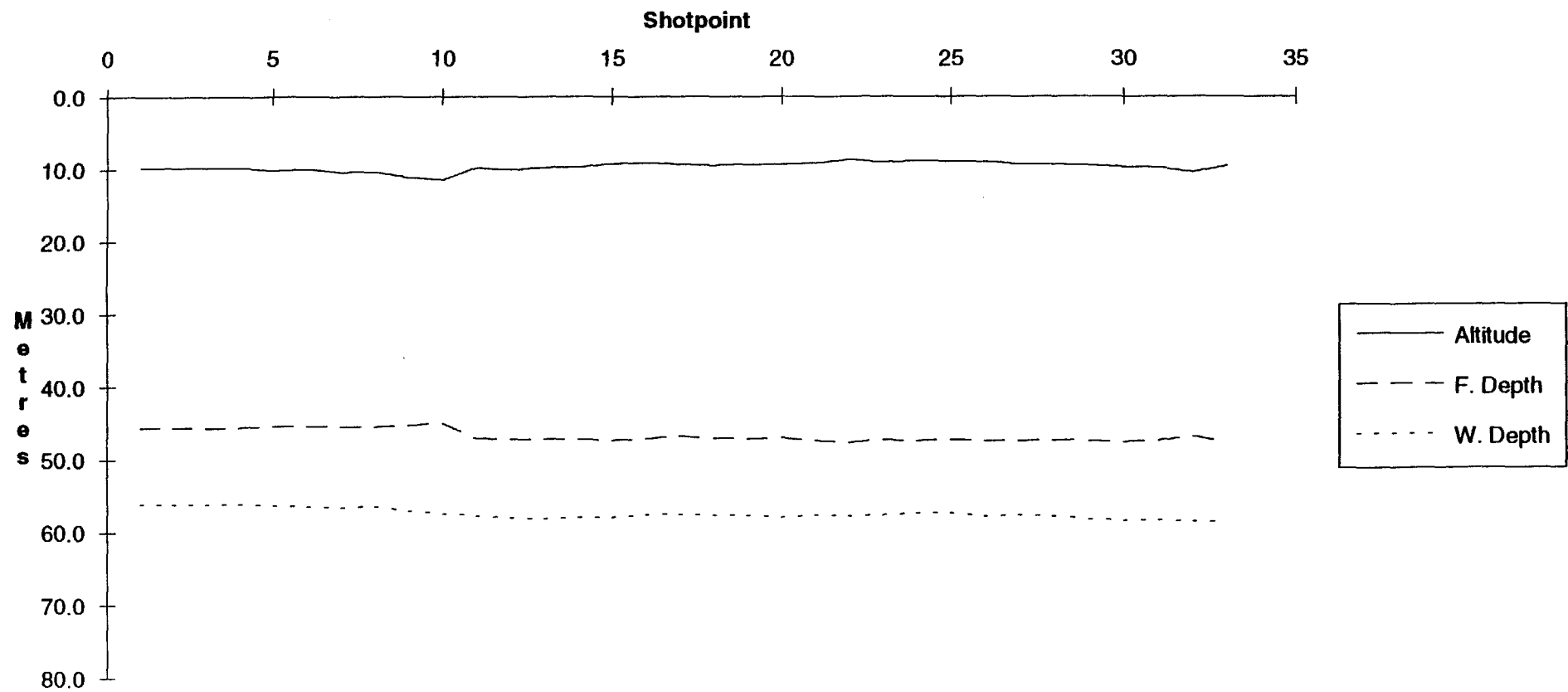
Line 104057 Methane, Ethane, Ethylene



Line 104057 Methane, Propane, Propylene



Line 104057 Depths, Altitude



Line Summary

Line Number 104059
No. of Shotpoints 27

	Shotpoint	Date	Time	Latitude	Longitude
Start	1	06-Oct-91	17:10:45	38	09.999 148 17.699
End	27	06-Oct-91	18:05:52	38	06.082 148 20.641

	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	26.294	15.280	1.059	0.015	0.557	0.000	0.078	0.161	0.062	0.101	0.066	0.056	9.593
Std. Dev.	15.913	8.612	0.747	0.004	0.387	0.000	0.060	0.116	0.026	0.040	0.037	0.033	2.467
Minimum	8.650	5.165	0.189	0.009	0.104	0.000	0.000	0.000	0.029	0.052	0.023	0.012	5.441
Maximum	52.281	27.671	2.127	0.026	1.103	0.000	0.161	0.329	0.112	0.185	0.139	0.114	11.999

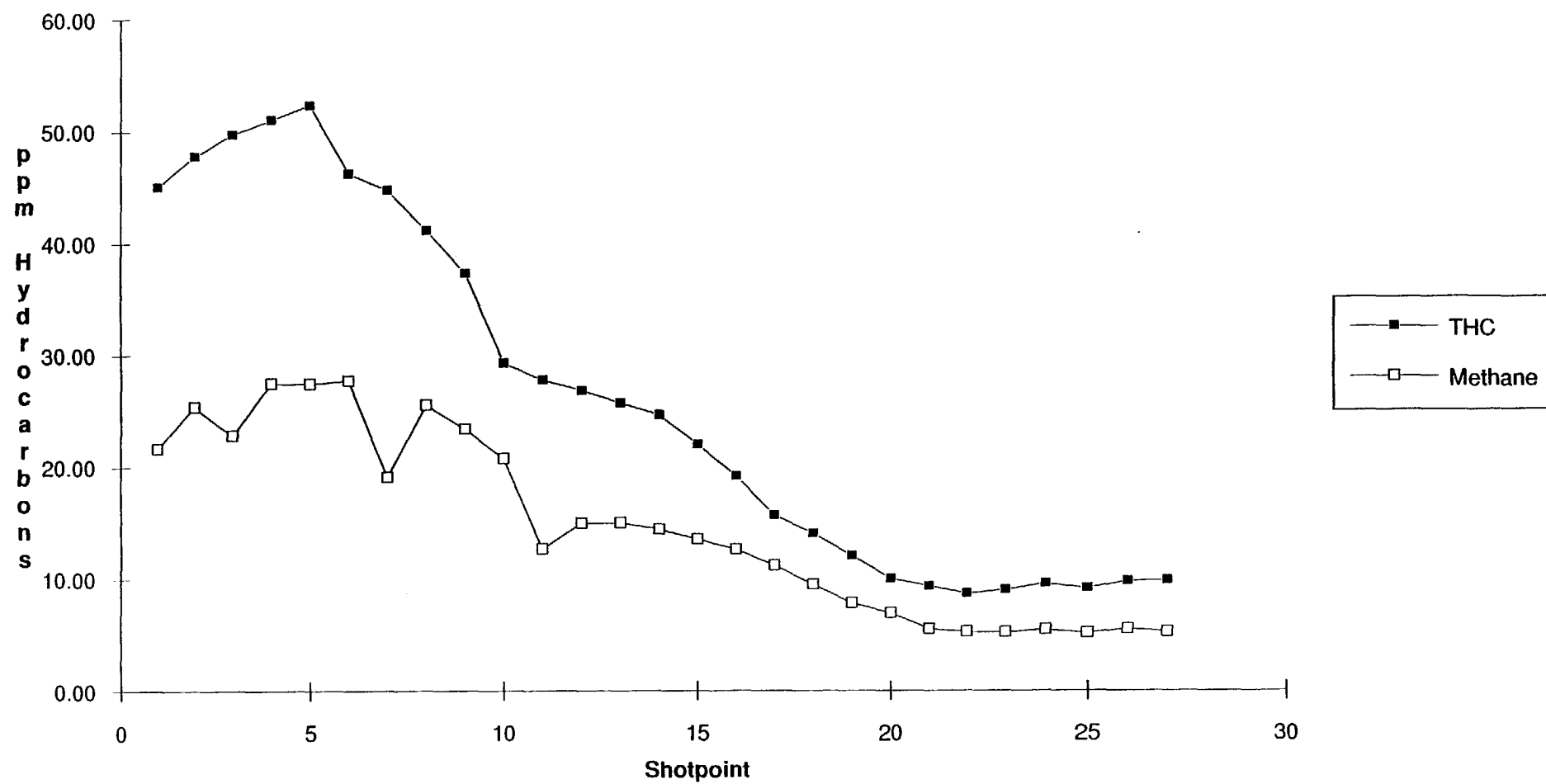
	Cond.	Temp.	Altitude	F. Depth	W.Depth
Mean	45.794	14.014	9.719	47.107	58.007
Std. Dev.	0.020	0.026	0.799	0.816	0.357
Minimum	45.750	13.960	8.400	46.000	57.300
Maximum	45.830	14.060	10.900	48.200	58.600

Notes

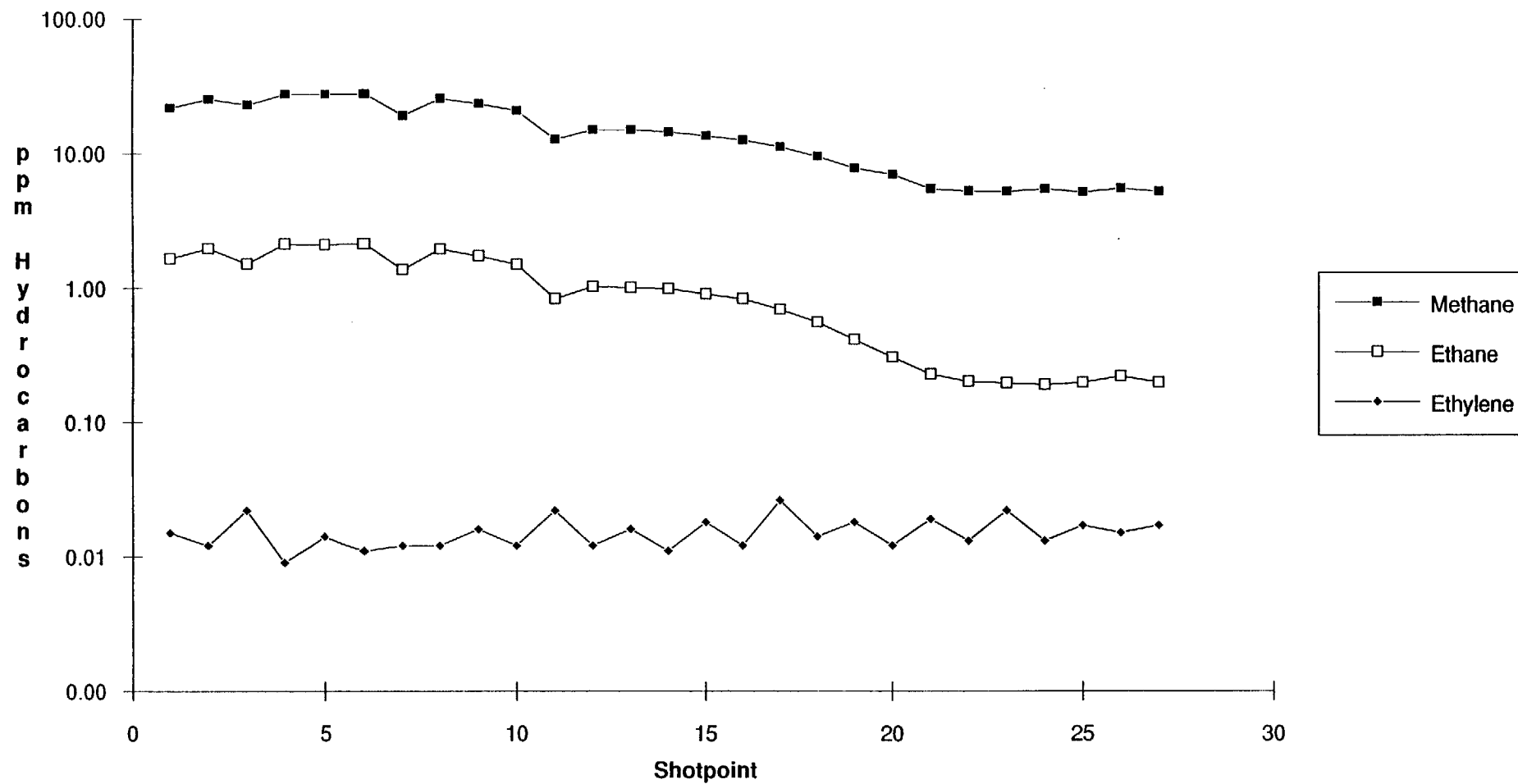
Strong THC, methane, ethane, propane, and butane anomaly at start of line, decreasing towards end of line.

No propylene detected

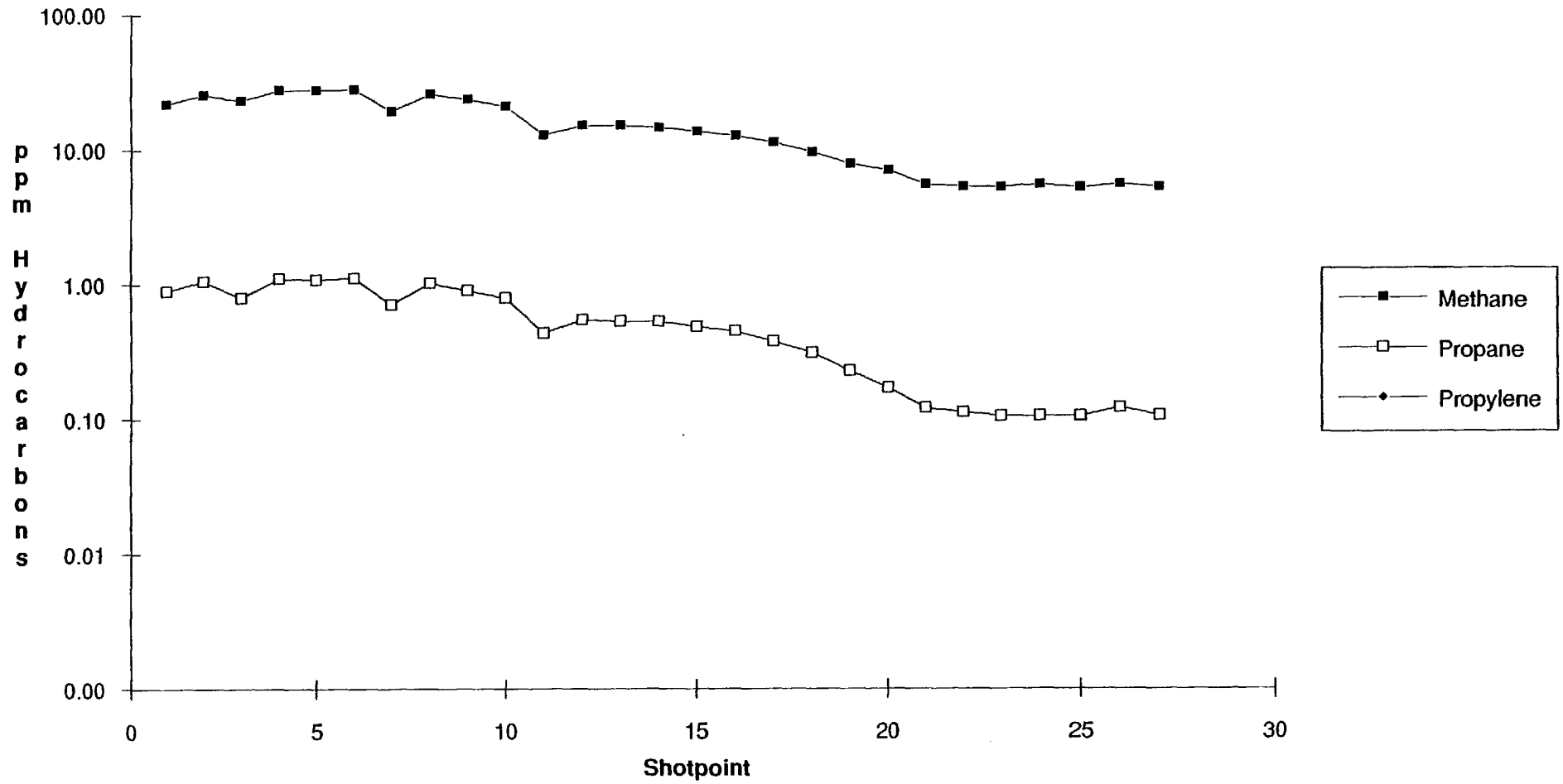
Line 104059 THC, Methane



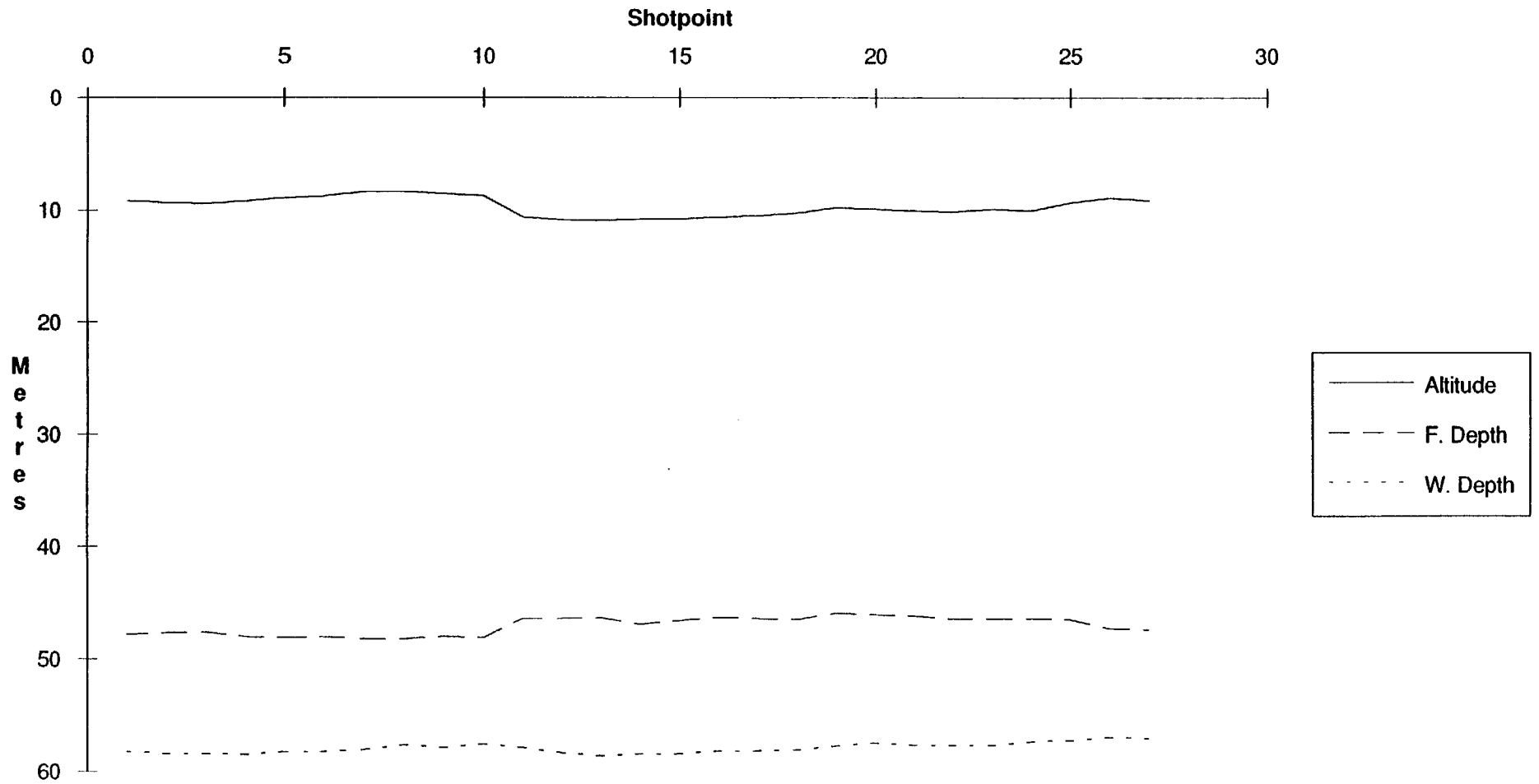
Line 104059 Methane, Ethane, Ethylene



Line 104059 Methane, Propane, Propylene



Line 104059 Depths, Altitude



Line Summary

Line Number 104060
No. of Shotpoints 40

	Shotpoint	Date	Time	Latitude	Longitude
Start	1	6-Oct-91	18:08:04	38 05.693	148 20.929
End	41	6-Oct-91	19:33:23	38 10.969	148 25.649

