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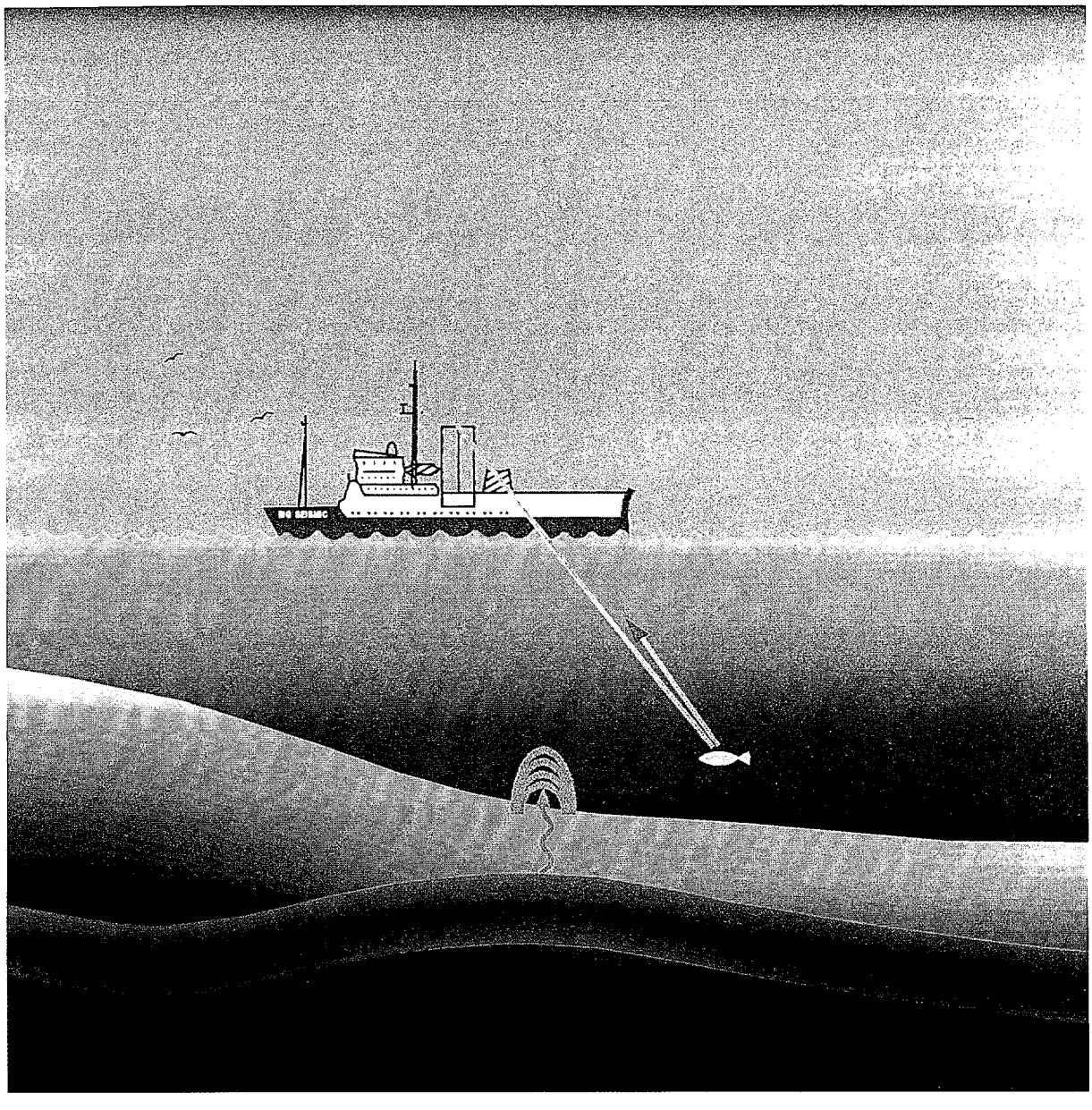
AGSO RECORD 1992/92

LIGHT HYDROCARBON GEOCHEMISTRY IN BOTTOM-WATERS OF THE PHILIPPINES CONTINENTAL SHELF Part A: RAGAY GULF AND TAYABAS BAY, *RIG SEISMIC* SURVEY 109

AGSO
AUSTRALIAN GEOLOGICAL SURVEY ORGANISATION

AUSTRALIAN INTERNATIONAL DEVELOPMENT ASSISTANCE BUREAU

teg



R9209201

PROJECT 123.03

D.Evans, D.T. Heggie, J.H. Bishop, E.N. Reyes and C-S. Lee

MARINE GEOSCIENCE AND PETROLEUM GEOLOGY PROGRAM

LIGHT HYDROCARBON GEOCHEMISTRY IN BOTTOM-WATERS OF THE PHILIPPINES CONTINENTAL SHELF

PART A:
RAGAY GULF AND TAYABAS BAY,

AGSO RECORD 1992/92

Project 123.03
AGSO (SURVEY 109)

D.Evans, D.T. Heggie, J.H. Bishop, E.N. Reyes, C-S. Lee.

This project was conducted by the Australian Geological Survey Organisation, for the Philippines Office of Energy Affairs with funding from the Australian International Development Assistance Bureau.

DEPARTMENT OF PRIMARY INDUSTRIES AND ENERGY
Minister: The Hon. Simon Crean
Secretary: G.L. Miller

AUSTRALIAN GEOLOGICAL SURVEY ORGANISATION
Executive Director: R.W.R. Rutland AO

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ISSN No. 1039-0073
ISBN No. 0 642 18586 7

EXECUTIVE SUMMARY (SURVEY 109) iv

INTRODUCTION 1

Surface geochemistry and offshore exploration for hydrocarbons: General 1

AGSO/PHILIPPINES OEA SURFACE GEOCHEMISTRY: GENERAL OBJECTIVES 2

DIRECT HYDROCARBON (DHD) DATA 3

Data Collection 3

Data presentation 6

Ragay Gulf 6

Tayabas Bay 7

NE Palawan Shelf 7

Cuyo Platform 7

REGIONAL GEOLOGY AND BRIEF EXPLORATION HISTORY: RAGAY GULF AND TAYABAS BAY. 8

RAGAY GULF AND TAYABAS BAY SURFACE GEOCHEMISTRY OBJECTIVES 10

RAGAY GULF DHD RESULTS. 12

Overview 12

Ragay Gulf Vertical Profiles of Hydrocarbons 14

'Shallow water' (less than 180 m water depth) vertical profiles 14

'Deep water' (more than 200 m water depth) vertical profiles 14

Ragay Gulf 'group 1' 28

Ragay Gulf 'group 2' 41

Ragay Gulf 'group 3' 58

RAGAY GULF HYDROCARBON 'SOURCE'. 73

CARBON ISOTOPE GEOCHEMISTRY OF RAGAY GULF GAS SAMPLES 88

13C Isotopic data 89

14C data 90

TAYABAS BAY DHD RESULTS 97

Overview 97

Tayabas Bay Hydrocarbon 'Source' 99

SUMMARY: RAGAY GULF AND TAYABAS BAY. 112
LIST OF TABLES (PART A). 114
LIST OF FIGURES (PART A). 115
LIST OF APPENDICES (PART A) 119
APPENDIX I (PART A). RAGAY GULF VERTICAL PROFILES. 120
APPENDIX II (PART A). RAGAY GULF LINE SUMMARY SHEETS AND
INDIVIDUAL LINE PLOTS. 169
APPENDIX III (PART A). TAYABAS BAY LINE SUMMARY SHEETS
AND INDIVIDUAL LINE PLOTS. 439

EXECUTIVE SUMMARY (SURVEY 109)

Between March and May 1992 the Australian Geological Survey Organisation (AGSO), formally the Bureau of Mineral Resources (BMR), and the Philippines Office of Energy Affairs (OEA) conducted a combined deep crustal seismic and Direct Hydrocarbon Detection (DHD) survey, AGSO Survey 109 (Figures 1a through 1e) in four areas of the Philippines continental shelf (Ragay Gulf, Tayabas Bay, NE Palawan Shelf and Cuyo Platform) using *Rig Seismic*. The project was funded by the Australian International Development Assistance Bureau (AIDAB).

A total of 5160 line-km of DHD (Direct Hydrocarbon Detection) data, along with gravity, magnetic and bathymetric data were acquired during survey 109. Two thousand seven hundred (2700) line-km of DHD data were acquired simultaneously with seismic data; 1180 line-km were collected during transits, and a further 1230 line-km were acquired during night-time 'sniffing only' operations, when seismic data acquisition was abandoned due to extensive night-time fishing activities by Filipino locals.

Three thousand three hundred and sixty (3360) line-km of DHD data were collected, and nine vertical profiles of light hydrocarbon distributions were measured in the water column of Ragay Gulf. Five hundred and eighty (580) line-km of DHD data were collected on the NE Palawan Shelf; 730 line-km over the Cuyo Platform and 490 line-km in Tayabas Bay.

This Record is divided into two parts. Part A is this DHD data Record combining a preliminary and brief interpretation of the data acquired in the Ragay Gulf and Tayabas Bay. Part B similarly presents the DHD data from NE Palawan and the Cuyo Platform. This Executive Summary (Part A) includes final comments from all areas surveyed. The references for both Part A and Part B are included in Part B.

Numerous light hydrocarbon anomalies were detected during the survey, predominantly in Ragay Gulf (Figure 1b & 1d). Several of these were repeatable on resurveying. Many of the strongest (greater than ten-fold typical background concentrations) anomalies were detected in the area of the R-1 and R-2 prospects (OEA-World Bank Rept, 1986) in the Ragay Gulf (Figure 1d). Some other anomalies in Ragay Gulf were associated with either faults or diapir structures, visible on ship-board seismic monitors.

Cross-plots of percent hydrocarbon wetness versus methane concentrations in anomalies (used as preliminary indicators of hydrocarbon 'source' - gas/condensate/liquids) show at least two trends in the Ragay Gulf data. One trend shows decreasing hydrocarbon wetness with increasing methane concentrations, which we have referred to as Type A anomalies. This trend predicts a 'dry' hydrocarbon 'source' for these anomalies. A second trend shows increasing percent hydrocarbon wetness with increasing methane concentrations. This trend we have referred to as Type B anomalies, and predicts a condensate-prone 'source' for these anomalies. There exists a third trend in these plots which predicts a liquids-prone hydrocarbon 'source'. Because of the possibility of artifacts in this trend, we have included this as a subset of Type B anomalies. Both trends are associated with increasing hydrocarbon wetness values at low and increasing methane concentrations - and hence predict condensate/liquids prone hydrocarbon 'sources'.

Twenty five gas samples collected from Ragay Gulf anomalies were analysed for the carbon isotopic composition of the methane, which varied between -57.3 ^{o}/oo and -37.8 ^{o}/oo. A consideration of both the molecular and isotopic compositions of these samples (the Bernard model), suggests that most samples were either of thermogenic origin or contained a significant proportion of thermogenic hydrocarbons. Only one sample was predicted to be of biogenic origin.

Eight samples, which represented different types of hydrocarbon anomalies, were selected for ^{14}C analysis of the methane. The results indicated that all samples contain predominantly 'fossil' carbon. These results, combined with the molecular compositions of the anomalies and the carbon isotopic compositions of methane, indicate a thermogenic origin for the light hydrocarbon anomalies in Ragay Gulf.

Light hydrocarbon anomalies were also detected in Tayabas Bay. However, there were fewer anomalies in Tayabas Bay, as compared to Ragay Gulf, and the anomalies were generally weak and are of Type A (dry) molecular compositions.

No significant anomalies were detected in NE Palawan. A weak but areally extensive anomaly was found near the intersection of lines 109/012 and 109/011, and the three abandoned oil exploration wells on the NE Palawan Shelf (Roxas-1, Paly-1, and Dumaran-1) were identified by hydrocarbon anomalies.

No significant hydrocarbon anomalies were found on the Cuyo Platform.

The DHD data on their own suggest that Ragay Gulf is the most petroleum prospective area of those surveyed. There were more anomalies found in Ragay Gulf than elsewhere, and the strongest anomaly found during the survey was also found in Ragay. However the general lack of anomalies found in the other areas surveyed may result from inadequate hydrocarbon migration pathways to the seafloor.

Detailed track-maps and floppy diskettes of DHD data are available from AGSO.

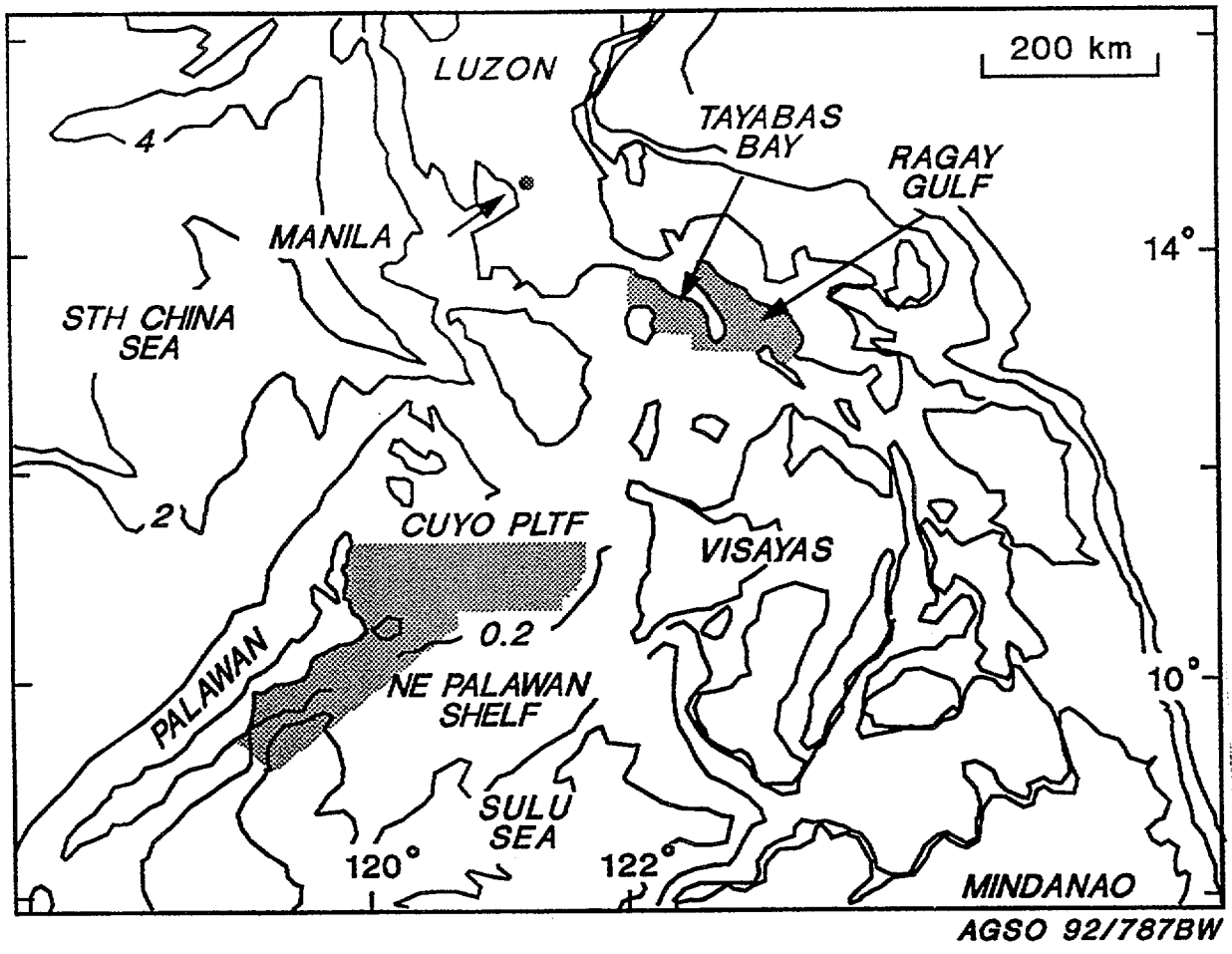


Figure 1a. Location map of the Philippines showing the four basins surveyed during AGSO Survey 109.

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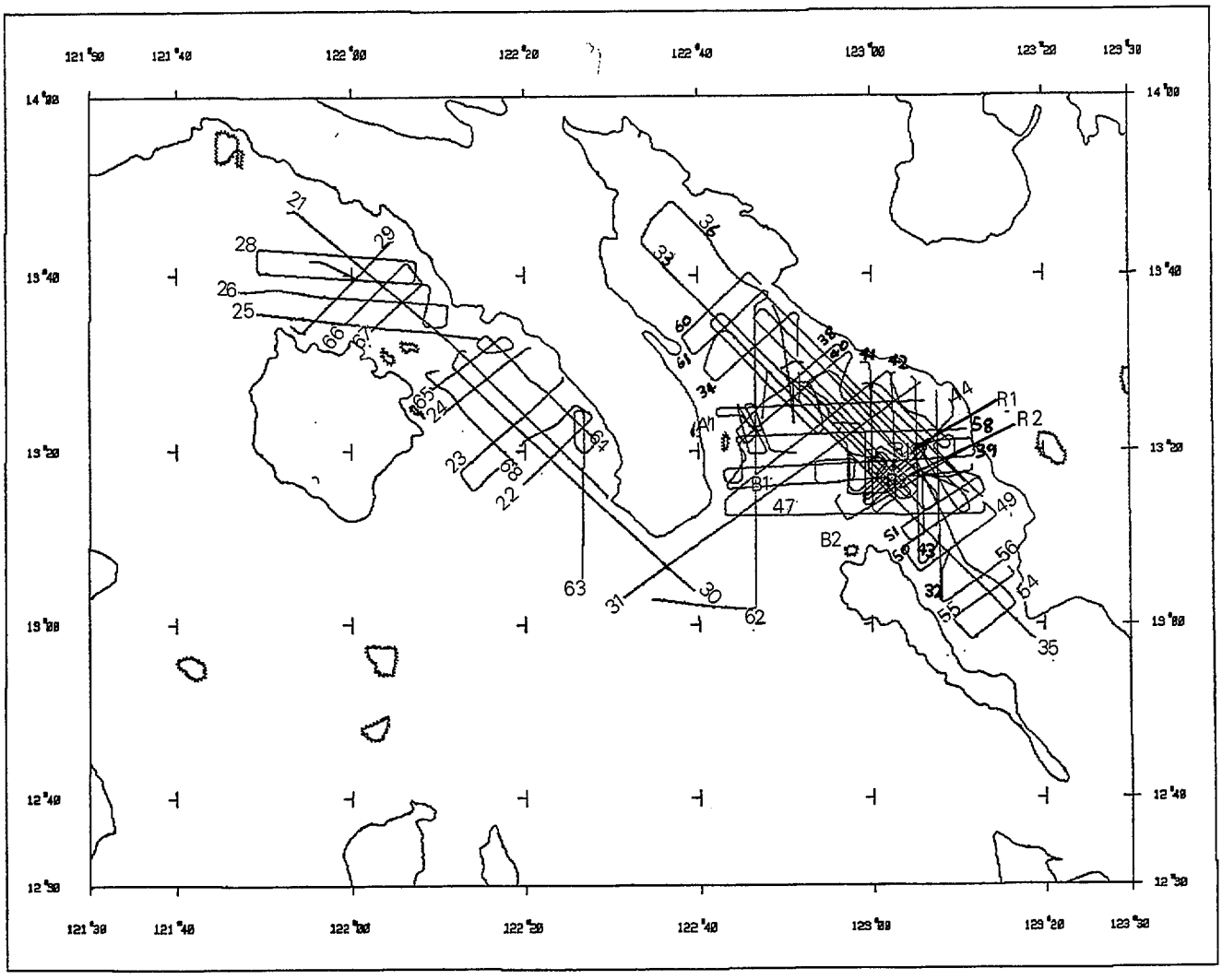


Figure 1b. Map of Ragay Gulf and Tayabas Bay area showing the DHD survey lines and prospects R-1, R-2, B-1, B-2, and A-1(OEA-World Bank Rept 1986) for AGSO Survey 109.

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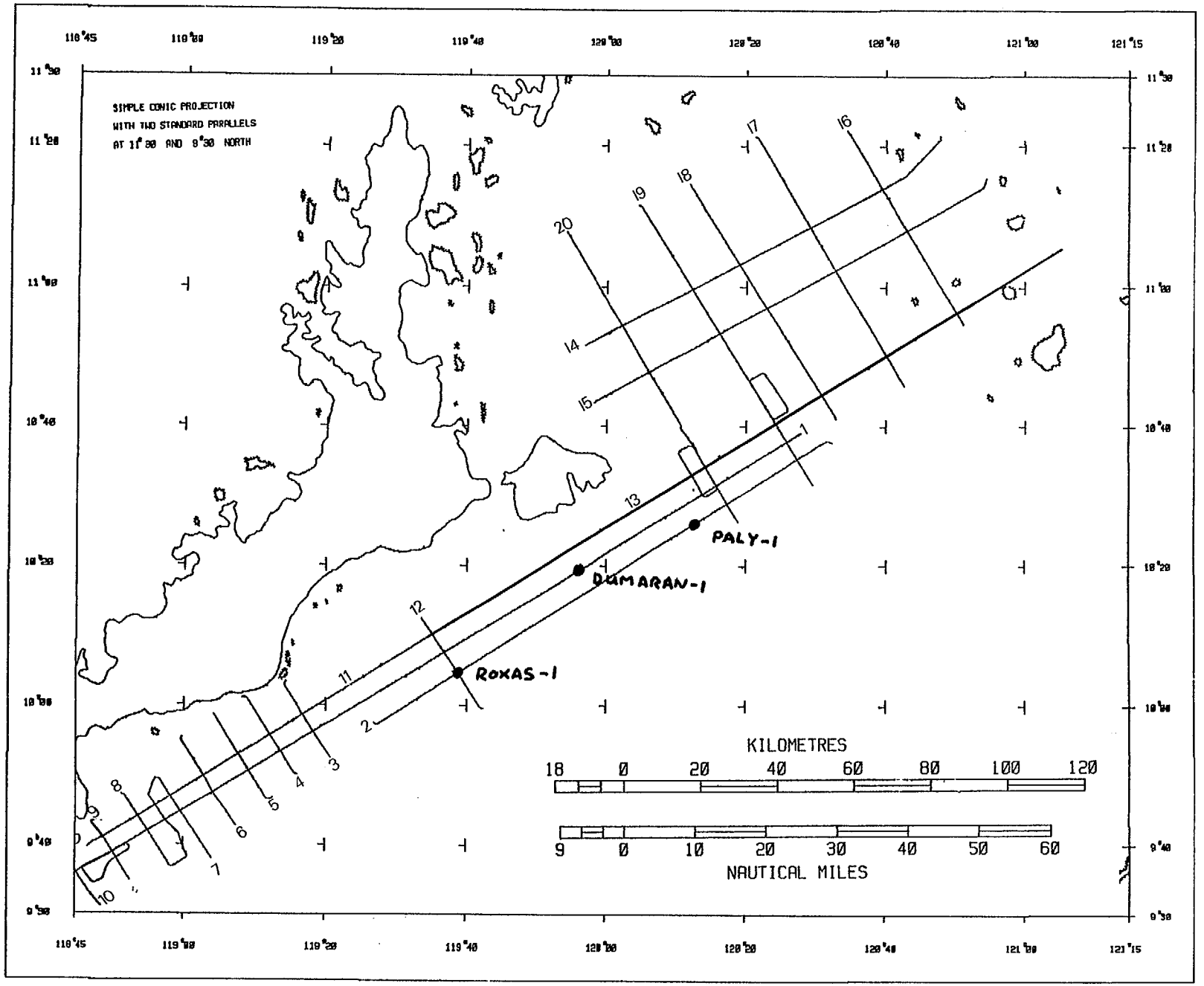


Figure 1c. Map of the NE Palawan Shelf and Cuyo Platform showing the DHD survey lines and selected well locations for AGSO Survey 109.

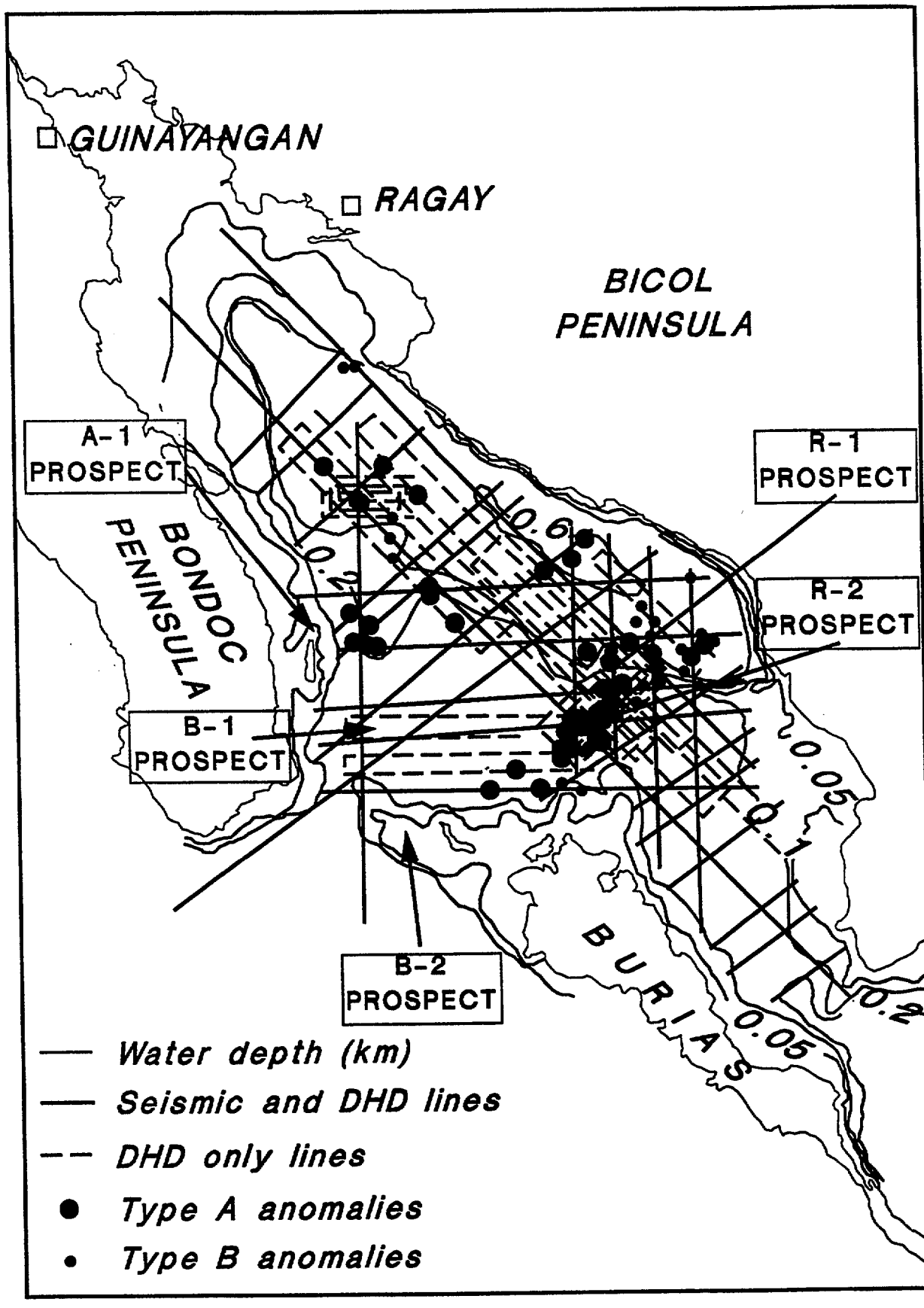


Figure 1d. Map of Ragay Gulf showing the distribution of Type A and Type B anomalies, DHD and seismic lines and bathymetry.

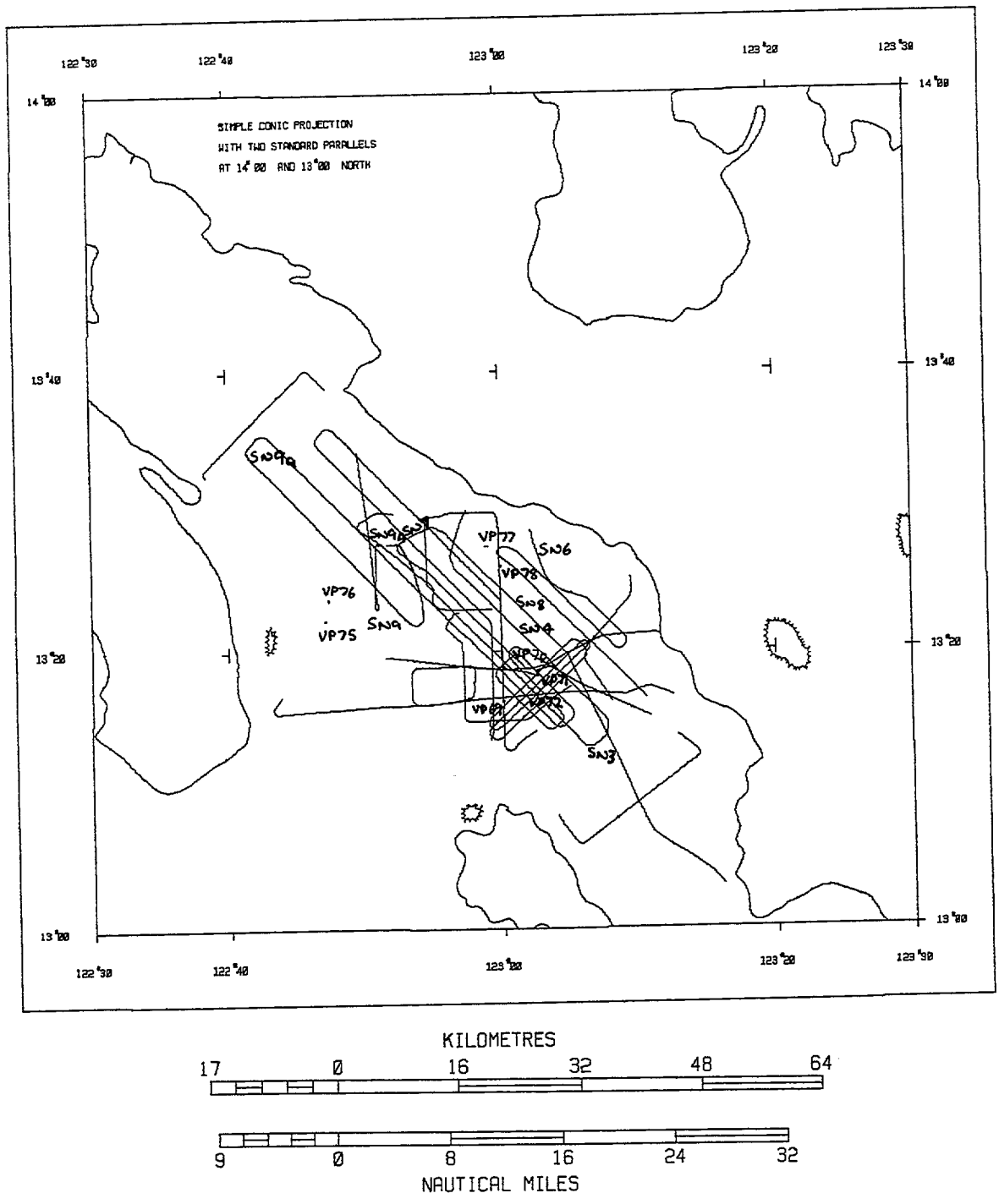


Figure 1e. Map of Ragay Gulf showing locations of DHD only lines and vertical profiles.

INTRODUCTION

Surface geochemistry and offshore exploration for hydrocarbons: General

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. Schiener et al. (1985) have commented about the use of the geochemical 'sniffer' in the North Sea.

The Australian Geological Survey Organisation (AGSO), as part of the Continental Margins Program, and a joint Agreement with Transglobal Exploration and Geoscience (TEG) of Leucadia California (Heggie et al., 1990), has been conducting (DHD) surveys on parts of the Australian continental margin, and elsewhere since 1989. One intention of this work was to evaluate the potential of (DHD) and bottom-water exploration methods in hydrocarbon exploration around Australia and South-East Asia. Part of this work includes developing an understanding of: (i) the origins (biogenic or thermogenic) of bottom-water light hydrocarbons, (ii) the 'source' (liquids, condensate or dry gas) of light hydrocarbon anomalies in bottom-waters, (iii) bottom-water and seafloor expressions of seepage and the relationships of seepage to the surface and sub-seafloor geology, including hydrocarbon accumulations and source rock types and distributions.

To the best of our knowledge bottom-water geochemical exploration (DHD), techniques have not been used for hydrocarbon exploration in the offshore Philippines area.

This record presents the (DHD) data collected during AGSO Survey 109 to the Philippines between March and may 1992. Because of the large amount of (DHD) data collected during this survey, this Record is presented in two parts. Part A includes the data from Ragay Gulf and Tayabas Bay. These data are presented first because most anomalies were detected in the Ragay Gulf (and therefore are expected to be of most interest), and Ragay Gulf and Tayabas Bay are similar geologically. Part B of this Record includes the data from the Northeast Palawan Shelf and the Cuyo Platform. All references are in Part B. Other data collected throughout the survey, such as the deep seismic, gravity and magnetics are not presented here.

AGSO/PHILIPPINES OEA SURFACE GEOCHEMISTRY: GENERAL OBJECTIVES

The overall objectives of the AGSO/Philippines OEA offshore surface geochemistry program are:

1. To upgrade the knowledge of petroleum prospectivity of four offshore areas (Ragay Gulf, Tayabas Bay, Cuyo Platform and NE Palawan Shelf) in the Philippines.

2. To contribute to petroleum exploration risk assessment in these areas.

3. To promote potential opportunities for future Philippines-Australia joint venture exploration.

4. To assist the Philippines Government (through appropriate training of Filipino nationals), in acquiring the skills to plan, collect and interpret seismic data and other petroleum resource (DHD, gravity, magnetic and bathymetric) related information and use these to focus future petroleum exploration in Philippine waters.

To achieve these objectives, multi-disciplinary programs involving the simultaneous collection of bottom-water DHD, seismic reflection, gravity, and magnetic data were carried out by the AGSO's research vessel *Rig Seismic* in the Ragay Gulf, Tayabas Bay, NE Palawan Shelf and Cuyo Platform.

DIRECT HYDROCARBON (DHD) DATA

Data Collection

During the survey, a total of approximately 5160 line-km DHD data were acquired (Table 1). Of this total, 2750 line-km of DHD data were collected concurrently with deep-seismic, gravity, magnetic and bathymetric data along seventy three lines (109/001 to 109/056, 109/058 to 109/070, and 109/073, to 109/076, and 109/079) from all four areas.

Of the 2750 line-km of DHD data collected simultaneously with gravity, magnetic and bathymetric data, 1850 line-km (37 lines) were acquired in the Ragay Gulf (Table 2); 490 line-km (16 lines) were acquired in Tayabas Bay (Table 2); 580 line-km (12 lines) were acquired from NE Palawan (Table 2), and 730 line-km (8 lines) were acquired from the Cuyo Platform (Table 2).

From the Ragay Gulf, approximately 280 line-km of DHD, gravity and magnetic data were collected from Ragay, during transits and maintenance of the seismic acquisition system (Table 2). Also from Ragay Gulf, an additional 1230 line-km of DHD data were acquired along ten 'DHD-only' lines (Lines 109/sniff1 through 109/sniff9a), during night-time 'sniffing only' operations when seismic data acquisition was abandoned due to extensive night-time fishing activities, by Filipinos, in the area (Table 2).

Nine vertical profiles (Table 2), were carried out in Ragay Gulf at the end of the survey (Lines vp109/069, through vp109/072 and vp109/075 through vp109/078).

Table 1. Line kilometres of DHD survey data collected in the four sedimentary basins offshore Philippines

Basin	Number of lines	Line kilometres
Ragay Gulf	47 (plus 9 vertical profiles)	3360 km
Tayabas Bay	16	490 km
NE Palawan	12	580 km
Cuyo Platform	8	730 km

Table 2. Survey Area and Data Collected

Area	Line Number(s)	Data Collected.
Ragay Gulf	109/031 to 109/056	1850 line-km of
	109/058 to 109/062	DHD, & seismic
	109/069 to 109/070	
	109/073 to 109/076	280 line-km DHD
	and 109/079	during transits
	109/sniff1 to 109/sniff9a	1230 line-km
		DHD only data
	vp109/069 to vp109/072	9 vertical profiles
	vp109/075 to vp109/078	
	vp on line sniff9	
Tayabas Bay	109/021 to 109/030	490 line-km of
	and 109/063 to 109/068	DHD & seismic
NE Palawan	109/001 to 109/012	580 line-km of
		DHD & seismic
Cuyo Platform	109/013 to 109/020	730 line-km of
		DHD & seismic

Data presentation

The following sections present the results obtained during the survey on a basin-by-basin basis. Much of the discussion relates to a number of data plots which summarise the various light hydrocarbon concentrations along the survey lines within each basin.

The complete set of DHD results for the survey, on an individual line by line basis, are presented in Part A for the Ragay Gulf (Appendices I and II), and for Tayabas Bay (Appendix III). Data from NE Palawan are found in Part B (Appendix I), and for the Cuyo Platform also in Part B (Appendix II). The Appendices include:

a. Line summary sheets, which summarise the light hydrocarbon statistics and characteristics of each survey line including the start and end latitude and longitudes.

b. Charts showing the distributions of the C_1 to C_3 hydrocarbons (and tow-fish depth) along each survey line.

Full details of the acquisition methods used and the interpretative methodologies employed are given in Part B, Appendices III and IV. An explanation of the classification scheme used in describing the anomalies is given in Appendix IV.

In the following discussion the line summary plots have been grouped and discussed as follows:

Ragay Gulf

Because of the large amount of data gathered in Ragay Gulf, these data have been split into three groups of roughly the same number of lines, and presented below, in the order in which the lines were recorded.

a. Ragay Gulf 'group 1' (Lines 109/31 through 109/44 and including lines 109/sniff 1 through 109/sniff 4); Figures 5a-m & 8a-d, Part A).

b. Ragay Gulf 'group 2' (Lines 109/045 through 109/056, 109/058 and 109/059, and 109/sniff5 through 109/sniff9a), (Figures 6a-m & 9a-d, Part A).

c. Ragay Gulf 'group 3' (Lines 109/060 through 109/062; lines 109/069, 109/070, 109/073, through 109076 and 109/079; vertical profile lines vp109/069, through vp109/072 and lines vp109/075 through vp109/078), (Figures 7a-m & 10a-d, Part A)

Tayabas Bay

Tayabas Bay (Lines 109/021 through 109/030 and 109/063 through 109/068), (Figures 12a-m & 13a Part A)

NE Palawan Shelf

NE Palawan Shelf (lines 109/001 through 109/012), (Figures 2a-m & 3a-b, Part B)

Cuyo Platform

Cuyo Platform (Lines 109/013 through 109/020), (Figures 4a-m & 5a-b, Part B)

Typical background values for hydrocarbons throughout the survey areas were: total hydrocarbons (THC) 8 to 10 ppm, methane 3 to 5 ppm, C_2 and C_3 hydrocarbons less than 0.05 ppm. Butane levels were generally below the detection limit of 0.005 ppm.

REGIONAL GEOLOGY AND BRIEF EXPLORATION HISTORY: RAGAY GULF AND TAYABAS BAY.

Tectonics

The Ragay Gulf and Tayabas Bay area contains narrow, northwest-trending horst and graben features. The basin fill is composed of Oligocene to Holocene clastics and carbonates of shallow to deep marine paleoenvironments. The deepest grabens contain up to 9 km of Tertiary sediments. Basin deformation is the combined result of extensional block faulting, differential uplift, and shearing along individual faults of the Philippine Fault System. Folds are small and mostly wrench-induced. These basins are considered to be backarc basins.

Stratigraphy

The Paleocene-Oligocene period is characterised by stable tectonic conditions wherein sedimentation occurred on a broad, shallow, basement floor. Transitional to shallow marine deposits typify this episode and are represented by coal measures, basal conglomerates and carbonates, with occasional basalt flows and associated volcaniclastics.

Tensional forces at the onset of the Oligocene initiated horst and graben features in the central part of the basin. From Late Oligocene to Early Miocene time, shallow marine conditions prevailed with the deposition of lagoonal to shelfal carbonates and their clastic equivalents. Towards the Middle Miocene, significant subsidence of the basin occurred. Turbidites were deposited within the graben while shelfal sandstones and shales accumulated along basin margins and over the submerged horst blocks. The Upper Oligocene-Middle Miocene sequence represents a major transgressive phase.

Wrench tectonism at the end of the Middle Miocene caused a short period of local uplift and erosion. From the late Miocene to Holocene, the ensuing sedimentation took place generally under transitional to shallow marine conditions. The sedimentary section is represented by a regressive sequence of conglomerates, sandstones, claystones and shelfal carbonates with reef development. Minor turbidity current deposition in Late Miocene time occurred in the deep central portions of the basin.

Geophysics

Prior to the 1986 Petro-Canada International Assistance Corporation seismic survey, survey area 2 was covered by about 4000 km of seismic data recorded by several exploration companies since 1973. These data include a number of regional lines by Philips in 1979, SEDCO in 1980, and BED in 1983. The Petro-Canada survey recorded 975 km in Ragay Gulf. Overall, data quality is good, except in some structurally disturbed areas where reflections are obliterated.

Onshore seismic data are confined to the Bondoc Peninsula, but these are few, widely spaced, and were acquired before 1980.

Also as part of the OEA-World Bank petroleum exploration promotion project, a total of 10,500 km (2 km x 15 km detailed grid) of aeromagnetic data covering the Southeast Luzon Basin was acquired in 1983-1984. These data served to complement the seismic data in defining the regional structures and thickness of sediments throughout the basin.

Drilling

No wells have been drilled offshore. Onshore drilling in the Bondoc and Bicol Peninsulas started in 1906. Forty-seven wells have been drilled to depths ranging from 32 to 2100 m, with 80% of the wells penetrating less than 1000 m. These shallow wells were drilled in the vicinity of oil seeps, based solely on surface geology or following up shows, and some had significant oil and gas shows.

Generation of hydrocarbons is indicated by small oil and gas flows and tar traces in 22 wells, numerous surface oil/gas seepage's on the Bondoc and Bicol Peninsulas, and one seep on Burias Island.

Prospects

Five play types (A-1, R-1, R-2, B-1 and B-2) have been identified and include Oligocene/Miocene carbonate talus and reefal features, turbidity mounds, delta fans and shelfal sand. Stratigraphic, structural and combination trap types are all present. The untested offshore areas offer the most promising plays.

RAGAY GULF AND TAYABAS BAY SURFACE GEOCHEMISTRY OBJECTIVES.

1. To seek evidence of thermogenic hydrocarbon anomalies (and seepage) from the Ragay Gulf and Tayabas Bay and hence, assist in new exploration and reduce exploration risk in these areas.

2. To test for new exploration leads and prospects; but specifically to test some of the prospects (R-1, R-2, B-1, B-2, A-1) identified above for evidence of thermogenic anomalies and seepage.

3. To test for hydrocarbon anomalies and seepage above previously identified diapir structures in the eastern part (albeit, in water deeper than 500 m) of Ragay Gulf.

4. To relate the chemical and isotopic compositions of hydrocarbon anomalies to potential hydrocarbon 'sources', i.e. gas, condensate, liquids.

5. To examine the relationship(s) between hydrocarbon generation and migration by relating the surface and sub-seafloor expressions of hydrocarbon anomalies (seeps) to the sub-seafloor geology and probable locations and type(s) of source rocks.

6. To examine oceanographic (and biogenic) dispersal processes of light hydrocarbon anomalies.

The geochemical analysis system (DHD) that has been installed aboard the *Rig Seismic* is shown schematically in (Figure 2) and discussed in more detail in Part B (Appendix III). The laboratory system analyses a variety of gases extracted from seawater, including C_1-C_8 hydrocarbons with facilities to collect gases for shore-based isotopic analyses. Complete details of both the DHD system and the interpretative methodologies used are given in Part B (Appendices III and IV).

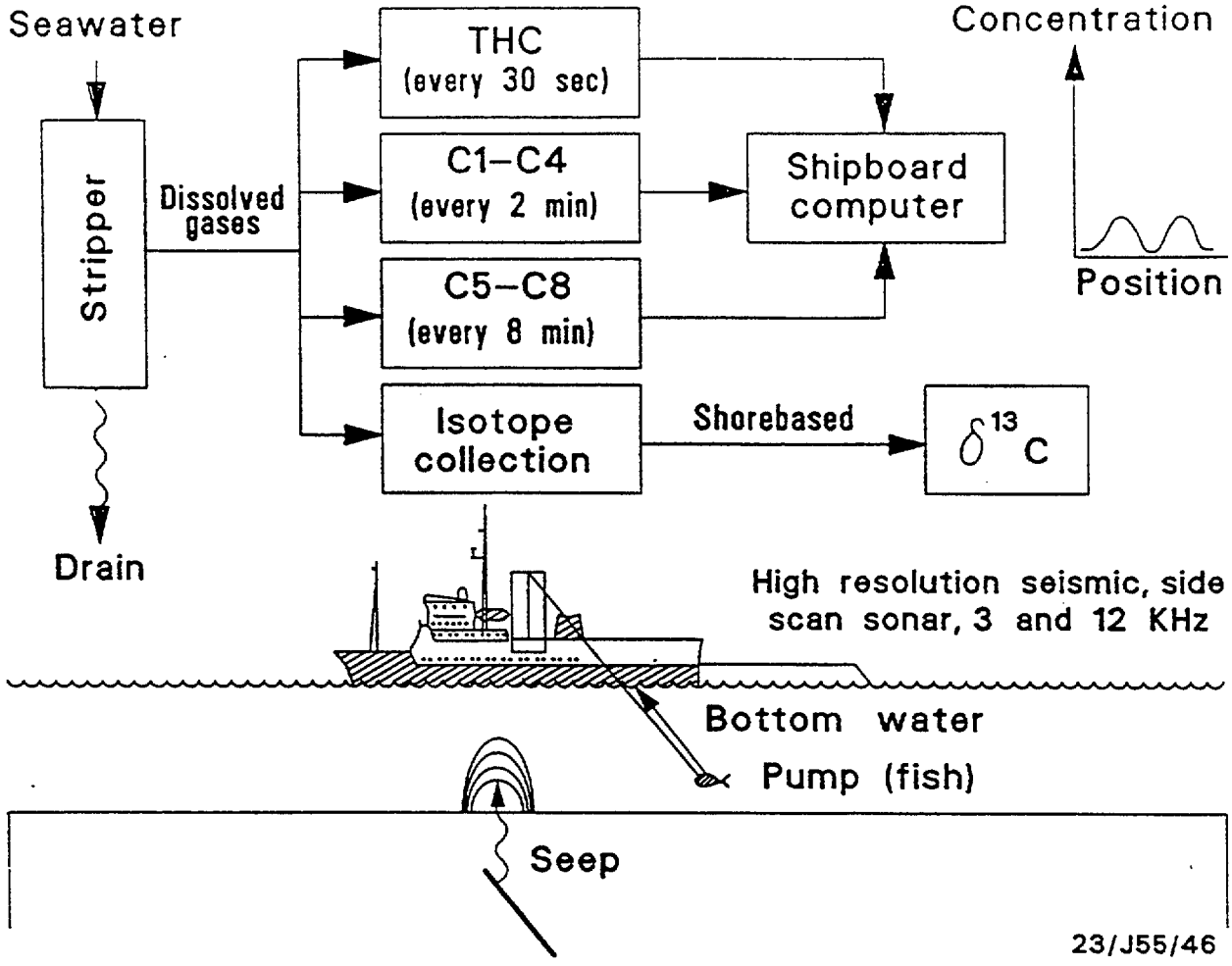


Figure 2 Schematic of the geochemical equipment aboard *Rig Seismic* for the continuous profiling of hydrocarbons in seawater: the bottom-water DHD technique.

RAGAY GULF DHD RESULTS.

Overview

A large number (approximately 32) of moderate to strong light hydrocarbon anomalies were detected in Ragay Gulf.

The vertical distributions of hydrocarbons in the water column suggest that light hydrocarbon anomalies are 'trapped' near the base of the stratified region of the water column, where there are significant changes in the depth-gradients of both temperature and salinity. These data are summarised in Figures 3a-g and 4a-g.

Ragay 'group 1' lines (Lines 109/031 through 109/044 and 109/sniff1 through 109/sniff4), are presented in Figures 5 a-m and 8a-d. Approximately ten moderate to strong light hydrocarbon anomalies were detected in this grouping of lines.

The data from Ragay 'group 2' lines (Lines 109/045 through 109/056, 109/058 and 109/059 and 109/sniff5 through 109/sniff9a), are presented in Figures 6 a-m and 9a-d. Approximately nine moderate to strong light hydrocarbon anomalies were detected in this grouping.

The data from Ragay 'group 3' lines (Lines 109/062 through 109/062; lines 109/069, 109/070, 109/073 through 109/076 and 109/079; vertical profile lines vp109/069 through vp109/072 and lines vp109/075 through vp109/078), are reported in Figures 7a-m and 10a-d. Approximately thirteen light hydrocarbon anomalies were detected in this grouping.

The cross-plots of percent hydrocarbon wetness versus methane, used as preliminary indicators of hydrocarbon 'source' (see Figures 8a-d, 9a-d & 10a-d), indicate that the anomalies recorded in Ragay Gulf fall into two distinct types.

Type A anomalies are very rich in methane with traces of ethane only, and hydrocarbon wetness values less than 0.5 %.

Type B anomalies are composed of methane, ethane, and propane plus traces of C_4 and C_5 hydrocarbons, with percent hydrocarbon wetness values of 1 to 2 %. Some anomalies have percent hydrocarbon wetness values up to 12 %.

There are no offshore wells in Ragay Gulf. However, the survey lines tie several previously identified prospects: Alibijaban-1 (Far East Resources, 1989); and B-1, B-2,

R-1, R-2 (OEA-World Bank Report, 1986). Numerous repeatable hydrocarbon anomalies were recorded, particularly around prospects R-1 and R-2 (Figures 1b and d). Other anomalies were associated with either faults or diapir structures, which were visible on ship-board seismic monitors.

Ragay Gulf Vertical Profiles of Hydrocarbons

Nine vertical profiles of light hydrocarbon distributions in the water column were measured in the Ragay Gulf. Because many anomalies were found in the Ragay Gulf, and it was recognised that anomalies may possibly be of different origins (biogenic or thermogenic)o arise from several different 'sources', these profiles were acquired to aid in the interpretation of the large amount of line-km of DHD collected. The vertical profiles can be divided in two groups: (i) those with water depths less than 180m (Figures 3 a-g) and, (ii) those with water depths greater than 200m (Figures 4 a-g).

The vertical distributions of light C_1-C_4 hydrocarbons from all of these profiles are summarised graphically in Appendix 1.

'Shallow water' (less than 180 m water depth) vertical profiles

VP109/070 (Figure 3) is an example of the shallower group of profiles (vp's 109/069; 109/070, 109/071, and 109/072). Temperature and conductivity systematically decrease with increasing water depth to about 160 m (Figures 3a-b). Similarly, ethylene (the unsaturated hydrocarbon) profiles show a relatively constant gradient down to 155m, with the highest concentrations in surface waters decreasing to values less than 0.05 ppm at depths below 150m. Propylene concentrations vary similarly. In the following descriptions of the DHD line summary plots, the occurrences of high values of both ethylene and propylene are indicative of the DHD tow-fish rising in the water column. Total hydrocarbons (THC), methane, ethane, and propane values are low in surface waters and increase rapidly below about 120 m depth, with maxima near the seafloor. These distributions suggest hydrocarbons are emanating from the seafloor and these remain 'trapped' in a shallow layer near the base of the stratified layer.

'Deep water' (more than 200 m water depth) vertical profiles

An example of one of the deeper water group of profiles, vp109/078, is shown in (Figures 4 a-g). The lines in this group include vp109/075, vp109/076, vp109/077, vp109/078 and 109/sniff9. Temperature and conductivity decrease systematically with increasing water depth, to depths of about 150 m. Below 150 m temperature and conductivity remain nearly constant. These data suggest a 'two-layer' water column, with stratification to about 150 m water depth, and a relatively well mixed zone below 150 m.

Ethylene concentrations decrease systematically to very low concentrations (<0.03 ppm) at depths of about 150 m, and remain constant below that depth. Hence, ethylene and propylene concentration variations in the line-summary plots, may be used as indicators of the DHD tow-fish passages between the surface waters (depths to 150 m) and the deep waters (depths greater than 150 m).

THC, methane, ethane and propane values are highest in the depth-zone between 120 m and 150 m. Several of these profiles also indicate increasing hydrocarbon concentrations with increasing depth below 150 m, indicating an input of hydrocarbons from the seafloor. The mid-water maxima in these profiles also suggest that hydrocarbons (which have migrated from the seafloor) are 'trapped' near the base of the stratified water column.

The purpose of presenting these profiles here is to demonstrate the importance of the depth variations in the hydrocarbon distributions, and how the presence/absence of anomalies is influenced by these distributions and the variations of the tow-fish depth during the survey.