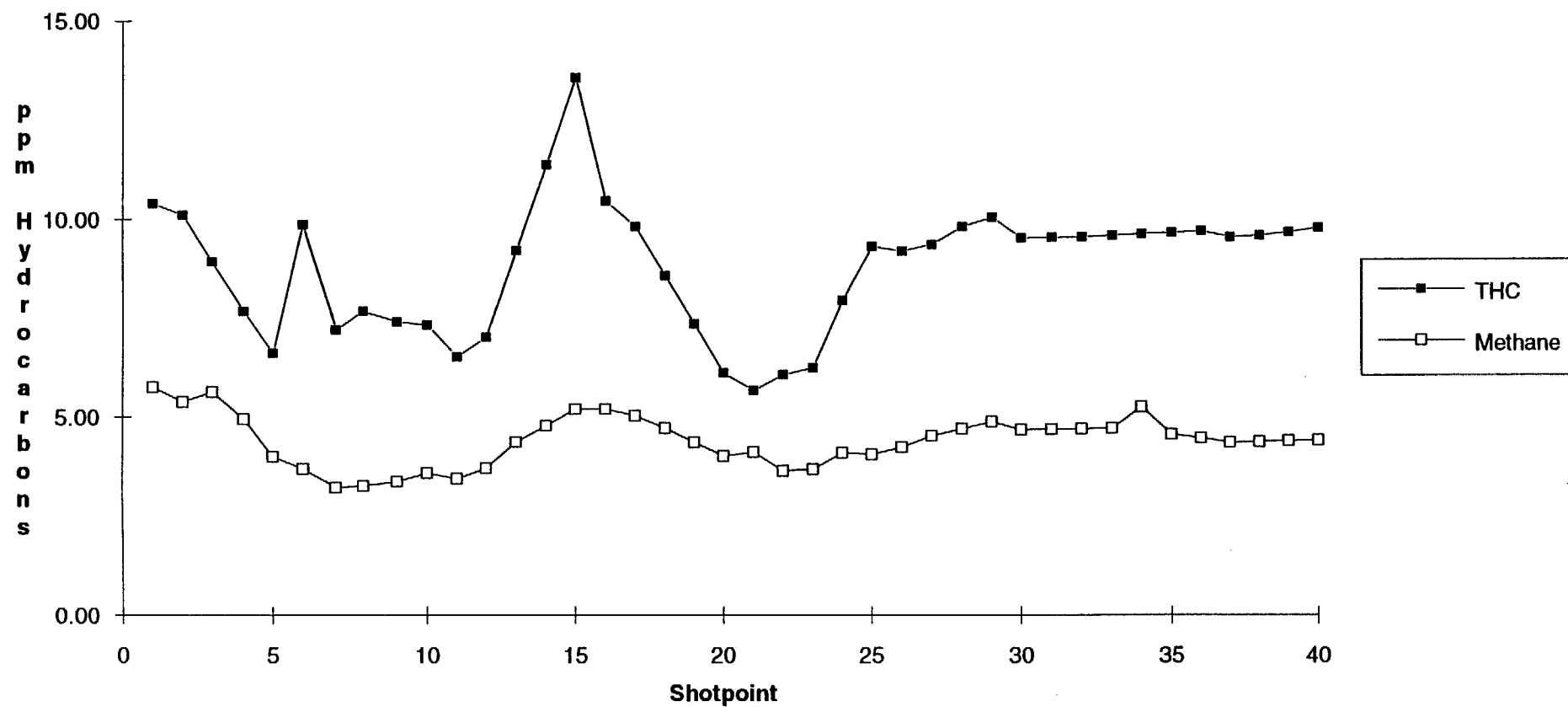
	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	8.814	4.394	0.086	0.015	0.051	0.000	0.004	0.003	0.082	0.134	0.061	0.121	3.026
Std. Dev.	1.654	0.640	0.053	0.002	0.029	0.000	0.012	0.012	0.096	0.136	0.092	0.472	1.501
Minimum	5.656	3.219	0.032	0.012	0.013	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.541
Maximum	13.558	5.753	0.223	0.022	0.118	0.000	0.045	0.049	0.373	0.478	0.361	2.786	7.175

	Cond.	Temp.	Altitude	F. Depth	W.Depth
Mean	45.539	13.852	10.898	47.998	59.903
Std. Dev.	0.156	0.095	0.829	0.703	1.447
Minimum	45.340	13.700	9.300	46.400	57.100
Maximum	45.760	14.000	12.700	48.900	62.500

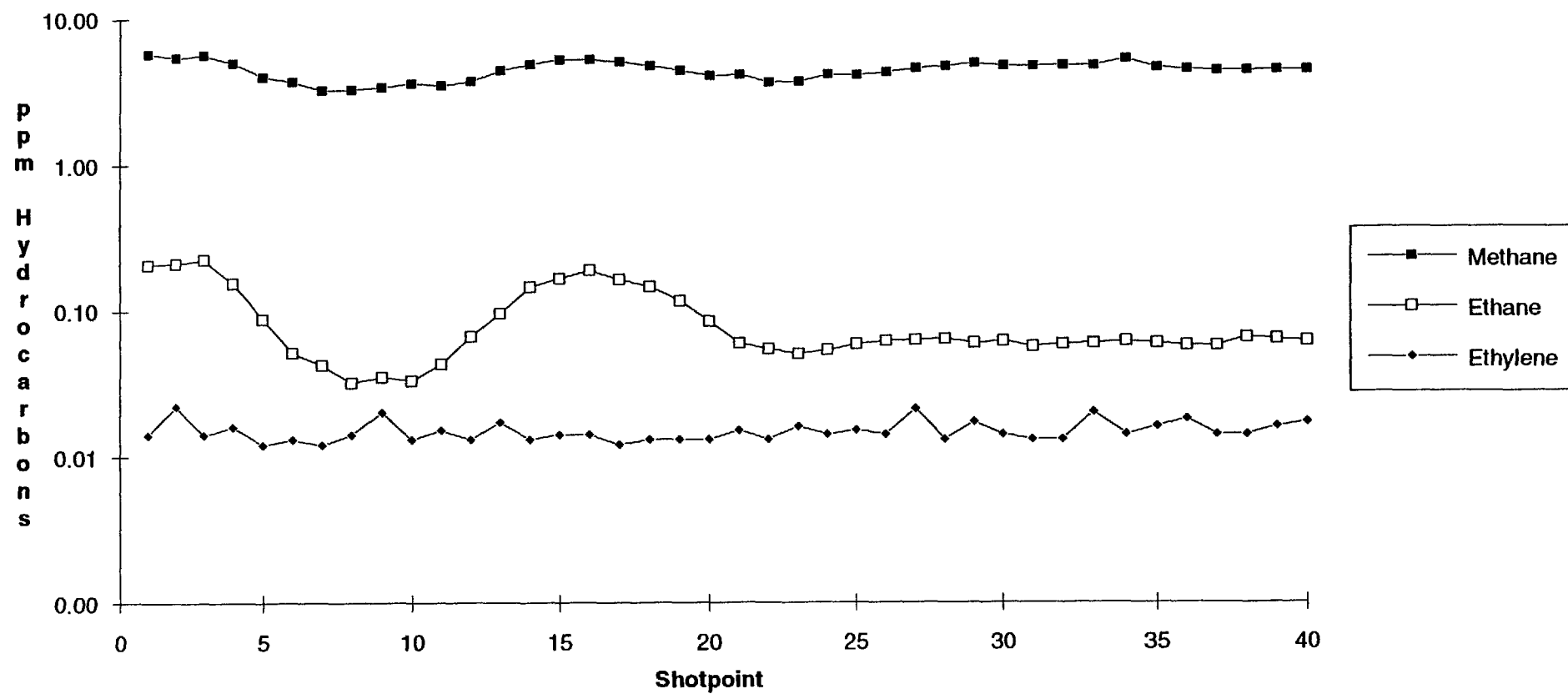
Notes

Weak to moderate THC, methane, ethane, propane, and butane anomalies detected at start and middle of line.
No propylene detected

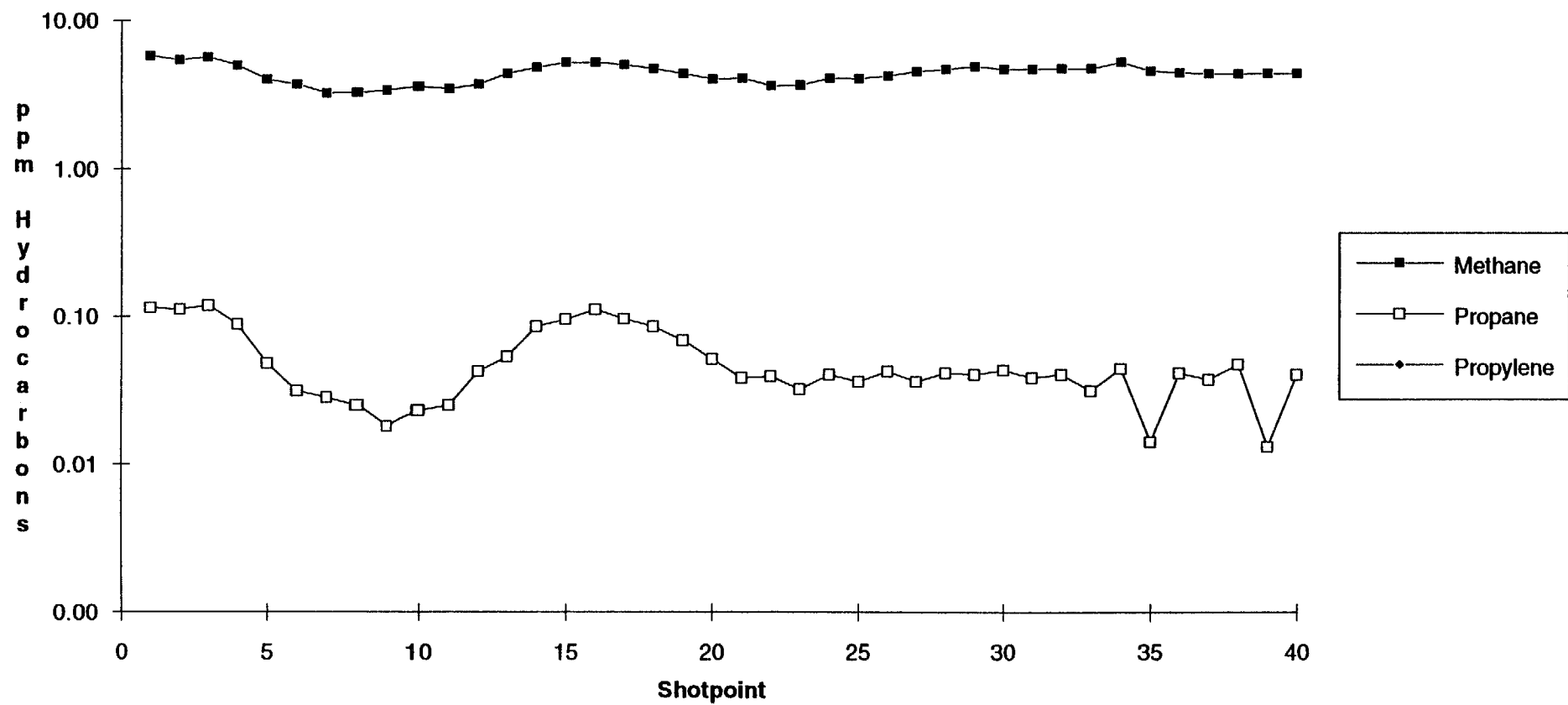
Line 104060 THC, Methane



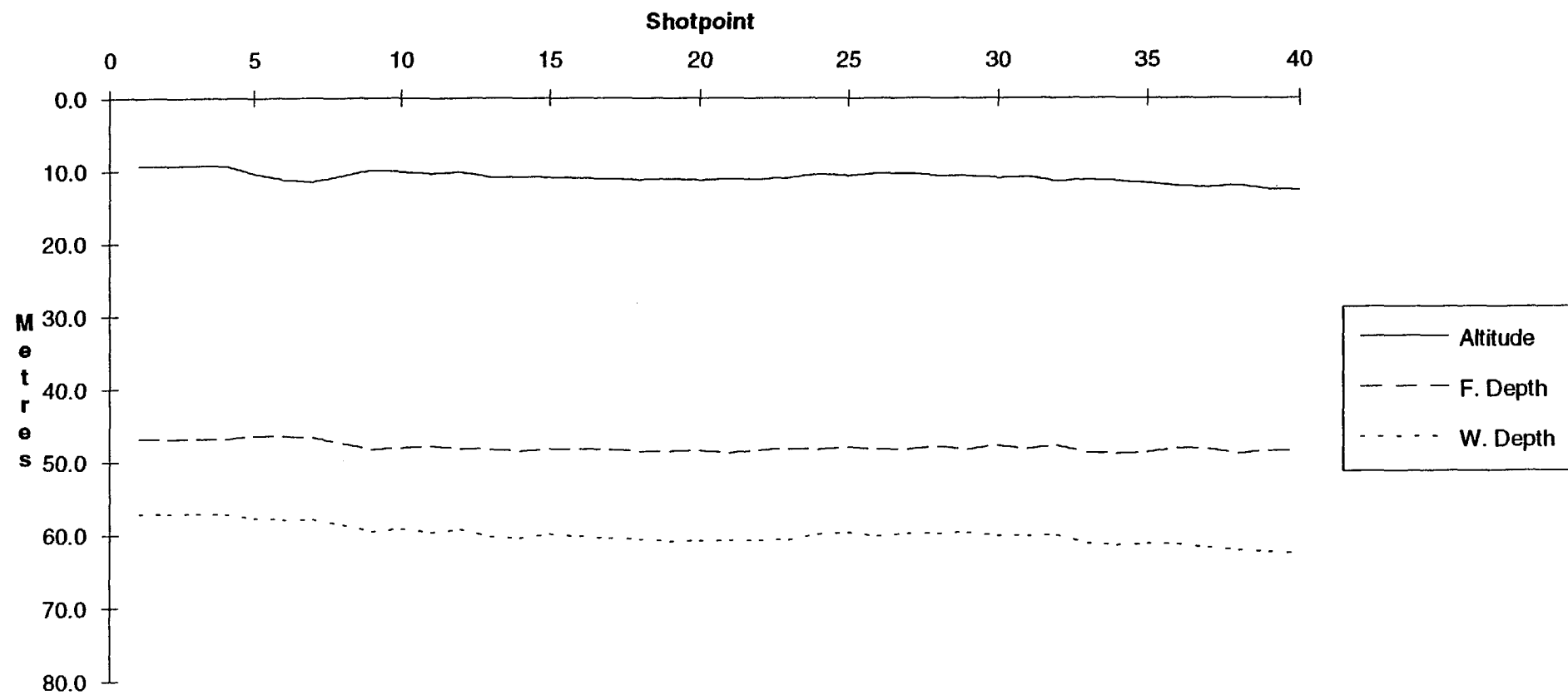
Line 104060 Methane, Ethane, Ethylene



Line 104060 Methane, Propane, Propylene



Line 104060 Depths, Altitude



Line Summary

Line Number 104061
No. of Shotpoints 74

	Shotpoint	Date	Time	Latitude	Longitude
Start	1	06-Oct-91	19:49:22	38	10.860 148 26.303
End	75	06-Oct-91	22:21:52	37	59.420 148 33.051

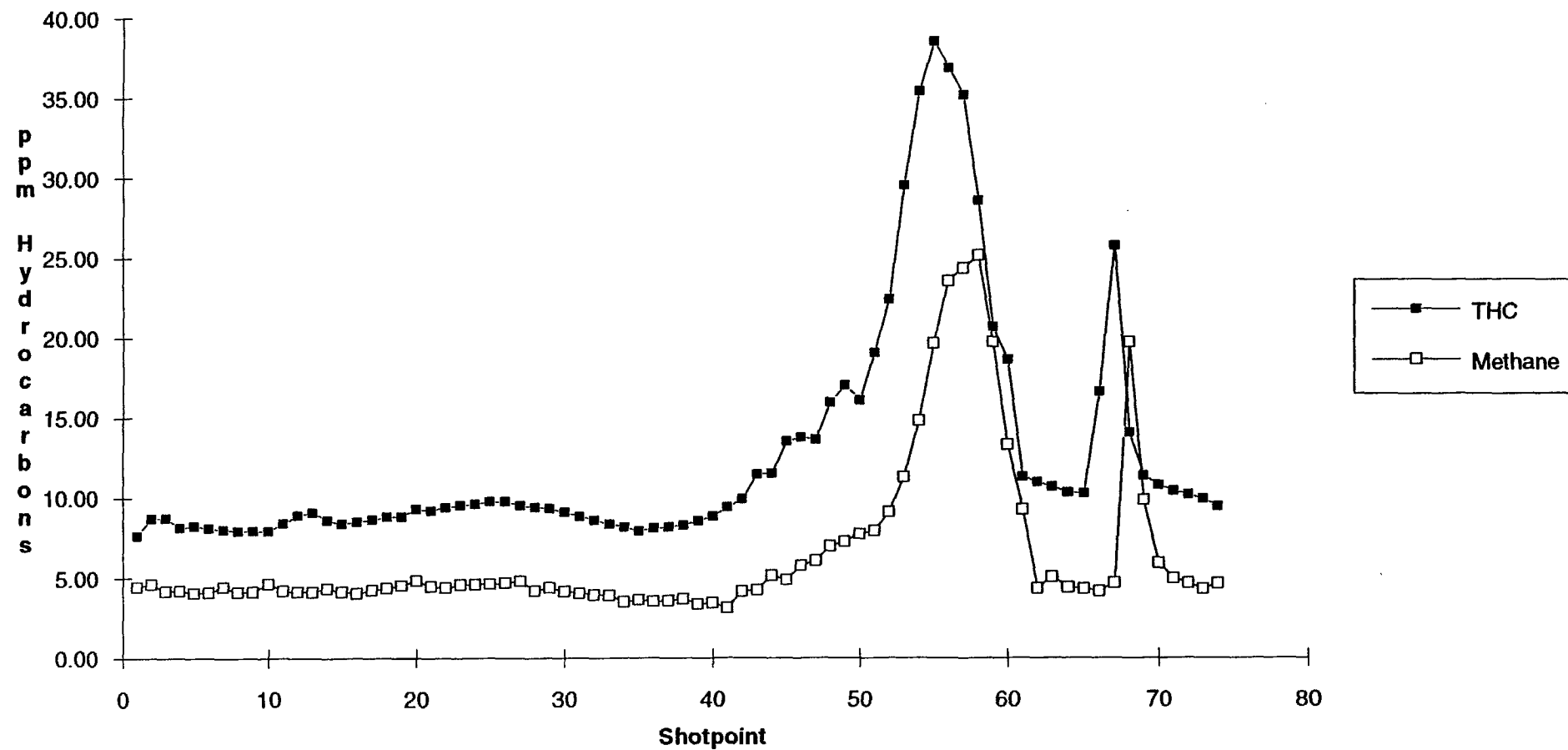
	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	12.639	6.502	0.093	0.017	0.047	0.000	0.001	0.003	0.033	0.040	0.060	0.024	2.342
Std. Dev.	7.406	5.142	0.059	0.006	0.022	0.000	0.006	0.016	0.044	0.052	0.090	0.040	0.856
Minimum	7.615	3.139	0.027	0.008	0.014	0.000	0.000	0.000	0.005	0.000	0.000	0.000	0.960
Maximum	38.510	25.117	0.231	0.036	0.100	0.000	0.037	0.110	0.229	0.280	0.483	0.125	5.008

	Cond.	Temp.	Altitude	F. Depth	W.Depth
Mean	45.713	14.023	10.258	45.782	57.146
Std. Dev.	0.299	0.197	1.177	3.475	3.570
Minimum	45.280	13.730	8.100	40.500	52.400
Maximum	46.160	14.360	12.600	53.100	64.100

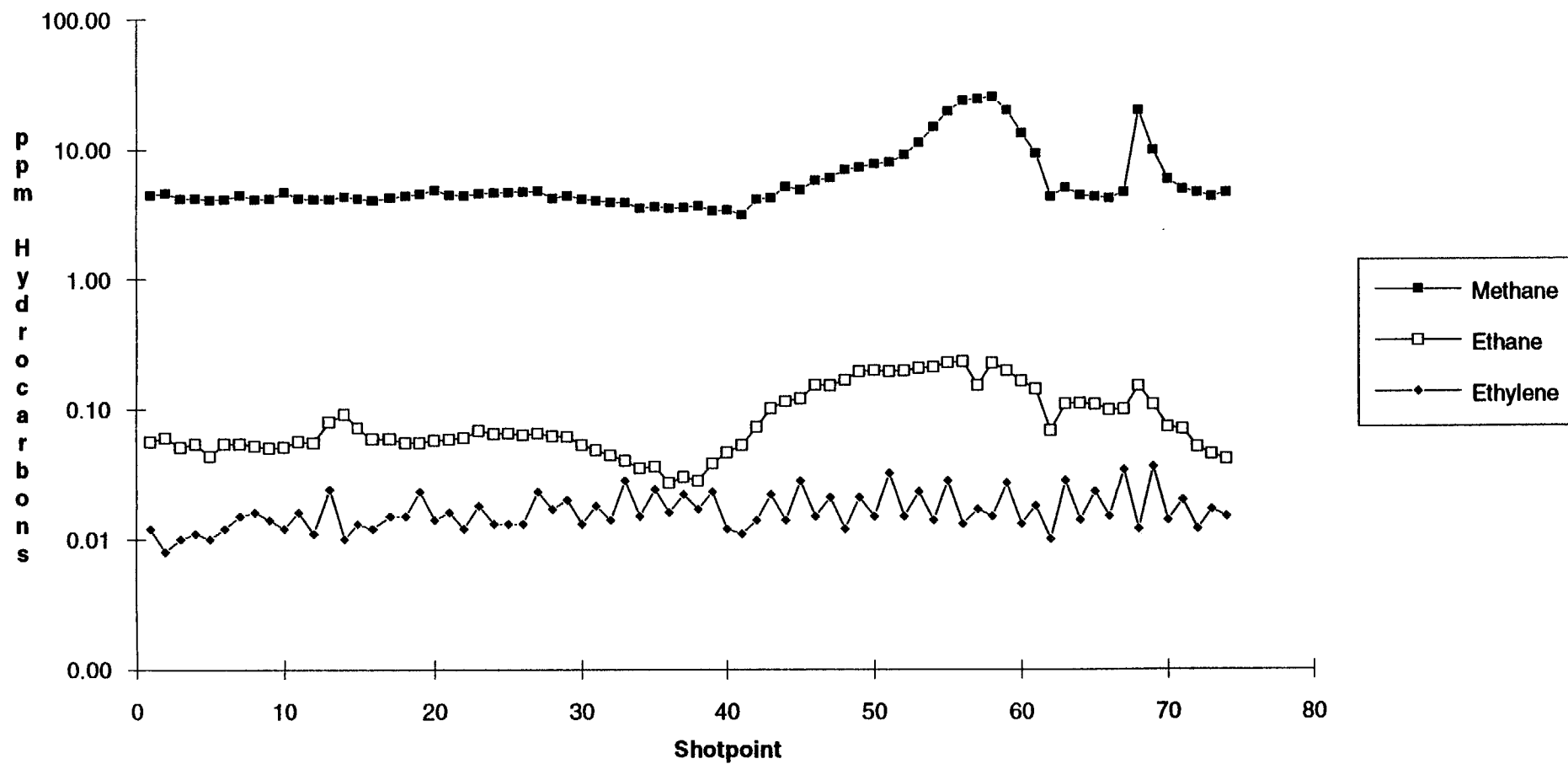
Notes

Moderate THC, methane, ethane, propane, and butane anomaly from sp 40 to 70.
No propylene detected

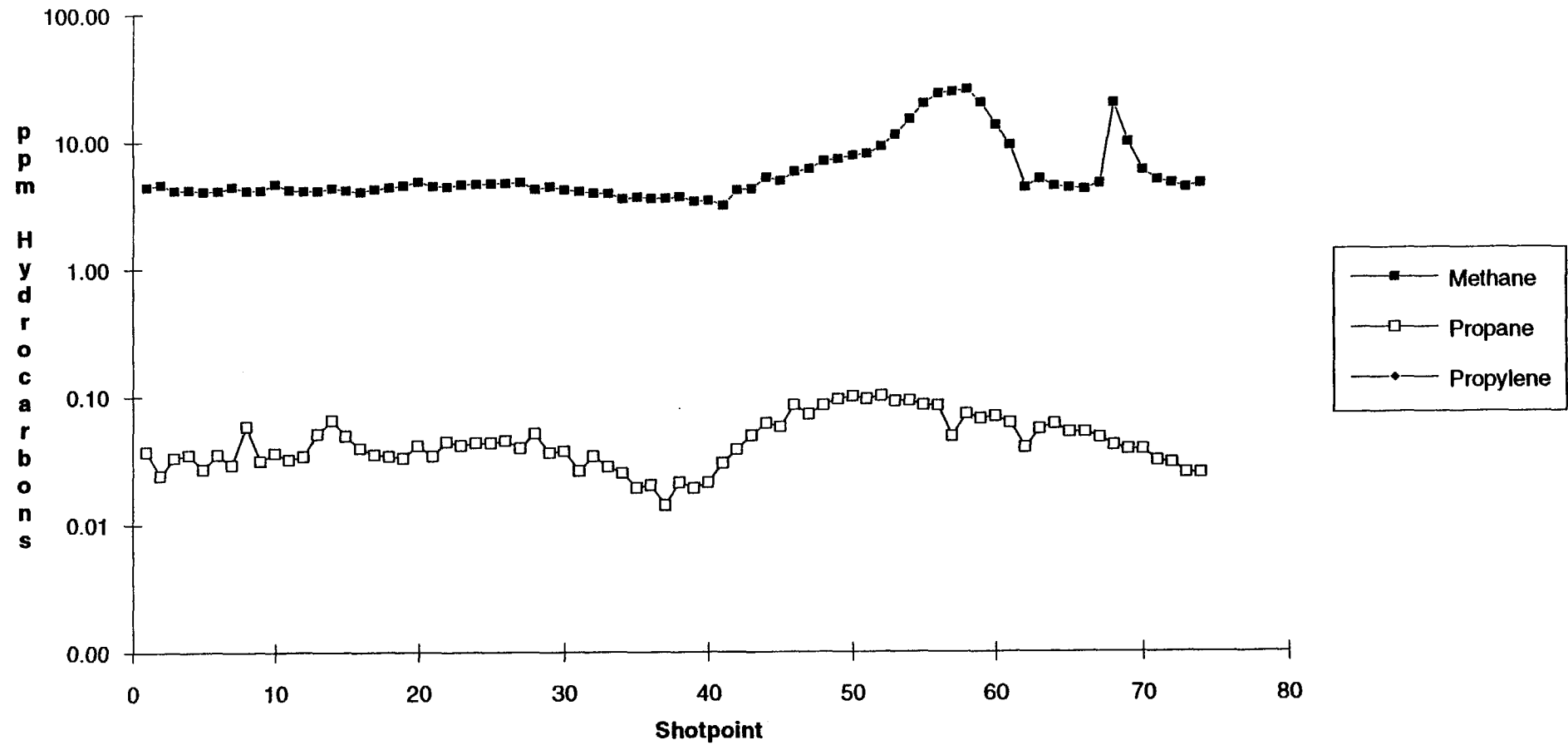
Line 104061 THC, Methane



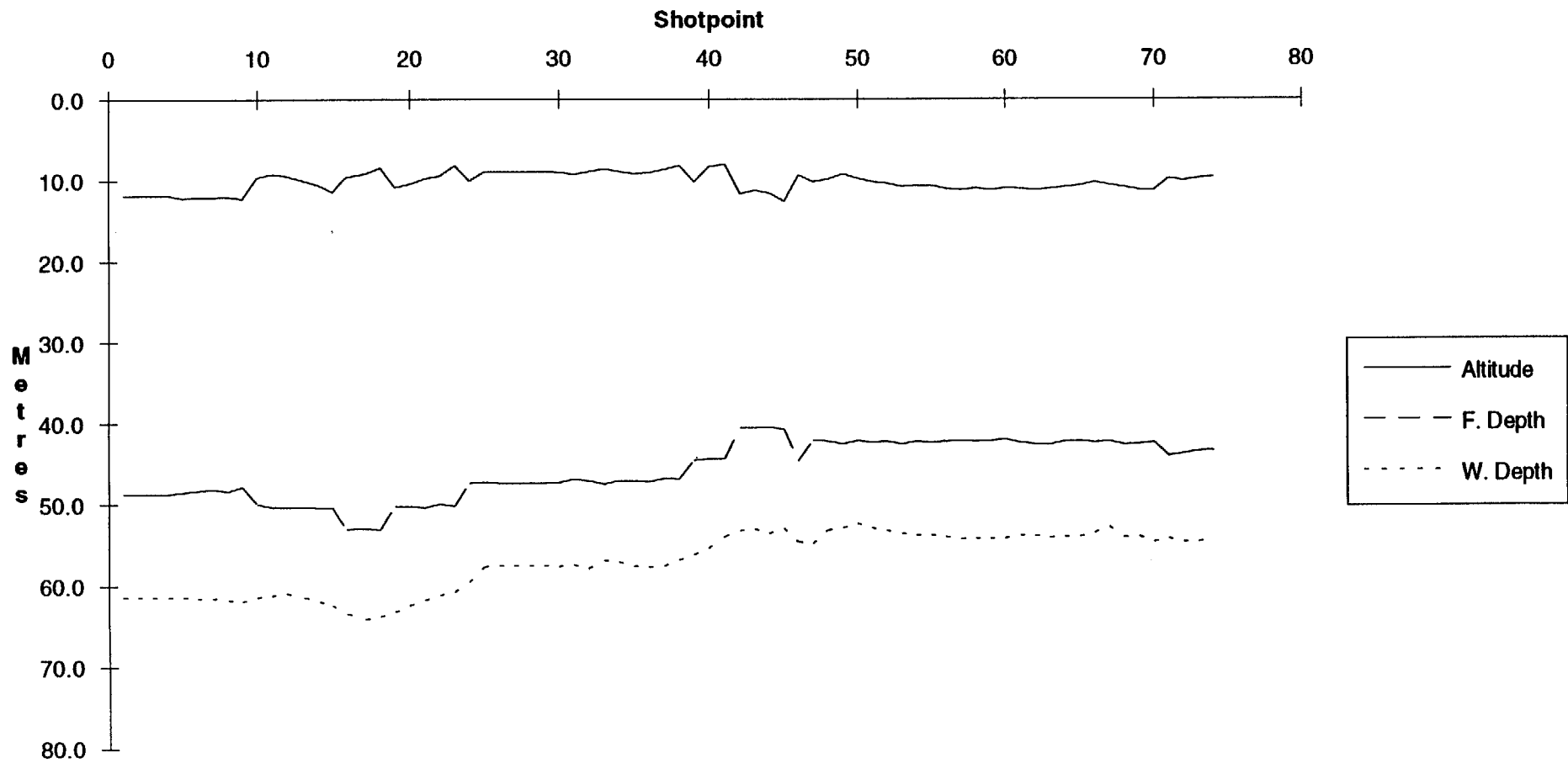
Line 104061 Methane, Ethane, Ethylene



Line 104061 Methane, Propane, Propylene



Line 104061 Depths, Altitude



Line Summary

Line Number 104062
No. of Shotpoints 46

	Shotpoint	Date	Time	Latitude	Longitude	
Start	1	06-Oct-91	22:28:08	37	58.720	33.154
End	50	07-Oct-91	00:11:51	38	02.194	43.568

	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	15.641	6.527	0.054	0.017	0.025	0.000	0.003	0.001	0.000	0.035	0.073	0.010	1.466
Std. Dev.	6.861	3.742	0.033	0.005	0.017	0.000	0.013	0.009	0.000	0.012	0.035	0.024	1.063
Minimum	8.530	3.108	0.015	0.011	0.012	0.000	0.000	0.000	0.000	0.016	0.018	0.000	0.547
Maximum	34.529	16.055	0.124	0.035	0.063	0.000	0.066	0.060	0.000	0.052	0.141	0.082	4.012

	Cond.	Temp.	Altitude	F. Depth	W.Depth
Mean	46.638	14.811	10.787	49.363	61.022
Std. Dev.	0.202	0.210	1.310	6.022	7.176
Minimum	46.240	14.390	9.100	42.700	52.700
Maximum	46.950	15.100	13.600	59.600	74.700