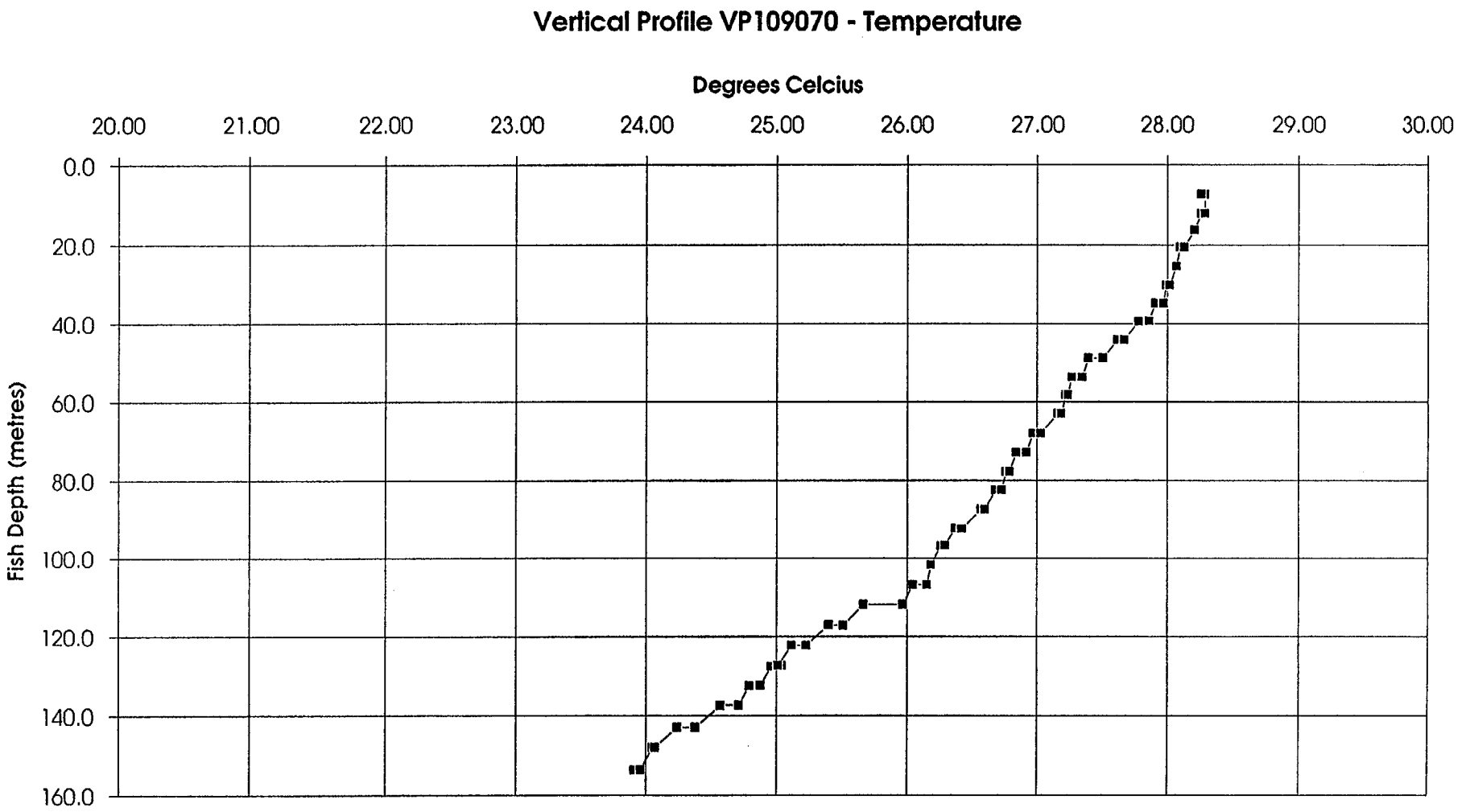


Figure 3a. Vertical profile of fish depth vs temperature line VP 109/070

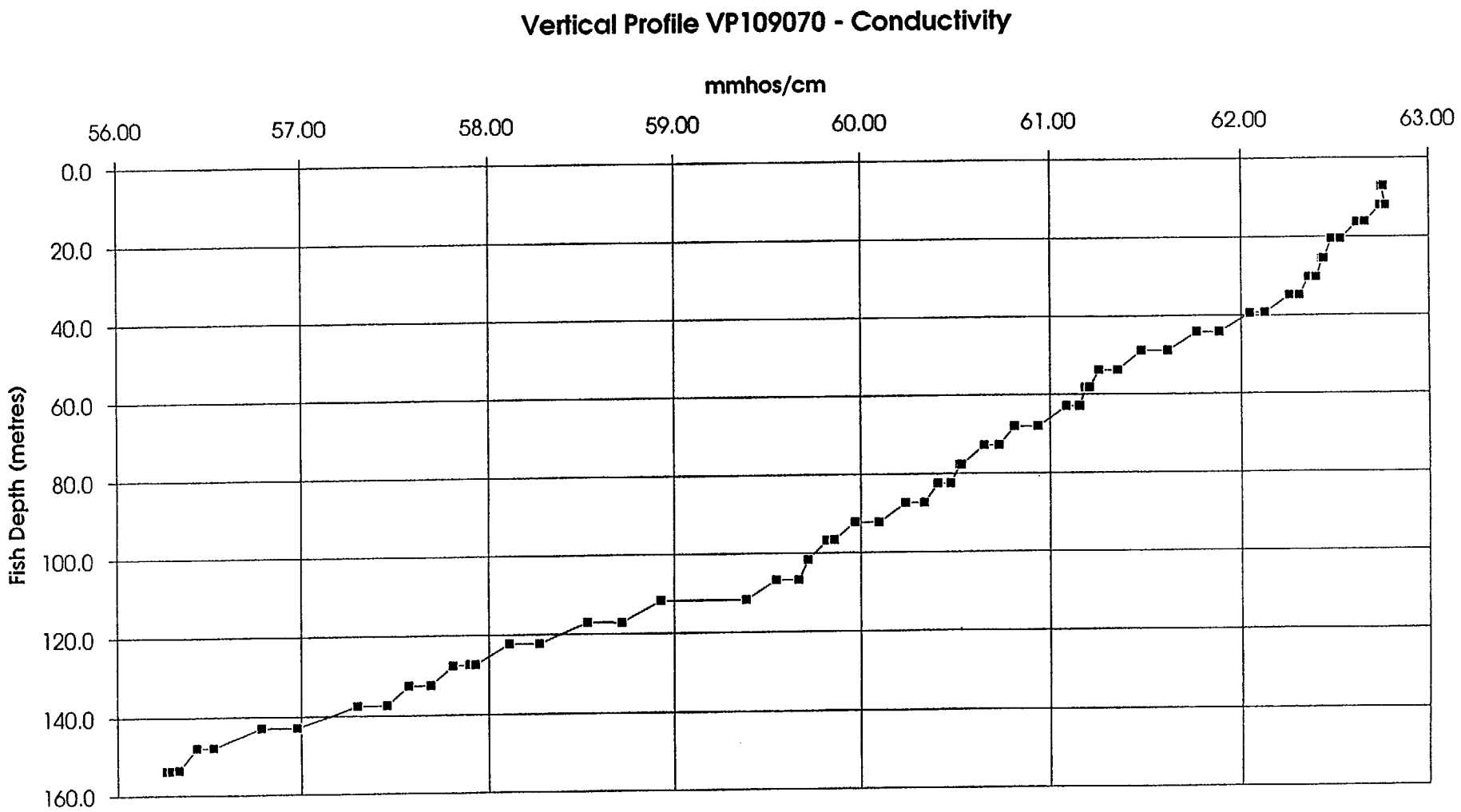


Figure 3b. Vertical profile of fish depth vs conductivity line VP 109/070

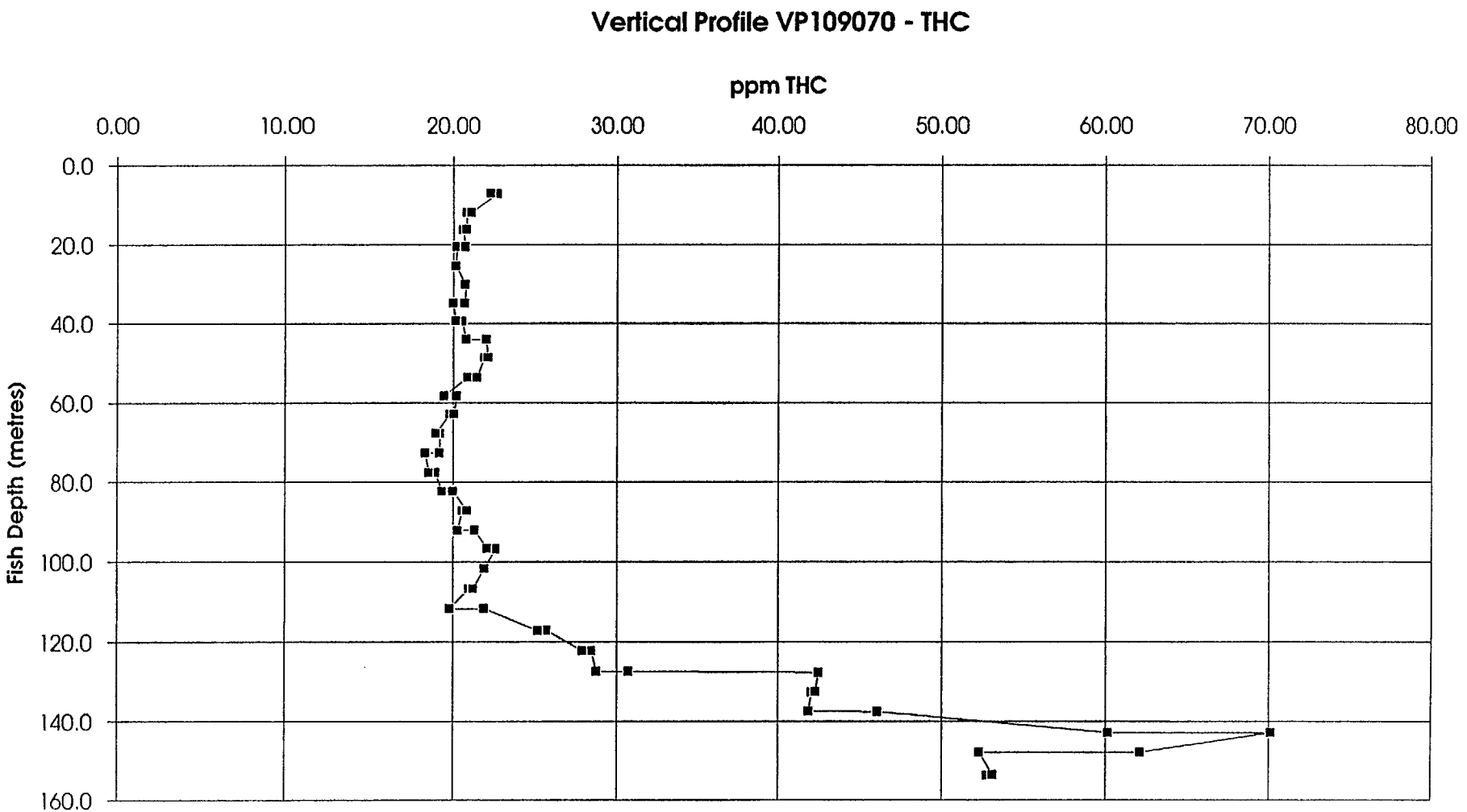


Figure 3c. Vertical profile of fish depth vs THC line VP 109/070

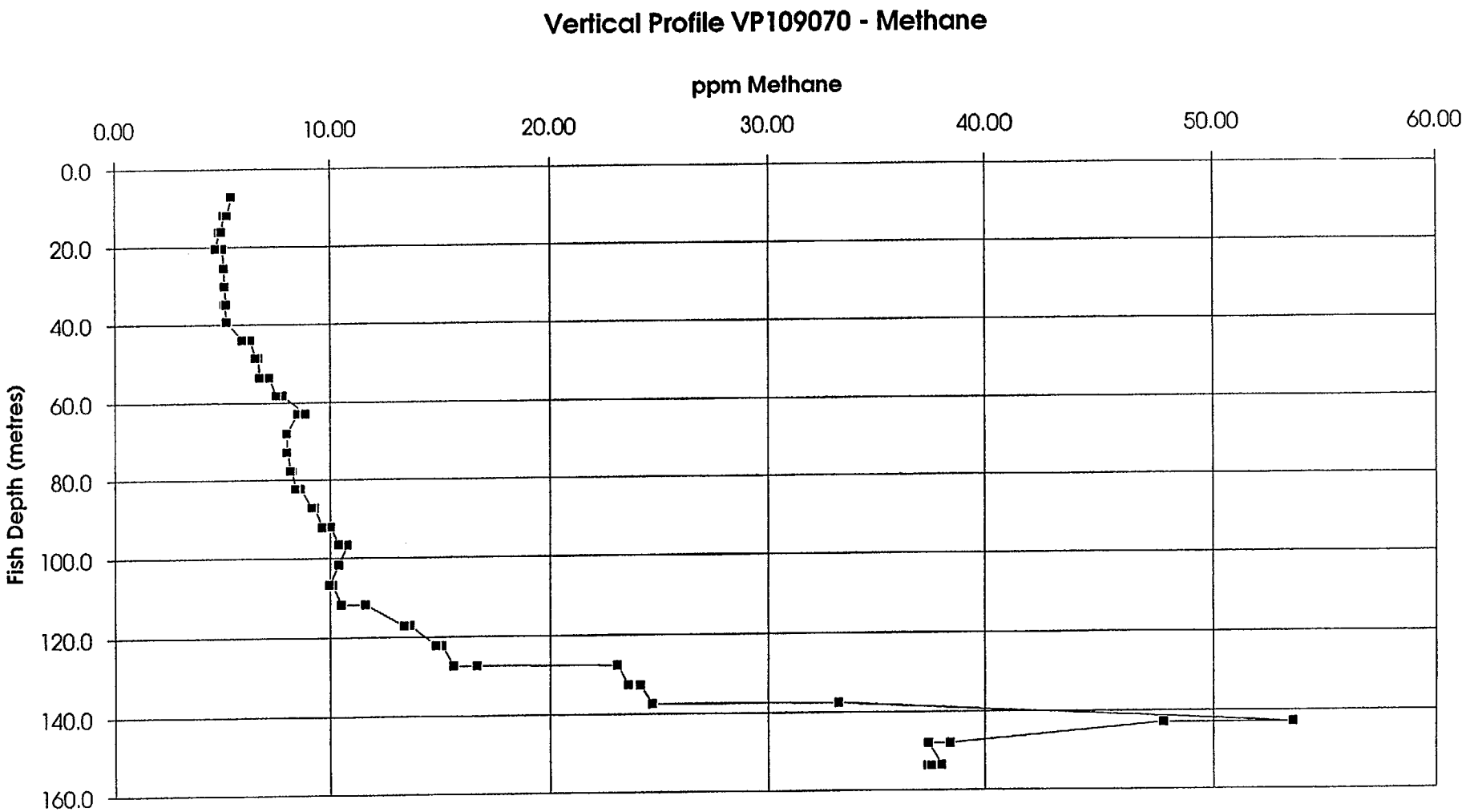


Figure 3d. Vertical profiles of fish depth vs methane line VP 109/070

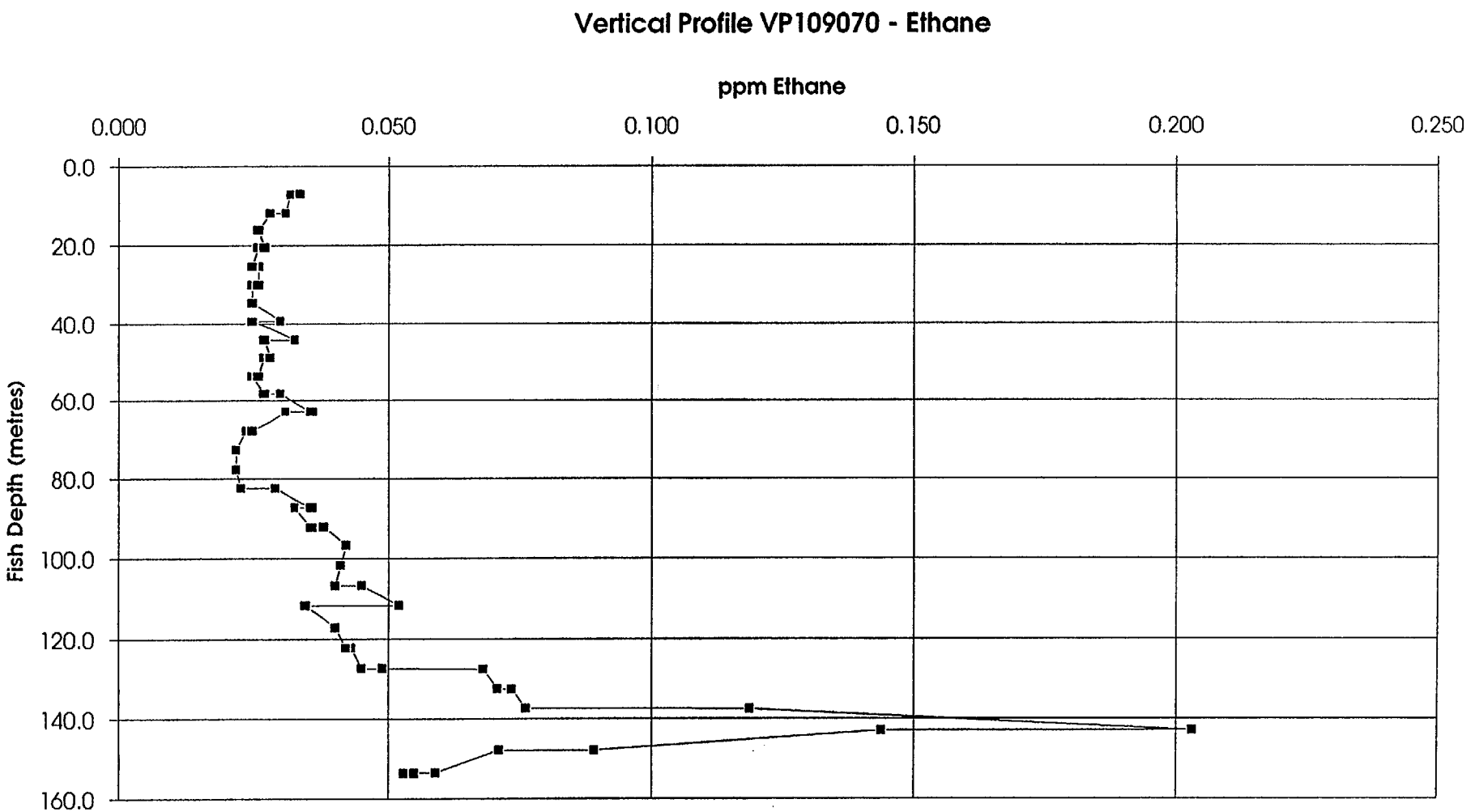


Figure 3e. Vertical profile of fish depth vs ethane line VP 109/070

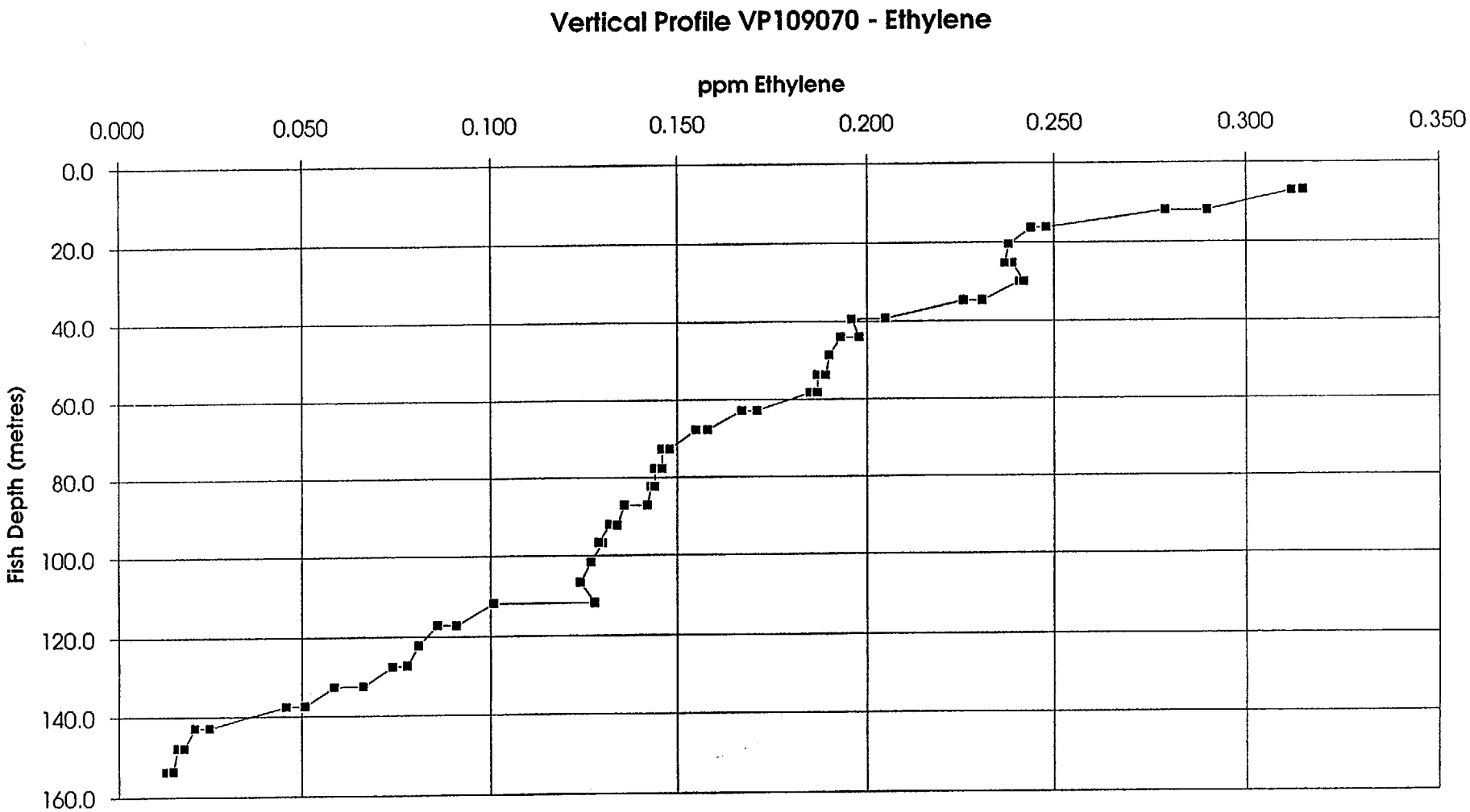


Figure 3f. Vertical profile of fish depth vs ethylene line VP 109/070

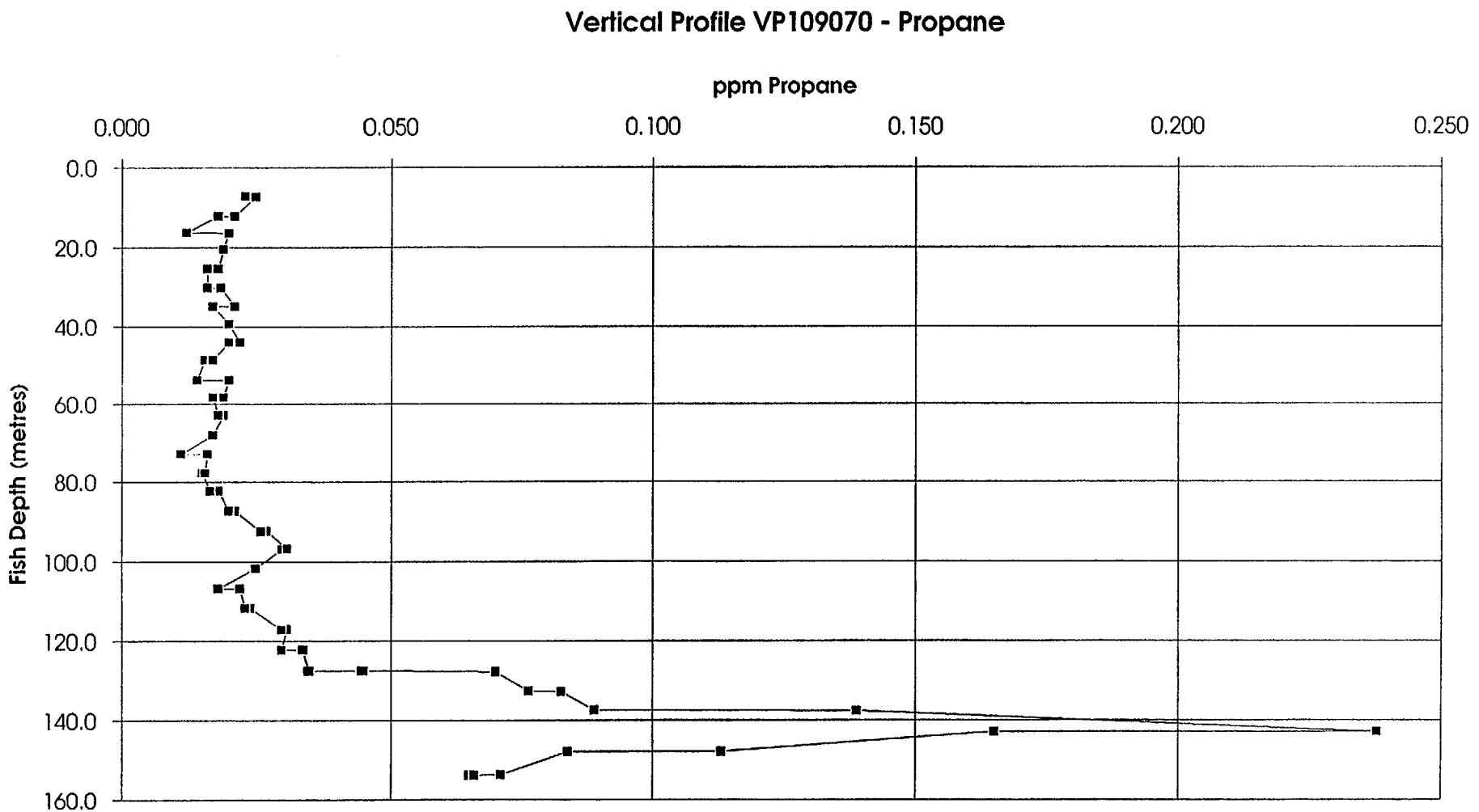


Figure 3g. Vertical profile of fish depth vs propane line VP 109/070

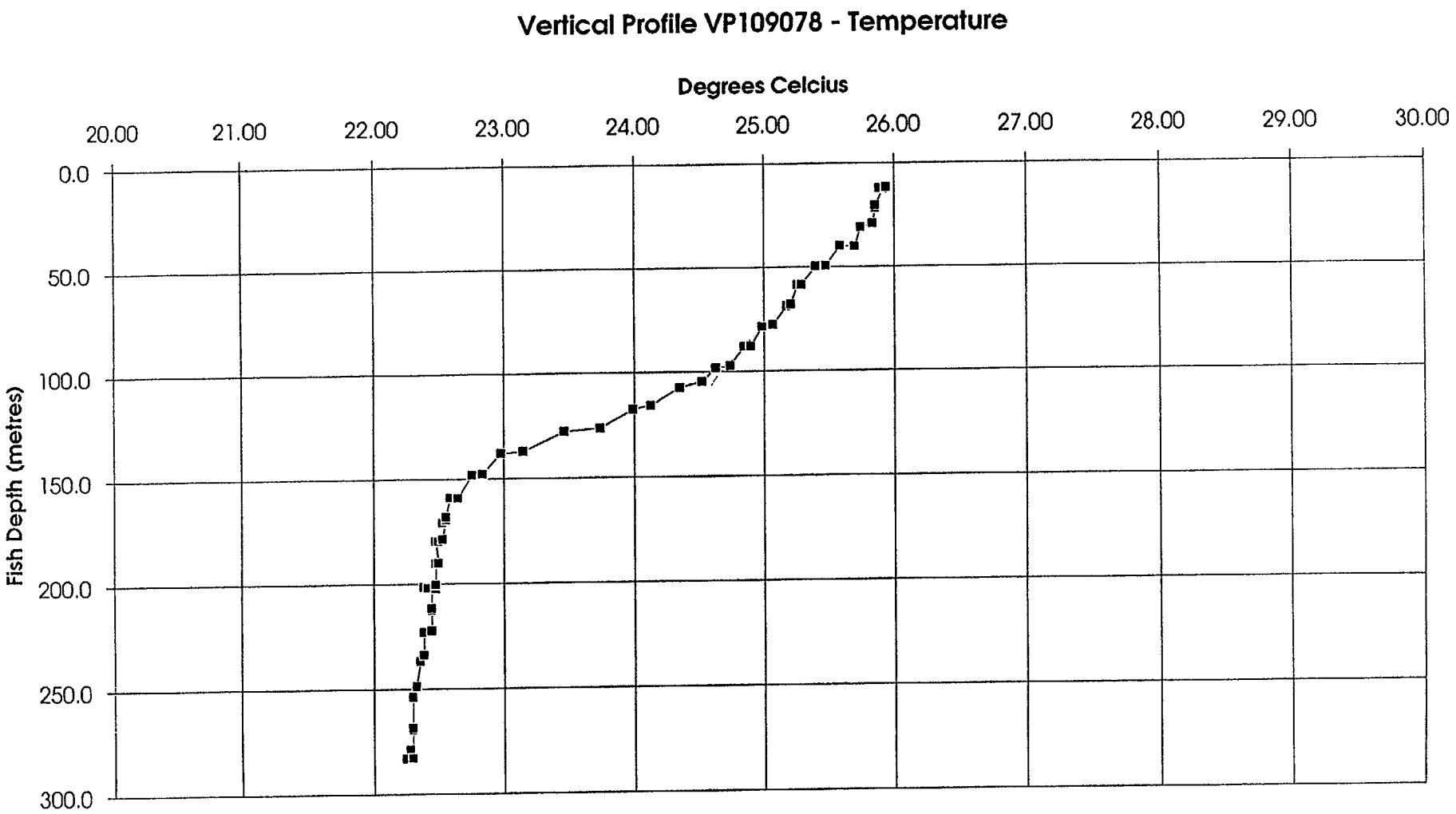


Figure 4a. Vertical profile of fish depth vs temperature line VP 109/078

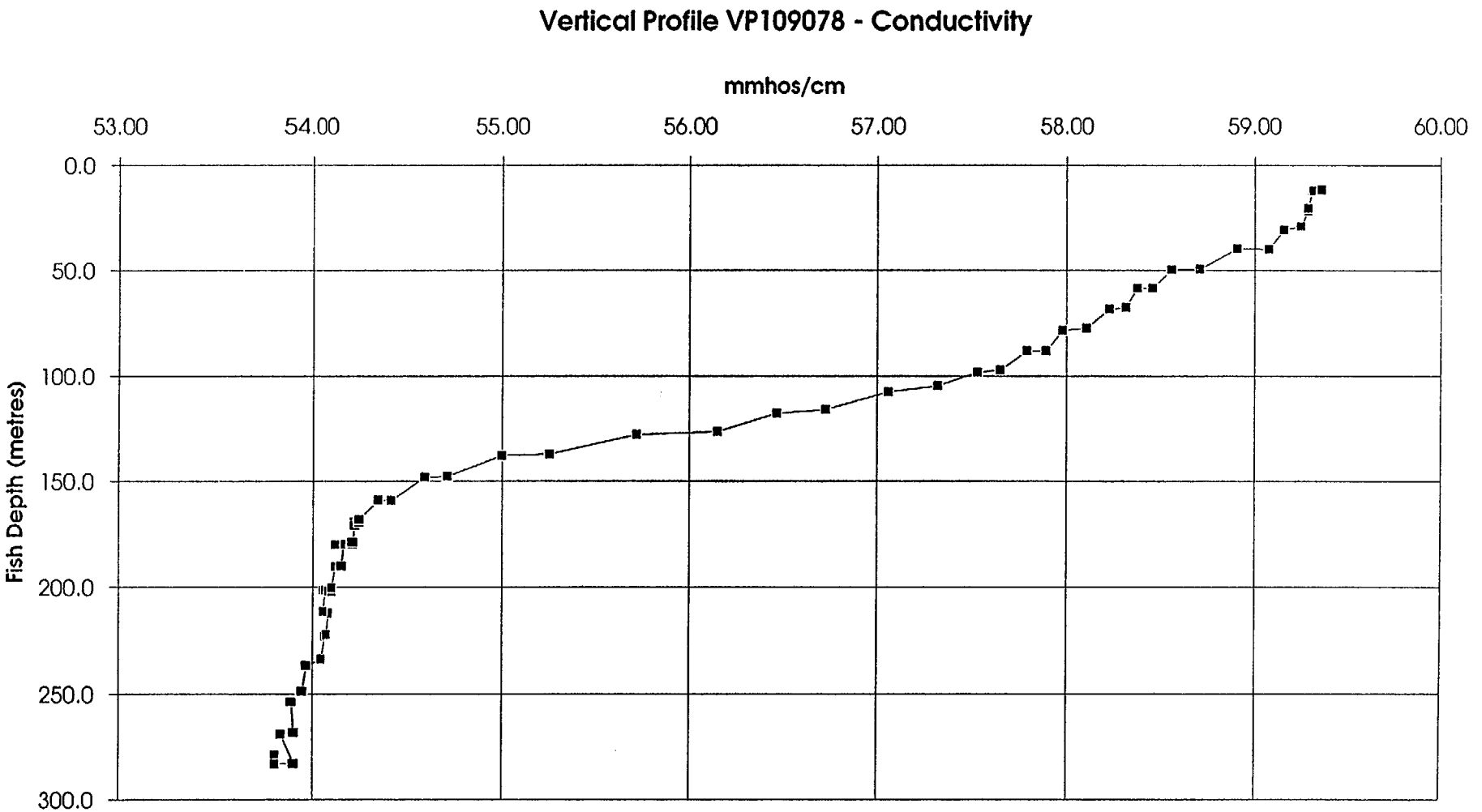


Figure 4b. Vertical profile of fish depth vs conductivity line VP 109/078

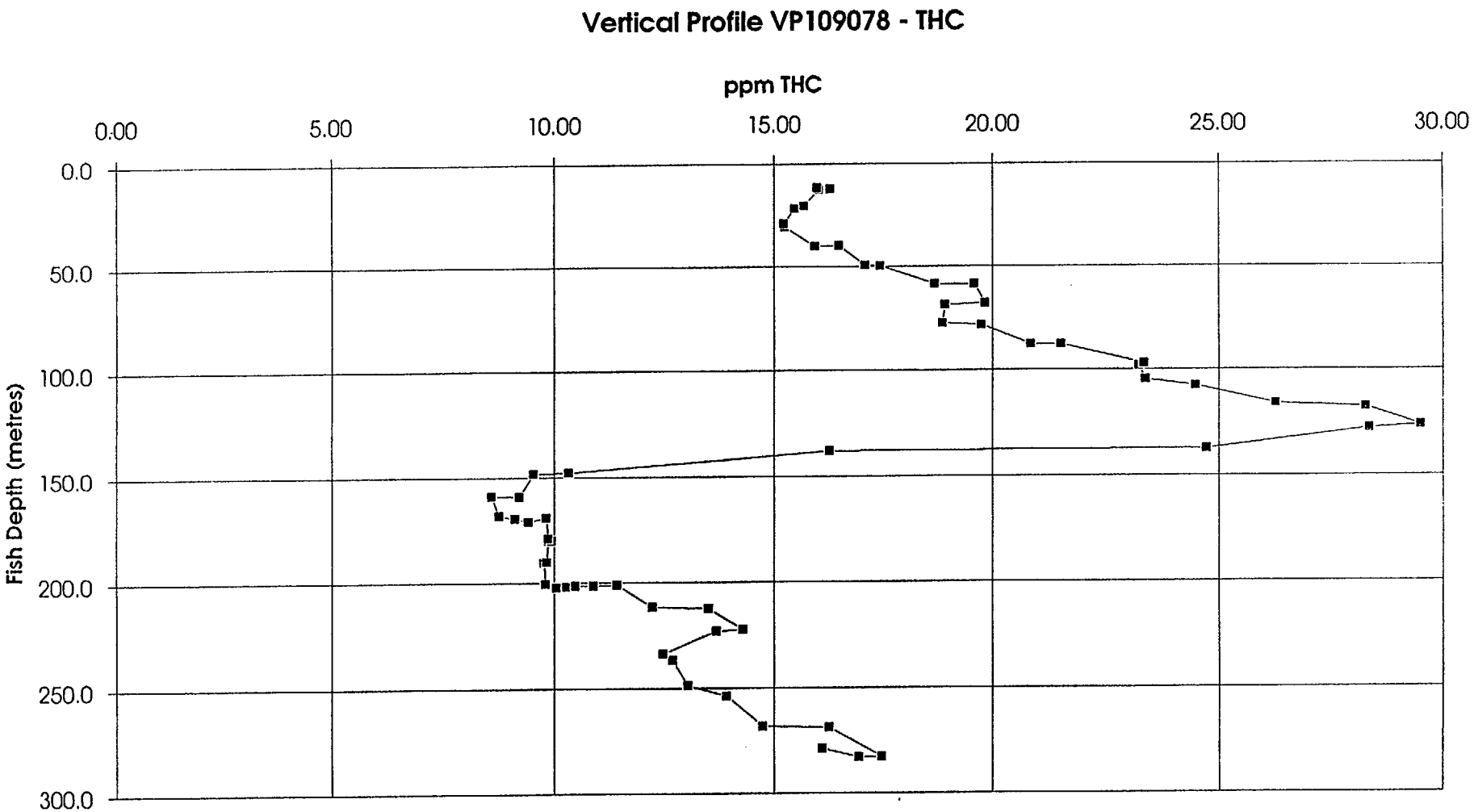


Figure 4c. Vertical profile of fish depth vs THC line VP 109/078

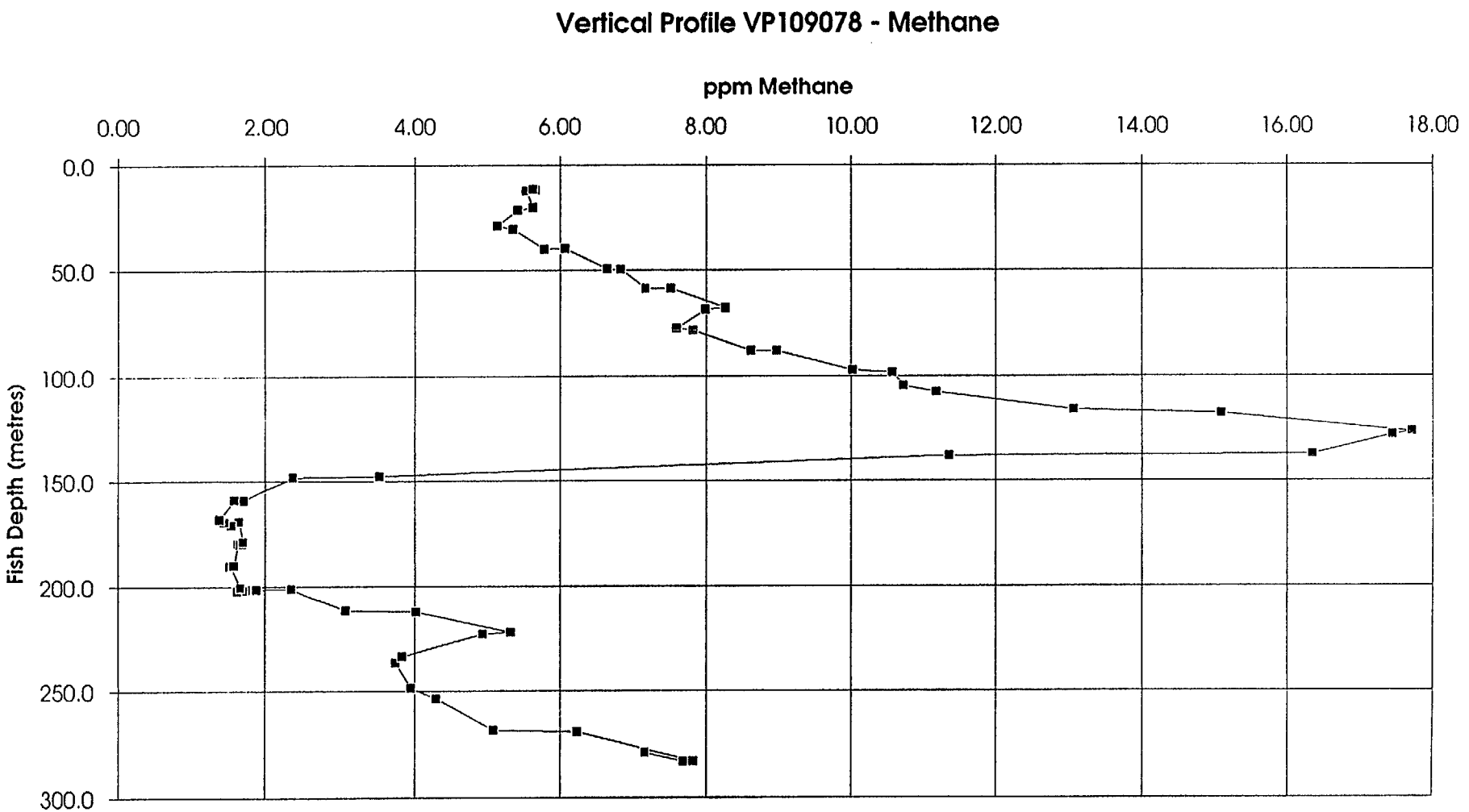


Figure 4d. Vertical profiles of fish depth vs methane line VP 109/078

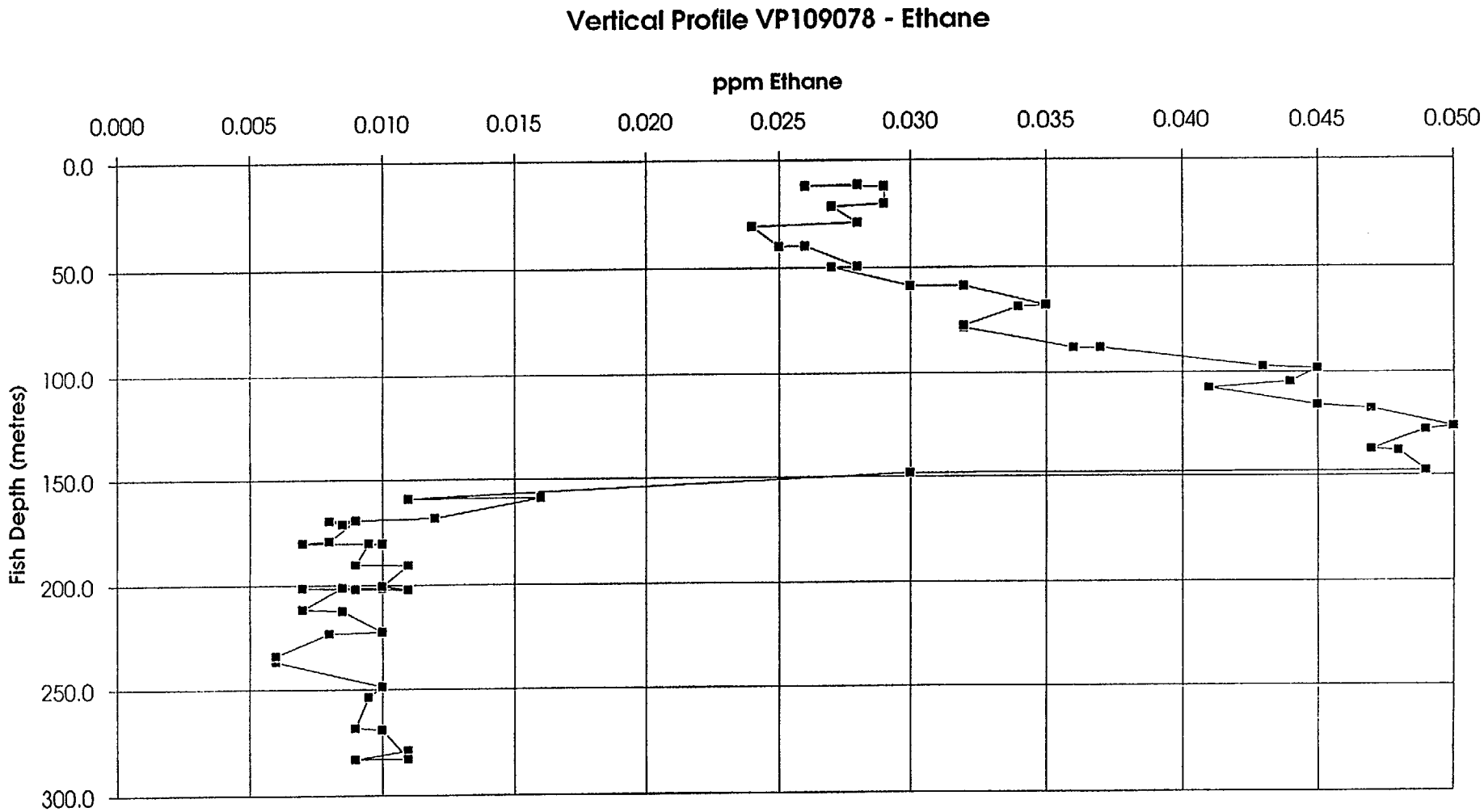


Figure 4e. Vertical profile of fish depth vs ethane line VP 109/078

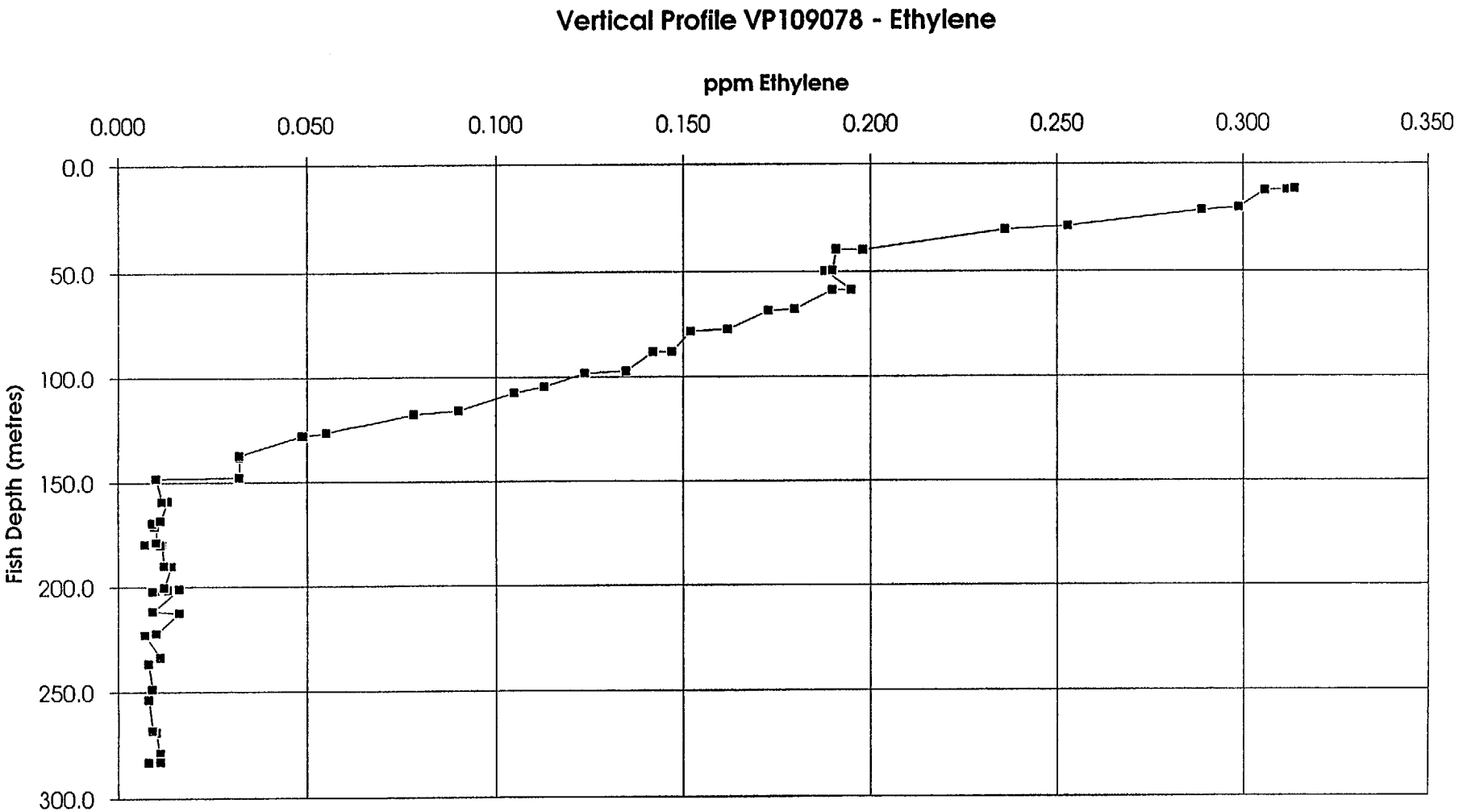


Figure 4f. Vertical profile of fish depth vs ethylene line VP 109/078

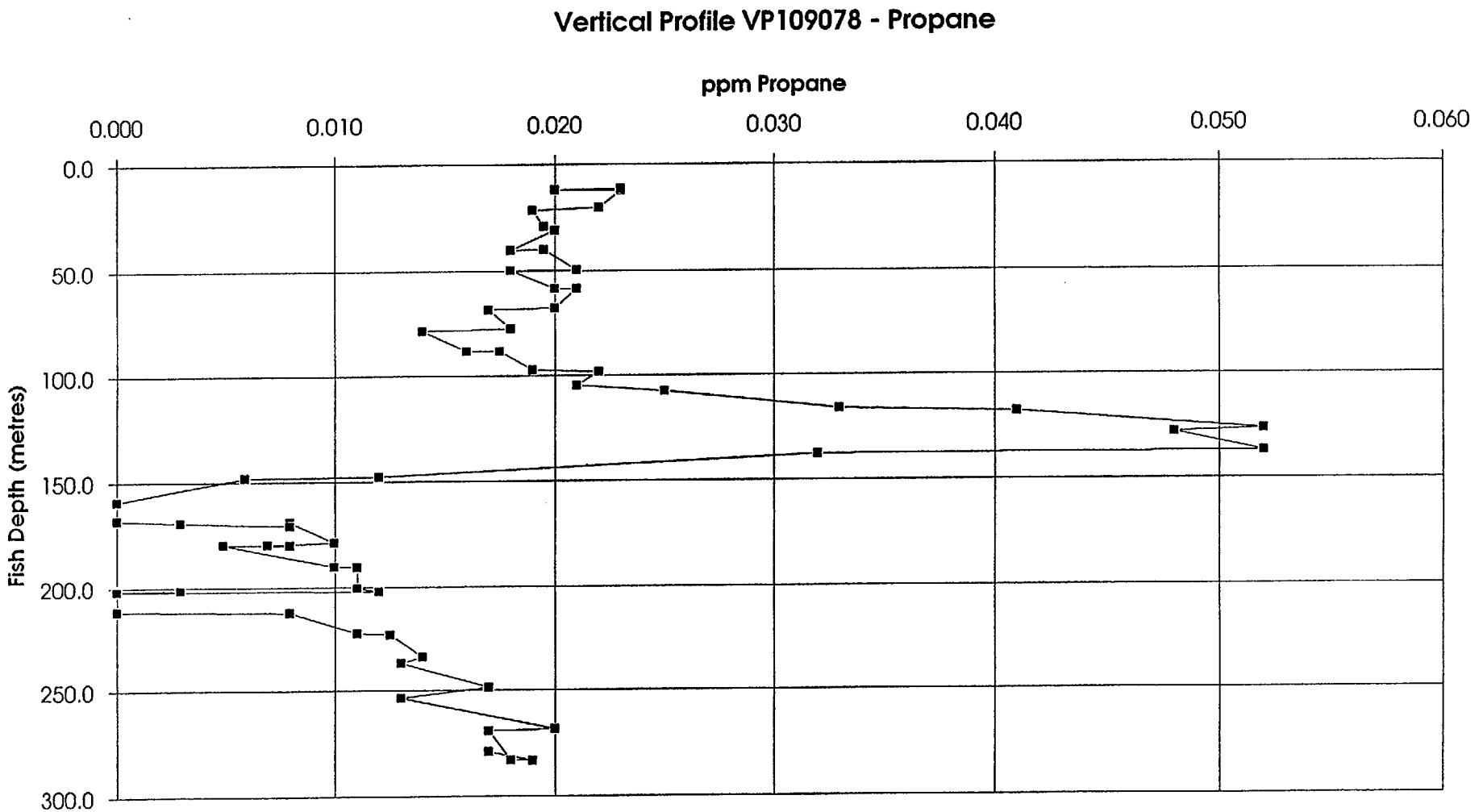


Figure 4g. Vertical profile of fish depth vs propane line VP 109/078

Ragay Gulf 'group 1'

(Lines 109/031 through 109/044 and including lines 109/sniff 1 through 109/sniff 4)

There are a range of weak to strong bottom-water light hydrocarbon anomalies in Ragay Gulf 'group 1', all lines showing at least one anomalous signature (Figures 5a-m).

The strongest anomaly in sum C_1-C_4 hydrocarbons (more than a ten-fold increase above typical background concentrations), occurs on line 109/040 (Figure 5a-f). Total hydrocarbon concentration (THC), sum C_1-C_4, methane, and propane show an approximate ten-fold increase above background, while ethane and the butanes show about a two to three -fold increase above background.

There are four moderate to strong anomalies on line 109/sniff 1 (Figures 5a-i). Six to ten-fold increases in C_1 to C_5 hydrocarbons were found. The different hydrocarbon concentrations on this line indicate an alternative hydrocarbon 'source' to line 109/040 above, (Type B for line 109/sniff1, as opposed to Type A for line 109/040).

The single anomaly on line 109/041 (Figures 5a-h) shows an almost ten-fold increase in THC, methane, and sum C_1-C_4, while ethane and propane show a two to three-fold increase above a background, and butanes a minor increase above background. This anomaly is evident in the ratio C_1/C_2, and the Bernard parameter (Figs. 5k & m).

Two different anomalous signatures occur on line 109/sniff3. The first at shotpoint 65 through 80 shows two to four-fold increases in THC, sum C_1-C_4, methane, ethane, and propane, and a minor increase in butanes(Figures 5a-h). The anomaly has a two to four-fold increases in percent wetness (Figure 5j,), and is classified as a Type A 'dry' anomaly. The second anomaly at shotpoint 165 through 175 shows a more than ten-fold increase in THC, sum C_1-C_4, methane, ethane, propane, butane, and iso-pentane, and has been classified as a Type B anomaly. The wetness parameter in this anomaly increases to 11%. In this anomaly the ratio of C_1/C_2 and the Bernard parameter show only minor increases and ratio C_2/C_3 a large increase (Figures 5j-m).

Throughout the following, refer to the appropriate Appendix for details.

Line 109/031:

A weak THC, methane and propane anomaly was detected in the middle of the line. THC shows an approximate two-fold increase above typical background values. The variations in hydrocarbon concentration along this line are (in part) related to variations in tow-fish depth and its relation to the local thermocline. Ethylene (an unsaturated hydrocarbon in surface waters) values are seen to decrease as the tow-fish is lowered through the surface waters. As the tow-fish altitude varies, the saturated hydrocarbon values also vary; THC and other concentrations are highest when the tow-fish appears to be at a depth of between 120 to 150 m. Four weak THC and methane anomalies were found at the end of the line.

Line 109/032:

A weak THC, methane, ethane and propane anomaly is evident near the beginning of the line. A very weak THC, methane, ethane and propane anomaly was found near the end of the line.

Line 109/033:

A weak to moderate THC, methane, ethane and propane anomaly occurs between shotpoint 135 and 155, and is related to the passage of the tow-fish into deeper water. THC shows a three-fold increase above background levels. A weak to moderate THC, methane and ethane anomaly occurs towards the end of the line, covering thirty shotpoints or about 10 kms, THC shows an eight-fold increase over background values.

Line 109/034:

A moderate to strong THC, methane, and weak ethane anomaly occurs close to the beginning of the line. THC increases from background values to 117 ppm. The anomaly covers 30 shotpoints or roughly 10 kms. A weak to moderate THC and methane anomaly occurs towards the end of the line. Numerous very weak THC and methane anomalies occur along the length of the line, and may be related to variations in tow-fish depth and the distributions of hydrocarbons within the water column.

Line 109/035:

A weak to moderate THC, methane, ethane and propane anomaly occurs near to the beginning of the line. The tow-fish was at about 150 m water depth and the anomaly occurs in the zone of temperature and salinity change within the water column (also indicated by increasing ethylene concentrations).

Line 109/036:

The weak to moderate THC, methane, ethane and propane anomalies occurring between shotpoint 75 to 85 and 247 to 255 mark the position of a rapid change in temperature and salinity within the water column. The anomaly at shotpoint 80 is detected as the tow-fish passes from shallow into deeper water through the thermocline. The anomaly near shotpoint 250 also is evident as the tow-fish passes from deep into shallower water. Four very weak THC and methane anomalies occur between shotpoint 80 and 250. THC and methane show a 5 ppm increase above background values.

Line 109/Sniff1:

Four moderate to strong THC, methane, ethane, propane, butane and iso-pentane anomalies show an increase of nearly ten-fold above background values along this line. Two weak THC, methane, ethane and propane anomalies occur as a result of the tow-fish hitting the seafloor at shotpoints 54 and 90.

The R-1 and R-2 prospects identified from seismic in the OEA- World Bank Report, 1986 (Figure 1b) are evident from THC and methane anomalies between shotpoints 36 and 47 for R-1, and a moderate anomaly between shotpoints 103 and 113 for R-2. Numerous other weak THC, methane, ethane and propane anomalies occur throughout the length of the line.

Line 109/037:

A weak to moderate THC, methane, ethane and propane anomaly occurs over 15 shotpoints, or approximately 5 kms, between shotpoints 25 to 40. THC shows an almost five-fold increase above background values. A very weak THC, methane and propane anomaly occurs at the beginning of the line. Two weak THC and methane anomalies were found in the latter half of the line. The second of the two occurs prior

to the tow-fish passing up through the thermocline. Ethylene values are also seen to increase as the water shallows.

Line 109/038:

A single, moderate THC and methane anomaly is evident as the tow-fish passes through the thermocline.

Line 109/Sniff2:

The five weak to moderate THC, methane, ethane and propane anomalies were detected beyond shotpoint 90. The tow-fish hit the seafloor at shotpoint 183, and hydrocarbon values show a minor increase above background values. Three weak THC, methane, ethane and propane anomalies occur prior to shotpoint 60.

Line 109/039:

Moderate THC, methane, ethane and propane anomalies were found near to the R-2 prospect. A weak THC, methane and propane anomaly occurs towards the end of the line.

Line 109/Sniff3:

A strong THC, methane, ethane and propane anomaly occurs between shotpoint 167 and 175. THC shows a ten-fold increase above background values. This anomaly also has strong butane and iso-pentane values associated with it. The numerous very weak THC, methane, ethane and propane anomalies along the line, have elevated levels of ethylene associated with them.

Line 109/040:

A single, strong THC and methane anomaly along with a weak ethane anomaly is evident on this line.

Line 109/041:

A strong THC, methane, and weak ethane, anomaly occurs towards the end of the line. THC shows about a ten-fold increase above background values. A weak THC, methane and moderate ethane and propane anomaly was found at the end of the line.

Line 109/042:

A moderate THC, methane, ethane and propane anomaly near the start of the line, (25 shotpoints or roughly 8 kms), coincides with the tow-fish being lowered through the thermocline - as the ship moved into deep water. At the end of the line there is a weak THC, methane and strong ethane and propane anomaly as the tow-fish is raised through the thermocline.

Line 109/043:

A group of weak THC, methane, ethane and propane anomalies were detected at the beginning of the line.

Line 109/Sniff4:

A strong THC, methane, ethane and propane anomaly occurs at the end of the line. THC shows an approximate twelve-fold increase above background levels, while ethane and propane show an approximate twenty-fold increase above background. The anomaly occurs as the tow-fish passes through the thermocline into deeper water. The weak THC, methane, ethane and propane anomaly at shotpoint 124 marks the position where the tow-fish hit bottom.

Line 109/044:

The strong THC, methane, ethane, propane, butane and iso-pentane anomaly on this line is one of the few in Ragay Gulf 'group 1' lines that does not appear to be associated with the thermocline. The DHD tow-fish was below the thermocline on much of this survey-line. THC is seen to increase about ten-fold above background and propane about twenty-fold above background. This anomaly was found near the R-1 prospect.

Towards the end of the line, THC and methane values increase as a result of the tow-fish being raised into surface waters.

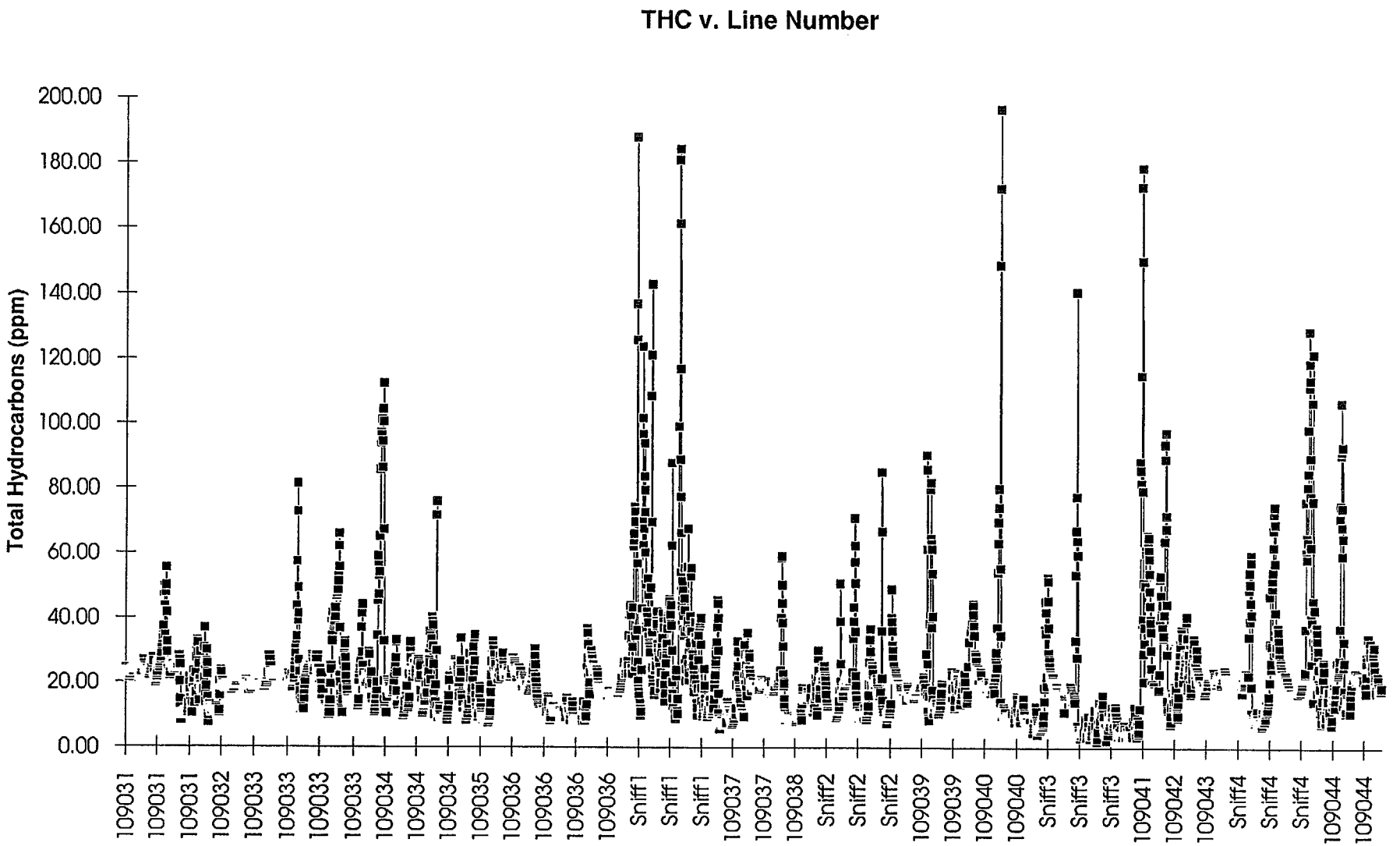


Figure 5a Total Hydrocarbons (THC) versus survey line number, Ragay Gulf 'group 1' (Lines 109/031 through 109/044 and including lines 109/sniff1 through 109/sniff4.

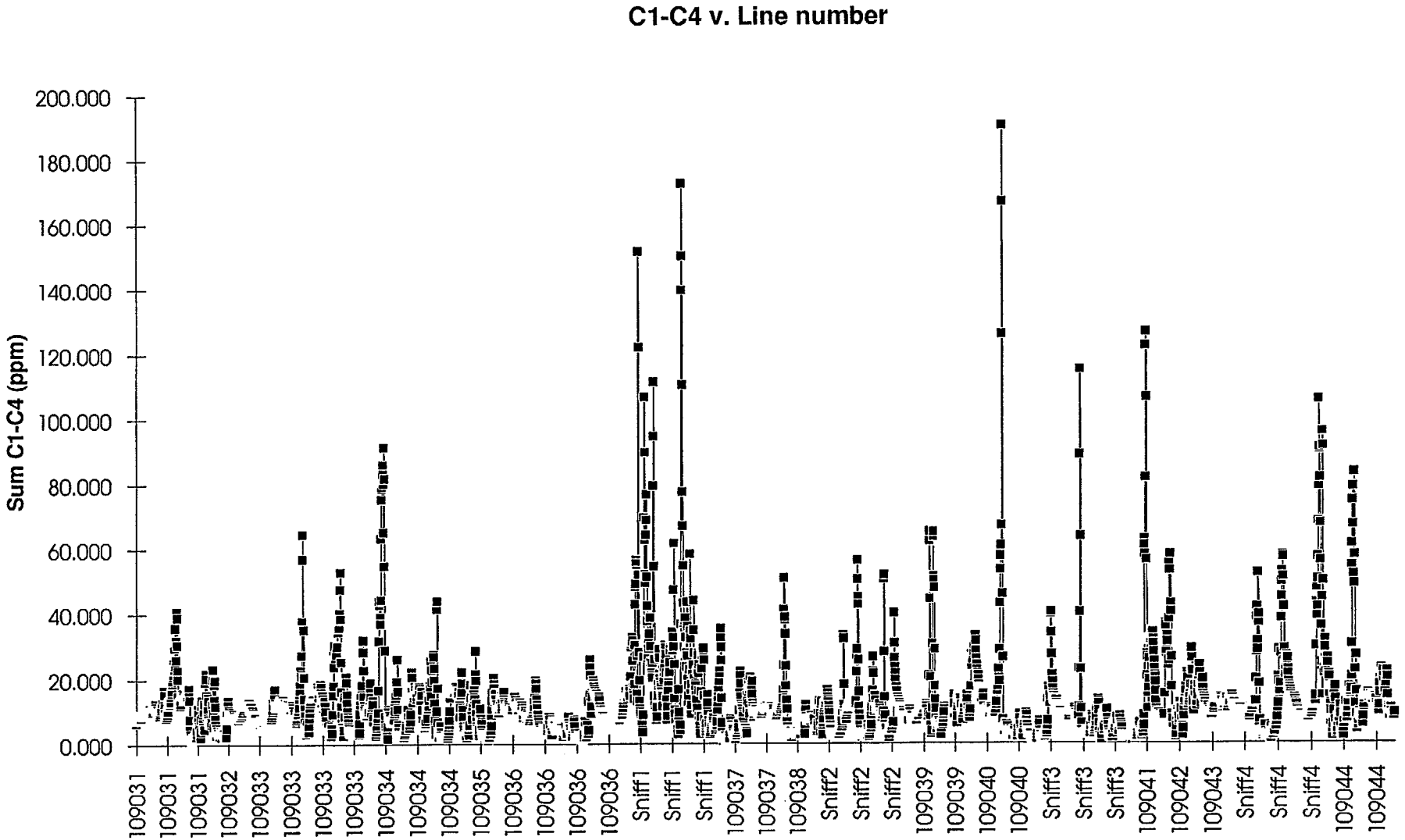


Figure 5b Sum C_1-C_4 versus survey line number, Ragay Gulf 'group 1' lines.

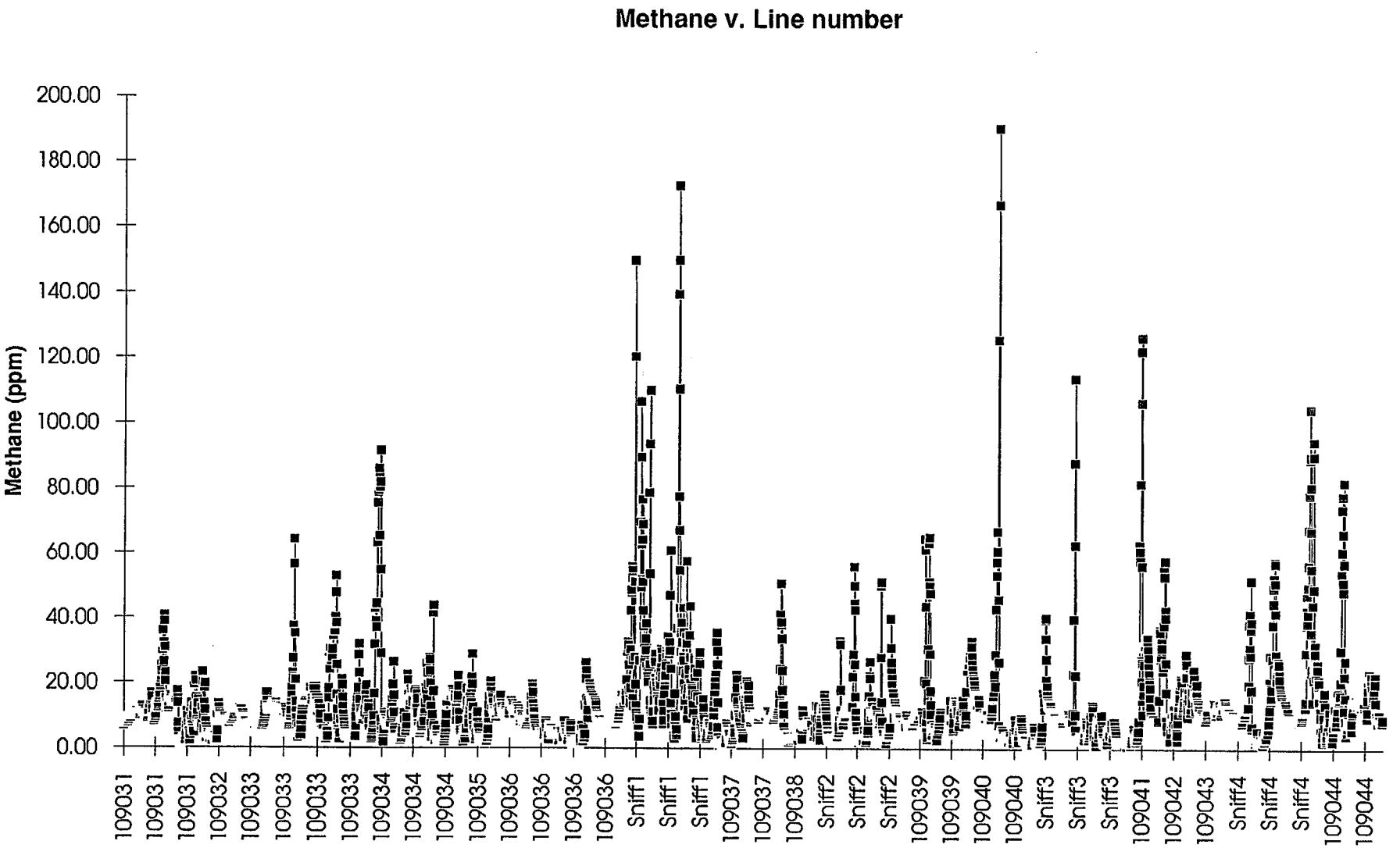


Figure 5c Methane versus survey line number, Ragay Gulf 'group 1' lines.

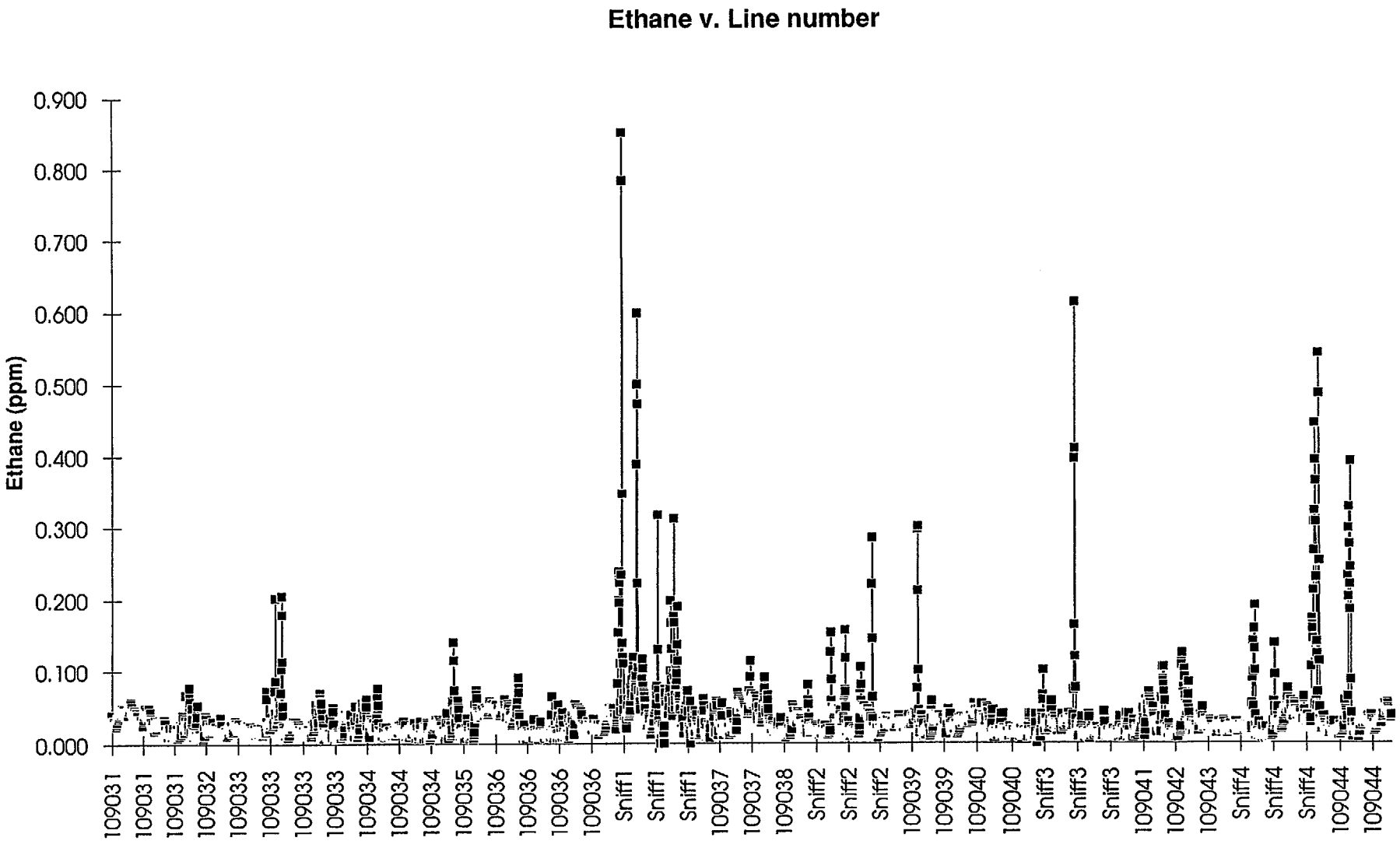


Figure 5d Ethane versus survey line number, Ragay Gulf 'group 1' lines.

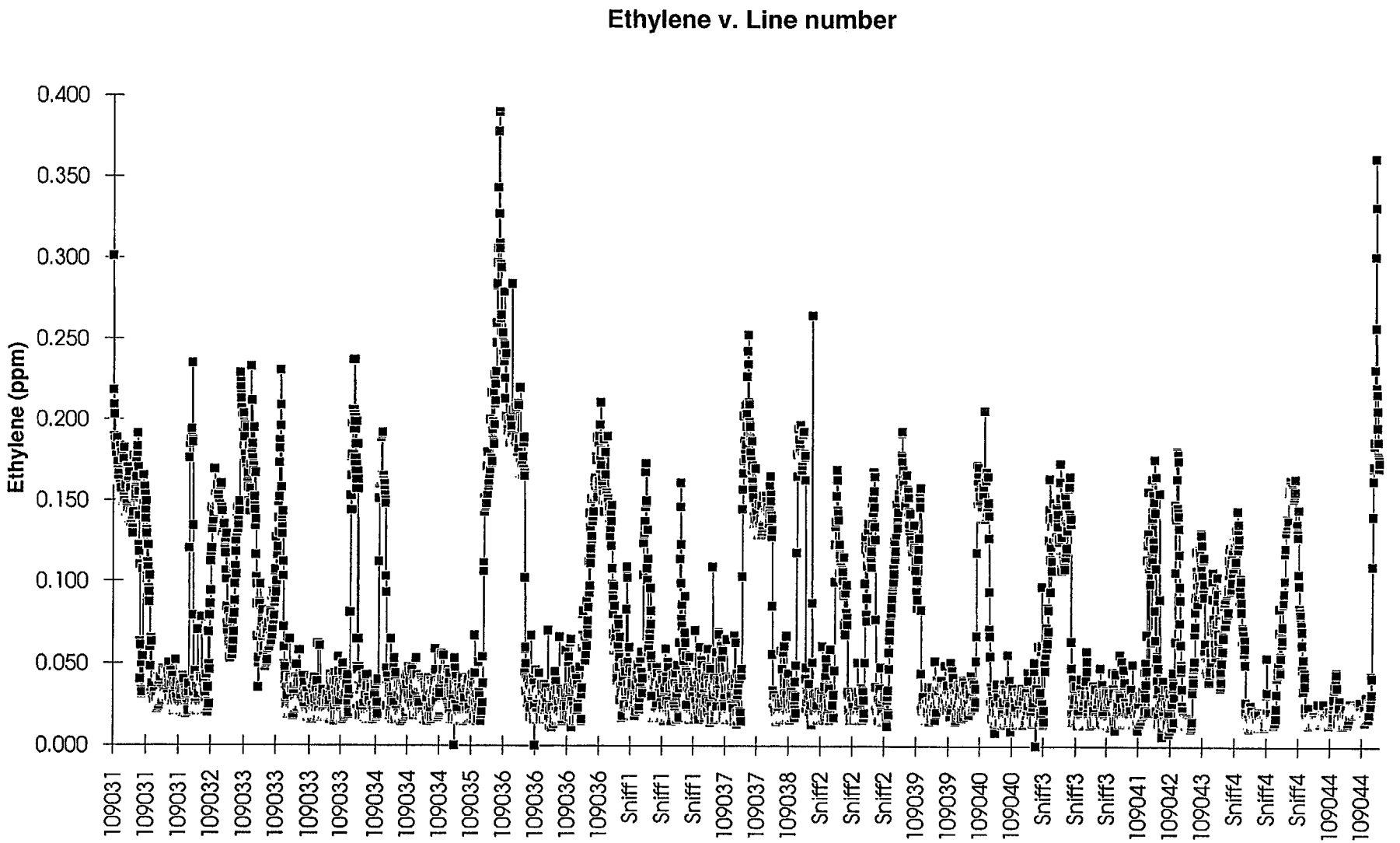


Figure 5e Ethylene versus survey line number, Ragay Gulf 'group 1' lines.

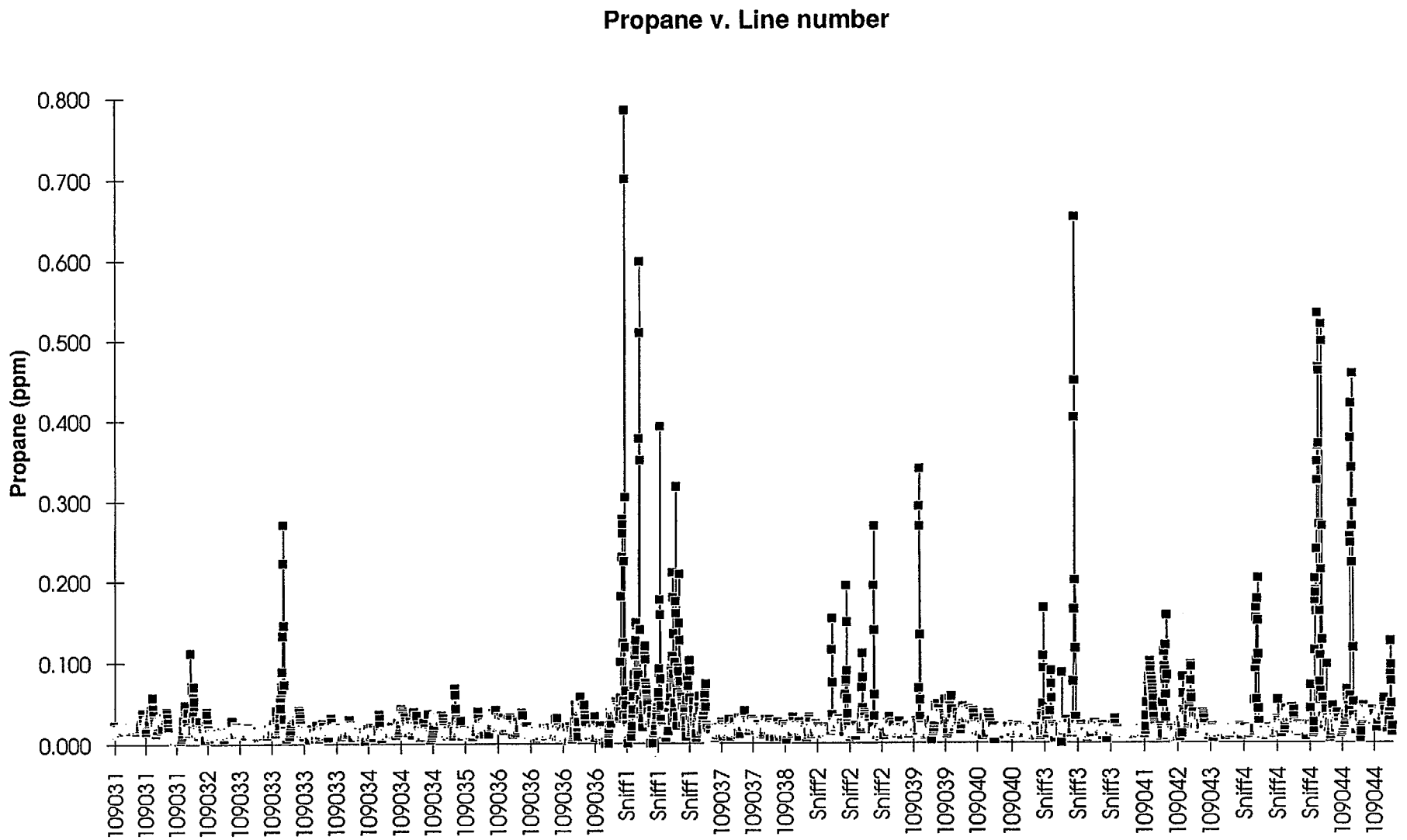


Figure 5f Propane versus survey line number, Ragay Gulf 'group 1' lines.

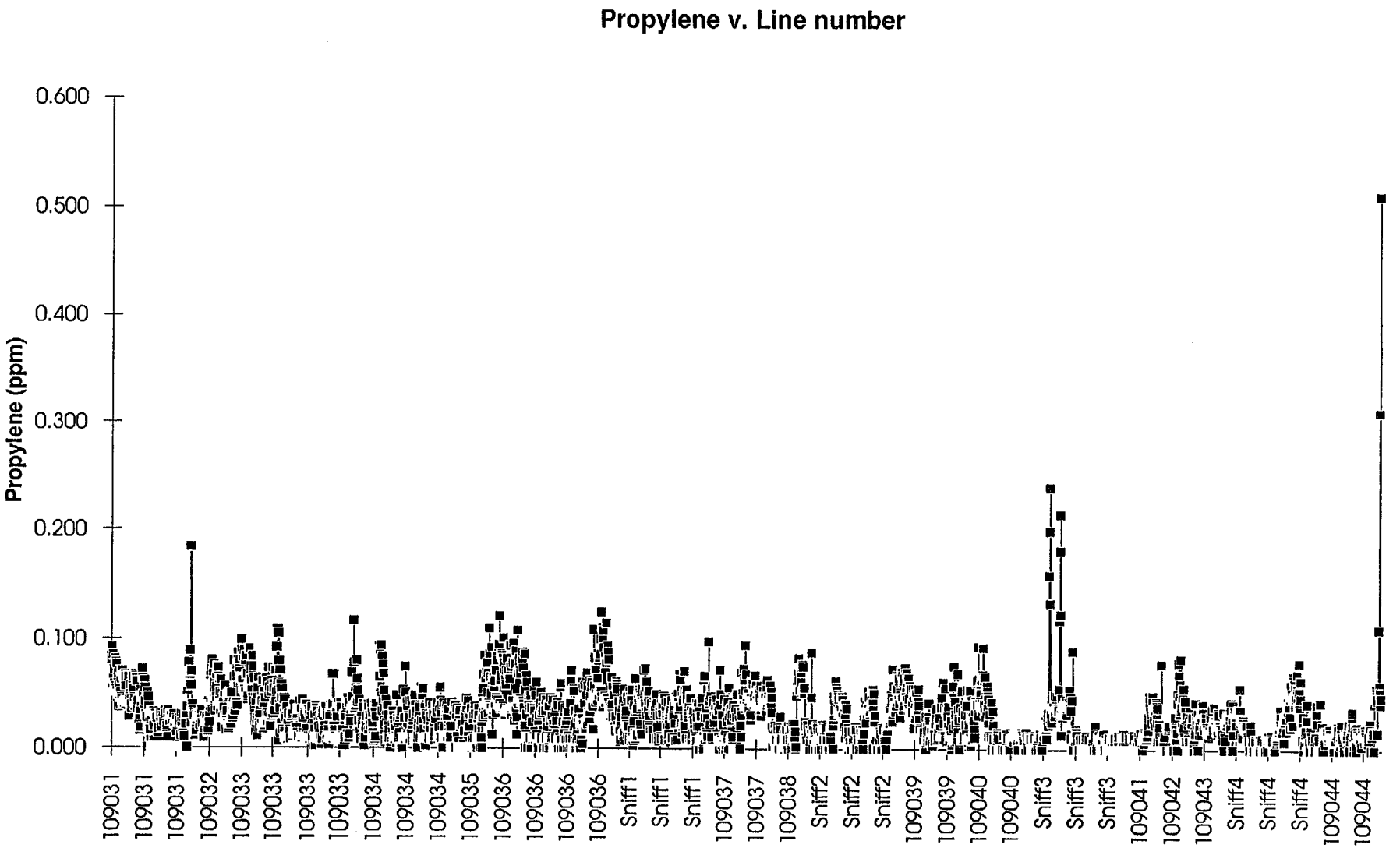


Figure 5g Propylene versus survey line number, Ragay Gulf 'group 1' lines.

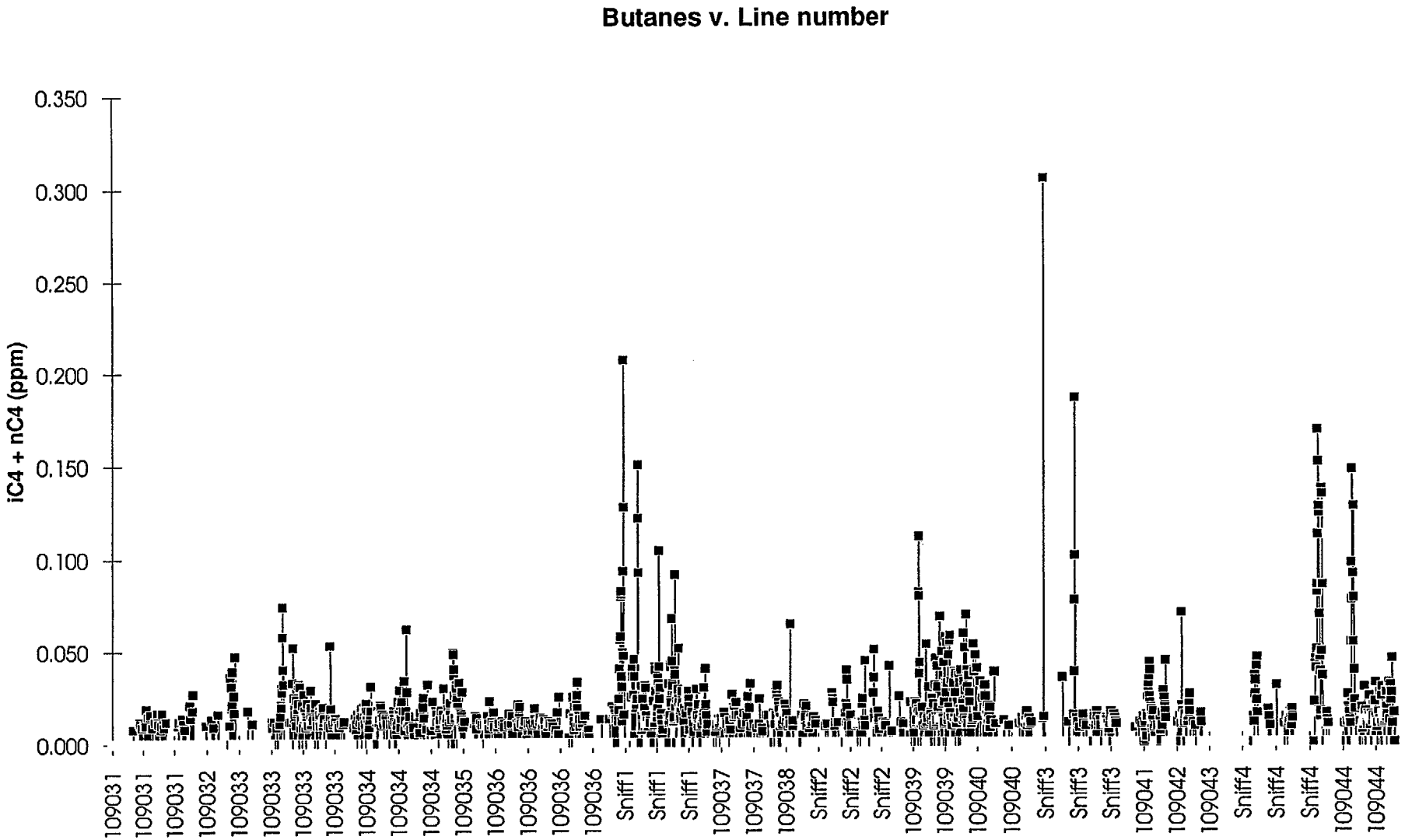


Figure 5h Total Butanes versus survey line number, Ragay Gulf 'group 1' lines.

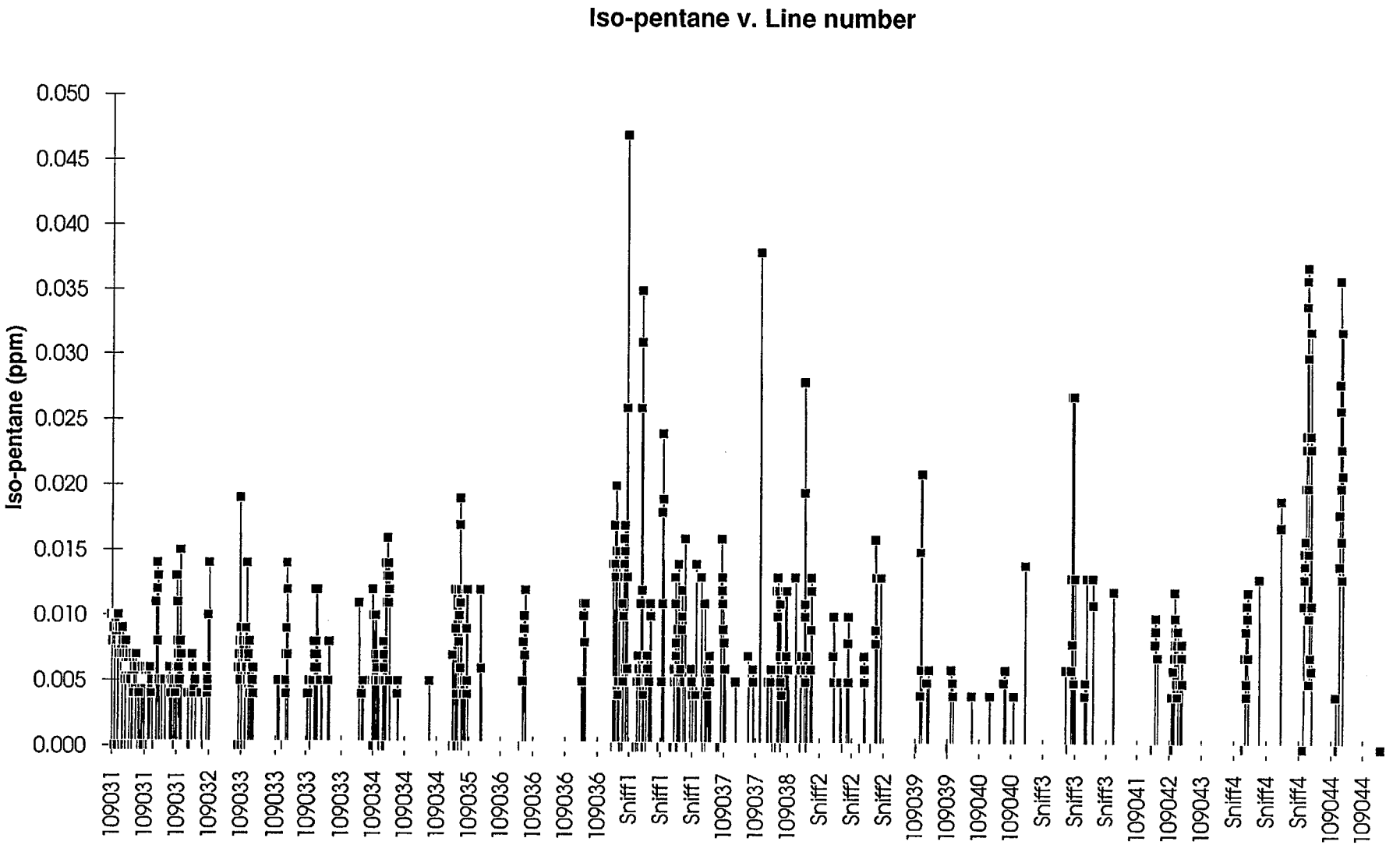


Figure 5i Iso-pentane versus survey line number, Ragay Gulf 'group 1' lines.

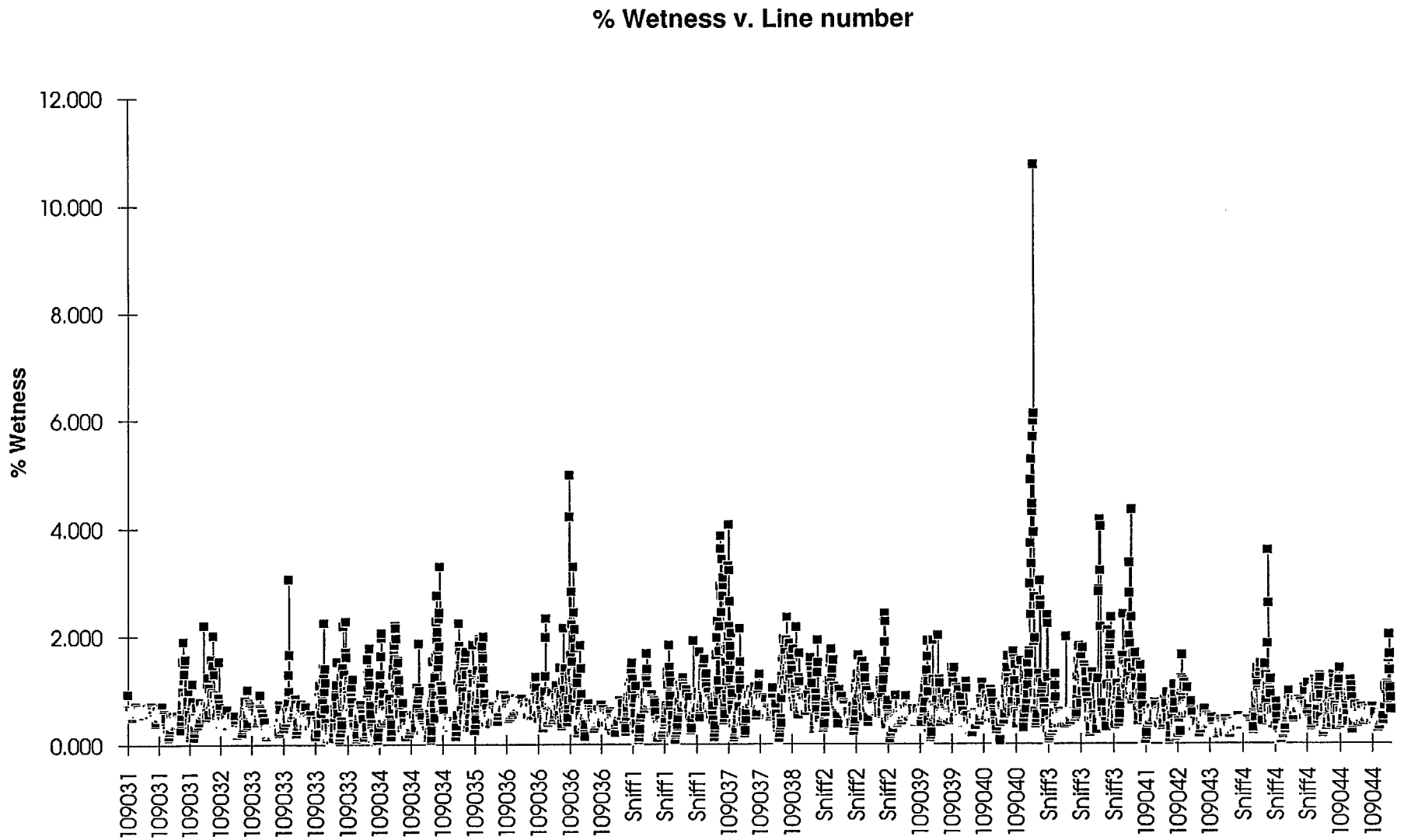


Figure 5j Percent hydrocarbon wetness versus survey line number, Ragay Gulf 'group 1' lines.

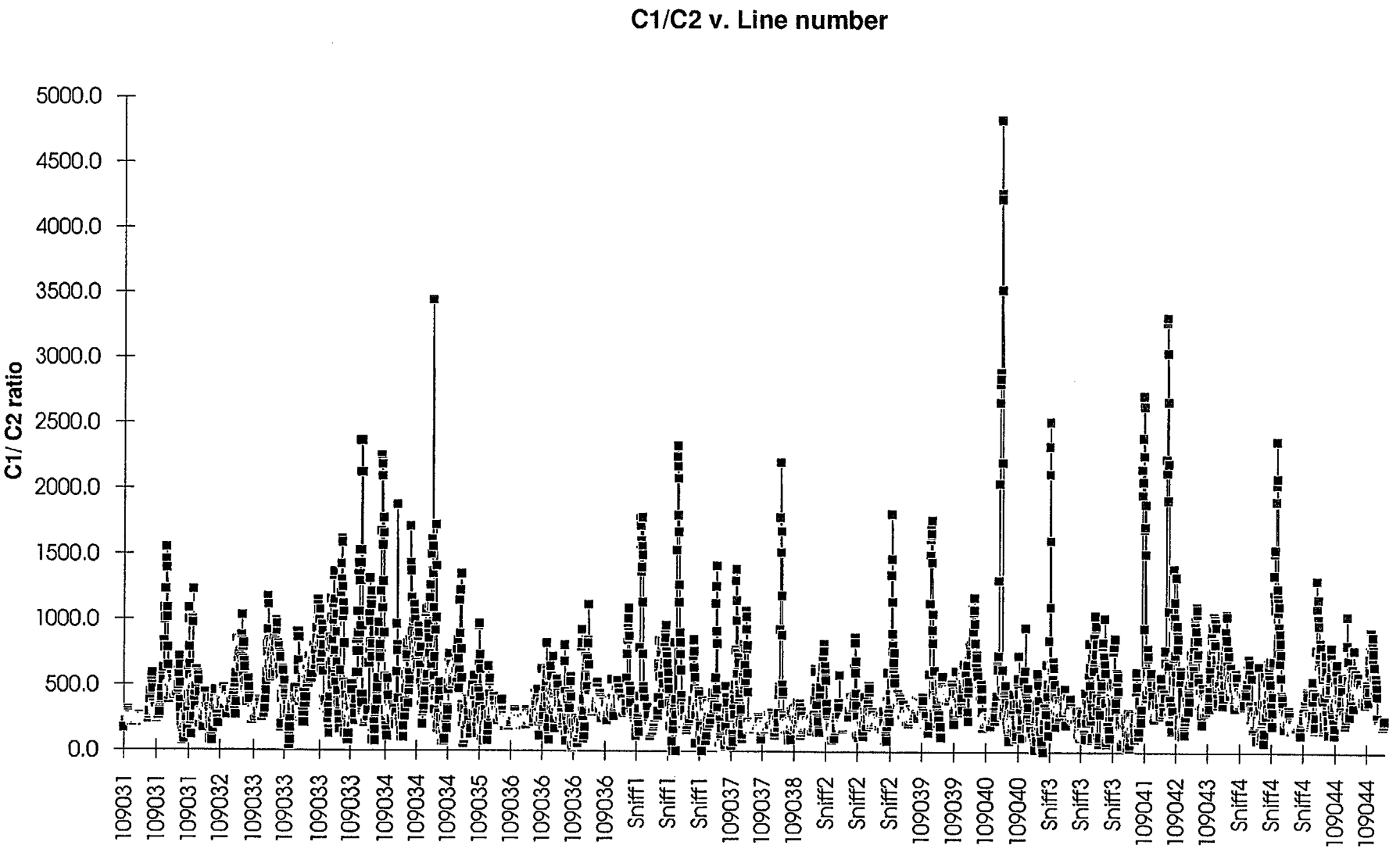


Figure 5k C_1/C_2 ratio versus survey line number, Ragay Gulf 'group 1' lines.

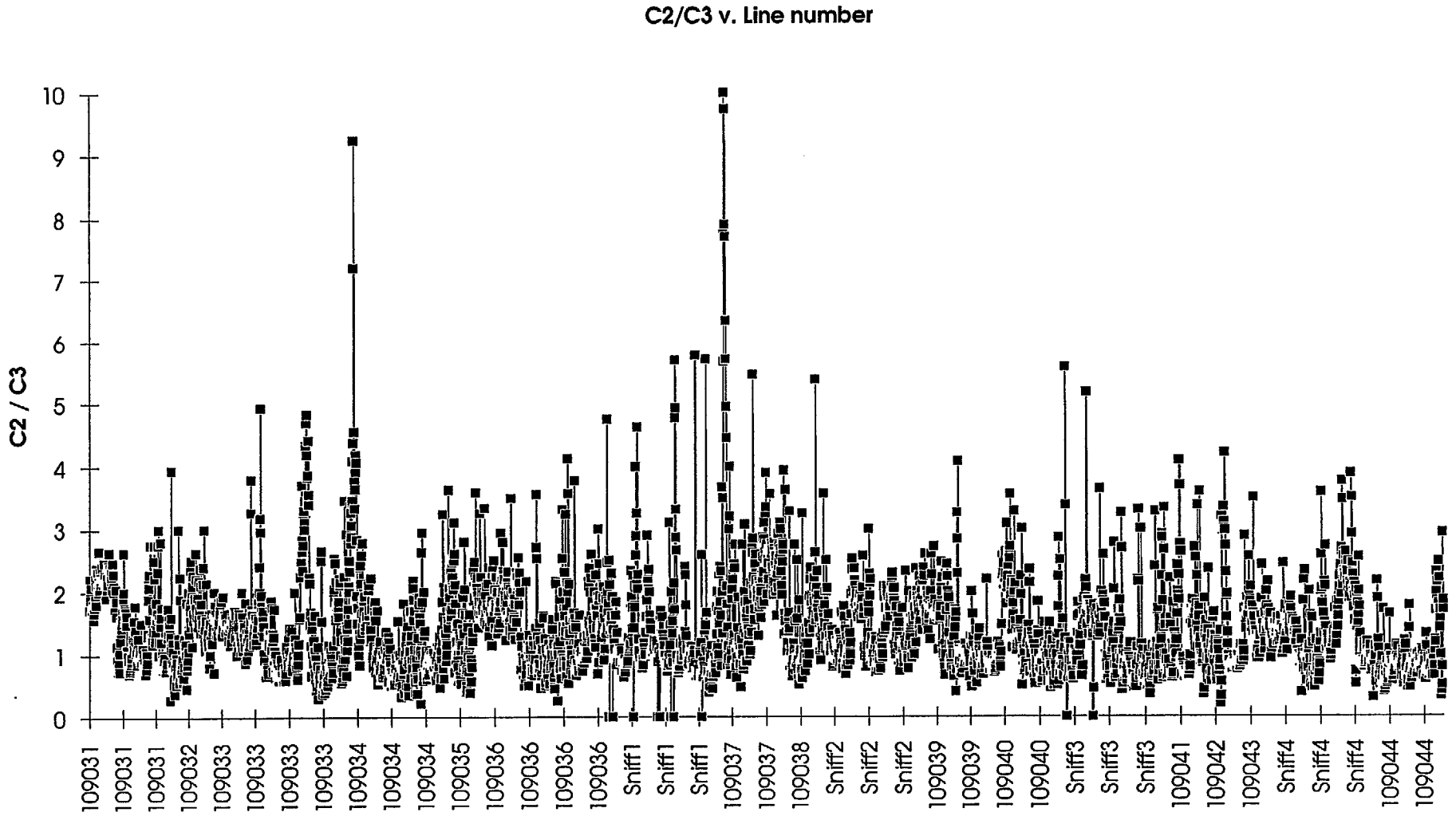


Figure 51 C_2/C_3 ratio versus survey Line number, Ragay Gulf 'group 1' lines.

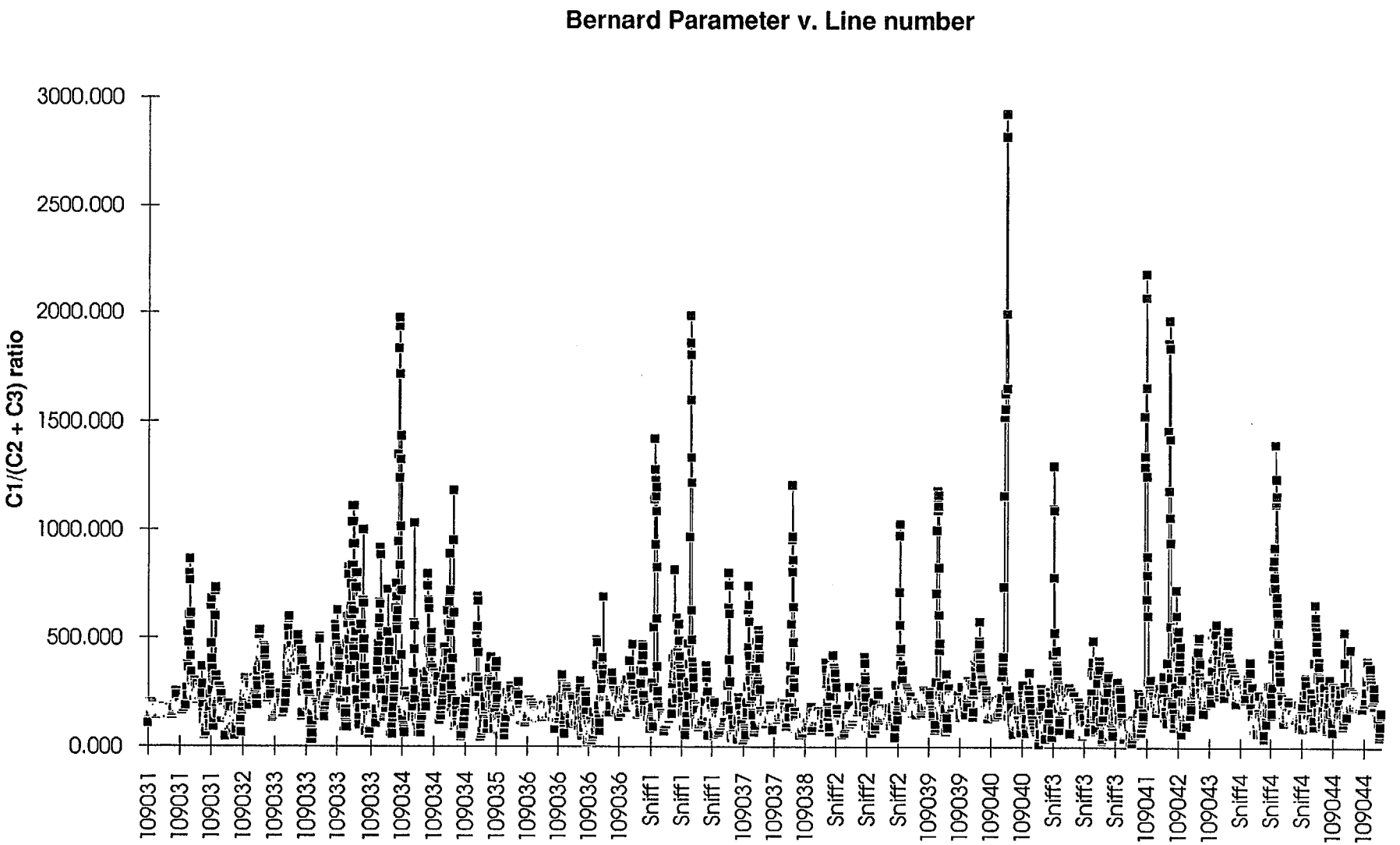


Figure 5m Bernard Parameter (C_1/C_2+C_3) versus survey line number, Ragay Gulf 'group 1' lines.

Ragay Gulf 'group 2'

(Lines 109/045 through 109056, 109/058 and 109/059, and 109/Sniff5 through 109/Sniff9A).

A collection of weak to strong anomalies occur in this group of lines. The most distinctive, strong Type A anomaly occurs at the end of line 109/053. THC, sum C1-C4 and methane show a more than ten-fold increase above background (Figures 6a-c).

The anomaly in the middle of line 109/sniff7 is the strongest Type B signature of the 'group 2' lines, with 12% hydrocarbon wetness. THC, ethane and propane show about a ten-fold increase above background (Figures 6a-j).

The single, strong anomaly on line 109/058, shows a more than twelve-fold increase above background in THC values. This line shows the largest ethane, butane and iso-pentane signatures of 'group 2' survey lines.(Figures 6a-i). Propane shows a forty two-fold increase above background and ethane a thirty-fold increase above background. Butanes show a ten-fold increase above background, and iso-pentane an approximate ten-fold increase above background. Sum C_1-C_4 and C_2/C_3 ratio show large increases over these anomalies (Figures 4b & 4l).

Line 109/059 has a moderate to strong THC and methane anomaly, and an associated weak ethane and propane anomaly. Sum C_1-C_4 shows an increase from 15 ppm to 150 ppm over this anomaly (Figures 6a-d,& f).

The highest Bernard parameter and C_1/C_2 ratio, in 'group 2' survey lines, were found on Line 109/sniff9a (Figures 6k & 4m).

Line 109/sniff8, shows a strong THC, methane, ethane propane, butane and iso-pentane anomaly (Figures 4a-i).

Refer to Figures 6a-m, and Appendix II for the following.

Line 109/045:

A weak THC, methane, ethane and propane anomaly occurs at the beginning of the line. As the tow-fish was raised through the water column towards the end of the line, a weak THC, methane, ethane and propane anomaly was detected.

Line 109/Sniff5:

A weak THC and methane, anomaly covering approximately 30 shotpoints or 10 kms, was found in the middle of the line.

Line 109/045:

A moderate, and two weak THC, methane, ethane and propane anomalies were found at the beginning of the line.

Line 109/047:

A trace increase in hydrocarbon values occurs between shotpoints 80 and 140. .

Line 109/048:

A weak to moderate THC, methane, ethane and propane anomaly was detected at the end of the line and coincides with the tow-fish crossing the thermocline.

Line 109/Sniff6:

Six weak THC, methane, ethane and propane anomalies were detected throughout the line.

Line 109/049:

A weak increase in THC and methane was detected between shotpoints 40 and 75, as the ship passed over deeper water.

Line 109/050:

A weak increase in THC and methane above background values was detected between shotpoint 15 and 47. Water depths were deeper in this section of the line.

Line 109/051:

Four very weak THC and methane anomalies were detected along the length of the line.

Line 109/052:

Two weak THC and methane anomalies were found in the deeper water section of this short line.

Line 109/053:

A strong THC and methane, but weak ethane and propane, anomaly was found at the end of the line. This is the strongest THC and methane Type A ('dry') anomaly in Ragay Gulf 'group 2' survey lines. A moderate ethane and propane anomaly along with a weak THC and methane anomaly was found in close proximity to this strong anomaly.

Line 109/054:

Two very weak THC and methane anomalies were found in the middle of the line.

Line 109/Sniff7:

A moderate to strong THC and methane anomaly coupled, with strong ethane and propane increases above background, was detected near to the middle of the line. This anomaly was detected as the tow-fish passed through the thermocline. A moderate THC, methane, and weak ethane and propane anomaly was detected at the beginning of the line.

Line 109/055:

A weak THC and methane anomaly was detected in the first half of the line.

Line 109/056:

Two weak THC and methane anomalies were detected in the middle of the line and are associated with increases in water depth.

Line 109/Sniff8:

The very strong ethylene anomaly at the beginning of the line occurs as a result of the tow-fish hitting the seafloor. A strong THC, methane, ethane and propane anomaly was found at the end of the line. This strong anomaly is separated from a moderate THC, methane, ethane and propane anomaly by an increase in ethylene. This feature can be explained by examination of the individual line plots (Appendix II), which show the tow-fish being raised into shallow water over a bathymetric high, before descending down through the thermocline at the other side of the bathymetric high.

A weak THC and methane anomaly coupled with a moderate ethane and propane anomaly occurs between shotpoint 125 and 140.

Line 109/058:

A strong THC (showing a more than fifteen-fold increase above background), methane, ethane (showing an approximate forty five-fold increase above background), and propane anomaly was found between shotpoint 62 and 72 and is associated with the DHD tow-fish passing down through the thermocline into deeper water. The tow-fish passes over the R-1 prospect at shotpoint 56, where small increases in THC and other hydrocarbon values were detected.

Line 109/059:

A strong THC, methane and weak ethane and propane anomaly was detected near the beginning of the line.

Line 109/Sniff9:

Several weak THC, methane, ethane, and propane anomalies were detected throughout the line. A moderate to strong THC, methane, ethane and propane, anomaly was detected between shotpoints 85 and 100. Two weak THC and methane anomalies were

found between shotpoints 230 and 240. A vertical profile was conducted at the end of this line (see Appendix I and II).

Line 109/Sniff9A:

A strong THC and methane anomaly was detected at the end of the line. Two moderate THC and methane anomalies were detected between shotpoints 8 to 30 and 65 to 90 respectively.

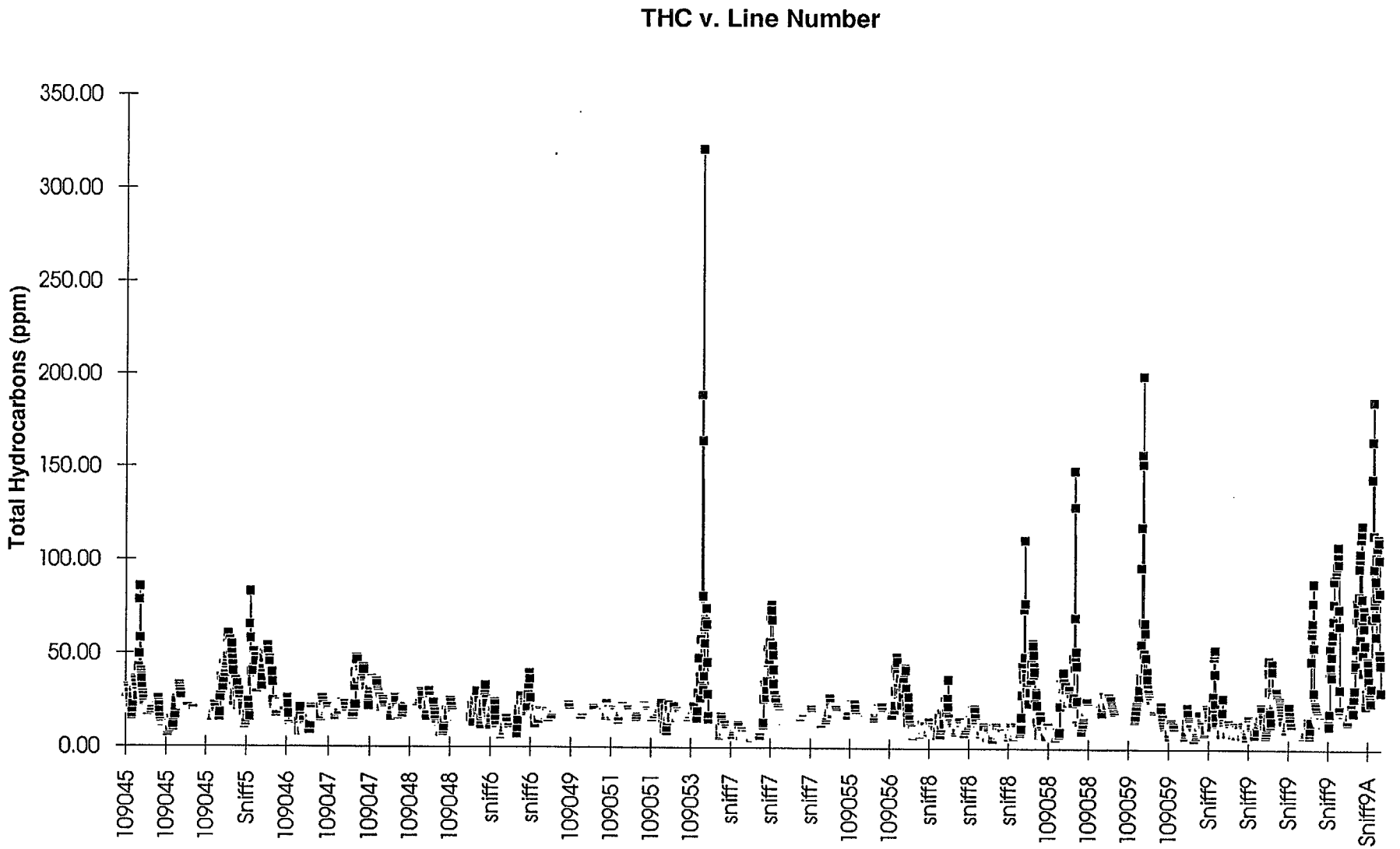


Figure 6a Total Hydrocarbons (THC) versus survey line number, Ragay Gulf 'group 2' (Lines 109/045 through 109/056, 109/058, and 109/059, and 109/sniff5 through 109/sniff9a).