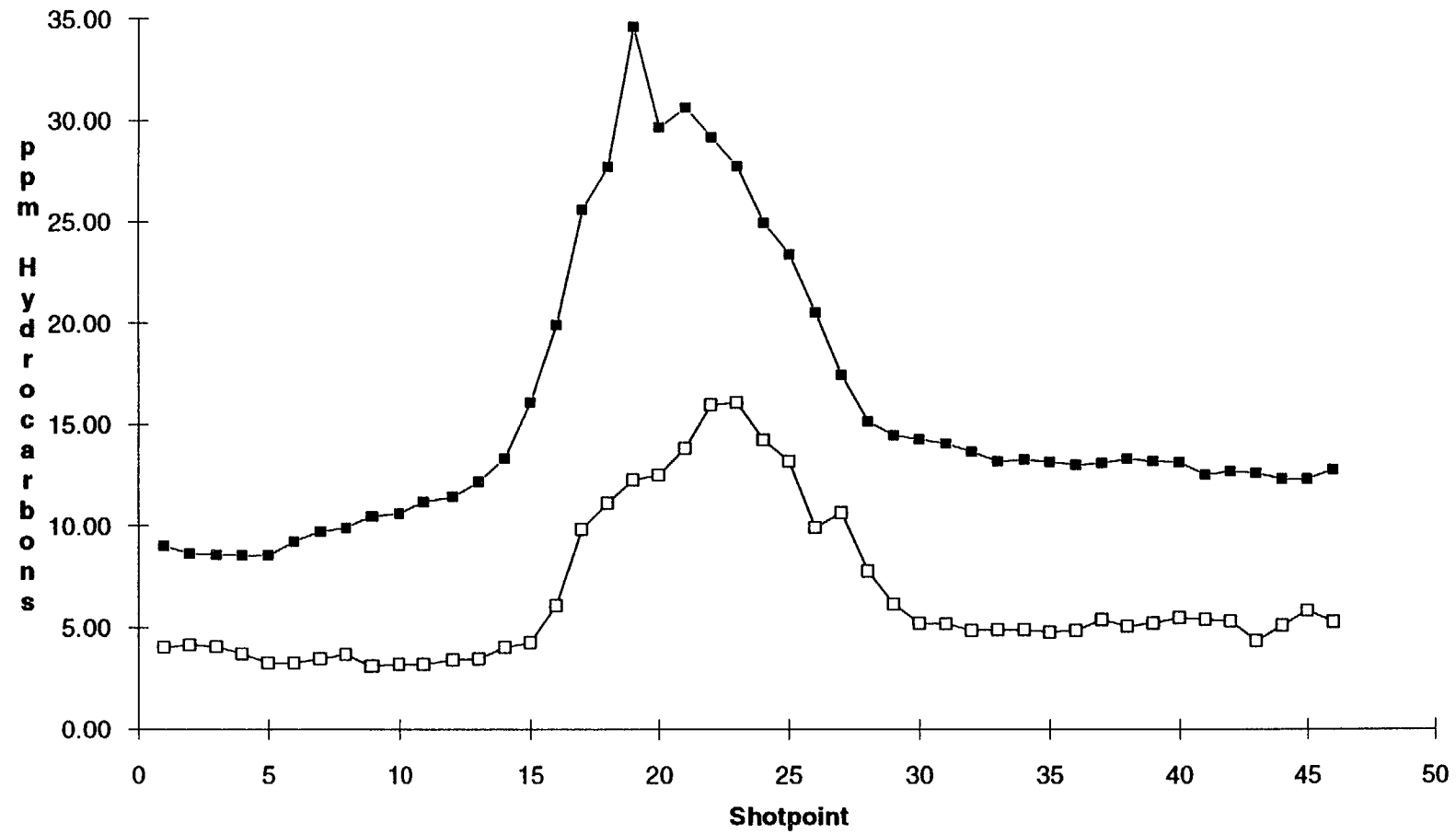
Notes

Weak to moderate THC, methane, ethane and propane anomaly, shotpoints 15 to 30.

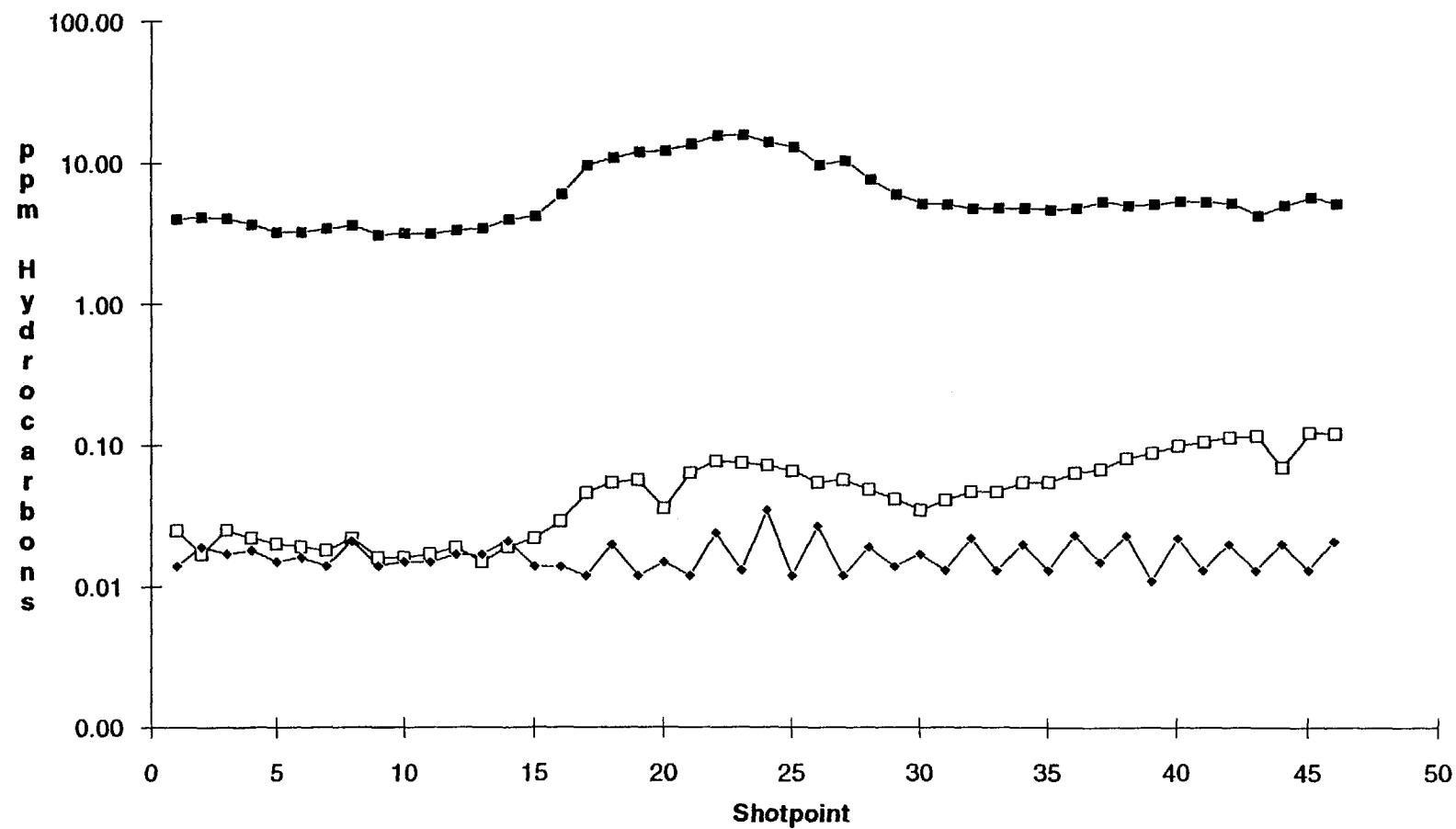
Moderate ethane and propane anomaly towards end of line.

No propylene detected

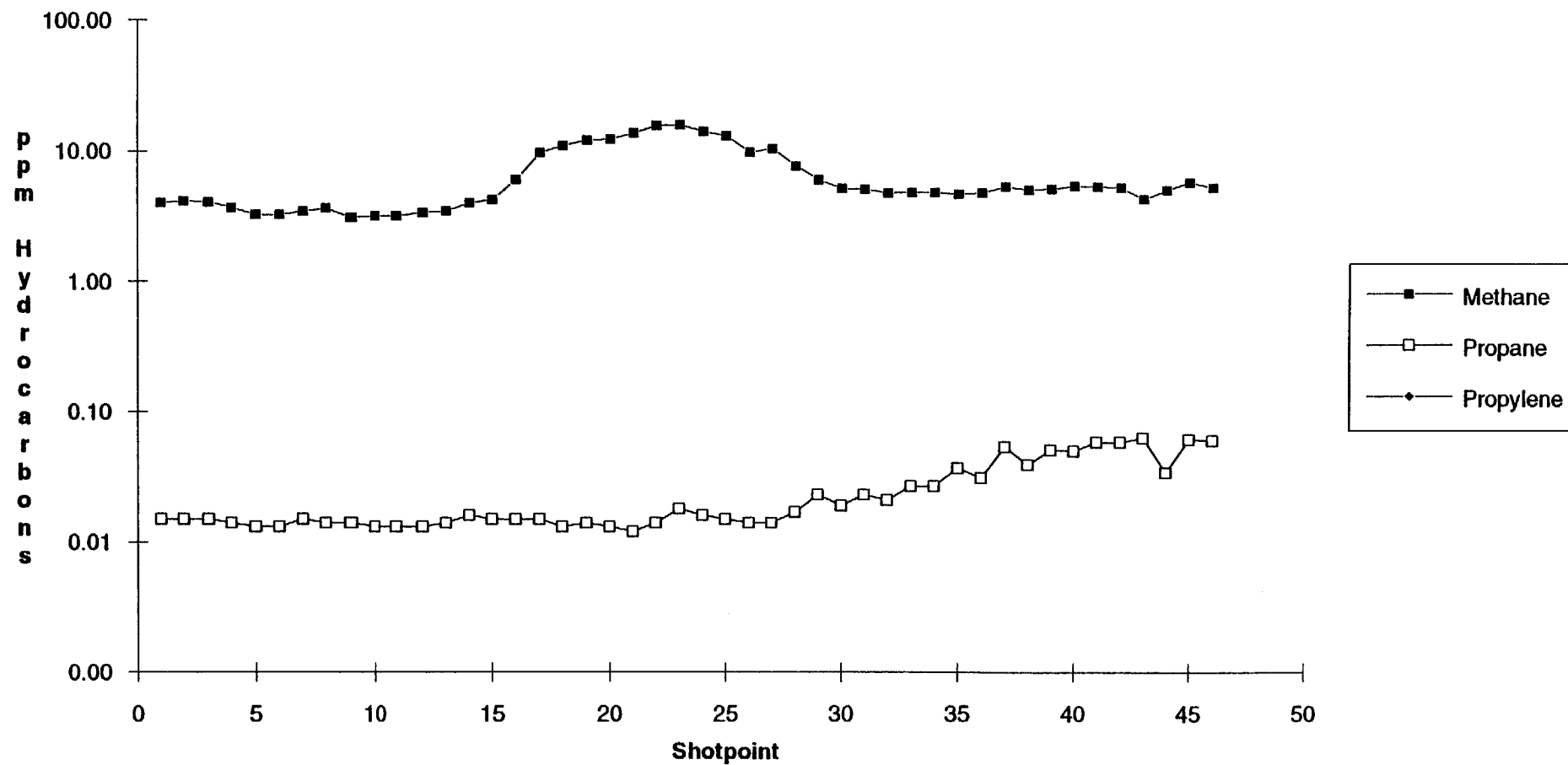
Line 104062 THC, Methane



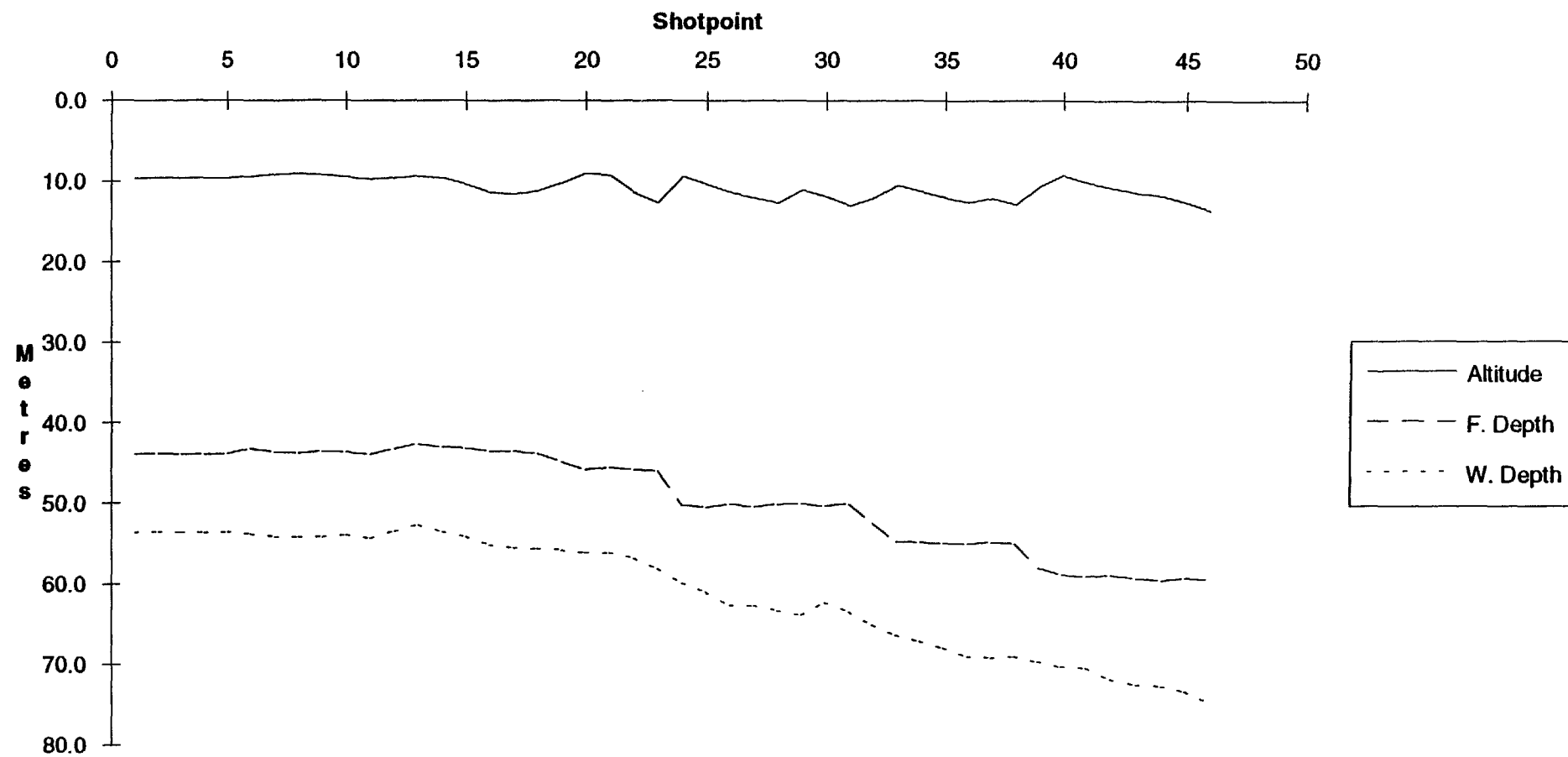
Line 104062 Methane, Ethane, Ethylene



Line 104062 Methane, Propane, Propylene



Line 104062 Depths, Altitude



Line Summary

Line Number 104063
No. of Shotpoints 44

	Shotpoint	Date	Time	Latitude	Longitude	
Start	1	7-Oct-91	00:13:51	38	02.323 148	44.101
End	44	7-Oct-91	01:40:08	37	56.709 148	49.350

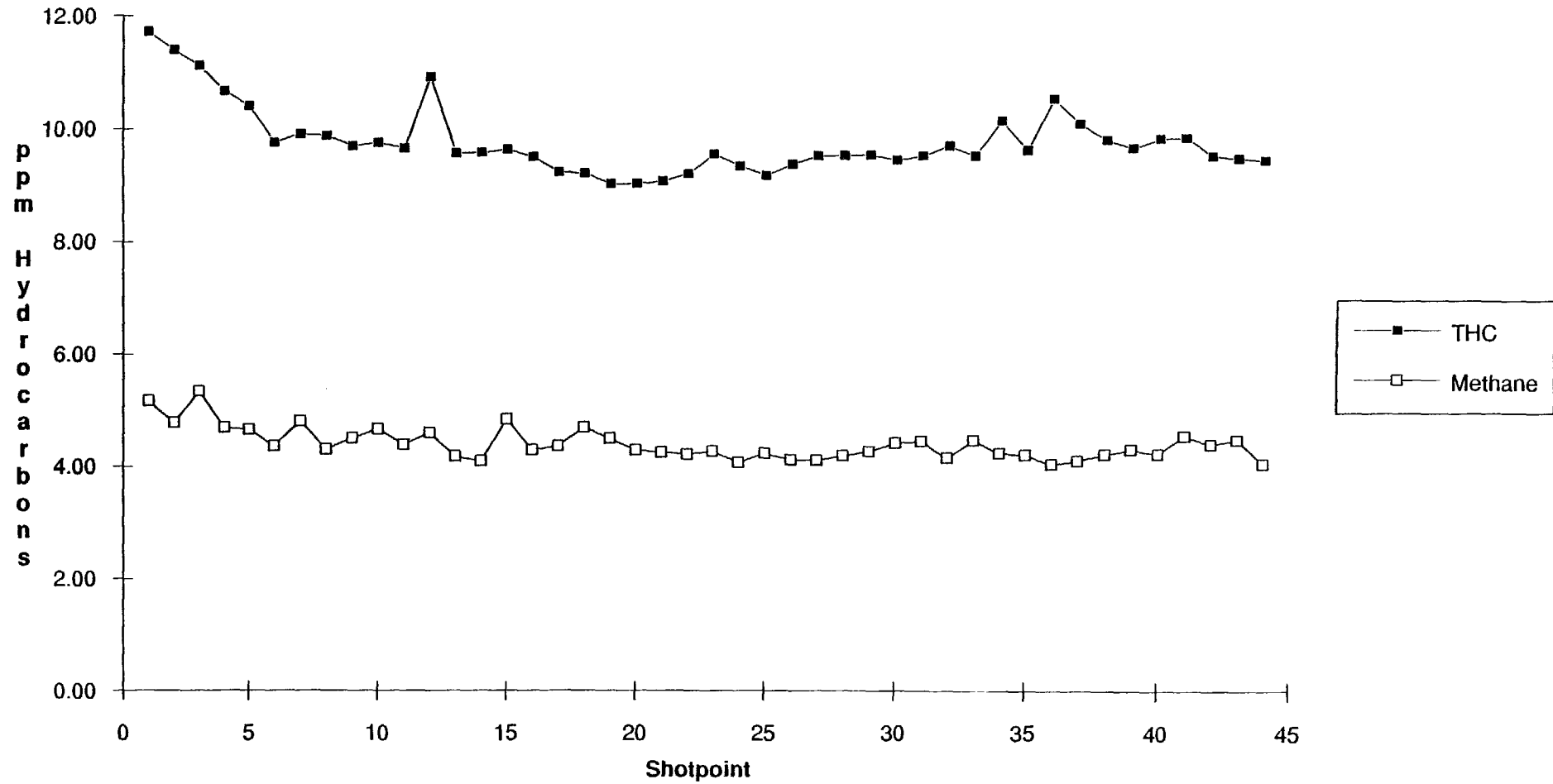
	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	9.795	4.400	0.094	0.019	0.047	0.000	0.003	0.000	0.000	0.044	0.095	0.000	3.157
Std. Dev.	0.600	0.284	0.014	0.005	0.008	0.000	0.012	0.000	0.000	0.008	0.033	0.000	0.432
Minimum	9.045	4.042	0.075	0.013	0.033	0.000	0.000	0.000	0.000	0.019	0.010	0.000	2.491
Maximum	11.712	5.333	0.140	0.033	0.073	0.000	0.070	0.000	0.000	0.051	0.146	0.000	4.770