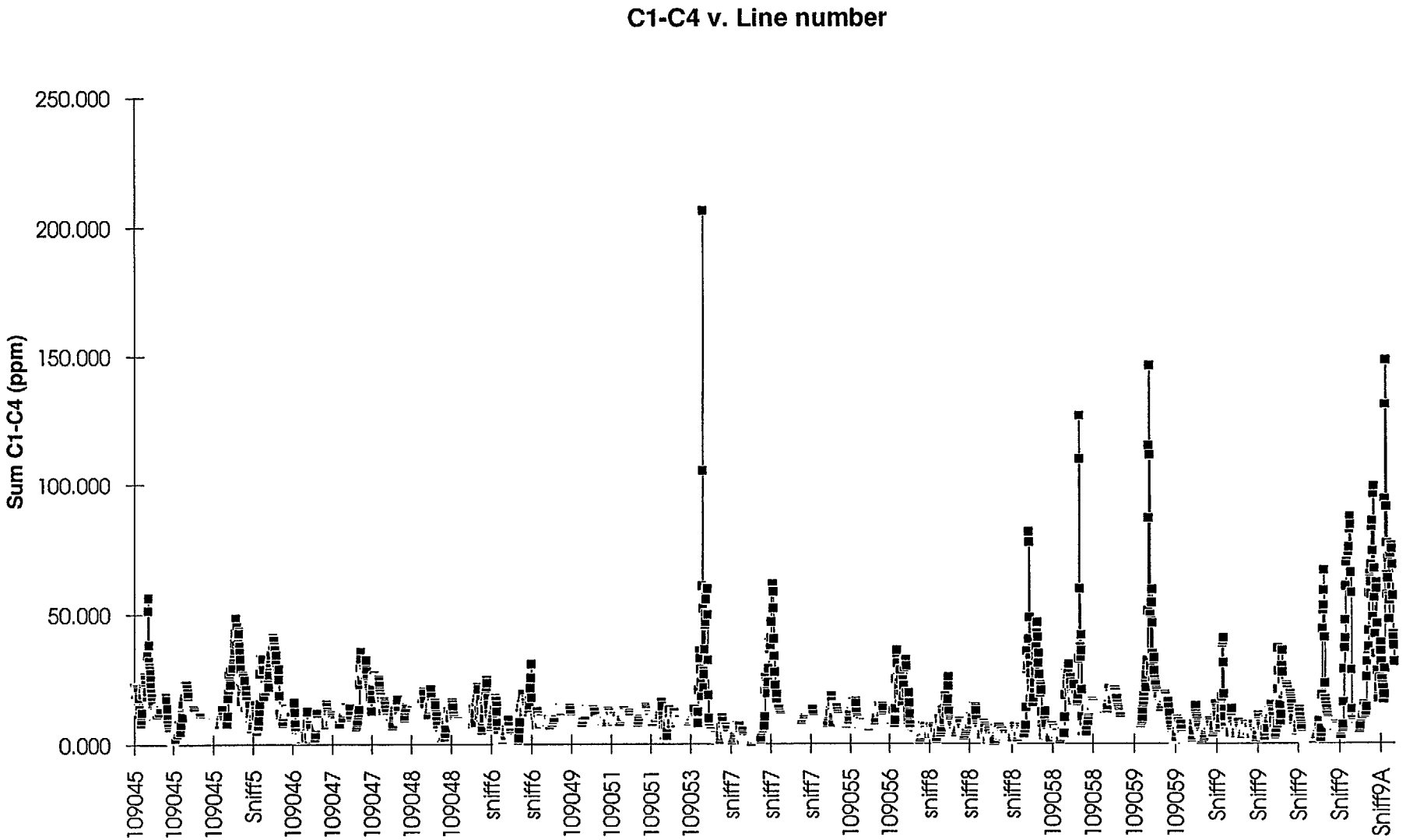


Figure 6b Sum C_1-C_4 versus survey line number, Ragay Gulf 'group 2' lines.

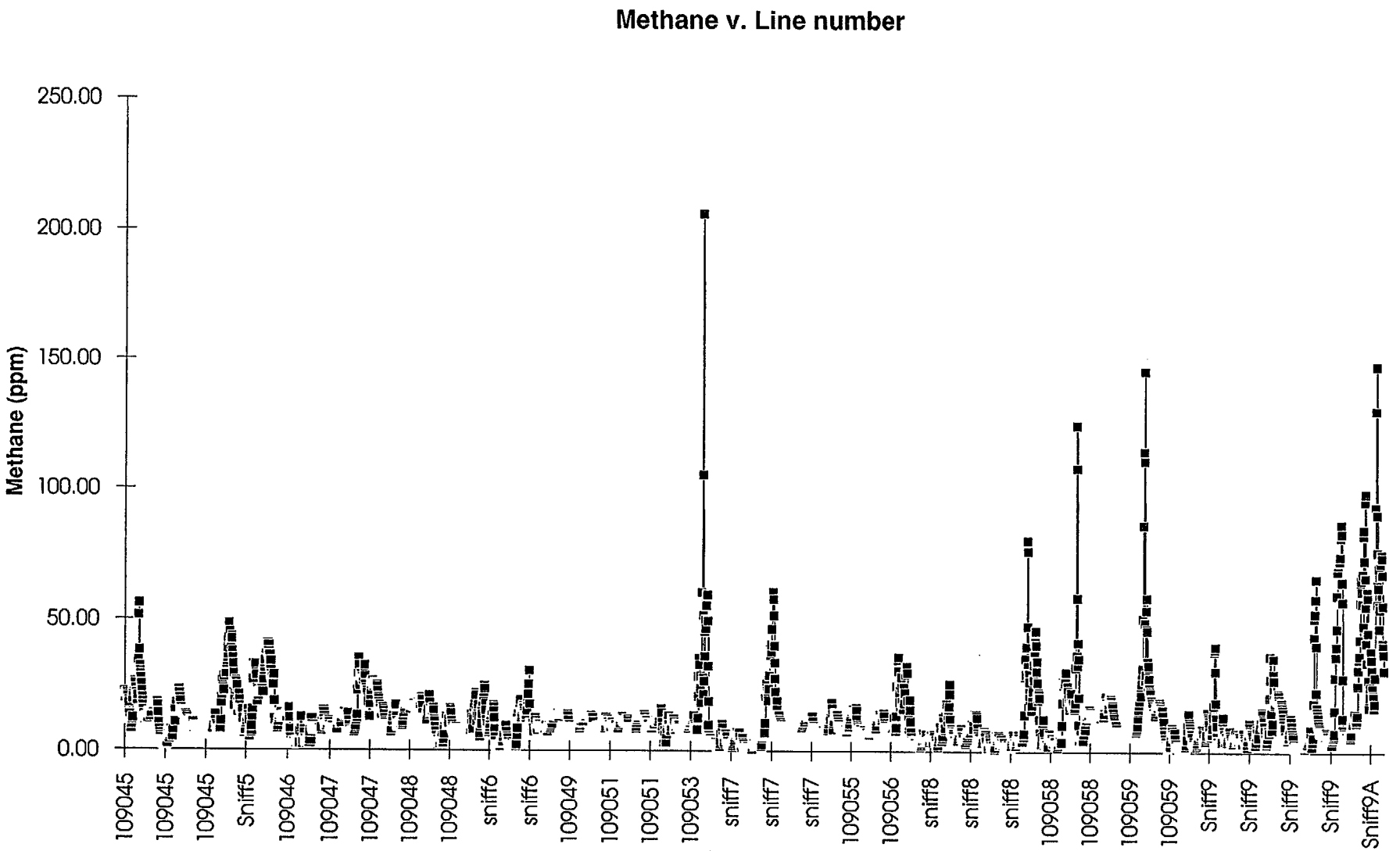


Figure 6c Methane versus survey Line number, Ragay Gulf 'group 2' lines.

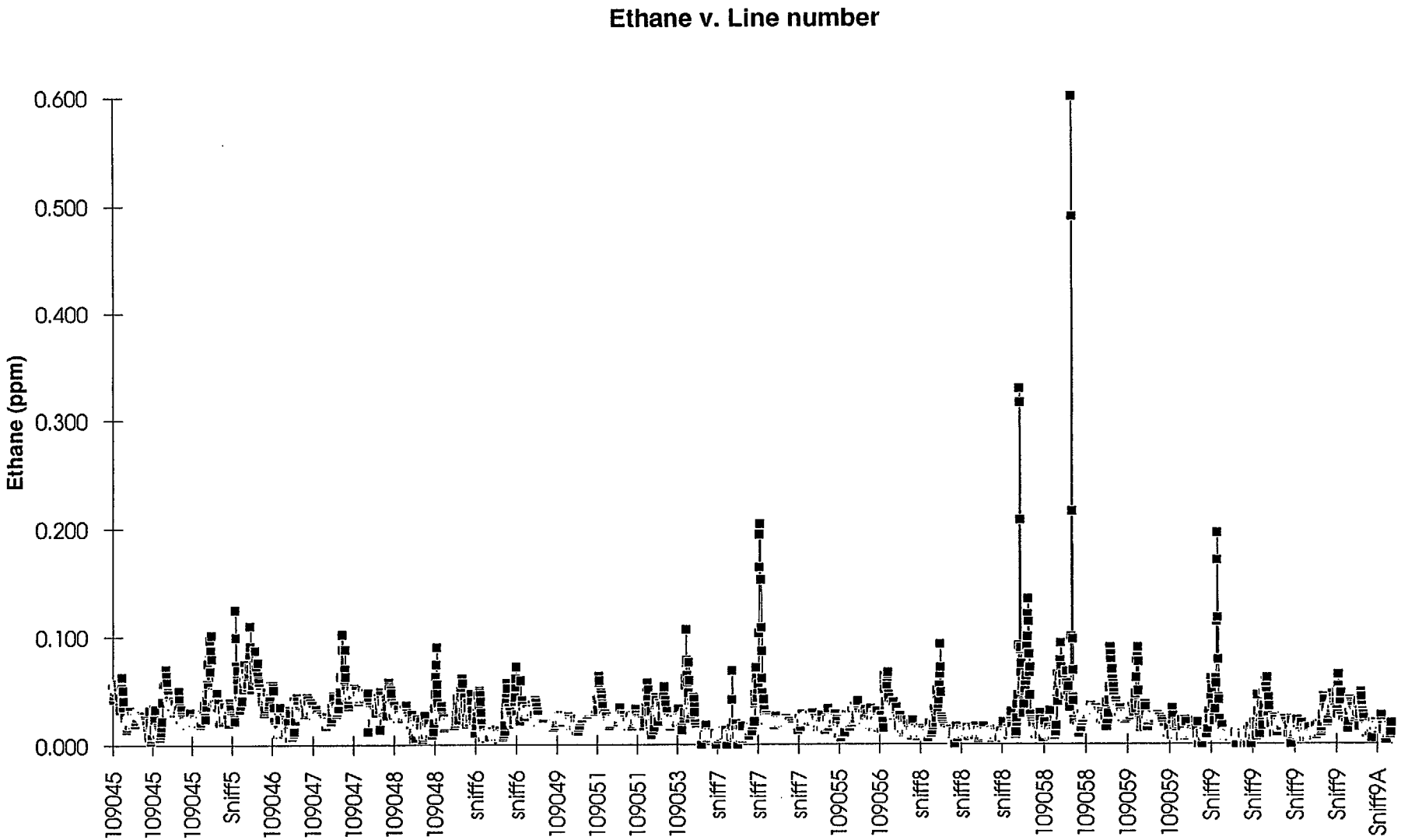


Figure 6d Ethane versus survey line number, Ragay Gulf 'group 2' lines.

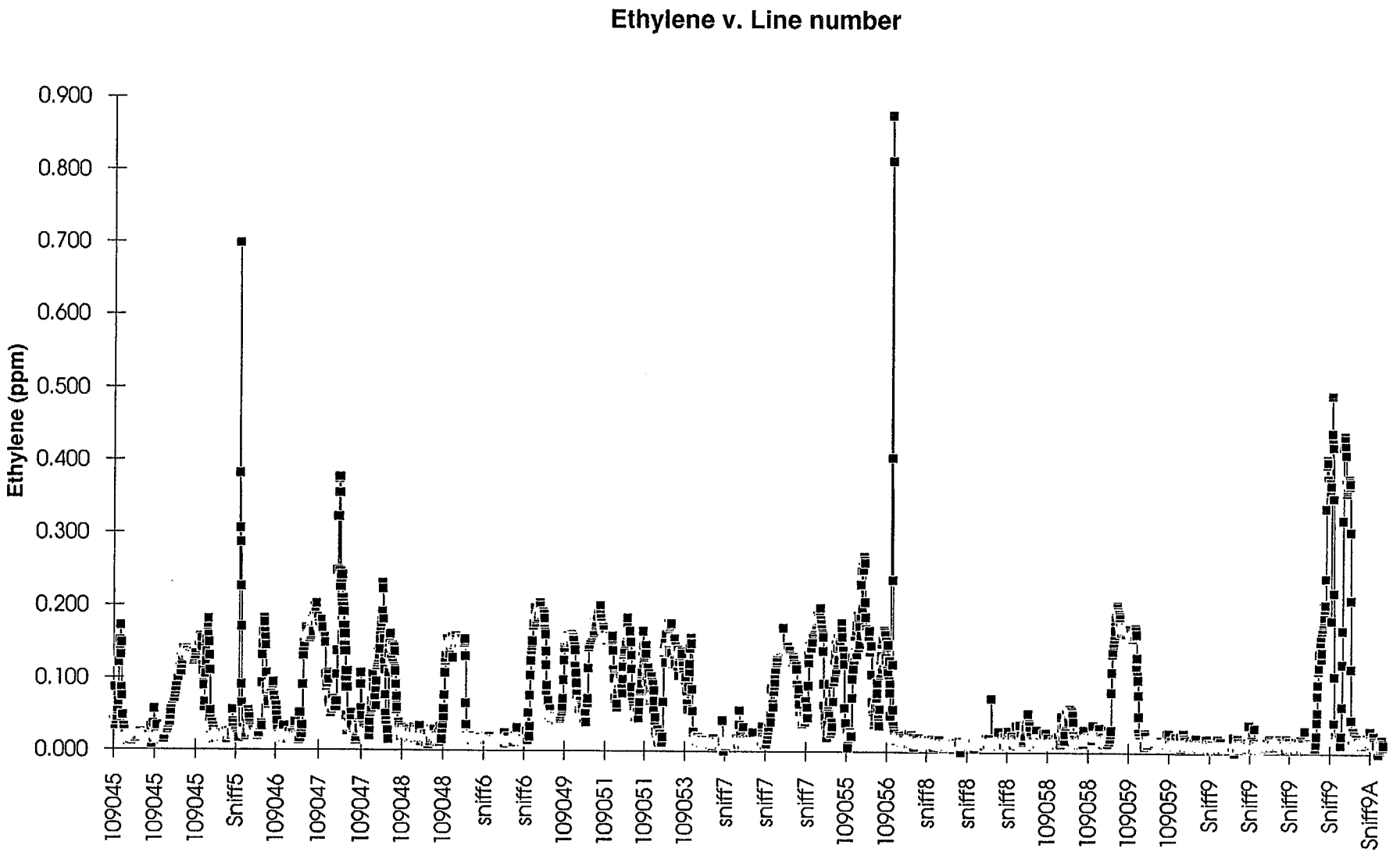


Figure 6e Ethylene versus survey line number, Ragay Gulf 'group 2' lines.

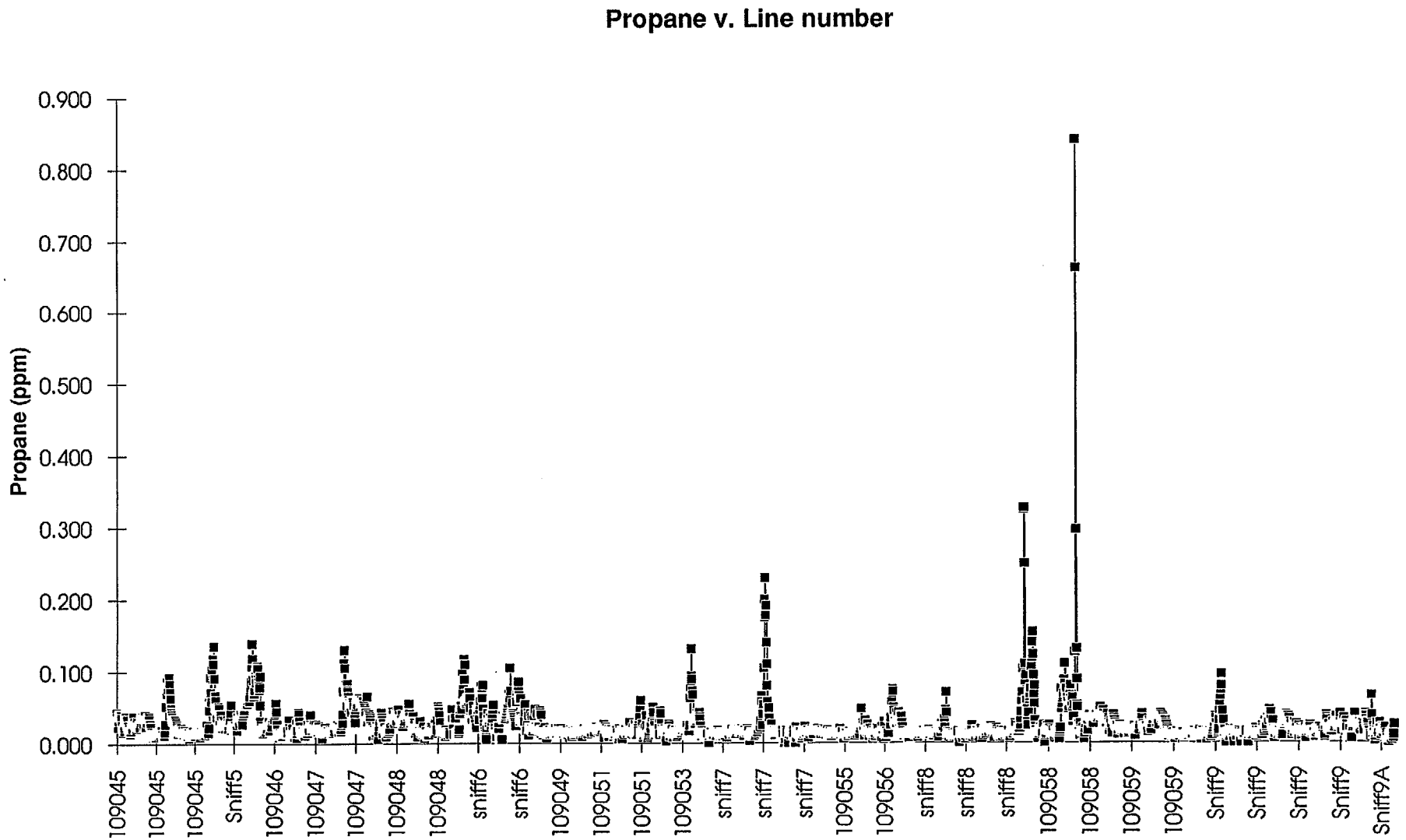


Figure 6f Propane versus survey line number, Ragay Gulf 'group 2' lines.

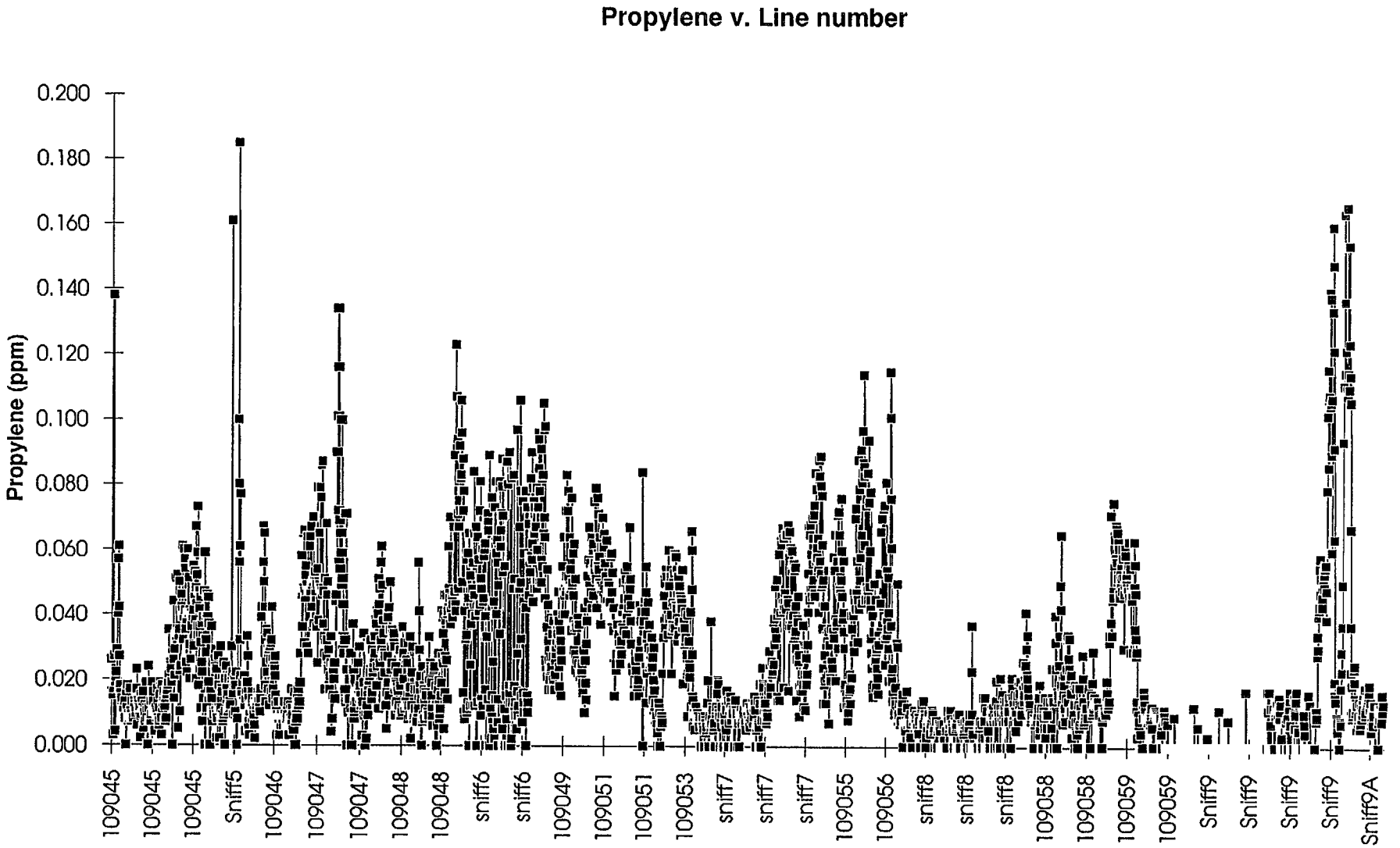


Figure 6g Propylene versus survey line number, Ragay Gulf 'group 2' lines.

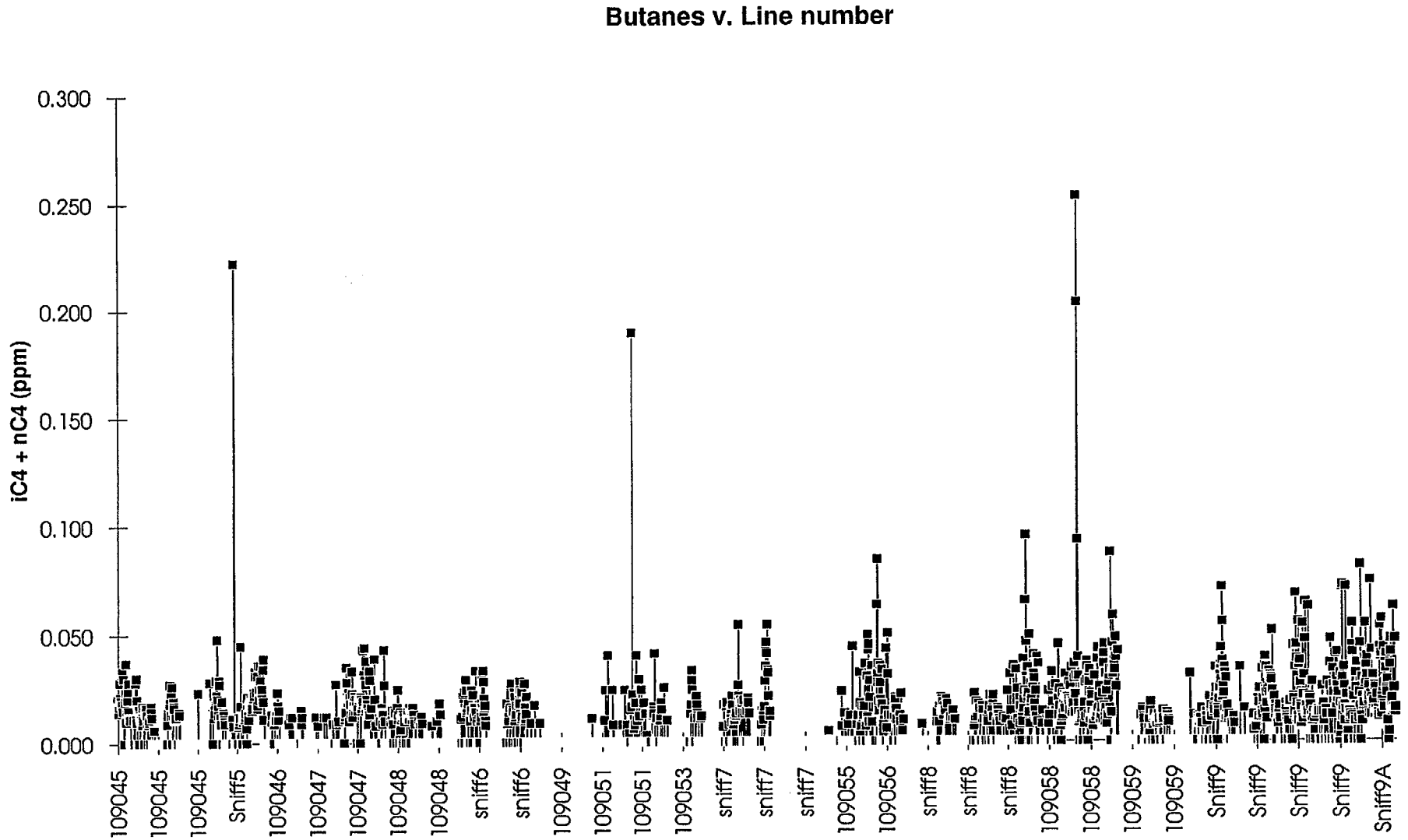


Figure 6h Total Butanes versus survey line number, Ragay Gulf 'group 2' lines.

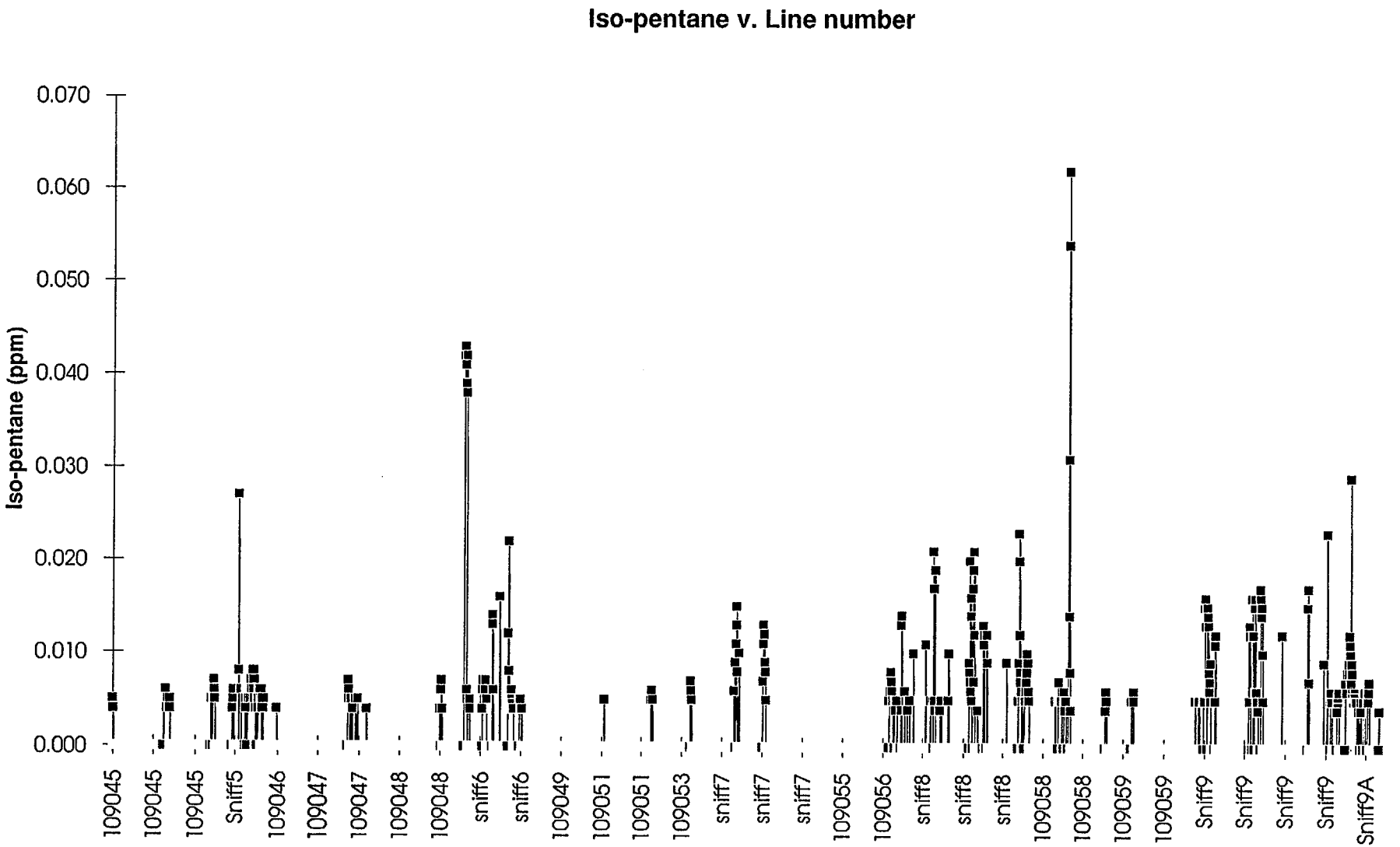


Figure 6i Iso-pentane versus survey line number, Ragay Gulf 'group 2' lines.



Figure 6j Percent hydrocarbon wetness versus survey line number, Ragay Gulf 'group 2' lines.

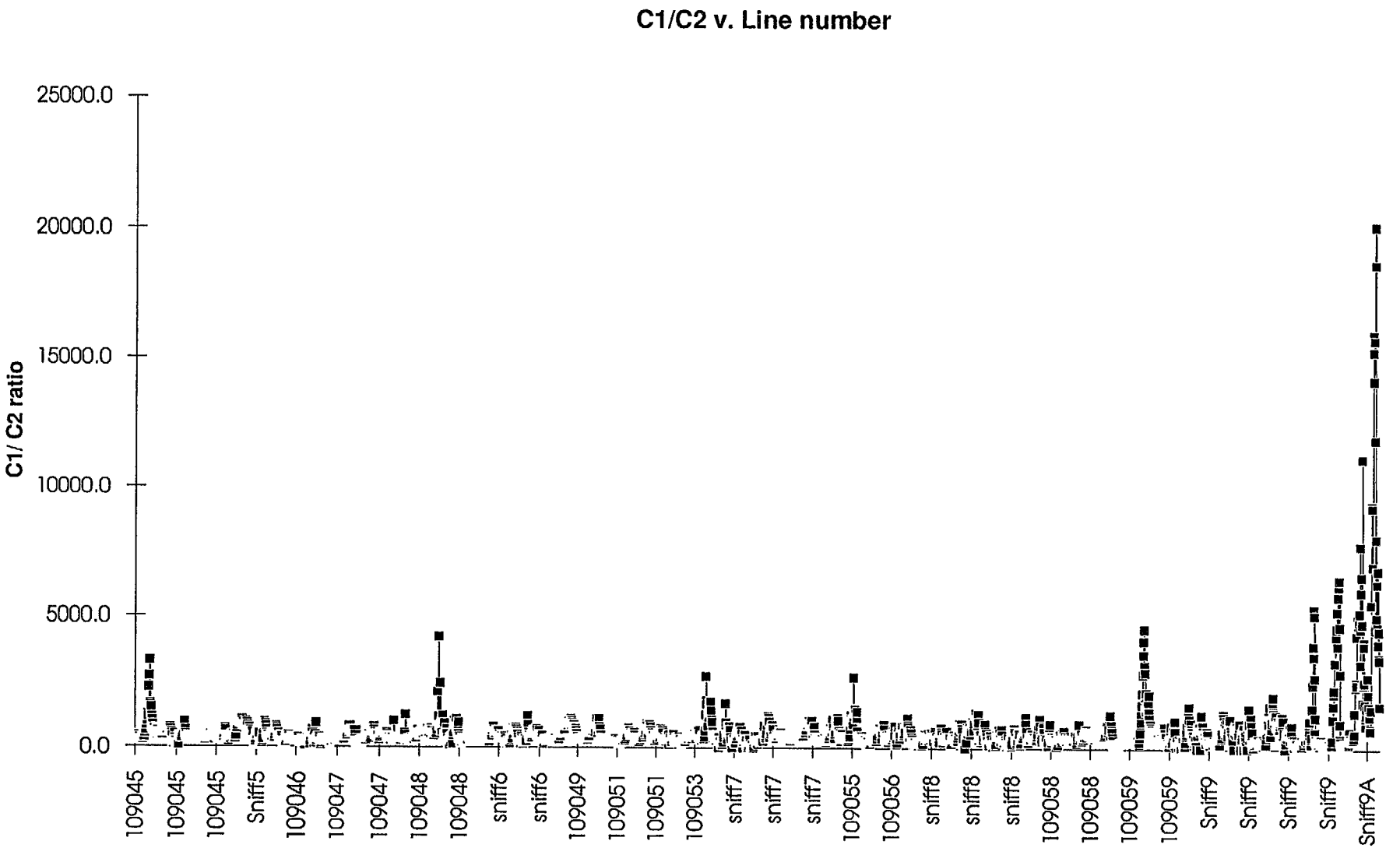


Figure 6k C_1/C_2 ratio versus survey line number, Ragay Gulf 'group 2' lines.

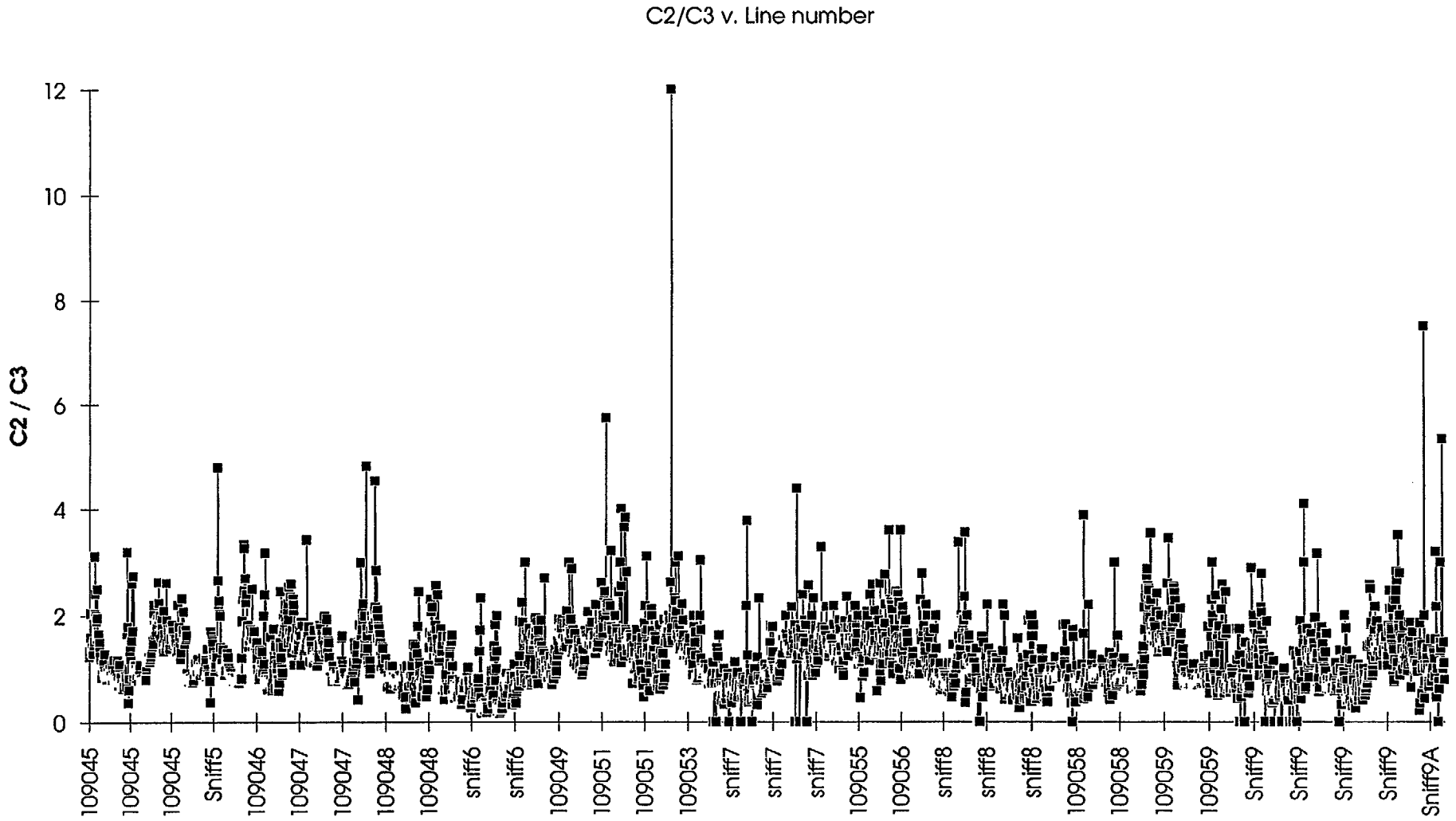


Figure 61 C_2/C_3 ratio versus survey line number, Ragay Gulf 'group 2' lines.

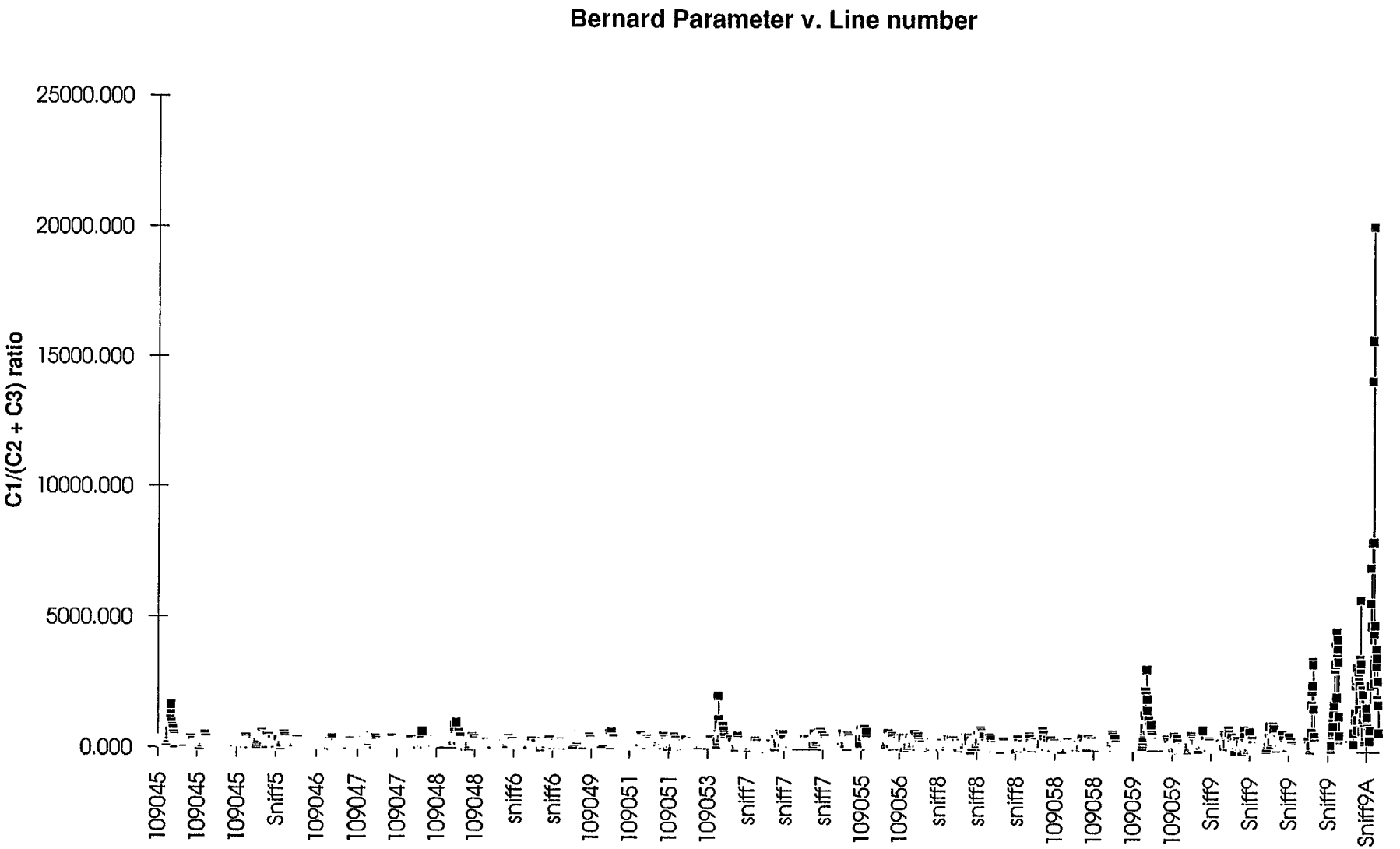


Figure 6m Bernard Parameter (C_1/C_2+C_3) versus survey line number, Ragay Gulf 'group 2' lines.

Ragay Gulf 'group 3'

(Lines 109/060 through 109/062; lines 109/069, 109/070, 109073, through 109076 and 109/079; vertical profiles VP109/069, through VP109/072 and VP109/075 through VP109/078.)

Several weak to strong hydrocarbon anomalies were detected in this group of lines. The seven vertical profiles are included as parts of some of these lines. It is important to note that the DHD tow-fish depth may have been varying considerably if a vertical profile was being conducted - sometimes as the ship was moving. All vertical profiles were conducted over previously detected anomalies.

The most distinctive, strong Type A ('dry') anomaly was detected as part of vp109/069. THC values measured (about 1100 ppm) are the highest found during the survey (Figure 7a).

Line 109/079 has the highest concentrations of ethane, propane, butane and iso-pentane measured in Ragay Gulf, with a high C_2/C_3 ratio (Figures 7 d-l). Ethane and propane values are as high as 1.2 ppm.

For the following refer o Figures 7a-m, and Appendices I and II.

Line 109/060:

Weak THC, methane and ethane anomalies were detected between shotpoints 15 to 20 and 65 to 72, respectively.

Line 109/061:

Two weak THC, methane and ethane anomalies were found at either end of the line.

Line 109/062:

A strong THC and methane anomaly was detected between shotpoints 75 and 96. A moderate THC, methane and ethane anomaly was detected towards the end of the line.

Line 109/069:

A moderate THC and methane, along with a strong ethane and propane, anomaly was detected in the centre of the line. THC shows an almost ten-fold increase above background, but ethane and propane show an almost twenty-fold increase above background. A vertical profile was conducted over this anomaly (see VP 109/69; Appendix I).

Line 109/070:

Two strong THC, methane, ethane and propane anomalies were detected mid way along this line. THC shows a ten-fold increase above background, while ethane and propane show an almost 30 -fold increase above background. A vertical profile was conducted over this anomaly (see VP 109/70; Appendix I).

Vertical Profile VP109/071:

A weak THC, methane, ethane and propane anomaly was detected directly below the thermocline at 150m. THC values double, and propane shows a four-fold increase above background.

Line 109/073:

A strong THC and methane, and weak ethane, anomaly was detected in the middle of the line and covers 10 shotpoints or approximately 3 km. THC shows an approximate fifteen-fold increase above background.

Line 109/074:

Two weak THC, methane and ethane anomalies were detected on this short line.

Line 109/075:

THC and methane values increase as the tow-fish descends into deeper water at the end of the line. Elevated ethylene, ethane and propane values were detected in the middle of the line as the tow-fish rises in the water column as the water depth decreases slightly. A vertical profile was conducted near the end of the line (see vp 109/075; Appendix I).

Vertical Profiles VP109/076;109/077;109/078

See Appendix I.

Line 109/079:

A strong THC, methane, ethane and propane anomaly was detected towards the end of the line. THC shows a twenty five-fold increase above background, and ethane and propane concentrations are nearly thirty-fold above background. Ethane and propane concentrations measured here were the highest detected in Ragay Gulf.

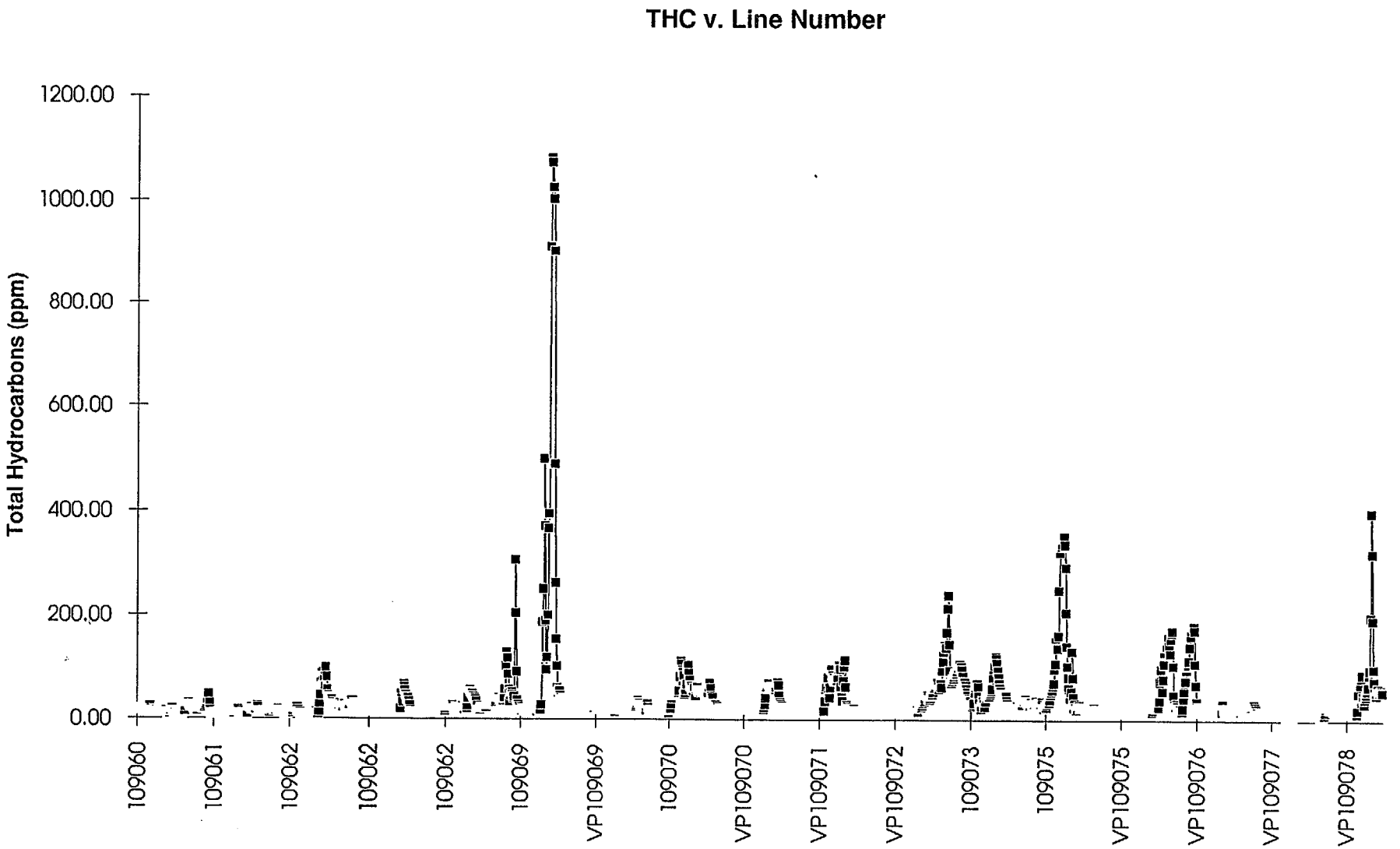


Figure 7a Total Hydrocarbons (THC) versus survey line number, Ragay Gulf 'group 3' (Lines 109/060 through 109/062; lines 109/069, 109/070, 109/075; vertical profile lines vp109/070, vp109/072 and lines vp109/072 and lines vp109/075 through vp109/078)

RAG3_THC.XLC 02/11/92

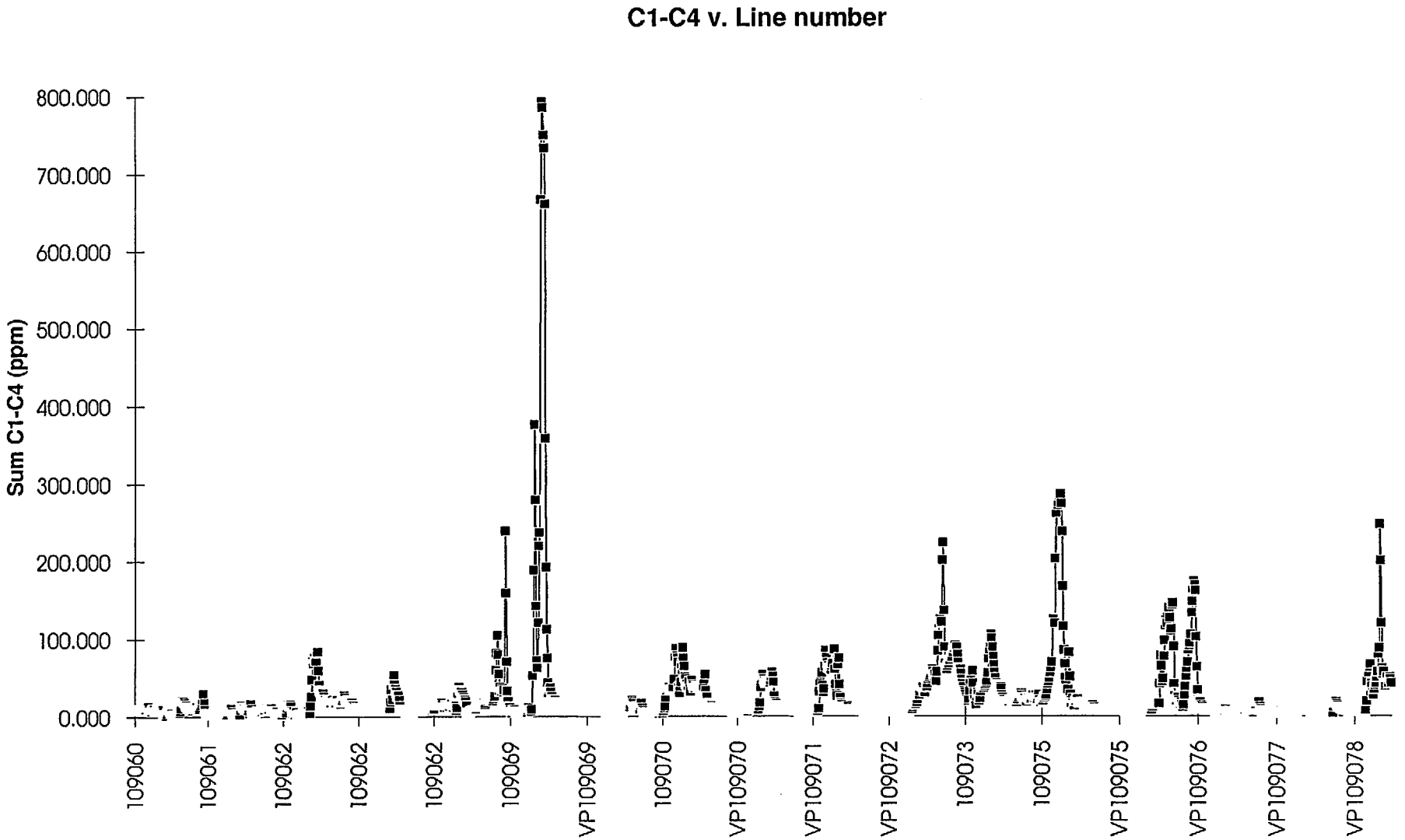


Figure 7b Sum C_1-C_4 versus survey line number, Ragay Gulf 'group 3' lines.

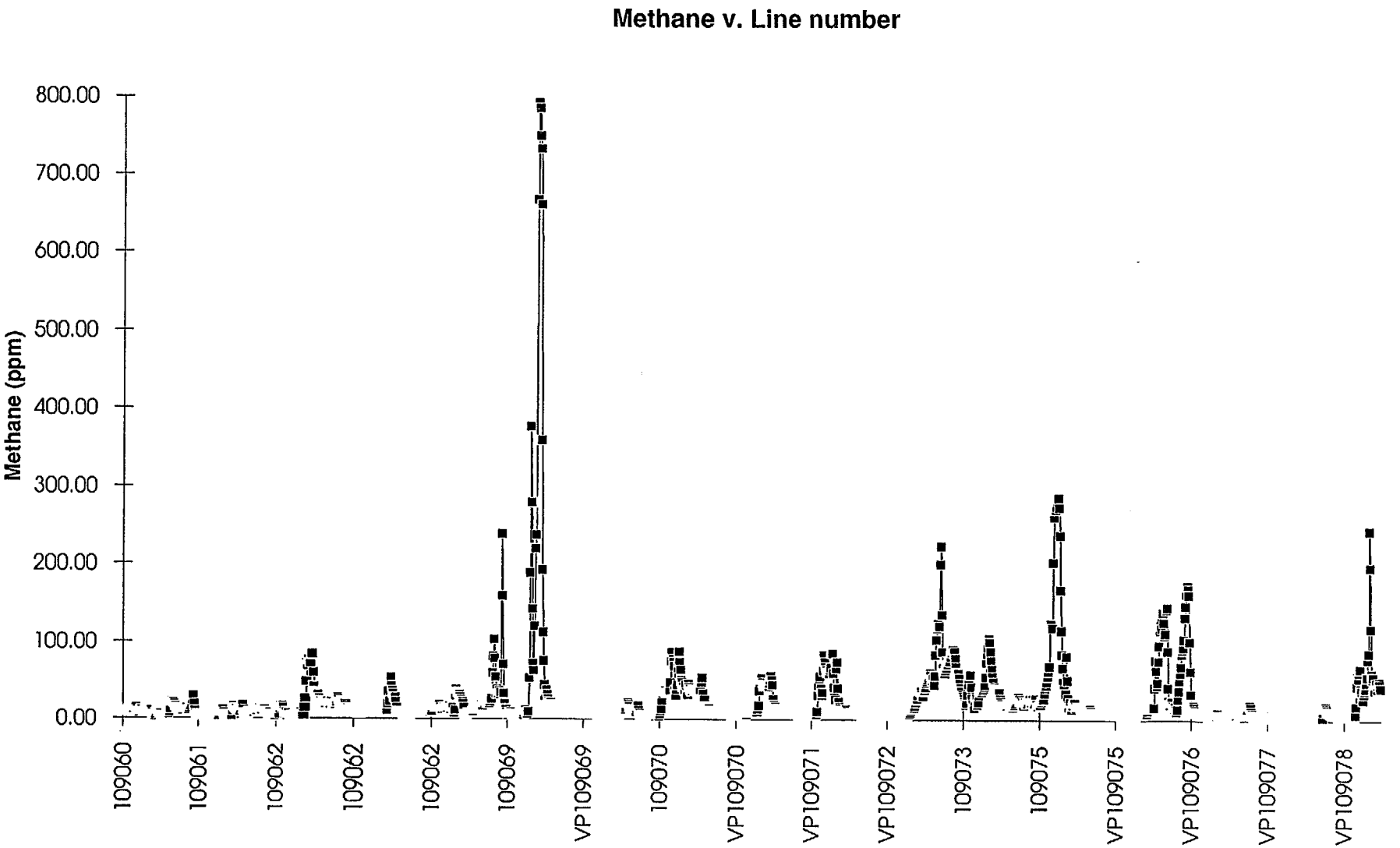


Figure 7c Methane versus survey line number, Ragay Gulf 'group 3' lines.

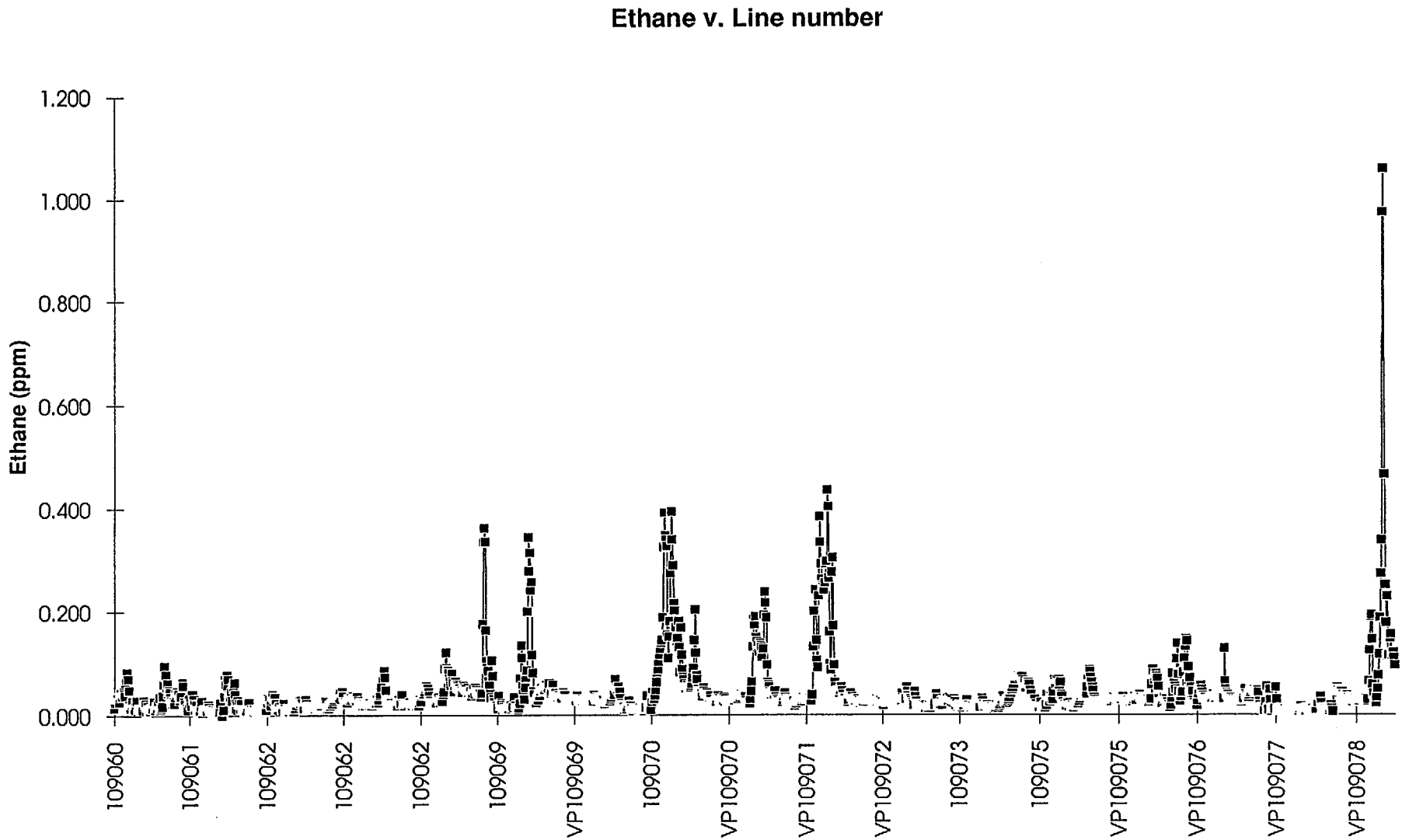


Figure 7d Ethane versus survey line number, Ragay Gulf 'group 3' lines.

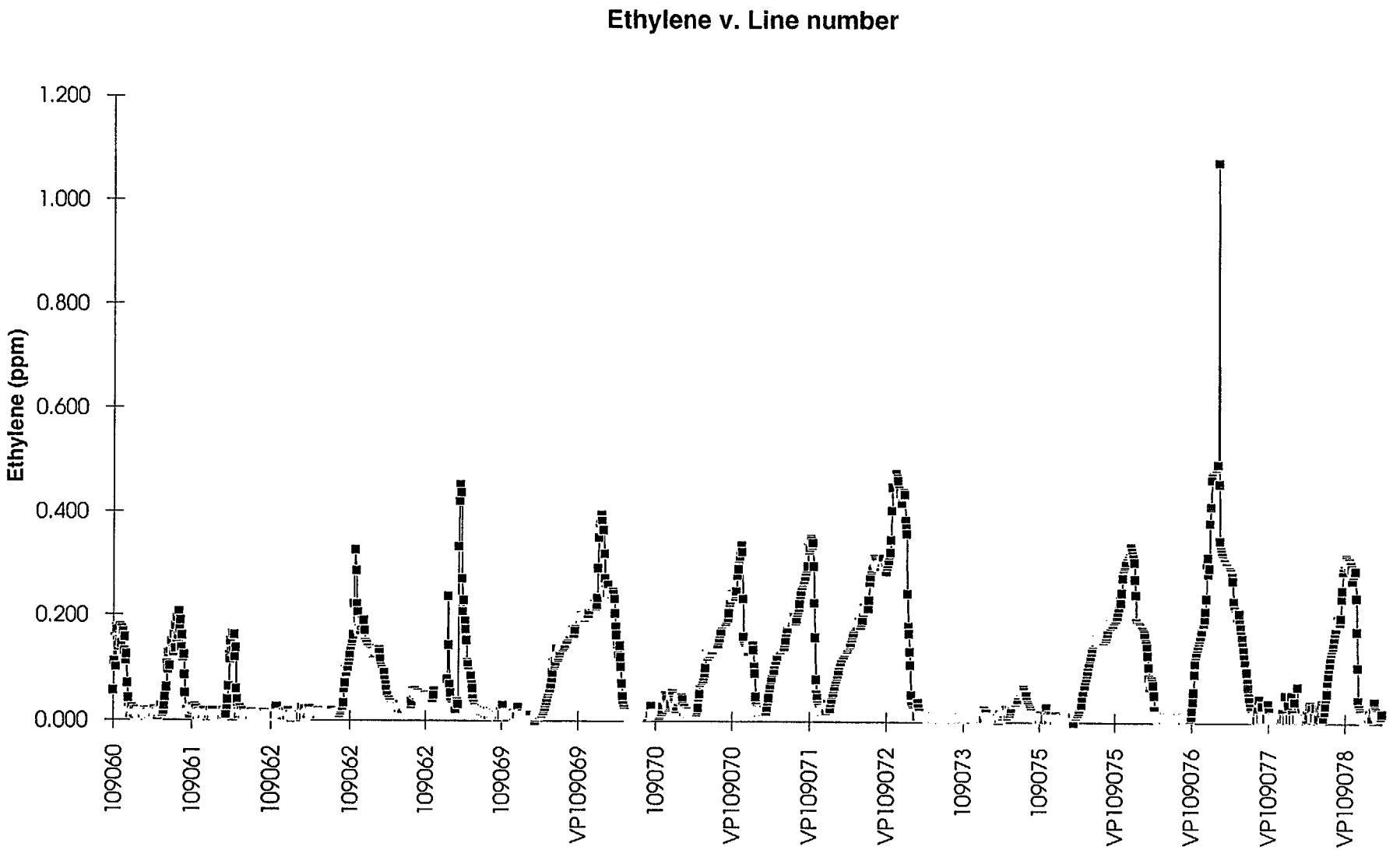


Figure 7e Ethylene versus survey line number, Ragay Gulf 'group 3' lines.

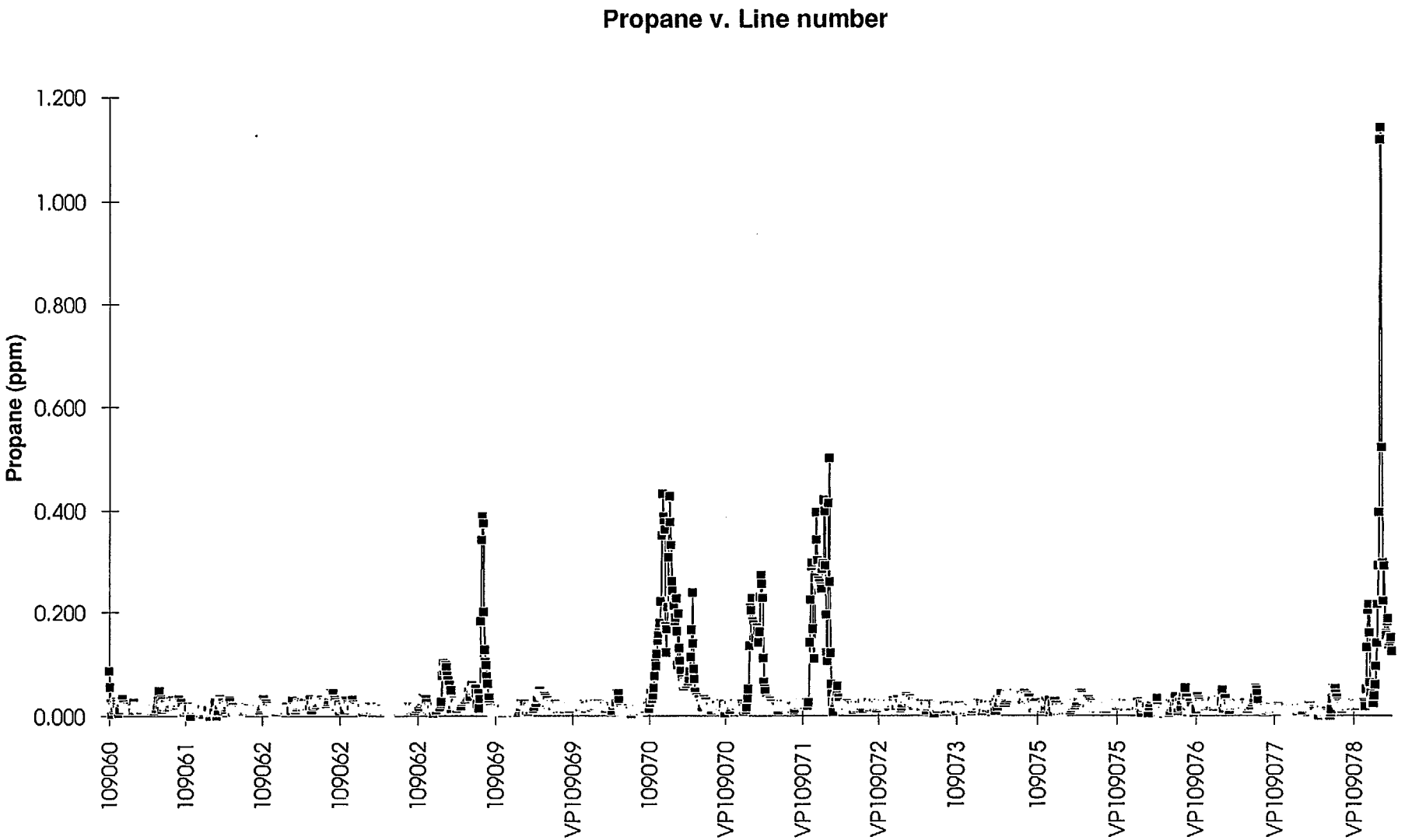


Figure 7f Propane versus survey line number, Ragay Gulf 'group 3' lines.

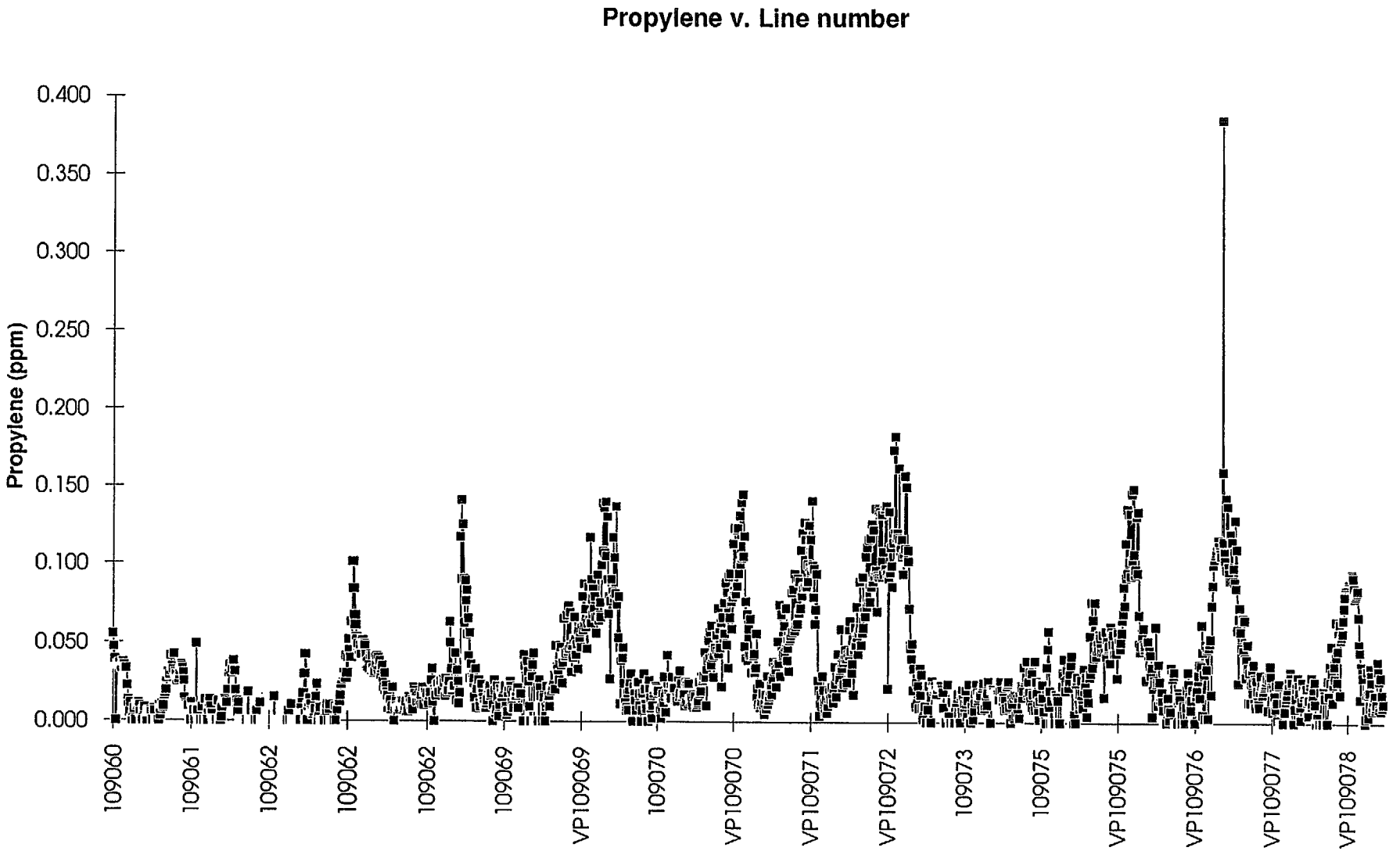


Figure 7g Propylene versus survey line number, Ragay Gulf 'group 3' lines.

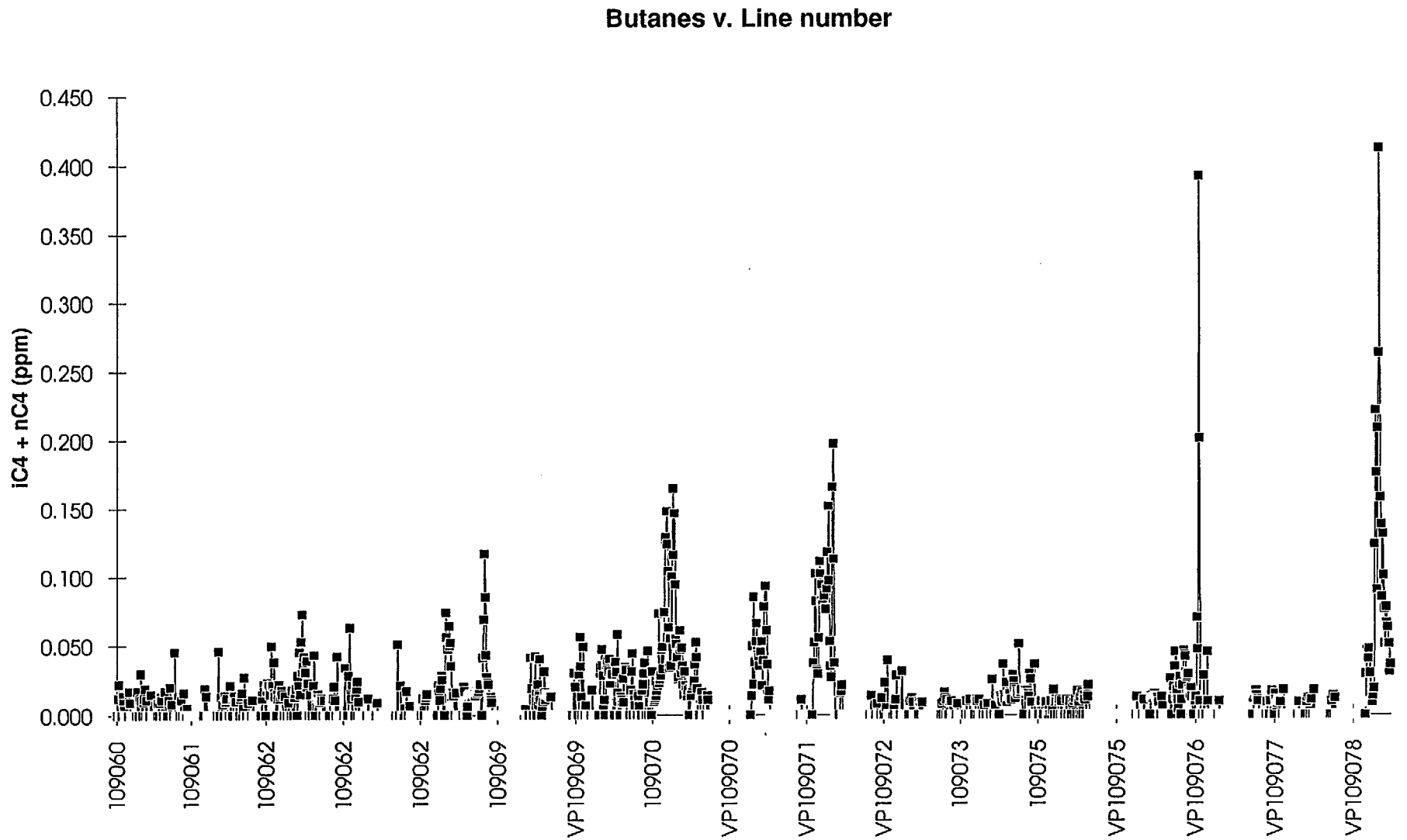


Figure 7h Total Butanes versus survey line number, Ragay Gulf 'group 3' lines.

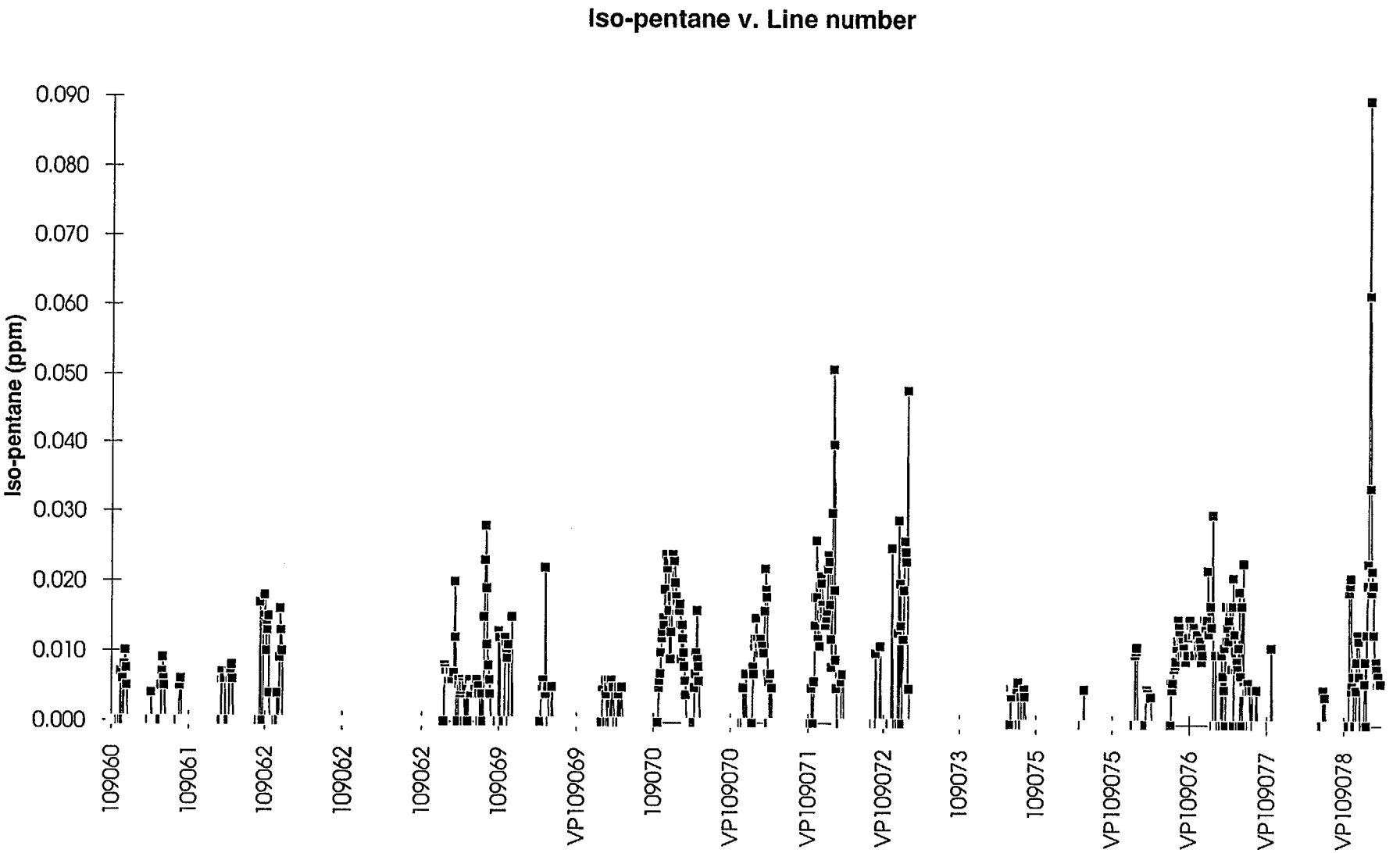


Figure 7i Iso-pentane versus survey line number, Ragay Gulf 'group 3' lines.

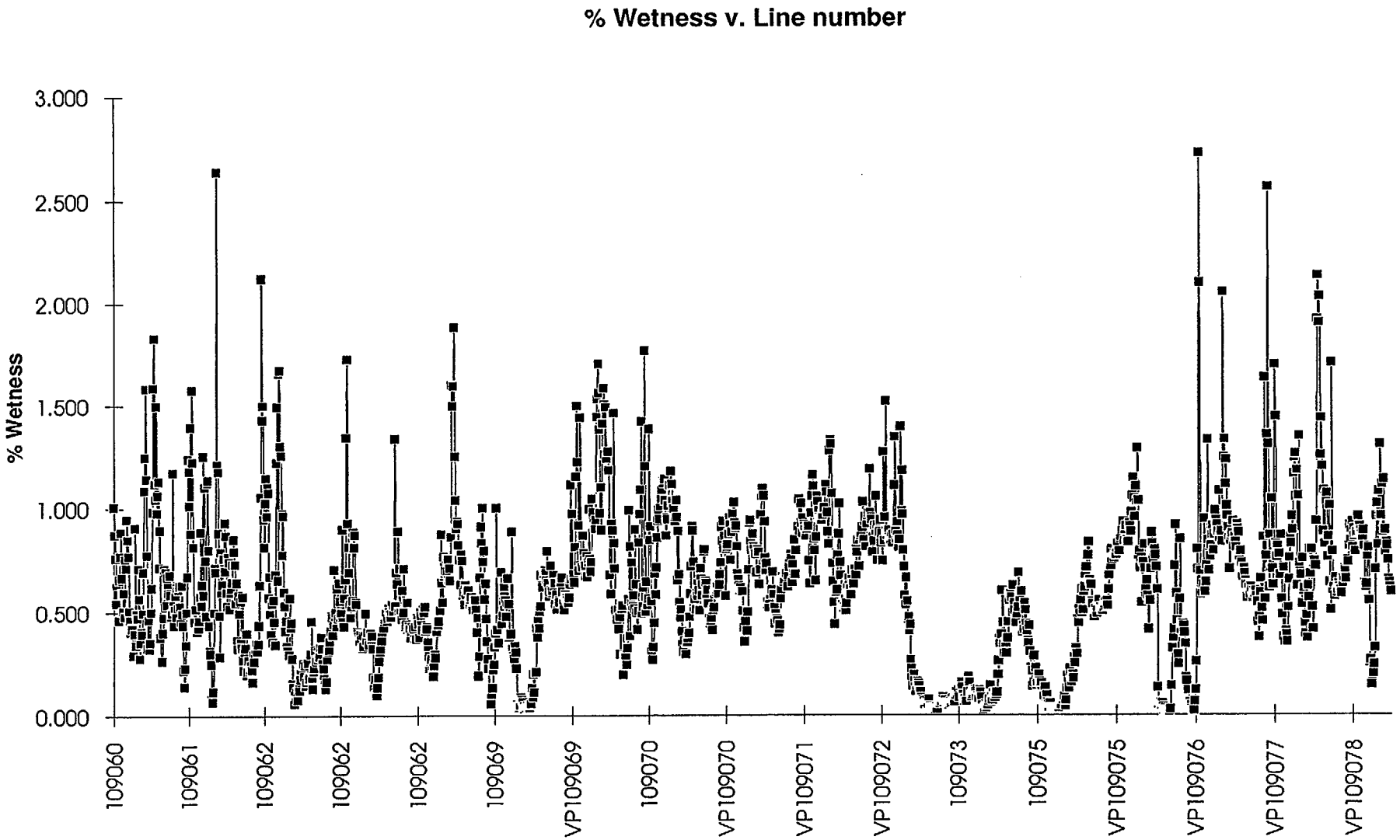


Figure 7j Percent hydrocarbon wetness versus survey line number, Ragay Gulf 'group 3' lines.

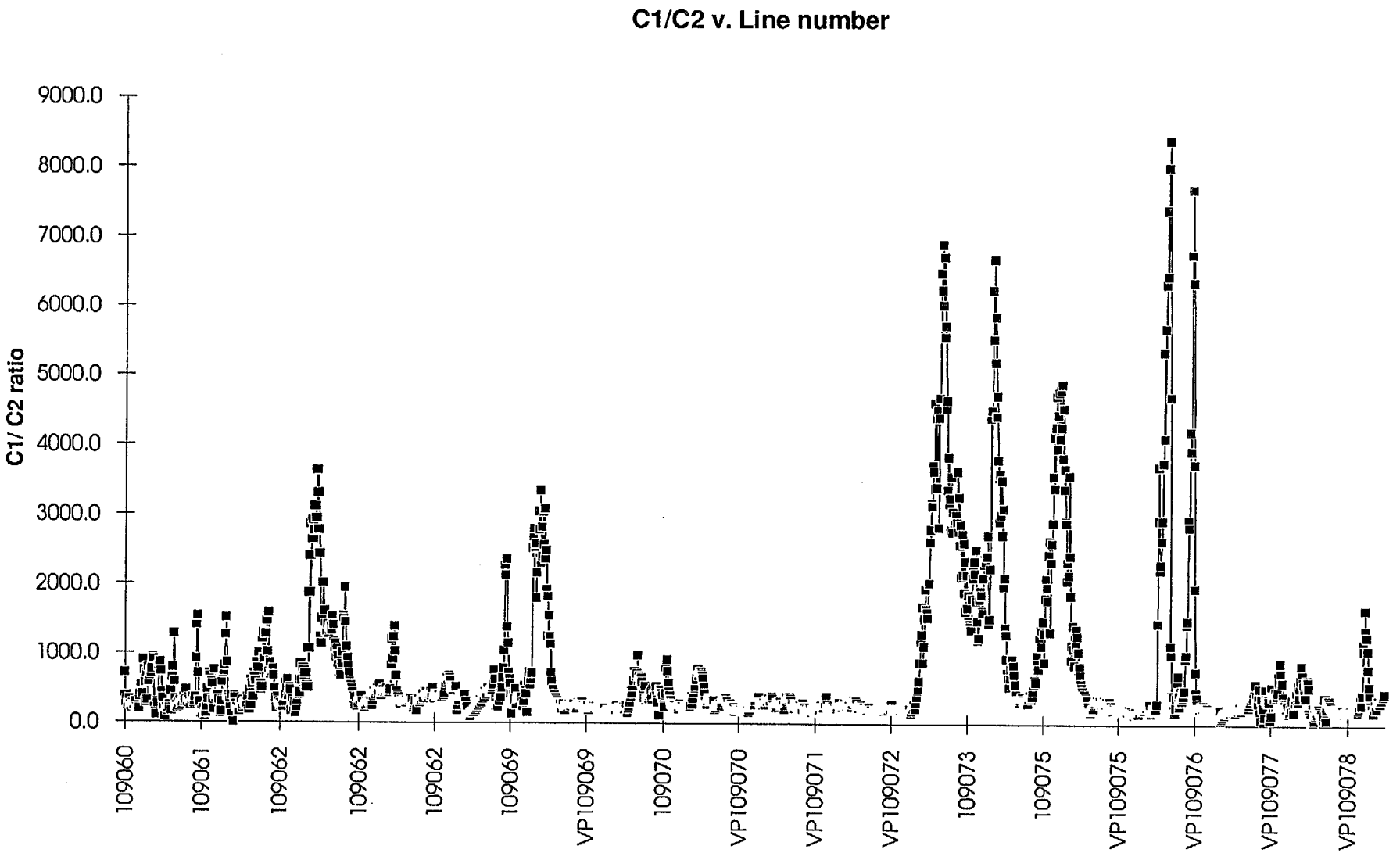


Figure 7k C_1/C_2 ratio versus survey line number, Ragay Gulf 'group 3' lines.

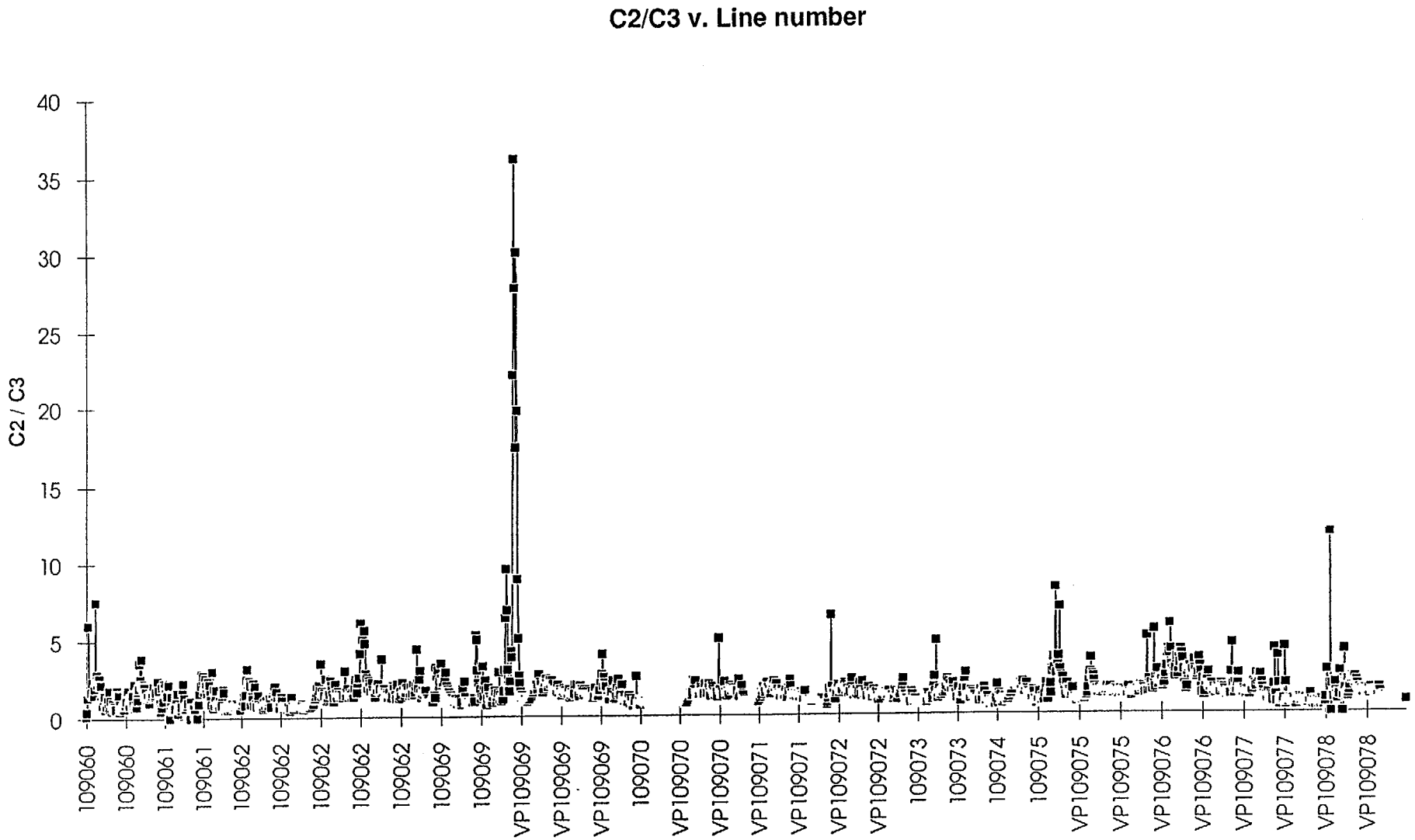


Figure 71 C_2/C_3 ratio versus survey line number, Ragay Gulf 'group 3' lines.

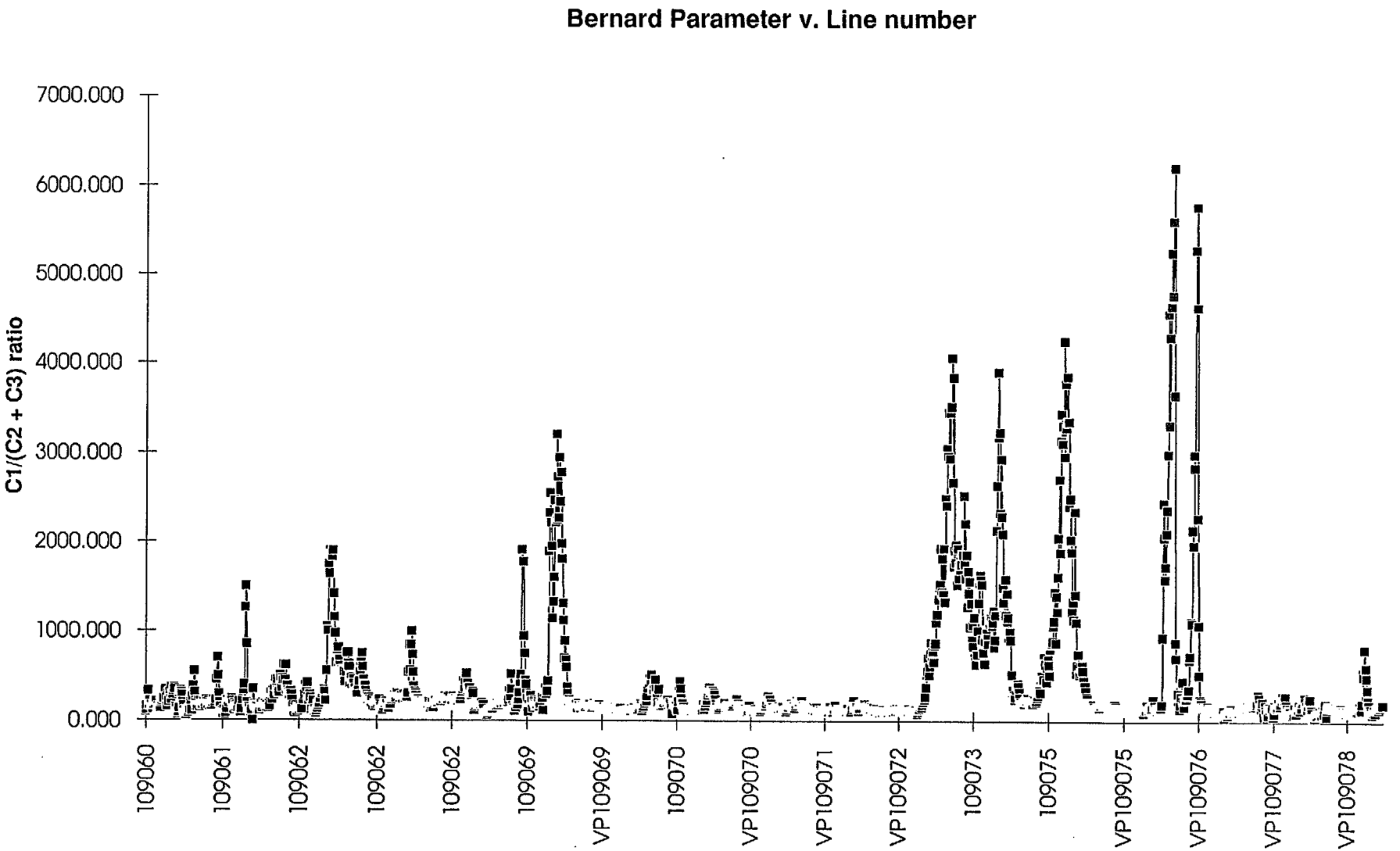


Figure 7m Bernard Parameter (C_1/C_2+C_3) versus survey line number, Ragay Gulf 'group 3' lines.

RAGAY GULF HYDROCARBON 'SOURCE'.

To investigate the possible 'source' of bottom-water anomalies of the Ragay Gulf crossplots of methane concentrations versus percent hydrocarbon wetness, and other selected crossplots of the anomalies, were constructed (Figures 8a-d, 9a-d, & 10a-d) The rationale for these plots is discussed in Appendix IV and Figure IV Part B.

Ragay Gulf 'group 1'

Figure 8a is a crossplot of methane versus percent hydrocarbon wetness of the Ragay Gulf 'group 1' lines, 109/031 through 109/044 and 109/sniff1 through 109/sniff4. At least two (and perhaps three) trends can be distinguished.

One trend in Figure 8a shows hydrocarbon wetness values less than 0.5 %, with an almost ten-fold increase in ppm methane from 20 ppm to approximately 200 ppm. The crossplot model suggests that this trend is sourced from 'dry' gas. This trend defines what we have referred to as a Type A anomaly. The anomaly on line 109/040 dominates this trend line.

The second trend in Figure 8a shows a small increase in percent hydrocarbon wetness from 0.6% to about 1.5 %, with methane increasing to about 140 ppm. The crossplot model suggests that this trend, of increasing wetness with increasing methane concentrations, is from a gas condensate, or perhaps liquid-prone source. This trend defines what we refer to as Type B anomalies. The strong THC, methane, ethane, propane, butane and iso-pentane anomaly on line 109/sniff1 contributes substantially to this trend.

The third trend seen in Figure 8a shows an increase in percent wetness from background values of around 0.7% to approximately 12% with little or no increase in methane values. The crossplot model suggests a liquid-prone trend. This trend comprises data points from the strong anomaly on line 109/sniff3. However, this type of trend could also be produced by methane oxidation effects during hydrocarbon migration and within seawater on the continental shelf. Generally these types of trends comprise only a few data points from any one anomaly and, because of the possibility of methane oxidation we consider these a sub-set of the Type B anomaly - a trend of increasing wetness at low, or increasing methane concentrations. Distinguishing these trends further is beyond the scope of this work. Nevertheless, these trends are clearly distinguishable from the Type A anomaly - a trend of decreasing hydrocarbon wetness with increasing methane.

Figures 8b (methane vs ethane), 8c (methane vs propane) and 8d (methane vs butane) show the first two trends clearly and to a lesser extent the third trend, confirming at least two clearly different 'sources' for these anomalies.

Ragay Gulf 'group 2'

Figure 9a is a crossplot of methane versus percent hydrocarbon wetness for the Ragay Gulf 'group 2' lines - three trends can again be seen.

One trend shows hydrocarbon wetness value < 0.5 % with a ten-fold increase in methane to approximately 210 ppm. This is a Type A trend line. The highest methane value is from the strong anomaly on line 109/053.

The second trend shows a small increase in percent hydrocarbon wetness from 0.5% to 1.5% with an approximate six-fold increase in methane, above a background, to about 130 ppm. This is a Type B trend line. The strong THC, methane, ethane, propane, butane and iso-pentane anomaly on line 109/058, and to a lesser extent line 109/sniff8, support this trend.

The third trend visible in Figure 9a shows an increase in percent hydrocarbon wetness from background values of around 0.6% to nearly 12% with little or no increase in methane value. The trend evolves predominantly as a result of the anomalies on line 109/sniff7, and to a lesser extent on line 109/sniff9.

Figures 9b (methane vs ethane), 9c (methane vs propane) and 9d (methane vs butane), confirm at least two trends.

Ragay Gulf 'group 3'

Figure 10a is a crossplot of methane versus percent hydrocarbon wetness of the Ragay Gulf 'group 3' lines. Three trends can be seen.

One trend shows low (less than 0.5 %) hydrocarbon wetness values, with methane increasing to nearly 800 ppm. This is a Type A trend line and is indicative of a 'dry' gas trend. Line vp109/069 with its very high methane concentration dominates this trend.

The second visible trend shows an increase in wetness from background to about 1.5% with methane increasing to about 200 ppm. This is a' Type B trend line.

A third trend shows an increase in percent wetness from a background value of <0.50% to about 2.8% with no significant increase in methane values. This trend is weak (wetness values < 3%) compared to similar trends noted in the group 1 and 2 plots, which have wetness values up to about 12 %.

Figure 10b (methane vs ethane), 10c (methane vs propane) and 10d (methane vs butanes) confirm the existence of two trends.

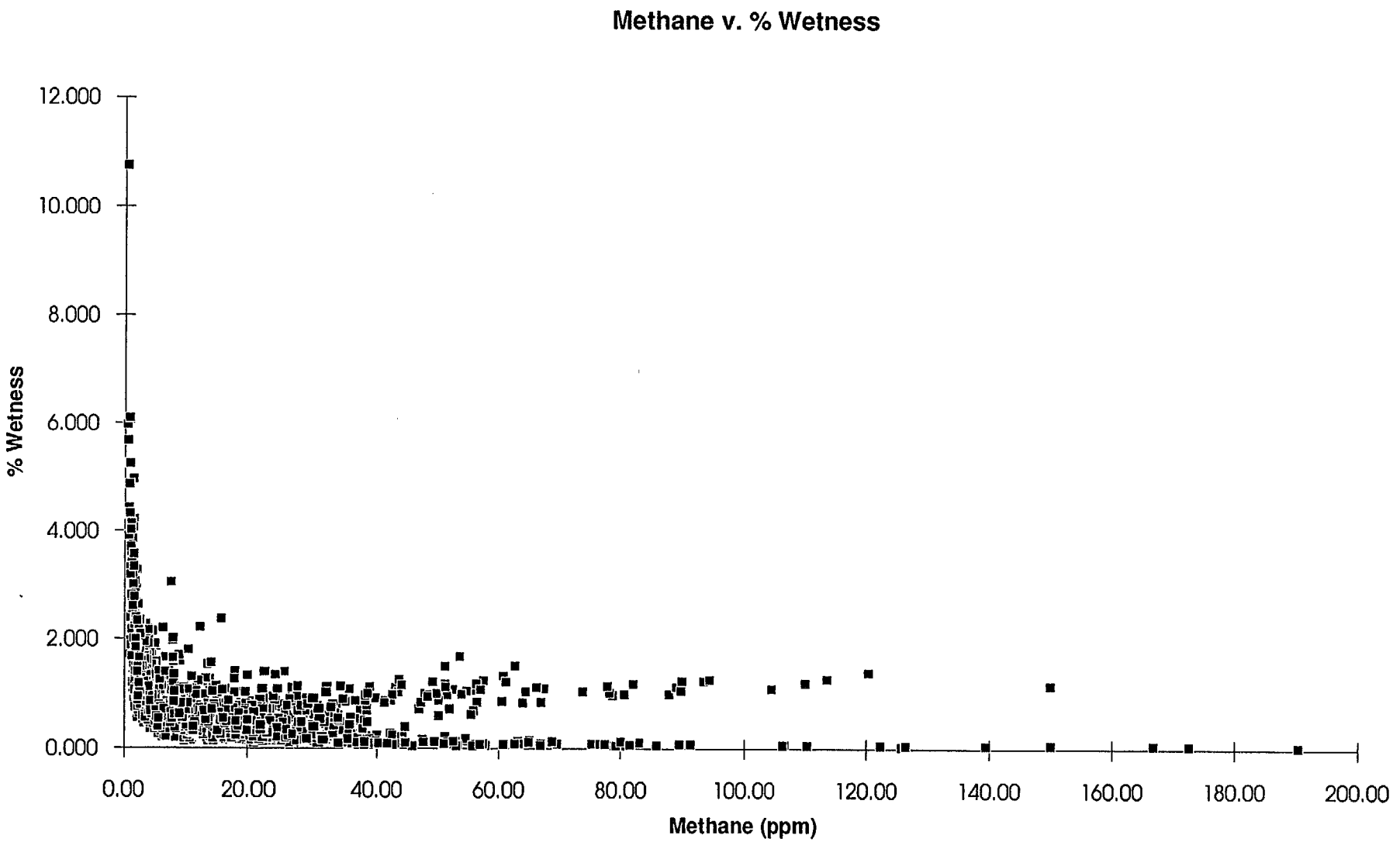


Figure 8a Methane versus percent hydrocarbon wetness , Ragay Gulf 'group 1' lines.

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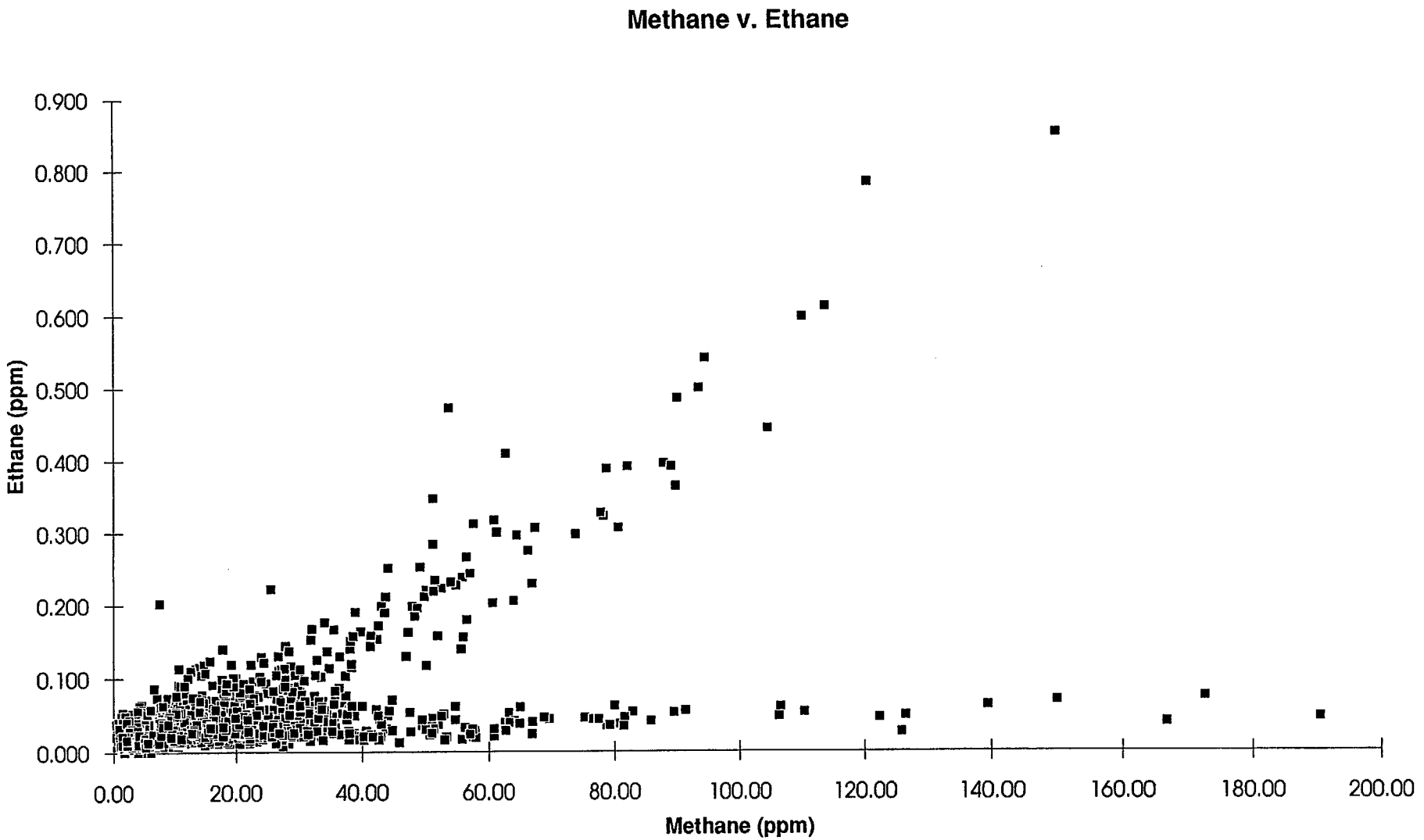


Figure 8b Methane versus ethane, Ragay Gulf 'group 1' lines.

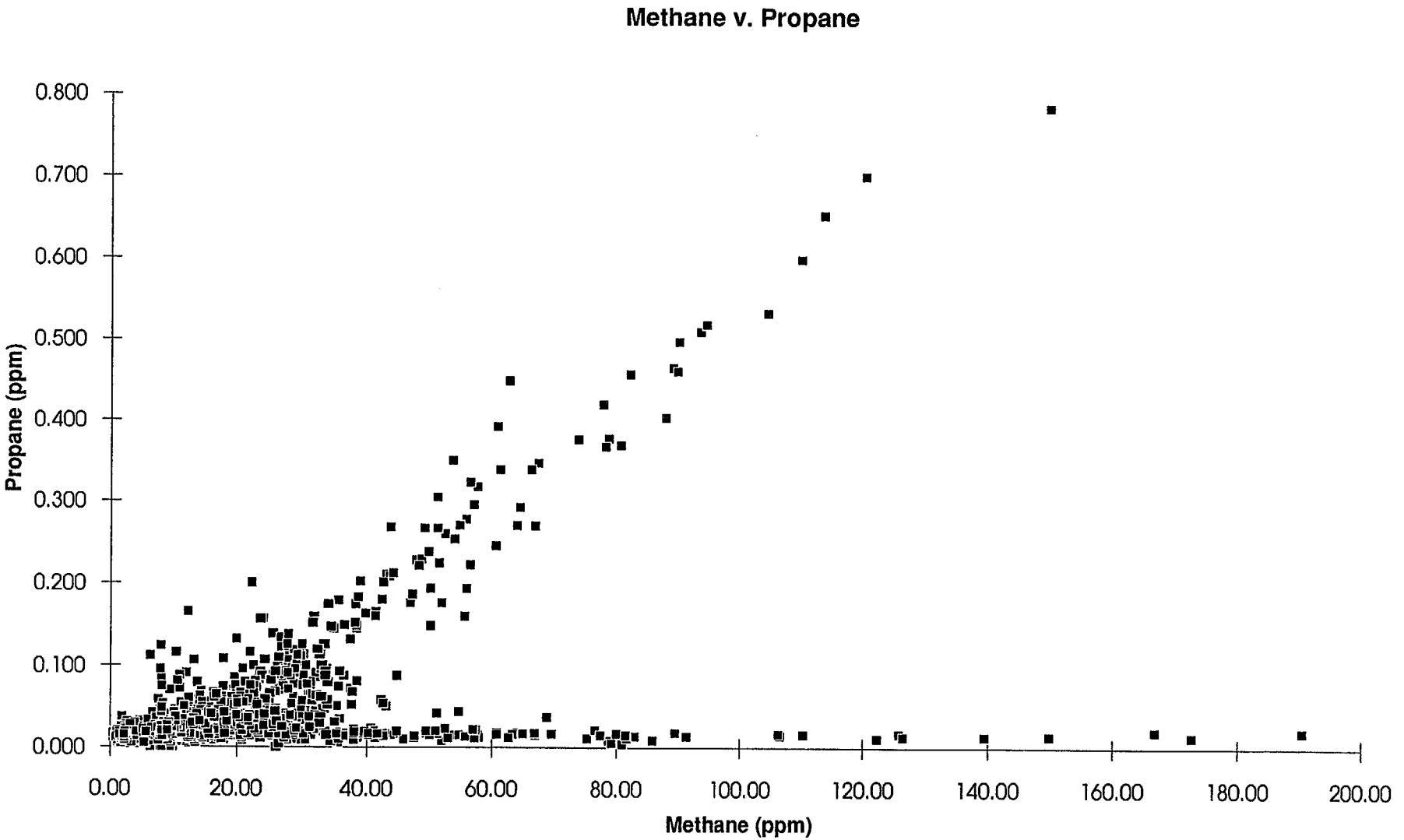


Figure 8c Methane versus propane, Ragay Gulf 'group 1' lines.

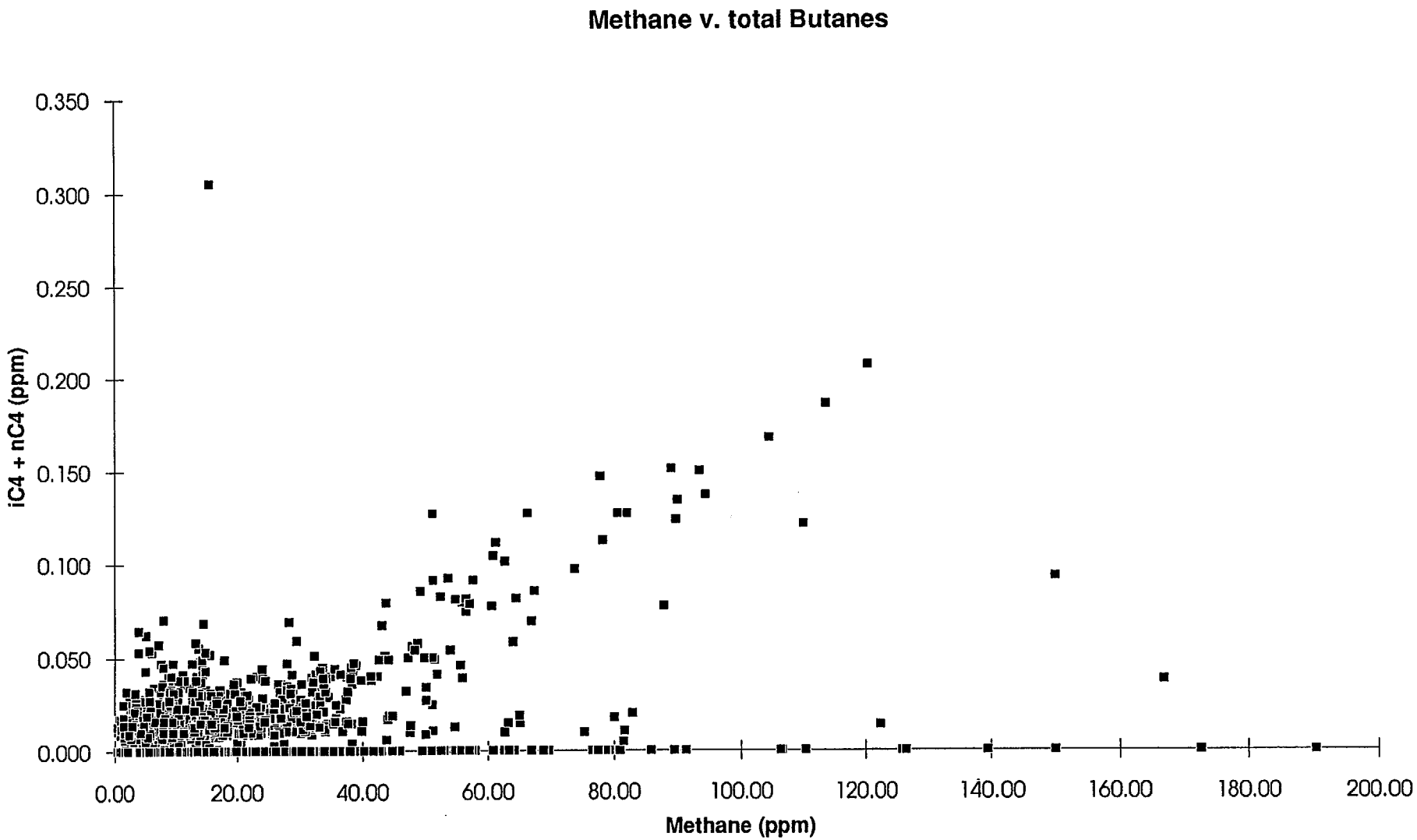


Figure 8d Methane versus butanes, Ragay Gulf 'group 1' lines.

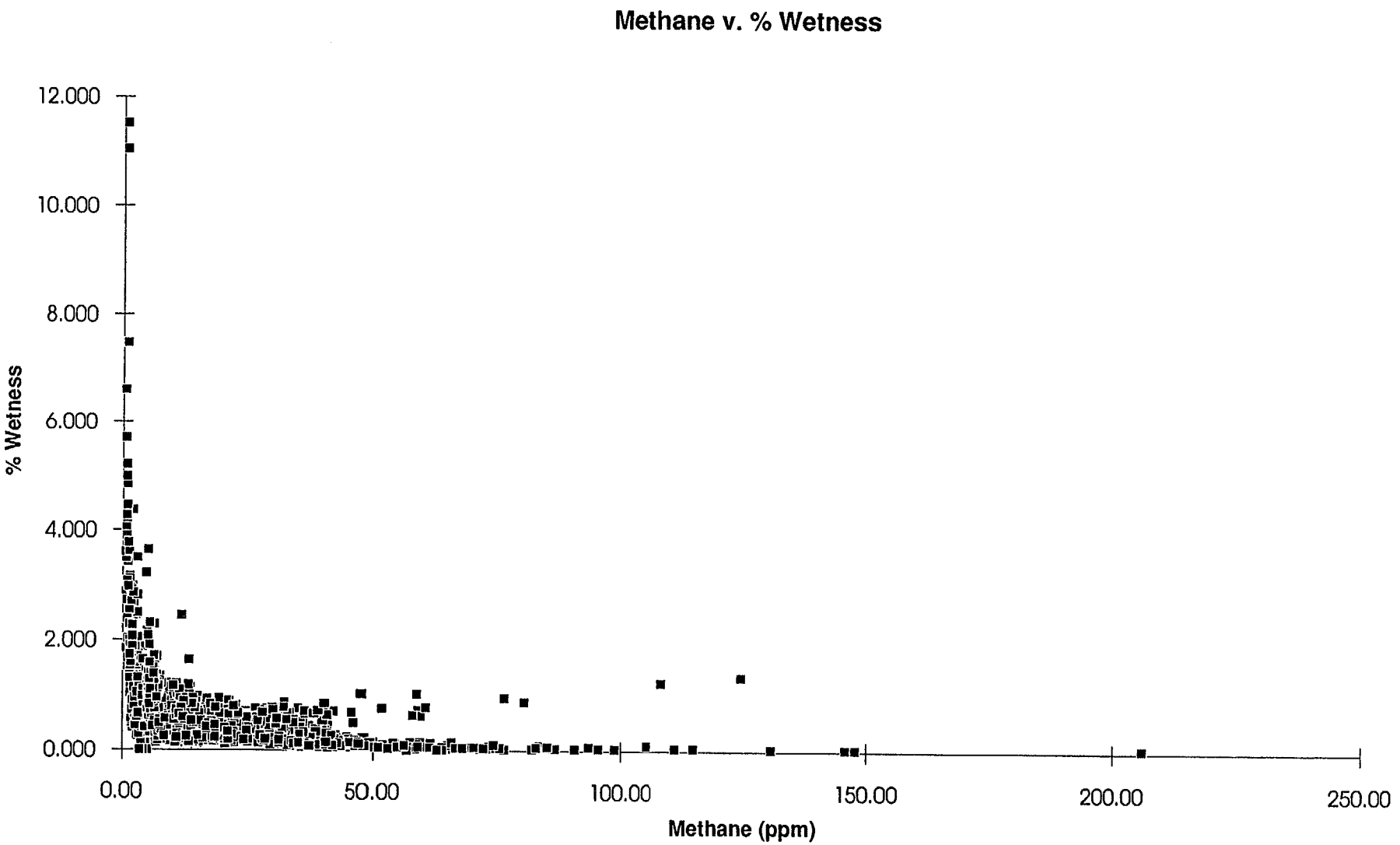


Figure 9a Methane versus percent hydrocarbon wetness , Ragay Gulf 'group 2' lines.

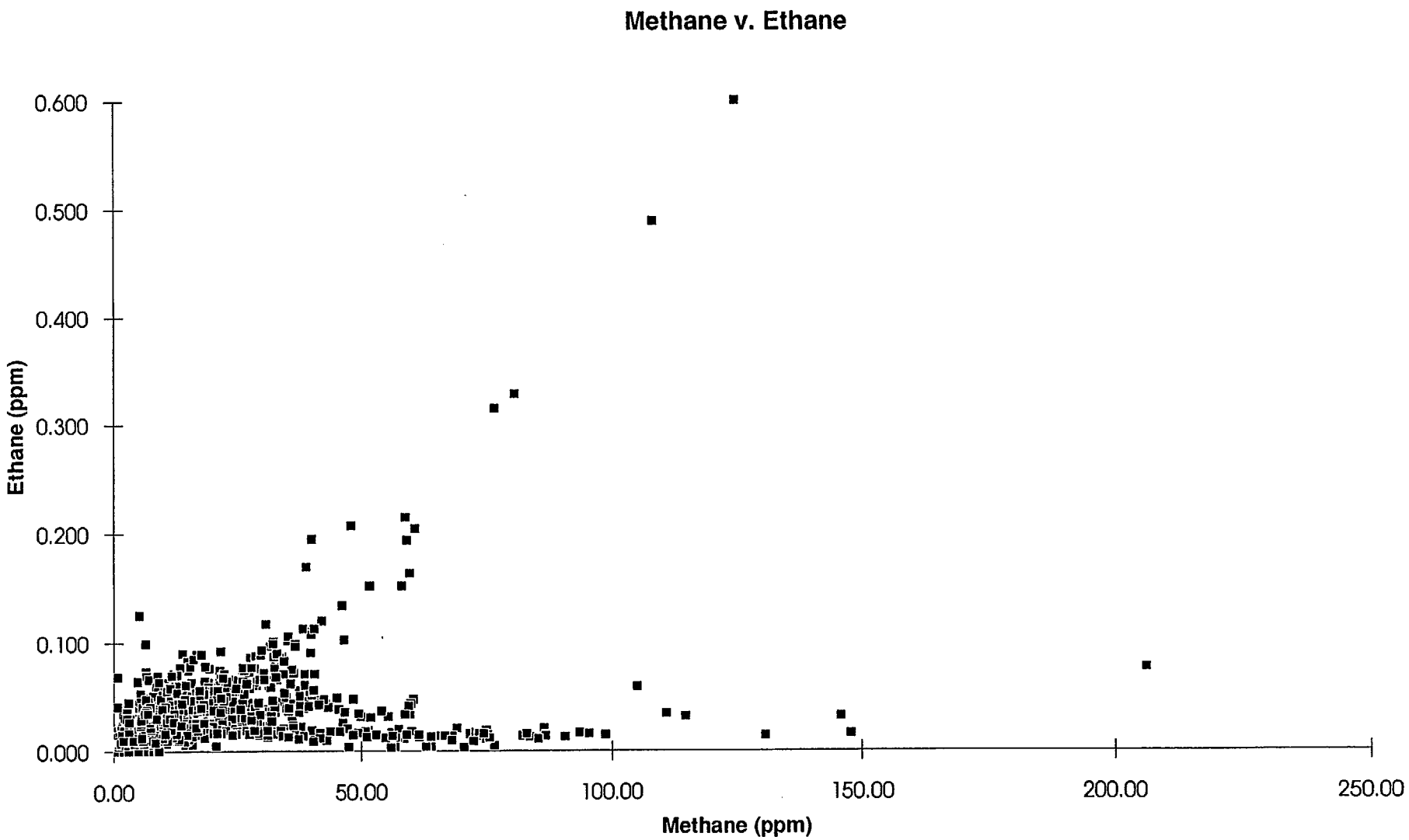


Figure 9b Methane versus ethane, Ragay Gulf 'group 2' lines.

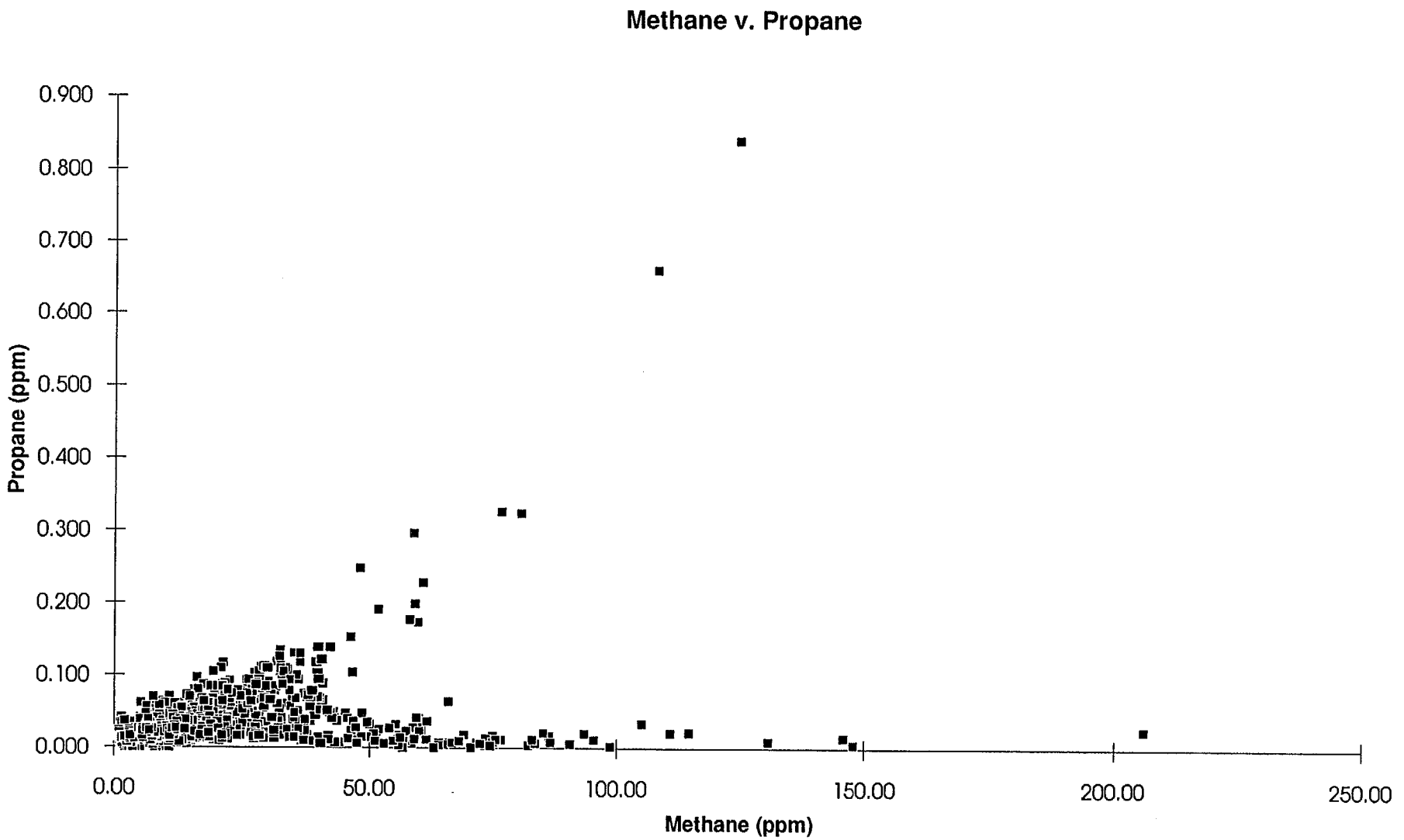


Figure 9c Methane versus propane, Ragay Gulf 'group 2' lines.

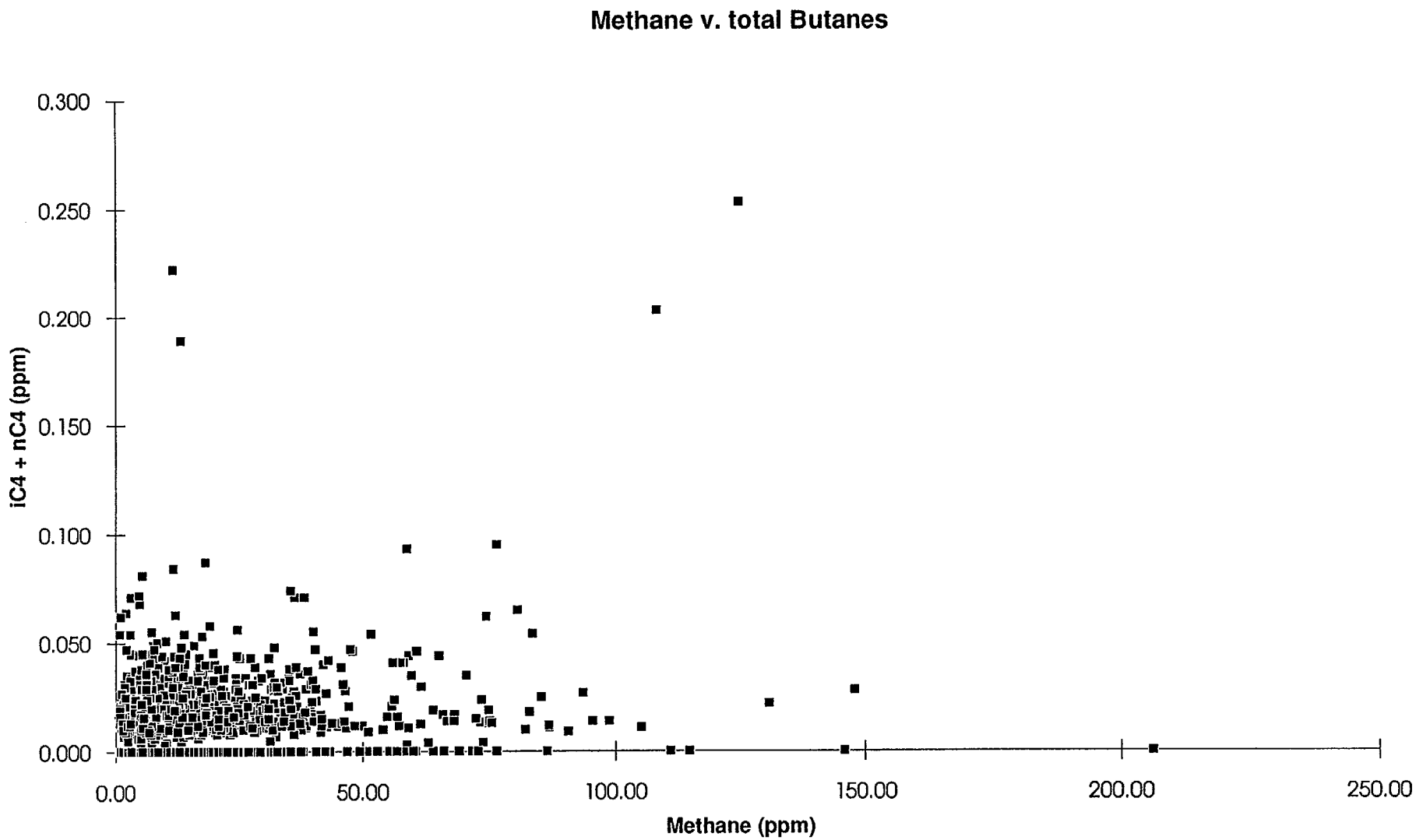


Figure 9d Methane versus butanes, Ragay Gulf 'group 2' lines.

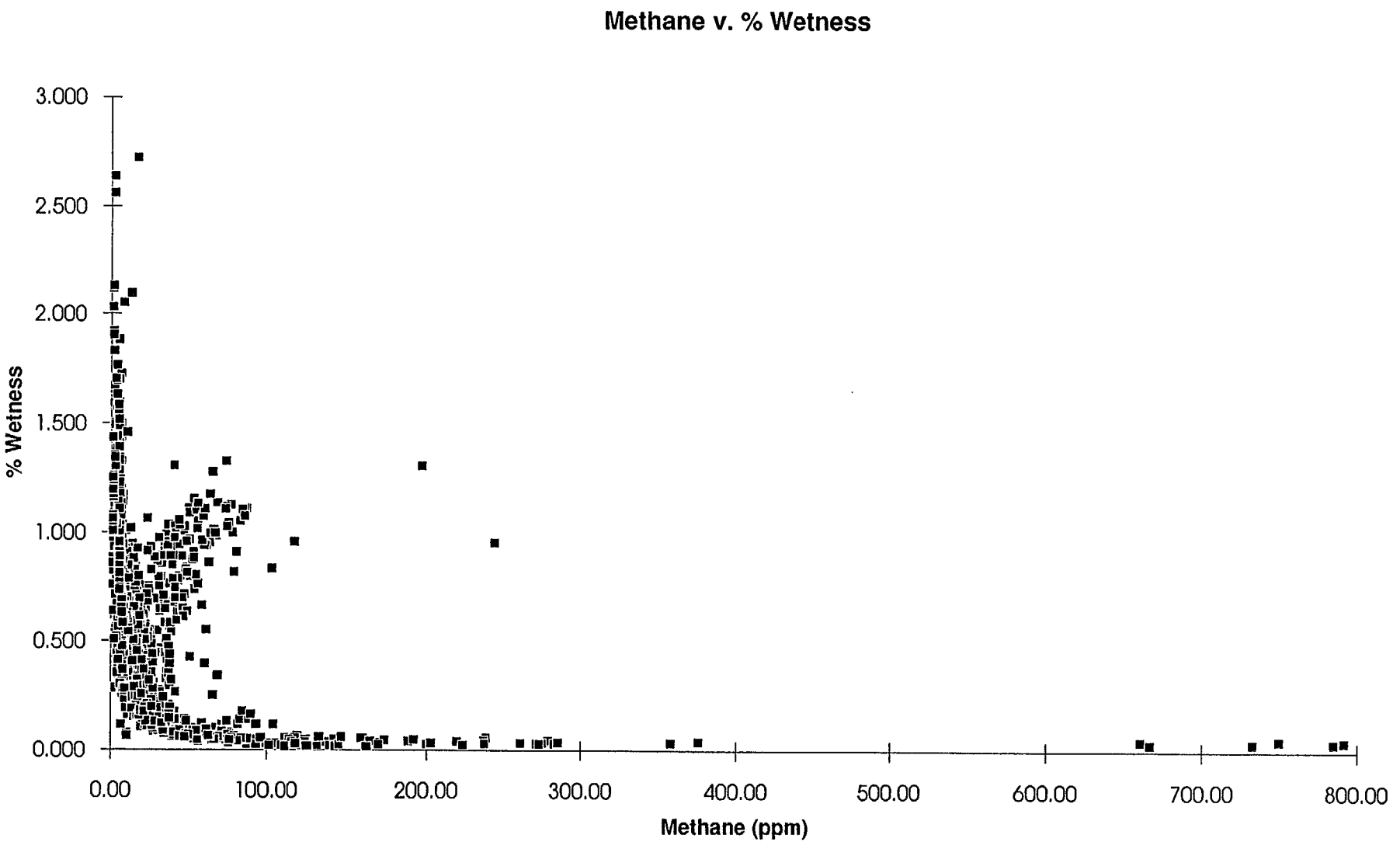


Figure 10a Methane versus percent hydrocarbon wetness , Ragay Gulf 'group 3' lines.

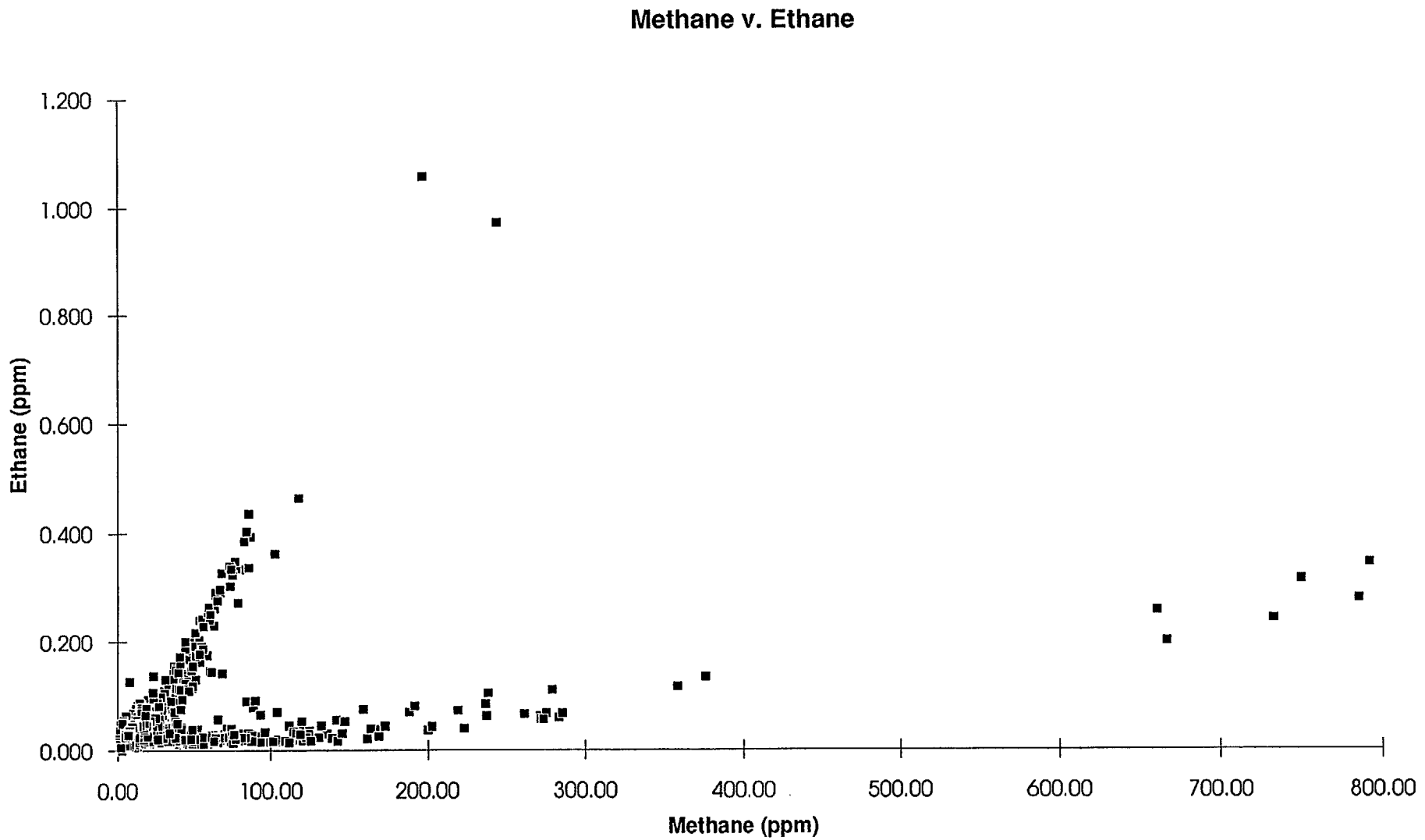


Figure 10b Methane versus ethane, Ragay Gulf 'group 3' lines.

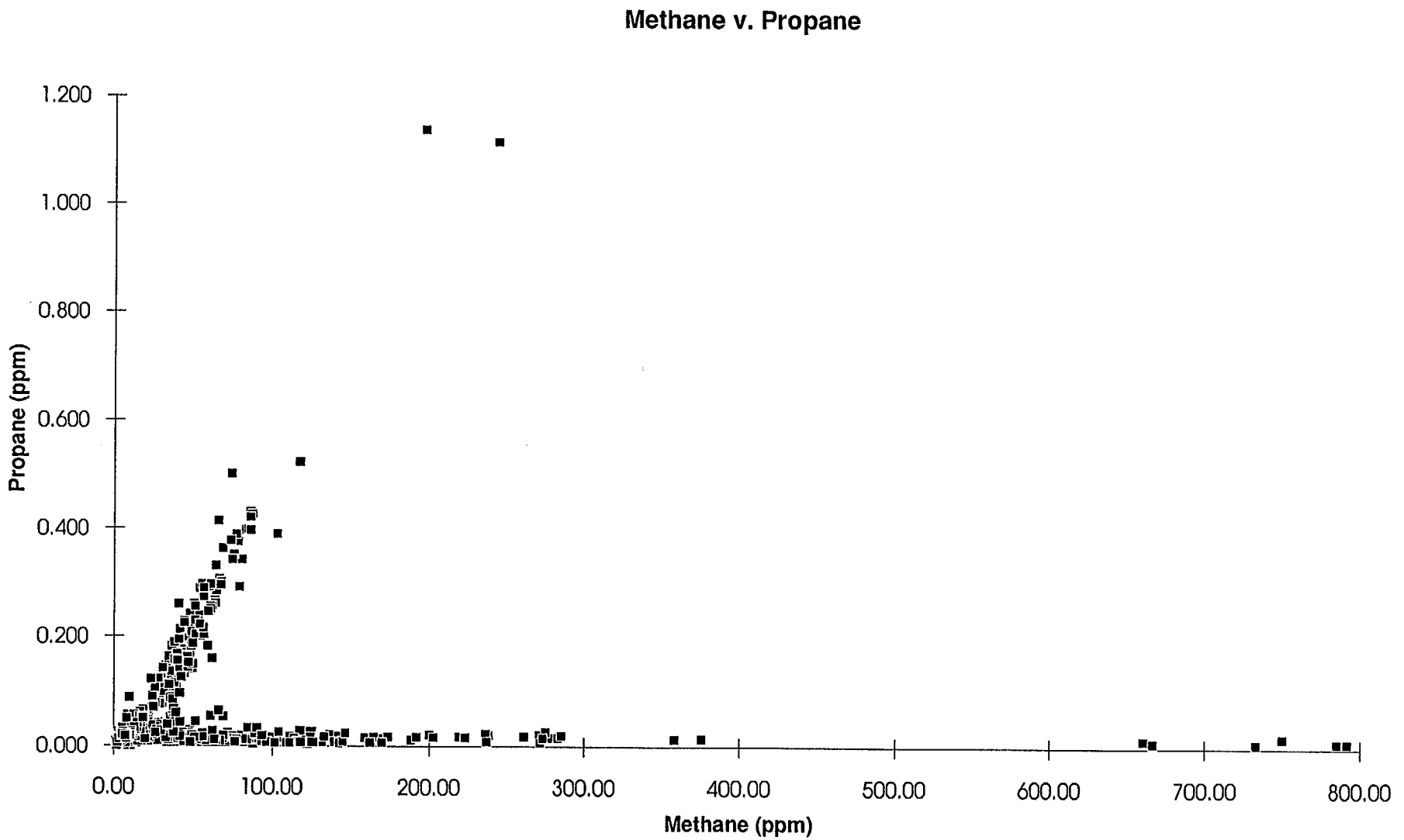


Figure 10c Methane versus propane, Ragay Gulf 'group 3' lines.

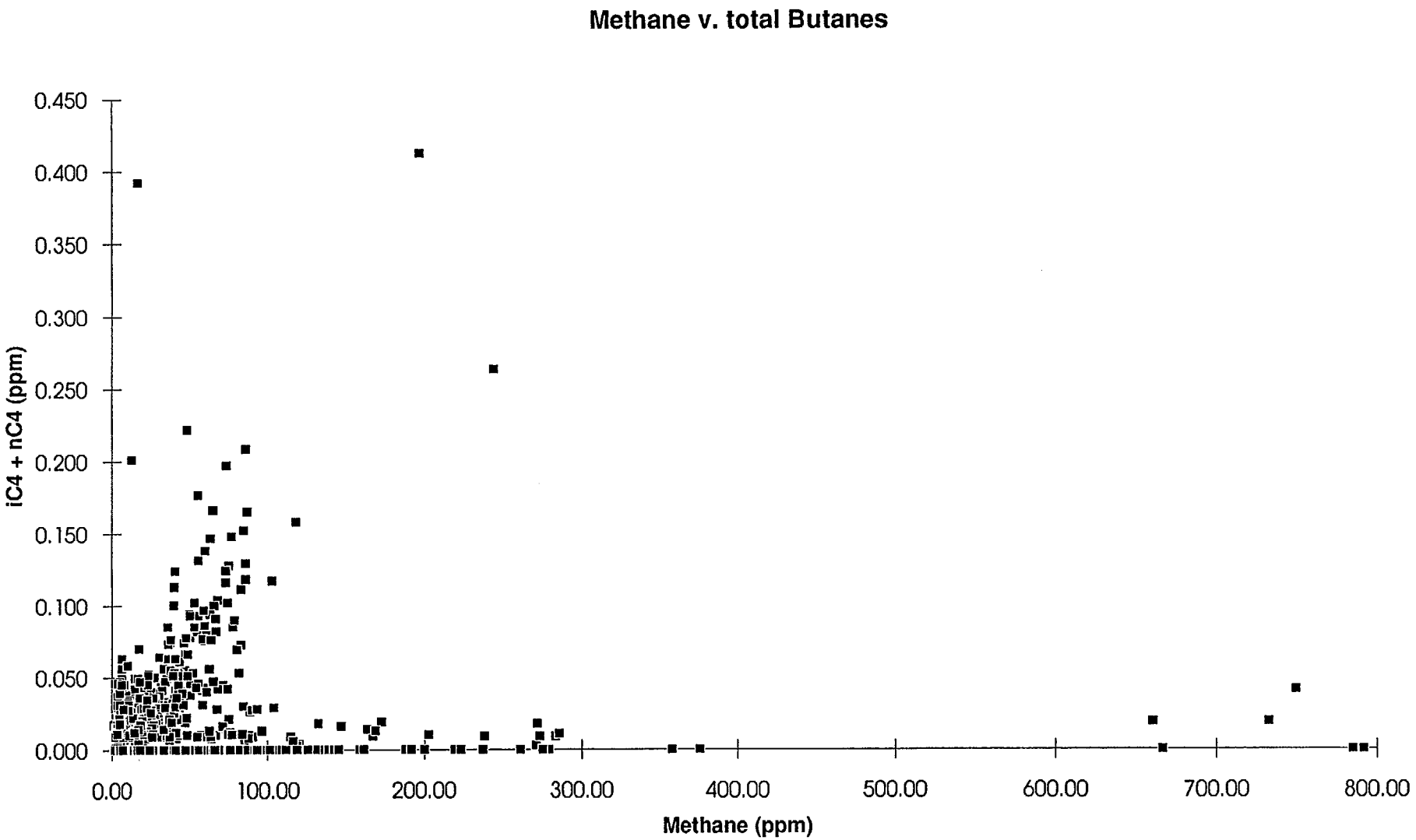


Figure 10d Methane versus butanes, Ragay Gulf 'group 3' lines.

CARBON ISOTOPE GEOCHEMISTRY OF RAGAY GULF GAS SAMPLES

Twenty-five gas samples of anomalous concentrations of light hydrocarbons were sent to the New Zealand National Institute of Water and Atmospheric Research Limited (NIWAR) for concentration, and carbon isotope analysis of the methane gas component.

The objectives of this work were:
1) To ascertain the origin of the bottom-water methane anomalies detected in the Ragay Gulf, i.e. whether they are biogenic (produced from microbial degradation of recent organic matter) or thermogenic (derived from catagenesis or metagenesis of deeply buried organic matter).

2) To determine if the methane in these samples are 'sourced' from 'dry' gas or 'oil-associated' source rocks.

The exact proportion and isotopic composition of the various hydrocarbon gas components produced depend to some extent on the chemical composition as well as on the burial and temperature history of the organic matter source. In general, biogenic gases generate at shallow depth (less than 1,000 m) and low temperature (less than 50°C) conditions. Compositionally, biogenic gases are 'dry' (methane content as high as 99 per cent) with extremely low proportions of higher hydrocarbons (Claypool and Kvenvolden, 1983; Tissot and Welte, 1984). Biogenic gases are characterised by Bernard Parameter ratios greater than 1000 (Bernard, et al. 1977) and $\delta^{13}C_1$ values more negative than -50 °/oo (Bernard, et al., 1977; Claypool and Kvenvolden, 1983).

Thermogenic gases, on the other hand, arise from high-temperature (greater than 80°C) breakdown of organic matter, usually at depth (Claypool and Kvenvolden, 1983; Tissot and Welte, 1984). They are characterised by stable carbon isotope ratios greater than -50 °/oo (Bernard, et al., 1977; Rice and Claypool, 1981; Claypool and Kvenvolden, 1983) and Bernard Parameter less than 50, although values less than 500 indicate mixtures of biogenic and thermogenic hydrocarbons in which the proportion of thermogenic components is large (Bernard et al., 1977).

C_{13} Isotopic data

Table 3 lists the shotpoint coverage over which the gas samples were collected in the Ragay Gulf, the respective 'tow-fish' depths during each sample collection, the approximate hydrocarbon component concentrations, and the corresponding carbon isotopic values including the carbon-14 values.

Table 4 tabulates results of the median methane concentrations calculated from the ship-board data and the methane concentration measured in the collected sample by the NZ laboratory, the Bernard Parameter values, the percent hydrocarbon wetness, and the preliminary classification into either Type B or Type A anomaly (see above).

When plotted, the methane gas content values calculated form the Australian Geological Survey Organisation (AGSO) are comparable with those measured in the samples sent to New Zealand (Figure. 11a). The NZ data report the total methane in the sample assuming a volume of one litre. The reason for comparing the NZ and AGSO data is to then be able to utilise and combine, with confidence, the higher hydrocarbon data (C_{2+}) measured by AGSO, with the NZ measured isotopic data.

The carbon-13 isotopic compositions of the methane gas component of the Ragay samples range from -57 to -38 °/oo (Fig. 11b). (Note that the carbon isotopic composition of methane is obtained using the formula: $\delta^{13}C_1$ sample(°/oo) = $[(R_{sample}/R_{standard}) - 1] \times 100$, where $R = {}^{13}C/{}^{12}C$ and the standard refers to Pee Dee Belemnite, PDB.) The frequency plot of $\delta^{13}C_1$ values shows two dominant data populations, X and Y, with maxima between -42.5 to -41.5 °/oo and, -48.5 to -47.5 °/oo respectively. The discrete value ($\delta^{13}C > -57$) at the very light end of the profile represents still another data population (Z).

To assist in the determination of the 'origin' of hydrocarbons in these samples, the calculated Bernard Parameter ($BP = C_1/[C_2+C_3]$) ratios are plotted against the $\delta^{13}C_1$ values (Fig. 11c). The cross-plot shows three different groups of gases in the Ragay Gulf with the following characteristics:

Thermogenic
[Samples 1, 2, 3, 4, 5, 7, 8, 9, 10, 11, 12, 17, 19, 20, 25]

Fifteen samples with $BP < 1000$ and $\delta^{13}C_1$ between -49 to -39 °/oo all lie within the zone of thermogenic origin in the Bernard model. The proportion of higher

hydrocarbons in these samples is quite variable and is reflected in the significant scatter of the BP values. Eight samples (i.e. 2, 4, 7, 9, 10,12, 19, 20) correspond to the Type B anomalies defined earlier. The other samples (i.e. 1, 3, 5, 8, 11, 17, 25) correspond to Type A anomalies.

Mixed thermogenic and 'dry' (biogenic?) gas
[Samples 6, 13, 14, 15, 16, 18, 21, 22, 24]

Nine samples (all Type A anomalies) with BP > 1000 and $\delta^{13}C_1$ between -52 to -38 °/oo are classified under this group. Isotopically, these data appear to be thermogenic. However, methane (C_1) is the predominant hydrocarbon and the BP range of values is greater than 1000. As such, these gases may have a biogenic component according to the Bernard model.

Biogenic? gas
[Sample 23]

Only one sample (Type A), with BP > 1000 and $\delta^{13}C_1$ of -57.3 °/oo, falls in the biogenic field according to this model.

^{14}C data

The ^{14}C data for methane are summarised in Table 4. All samples showed pMC values less than 17. These results indicate 'fossil' carbon in the methane - a result that suggests most of these samples are probably of a thermogenic origin. One sample (23) which plots in the biogenic field according to the Bernard model, is isotopically light, but its origin is not clearly defined.

In the absence of any other applicable geochemical data, other than reports of occurrences of oil and/or gas seeps in several onshore wells drilled on the Bondoc and Bicol Peninsulas located west and east of the survey area, the range of relative abundances and isotopic compositions of Ragay bottom-water samples has been compared with that of other known gas fields in W. Europe, North America and Siberia (Figure 11d). The cross-plot reveals that the Ragay thermogenic samples plot toward the 'dry' (methane abundant) end of the molecular compositional axis, compared to the shaded area defined for oil-associated gases (Tissot and Welte, 1984). This suggests a more gas prone kerogen 'source' for methane collected in Ragay.

SAMPLE No	SAMPLE SHOTPOINT COVERAGE OVER WHICH SAMPLES WERE COLLECTED	FISH DEPTH ms	MEDIAN VALUE METHANE PPM	MEDIAN VALUE ETHANE PPM	MEDIAN VALUE PROPANE PPM	C 13 o/oo PDB	C 14 pMC
109/01	34 (SP 65 - 85)	185	60	0.053		-41.70	
109/02	SN 1 (SP 98 - 104, 109 - 113)	100	40	0.200	0.150	-40.70	
109/03	SN 1 (SP 201 - 212)	160	38	0.047	0.055	-40.60	1.8 +/- 1.8
109/04	SN 1 (SP 224 - 229, 236 - 239)	115	30	0.150	0.100	-42.80	
109/05	39 (SP 74 - 82)	170	45	0.031	0.015	-41.80	
109/06	40 (SP 50 - 58)	200	50	0.015	0.014	-50.20	1.2 +/- 1.2
109/07	SN 3 (SP 174 - 176), 41 (SP 86-90), 42 (SP 30-35), SN4 (SP 56-54)	178	40	0.080	0.080	-46.50	
109/08	42 (SP 38 - 44), SN4 (SP 136-144)	175	45	0.025	0.019	-48.80	
109/09	SN 4 (SP 243 - 257, 261 - 263)	136	75	0.275	0.290	-46.70	1.1 +/- 1.1
109/10	SN 5 (SP 36 - 46), 53 (SP 62-71), SN6 (SP 116-172)	155	47	0.800	0.850	-38.80	
109/11	53 (SP 71 - 76), SN 7 (SP 1-3), SN8 (SP 6-15), 59 (SP 35-42)	164	40	0.043	0.042	-48.50	
109/12	SN 8 (SP 333 - 340), 58 (SP 66-73), 59 (SP 48-52), SN9 (SP 342-346)	190	45	0.150	0.160	-43.40	
109/13	SN 9A (SP 13 - 28)	159	72	0.019	0.011	-47.80	
109/14	SN 9A (SP 69 - 81)	74	65	0.015	0.011	-46.70	7.0 +/- 1.5
109/15	SN 9A (SP 81 - 86, 88 - 91)	140	55	0.015	0.010	-40.60	
109/16	SN 9A (SP 111 - 128)	149	70	0.011	0.009	-47.00	
109/17	69 (SP 52 - 58), VP71 (SP 7-21), VP72 (SP 9-25)	155	60	0.230	0.240	-43.00	5.6 +/- 1.6
109/18	69 (SP 64 - 67), VP69 (SP 1-20)	167	390	0.100	0.020	-37.80	0.6 +/- 0.2
109/19	70 (SP 35 - 55), 73 (SP 30-57)	167	70	0.100	0.110	-44.80	
109/20	VP 72 (SP 25 - 33), 79 (SP 16-22)	153	57	0.200	0.210	-46.10	
109/21	73 (SP 63 - 78), 74 (SP 7-11)	210	61	0.024	0.013	-51.30	
109/22	74 (SP 28 - 48), 75 (SP 58-60)	185	59	0.020	0.019	-49.10	
109/23	VP 75 (SP 3 - 26)	182	190	0.037	0.021	-57.30	2.0 +/- 05
109/24	VP 76 (SP 33 - 43, 59 - 75)	192	120	0.035	0.021	-48.30	16.2 +/- 1.1
109/25	79 (SP 22-28)	140	38	0.041	0.044	-49.10	

Table 3. Hydrocarbon composition and Carbon Isotopic values of methane in the Ragay Gulf Anomalies.

SAMPLE No.	SAMPLE SHOTPOINT COVERAGE OVER WHICH SAMPLES WERE COLLECTED	FISH DEPTH (ft)	MEDIAN VALUE METHANE PPM	NZ VALUE METHANE PPM	BERNARD PARAMETER	WETNESS VALUE (AVE)	GAS ANOMALY TYPE
109/01	34 (SP 65 - 85)	185	60	62	923.07	0.15	A
109/02	SN 1 (SP 98 - 104, 109 - 113)	100	40	21	114.28	0.86	B
109/03	SN 1 (SP 201 - 212)	160	38	39	372.55	0.38	A
109/04	SN 1 (SP 224 - 229, 236 - 239)	115	30	16	120.00	0.91	B
109/05	39 (SP 74 - 82)	170	45	20	978.26	0.16	A
109/06	40 (SP 50 - 58)	200	50	51	1724.14	0.29	A
109/07	SN 3 (SP 174 - 176), 41 (SP 86-90), 42 (SP 30-35), SN4 (SP 56-54)	178	40	29	250.00	0.53	B
109/08	42 (SP 38 - 44), SN4 (SP 136-144)	175	45	36	1022.73	0.09	A
109/09	SN 4 (SP 243 - 257, 261 - 263)	136	75	63	132.00	0.95	B
109/10	SN 5 (SP 36 - 46), 53 (SP 62-71), SN6 (SP 116-172)	155	47	34	28.48	0.97	B
109/11	53 (SP 71 - 76), SN 7 (SP 1-3), SN8 (SP 6-15), 59 (SP 35-42)	164	40	60	470.59	0.21	A
109/12	SN 8 (SP 333 - 340), 58 (SP 66-73), 59 (SP 48-52), SN9 (SP 342-346)	190	45	44	145.16	0.49	B
109/13	SN 9A (SP 13 - 28)	159	72	55	2400.00	0.10	A
109/14	SN 9A (SP 69 - 81)	74	65	63	2500.00	0.08	A
109/15	SN 9A (SP 81 - 86, 88 - 91)	140	55	9	2200.00	0.10	A
109/16	SN 9A (SP 111 - 128)	149	70	3	3500.00	0.08	A
109/17	69 (SP 52 - 58), VP71 (SP 7-21), VP72 (SP 9-25)	155	60	55	127.66	0.10	A
109/18	69 (SP 64 - 67), VP69 (SP 1-20)	167	390	280	3250.00	0.06	A
109/19	70 (SP 35 - 55), 73 (SP 30-57)	167	70	116	333.34	0.48	B
109/20	VP 72 (SP 25 - 33), 79 (SP 16-22)	153	57	57	139.02	0.83	B
109/21	73 (SP 63 - 78), 74 (SP 7-11)	210	61	56	1648.64	0.07	A
109/22	74 (SP 28 - 48), 75 (SP 58-60)	185	59	57	1512.82	0.08	A
109/23	VP 75 (SP 3 - 26)	182	190	178	3275.86	0.05	A
109/24	VP 76 (SP 33 - 43, 59 - 75)	192	120	111	2142.86	0.13	A
109/25	79 (SP 22-28)	140	38	28	447.05	0.39	A

Table 4. Methane gas concentrations, Bernard parameter, percent hydrocarbon wetness values and the anomaly Type A or B for the Ragay Gulf gas samples.

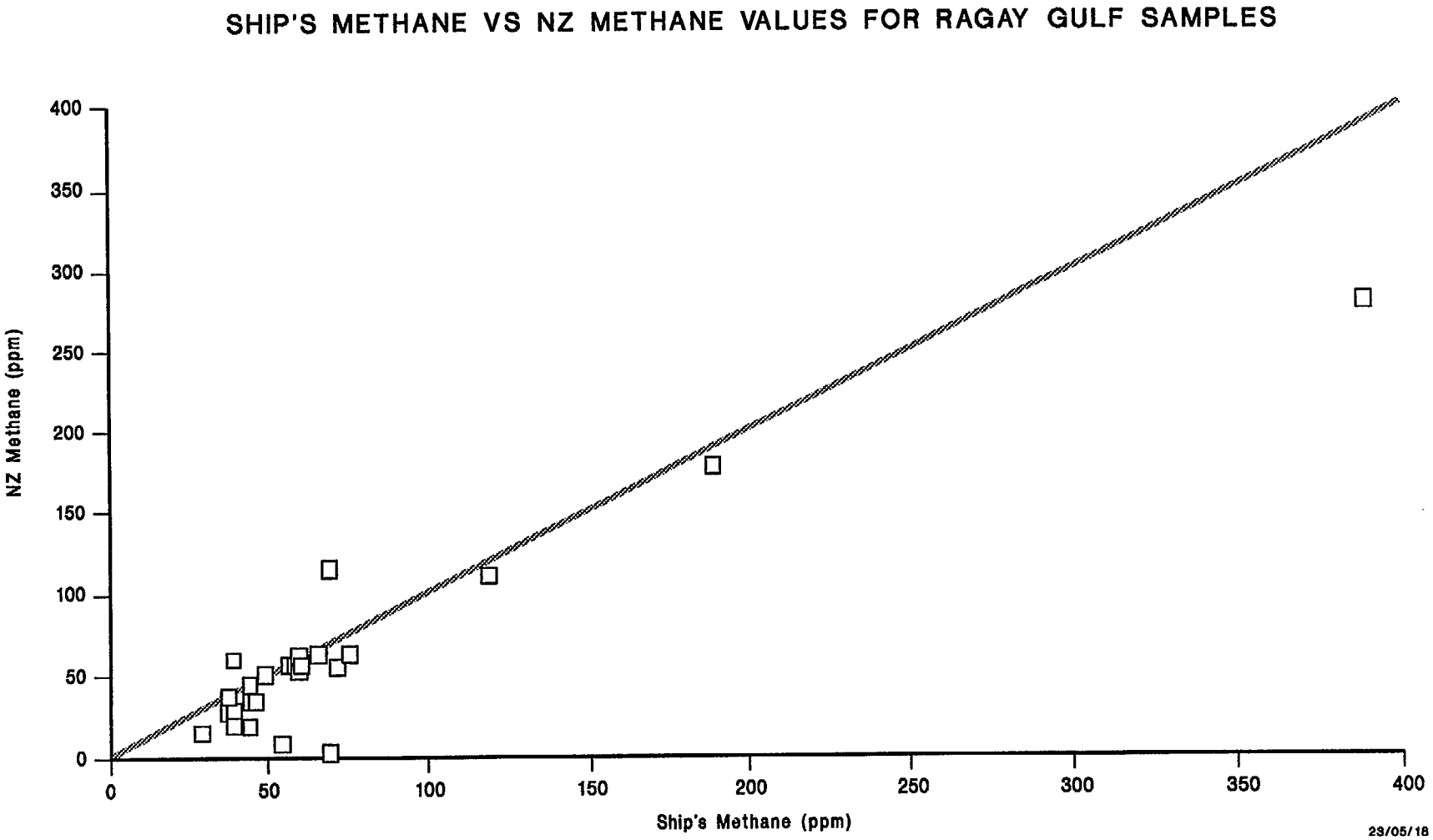


Figure 11a. Ship's methane values vs New Zealand methane values.

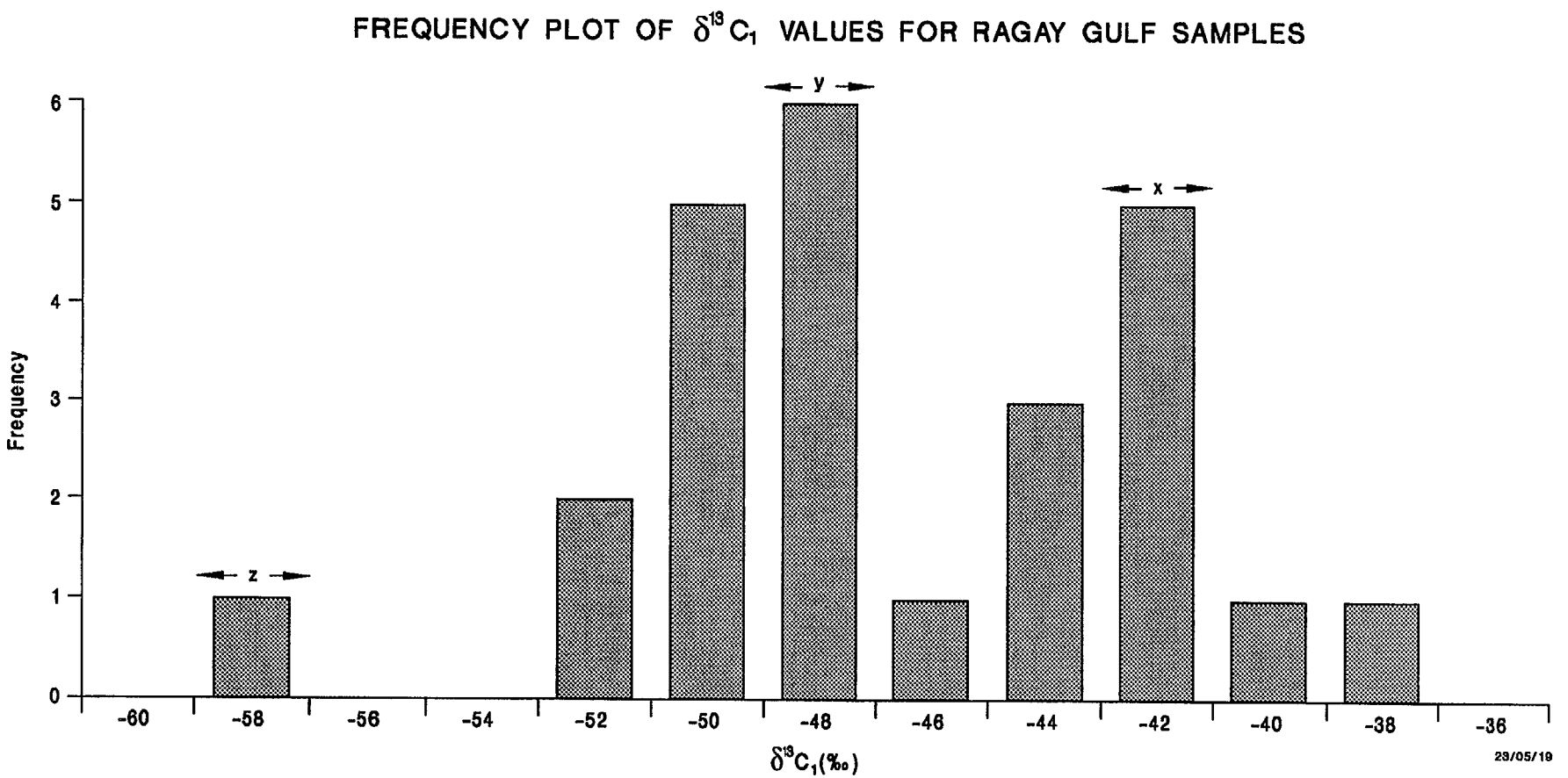


Figure 11b Frequency plot of $^{C}13$ values for Ragay Gulf samples.

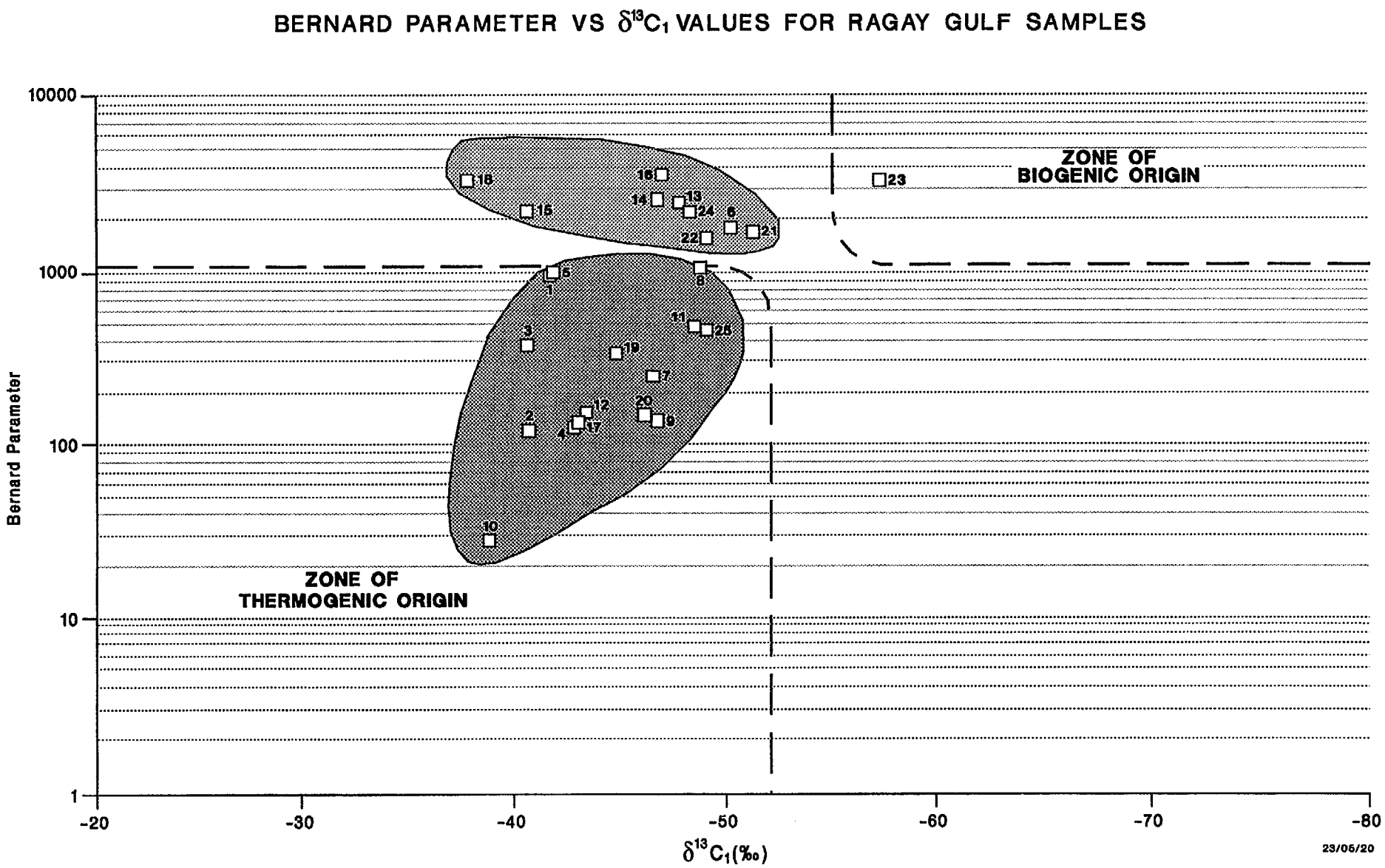


Figure 11c Bernard Parameter vs C_{13} values for Ragay Gulf samples

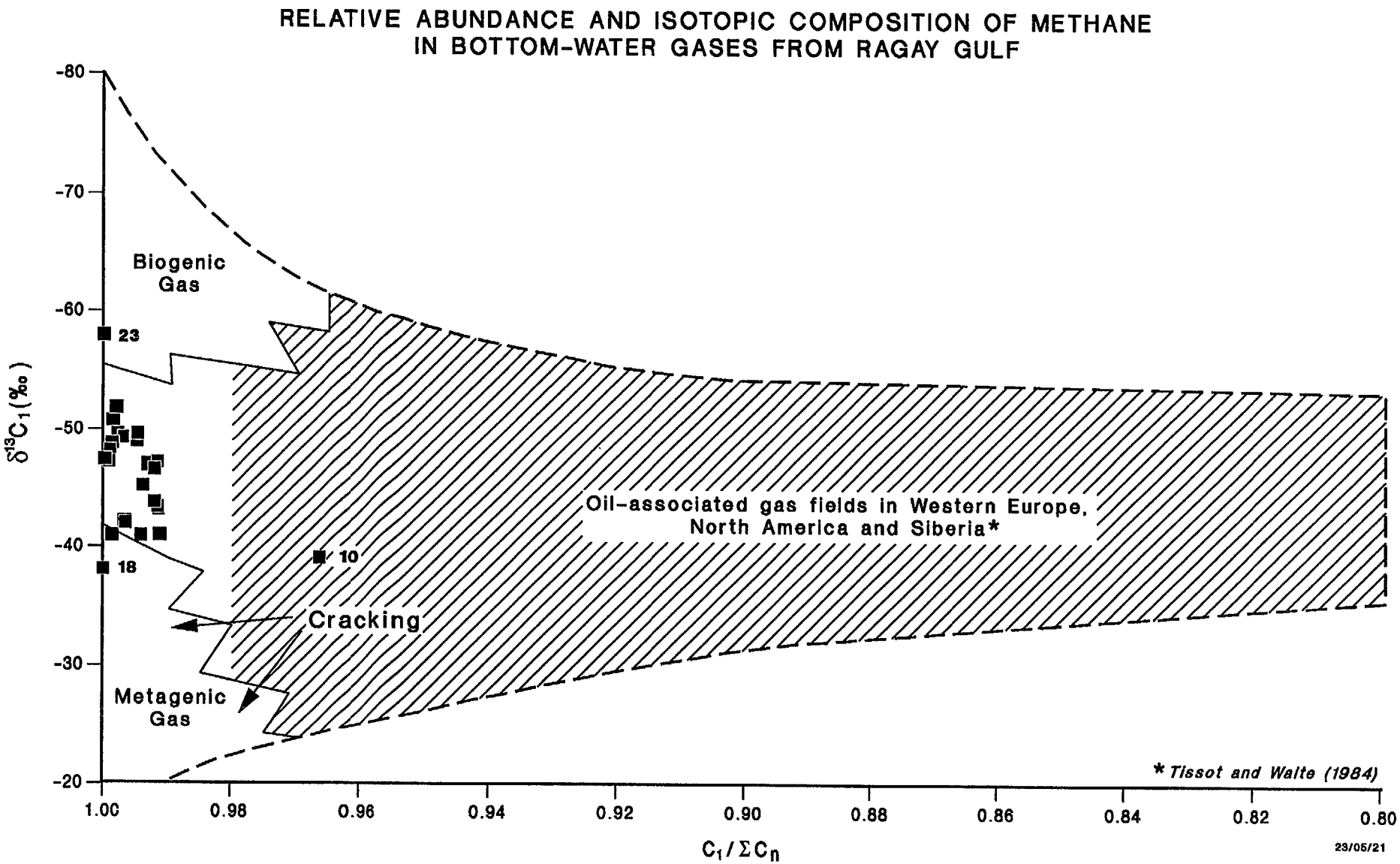


Figure 11d Relative abundance and isotopic composition of methane in bottom-water gases from Ragay Gulf.