	Cond.	Temp.	Altitude	F. Depth	W.Depth
Mean	46.843	15.069	10.150	58.264	70.643
Std. Dev.	0.124	0.128	0.989	3.556	4.051
Minimum	46.660	14.910	8.200	52.100	63.800
Maximum	47.030	15.260	12.100	63.300	76.600

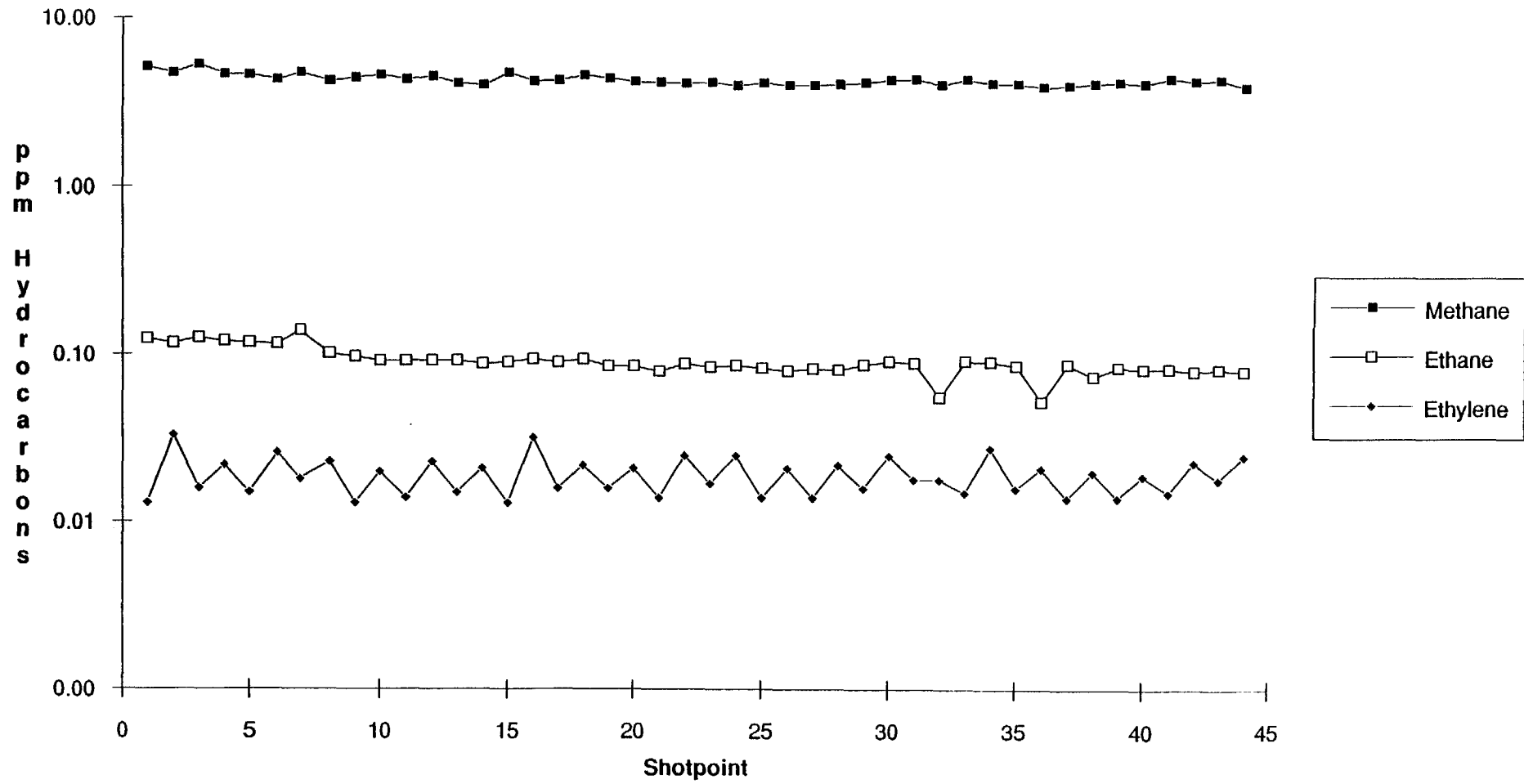
Notes

Elevated levels of ethane and propane, but no clearly defined anomaly
No propylene detected

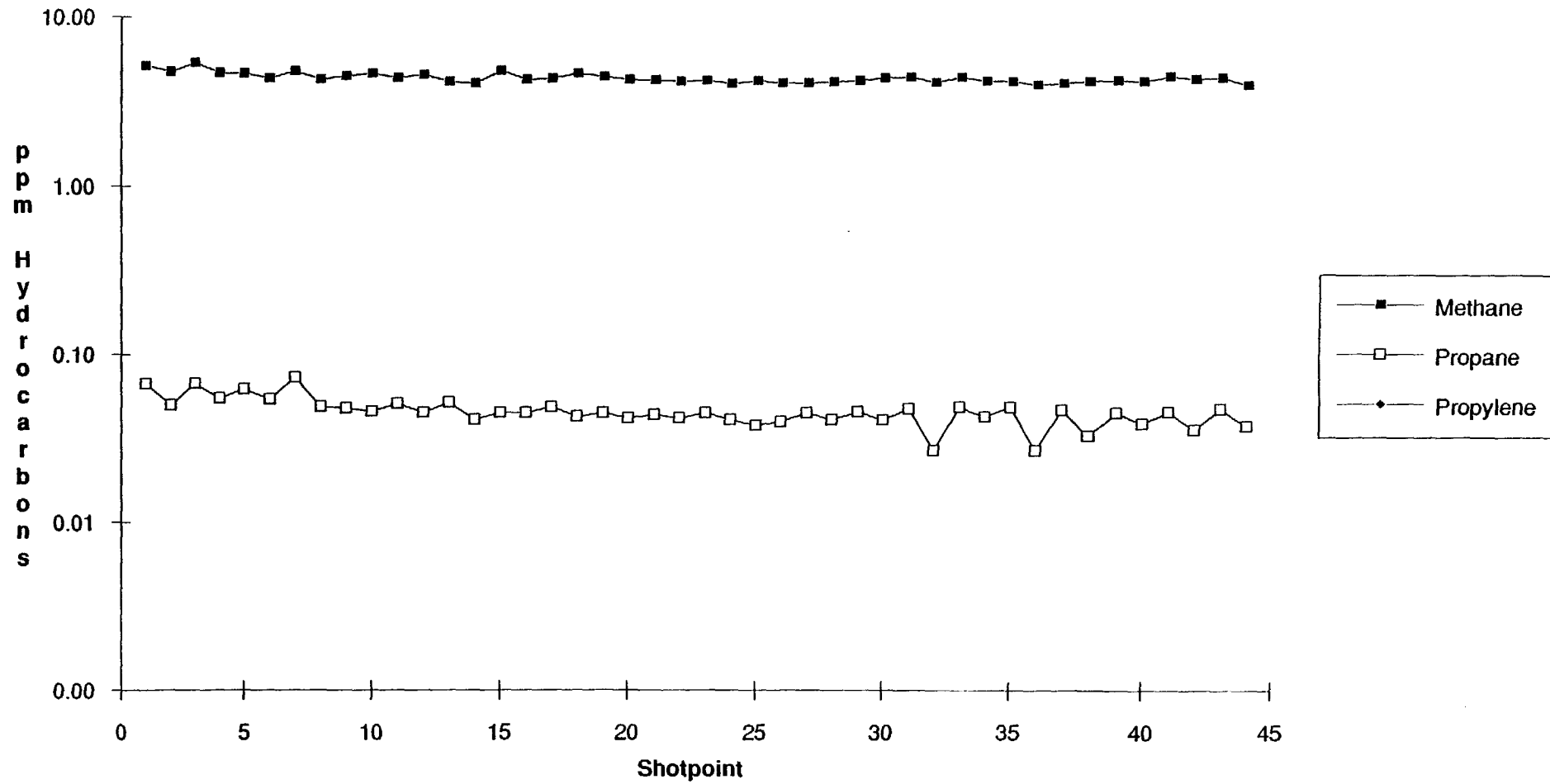
Line 104063 THC, Methane



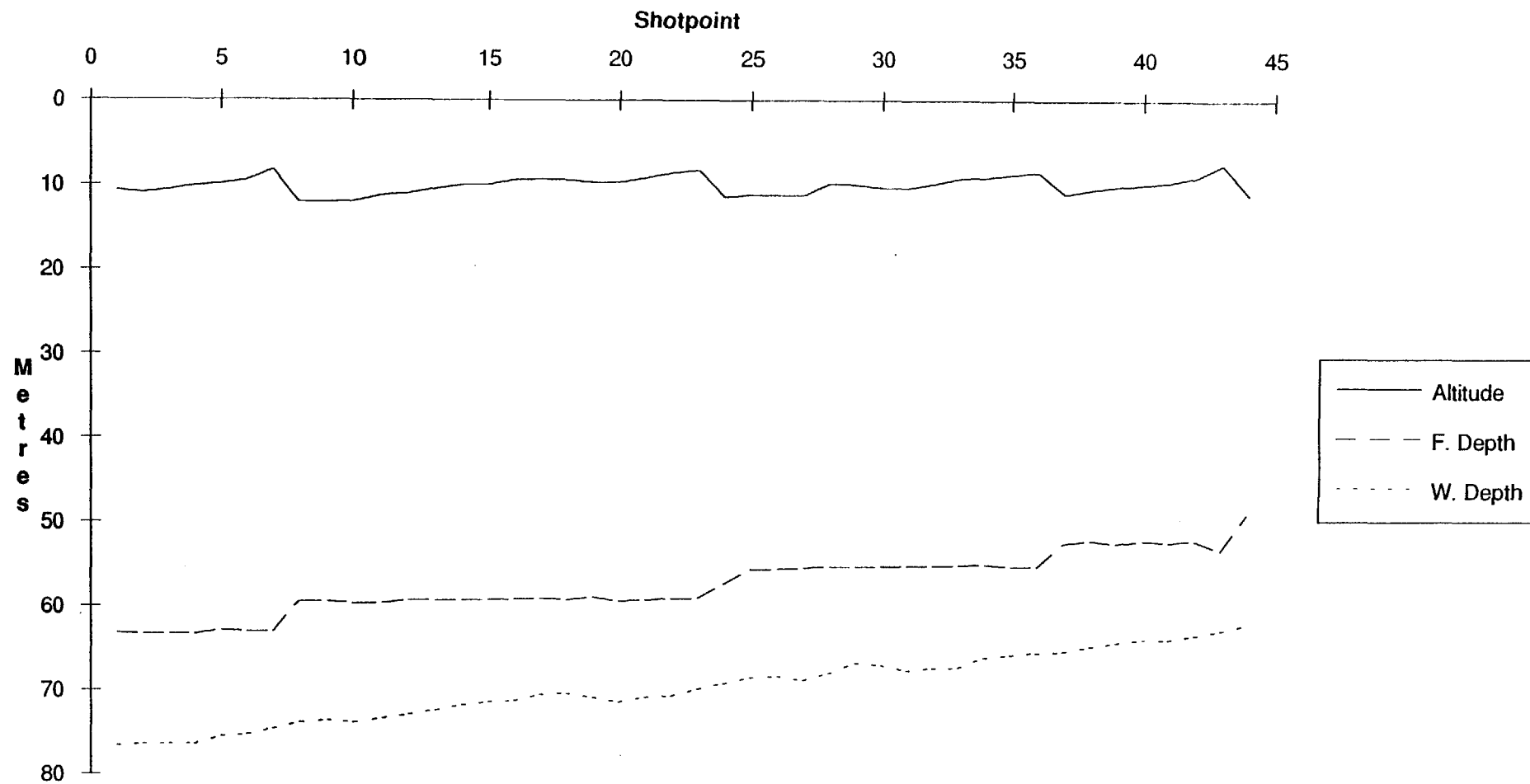
Line 104063 Methane, Ethane, Ethylene



Line 104063 Methane, Propane, Propylene



Line 104063 Depths, Altitude



Line Summary

Line Number 104064
No. of Shotpoints 53

	Shotpoint	Date	Time	Latitude	Longitude
Start	1	07-Oct-91	01:42:08	37	56.390 148 49.900
End	53	07-Oct-91	03:26:30	38	01.713 148 43.001

	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	13.209	4.617	0.103	0.017	0.053	0.000	0.006	0.001	0.001	0.041	0.080	0.000	3.403
Std. Dev.	2.132	0.263	0.023	0.004	0.011	0.000	0.018	0.008	0.004	0.010	0.034	0.000	0.775
Minimum	9.597	4.035	0.053	0.011	0.029	0.000	0.000	0.000	0.000	0.019	0.019	0.000	1.733
Maximum	24.500	5.232	0.138	0.028	0.077	0.000	0.084	0.059	0.032	0.053	0.152	0.000	5.356

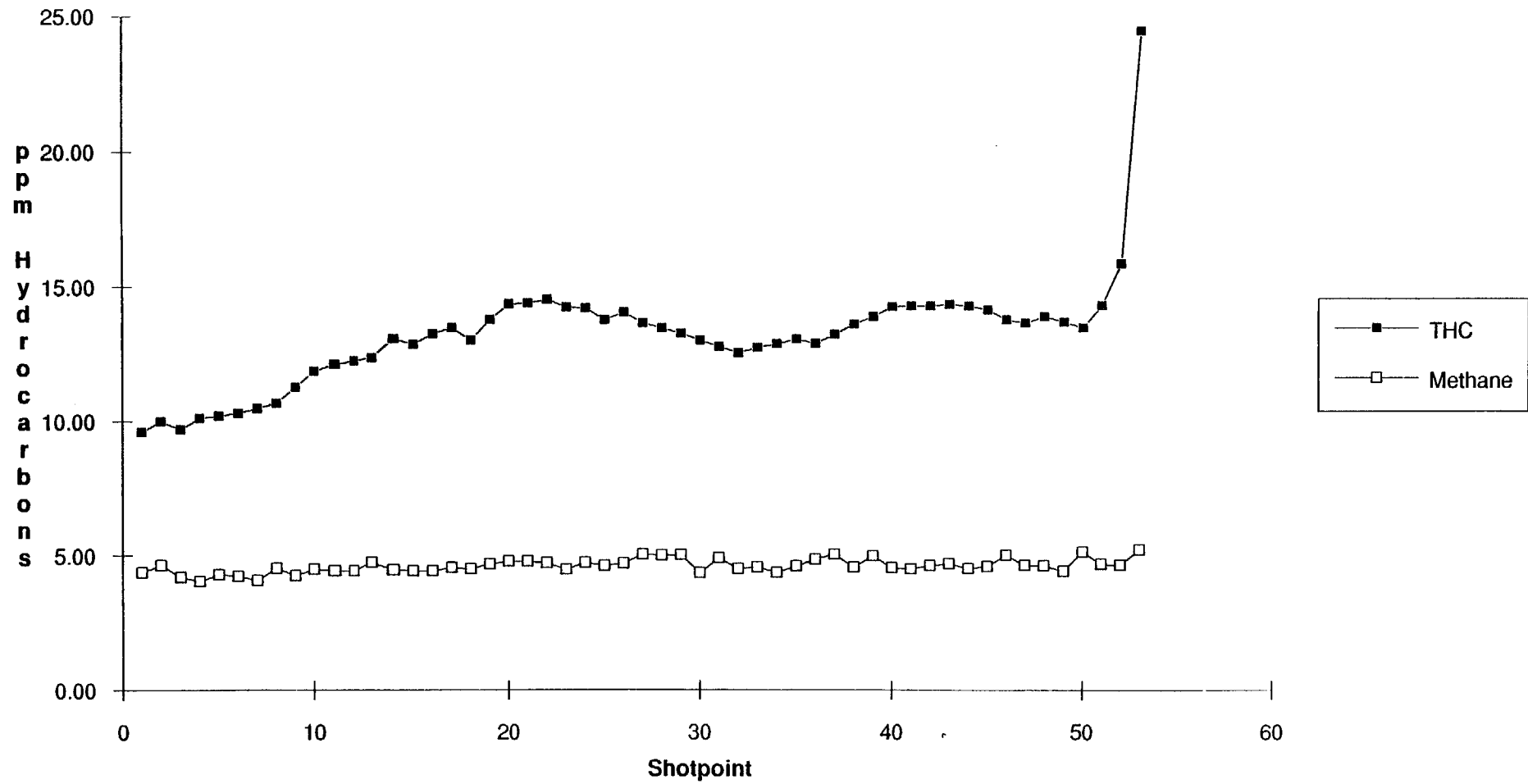
	Cond.	Temp.	Altitude	F. Depth	W.Depth
Mean	46.895	15.094	10.732	51.500	63.511
Std. Dev.	0.079	0.060	0.820	4.091	4.244
Minimum	46.740	14.970	8.500	43.900	55.600
Maximum	47.030	15.200	13.100	58.300	71.000