TAYABAS BAY DHD RESULTS.

(Lines 109/021 through 109/030 and 109/063 through 109/068)

Overview

A total of 16 lines covering 490 line-km of seismic and DHD data were recorded in Tayabas Bay (Lines 109/021 through 109/030 and 109/063 through 109/068; Figures 1a and 1c).

Several weak to moderate anomalies in THC, sum C1-C4, methane, ethane and propane were detected in Tayabas Bay. Many of the anomalous concentrations of hydrocarbons appear to be related to variations in the bathymetry and tow-fish depth as evidenced by changes in the ethylene and propylene concentrations (the biogenic hydrocarbons). Most variations in the saturated hydrocarbons appear related to variations in tow-fish depth or bathymetry, and the generally low levels of saturated C2+ hydrocarbons may be co-produced with ethylene and propylene. However, bottom-water sources of hydrocarbons cannot be ruled out (Figures 12 a-g).

A brief description of individual survey lines is presented below. Refer to Figures 12 a-m and Appendix III for the individual line-plots and summary sheets.

Line 109/021:

Three very weak THC and methane anomalies were detected at the beginning of the line and are coincident with the tow-fish being lowered through surface waters.

Line 109/022:

A weak THC anomaly was detected towards the end of the line and coincides with the tow-fish being lowered through surface waters.

Line 109/023:

No anomalies were observed on this line.

Line 109/024:

A very weak THC and methane anomaly was detected half way along the line, and is coincident with the tow-fish being raised and then lowered through surface waters, as indicated by the varying levels of the biogenic hydrocarbons.

Line 109/025:

Two very weak THC anomalies were detected on this line, and coincide with the passage of the tow-fish through the water column.

Line 109/026:

Three weak THC anomalies were detected along this line, and coincide with the passage of the tow-fish through the water column.

Line 109/027:

A weak THC and methane anomaly was detected at the beginning of the line.

Line 109/028:

A weak, almost four-fold increase in THC above background values, along this line was associated with the tow-fish being raised through the water column.

Line 109/029:

Five weak THC and methane anomalies were detected along this line.

Line 109/030:

Three weak THC, methane, and ethane anomalies were detected on this line and probably result from a shallowing in water depth.

Line 109/063:

Several weak THC, methane and ethane anomalies were detected on this line and are associated with the passage of the tow-fish through the water column.

Line 109/064:

A weak THC, methane, ethane and propane anomaly was detected towards the end of the line.

Line 109/065:

A weak THC and methane anomaly was detected towards the middle of the line and coincides with the tow-fish being raised through the water column.

Line 109/066:

Two very weak THC and methane anomalies were detected, both at the beginning and end of the line.

Line 109/067:

No anomalies were found along this line.

Line 109/068:

A very weak THC and methane anomaly was detected in the first half of the line.

Tayabas Bay Hydrocarbon 'Source'

A crossplot of methane concentration verses percent wetness is shown in Figure 13a. A weak trend of near constant, background wetness values (less than 1%), are associated with about three-fold increase in methane, and suggest Type A (dry) hydrocarbon mixtures. A very weak trend of increasing wetness (up to about 2.5 % wetness) is associated with low background methane values. No one anomaly is associated with this trend.

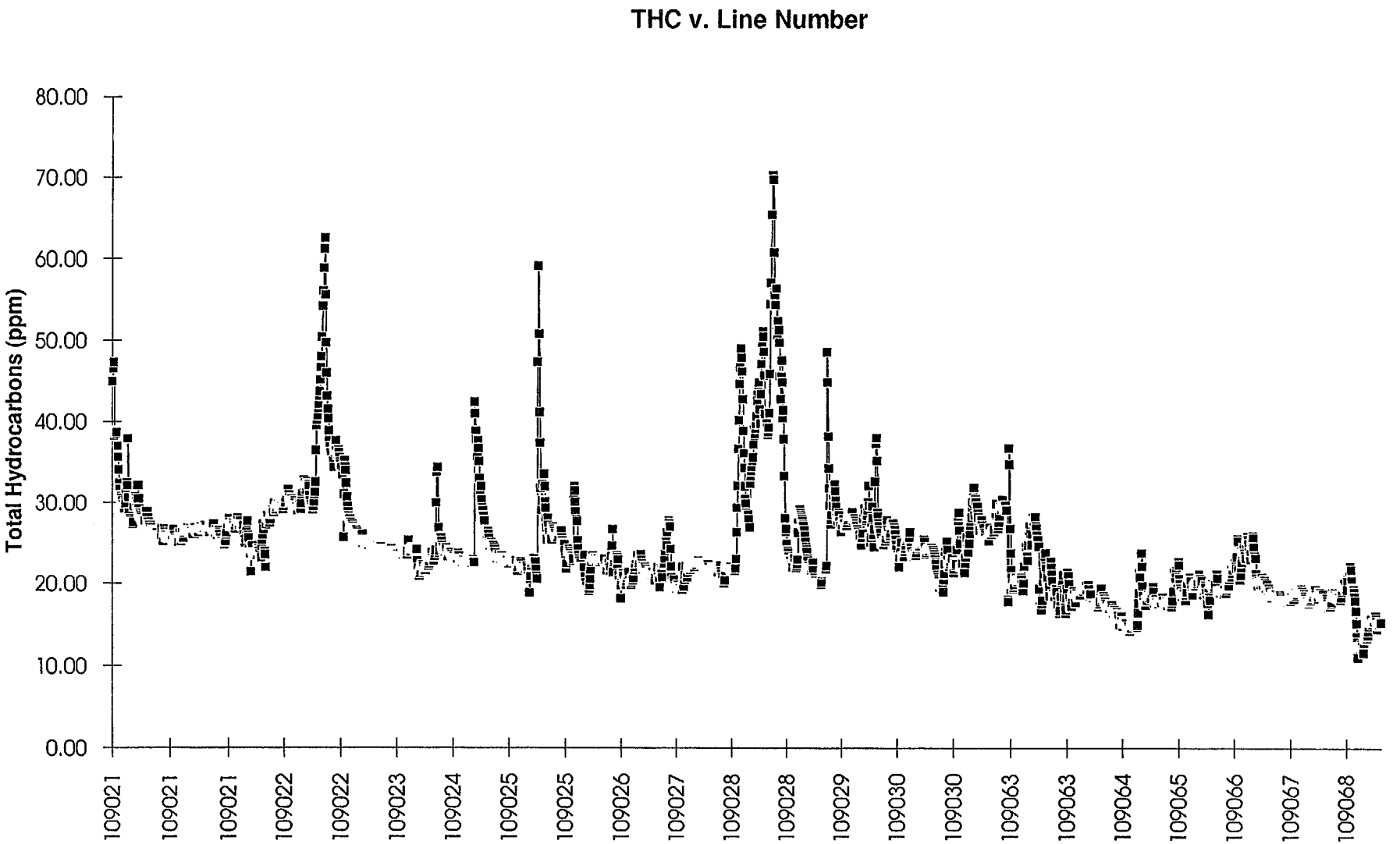


Figure 12a Total Hydrocarbons (THC) versus survey line number, Tayabas Bay (Lines 109/021 through 109/030 and 109/063 through 109/068).

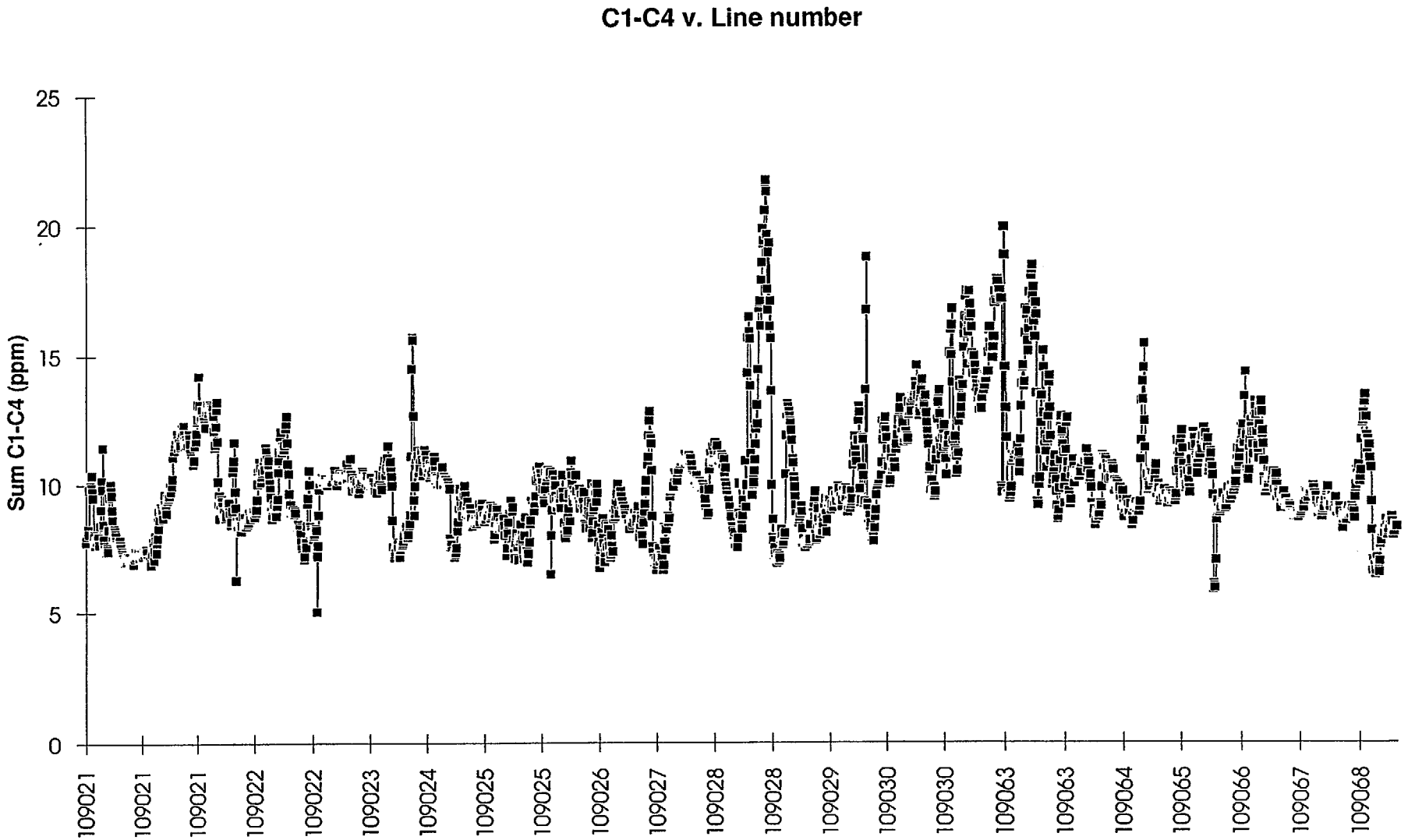


Figure 12b Sum C_1-C_4 versus survey line number, Tayabas Bay (Lines 109/021 through 109/030 and 109/063 through 109/068).

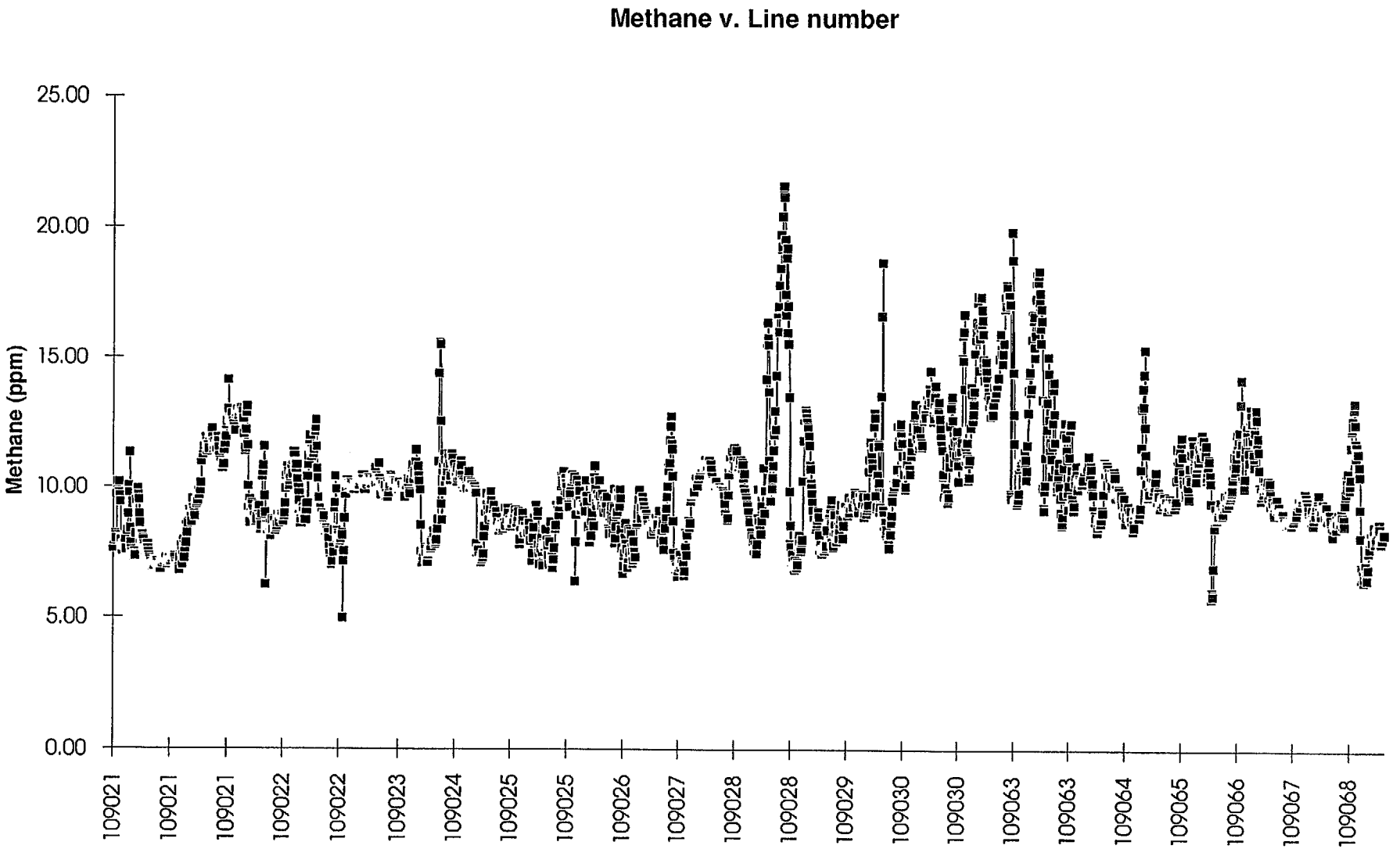


Figure 12c Methane versus survey line number, Tayabas Bay (Lines 109/021 through 109/030 and 109/063 through 109/068).

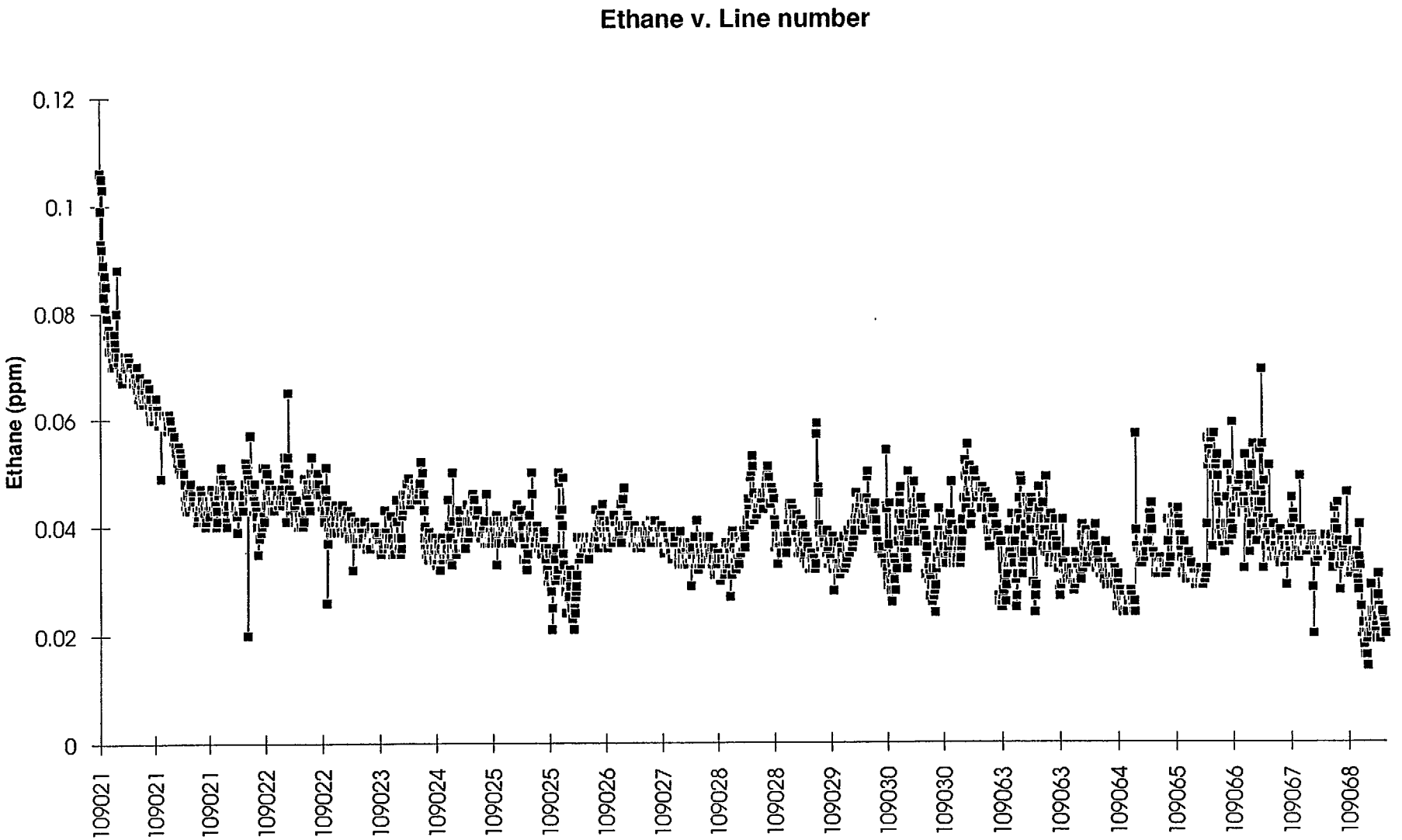


Figure 12d Ethane versus survey line number, Tayabas Bay (Lines 109/021 through 109/030 and 109/063 through 109/068).

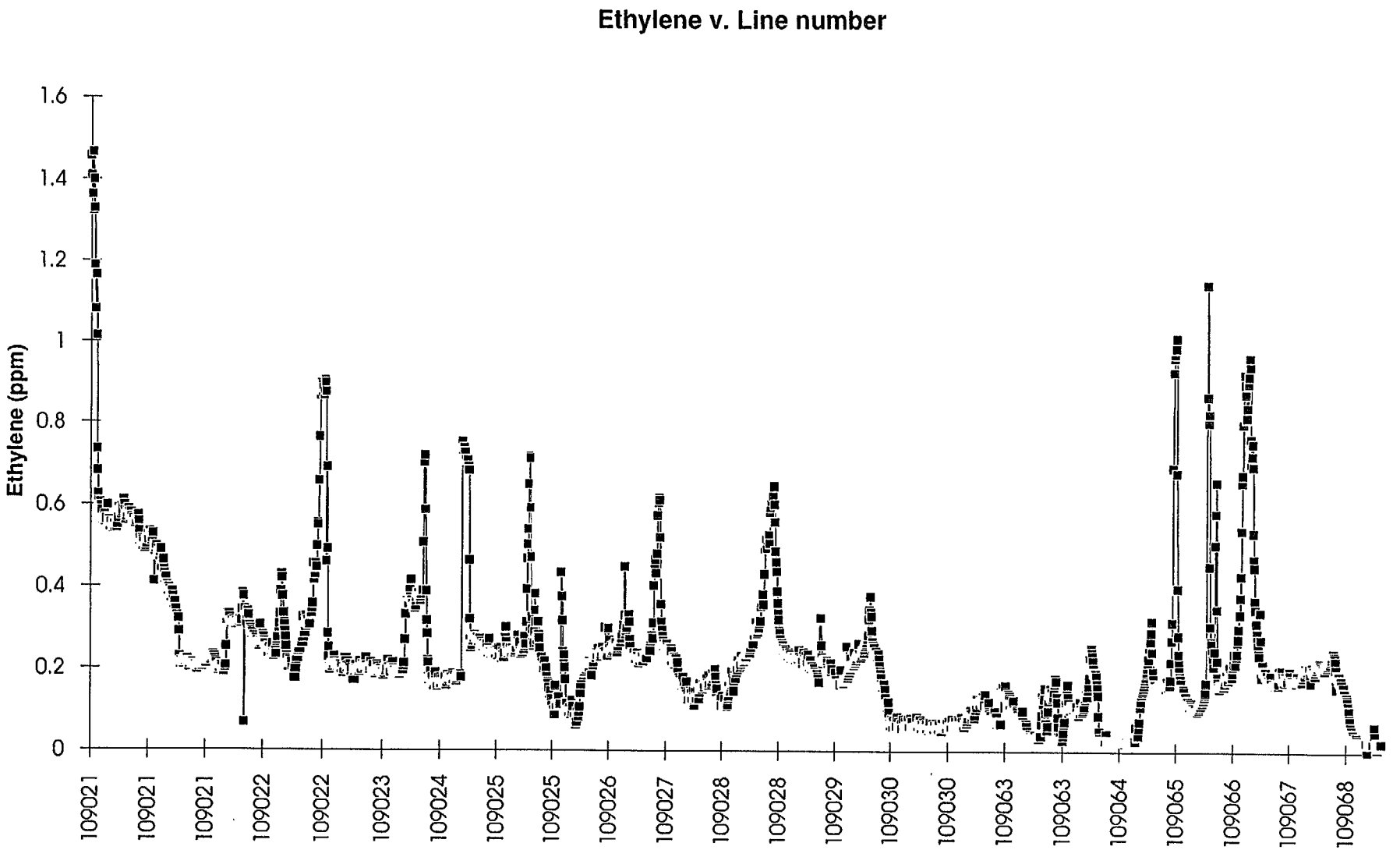


Figure 12e Ethylene versus survey line number, Tayabas Bay (Lines 109/021 through 109/030 and 109/063 through 109/068).

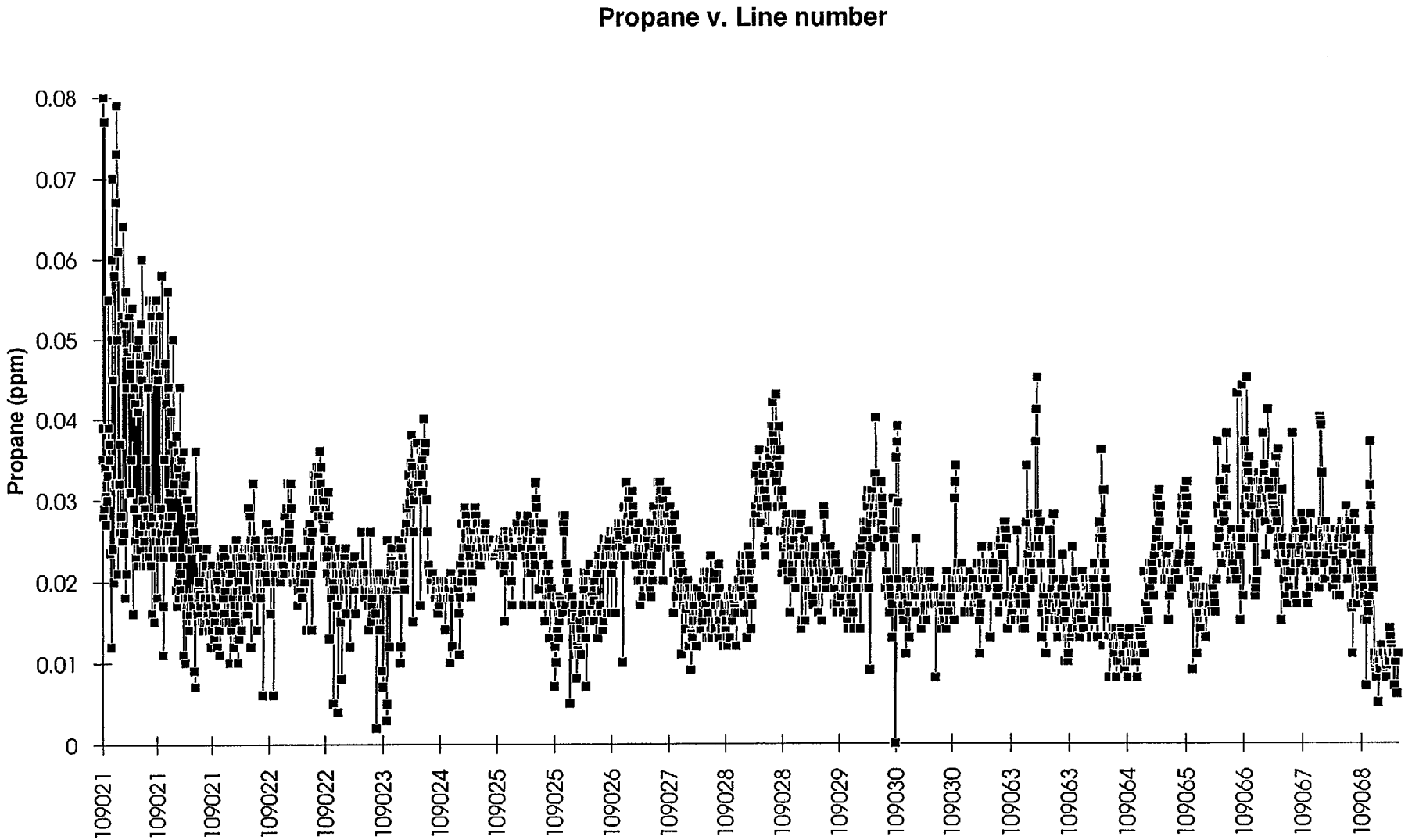


Figure 12f Propane versus survey line number, Tayabas Bay (Lines 109/021 through 109/030 and 109/063 through 109/068).

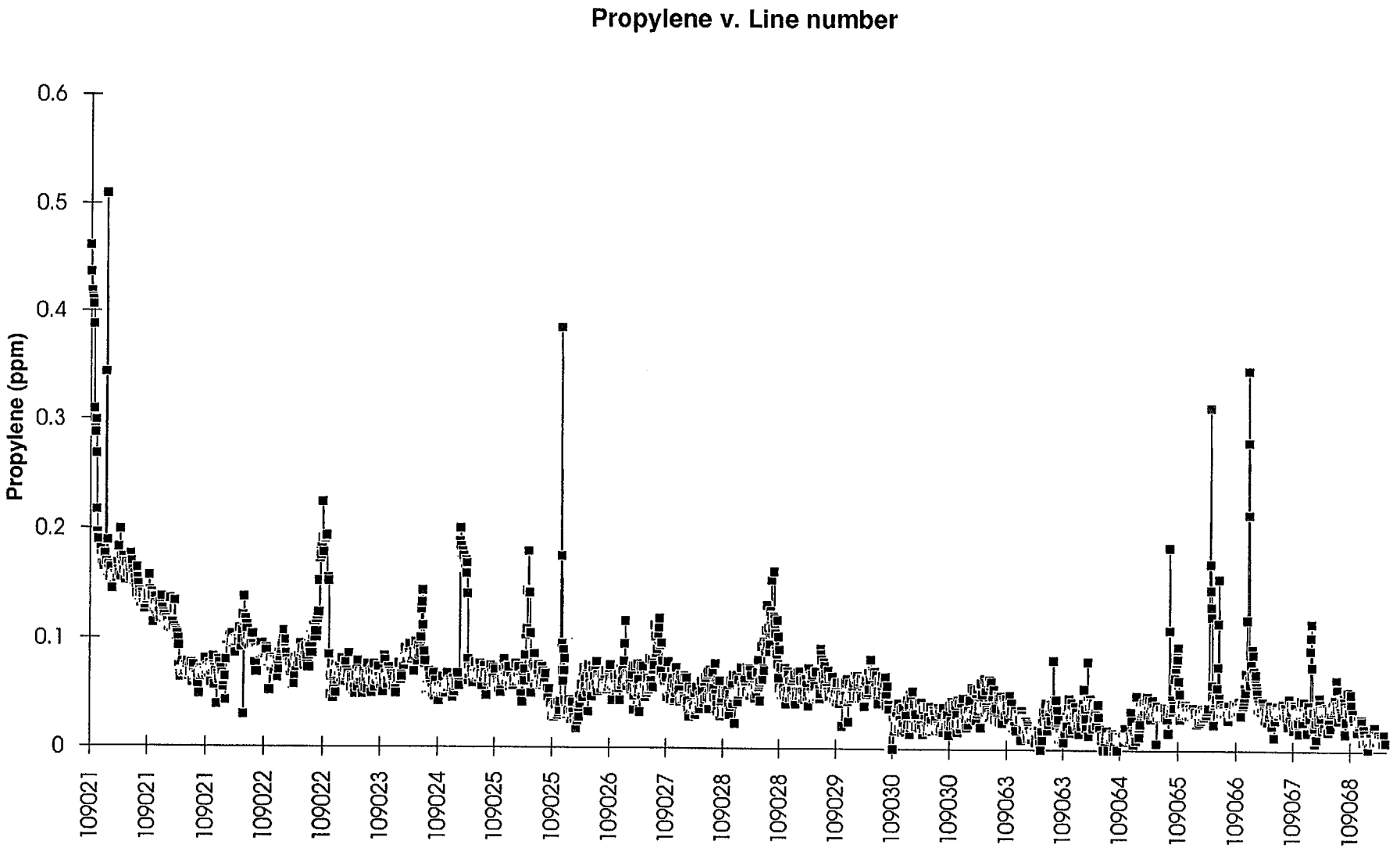


Figure 12g Propylene versus survey line number, Tayabas Bay (Lines 109/021 through 109/030 and 109/063 through 109/068).

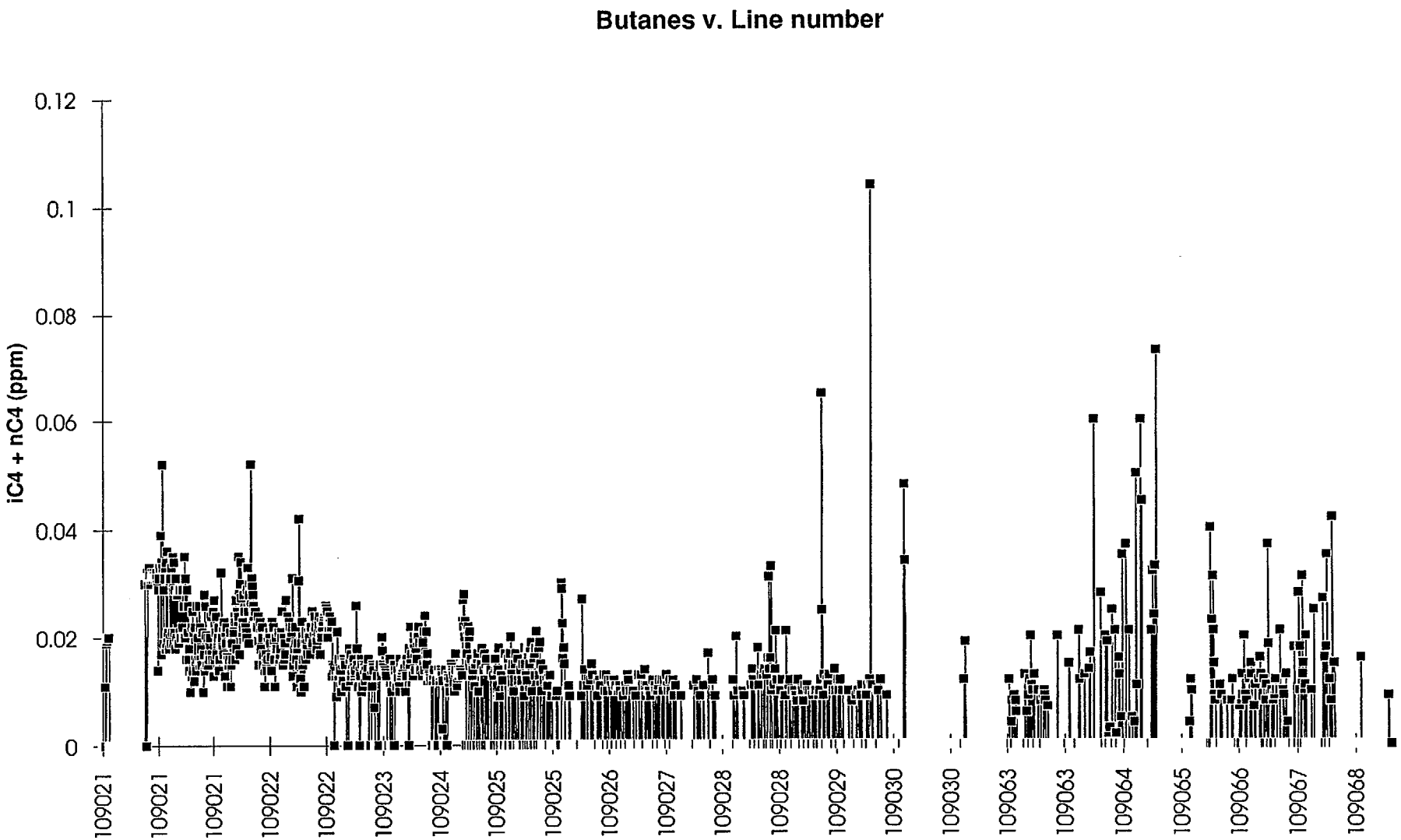


Figure 12h Total Butanes versus survey line number, Tayabas Bay (Lines 109/021 through 109/030 and 109/063 through 109/068).

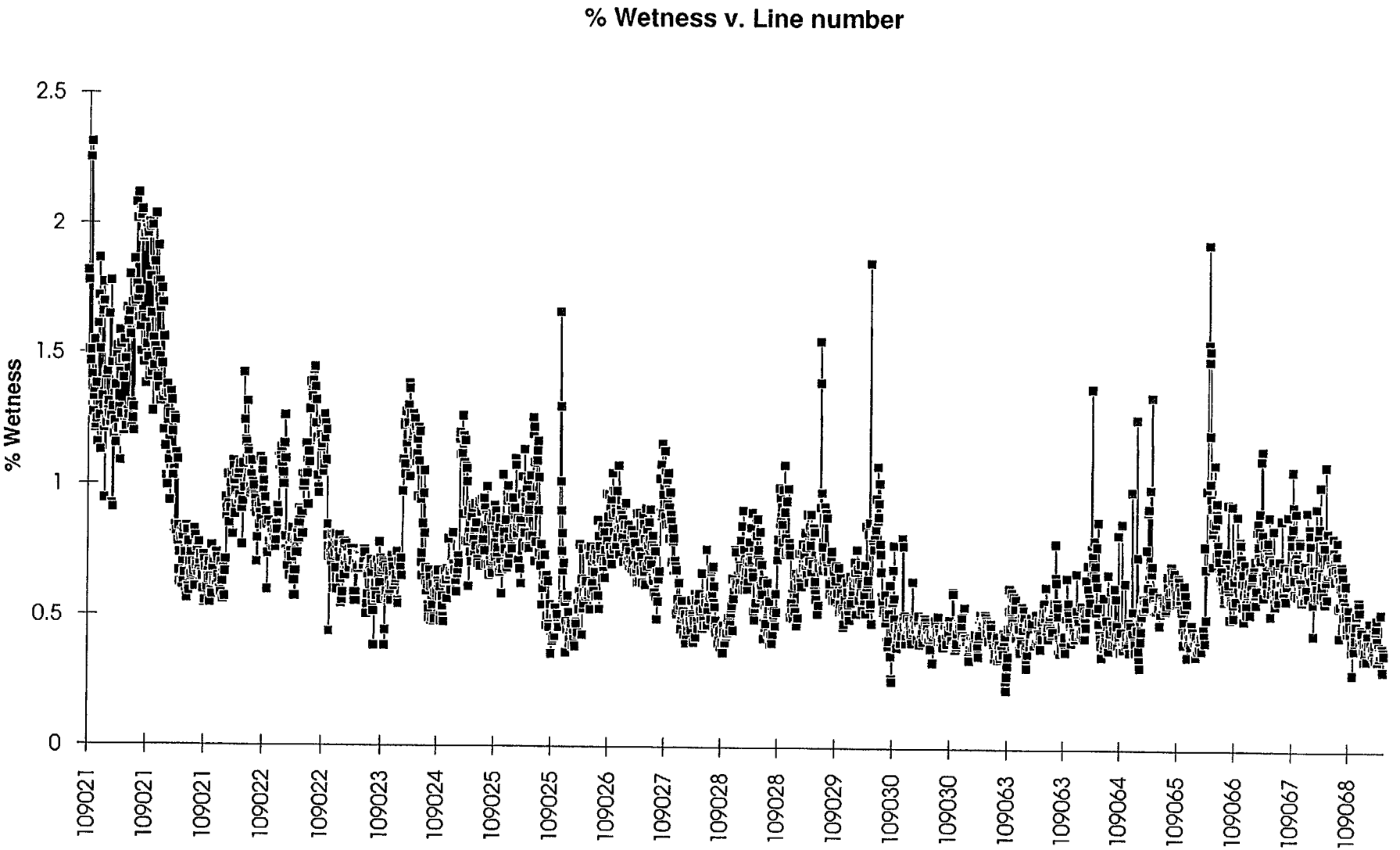


Figure 12j Percent hydrocarbon wetness versus survey line number, Tayabas Bay (Lines 109/021 through 109/030 and 109/063 through 109/068).

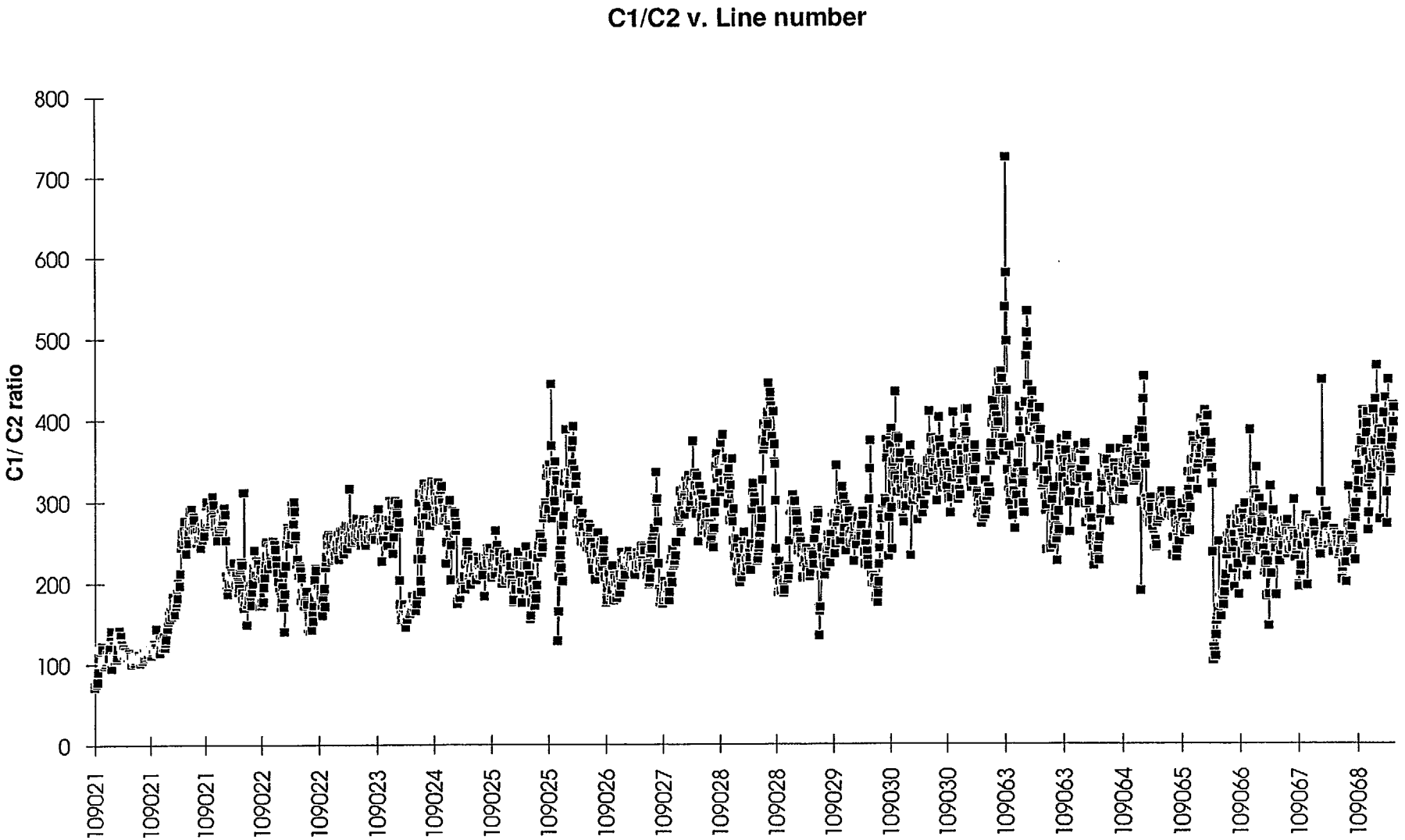


Figure 12k C_1/C_2 ratio versus survey line number, Tayabas Bay (Lines 109/021 through 109/030 and 109/063 through 109/068).

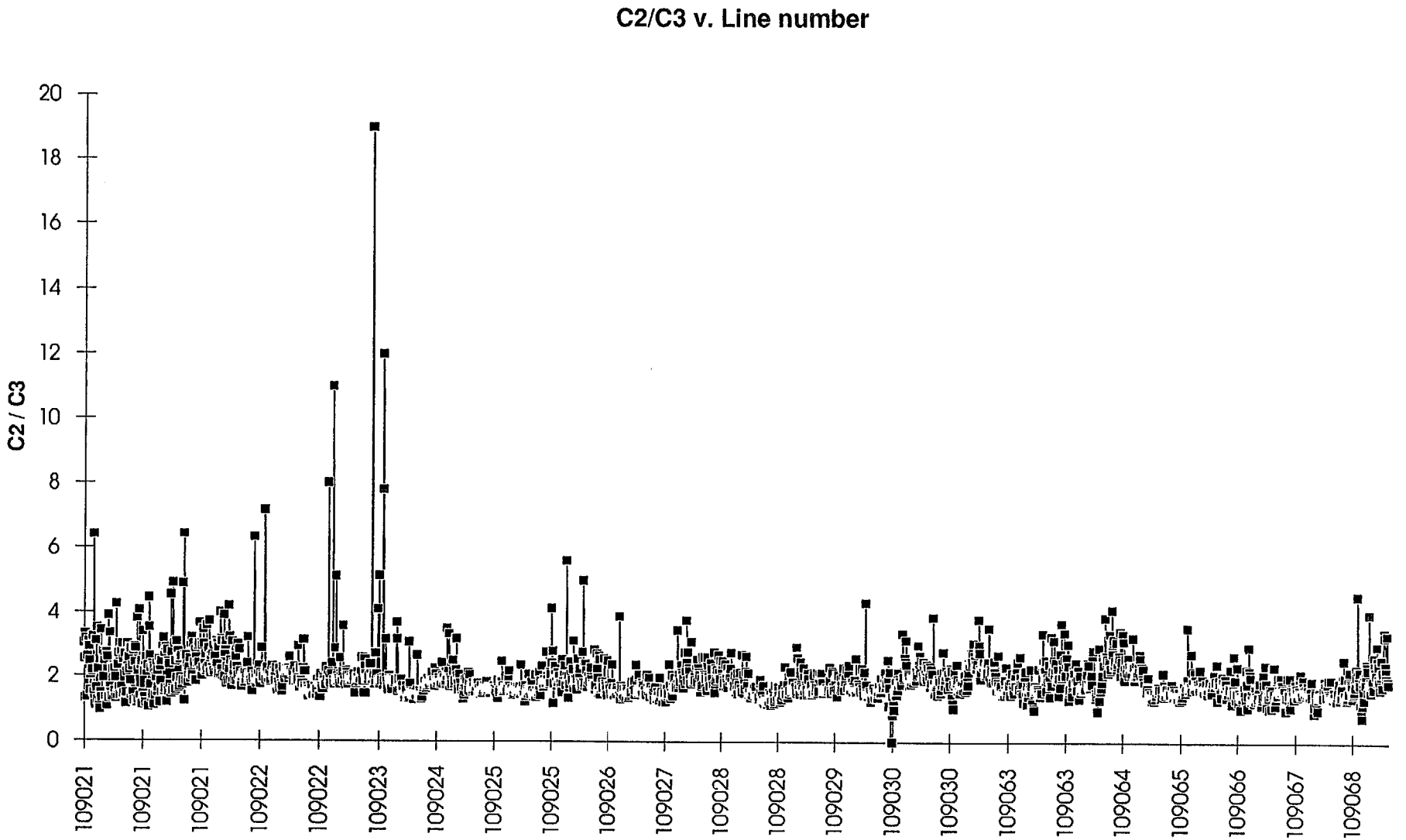


Figure 121 C_2/C_3 ratio versus survey line number, Tayabas Bay (Lines 109/021 through 109/030 and 109/063 through 109/068).

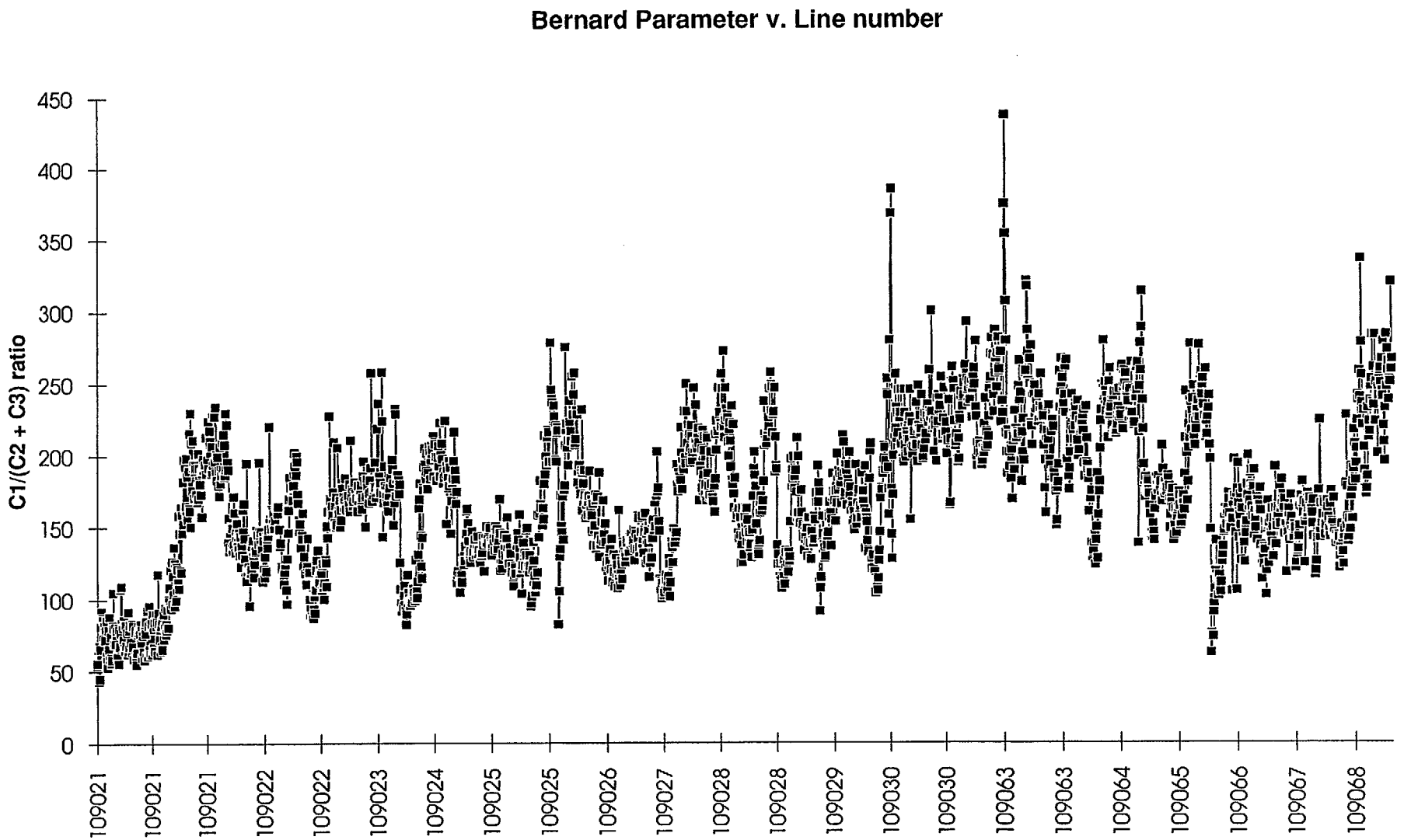


Figure 12m Bernard Parameter (C_1/C_2+C_3) versus survey line number, Tayabas Bay (Lines 109/021 through 109/030 and 109/063 through 109/068).

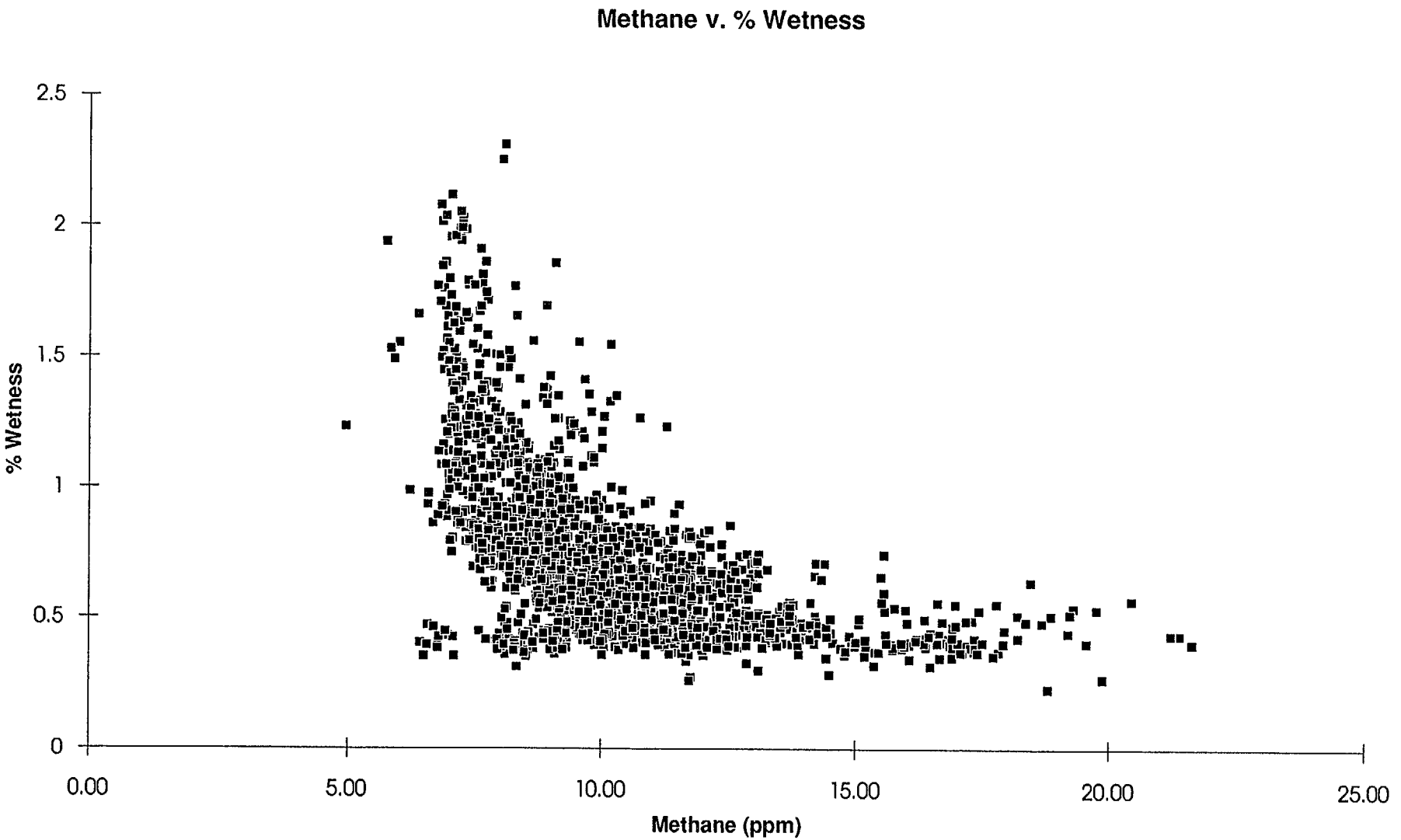


Figure 13a Methane versus percent hydrocarbon wetness , Tayabas Bay (Lines 109/021 through 109/030 and 109/063 through 109/068).

SUMMARY: RAGAY GULF AND TAYABAS BAY.

During Survey 109 numerous weak to strong (greater than ten-fold increases above background), hydrocarbon anomalies were detected using the DHD system in the Ragay Gulf. The strongest anomalies of the whole survey were found throughout the Ragay Gulf, particularly around prospects R-1 and R-2 (OEA-World Bank Report-1986, Figures 1b and d). Several other anomalies were associated with either faults or diapir structures, visible on the ship-board seismic monitors.

Cross-plots of percent hydrocarbon wetness versus methane concentrations in anomalies show at least two (perhaps three) trends.
(i) One trend shows decreasing hydrocarbon wetness with increasing methane concentrations, which we have referred to as Type A anomalies. This trend predicts a 'dry' hydrocarbon 'source' for these anomalies.
(ii) A second trend shows increasing percent hydrocarbon wetness (albeit weak - with wetness values increasing from background values of about 0.5 % up to about 2% only) with increasing methane concentrations. This trend we have referred to as a Type B trend, and predicts a condensate-prone 'source' for these anomalies. There exists a third trend in these plots of increasing wetness (up to 12%) at low methane concentrations. This trend (if real) predicts a liquid-prone 'source' for these anomalies. However, few shotpoints generally comprise these anomalies and the possibility of methane oxidation during hydrocarbon migration, and in the seawaters of the continental shelf, suggest this trend may be an artifact. However, we have no evidence of methane oxidation, although the process is well documented in seawater. We have therefore included this trend as a subset of Type B anomalies. Both trends are associated with increasing percent hydrocarbon wetness values at low and increasing methane concentrations - and hence predict condensate/liquids prone hydrocarbon 'sources'.

The light hydrocarbon geochemistry in the Ragay Gulf is complex. The complexity is evident in the vertical distributions of hydrocarbons in the water column (see Appendix I). These distributions suggest an input of hydrocarbons from the seafloor, and these appear to be 'trapped' in a zone near the base of the stratification in both temperature and salinity (conductivity). The local hydrography clearly exerts an important control on the distributions of hydrocarbons in the water column. Steep gradients in light hydrocarbon concentrations with depth in the water column of the continental shelf, combined with variations in DHD tow-fish depth and varying bathymetry (relative to the depth of the local thermocline), result in the large number of anomalies of various

concentrations. Many of the anomalous levels of hydrocarbons were encountered as the DHD tow-fish and bathymetry vary.

Because of the possibility that anomalies may be produced by in-situ biogenic processes, twenty five gas samples, were collected over anomalous areas in Ragay Gulf for carbon isotope analysis of the methane content, to help determine if the anomalies were of a biogenic or thermogenic origin. The isotopic composition of the methane varied between -57.3 °/oo and -37.8 °/oo. A consideration of both the molecular and isotopic compositions of these samples (the Bernard model), suggest that most samples were either of thermogenic origin or contained a significant proportion of thermogenic hydrocarbons. Only one sample may be of a biogenic origin.

To assist further with the biogenic/thermogenic classification of the anomalies, eight samples that appeared to represent the different types of hydrocarbon anomalies were selected for ^{14}C analysis. All of these samples contained less than 17 pMC (percent modern carbon). Eight of these samples contained less than 2 pMC. These results, combined with the molecular compositions of the anomalies and the carbon isotopic compositions of methane, suggest a thermogenic origin for the light hydrocarbon anomalies in Ragay Gulf.

The strongest Type B anomalies were found on lines 109/sniff7 and 109/sniff3, with significant concentrations of C_4+ hydrocarbons (Figures. 6h-j).

Light hydrocarbon anomalies were also detected in Tayabas Bay. However, there were fewer anomalies in Tayabas Bay, as compared to Ragay Gulf, and the anomalies were generally weak and appear to be Type A (dry) molecular compositions.

LIST OF TABLES (PART A).

Table 1. Line kilometres of DHD survey data collected in the four sedimentary basins offshore Philippines.

Table 2. Survey Area and Data Collected.

Table 3. Hydrocarbon composition and Carbon Isotopic values of methane in the Ragay Gulf Anomalies.

Table 4. Methane gas concentrations, Bernard parameter, percent hydrocarbon wetness values and the anomaly Type A or B for the Ragay Gulf gas samples.

LIST OF FIGURES (PART A).

Figure 1a. Location map of the Philippines showing the four basins surveyed during AGSO Survey 109.

Figure 1b. Map of the Ragay Gulf and Tayabas Bay area showing the DHD survey lines and R-1 and R-2 prospects locations for AGSO survey 109.

Figure 1c. Map of the NE Palawan Shelf and Cuyo Platform showing the DHD survey lines and well locations for AGSO survey 109.

Figure 1d. Map of Ragay Gulf showing Type B 'wet' gas anomalies and Type A 'dry' gas anomalies locations, DHD and seismic lines and bathymetry

Figure 1e. Map of Ragay Gulf showing locations of DHD only lines and vertical profiles.

Figure 2. Schematic diagram of the DHD equipment installed on the Rig Seismic for the Philippines survey 109.

Figure 3a. Vertical profile of fish depth vs temperature line VP 109/070

Figure 3b. Vertical profile of fish depth vs conductivity line VP 109/070

Figure 3c. Vertical profile of fish depth vs THC line VP 109/070

Figure 3d. Vertical profiles of fish depth vs methane line VP 109/070

Figure 3e. Vertical profile of fish depth vs ethane line VP 109/070

Figure 3f. Vertical profile of fish depth vs ethylene line VP 109/070

Figure 3g. Vertical profile of fish depth vs propane line VP 109/070

Figure 4a. Vertical profile of fish depth vs temperature line VP 109/078

Figure 4b. Vertical profile of fish depth vs conductivity line VP 109/078

Figure 4c. Vertical profile of fish depth vs THC line VP 109/078

Figure 4d. Vertical profiles of fish depth vs methane line VP 109/078

Figure 4e. Vertical profile of fish depth vs ethane line VP 109/078

Figure 4f. Vertical profile of fish depth vs ethylene line VP 109/078

Figure 4g. Vertical profile of fish depth vs propane line VP 109/078

Figure 5a Total Hydrocarbons (THC) versus survey line number, Ragay Gulf 'group 1' (Lines 109/031 through 109/044 and including lines 109/sniff1 through 109/sniff4.

Figure 5b Sum C_1-C_4 versus survey line number, Ragay Gulf 'group 1' lines.

Figure 5c Methane versus survey line number, Ragay Gulf 'group 1' lines.

Figure 5d Ethane versus survey line number, Ragay Gulf 'group 1' lines.

Figure 5e Ethylene versus survey line number, Ragay Gulf 'group 1' lines.
Figure 5f Propane versus survey line number, Ragay Gulf 'group 1' lines.
Figure 5g Propylene versus survey line number, Ragay Gulf 'group 1' lines.
Figure 5h Total Butanes versus survey line number, Ragay Gulf 'group 1' lines.
Figure 5i Iso-pentane versus survey line number, Ragay Gulf 'group 1' lines.
Figure 5j Percent hydrocarbon wetness versus survey line number, Ragay Gulf 'group 1' lines.
Figure 5k C_1/C_2 ratio versus survey line number, Ragay Gulf 'group 1' lines.
Figure 5l C_2/C_3 ratio versus survey Line number, Ragay Gulf 'group 1' lines.
Figure 5m Bernard Parameter (C_1/C_2+C_3) versus survey line number, Ragay Gulf 'group 1' lines.

Figure 6a Total Hydrocarbons (THC) versus survey line number, Ragay Gulf 'group 2' (Lines 109/045 through 109/056, 109/058, and 109/059, and 109/sniff5 through 109/sniff9a).
Figure 6b Sum C_1-C_4 versus survey line number, Ragay Gulf 'group 2' lines.
Figure 6c Methane versus survey Line number, Ragay Gulf 'group 2' lines.
Figure 6d Ethane versus survey line number, Ragay Gulf 'group 2' lines.
Figure 6e Ethylene versus survey line number, Ragay Gulf 'group 2' lines.
Figure 6f Propane versus survey line number, Ragay Gulf 'group 2' lines.
Figure 6g Propylene versus survey line number, Ragay Gulf 'group 2' lines.
Figure 6h Total Butanes versus survey line number, Ragay Gulf 'group 2' lines.
Figure 6i Iso-pentane versus survey line number, Ragay Gulf 'group 2' lines.
Figure 6j Percent hydrocarbon wetness versus survey line number, Ragay Gulf 'group 2' lines.
Figure 6k C_1/C_2 ratio versus survey line number, Ragay Gulf 'group 2' lines.
Figure 6l C_2/C_3 ratio versus survey line number, Ragay Gulf 'group 2' lines.
Figure 6m Bernard Parameter (C_1/C_2+C_3) versus survey line number, Ragay Gulf 'group 2' lines.

Figure 7a Total Hydrocarbons (THC) versus survey line number, Ragay Gulf 'group 3' (Lines 109/060 through 109/062; lines 109/069, 109/070, 109/075; vertical profile lines vp109/070, vp109/072 and lines vp109/072 and lines vp109/075 through vp109/078).
Figure 7b Sum C_1-C_4 versus survey line number, Ragay Gulf 'group 3' lines.
Figure 7c Methane versus survey line number, Ragay Gulf 'group 3' lines.
Figure 7d Ethane versus survey line number, Ragay Gulf 'group 3' lines.
Figure 7e Ethylene versus survey line number, Ragay Gulf 'group 3' lines.

Figure 7f	Propane versus survey line number, Ragay Gulf 'group 3' lines.
Figure 7g	Propylene versus survey line number, Ragay Gulf 'group 3' lines.
Figure 7h	Total Butanes versus survey line number, Ragay Gulf 'group 3' lines.
Figure 7i	Iso-pentane versus survey line number, Ragay Gulf 'group 3' lines.
Figure 7j	Percent hydrocarbon wetness versus survey line number, Ragay Gulf 'group 3' lines.
Figure 7k	C_1/C_2 ratio versus survey line number, Ragay Gulf 'group 3' lines.
Figure 7l	C_2/C_3 ratio versus survey line number, Ragay Gulf 'group 3' lines.
Figure 7m	Bernard Parameter (C_1/C_2+C_3) versus survey line number, Ragay Gulf 'group 3' lines.
Figure 8a	Methane versus percent hydrocarbon wetness , Ragay Gulf 'group 1' lines.
Figure 8b	Methane versus ethane, Ragay Gulf 'group 1' lines.
Figure 8c	Methane versus propane, Ragay Gulf 'group 1' lines.
Figure 8d	Methane versus butanes, Ragay Gulf 'group 1' lines.
Figure 9a	Methane versus percent hydrocarbon wetness , Ragay Gulf 'group 2' lines.
Figure 9b	Methane versus ethane, Ragay Gulf 'group 2' lines.
Figure 9c	Methane versus propane, Ragay Gulf 'group 2' lines.
Figure 9d	Methane versus butanes, Ragay Gulf 'group 2' lines.
Figure 10a	Methane versus percent hydrocarbon wetness , Ragay Gulf 'group 3' lines.
Figure 10b	Methane versus ethane, Ragay Gulf 'group 3' lines.
Figure 10c	Methane versus propane, Ragay Gulf 'group 3' lines.
Figure 10d	Methane versus butanes, Ragay Gulf 'group 3' lines.
Figure 11a.	Ship's methane values vs New Zealand methane values.
Figure 11b	Frequency plot of $^{C}13$ values for Ragay Gulf samples.
Figure 11c	Bernard Parameter vs $^{C}13$ values for Ragay Gulf samples
Figure 11d	Relative abundance and isotopic composition of methane in bottom-water gases from Ragay Gulf.
Figure 12a	Total Hydrocarbons (THC) versus survey line number, Tayabas Bay (Lines 109/021 through 109/030 and 109/063 through 109/068).

Figure 12b Sum C_1-C_4 versus survey line number, Tayabas Bay (Lines 109/021 through 109/030 and 109/063 through 109/068).

Figure 12c Methane versus survey line number, Tayabas Bay (Lines 109/021 through 109/030 and 109/063 through 109/068).

Figure 12d Ethane versus survey line number, Tayabas Bay (Lines 109/021 through 109/030 and 109/063 through 109/068).

Figure 12e Ethylene versus survey line number, Tayabas Bay (Lines 109/021 through 109/030 and 109/063 through 109/068).

Figure 12f Propane versus survey line number, Tayabas Bay (Lines 109/021 through 109/030 and 109/063 through 109/068).

Figure 12g Propylene versus survey line number, Tayabas Bay (Lines 109/021 through 109/030 and 109/063 through 109/068).

Figure 12h Total Butanes versus survey line number, Tayabas Bay (Lines 109/021 through 109/030 and 109/063 through 109/068).

Figure 12j Percent hydrocarbon wetness versus survey line number, Tayabas Bay (Lines 109/021 through 109/030 and 109/063 through 109/068).

Figure 12k C_1/C_2 ratio versus survey line number, Tayabas Bay (Lines 109/021 through 109/030 and 109/063 through 109/068).

Figure 12l C_2/C_3 ratio versus survey line number, Tayabas Bay (Lines 109/021 through 109/030 and 109/063 through 109/068).

Figure 12m Bernard Parameter (C_1/C_2+C_3) versus survey line number, Tayabas Bay (Lines 109/021 through 109/030 and 109/063 through 109/068).

Figure 13a Methane versus percent hydrocarbon wetness , Tayabas Bay (Lines 109/021 through 109/030 and 109/063 through 109/068).

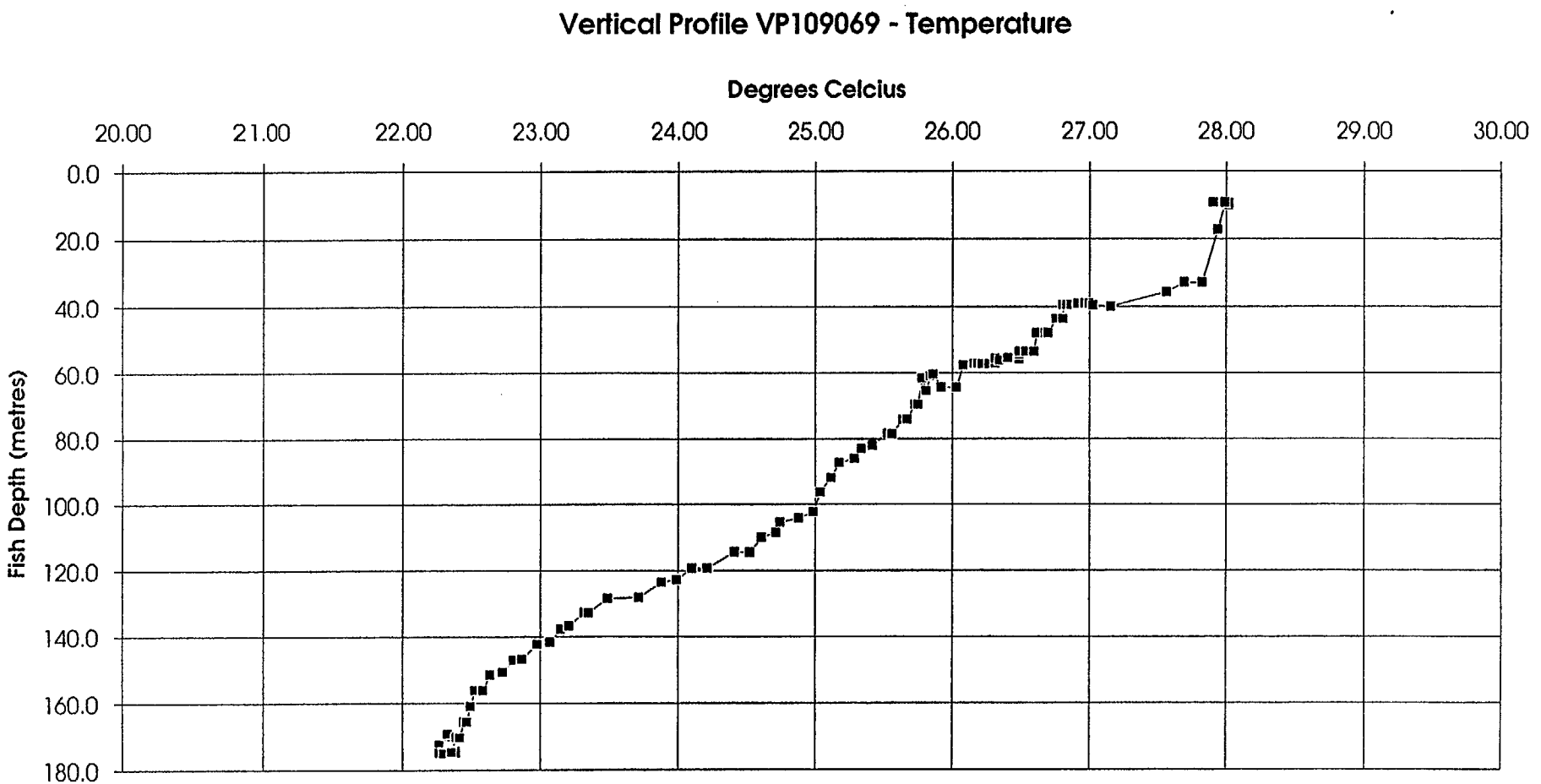
LIST OF APPENDICES (PART A)

APPENDIX I (PART A). RAGAY GULF VERTICAL PROFILES OF HYDROCARBONS, TEMPERATURE AND SALINITY.

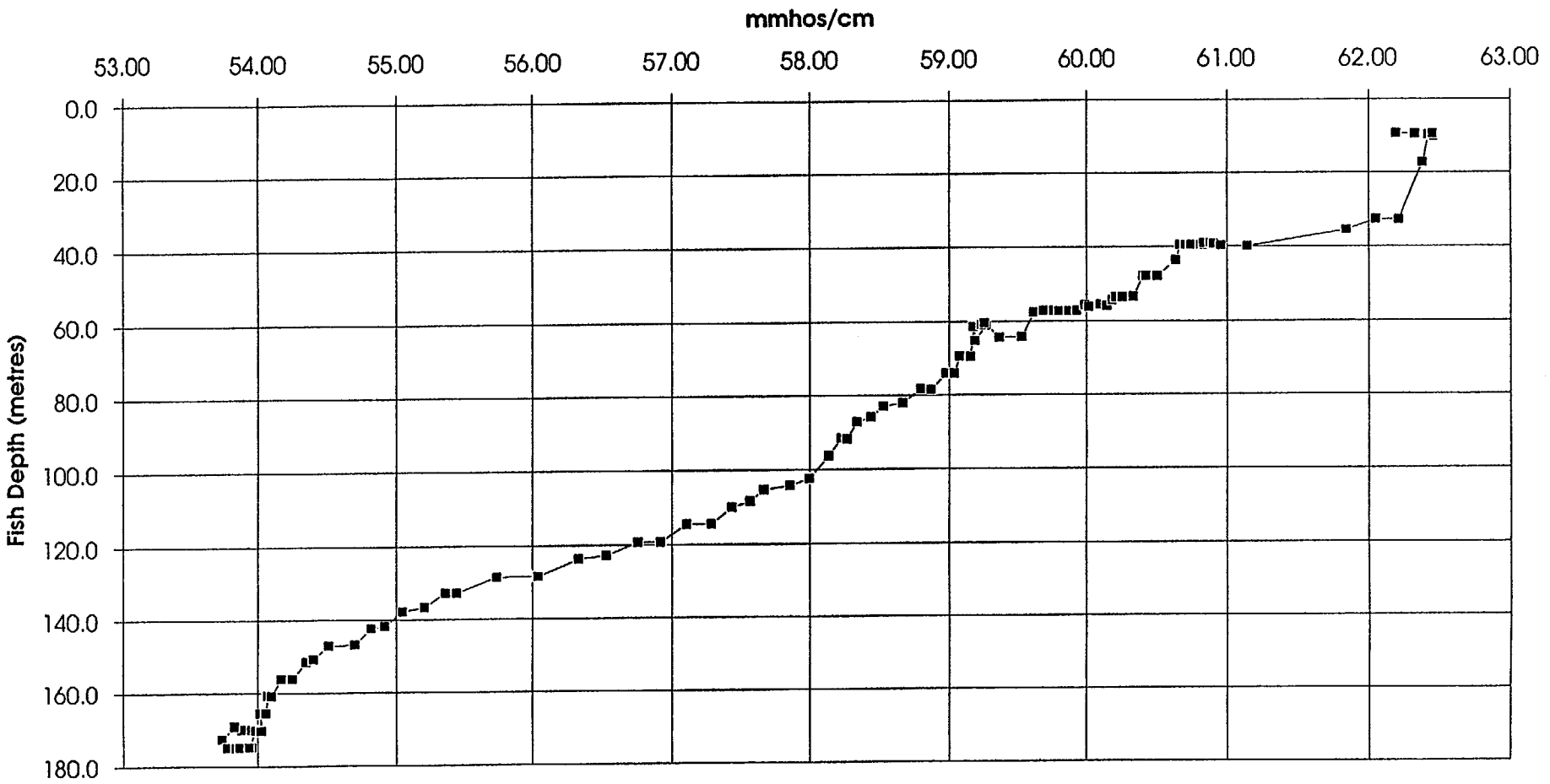
APPENDIX II (PART A). RAGAY GULF LINE SUMMARY SHEETS AND INDIVIDUAL LINE PLOTS, IN THE ORDER THEY WERE ACQUIRED.

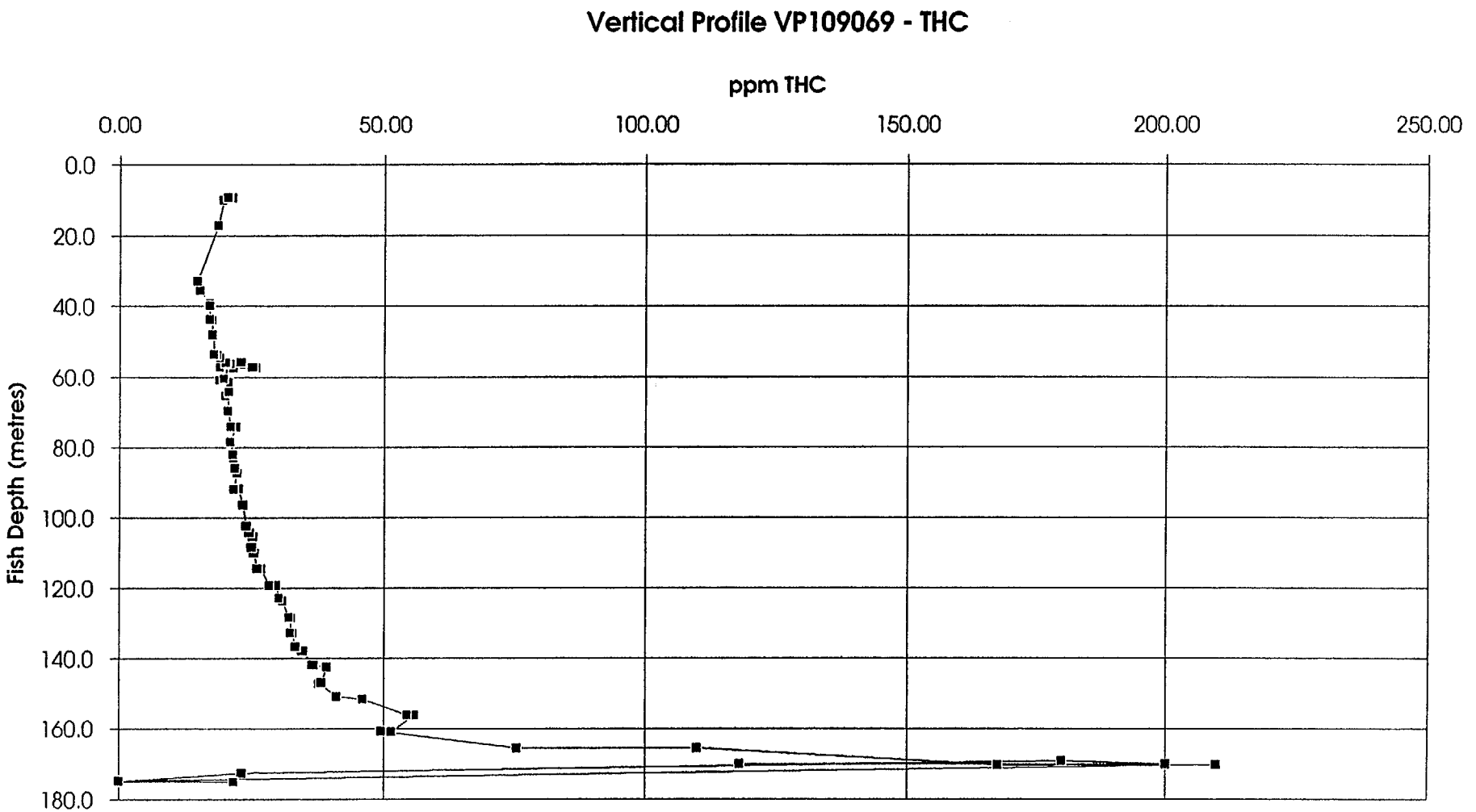
APPENDIX III (PART A). TAYABAS BAY LINE SUMMARY SHEETS AND INDIVIDUAL LINE PLOTS (LINES 109/021 THROUGH 109/030 AND 109/063 THROUGH 109/068).

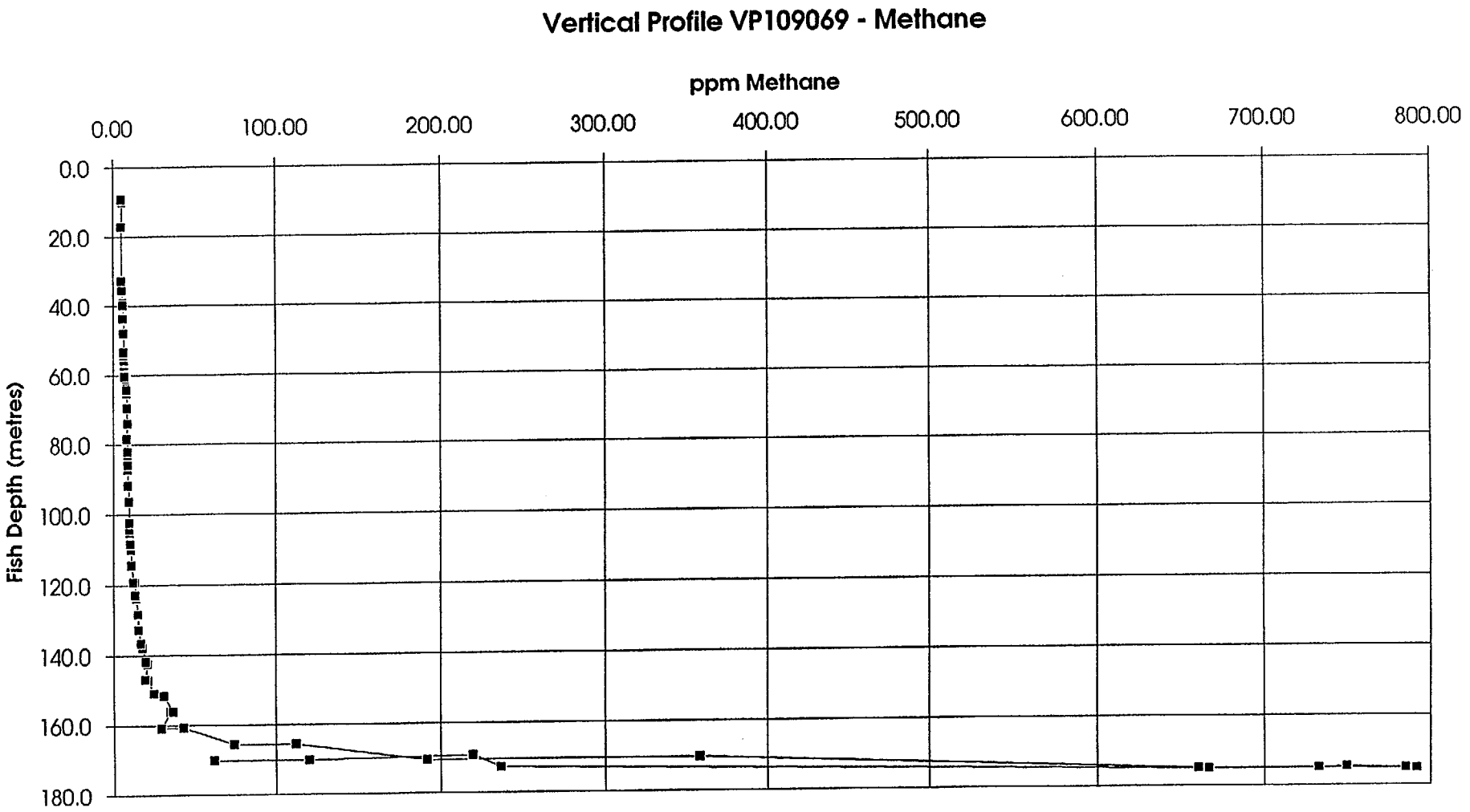
APPENDIX I (PART A). RAGAY GULF VERTICAL PROFILES.

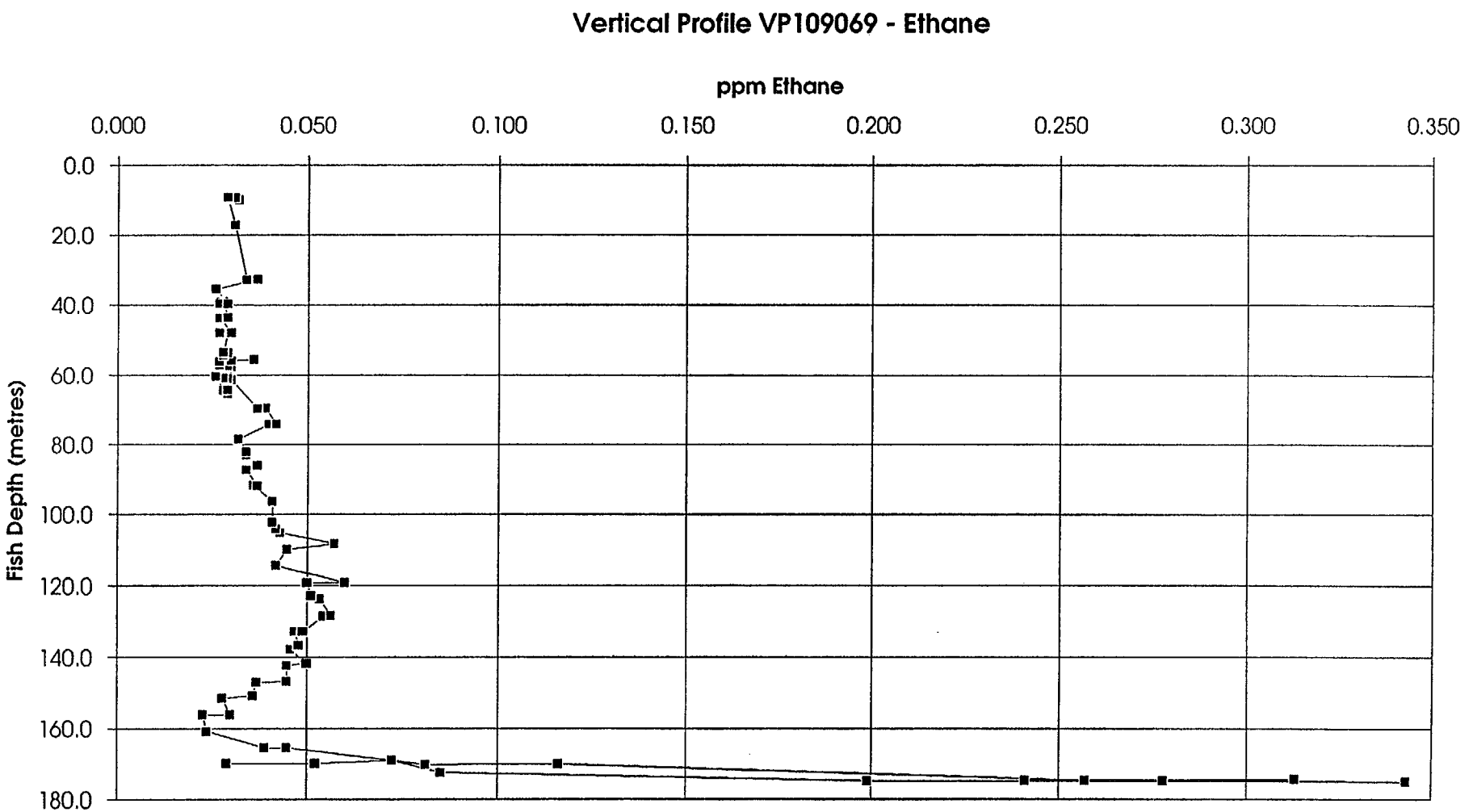

Vertical Profile VP109069 - Temperature
Degrees Celcius
20.00
21.00
22.00
23.00
24.00
25.00
26.00
27.00
28.00
29.00
30.00
Fish Depth (metres)
0.0
20.0
40.0
60.0
80.0
100.0
120.0
140.0
160.0
180.0

Vertical Profile VP109069 - Conductivity

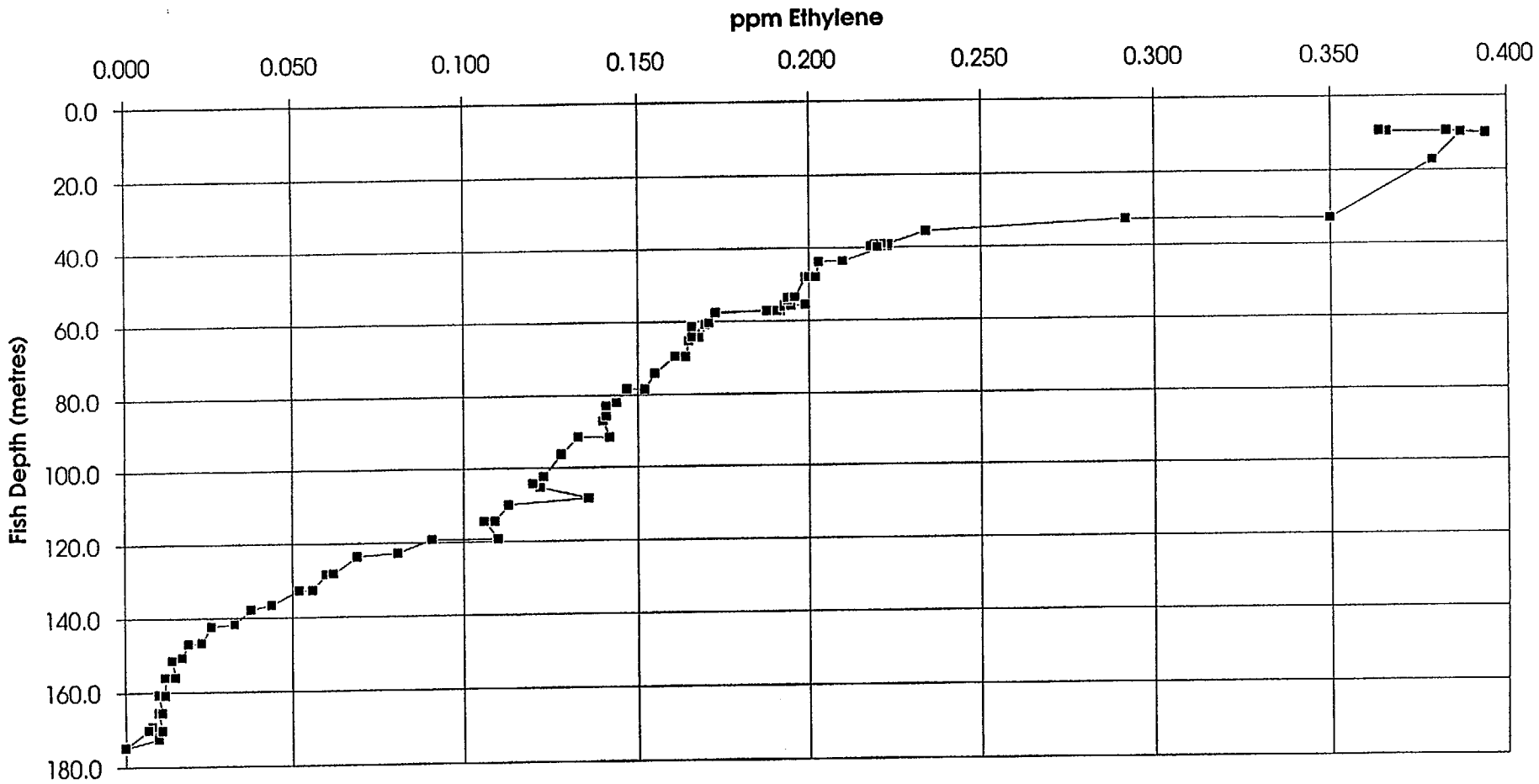


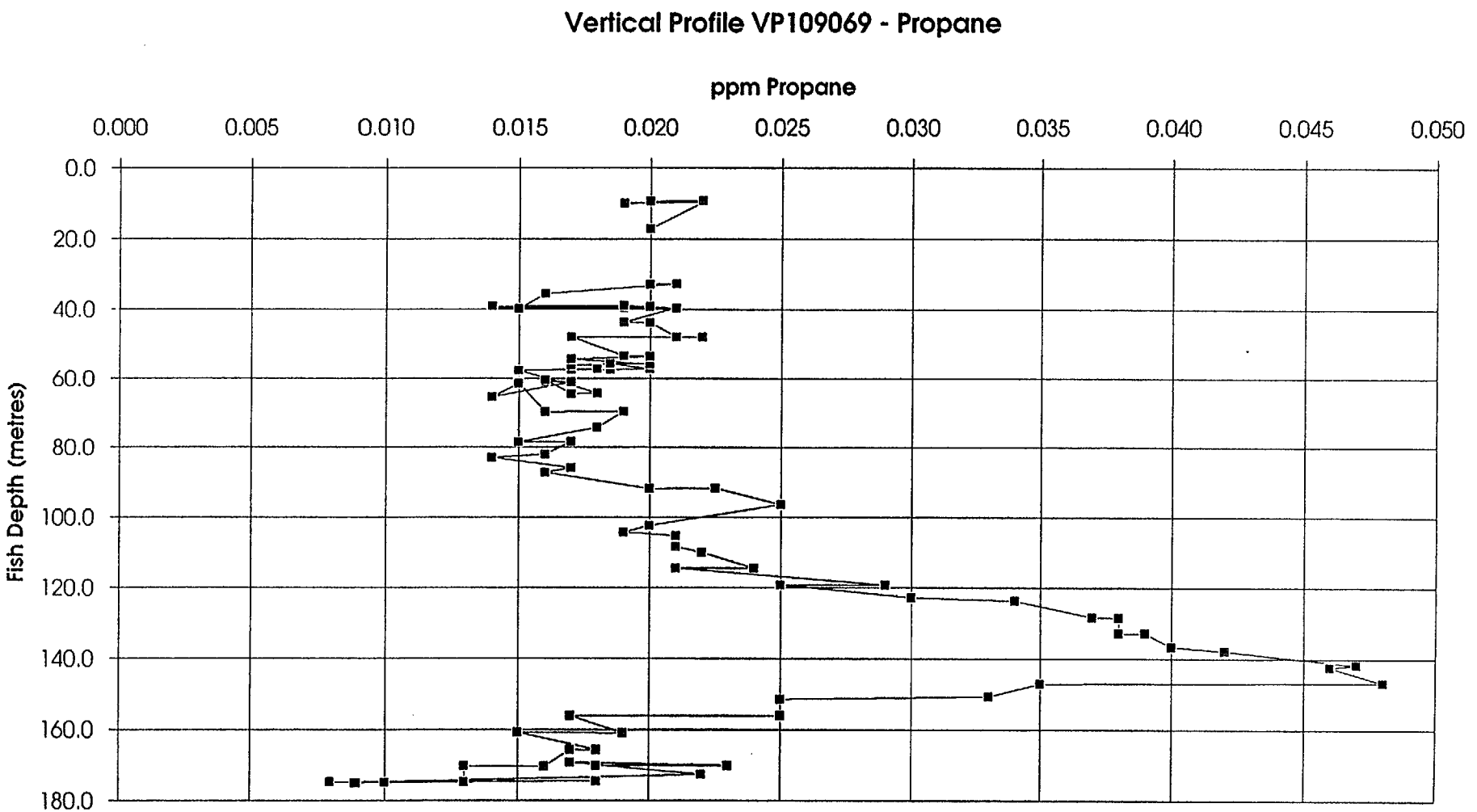

Vertical Profile VP109069 - THC
ppm THC
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50.00
100.00
150.00
200.00
250.00
Fish Depth (metres)
0.0
20.0
40.0
60.0
80.0
100.0
120.0
140.0
160.0
180.0


Vertical Profile VP109069 - Methane
ppm Methane
0.00
100.00
200.00
300.00
400.00
500.00
600.00
700.00
800.00
Fish Depth (metres)
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20.0
40.0
60.0
80.0
100.0
120.0
140.0
160.0
180.0

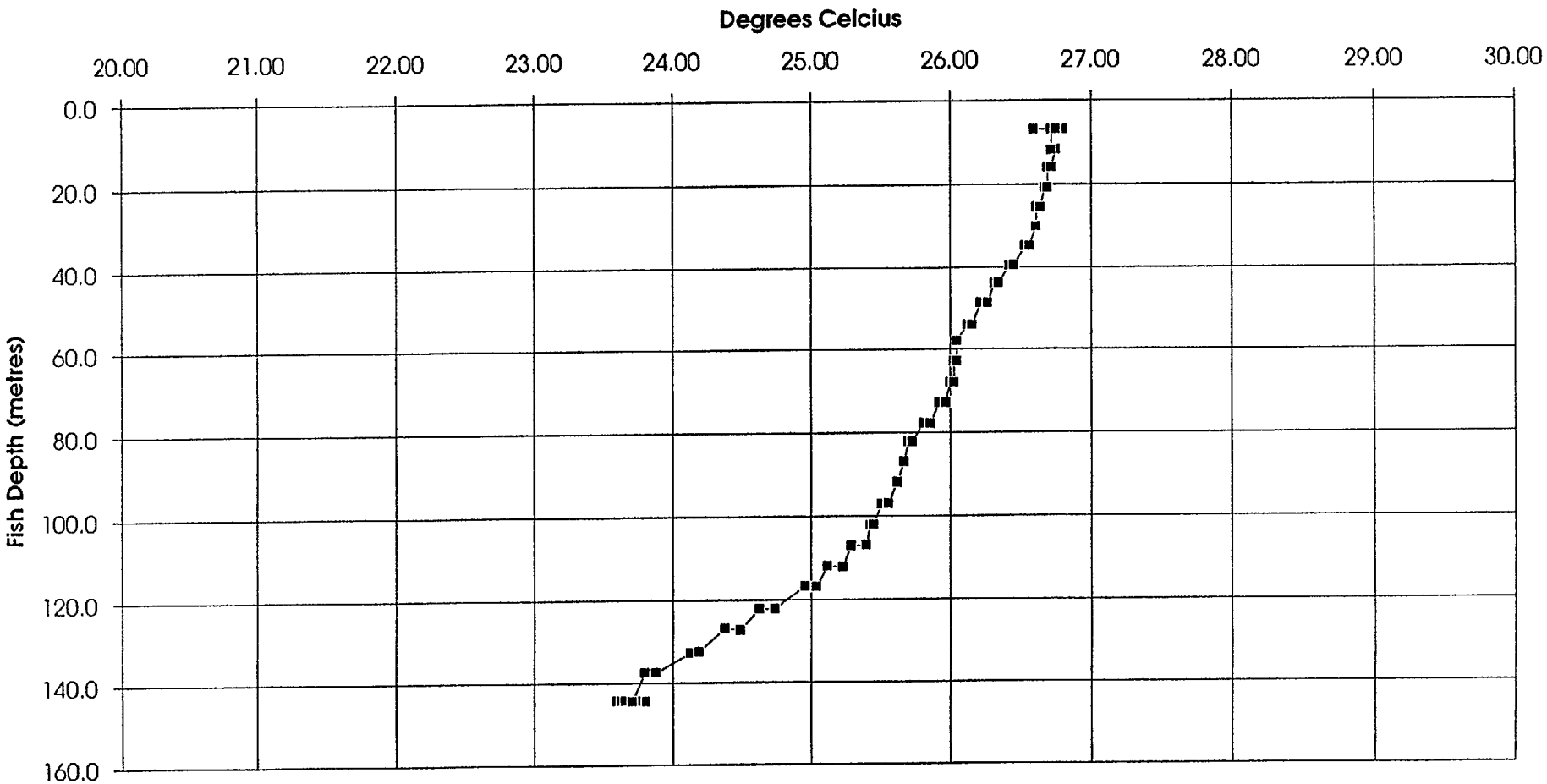

Vertical Profile VP109069 - Ethane
ppm Ethane
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0.050
0.100
0.150
0.200
0.250
0.300
0.350
Fish Depth (metres)
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20.0
40.0
60.0
80.0
100.0
120.0
140.0
160.0
180.0

Vertical Profile VP109069 - Ethylene

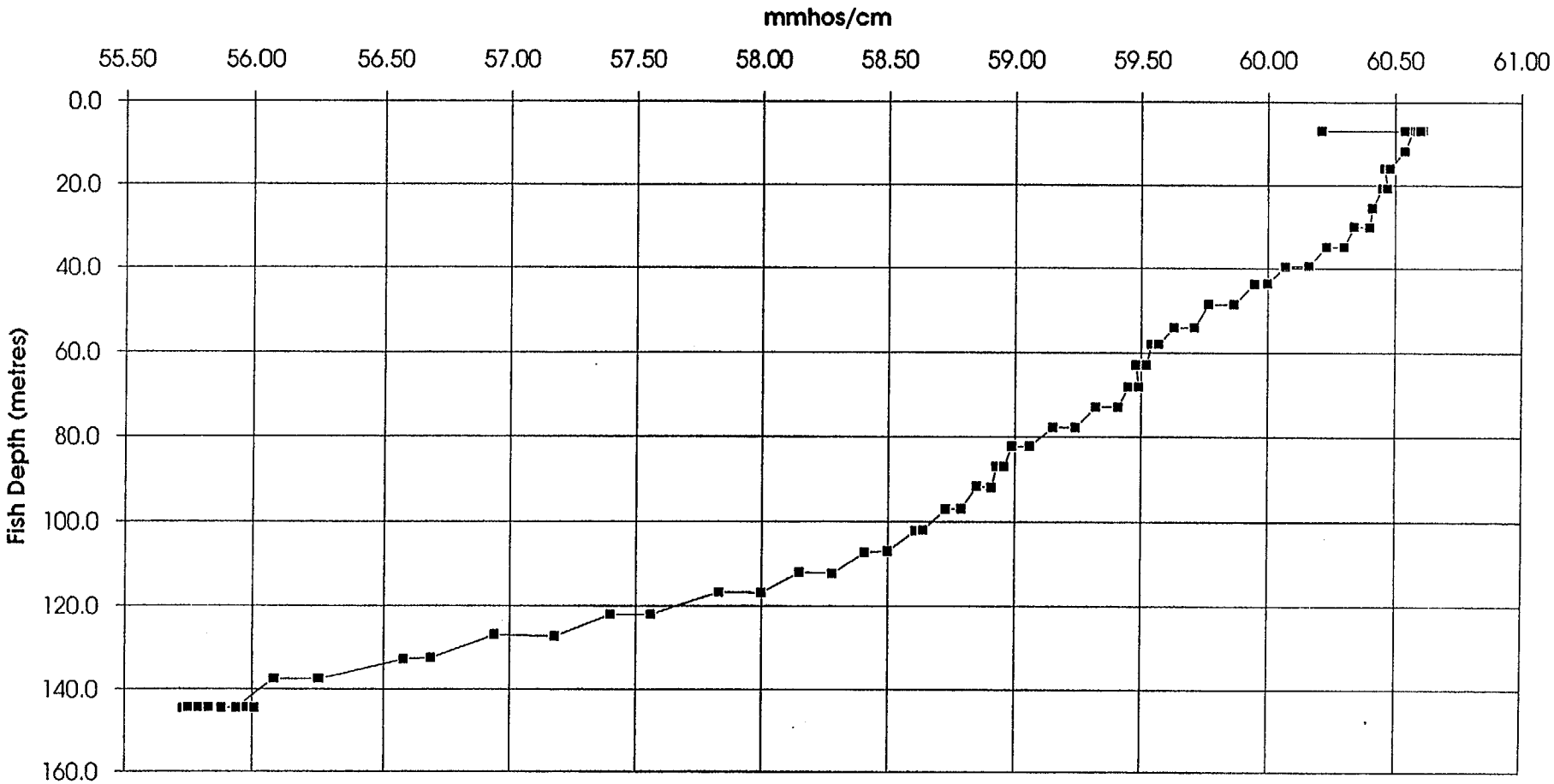



Vertical Profile VP109069 - Propane
ppm Propane
0.000
0.005
0.010
0.015
0.020
0.025
0.030
0.035
0.040
0.045
0.050
Fish Depth (metres)
0.0
20.0
40.0
60.0
80.0
100.0
120.0
140.0
160.0
180.0

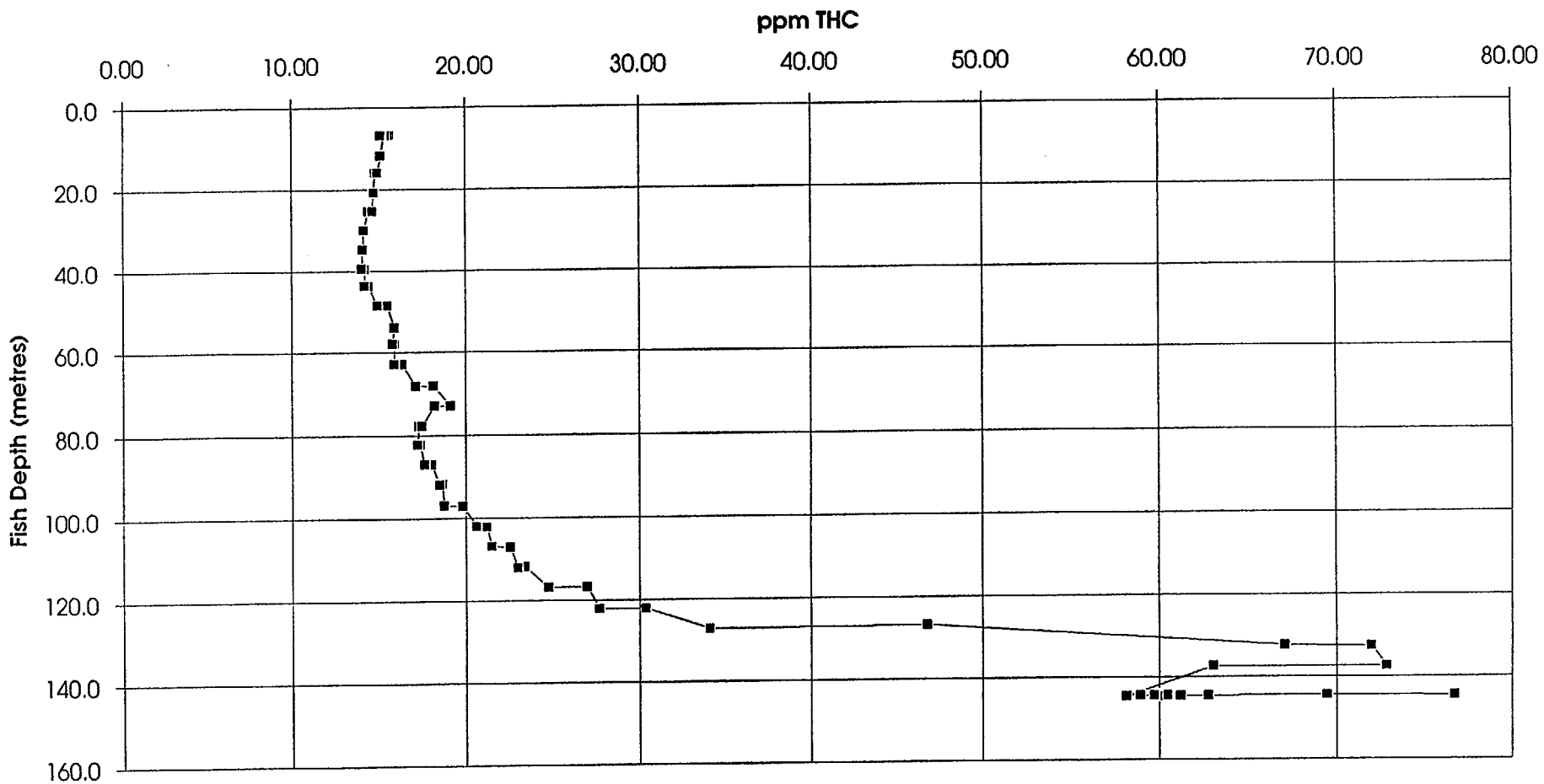
Vertical Profile VP109071 - Temperature



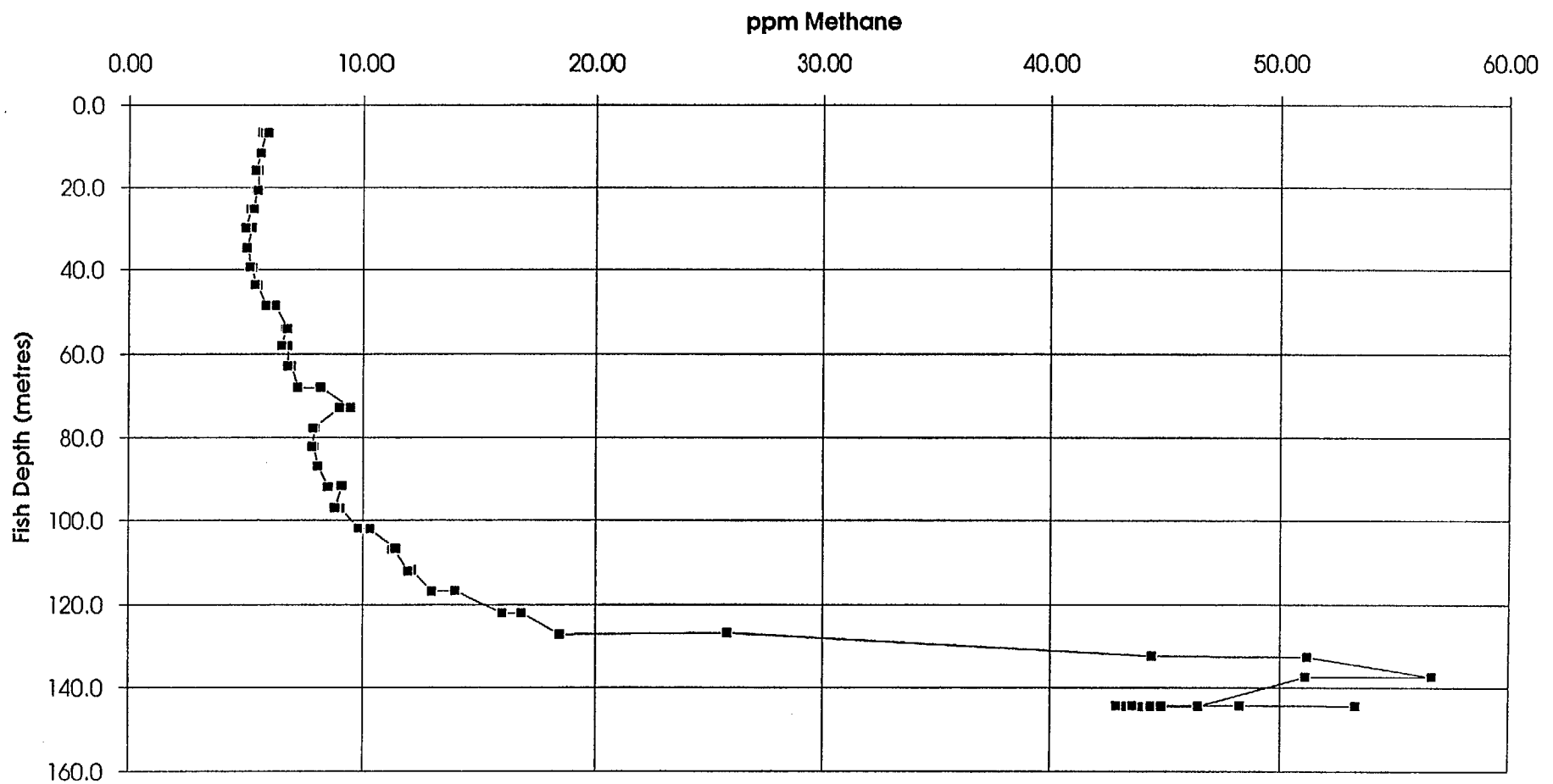
Vertical Profile VP109071 - Conductivity

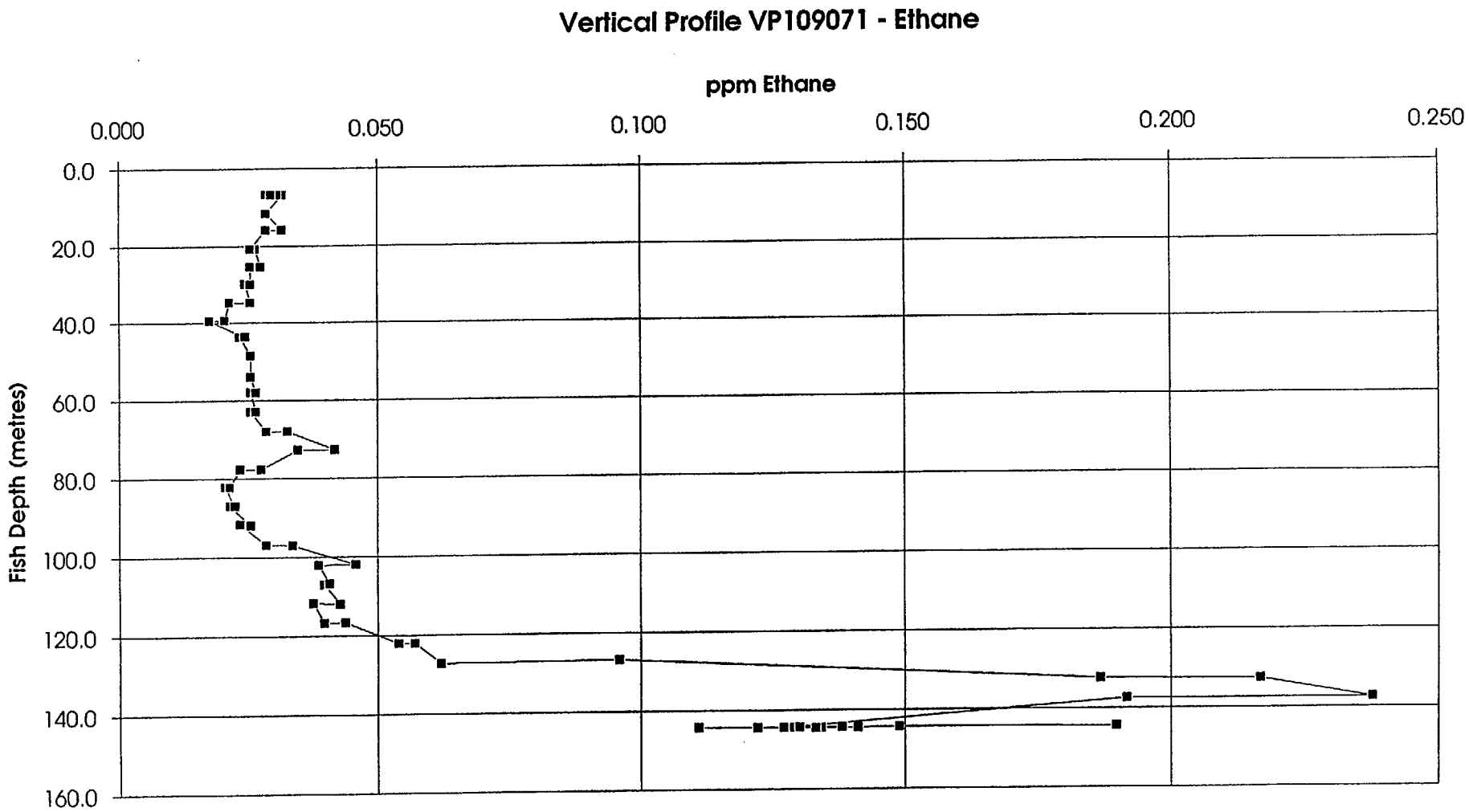


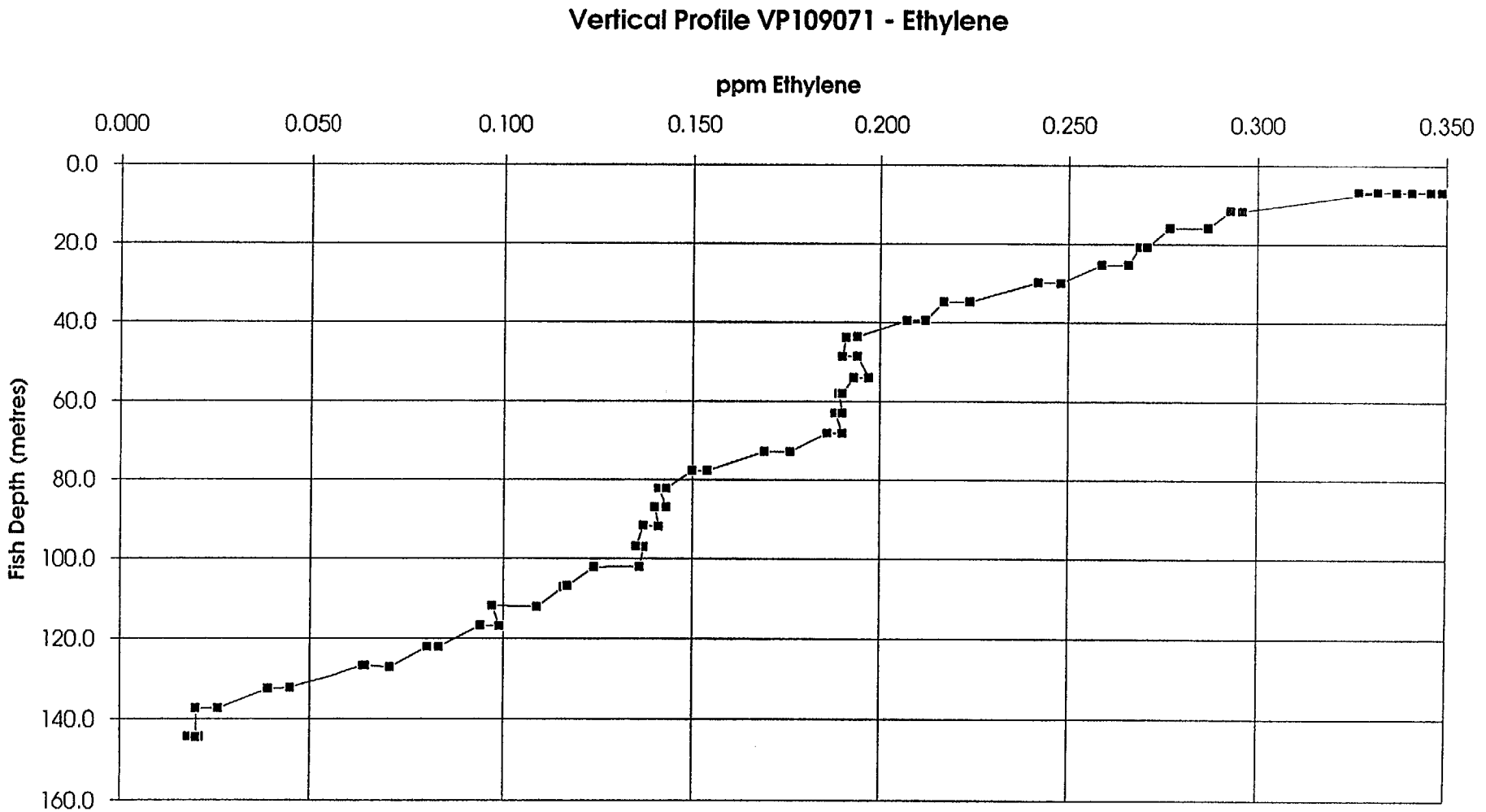
Vertical Profile VP109071 - THC

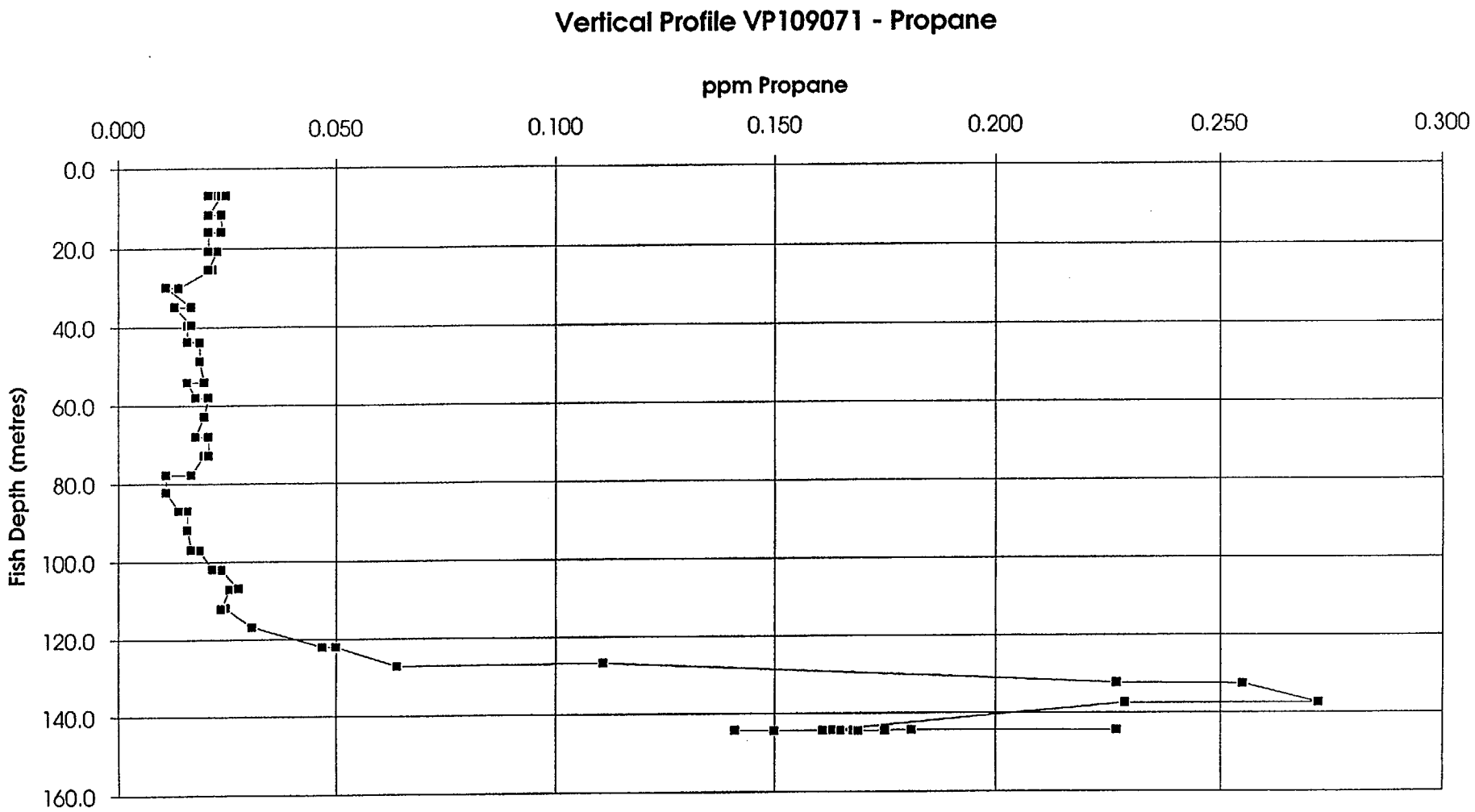


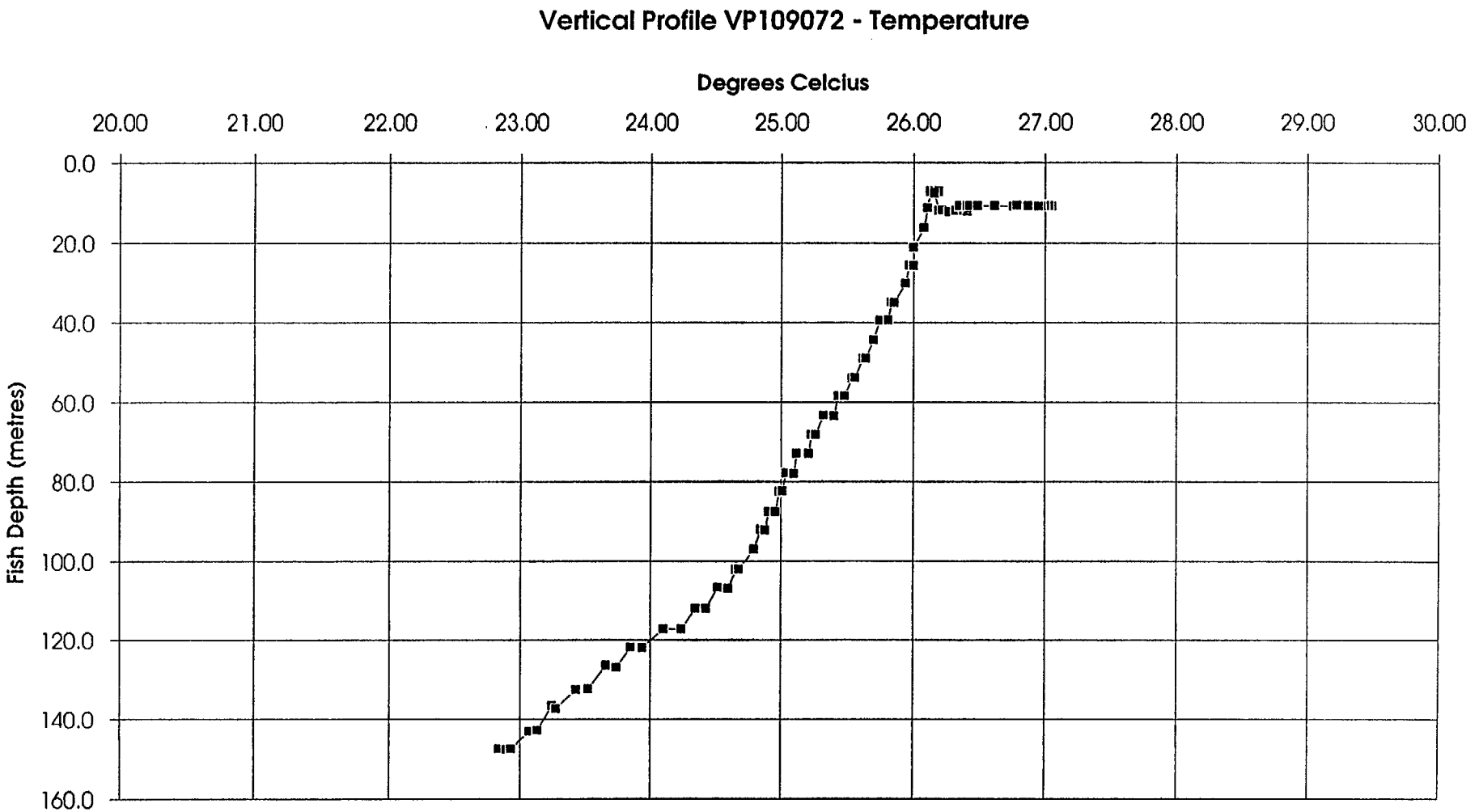
Vertical Profile VP109071 - Methane



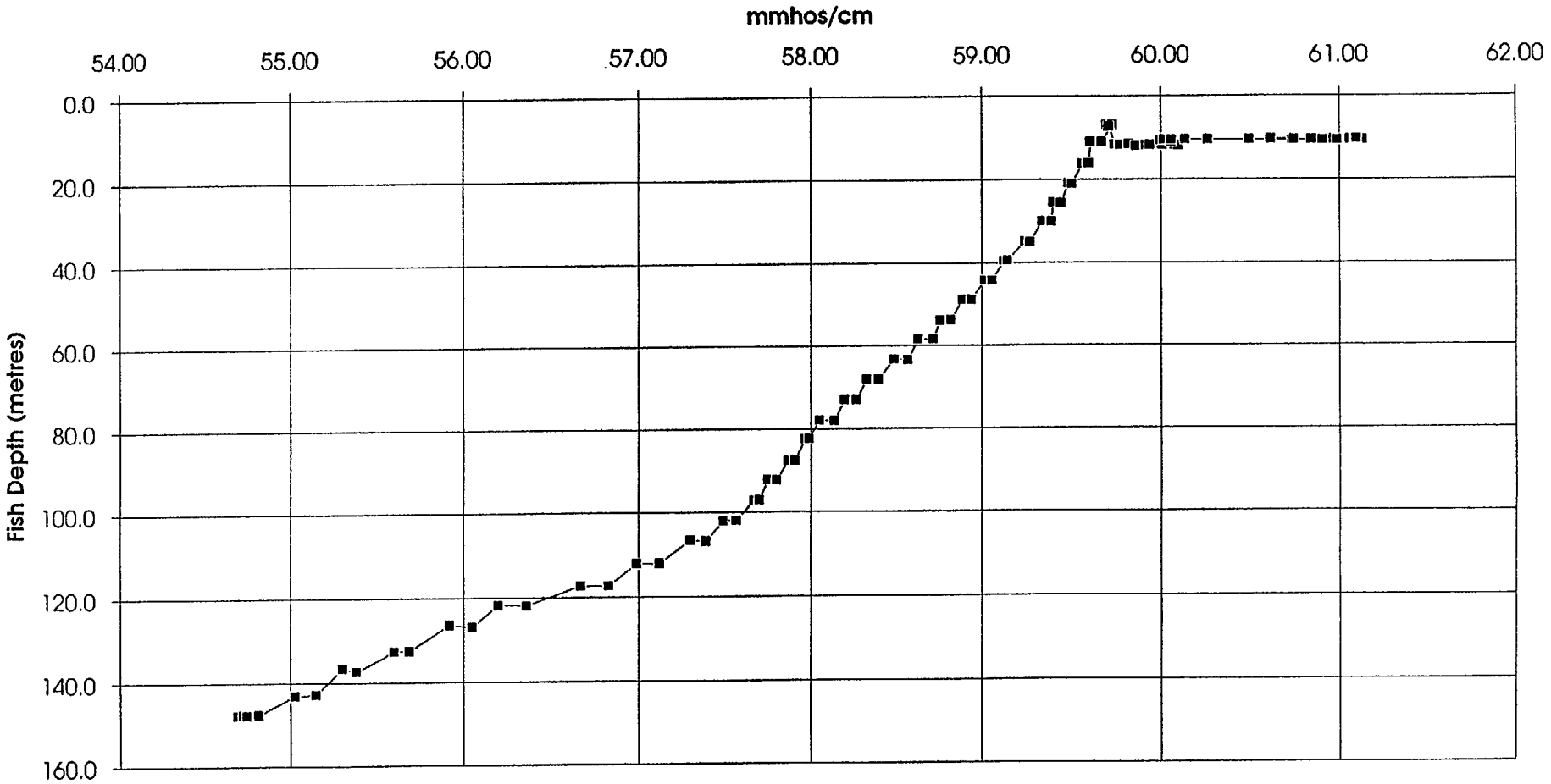

Vertical Profile VP109071 - Ethane
ppm Ethane
0.000
0.050
0.100
0.150
0.200
0.250
Fish Depth (metres)
0.0
20.0
40.0
60.0
80.0
100.0
120.0
140.0
160.0


Vertical Profile VP109071 - Ethylene
ppm Ethylene
0.000
0.050
0.100
0.150
0.200
0.250
0.300
0.350
Fish Depth (metres)
0.0
20.0
40.0
60.0
80.0
100.0
120.0
140.0
160.0

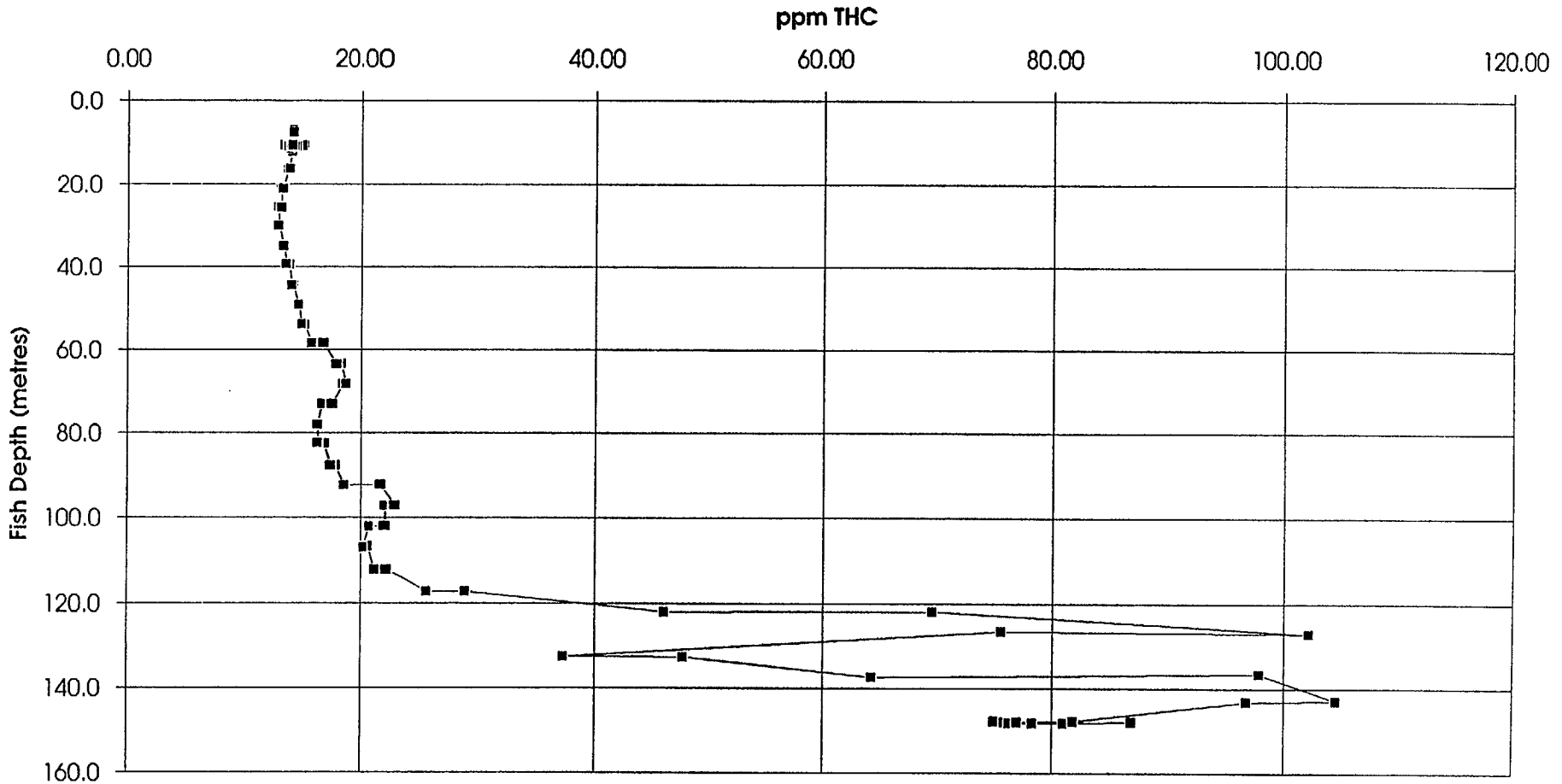

Vertical Profile VP109071 - Propane
ppm Propane
0.000
0.050
0.100
0.150
0.200
0.250
0.300
Fish Depth (metres)
0.0
20.0
40.0
60.0
80.0
100.0
120.0
140.0
160.0

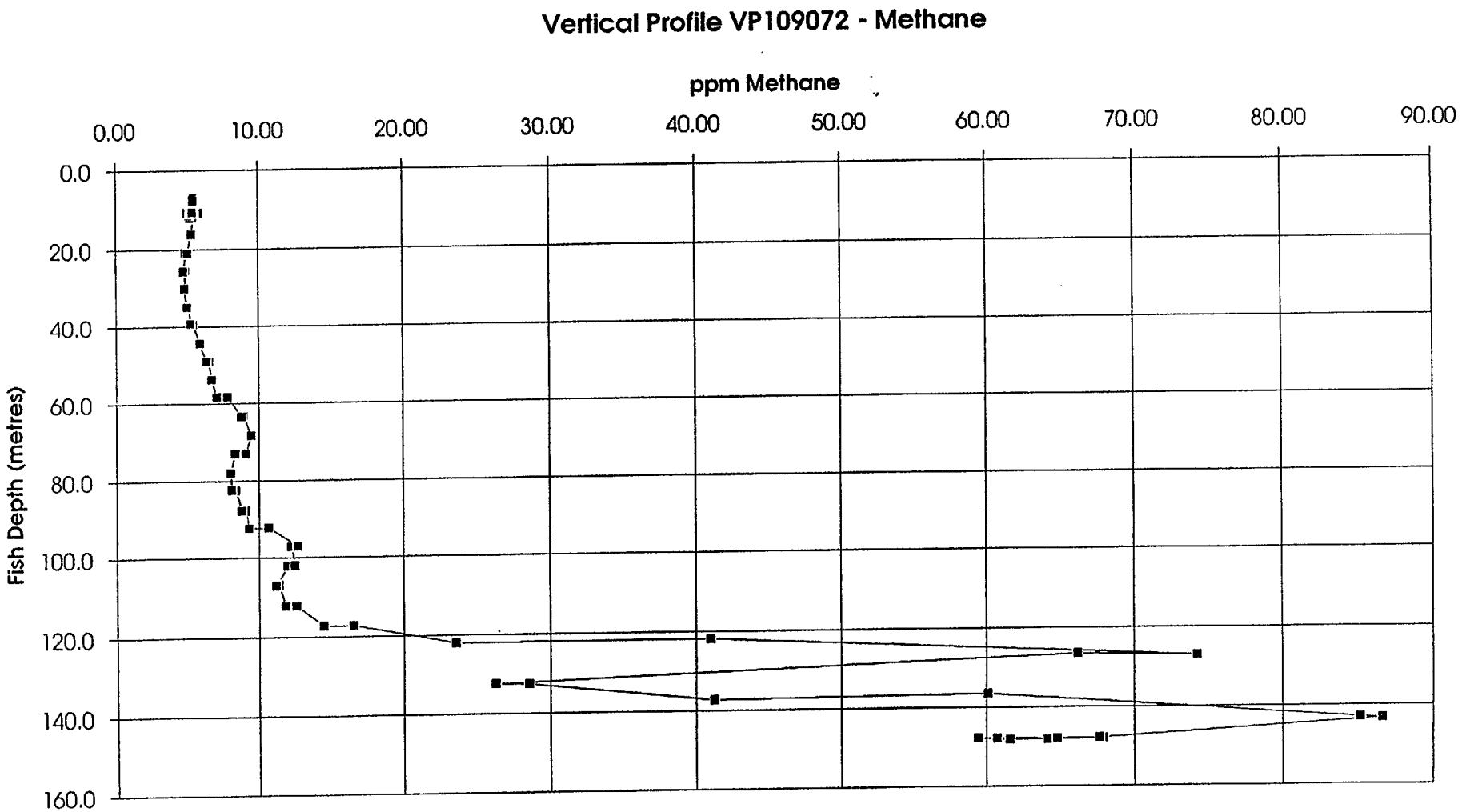

Vertical Profile VP109072 - Temperature
Degrees Celcius
20.00
21.00
22.00
23.00
24.00
25.00
26.00
27.00
28.00
29.00
30.00
Fish Depth (metres)
0.0
20.0
40.0
60.0
80.0
100.0
120.0
140.0
160.0

Vertical Profile VP109072 - Conductivity

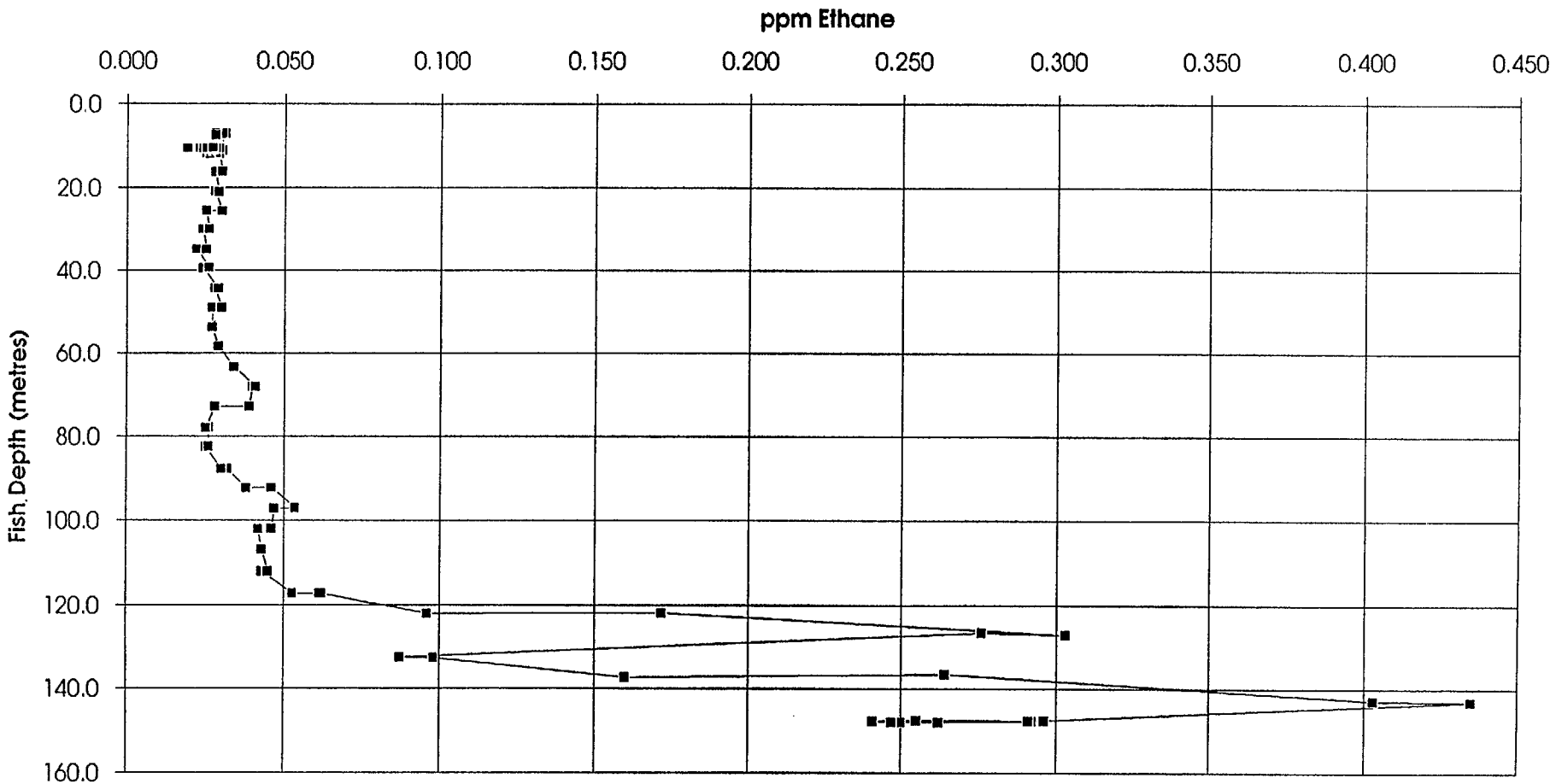


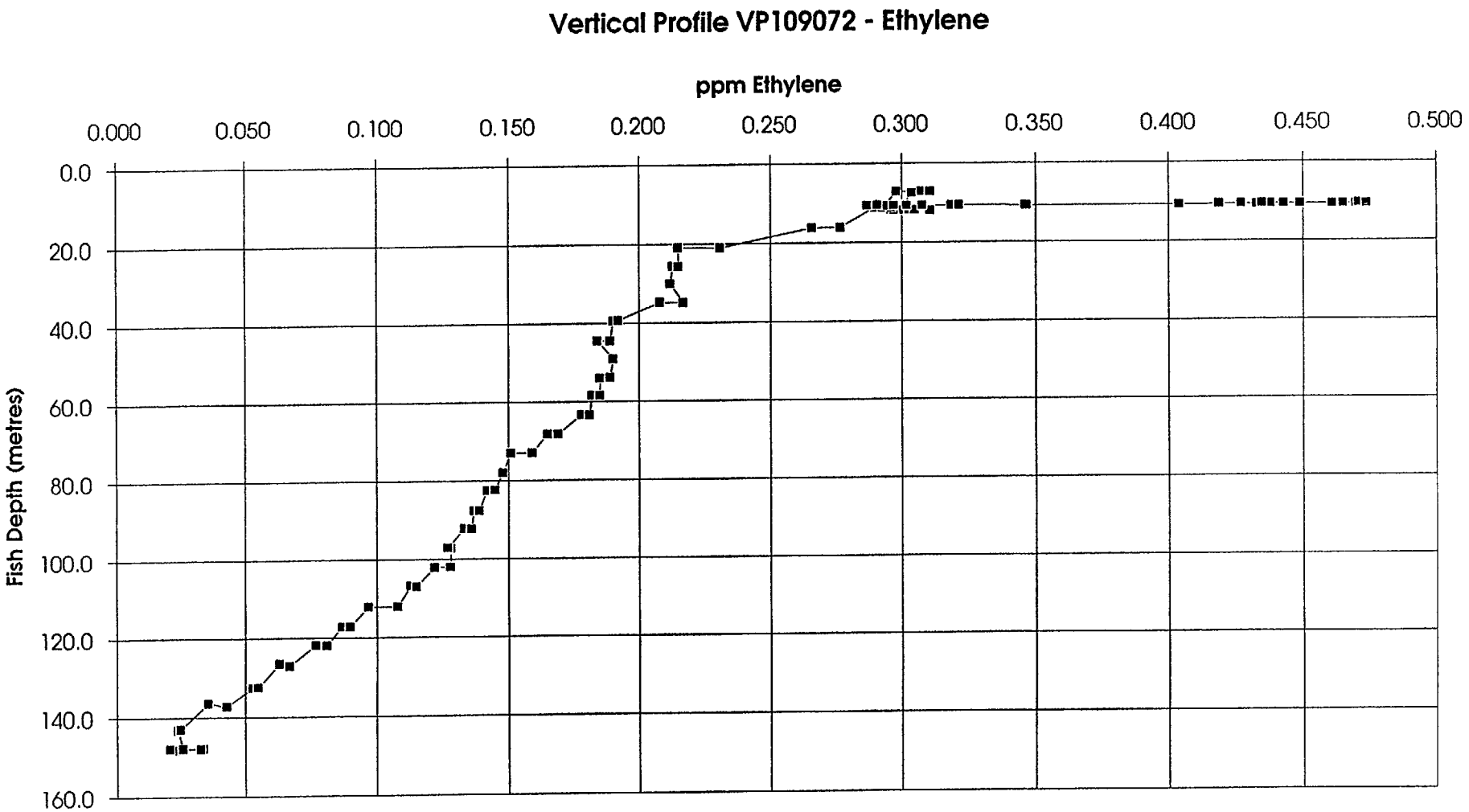
Vertical Profile VP109072 - THC



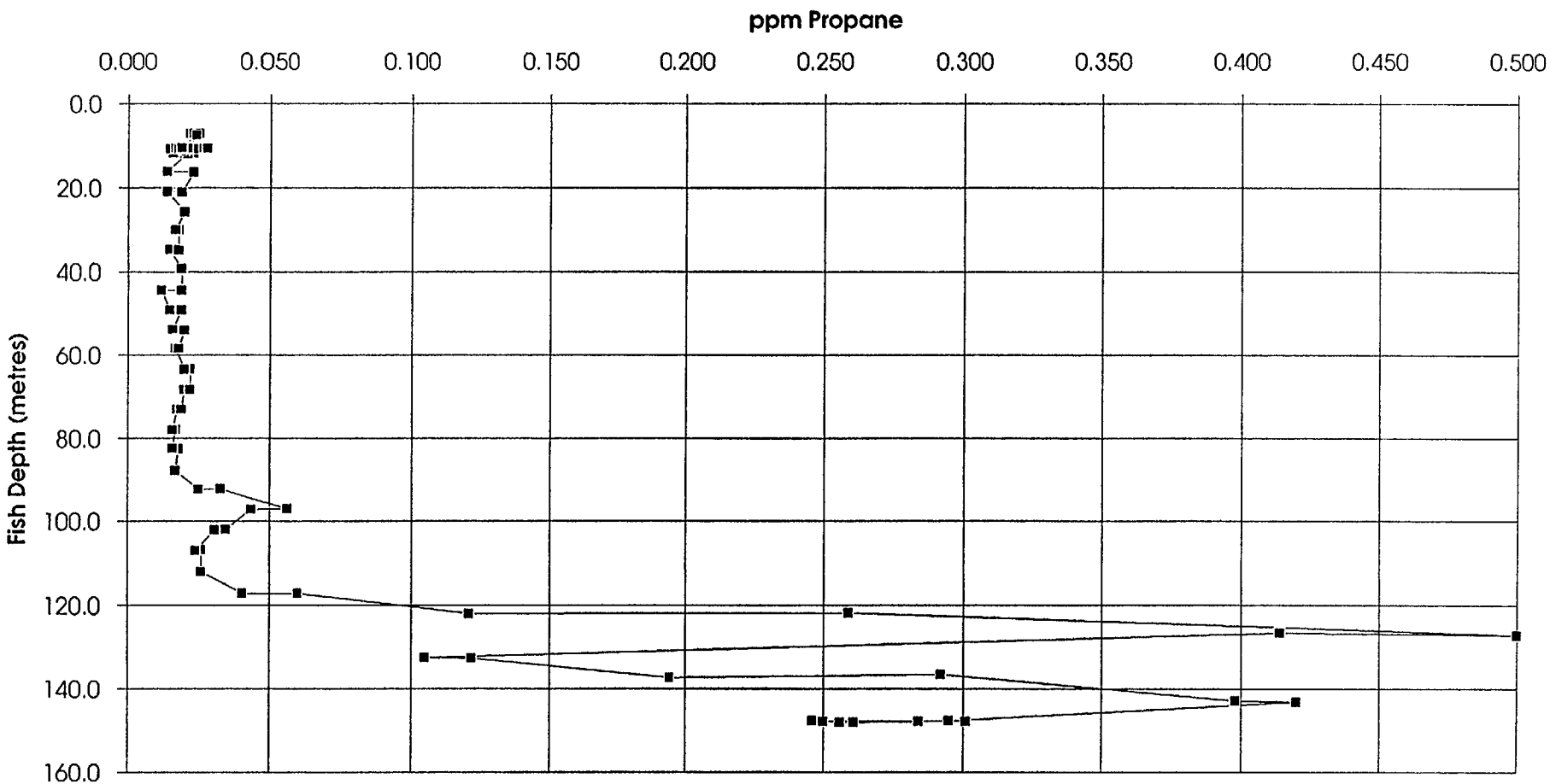

Vertical Profile VP109072 - Methane
ppm Methane
0.00
10.00
20.00
30.00
40.00
50.00
60.00
70.00
80.00
90.00
Fish Depth (metres)
0.0
20.0
40.0
60.0
80.0
100.0
120.0
140.0
160.0

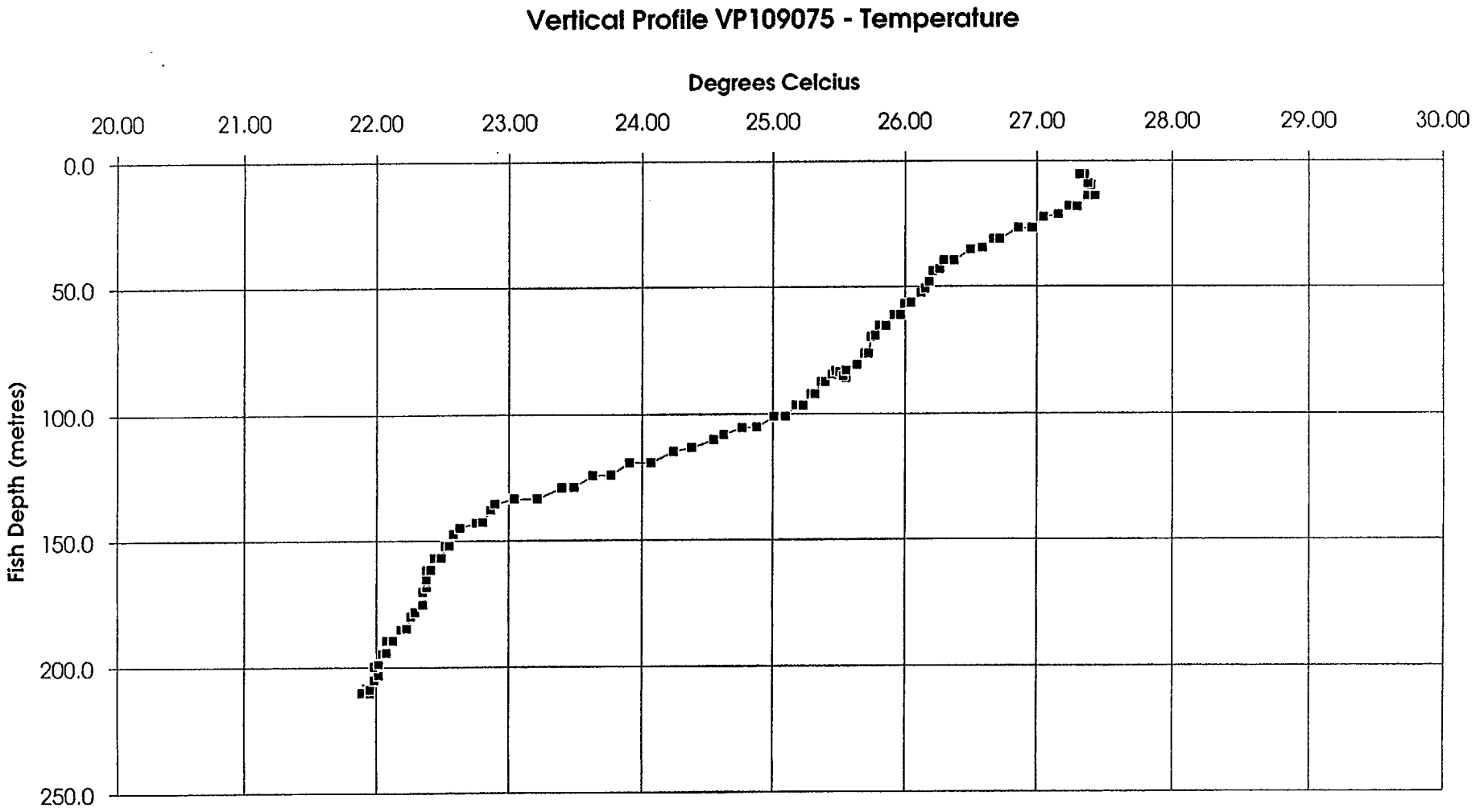
Vertical Profile VP109072 - Ethane



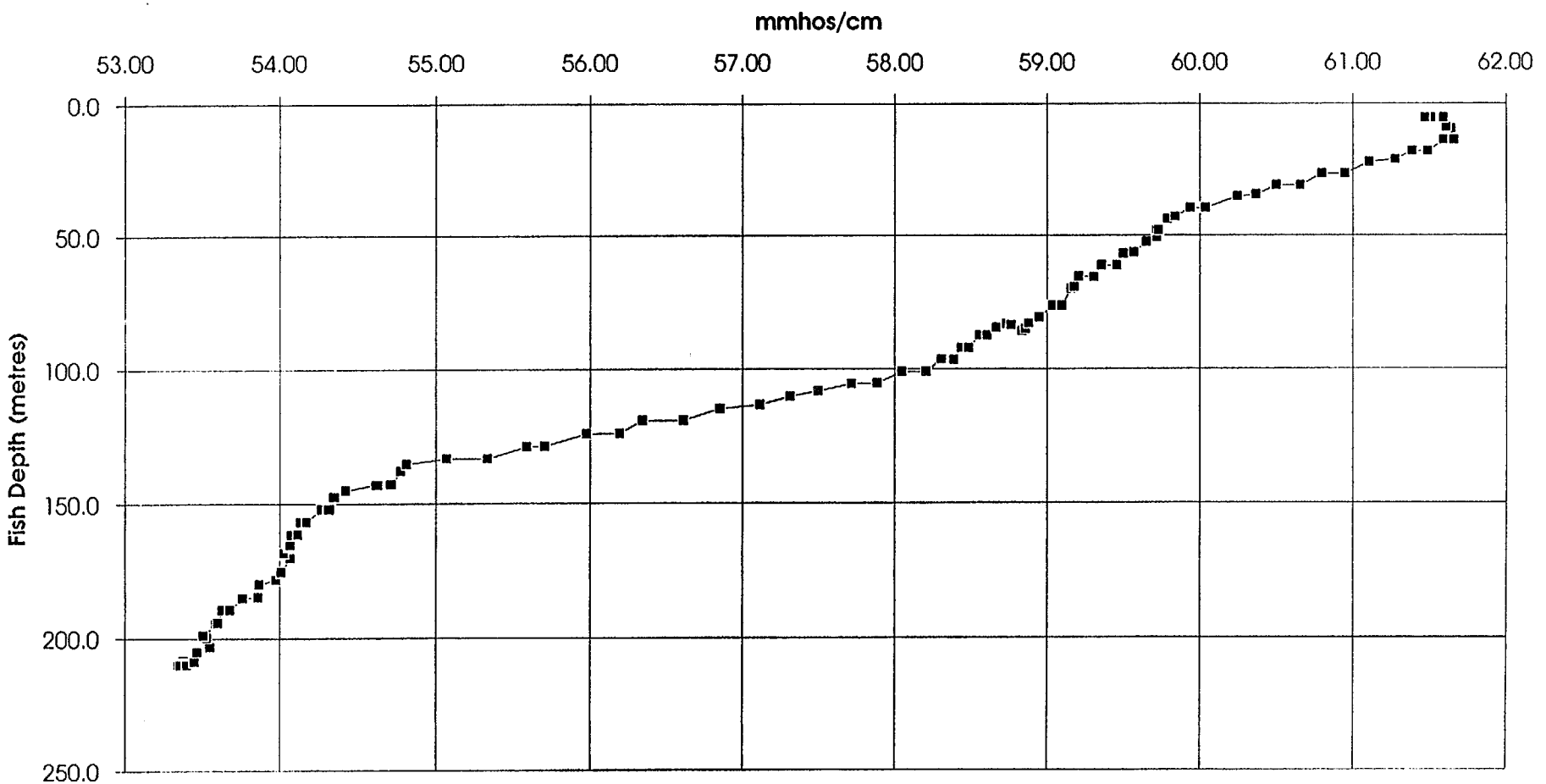

Vertical Profile VP109072 - Ethylene
ppm Ethylene
0.000
0.050
0.100
0.150
0.200
0.250
0.300
0.350
0.400
0.450
0.500
Fish Depth (metres)
0.0
20.0
40.0
60.0
80.0
100.0
120.0
140.0
160.0

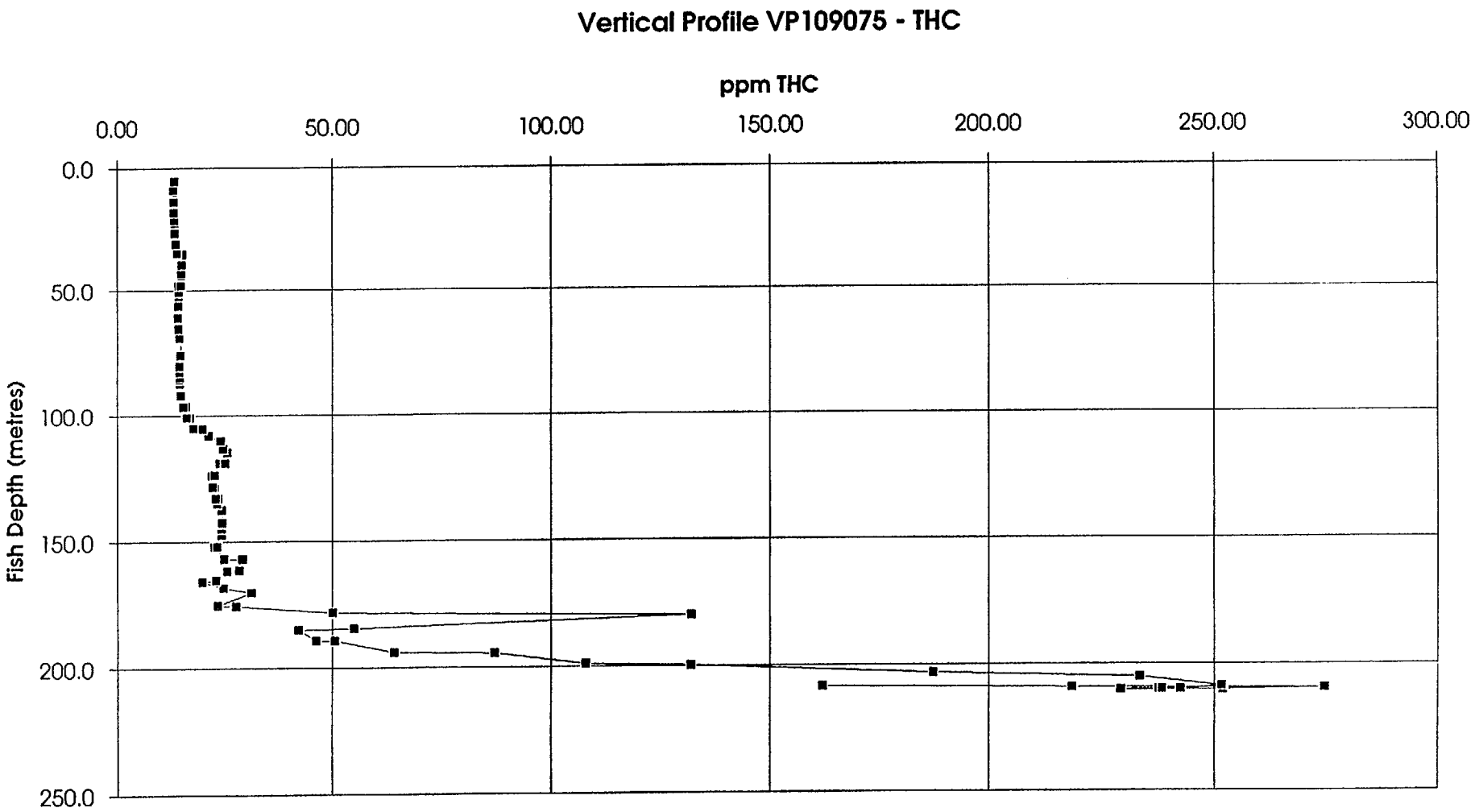
Vertical Profile VP109072 - Propane

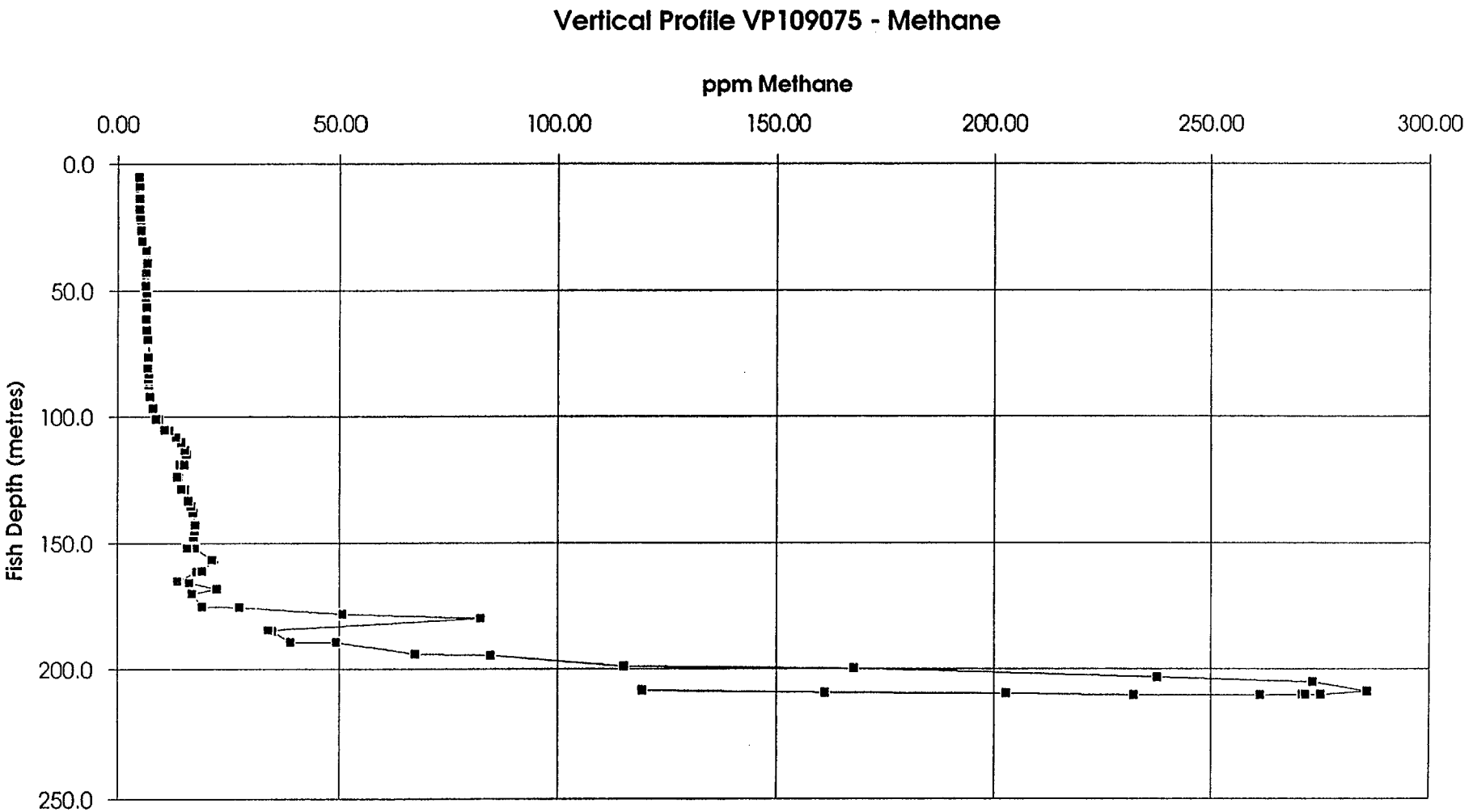


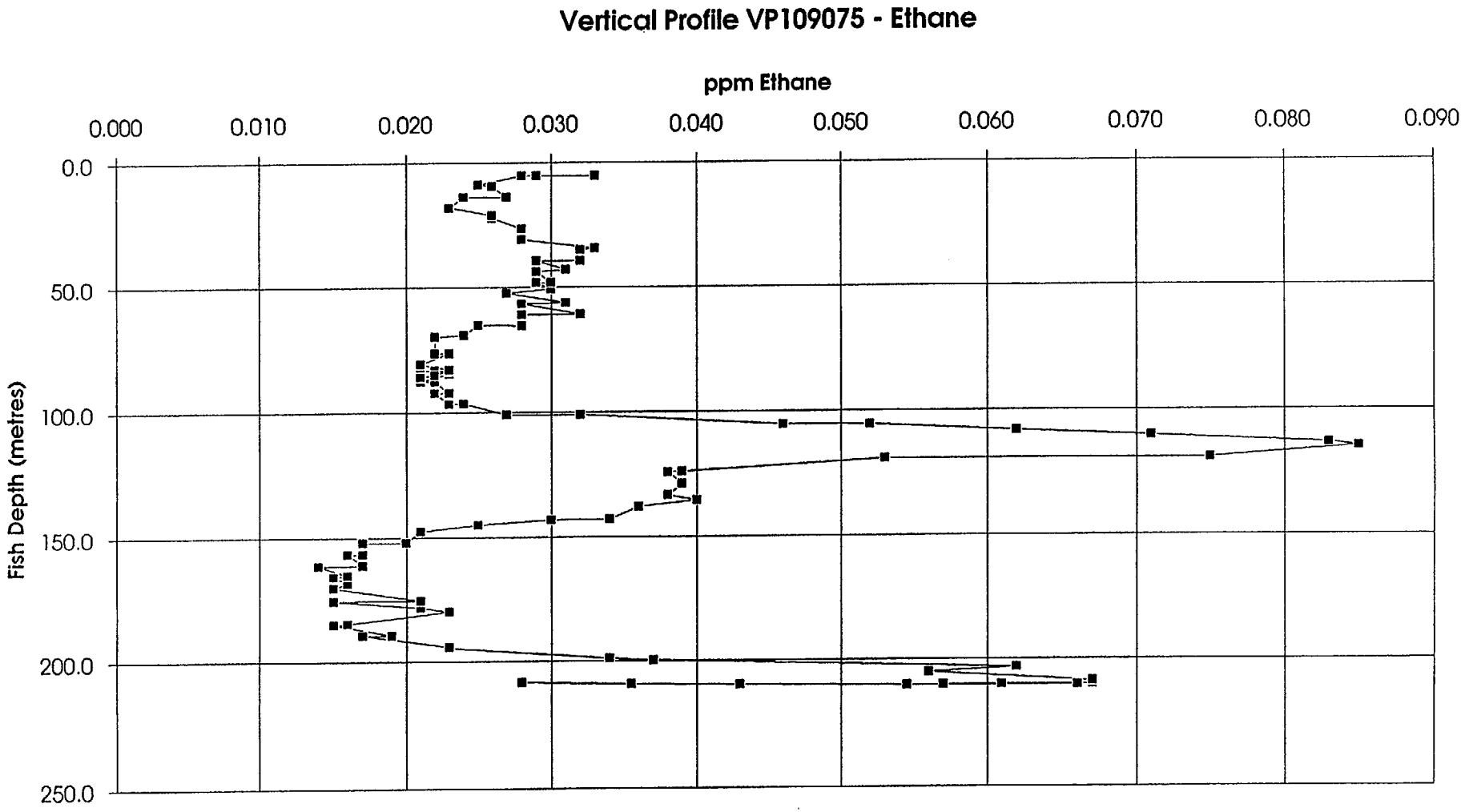

Vertical Profile VP109075 - Temperature
Degrees Celcius
20.00
21.00
22.00
23.00
24.00
25.00
26.00
27.00
28.00
29.00
30.00
Fish Depth (metres)
0.0
50.0
100.0
150.0
200.0
250.0