Notes

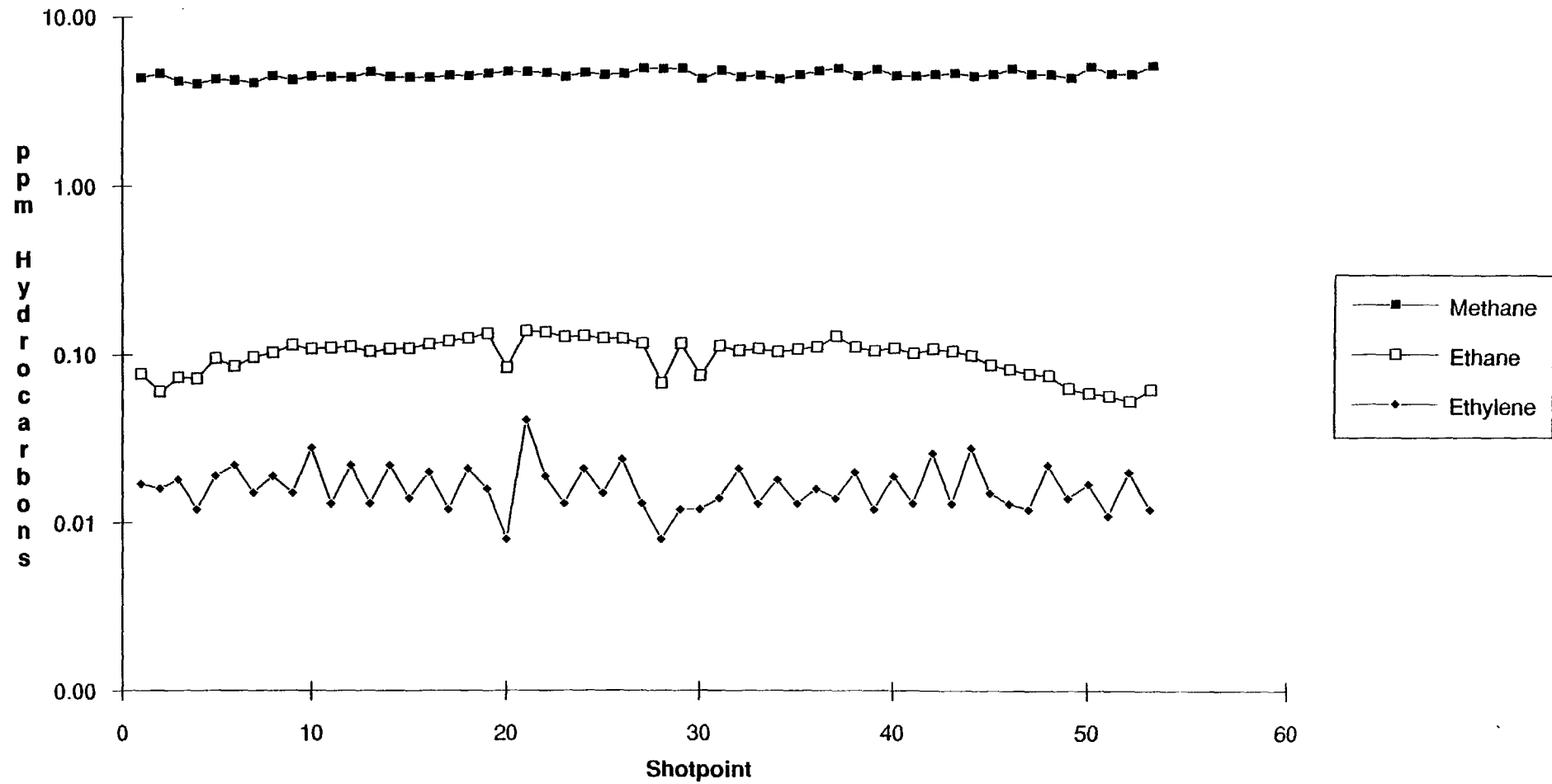
Weak to moderate ethane and propane anomaly over most of the line, with maximum around shotpoint 20.

No propylene detected

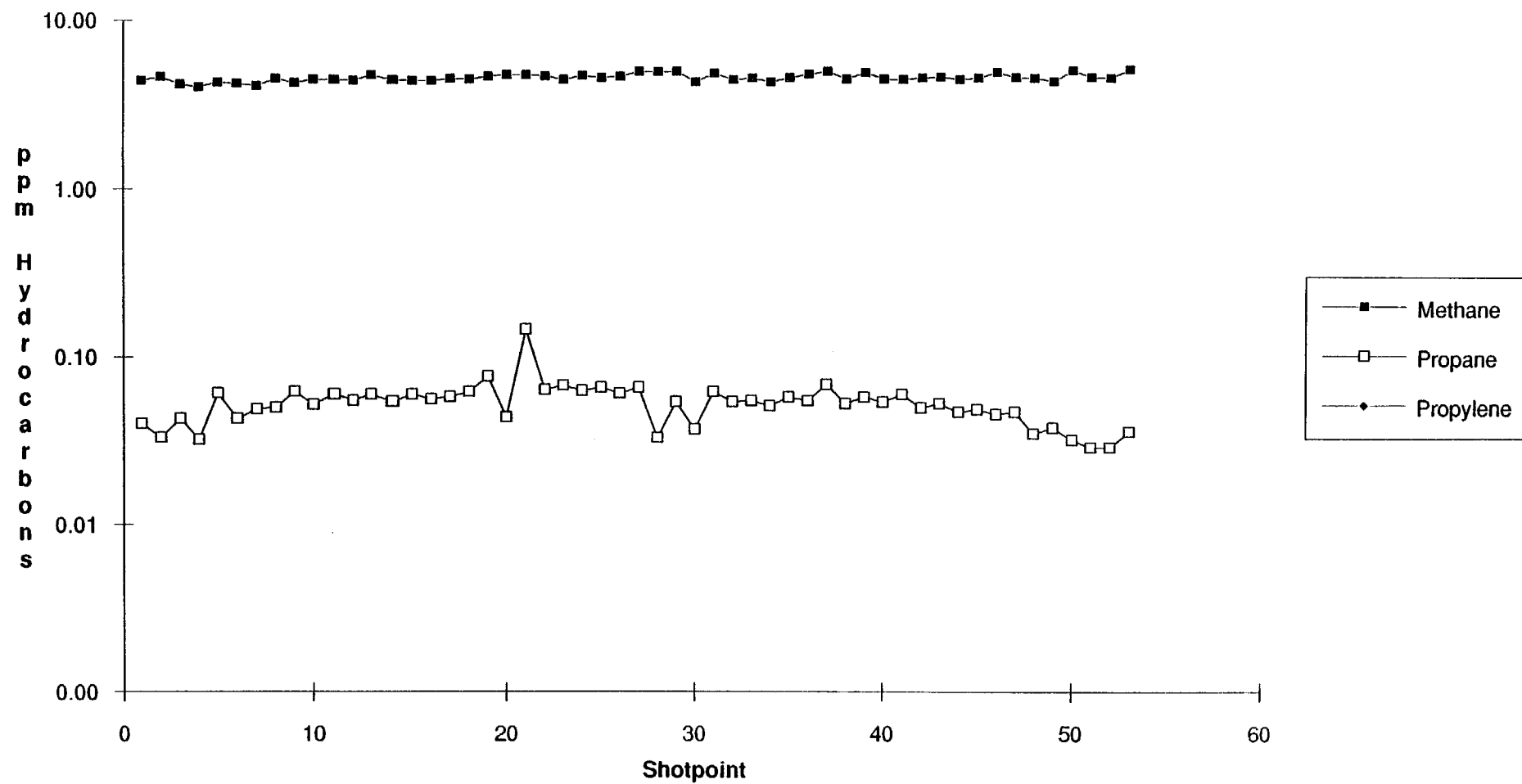
Line 104064 THC, Methane



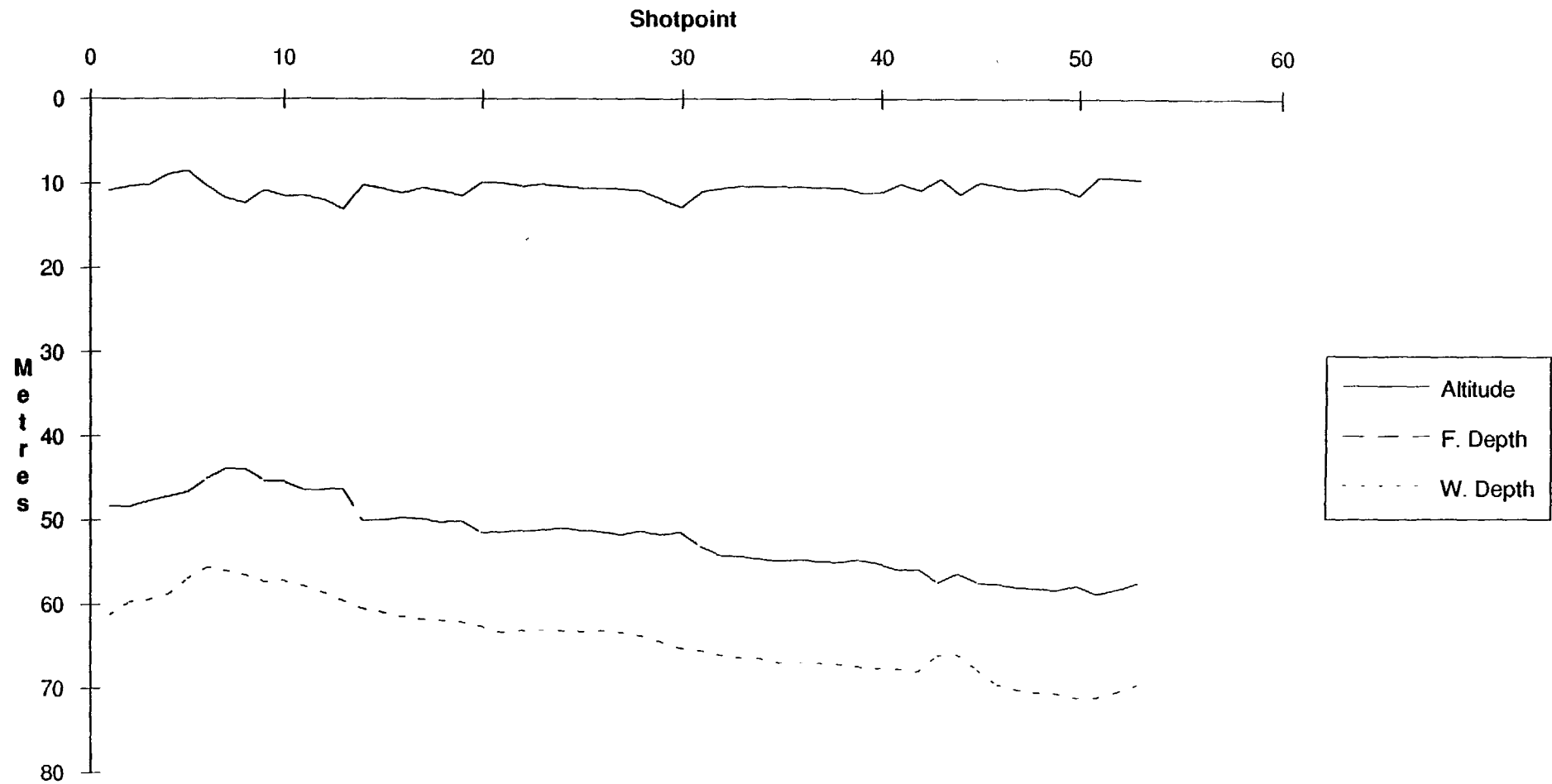
Line 104064 Methane, Ethane, Ethylene



Line 104064 Methane, Propane, Propylene



Line 104064 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 tow-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 tow-fish measures the depth of the tow-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 tow-fish above the seafloor allowing the operator to maintain the tow-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 tow-fish and relay CTD and sonar data from the tow-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 tow-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 tow-fish is deployed from the 'A-frame' on the port side of the R.V. *Rig Seismic*, which allows DHD data to be acquired concurrently with seismic data. Echo sounder data and GPS navigation are displayed in the laboratory and these 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 5% for the entire program and system blanks were less than 2 ppm for methane and 5 ppb for C₂+ 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 30m DB-1 Megabore column
n-Pentane	ppm	"
i-Hexane	ppm	"
n-Hexane	ppm	"
Water Depth	Metres	On-board 3.5 Khz and 12 Khz echo sounders
Tow-fish Altitude	Metres	Mesotech 807 altitude sonar.
Conductivity	mmhos/cm	Sea-Bird conductivity meter
Water Temperature	degrees Celsius	YSI temperature thermistor
Tow-fish Depth	Metres	Druck pressure transducer

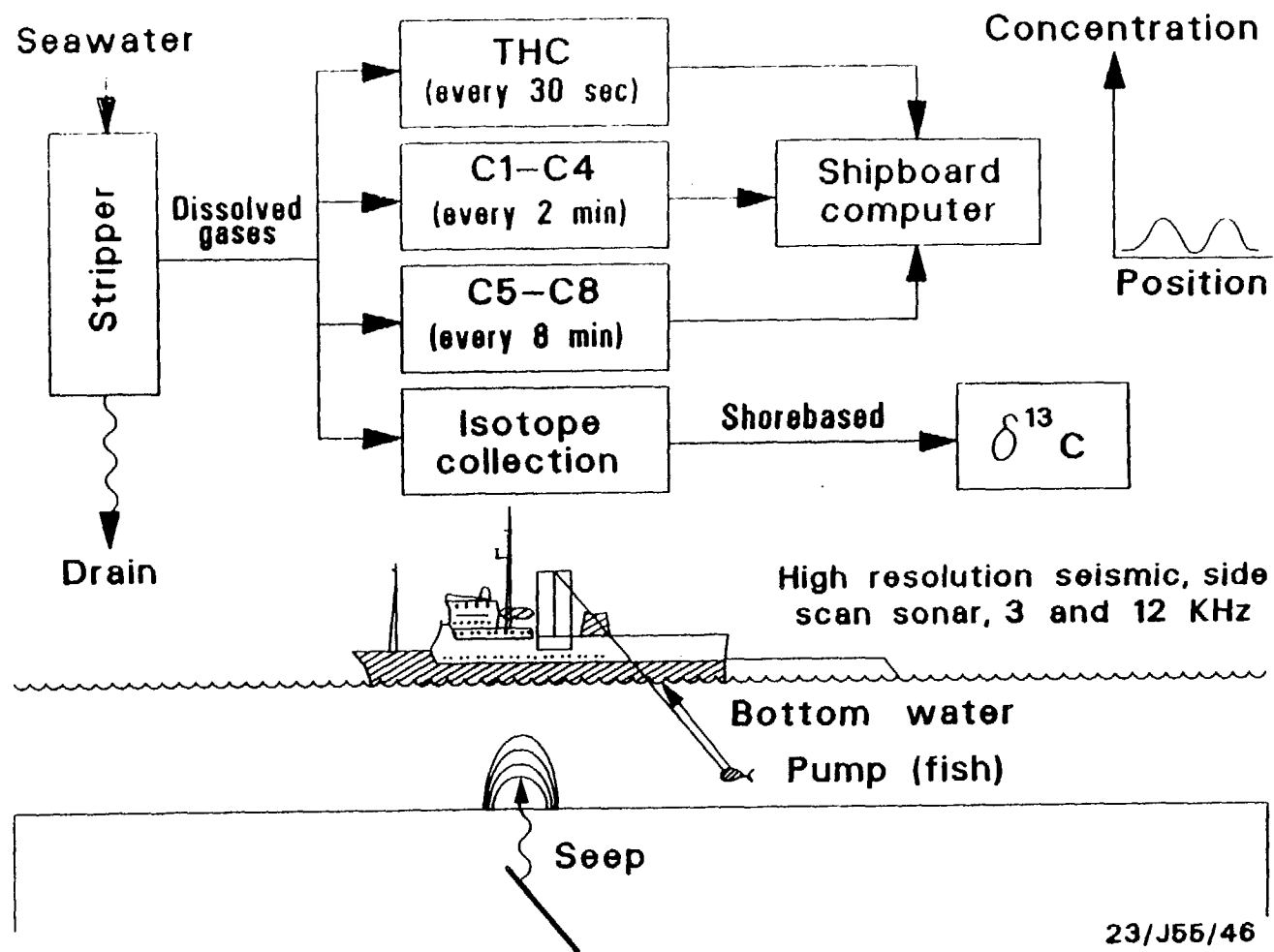


Figure II-1. Schematic of the geochemical equipment aboard *Rig Seismic* for the continuous profiling of hydrocarbons in seawater: the bottom-water DHD technique.

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 and Kvenvolden 1983 and references cited therein). The presence of the unsaturated hydrocarbons, which are only produced biochemically (Primrose and Dilworth 1976; Claypool and 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 and 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 (i.e., background) light hydrocarbons in seawater are generally an order of magnitude lower than those in the underlying seafloor sediments (Claypool and 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 (e.g., Brooks et al. 1974; Bernard et al. 1976; Reed and Kaplan 1977; Cline and Holmes 1977; Nelson et al. 1978; Reitsma et al. 1978; Brooks et al. 1979; Kvenvolden et al. 1979; Kvenvolden and Field 1981; Hovland and Judd 1988) does occur (via porous sediments, fault planes and microfissures etc). It is generally accepted that migration by diffusion is not important (Leythaeuser et al., 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 (e.g., Kvenvolden and Claypool 1980; Hunt 1984; Sweeney 1988; Hovland and 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 (percent wetness = $[\text{SUM}(\text{C}_2\text{-C}_4)/\text{SUM}(\text{C}_1\text{-C}_4)] \times 100$) to delineate seepage. The rationale behind this plot (Figure III-1) is that different hydrocarbon 'sources' e.g., biogenic versus thermogenic gas, condensate and liquids, can be distinguished on the basis of differences in their light hydrocarbon molecular compositions (Hunt 1979; Tissot and Welte 1984; Claypool and Kvenvolden 1983). In this model background hydrocarbons plot in a narrow range towards the left origin (low concentrations), while end-member 'source' hydrocarbons i.e., 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 (e.g., Fuex 1977; Bernard et al. 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 tow-fish above the seafloor, a shoaling of the water depth, penetration of the tow-fish above the local thermocline or combinations of these factors. In these cases, plotting the saturated hydrocarbon (methane, ethane, propane) concentrations against the tow-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 (e.g., 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.

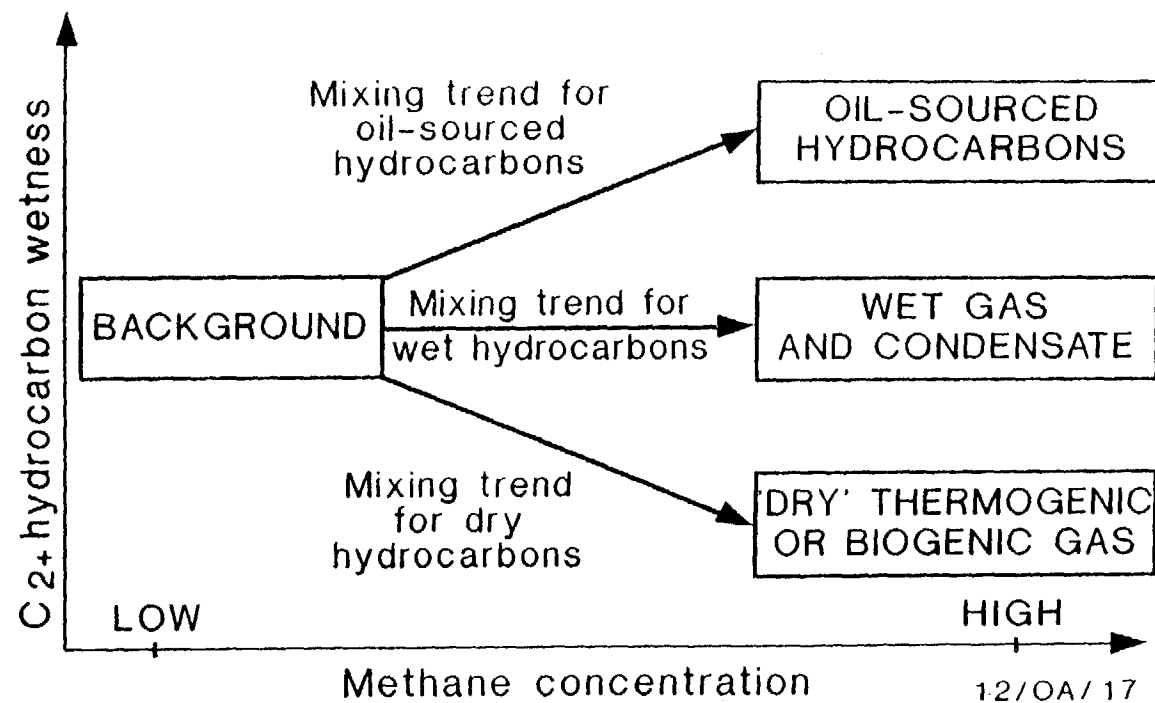


Figure III-1. Cross-plot of methane versus hydrocarbon wetness, showing the general decrease in wetness with increasing methane for gas-prone or biogenic sources. Conversely, oil-prone sources are indicated by increasing wetness with increasing methane. Gas-condensate sources fall between the dry gas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

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Appendix IV. Systems Operation Reports

This report was completed at sea after the completion of the survey.

Cruise 104 DHD report

A total of 1430 km of DHD data was acquired during cruise 104, which included 200 km of ocean outfall sampling outside Port Phillip Bay and off Sydney.

Durroon Basin (Bridge Oil): 350 km

Although DHD was not required as part of the Bridge Oil survey, DHD sampling was carried out over most of the survey area. No significant hydrocarbon anomalies were detected, although higher than background levels of THC and methane were observed on several lines.

Otway Basin : 310 km

After completion of the Bridge Oil seismic survey, approximately 300 km of DHD sampling was undertaken in the Otway Basin, based on a cruise track developed in co-operation BHP Petroleum. Poor weather made this section of the cruise uncomfortable. Two hydrocarbon anomalies were detected, one of which was resampled prior to transiting to the Torquay Sub-Basin.

Torquay Sub-Basin DHD: 330 km

The DHD survey in the Torquay Sub-Basin was designed to revisit and resample a hydrocarbon anomaly associated with a pockmark, which had previously been investigated as part of Cruise 89. Additional lines were run to test possible

hydrocarbon leakage from three nearby structures. A short high-resolution seismic program was carried out over four lines. Due to the poor sea and weather conditions, the seismic data quality was poor, but seismic washout zones could be seen coincident with two hydrocarbon anomalies, one of which was the pockmark anomaly.

Torquay Sub-Basin vibrocoreing : 8 cores

The vibrocoreing program was planned to investigate the geochemistry of the surface sediments in and near the seabed pockmark. We had planned to take 18 cores from 9 different sites in and around the pockmark, but this section of the program had to be cancelled following the loss of the vibrocorer. At this stage 8 cores had been recovered, with lengths ranging from 2.2 to 5 metres. Five of the cores were sampled and analysed on-board for light hydrocarbons; the remaining three cores were stored for analysis in Canberra.

Five gravity core attempts were made after completion of the ocean outfall studies, however no sediment was recovered in any of the attempts.

Melbourne ocean outfall (near Cape Schanks) and Geelong ocean outfall (near Barwon Heads): 145 km

A limited investigation was made of two ocean outfalls, one at Boags Rocks near Cape Schanks, the other at Black Rocks, near Barwon Heads. The Boags Rock outfall was not detected, probably because we were unable to take the ship any closer than 1 mile from the outfall. However, the Black Rocks outfall was detected, although hydrocarbon levels were not particularly high. Approximately 180 water samples were taken for analysis by the Geelong and Melbourne Water Boards.

Gippsland Basin : 240 km

A DHD survey was conducted in the Gippsland Basin to revisit anomalies detected during the Cruise 89 survey, and to investigate a fault complex suggested by BHP Petroleum. Several large anomalies were detected, although one may be associated with production activity from the Marlin field.

Sydney ocean outfalls : 55 km

Prior to the end of the cruise in Sydney, a short DHD survey was carried out over the new ocean outfalls at Malabar, Bondi, and North Heads. The cruise track was based on a computer model of the plumes provided by Sydney Water Board. All three outfall plumes were successfully detected, with the Malabar and Bondi plumes corresponding to the computer model, but the North Head plume was detected running north from the outfall, not south as predicted by the model. This short but successful program can probably be considered as one of the highlights of the survey as it clearly demonstrated the usefulness of the DHD system for environmental monitoring.

Operational Problems

Fish/cable/winch

A number of problems were experienced with the towfish, cable and fairings. The most serious was the entanglement of the ships taut wire with the sniffer cable whilst vibrocoring in the Torquay Sub-basin. It appears that the DP system suffered a temporary malfunction which caused the ship to move off station; when the ship was brought back on station, the sniffer cable became entangled with the taut wire.

Fortunately, both the taut wire and the sniffer fish were successfully recovered, although the stainless steel braiding of the sniffer cable was damaged in a number of places by the taut wire. In addition, a large number of fairings were damaged and/or torn off by the taut wire.

The damage to the cable appeared to be fairly superficial, and after testing by the electronics T.O.'s, the fish was subsequently redeployed. However, the fairings hid the site of worst damage, immediately above the termination bottle, where salt water was able to ingress, which lead to a short in the 240v power supply to the sub pump approximately 16 hours after redeployment. Following this failure, the fish was recovered and a full retermination was performed, after cutting back the cable to remove the damaged section.

During the sea-trials off Fremantle prior to this cruise, a large number of fairings were used, both to fair additional cable, and to refair other parts of the cable. Although the sea-trials were successful, the large number of fairings used left very few spare, and meant that large sections of fairings are in very poor condition, particularly after the taut wire incident. We will need to purchase a large number of fairings and spend a significant amount of time on fairing work before or at the start of the next DHD cruise.

During the bad weather off Otway, we also discovered that the camera housing is not completely waterproof; fortunately the camera appears to have survived its salt-water bath.

Echo-sounder - the Mesotech echo-sounder in the fish operated successfully for much of the time, but we continue to experience problems with the termination in the fish, and (prior to the retermination after the taut wire incident) a broken conductor in the main cable.

Gas Extractor

This was the first operational cruise with the new gas extractor built by ESU (although the gas extractor was tested during the Fremantle sea-trials). In general, the new system worked well, although a few minor problems were experienced, mainly due to 'teething' problems.

The high level alarm / cut-off does not operate correctly. On several occasions, the high level alarm came on without the water being at a high level, probably due to a water splash in the probe tube. Although the alarm activated, and the vacuum pump was stopped, the inlet solenoid remained open, which appears to indicate a fault in the high-level alarm circuit.

Echo sounder - the echo sounder electronics module (in the rack) needs to be isolated from the depth transducer (Druck) module, i.e. turning off the power to the echo sounder module should not affect the depth transducer module. The power supply should deliver a minimum 24v at the fish (the echo sounder needs a 22 to 32v supply).

The DGH A/D converter (voltage-to-RS232) needs to be incorporated into the echo sounder module, and fitted with a DB-25 connector, correctly wired for the acquisition PC. The voltage divider needs to be moved for easier access for calibration.

The alarm on/off switch should have illuminated indicator - it's easy to turn the alarm off and forget to turn it back on.

The temperature thermistor which measures the temperature of the exhausted water from the extractor tends to start drifting - after several days use. Also, a poor connection to the datalogger can cause problems here.

Gas Chromatographs

The gas chromatographs worked well, although some problems were experienced towards the end of the cruise with water droplets (from the gas extractor) getting onto the intermediate (IHC) and heavy (HHC) capillary columns.

The THC and (to a lesser extent) LHC2 integrators continue to suffer from occasional hangs whilst communicating with the acquisition PC, additionally, the LHC2 integrator occasionally terminates its analysis prematurely.

Computers

No significant problems. One or two bug fixes were made to the acquisition software. One printer appears to have a print-head problem and will need repairing. The acquisition PC and two processing PC's are now networked, a few minor problems to be sorted out though.

Appendix V. Enclosures

Enclosure 1: Regional map of south-eastern Australia showing the DHD survey lines.

Enclosure 2: Map of the DHD survey lines in the Durroon Sub-basin.

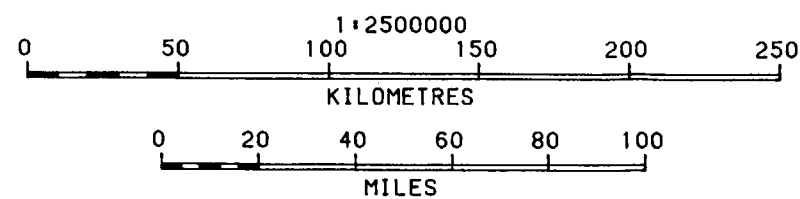
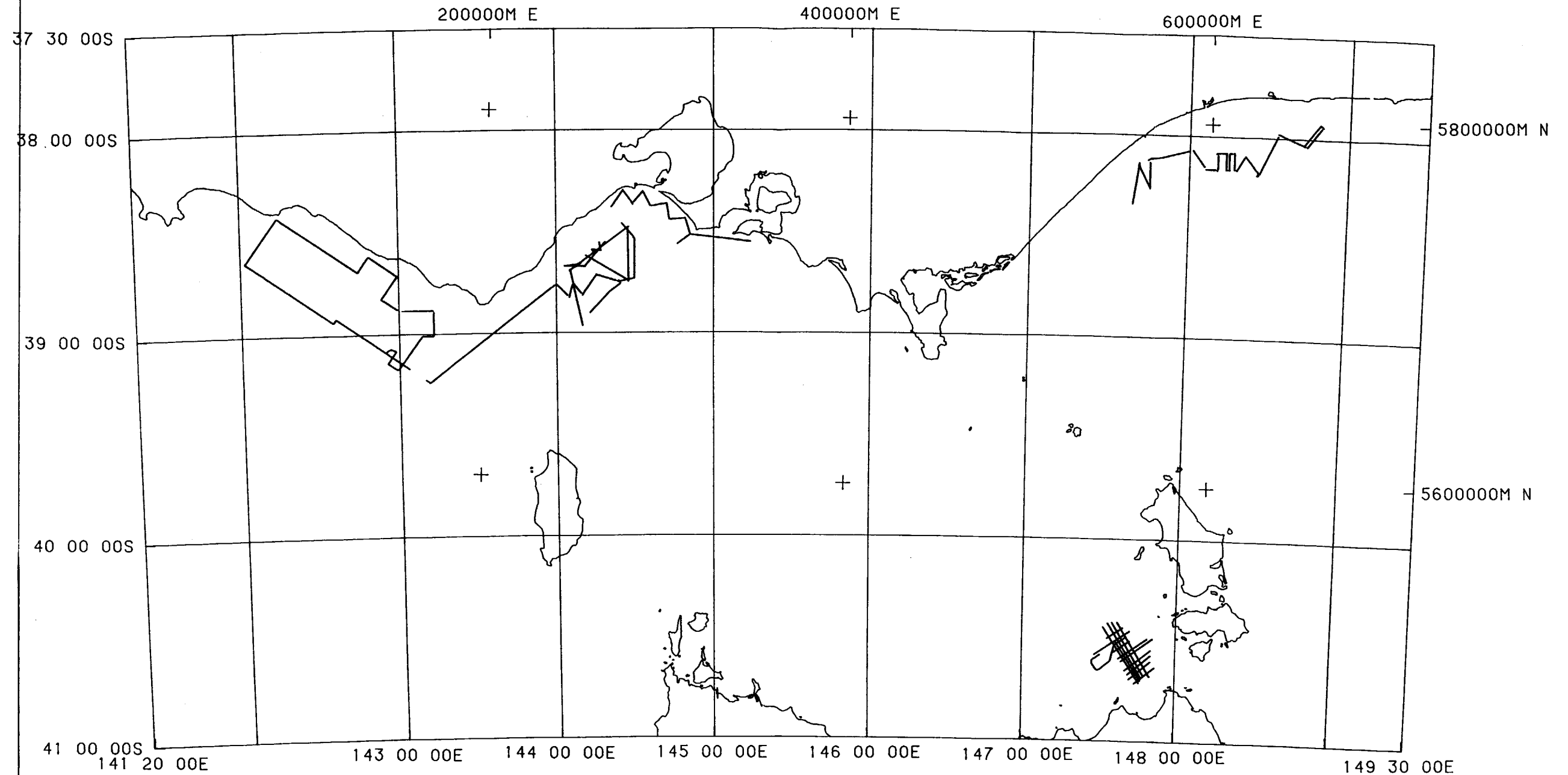
Enclosure 3: Map of the DHD survey lines in the Otway Basin.

Enclosure 4: Map of the DHD survey lines in the Torquay Sub-basin.

Enclosure 5: Map of the DHD survey lines in the Gippsland Basin.

Enclosure 6: Floppy diskette with ASCII files of geochemical data.