Vertical Profile VP109075 - Conductivity

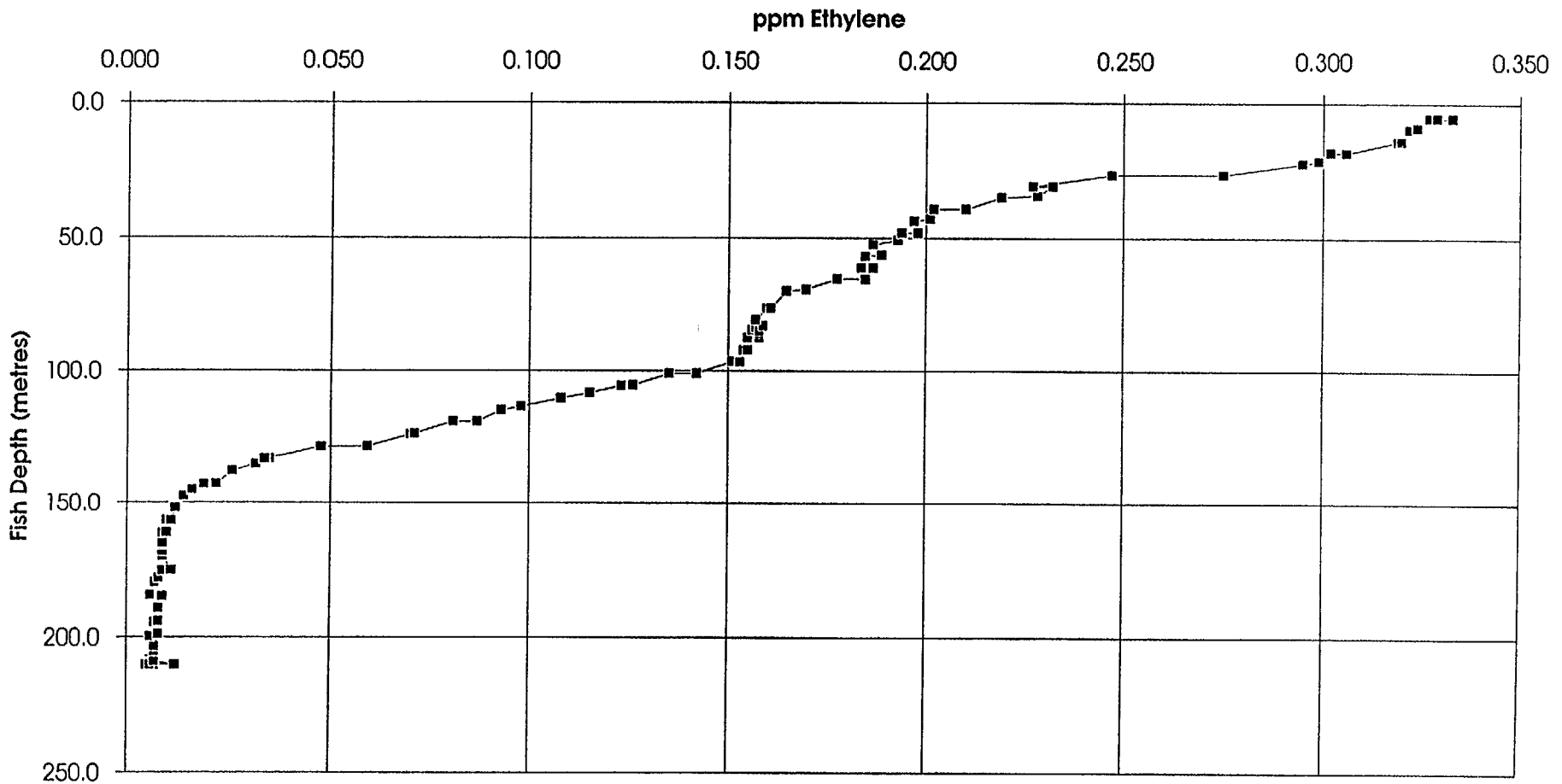


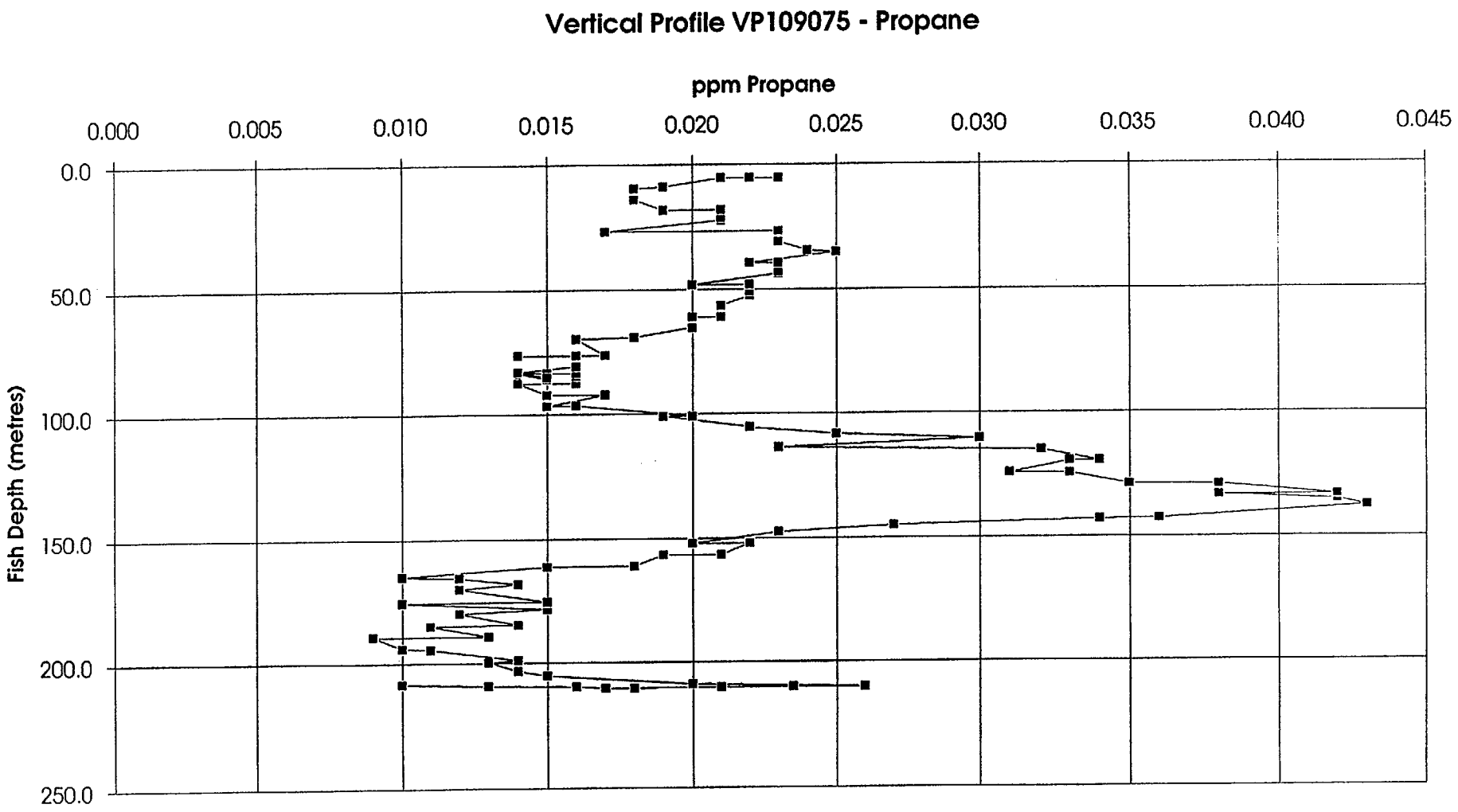

Vertical Profile VP109075 - THC
ppm THC
0.00
50.00
100.00
150.00
200.00
250.00
300.00
Fish Depth (metres)
0.0
50.0
100.0
150.0
200.0
250.0


Vertical Profile VP109075 - Methane
ppm Methane
0.00
50.00
100.00
150.00
200.00
250.00
300.00
Fish Depth (metres)
0.0
50.0
100.0
150.0
200.0
250.0

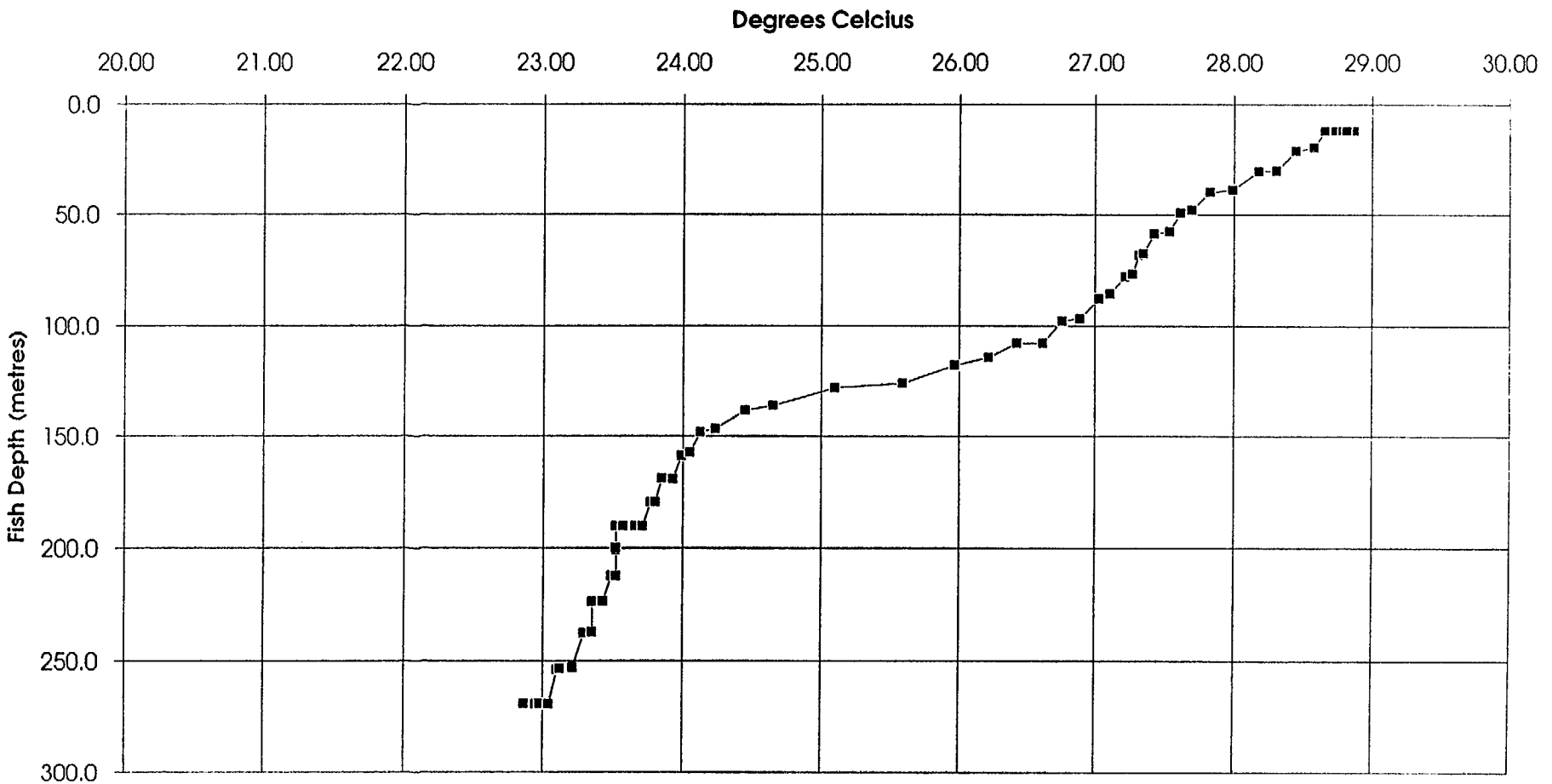

Vertical Profile VP109075 - Ethane
ppm Ethane
0.000
0.010
0.020
0.030
0.040
0.050
0.060
0.070
0.080
0.090
Fish Depth (metres)
0.0
50.0
100.0
150.0
200.0
250.0

Vertical Profile VP109075 - Ethylene

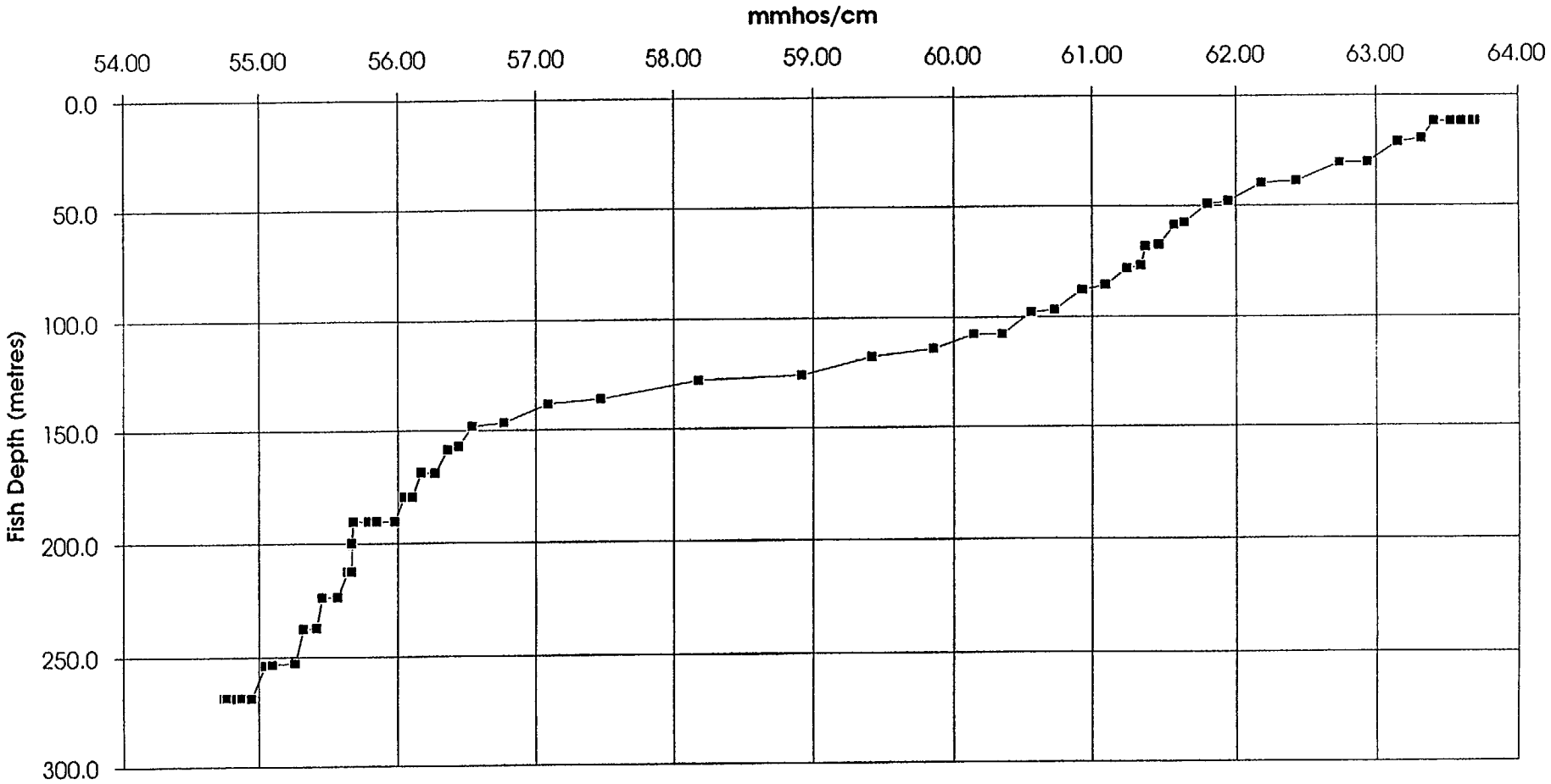



Vertical Profile VP109075 - Propane
ppm Propane
0.000
0.005
0.010
0.015
0.020
0.025
0.030
0.035
0.040
0.045
Fish Depth (metres)
0.0
50.0
100.0
150.0
200.0
250.0

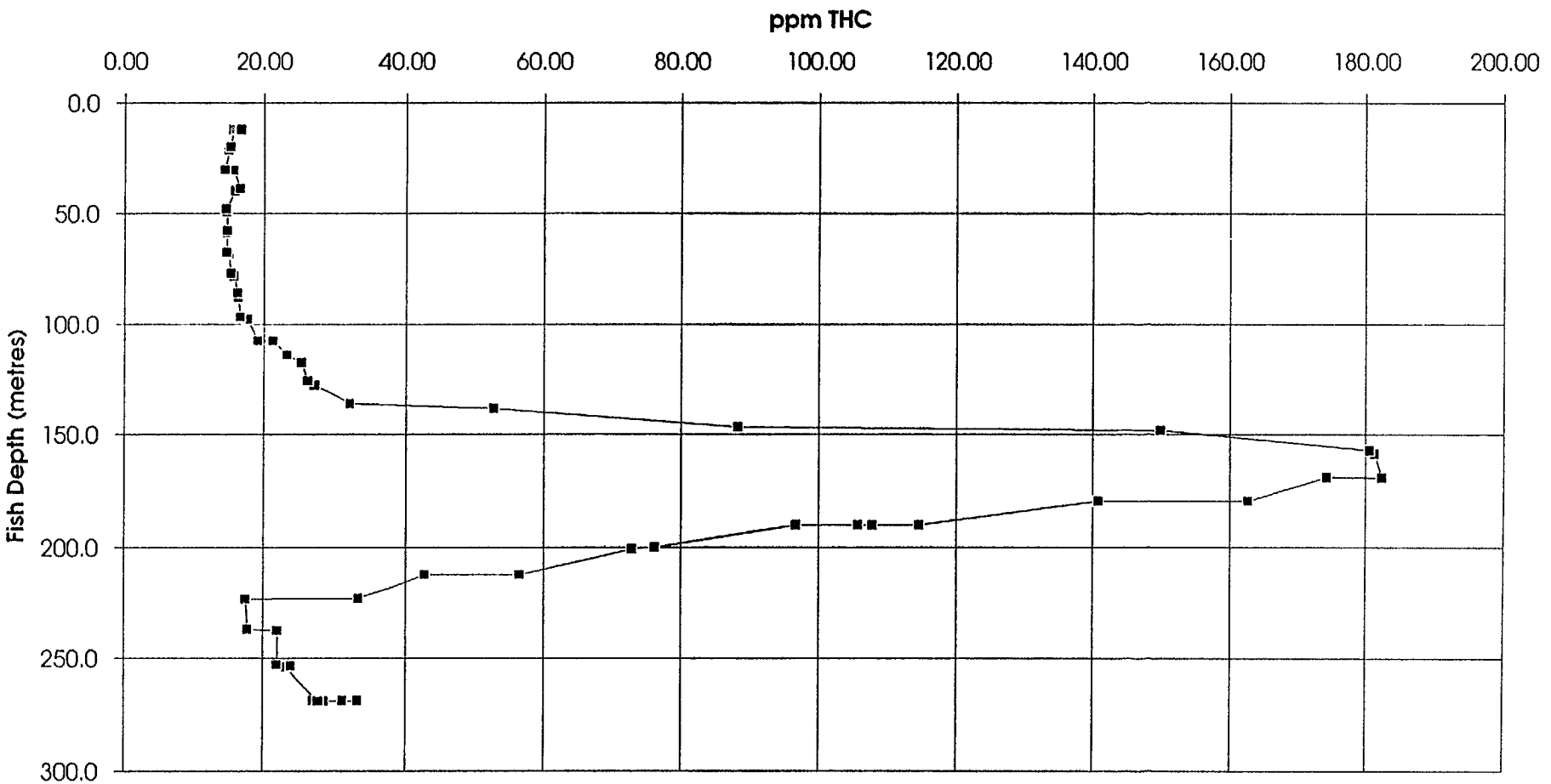
Vertical Profile VP109076 - Temperature



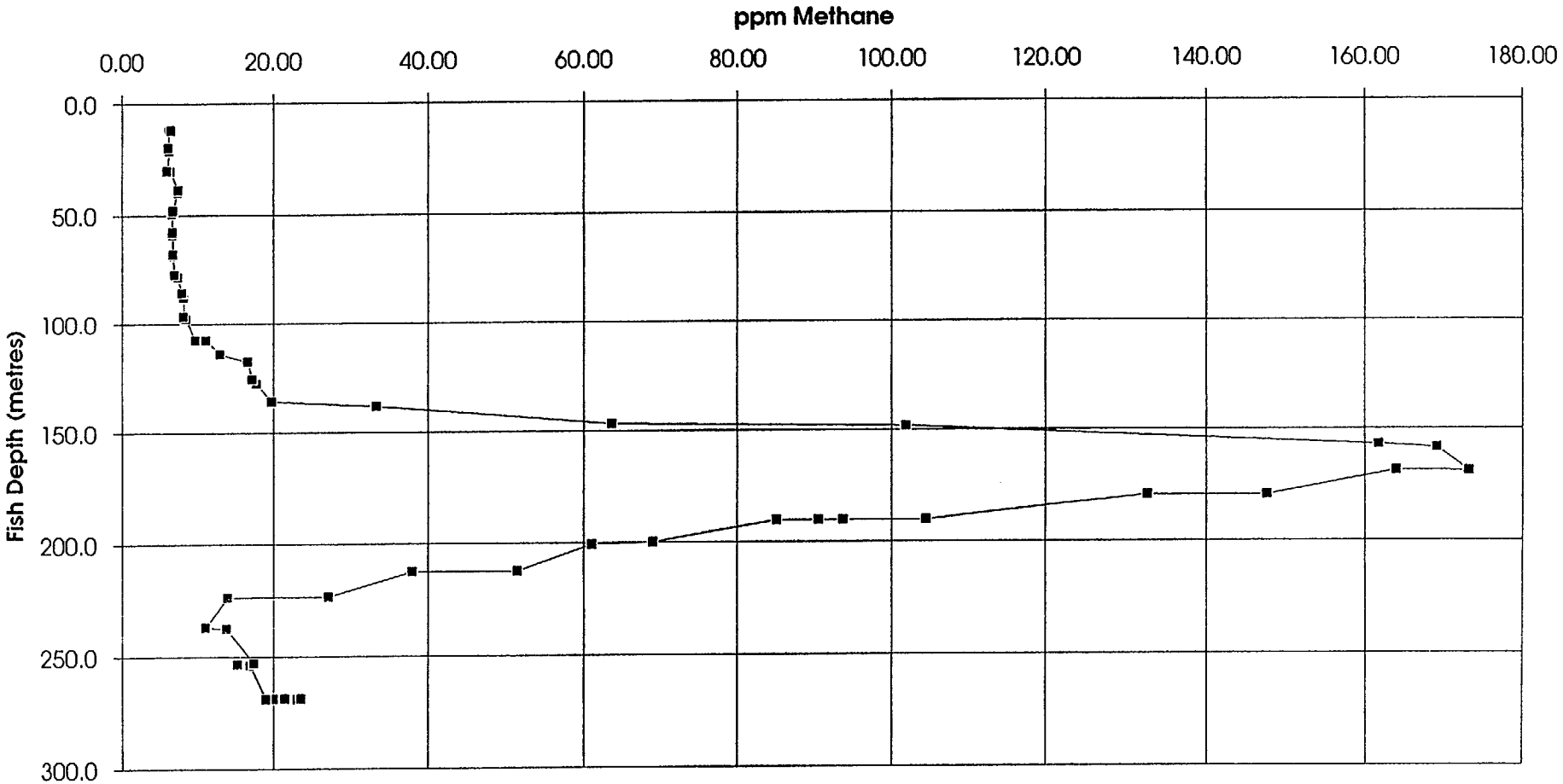
Vertical Profile VP109076 - Conductivity

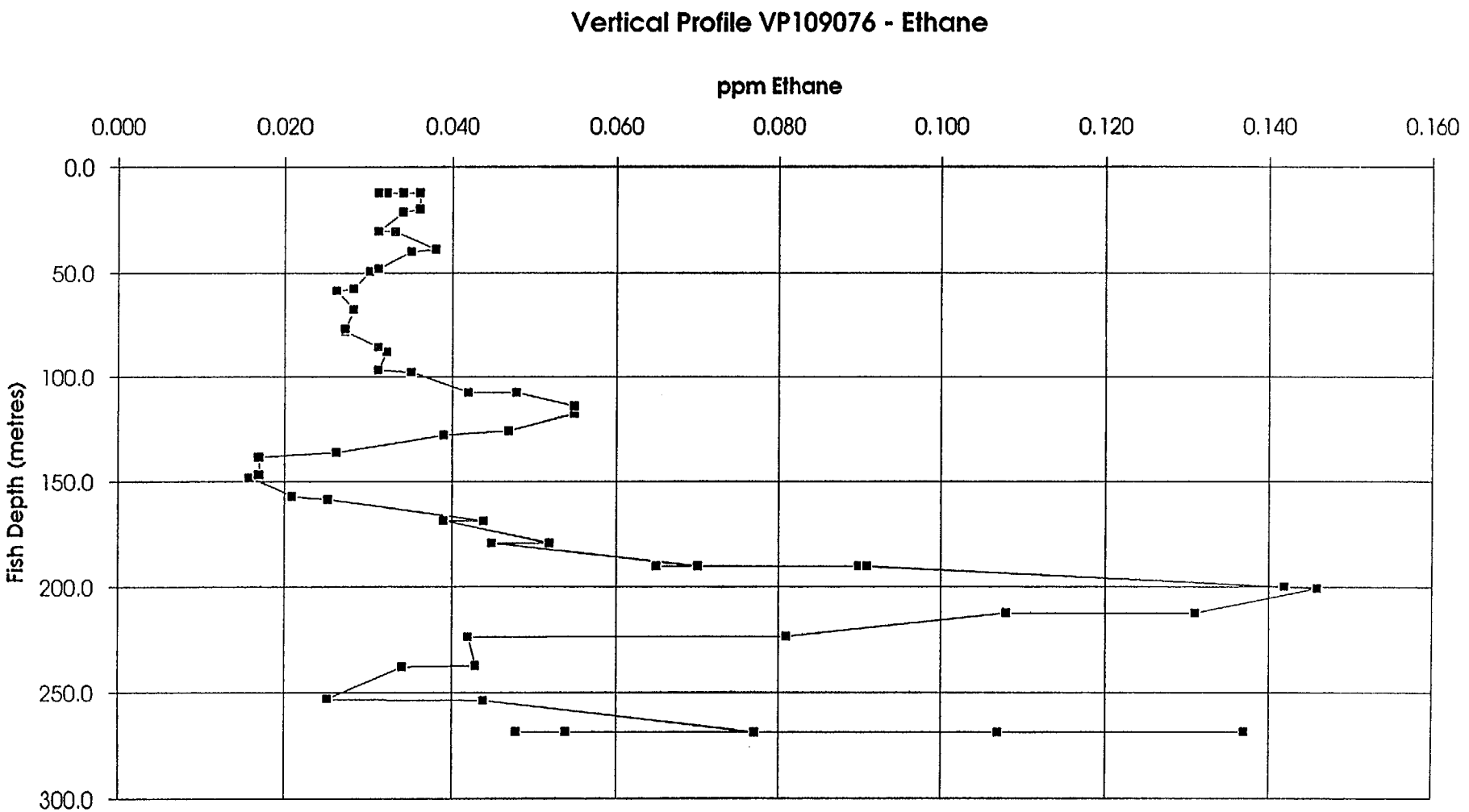


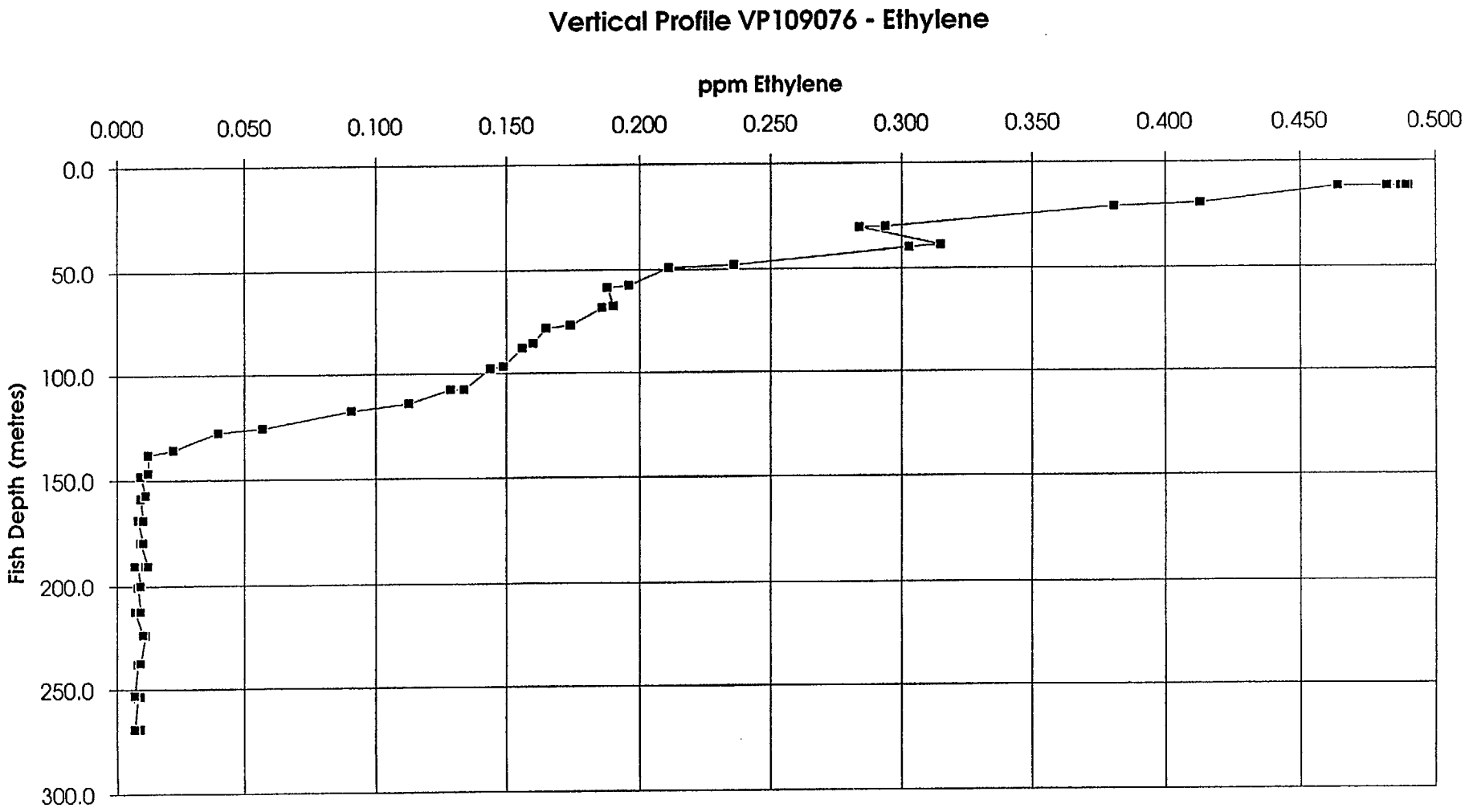
Vertical Profile VP109076 - THC

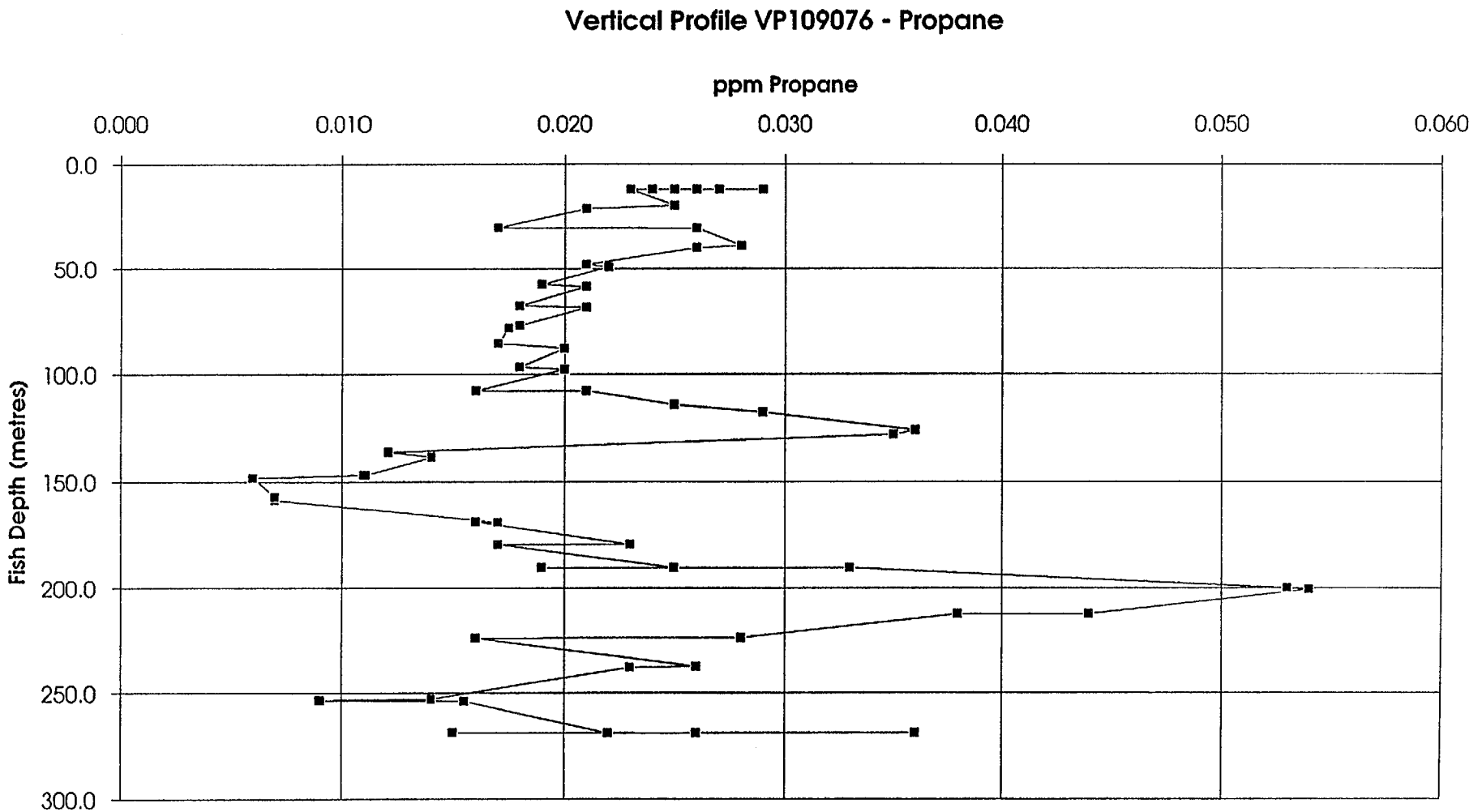


Vertical Profile VP109076 - Methane

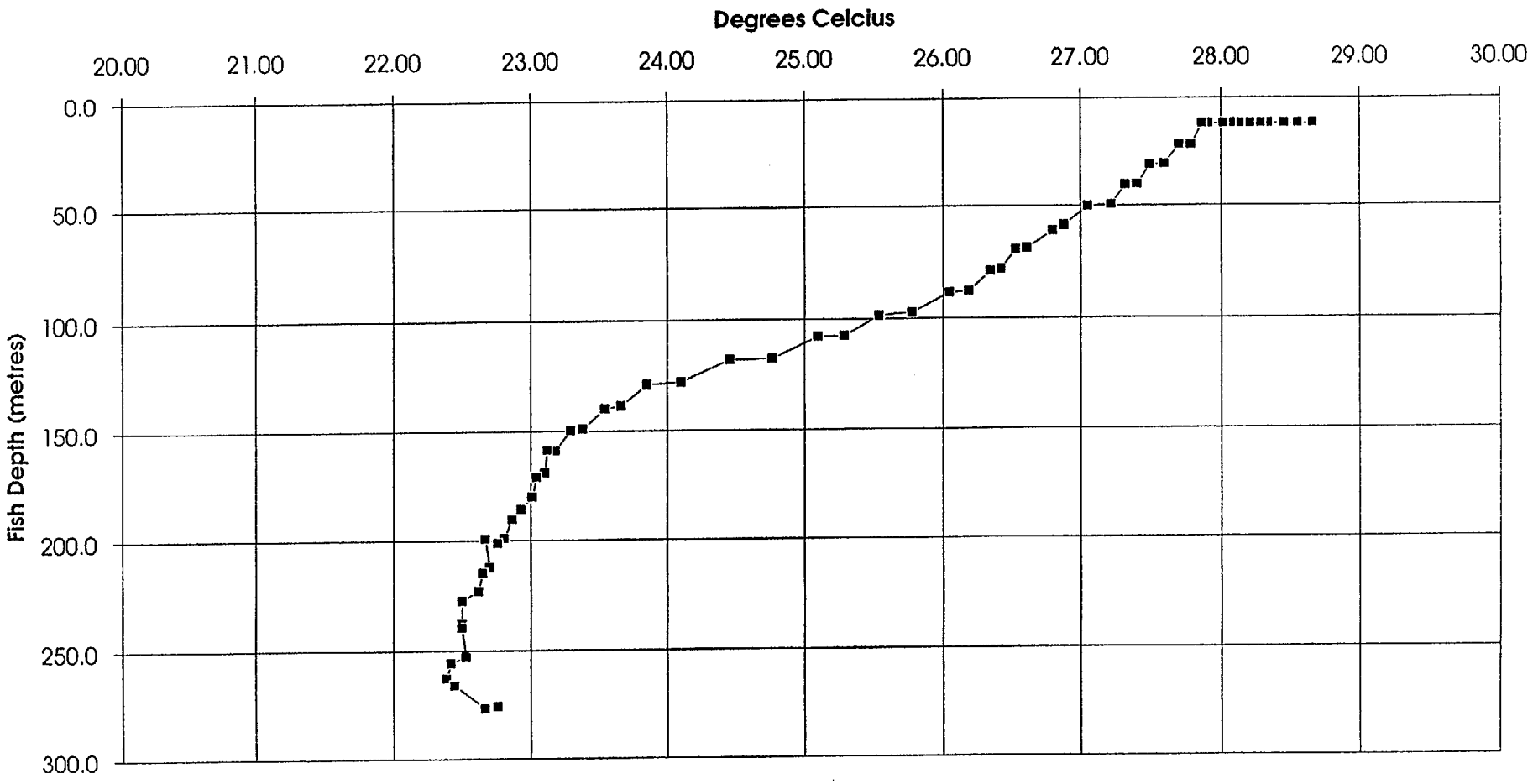



Vertical Profile VP109076 - Ethane
ppm Ethane
0.000
0.020
0.040
0.060
0.080
0.100
0.120
0.140
0.160
Fish Depth (metres)
0.0
50.0
100.0
150.0
200.0
250.0
300.0

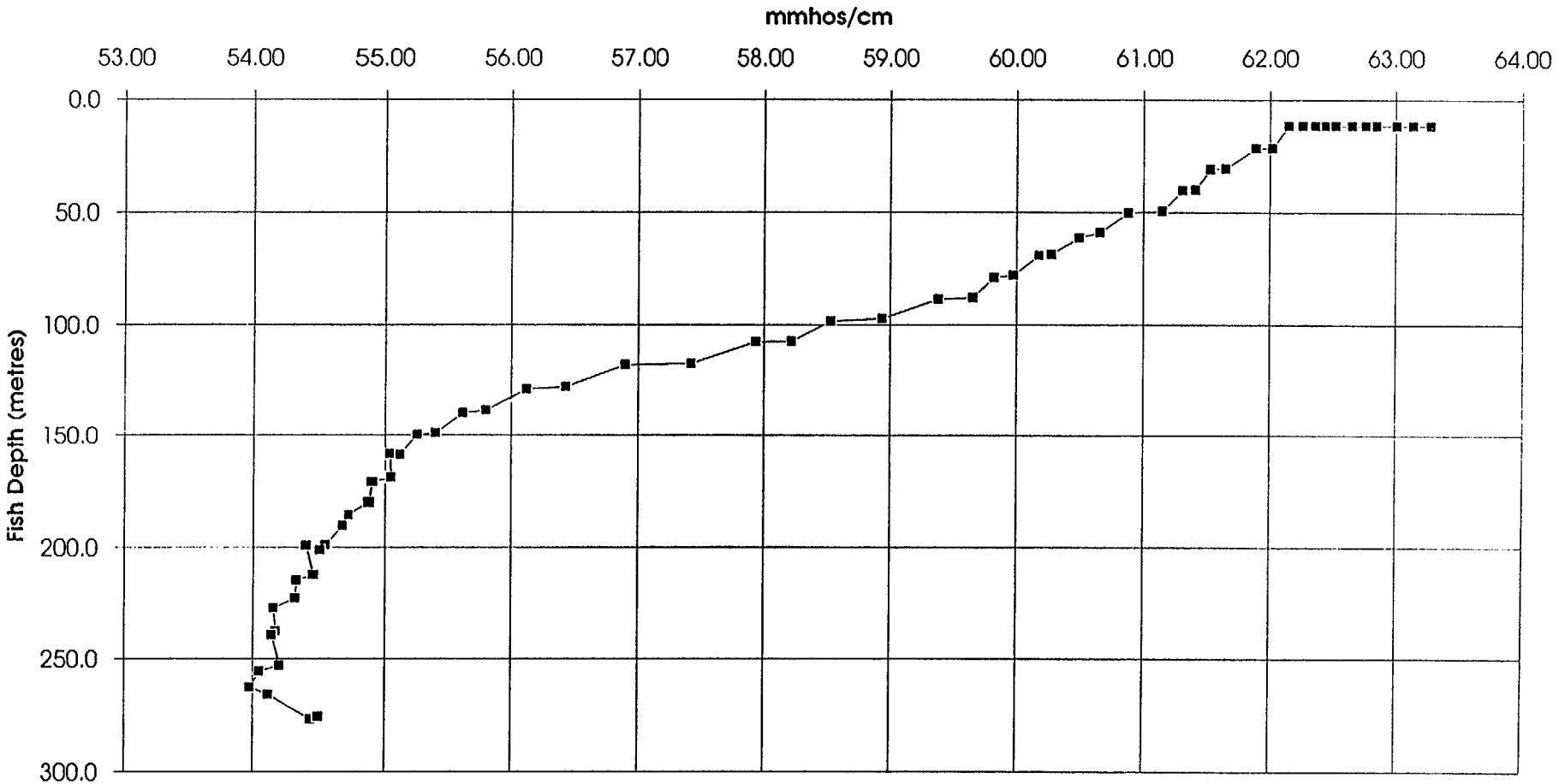

Vertical Profile VP109076 - Ethylene
ppm Ethylene
0.000
0.050
0.100
0.150
0.200
0.250
0.300
0.350
0.400
0.450
0.500
Fish Depth (metres)
0.0
50.0
100.0
150.0
200.0
250.0
300.0

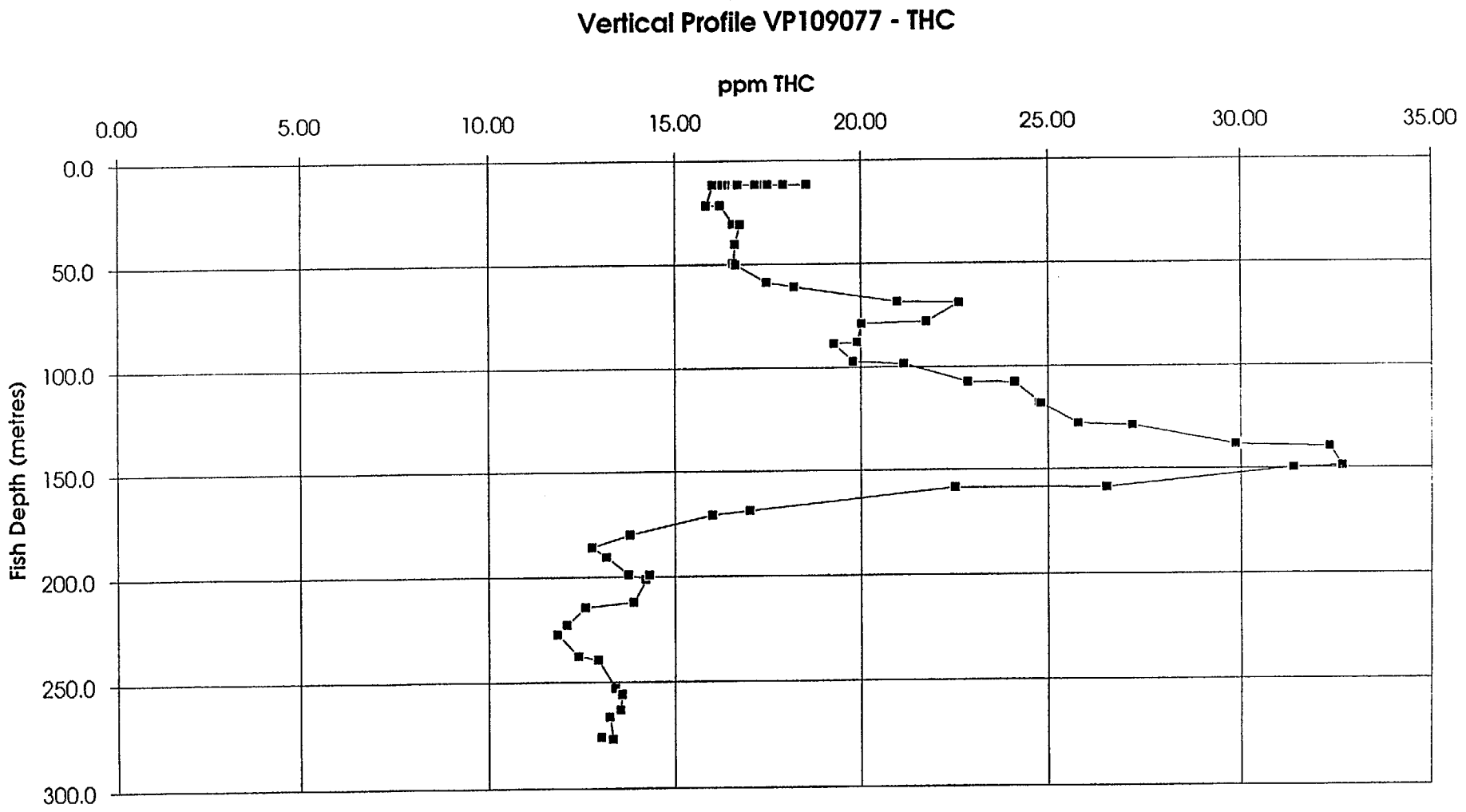

Vertical Profile VP109076 - Propane
ppm Propane
0.000
0.010
0.020
0.030
0.040
0.050
0.060
Fish Depth (metres)
0.0
50.0
100.0
150.0
200.0
250.0
300.0

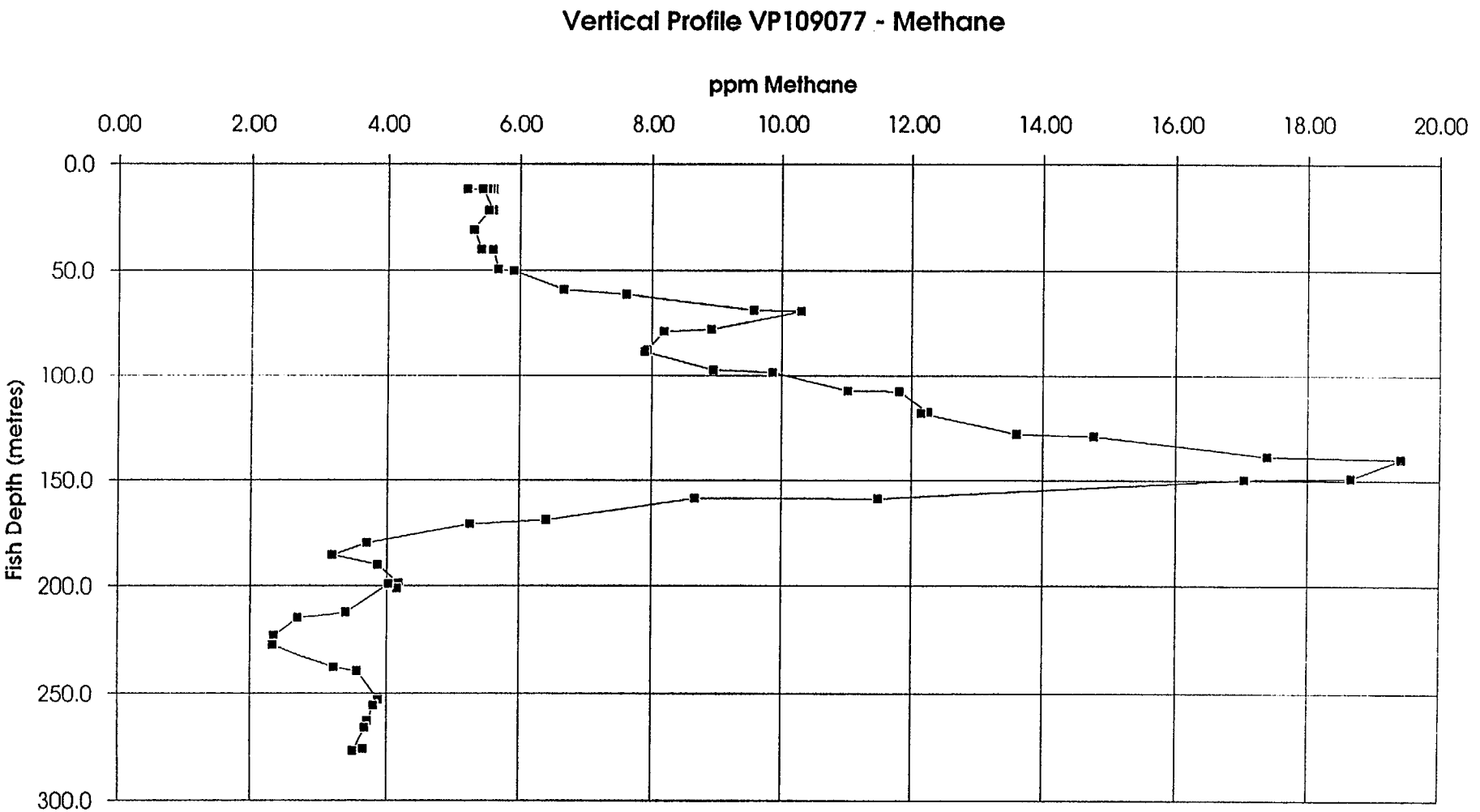
Vertical Profile VP109077 - Temperature



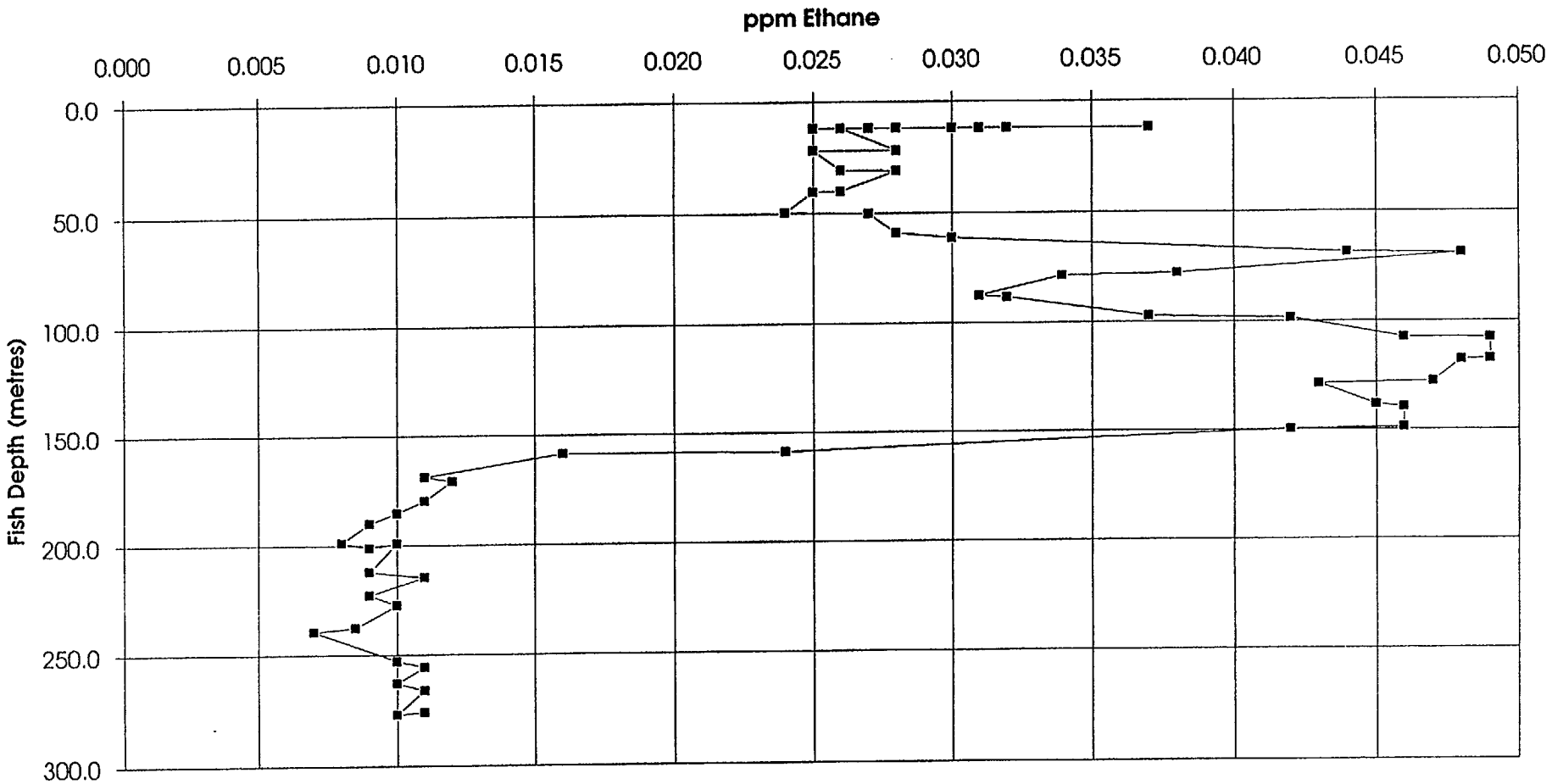
Vertical Profile VP109077 - Conductivity

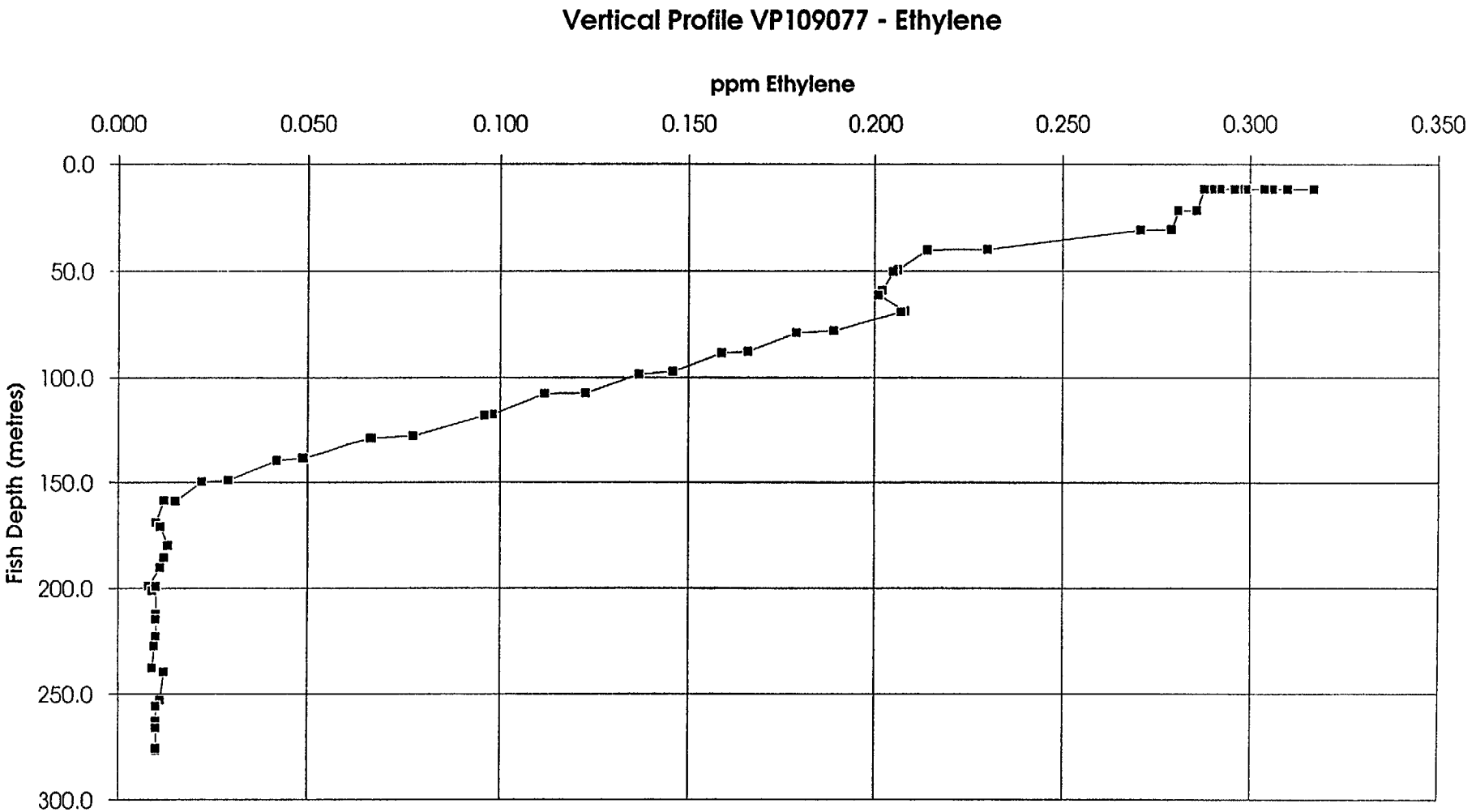


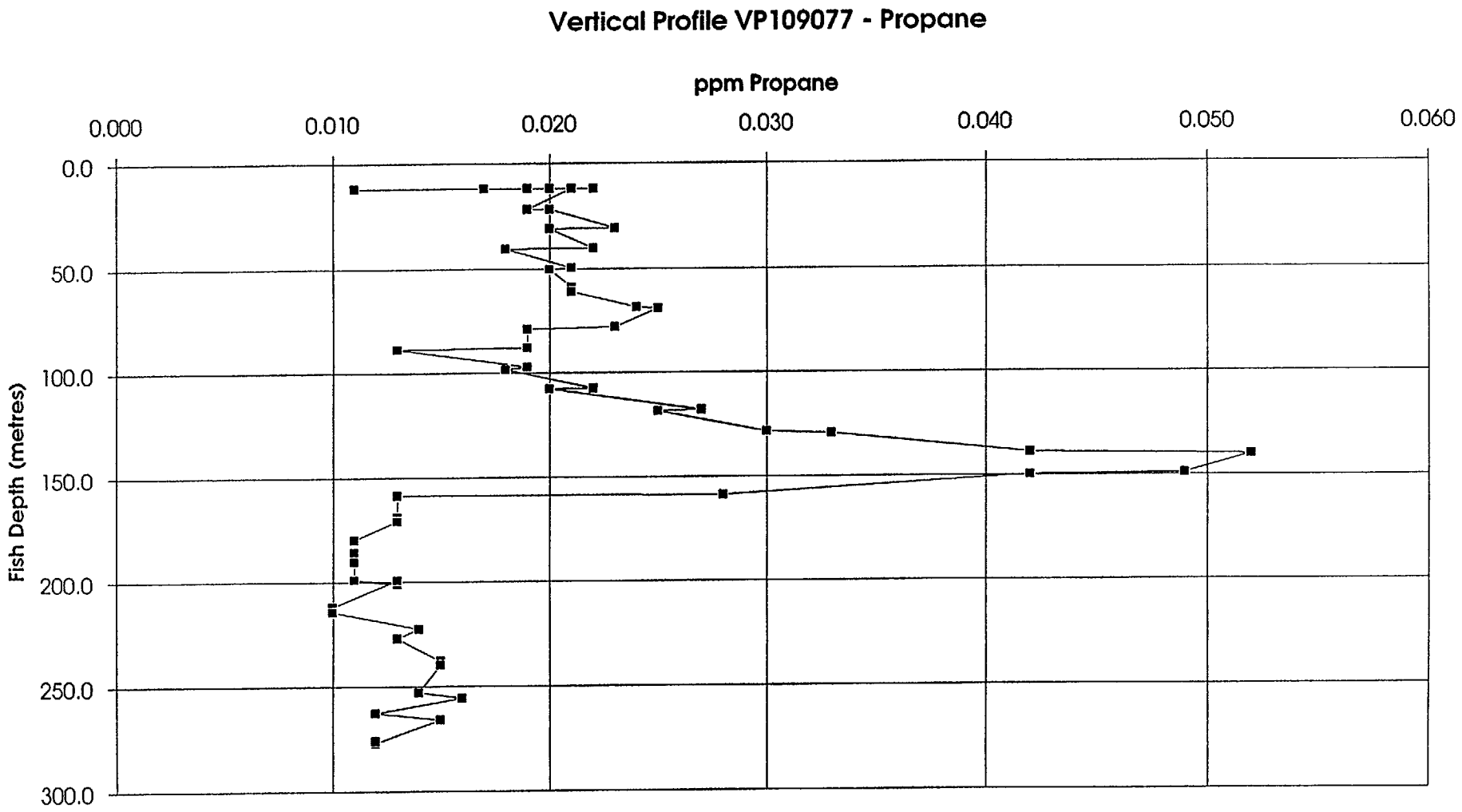

Vertical Profile VP109077 - THC
ppm THC
0.00
5.00
10.00
15.00
20.00
25.00
30.00
35.00
Fish Depth (metres)
0.0
50.0
100.0
150.0
200.0
250.0
300.0

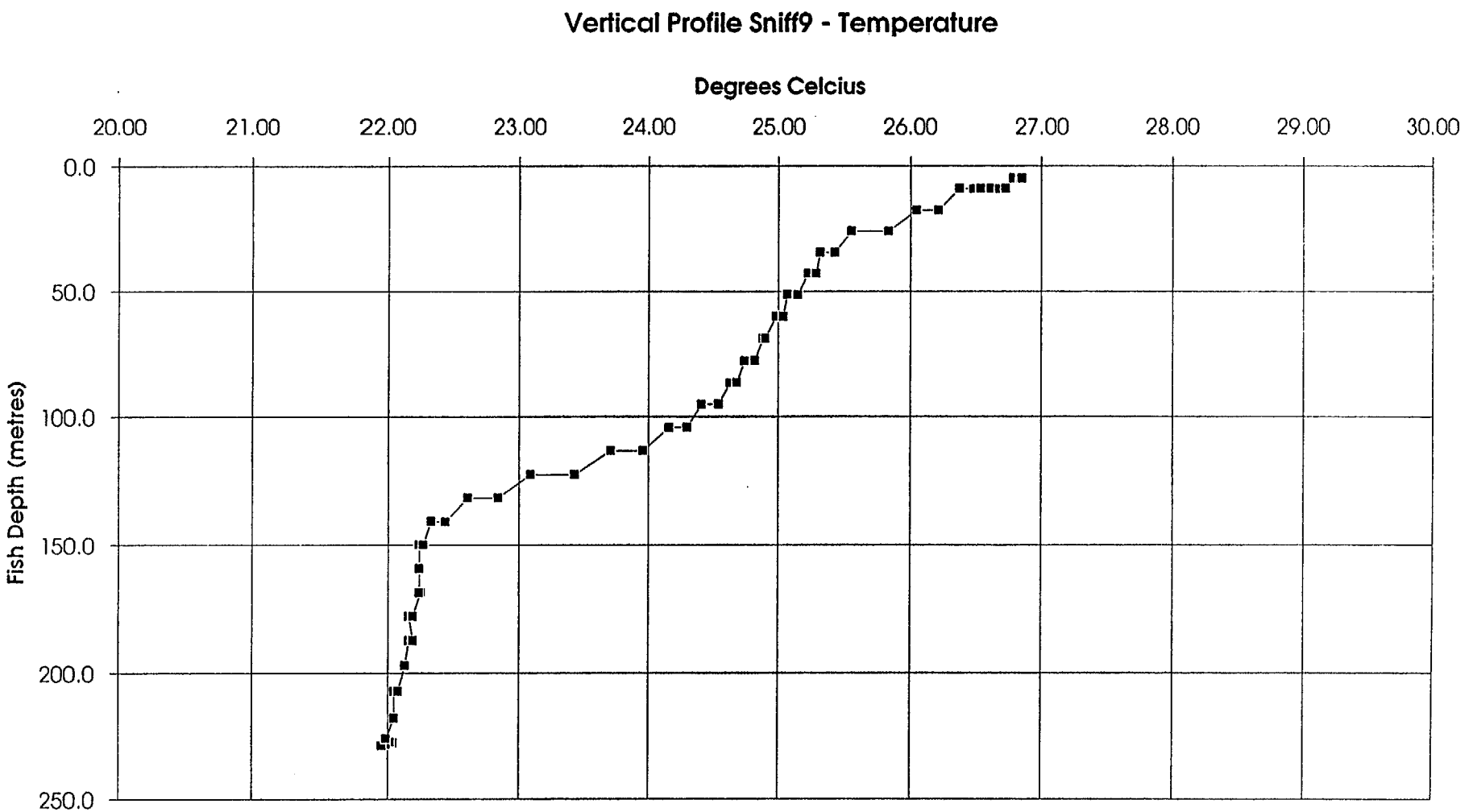

Vertical Profile VP109077 - Methane
ppm Methane
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
16.00
18.00
20.00
Fish Depth (metres)
0.0
50.0
100.0
150.0
200.0
250.0
300.0

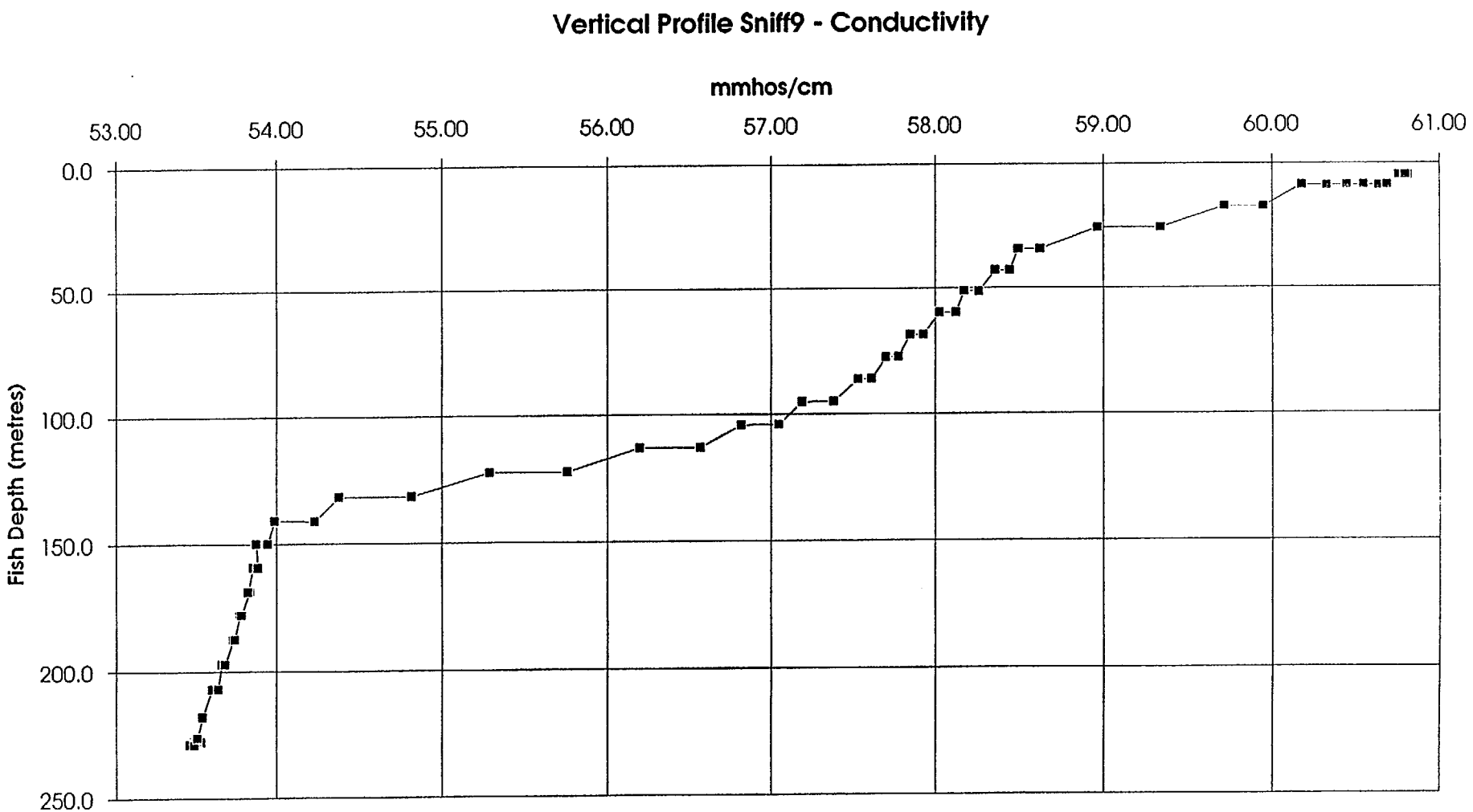
Vertical Profile VP109077 - Ethane

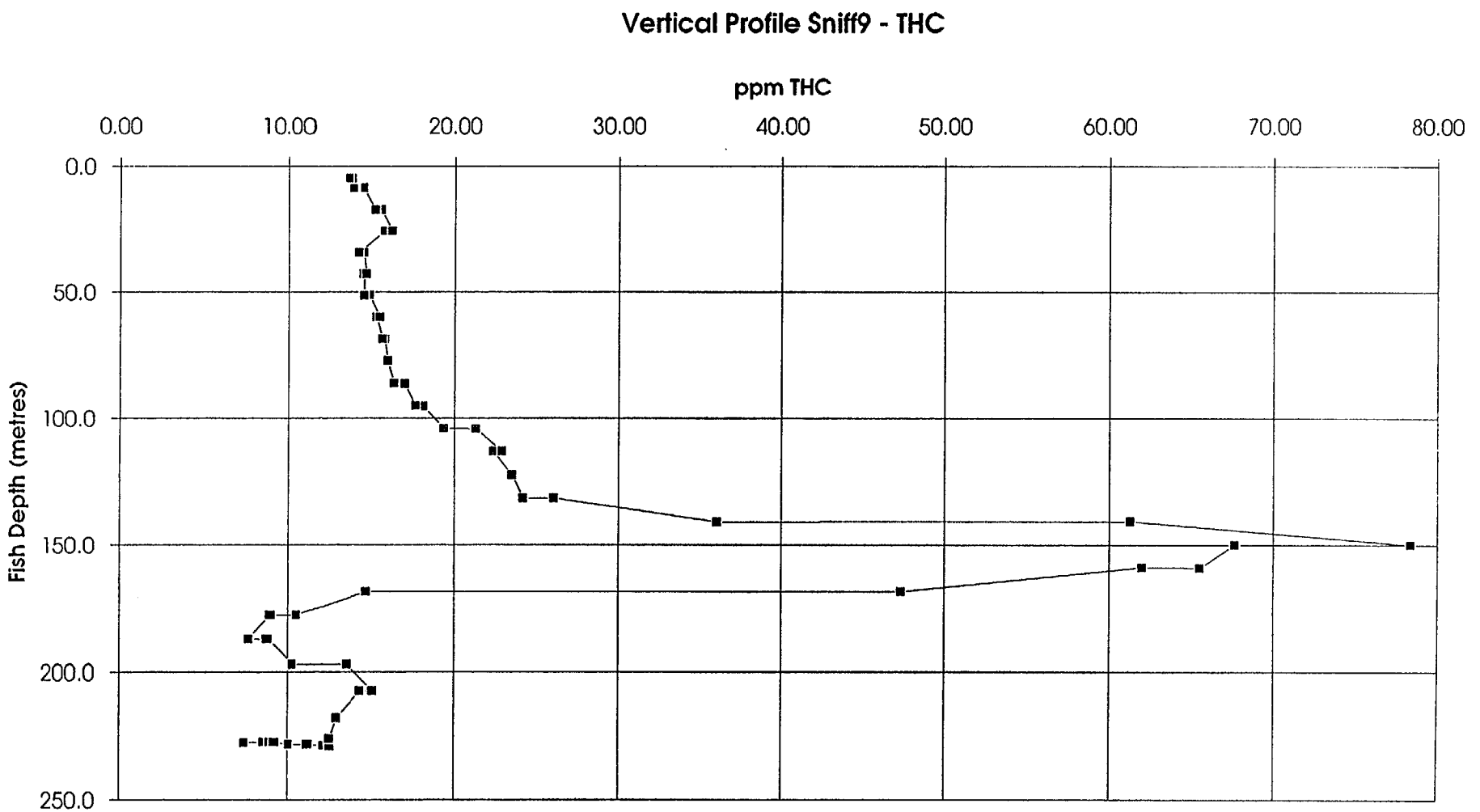


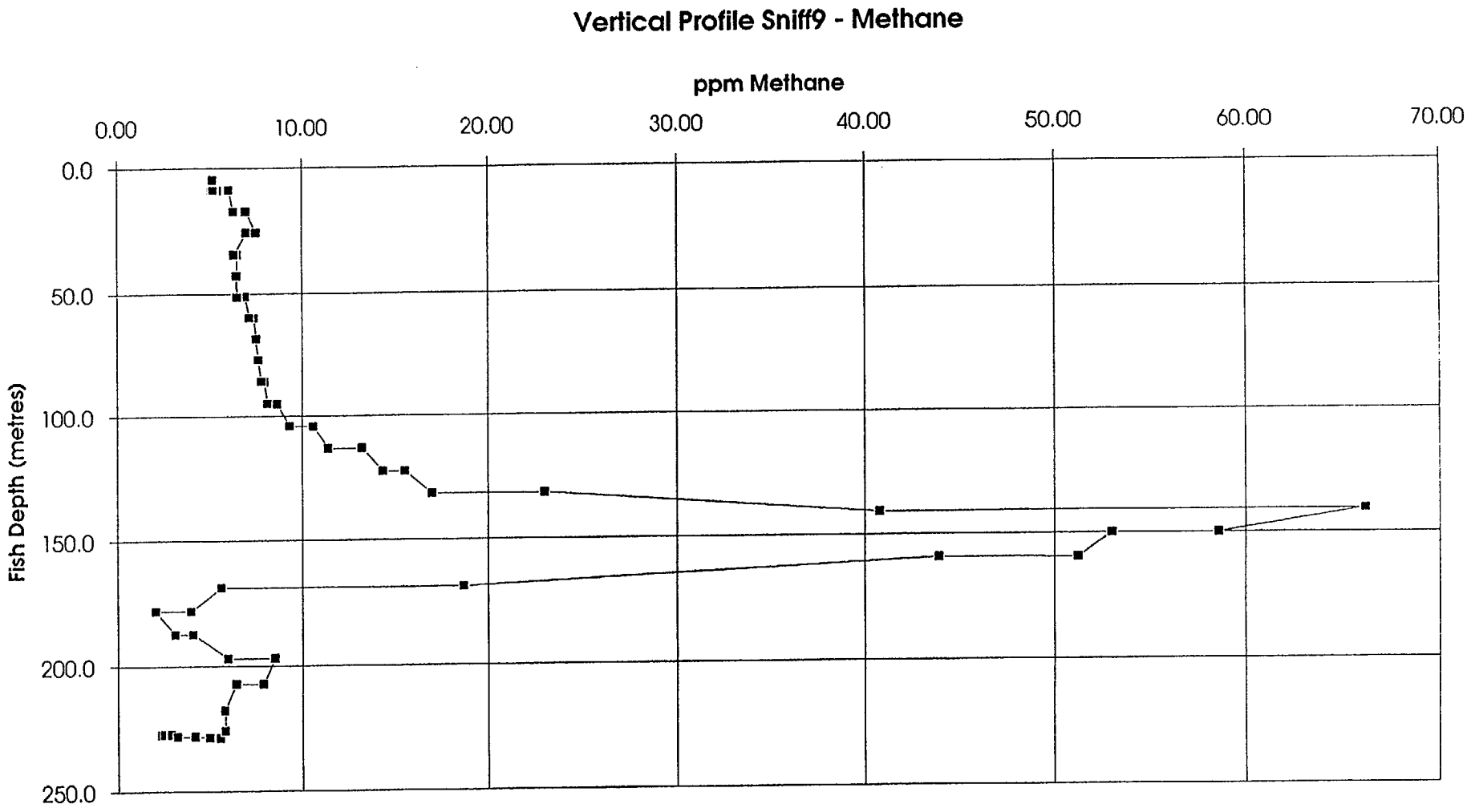

Vertical Profile VP109077 - Ethylene
ppm Ethylene
0.000
0.050
0.100
0.150
0.200
0.250
0.300
0.350
Fish Depth (metres)
0.0
50.0
100.0
150.0
200.0
250.0
300.0


Vertical Profile VP109077 - Propane
ppm Propane
0.000
0.010
0.020
0.030
0.040
0.050
0.060
Fish Depth (metres)
0.0
50.0
100.0
150.0
200.0
250.0
300.0

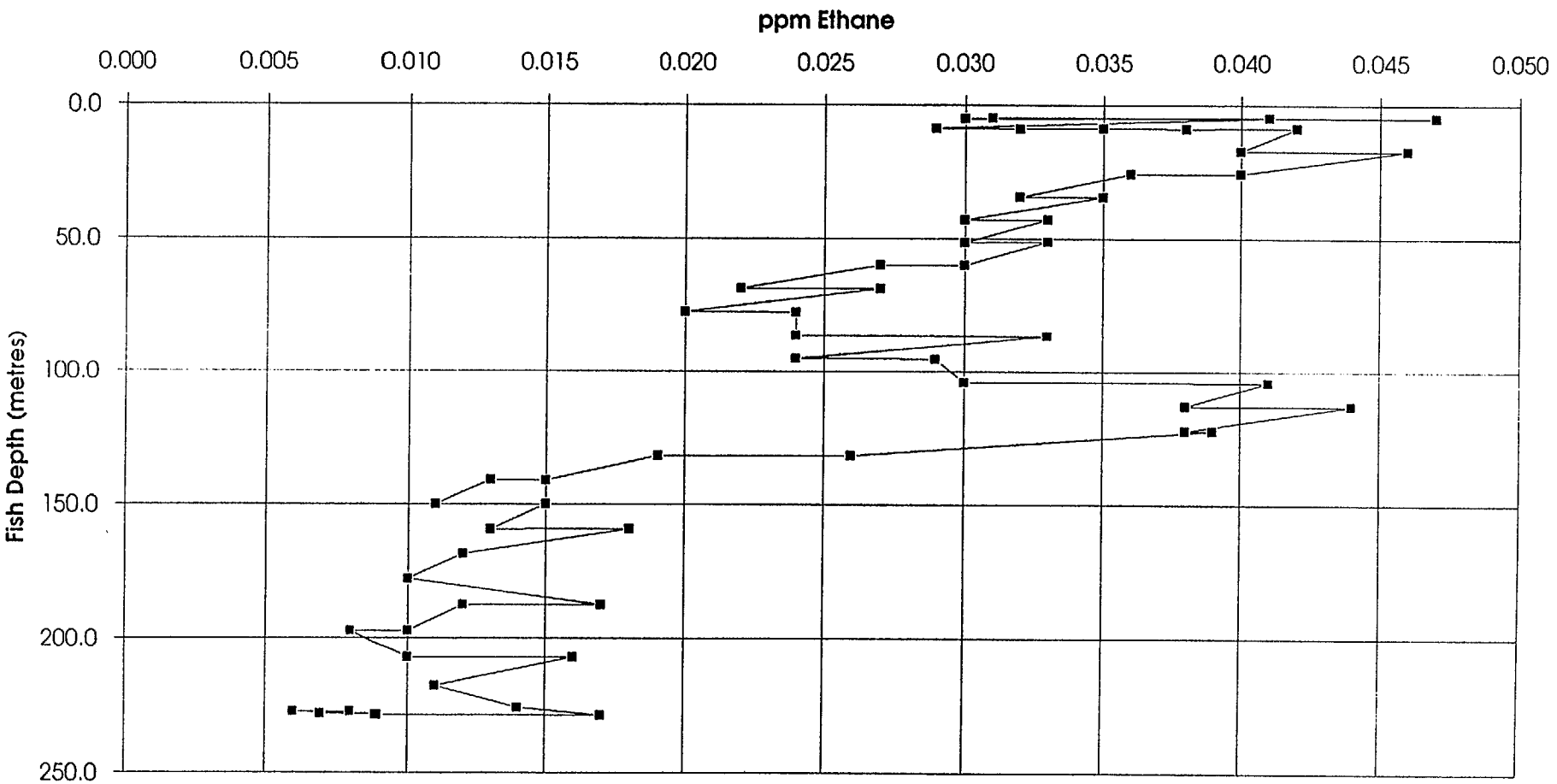

Vertical Profile Sniff9 - Temperature
Degrees Celcius
20.00
21.00
22.00
23.00
24.00
25.00
26.00
27.00
28.00
29.00
30.00
Fish Depth (metres)
0.0
50.0
100.0
150.0
200.0
250.0

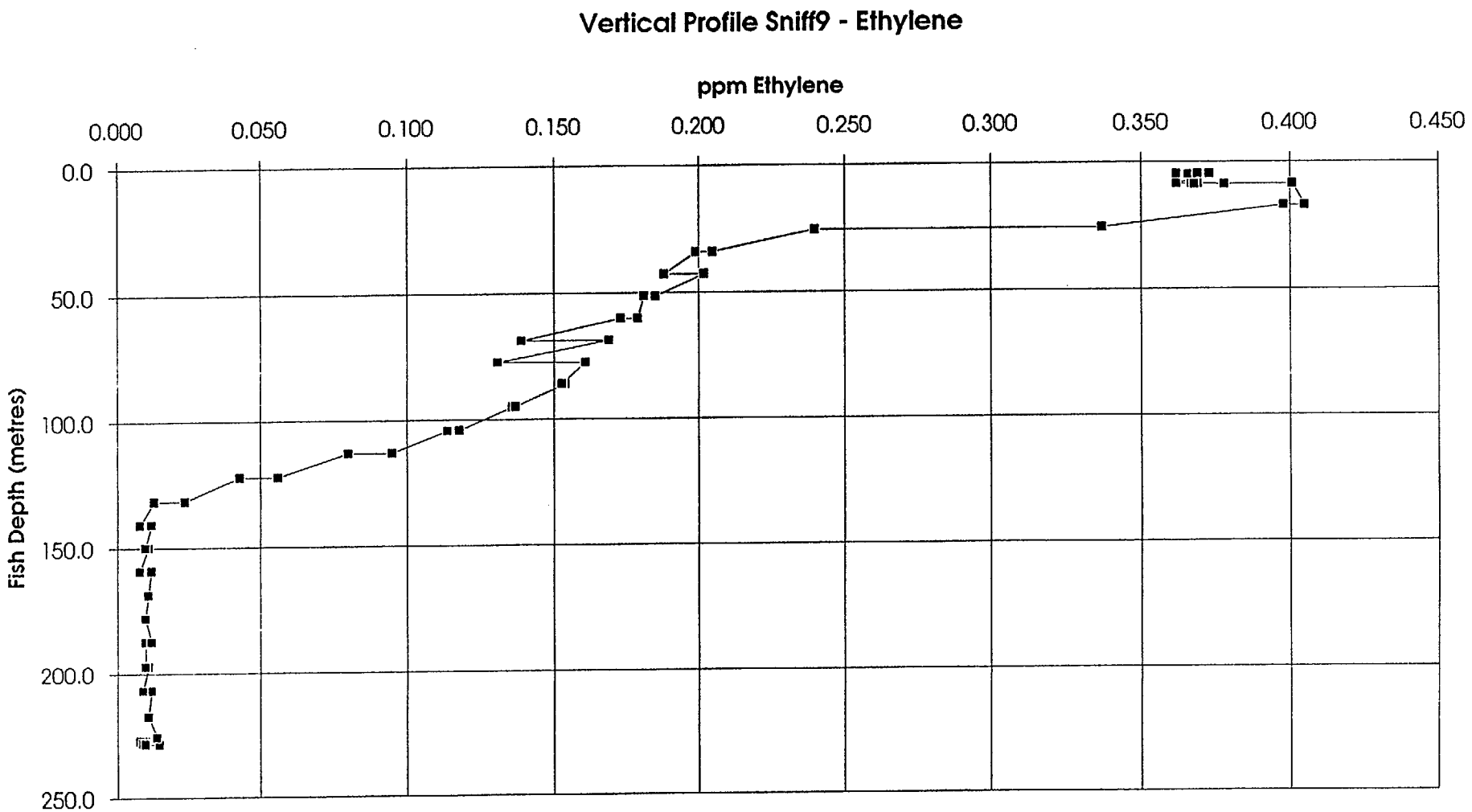

Vertical Profile Sniff9 - Conductivity
mmhos/cm
53.00
54.00
55.00
56.00
57.00
58.00
59.00
60.00
61.00
Fish Depth (metres)
0.0
50.0
100.0
150.0
200.0
250.0

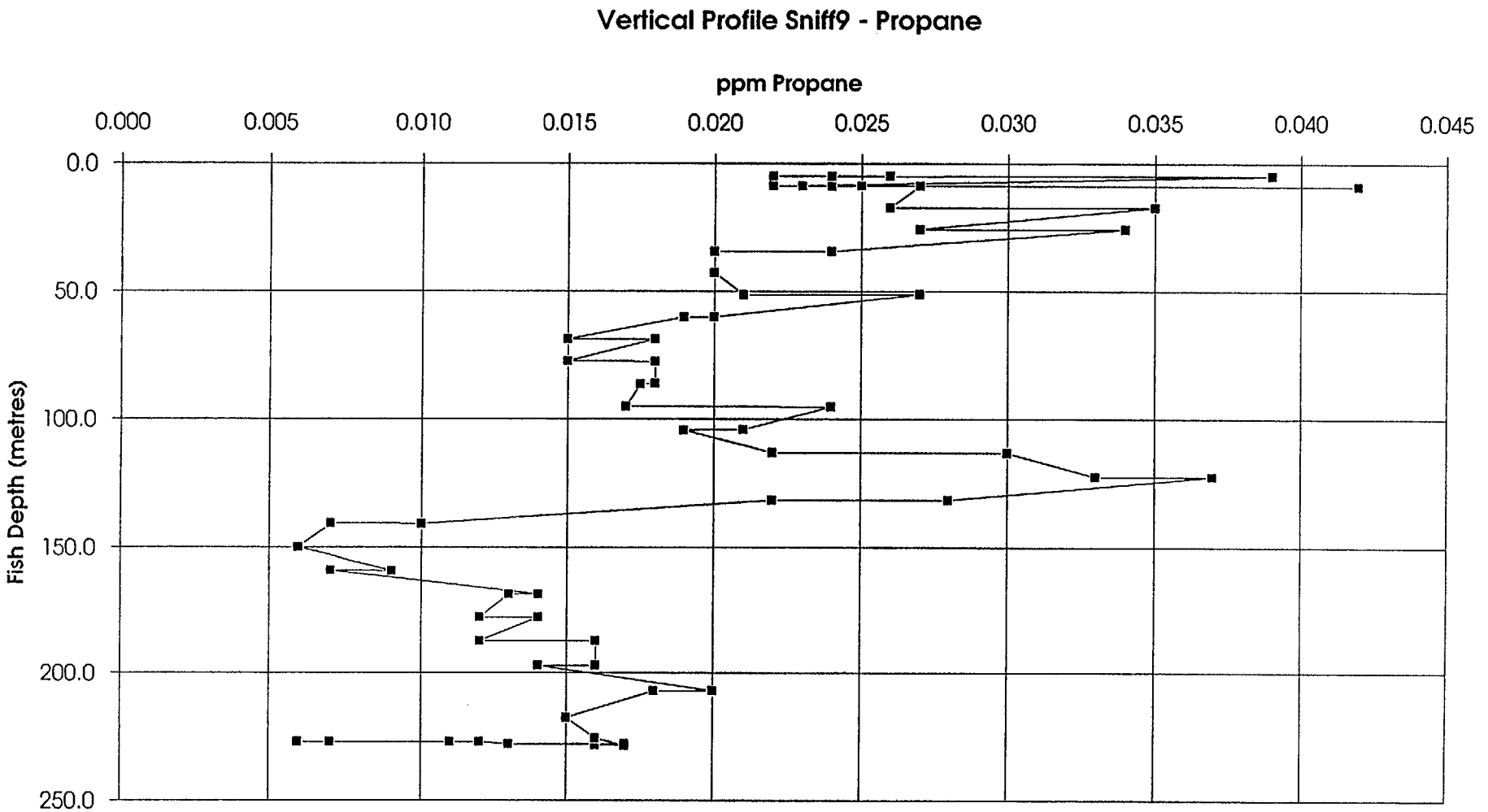

Vertical Profile Sniff9 - THC
ppm THC
0.00
10.00
20.00
30.00
40.00
50.00
60.00
70.00
80.00
Fish Depth (metres)
0.0
50.0
100.0
150.0
200.0
250.0


Vertical Profile Sniff9 - Methane
ppm Methane
0.00
10.00
20.00
30.00
40.00
50.00
60.00
70.00
Fish Depth (metres)
0.0
50.0
100.0
150.0
200.0
250.0

Vertical Profile Sniff9 - Ethane




Vertical Profile Sniff9 - Ethylene
ppm Ethylene
0.000
0.050
0.100
0.150
0.200
0.250
0.300
0.350
0.400
0.450
Fish Depth (metres)
0.0
50.0
100.0
150.0
200.0
250.0


Vertical Profile Sniff9 - Propane
ppm Propane
0.000
0.005
0.010
0.015
0.020
0.025
0.030
0.035
0.040
0.045
Fish Depth (metres)
0.0
50.0
100.0
150.0
200.0
250.0

APPENDIX II (PART A). RAGAY GULF LINE SUMMARY SHEETS AND INDIVIDUAL LINE PLOTS.