OTWAY TO GIPPSLAND - REGIONAL



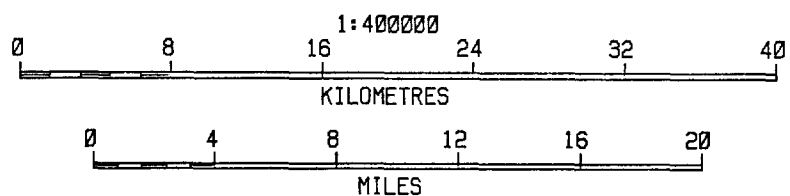
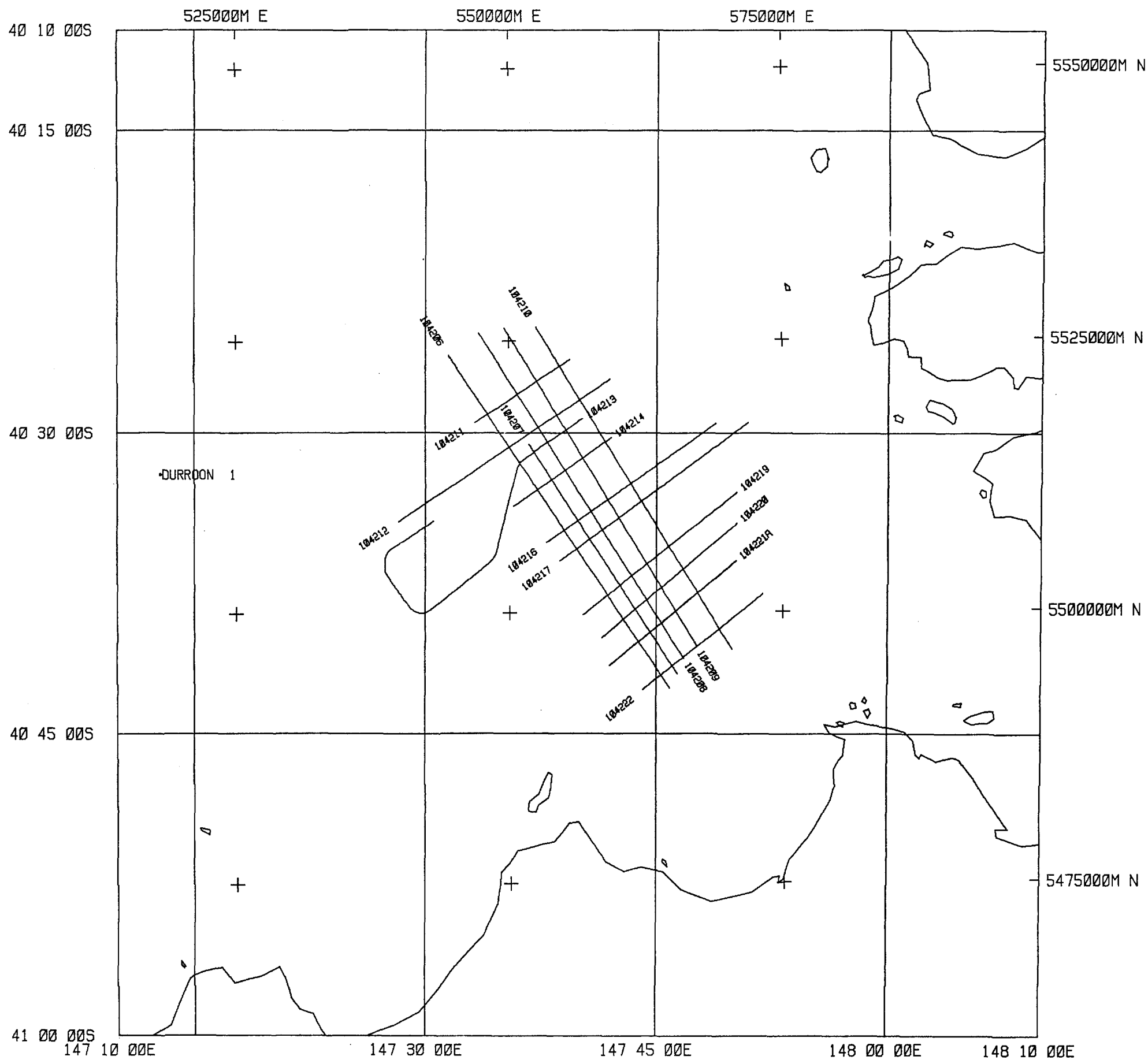
UNIVERSAL TRANSVERSE MERCATOR PROJECTION
AUSTRALIAN NATIONAL SPHEROID
CENTRAL MERIDIAN 147 00 00E

DHD SURVEY LINES		
OTWAY AND GIPPSLAND BASINS		
TORQUAY AND DURROON SUB-BASINS		
BMR SURVEY 104		
S13A30TB.PIC J NEEDHAM 14/7/92		



* R 9 2 0 5 4 0 6 *

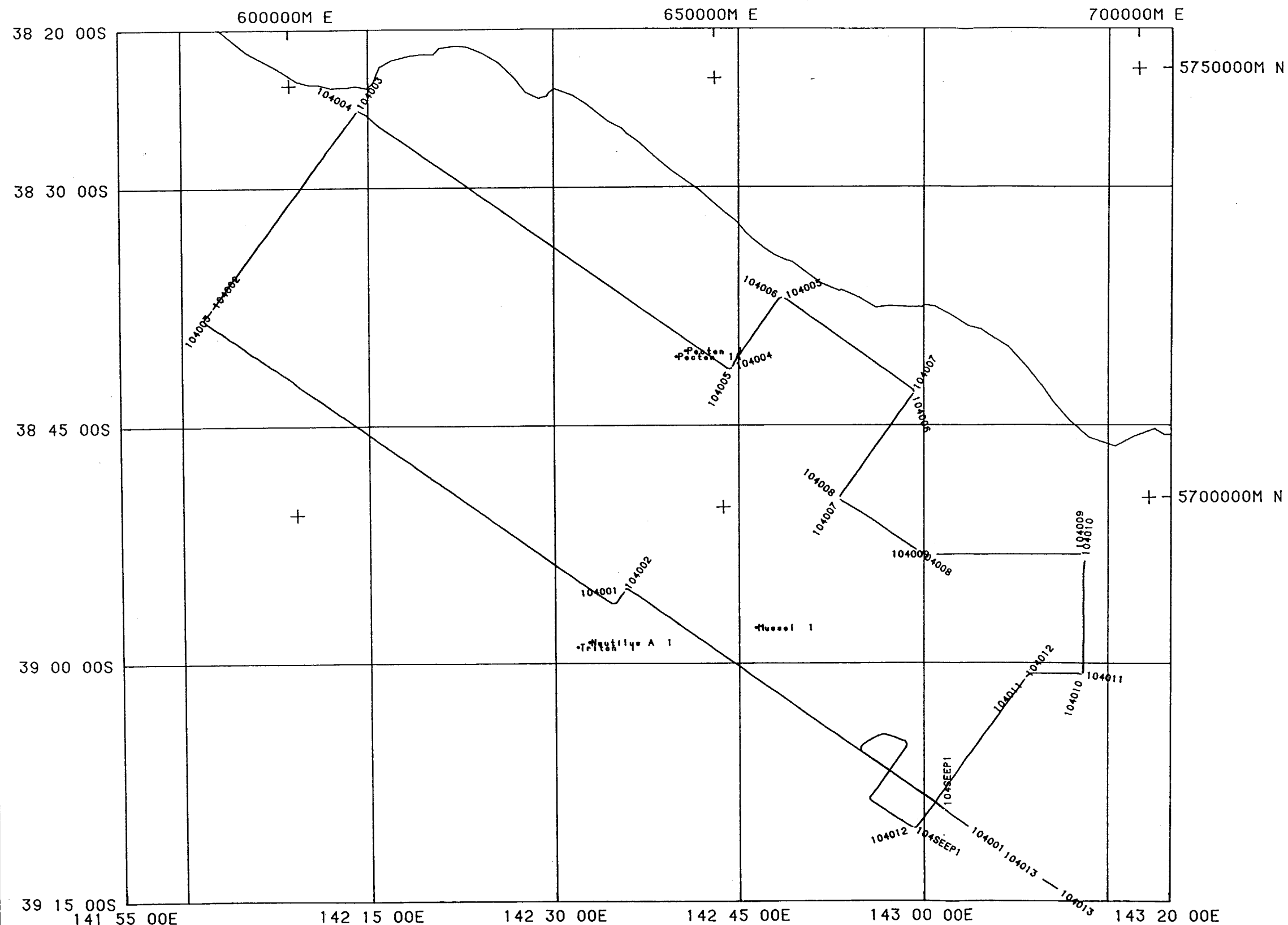
DURROON SUB-BASIN



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AUSTRALIAN NATIONAL SPHEROID
CENTRAL MERIDIAN 147 00 00E

DHD SURVEY LINES		
DURROON SUB-BASIN		
BMR SURVEY 104		
S13ADURR 7/6/92 J NEEDHAM		

OTWAY BASIN



DHD SURVEY LINES

OTWAY BASIN

BMR SURVEY 104

S1470TWY PIC J NEEDHAM 14/7/92

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CENTRAL MERIDIAN 141 00 00E

TORQUAY SUB-BASIN

200000M E

300000M E

38 10 00S

38 15 00S

38 30 00S

38 45 00S

39 00 00S

39 15 00S

39 20 00S

142 50 00E

143 15 00E

143 30 00E

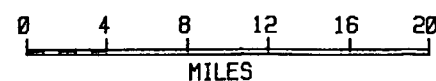
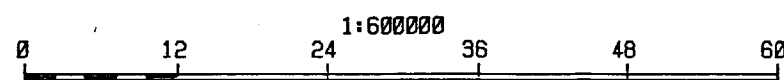
143 45 00E

144 00 00E

144 15 00E

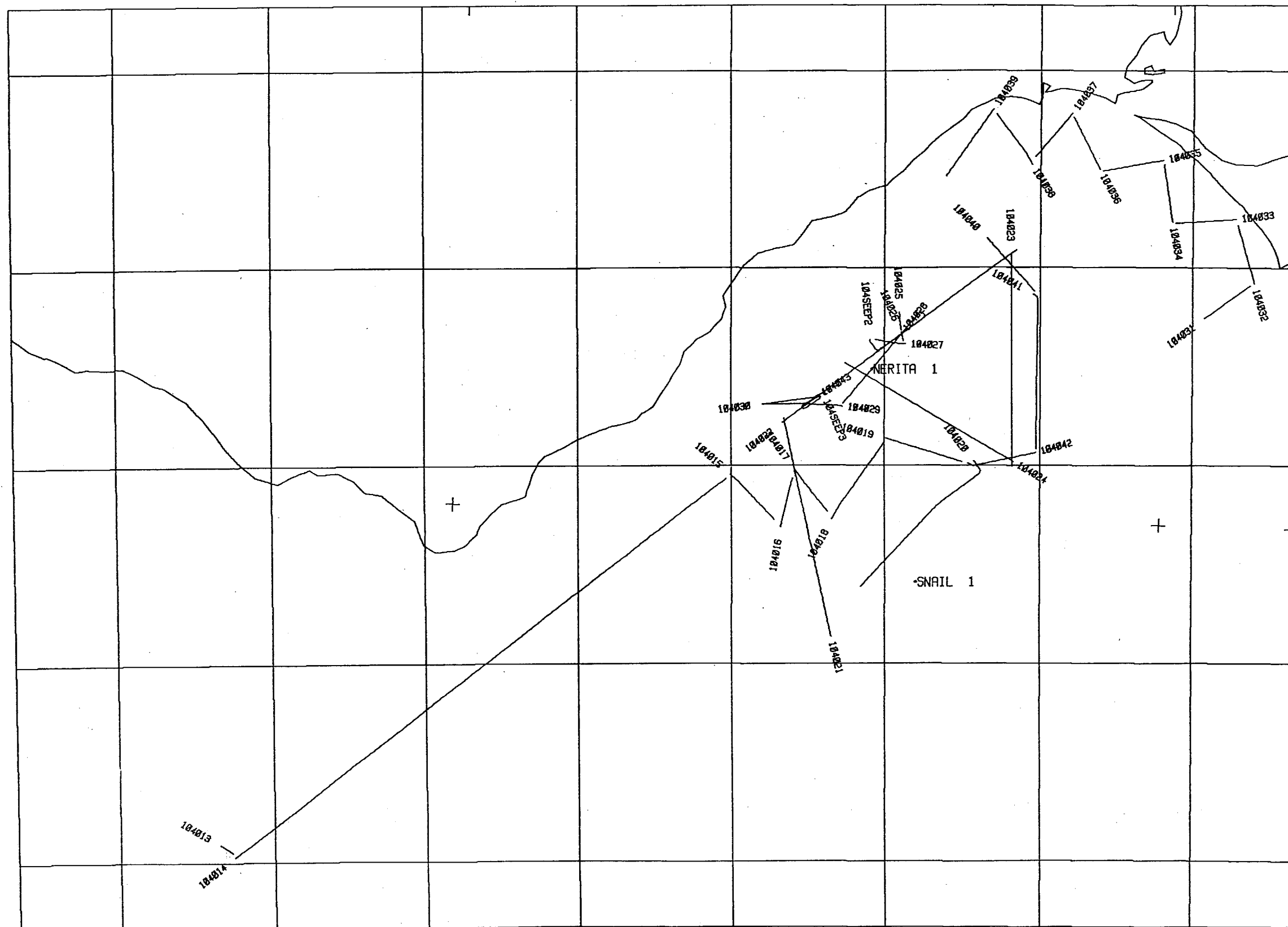
144 30 00E

144 55 00E



UNIVERSAL TRANSVERSE MERCATOR PROJECTION
AUSTRALIAN NATIONAL SPHEROID
CENTRAL MERIDIAN 147 00 00E

DHD SURVEY LINES
TORQUAY SUB-BASIN SURVEY 104
S10ATROY 7/6/92 J NEEDHAM

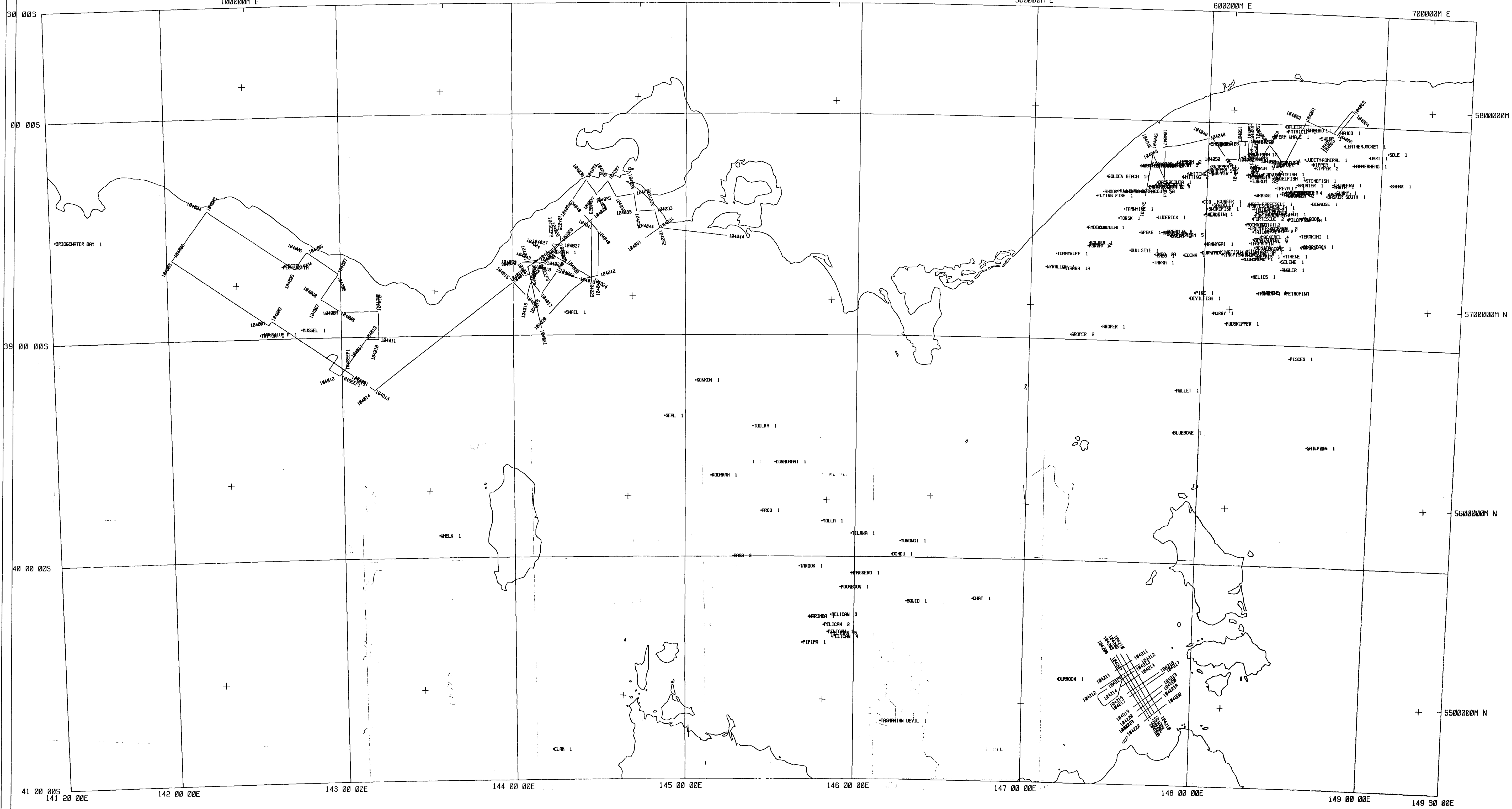


The map displays a survey track in the central Pacific Ocean, starting near the Hawaiian Islands and extending southwards. The track is marked with a line and various alphanumeric codes (e.g., 184845, 184846, 184847, 184848, 184849, 184850, 184851, 184852, 184853, 184854, 184855, 184856, 184857, 184858, 184859, 184860, 184861, 184862, 184863, 184864). The map includes latitude and longitude coordinates, with latitude ranging from 37° 45' 00" S to 39° 00' 00" S and longitude ranging from 147° 10' 00" E to 149° 15' 00" E. The Hawaiian Islands are visible in the upper left corner. Various marine species and their counts are labeled on the map, including: BALEEN WHALE 1, PATRICIA 1, LEATHHEAD 1, WAHOO 1, LEATHERJACKET 1, SOLE 1, DART 1, MANTA 1, BASKER 1, BASKER SOUTH 1, VOLADOR 1, HAPUKU 1, KINGFISH 1-7, PIKE 1, PERCH 1.2, DOLPHIN 1, BREEM 1-5, TARAHIPI 1, SERHORSE 1, TIRAH 1-3, WHITING 1.2, SNAPPER 1, MARLIN 1-4, ANGELFISH 1, FLOUNDER 1-6, COBIA 1.2, MACKEREL 1-4, FORTESCUE 1, FORTESCUE 1-4, HALIBUT 1, JUNG 1-4, REEF FISH 1.2, and SNAPPER 1-3. The map also shows several plus signs (+) and a small island in the upper right corner.

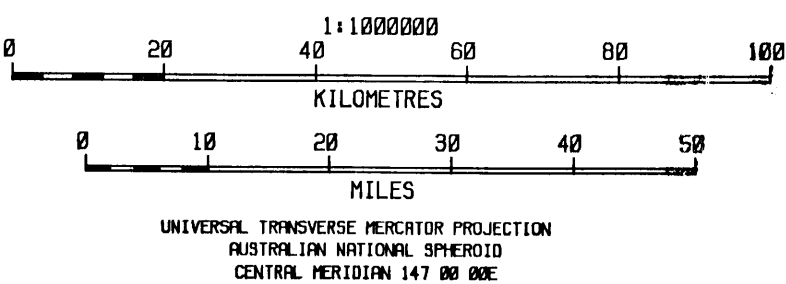


DHD SURVEY LINES		
GIPPSLAND BASIN SURVEY 104		
S12BGIPP.PIC	J NEEDHAM	9/6/92

OTWAY TO GIPPSLAND - REGIONAL



R9205407



DHD SURVEY LINES
OTWAY AND GIPPSLAND BASINS
TORQUAY AND DURROON SUB-BASINS
BMR SURVEY 104
DTG: 1960-01-01