Line Summary

Line Number	109031
No. of Shotpoints	235

	Shotpoint	Date	Time	Latitude		Longitude	
Start	1	17-Apr-92	20:21:15	13	03.410	122	31.789
End	237	18-Apr-92	04:20:48	13	27.233	123	05.058

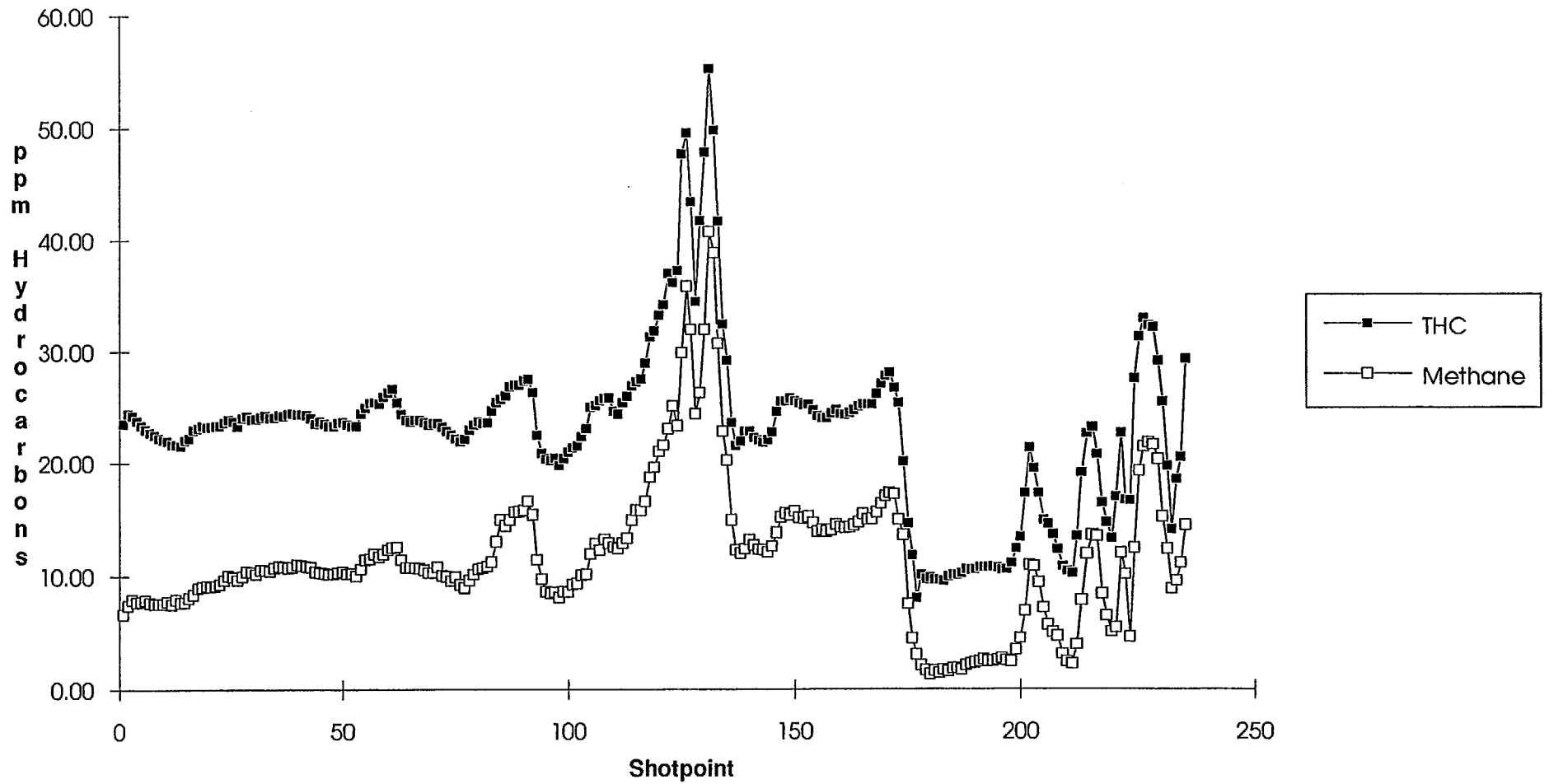
	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	23.092	11.580	0.031	0.085	0.022	0.030	0.001	0.000	0.004	0.065	0.038	0.028	0.559
Std. Dev.	7.304	6.327	0.012	0.064	0.011	0.024	0.004	0.001	0.004	0.028	0.025	0.005	0.246
Minimum	8.085	1.344	0.009	0.019	0.004	0.000	0.000	0.000	0.000	0.030	0.011	0.011	0.116
Maximum	55.180	40.701	0.058	0.301	0.057	0.092	0.016	0.012	0.015	0.186	0.128	0.046	1.898

	Cond.	Temp.	F. Depth	W.Depth	Altitude	Calc. Alt.
Mean	56.692	24.129	138.889	382.266	23.260	243.593
Std. Dev.	1.119	0.728	33.585	307.196	8.249	314.790
Minimum	55.120	23.060	67.100	83.100	10.300	0.300
Maximum	59.260	25.700	184.500	1223.100	30.900	1140.400

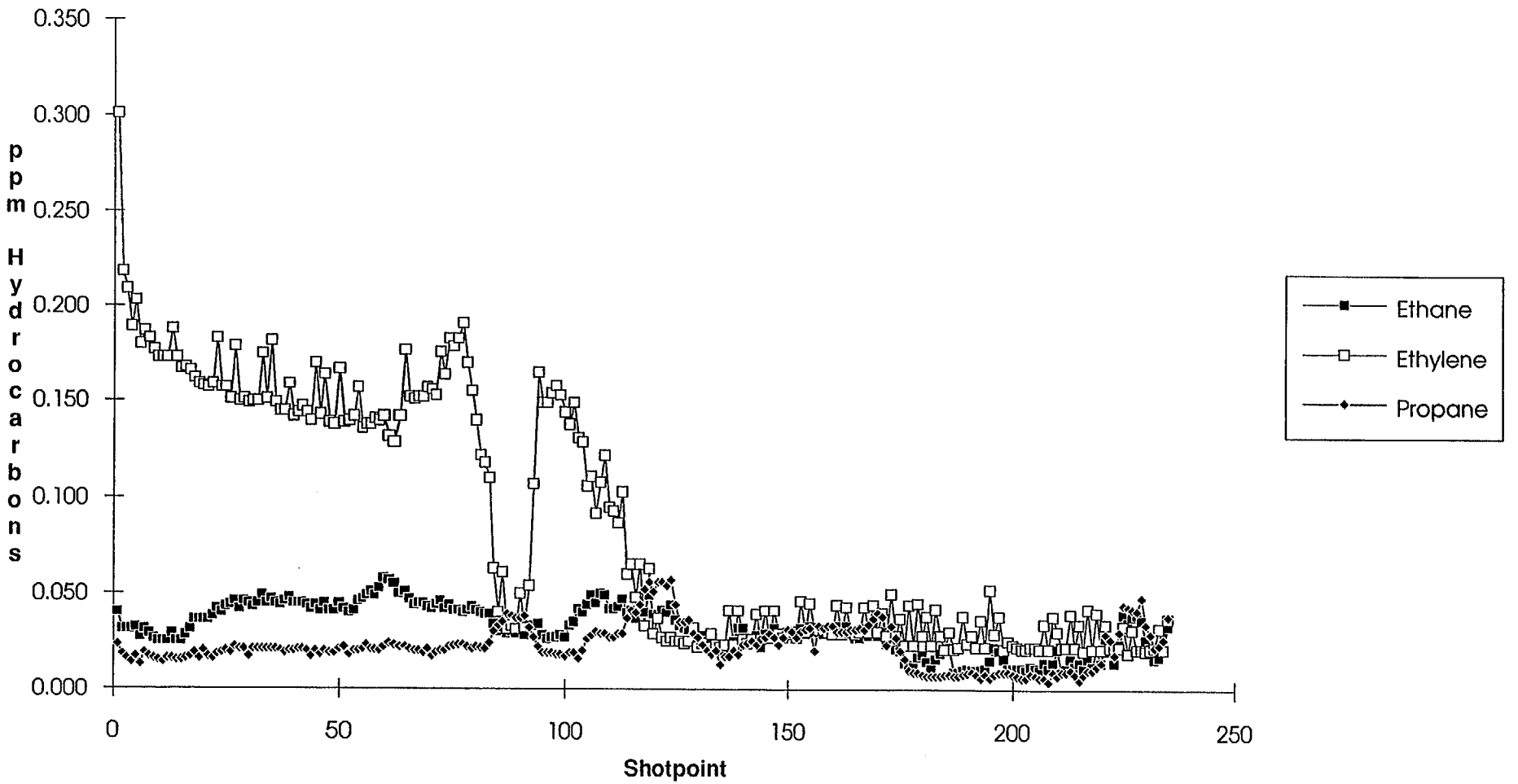
Notes

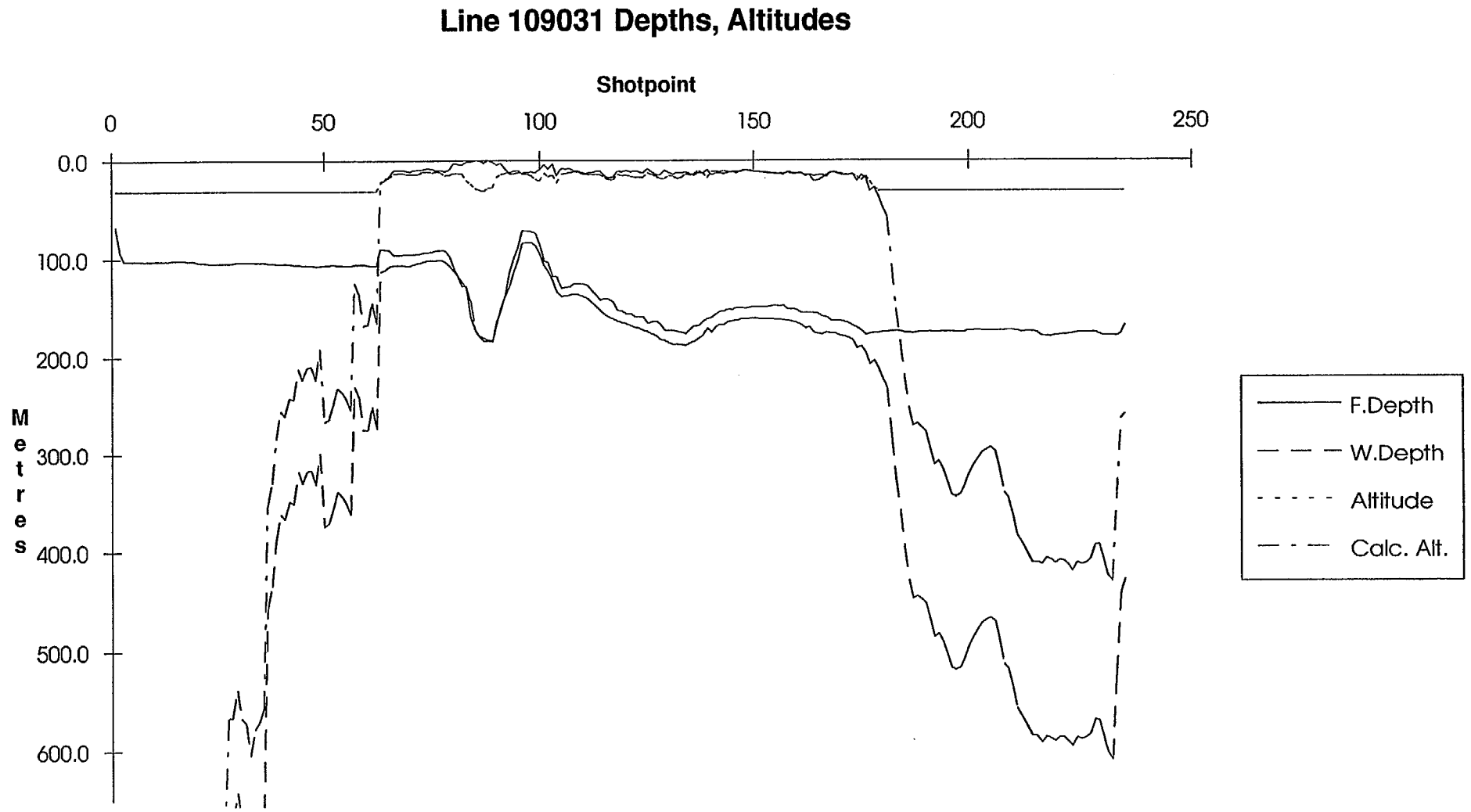
Weak THC and methane anomalies at SP 125 and from SP 200 to end of line.
Higher background levels of methane, ethane, ethylene, and propane from SP 1 to SP 175 are due to the influence of the thermocline, between 120m to 150m.

Line 109031 THC, Methane

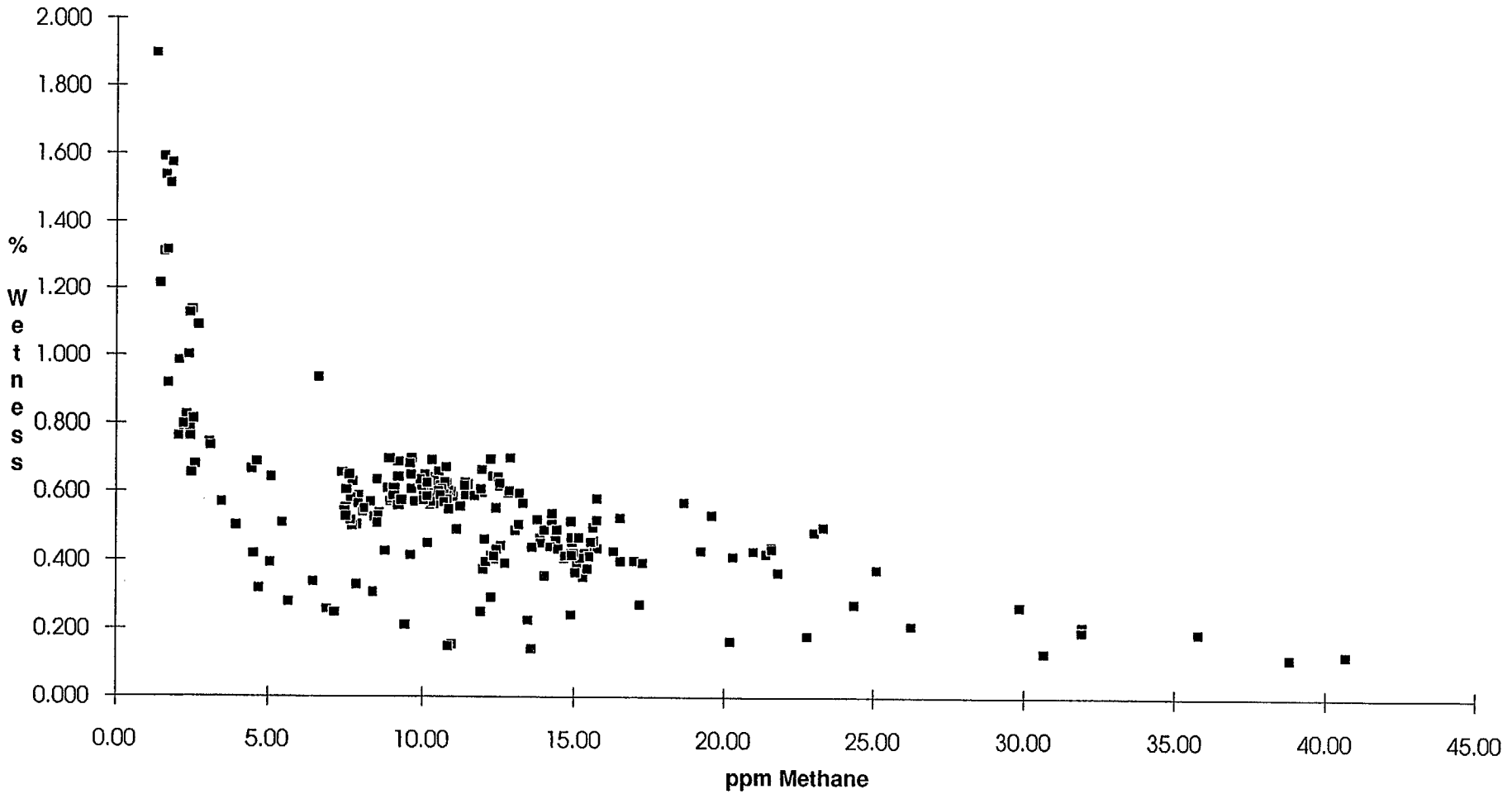


Line 109031 Ethane, Ethylene, Propane




Line 109031 Depths, Altitudes
Shotpoint
0
50
100
150
200
250
0.0
100.0
200.0
300.0
400.0
500.0
600.0
Metres
F.Depth
W.Depth
Altitude
Calc. Alt.

Line 109031 Methane v. %Wetness



R9209203

Line Summary

Line Number	109032
No. of Shotpoints	154

	Shotpoint	Date	Time	Latitude		Longitude	
Start	2	18-Apr-92	04:25:01	13	27.442	123	05.342
End	155	18-Apr-92	09:36:17	13	03.676	123	07.987

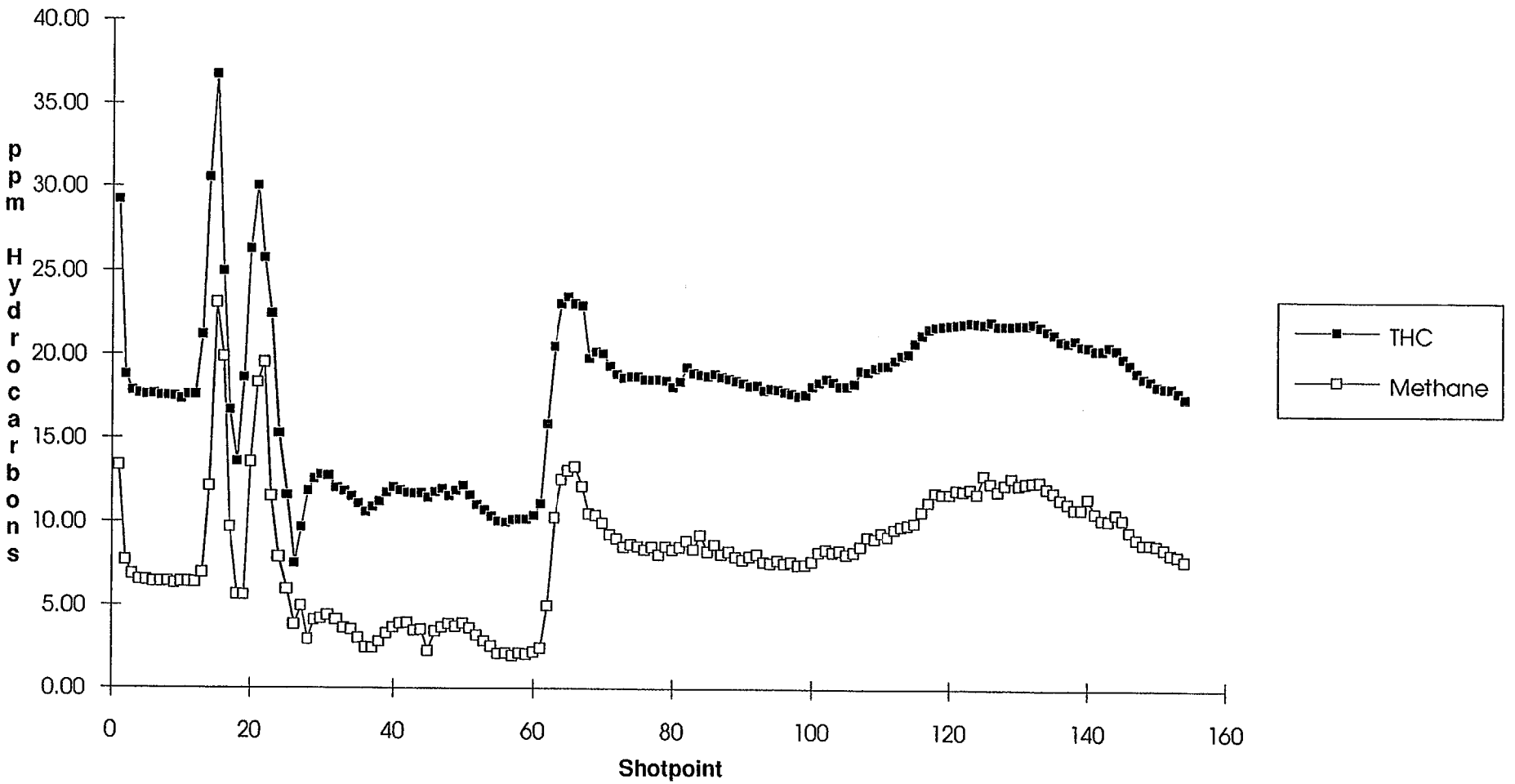
	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	17.909	8.228	0.021	0.096	0.017	0.040	0.001	0.001	0.001	0.086	0.027	0.033	0.566
Std. Dev.	4.626	3.733	0.011	0.055	0.013	0.021	0.006	0.004	0.002	0.033	0.009	0.008	0.316
Minimum	7.527	1.967	0.007	0.020	0.006	0.009	0.000	0.000	0.000	0.043	0.012	0.014	0.187
Maximum	36.743	23.077	0.077	0.235	0.112	0.184	0.036	0.022	0.014	0.187	0.046	0.060	2.196

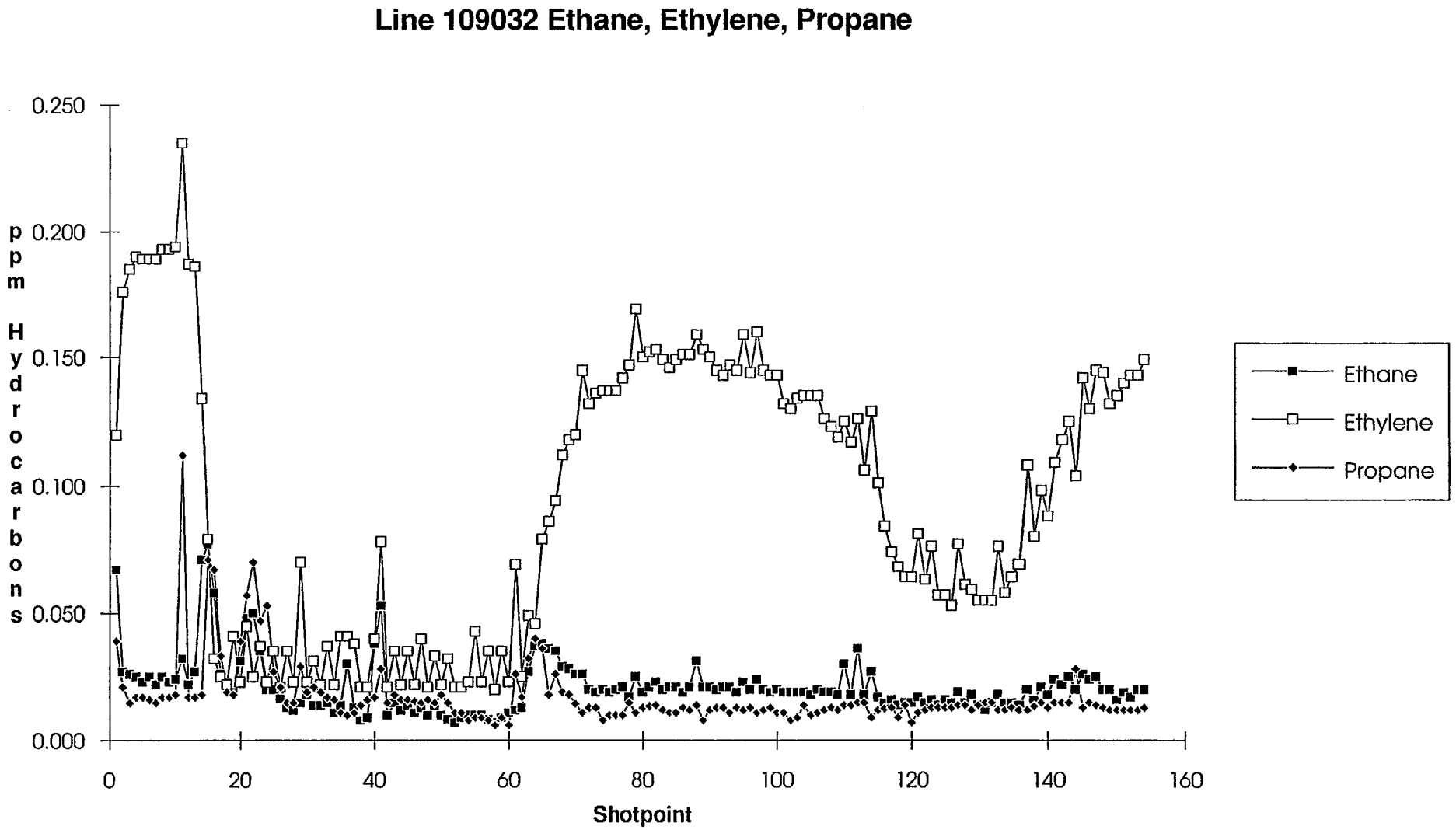
	Cond.	Temp.	F. Depth	W.Depth	Altitude	Calc. Alt.
Mean	57.516	24.688	128.495	266.330	20.145	137.823
Std. Dev.	1.764	1.166	38.271	181.364	8.740	159.559
Minimum	55.570	23.380	58.700	107.000	10.200	10.400
Maximum	61.480	27.350	185.500	558.300	30.900	378.000

Notes

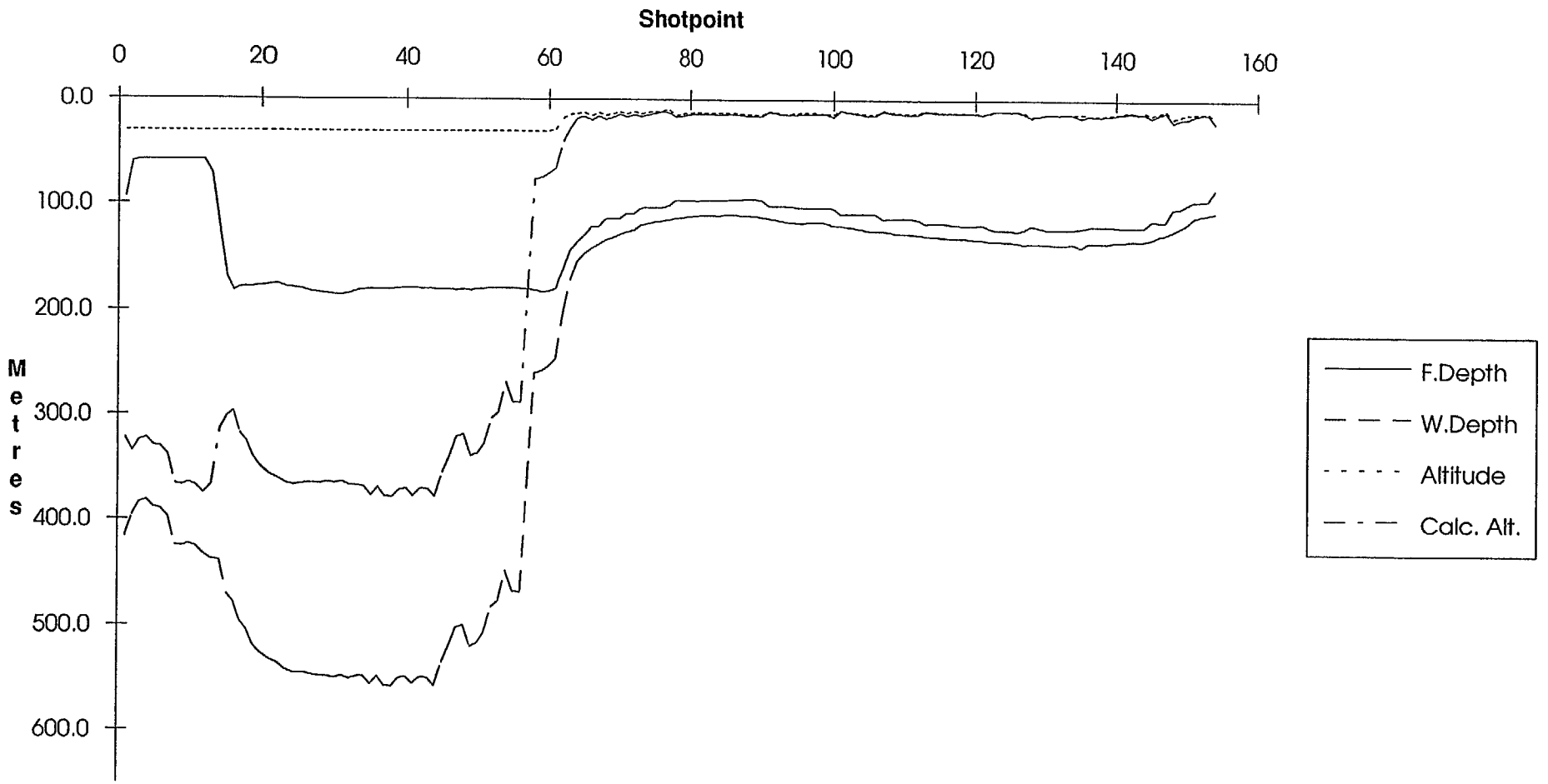
Weak THC and methane anomolies at SP 16 with a corrispondingly weak ethane, propane and ethylene anomaly
Increase in background hydrocarbon values before SP 16 and after SP 60 are due to the influence of the thermocline between 120m to 150m.

Line 109032 THC, Methane

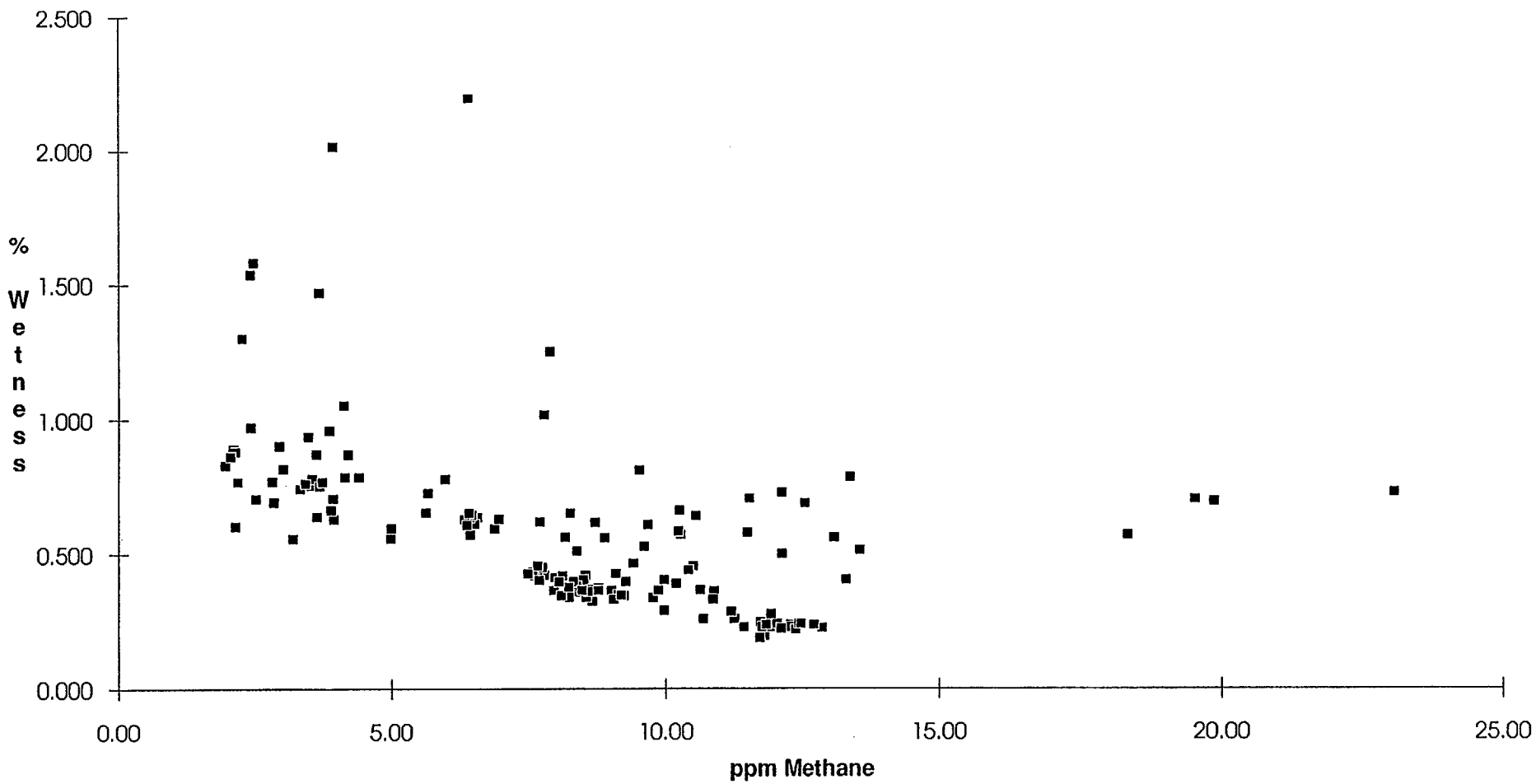



Line 109032 Ethane, Ethylene, Propane
ppm Hydrocarbons
0.250
0.200
0.150
0.100
0.050
0.000
0
20
40
60
80
100
120
140
160
Shotpoint
Ethane
Ethylene
Propane

Line 109032 Depths, Altitudes



Line 109032 Methane v. %Wetness



Line Summary

Line Number	109033
No. of Shotpoints	325

	Shotpoint	Date	Time	Latitude		Longitude	
Start	1	18-Apr-92	20:37:12	12	57.991	123	18.839
End	326	19-Apr-92	07:39:41	13	33.033	122	42.057

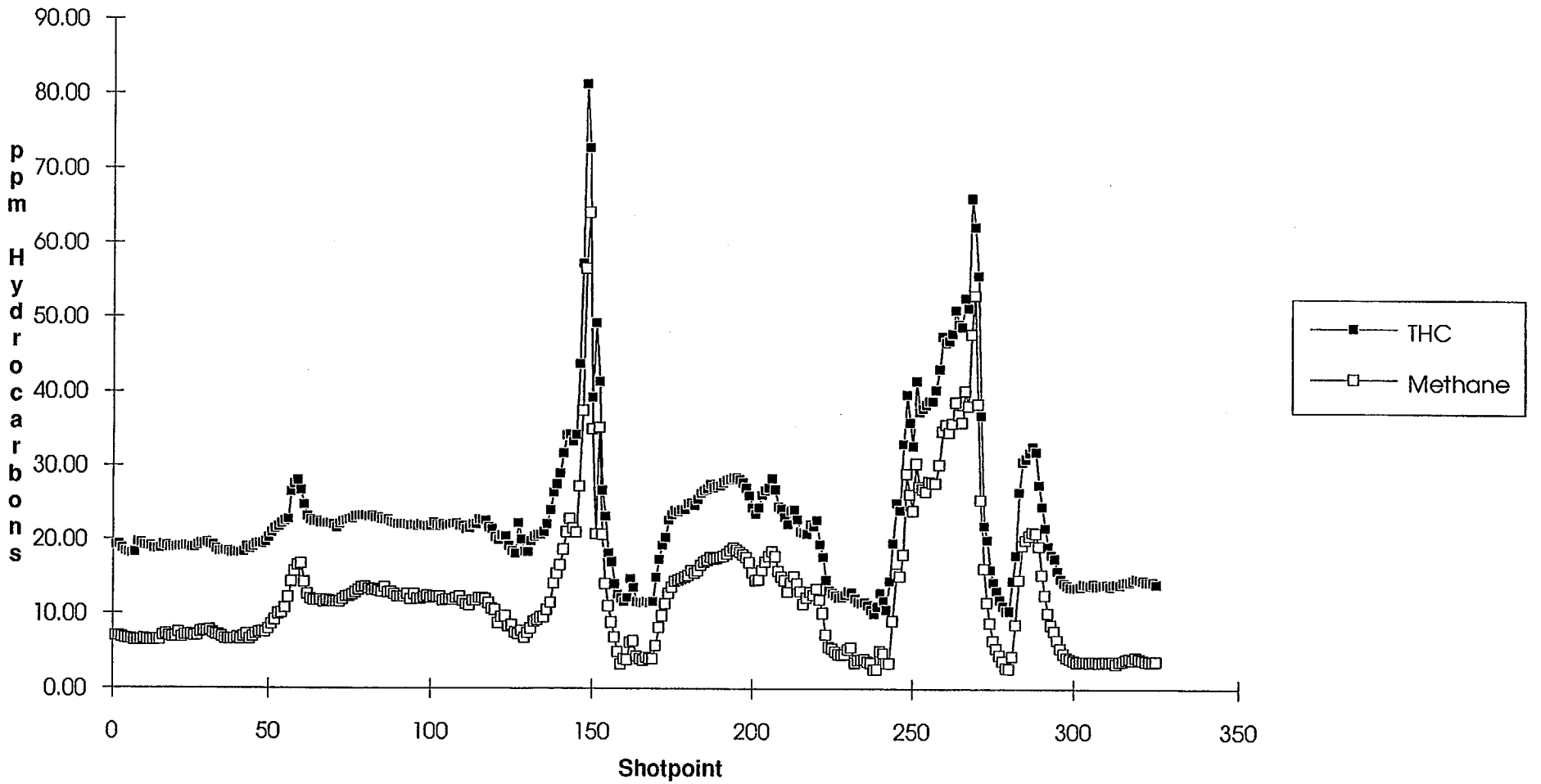
	THC	Methane	Ethane	Ethylene	Propane	Propylene	I-Butane	n-Butane	I-Pentane	n-Pentane	I-Hexane	n-Hexane	%Wetness
Mean	22.715	12.349	0.026	0.069	0.021	0.033	0.004	0.001	0.001	0.065	0.028	0.026	0.532
Std. Dev.	10.043	9.085	0.022	0.060	0.023	0.023	0.008	0.005	0.003	0.035	0.018	0.012	0.366
Minimum	9.962	2.532	0.007	0.015	0.006	0.002	0.000	0.000	0.000	0.025	0.001	0.000	0.090
Maximum	81.249	64.018	0.205	0.233	0.270	0.109	0.058	0.037	0.019	0.166	0.078	0.059	3.054

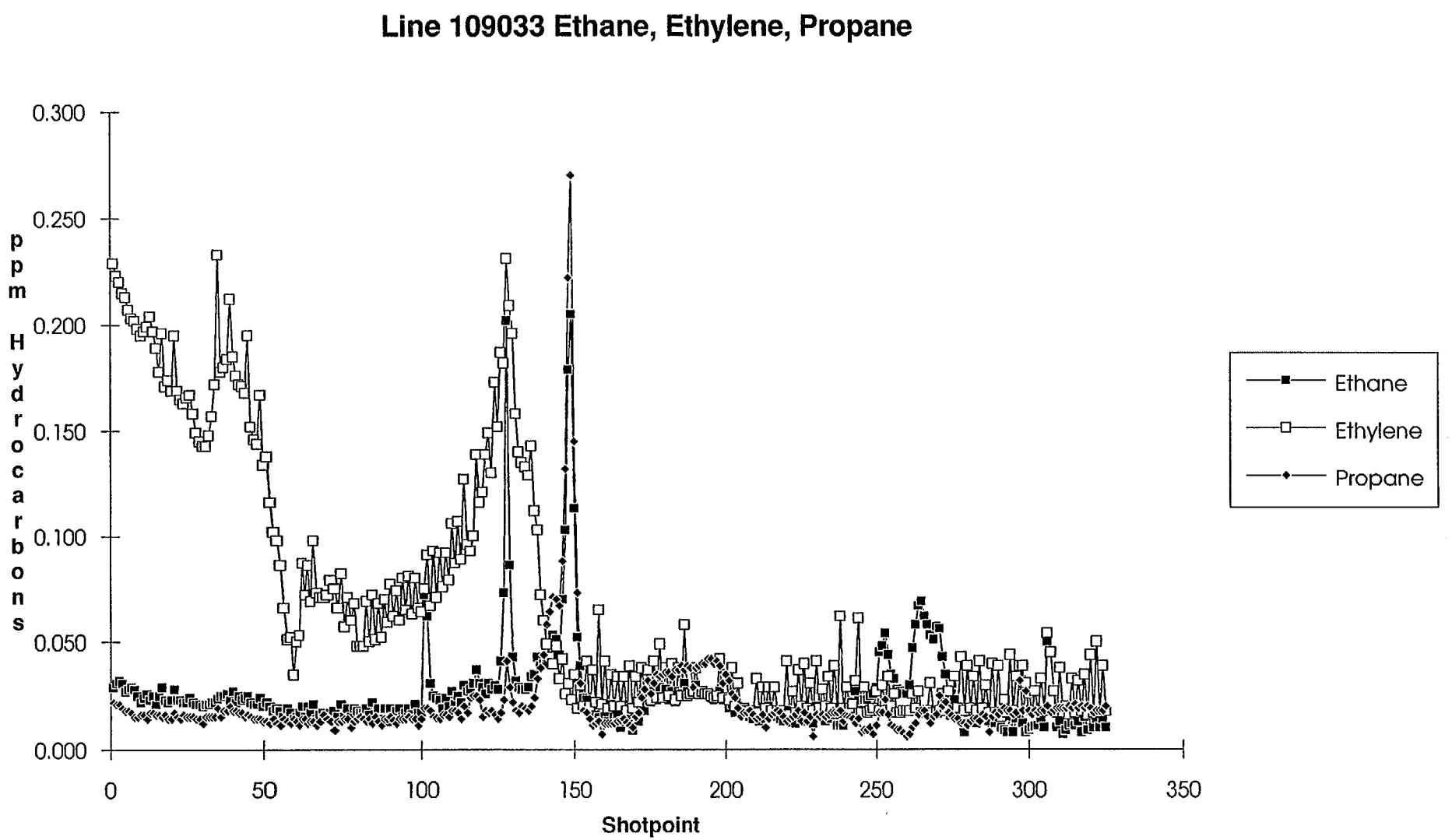
	Cond.	Temp.	F. Depth	W.Depth	Altitude	Calc. Alt.
Mean	56.419	23.973	150.062	218.510	19.541	68.152
Std. Dev.	1.222	0.802	48.081	120.621	8.442	84.782
Minimum	54.200	22.450	33.500	49.500	10.000	4.800
Maximum	60.040	26.380	220.500	484.300	30.900	275.500

Notes

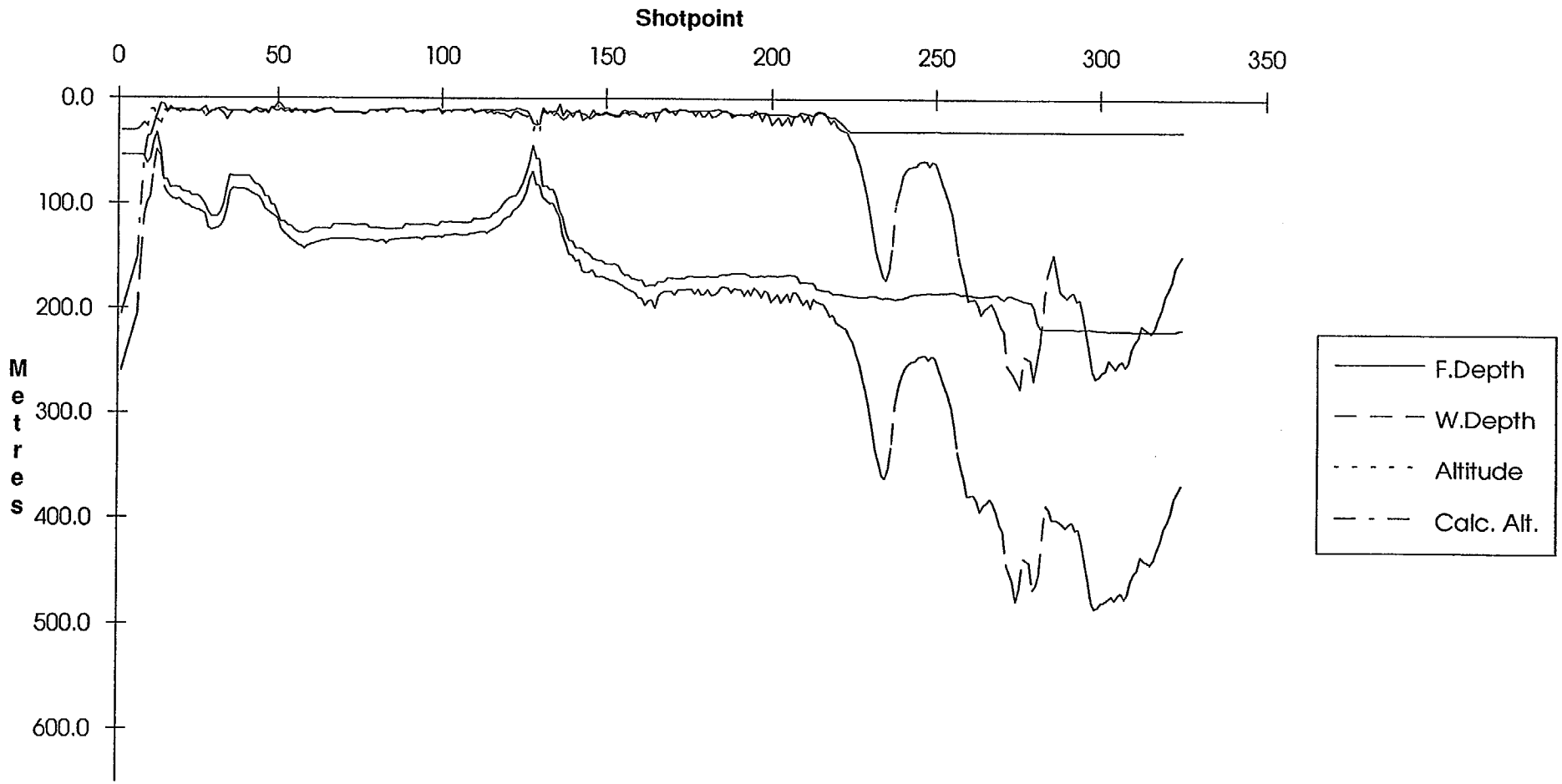
Weak THC and methane anomalies at SP 145, SP 245, SP 280.
A moderate ethane and propane anomaly at SP 145, and a moderate ethane and ethylene anomaly at SP 130, with a weak ethane anomaly at SP 251, and SP260.
Thermoclinal influences on hydrocarbon values are most notable between SP 1 and SP 50, and again between SP 120 and SP 135.

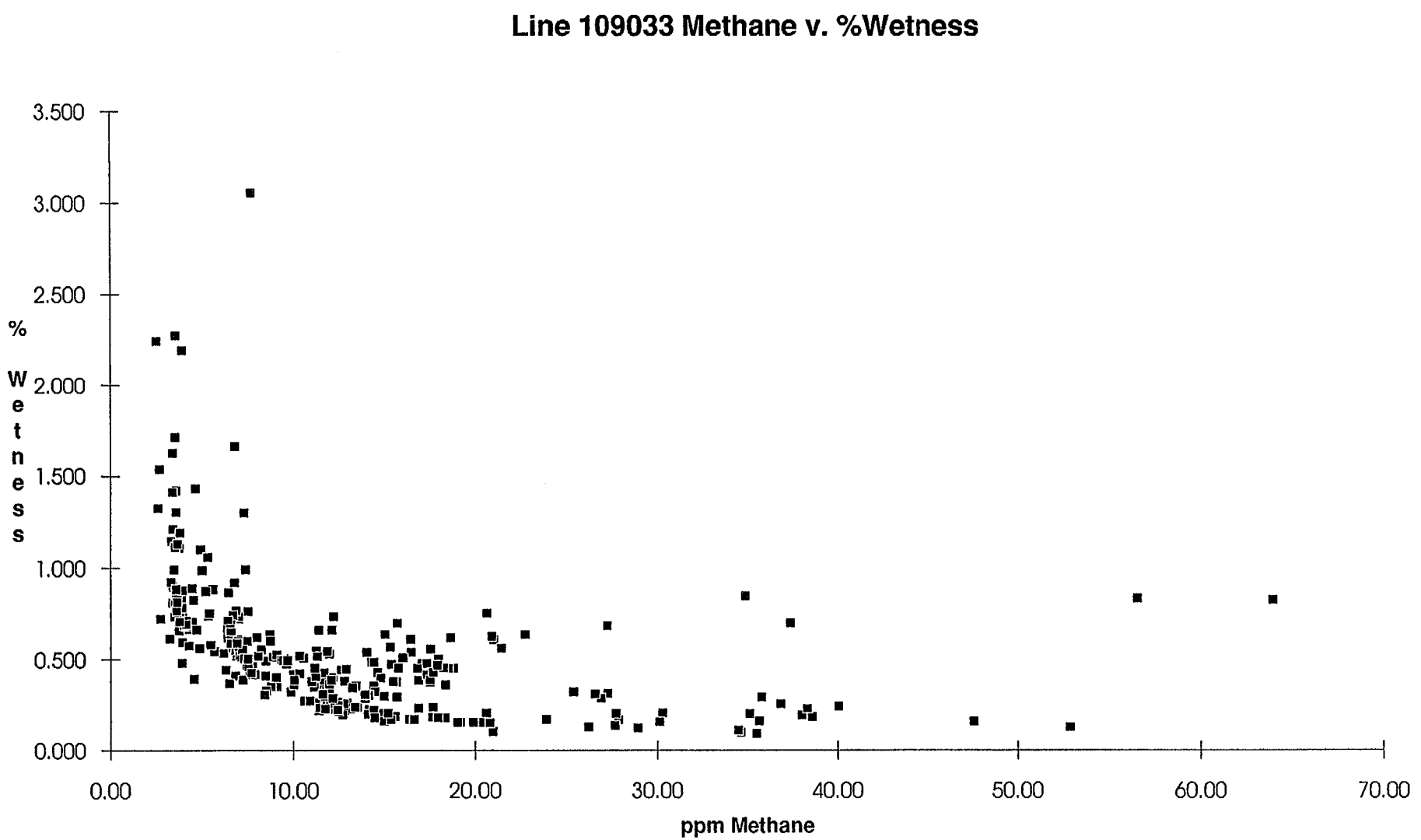
Line 109033 THC, Methane




Line 109033 Ethane, Ethylene, Propane
ppm Hydrocarbons
0.300
0.250
0.200
0.150
0.100
0.050
0.000
0
50
100
150
200
250
300
350
Shotpoint
Ethane
Ethylene
Propane

Line 109033 Depths, Altitudes




Line 109033 Methane v. %Wetness
3.500
3.000
2.500
2.000
1.500
1.000
0.500
0.000
% Wetness
0.00
10.00
20.00
30.00
40.00
50.00
60.00
70.00
ppm Methane

Line Summary

Line Number	109034
No. of Shotpoints	334

	Shotpoint	Date	Time	Latitude		Longitude	
Start	1	19-Apr-92	07:41:40	13	32.972	122	42.009
End	336	19-Apr-92	19:17:10	13	25.656	122	51.410

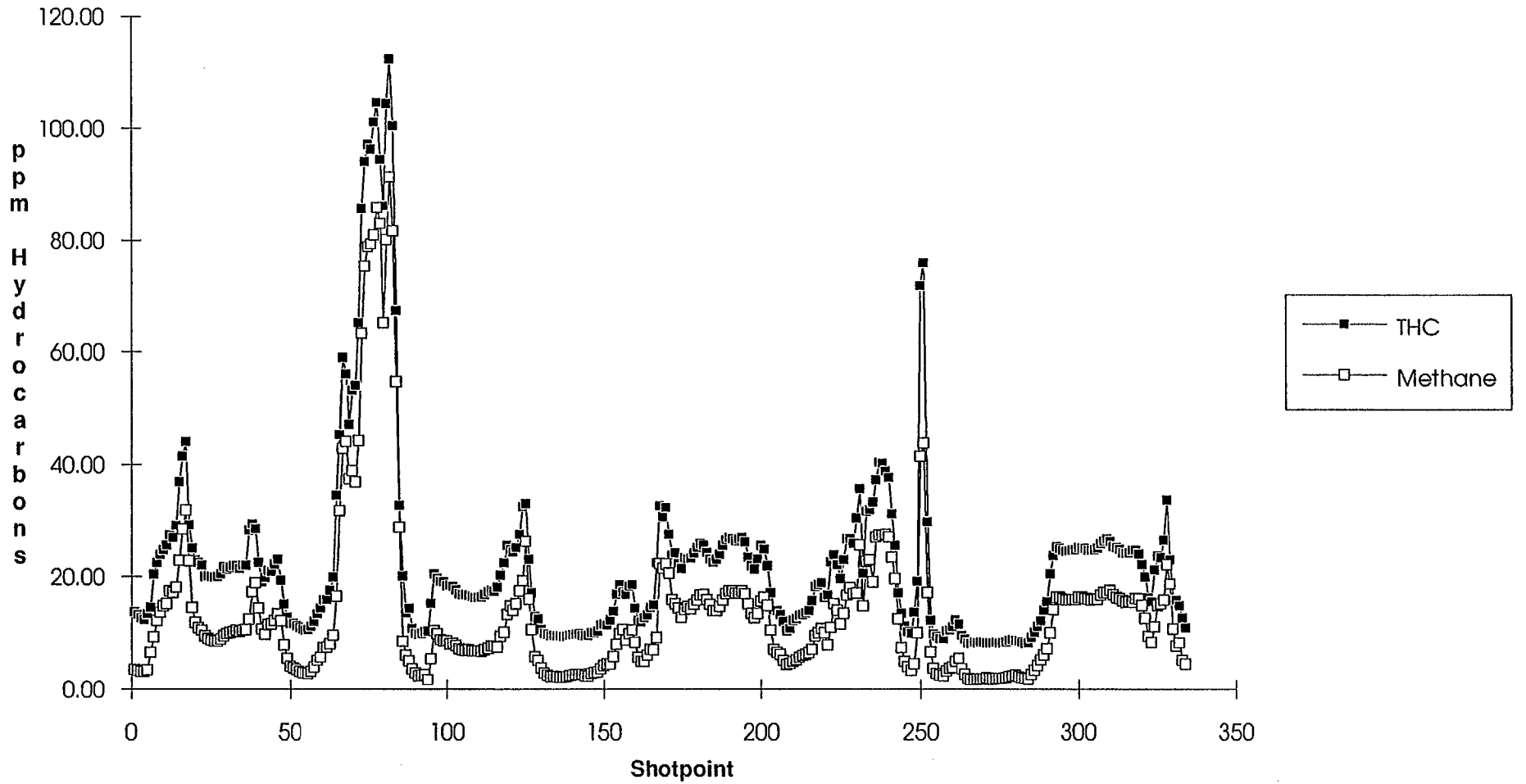
	THC	Methane	Ethane	Ethylene	Propane	Propylene	I-Butane	n-Butane	I-Pentane	n-Pentane	I-Hexane	n-Hexane	%Wetness
Mean	22.721	13.456	0.022	0.047	0.018	0.024	0.004	0.002	0.001	0.049	0.014	0.022	0.611
Std. Dev.	17.296	14.708	0.012	0.048	0.007	0.019	0.007	0.006	0.003	0.027	0.010	0.013	0.508
Minimum	8.211	1.730	0.006	0.015	0.004	0.000	0.000	0.000	0.000	0.023	0.000	0.000	0.051
Maximum	112.353	91.384	0.076	0.237	0.043	0.117	0.031	0.062	0.016	0.151	0.049	0.054	3.283

	Cond.	Temp.	F. Depth	W.Depth	Altitude	Calc. Alt.
Mean	55.147	23.112	163.453	284.259	22.318	120.874
Std. Dev.	1.472	0.997	35.017	141.738	8.131	142.180
Minimum	54.120	22.390	46.400	64.600	10.300	1.800
Maximum	59.830	26.350	213.100	542.600	30.900	448.500

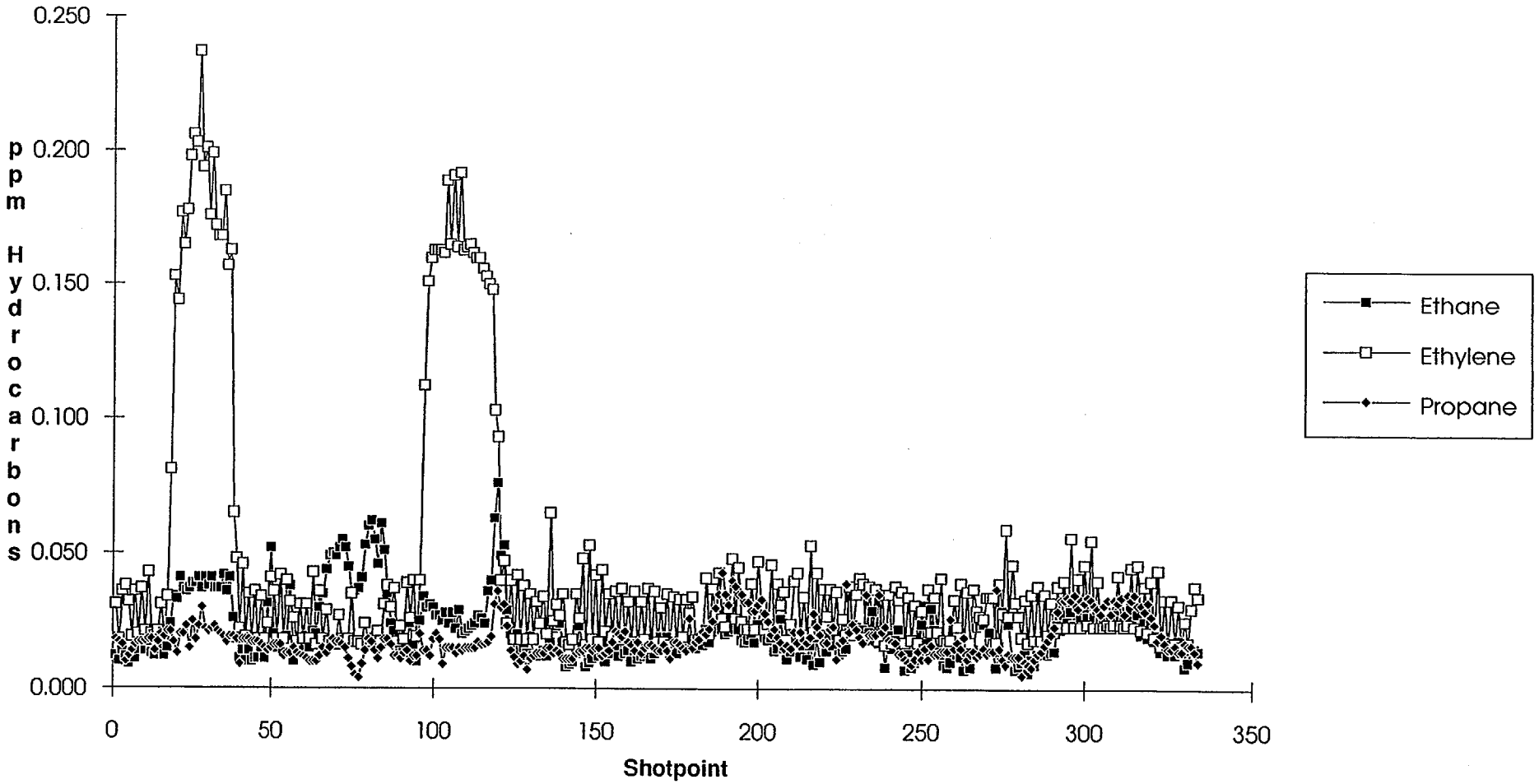
Notes

Moderate THC and methane anomalies occur at SP 68 and SP 250, a weak ethane anomaly also occurs at SP 68.
Numerous weak THC and methane anomalies occur throughout this line.
Ethelyne anomalies occur at SP 20 and SP 95 which correspond to shallow water and decreasing fish depth.
A gas sample was taken for carbon isotope analysis between SP 65 and SP 85.

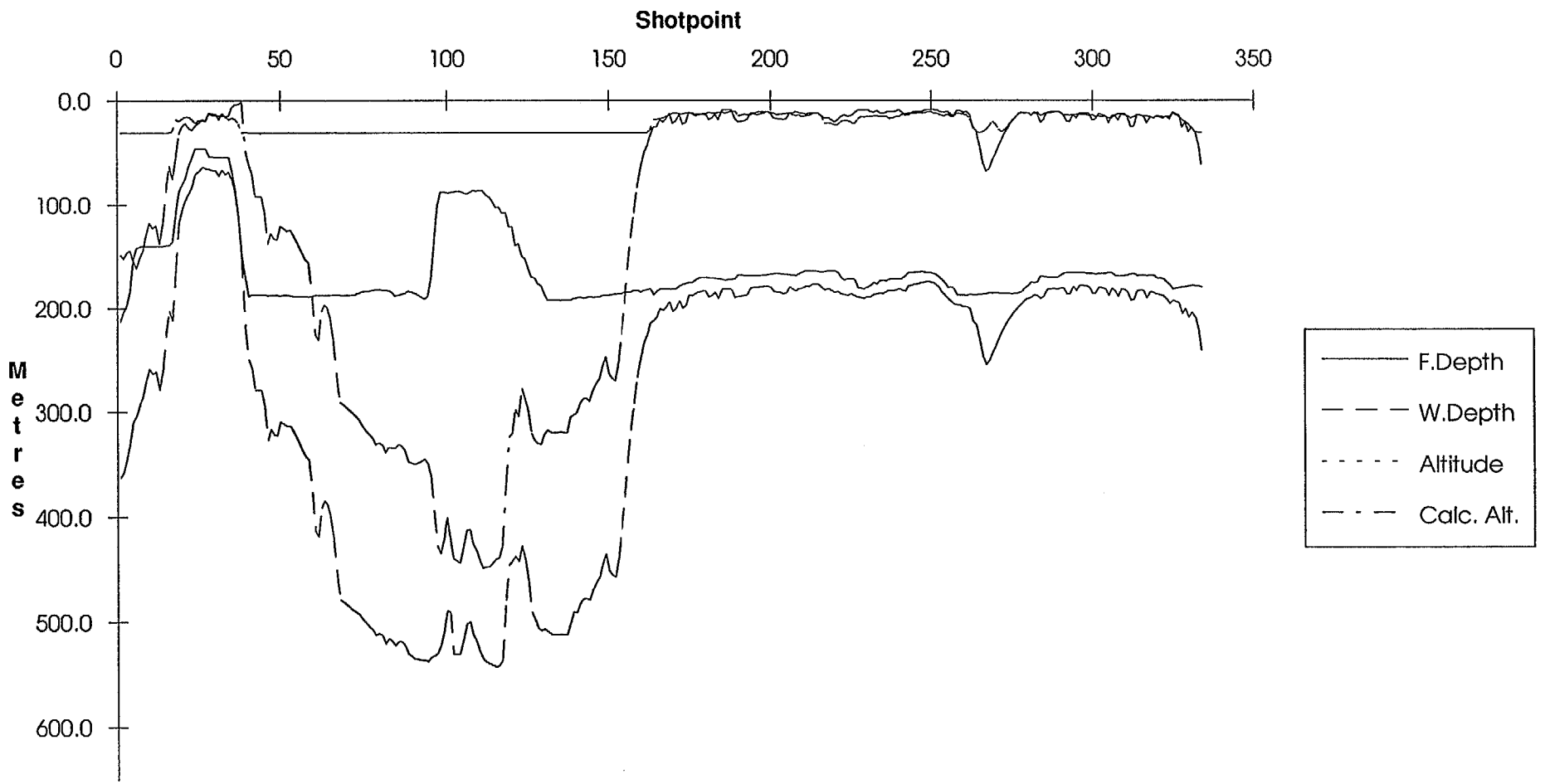
Line 109034 THC, Methane



Line 109034 Ethane, Ethylene, Propane



Line 109034 Depths, Altitudes



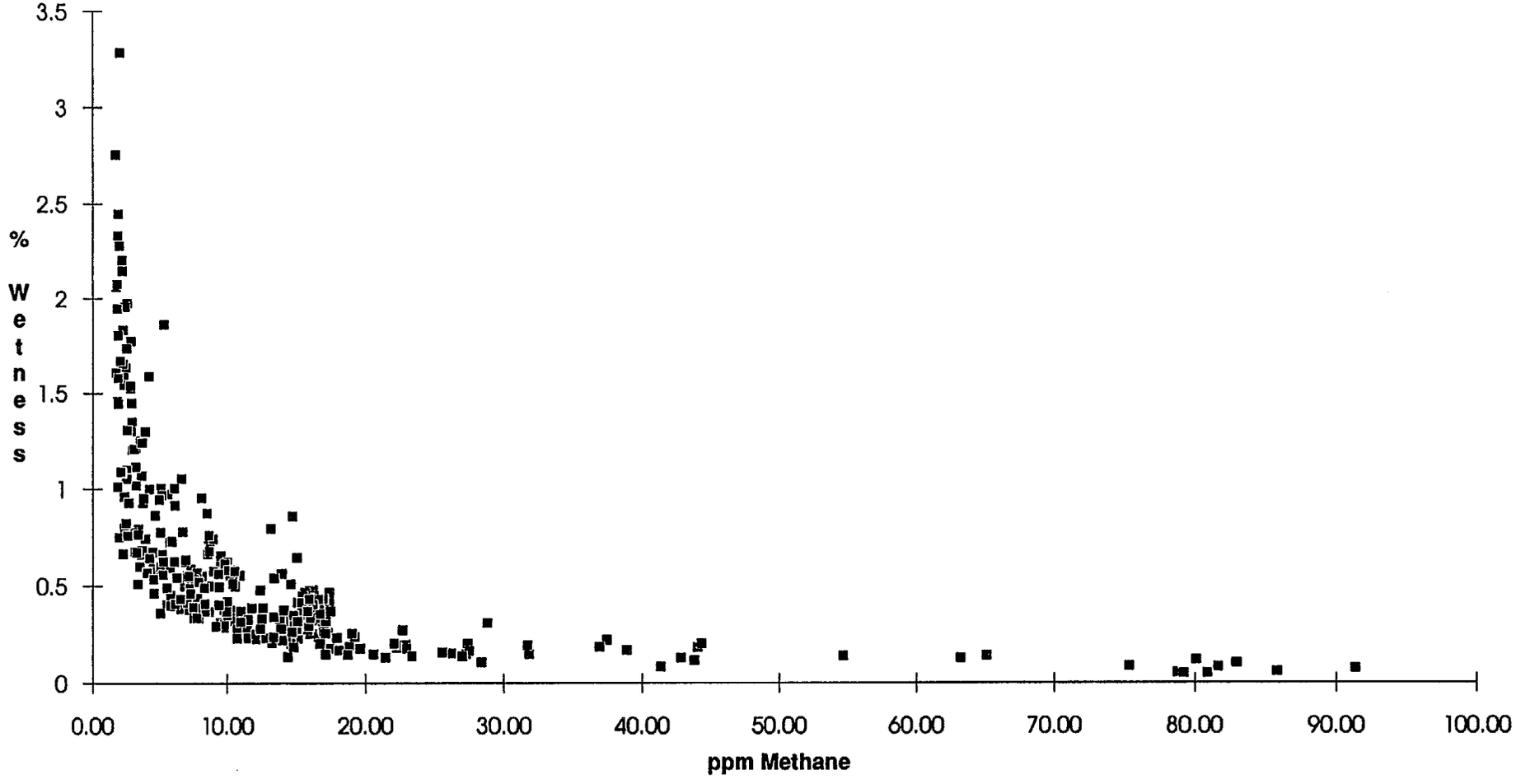
ADDITIONAL (DHD) GEOCHEMICAL LINES

The enclosed lines were omitted during the printing process of AGSO Record No. 1992/92 - Light Hydrocarbon Geochemistry in Bottom Waters of the Philippines Continental Shelf Part A, Ragay Gulf and Tayabas Bay, *Rig Seismic* Survey 109.

The amendments are in the order the lines were acquired and should be inserted in Appendix II (Part A). Ragay Gulf Line Summary Sheets and Individual Line Plots, between 'Line 109/034 Depths, Altitudes' and 'Line Sniff5 THC, Methane'.

We apologise for any inconvenience this may have resulted in.

Line 109034 Methane v. %Wetness



Line Summary

Line Number	109036
No. of Shotpoints	343

	Shotpoint	Date	Time	Latitude		Longitude	
Start	1	20-Apr-92	00:24:35	13	44.490	122	33.883
End	344	20-Apr-92	12:07:12	13	15.401	123	08.447

	THC	Methane	Ethane	Ethylene	Propane	Propylene	I-Butane	n-Butane	I-Pentane	n-Pentane	I-Hexane	n-Hexane	%Wetness
Mean	16.053	7.700	0.026	0.094	0.019	0.035	0.002	0.001	0.000	0.075	0.013	0.028	0.729
Std. Dev.	6.160	4.462	0.016	0.079	0.010	0.028	0.004	0.004	0.002	0.045	0.009	0.016	0.475
Minimum	7.492	1.422	0.006	0.000	0.004	0.000	0.000	0.000	0.000	0.019	0.000	0.000	0.145
Maximum	36.809	26.049	0.090	0.296	0.057	0.125	0.019	0.026	0.012	0.203	0.040	0.073	4.968

	Cond.	Temp.	F. Depth	W.Depth	Altitude	Calc. Alt.
Mean	57.395	24.629	132.912	297.068	22.456	164.227
Std. Dev.	1.904	1.282	54.923	210.133	8.892	160.397
Minimum	55.110	23.100	37.200	49.800	9.500	4.000
Maximum	60.580	26.760	196.000	589.800	30.800	406.200

Notes

A moderate THC and methane anomaly occurs at SP 250, along with a weak propane anomaly.
Two weak THC and methane anomalies occur at SP 80 and SP 270.
Four very weak THC and methane anomalies are seen at SP 125, SP 180, SP 200, and 240.

Line Summary

Line Number	109035
No. of Shotpoints	143

	Shotpoint	Date	Time	Latitude		Longitude	
Start	326	19-Apr-92	19:27:41	13	26.077	122	50.989
End	469	20-Apr-92	00:22:36	13	44.342	122	33.807

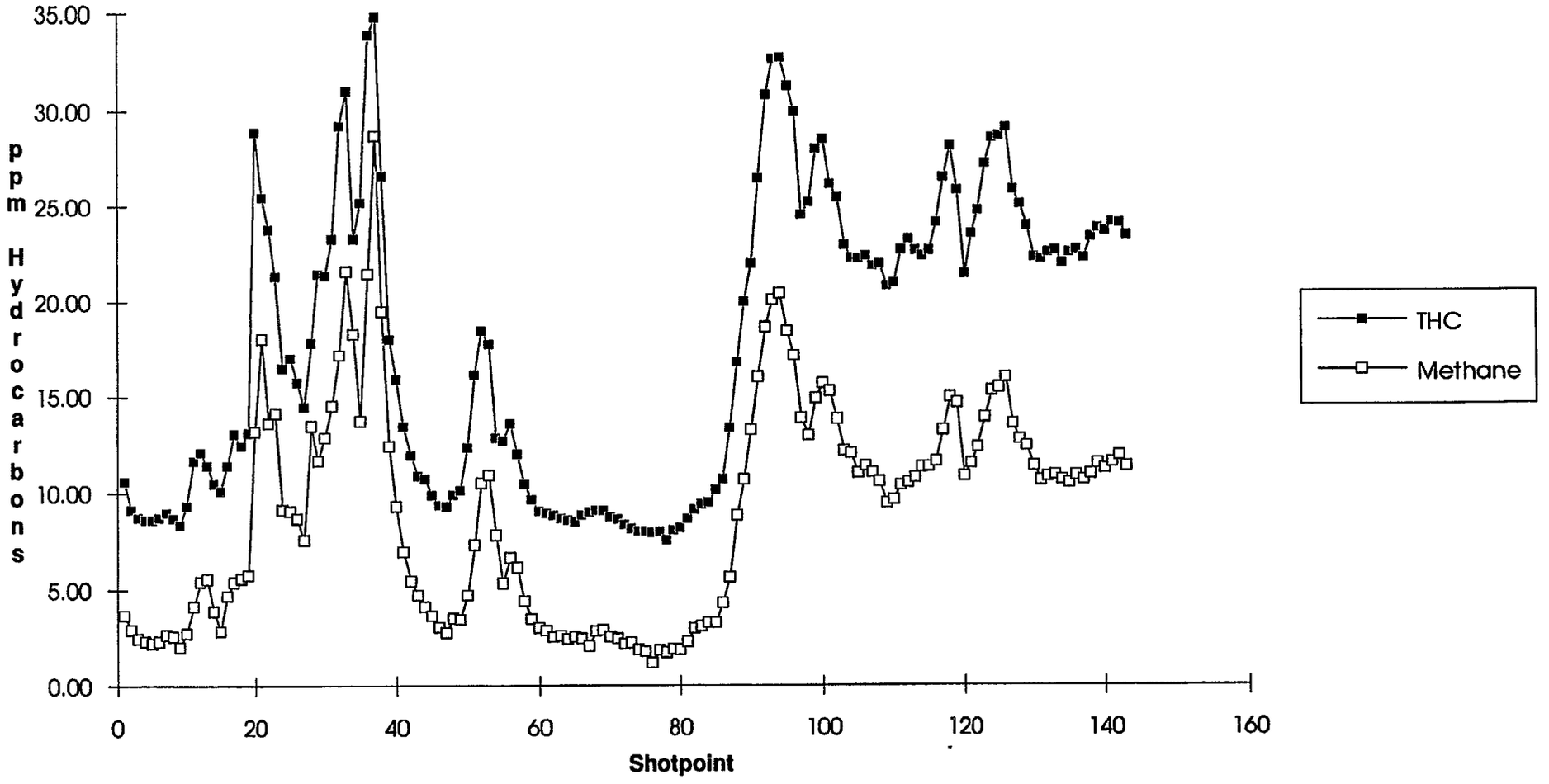
	THC	Methane	Ethane	Ethylene	Propane	Propylene	I-Butane	n-Butane	I-Pentane	n-Pentane	I-Hexane	n-Hexane	%Wetness
Mean	17.712	8.863	0.033	0.091	0.020	0.026	0.004	0.003	0.002	0.069	0.015	0.025	0.844
Std. Dev.	7.761	5.630	0.022	0.095	0.010	0.026	0.009	0.008	0.004	0.055	0.007	0.006	0.443
Minimum	7.519	1.191	0.005	0.000	0.009	0.000	0.000	0.000	0.000	0.020	0.005	0.009	0.257
Maximum	34.806	28.666	0.140	0.390	0.068	0.110	0.049	0.040	0.019	0.238	0.034	0.047	2.235

	Cond.	Temp.	F. Depth	W.Depth	Altitude	Calc. Alt.
Mean	56.027	23.683	139.493	244.556	22.891	104.838
Std. Dev.	2.218	1.496	60.395	149.298	8.935	99.489
Minimum	54.040	22.330	28.800	40.700	9.700	7.300
Maximum	60.190	26.510	189.300	482.600	30.800	296.500

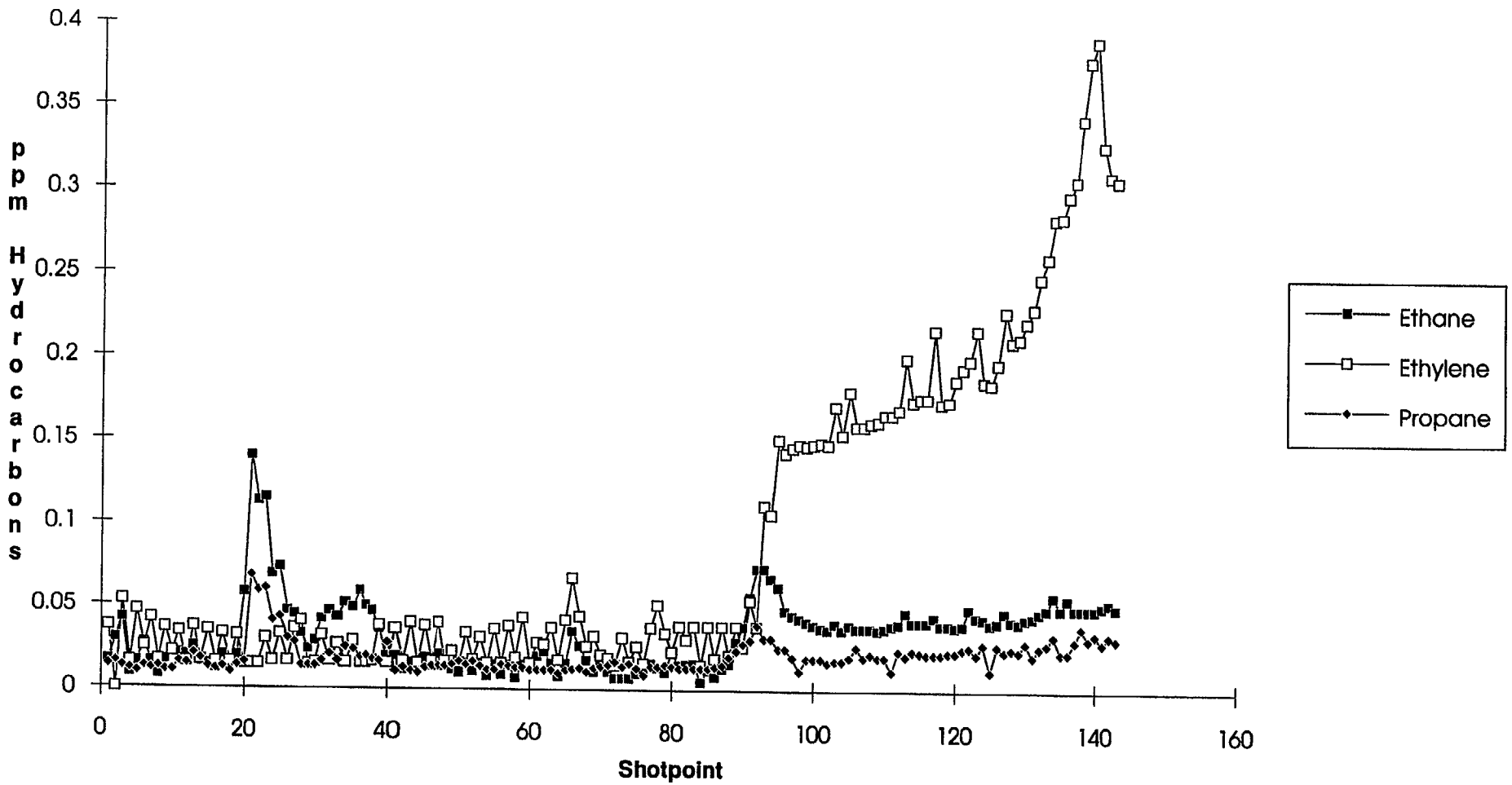
Notes

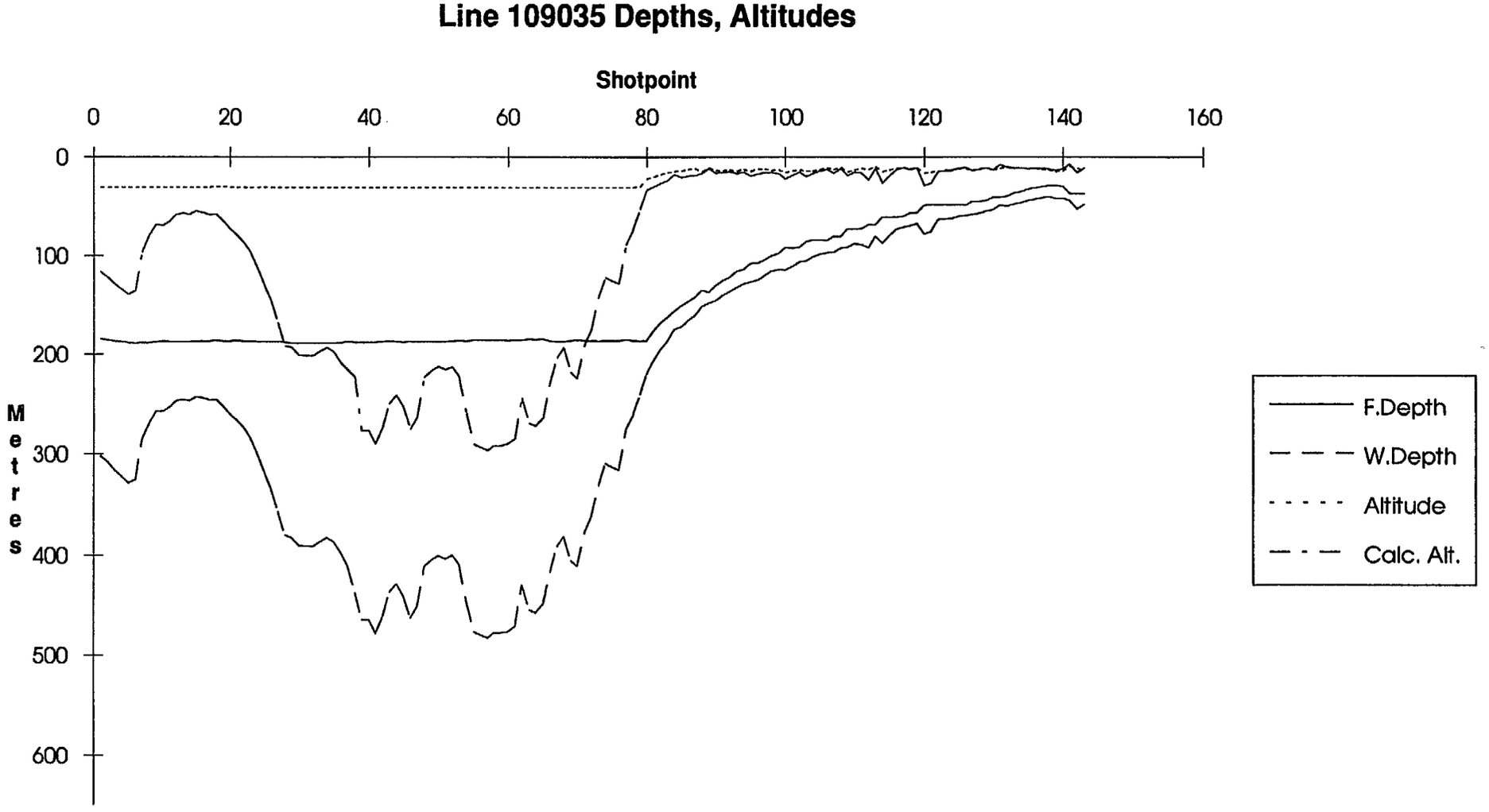
Three moderate THC and methane anomalies are seen at SP 20, SP 35 and SP 95, along with a weak anomaly at SP 52.
A weak ethane and propane anomaly occurs at at SP 20 and a weak ethane anomaly at SP 35.
From SP 85 the general increase in all hydrocarbons is relates to the fish being raised through surface waters.

Line 109035 THC, Methane

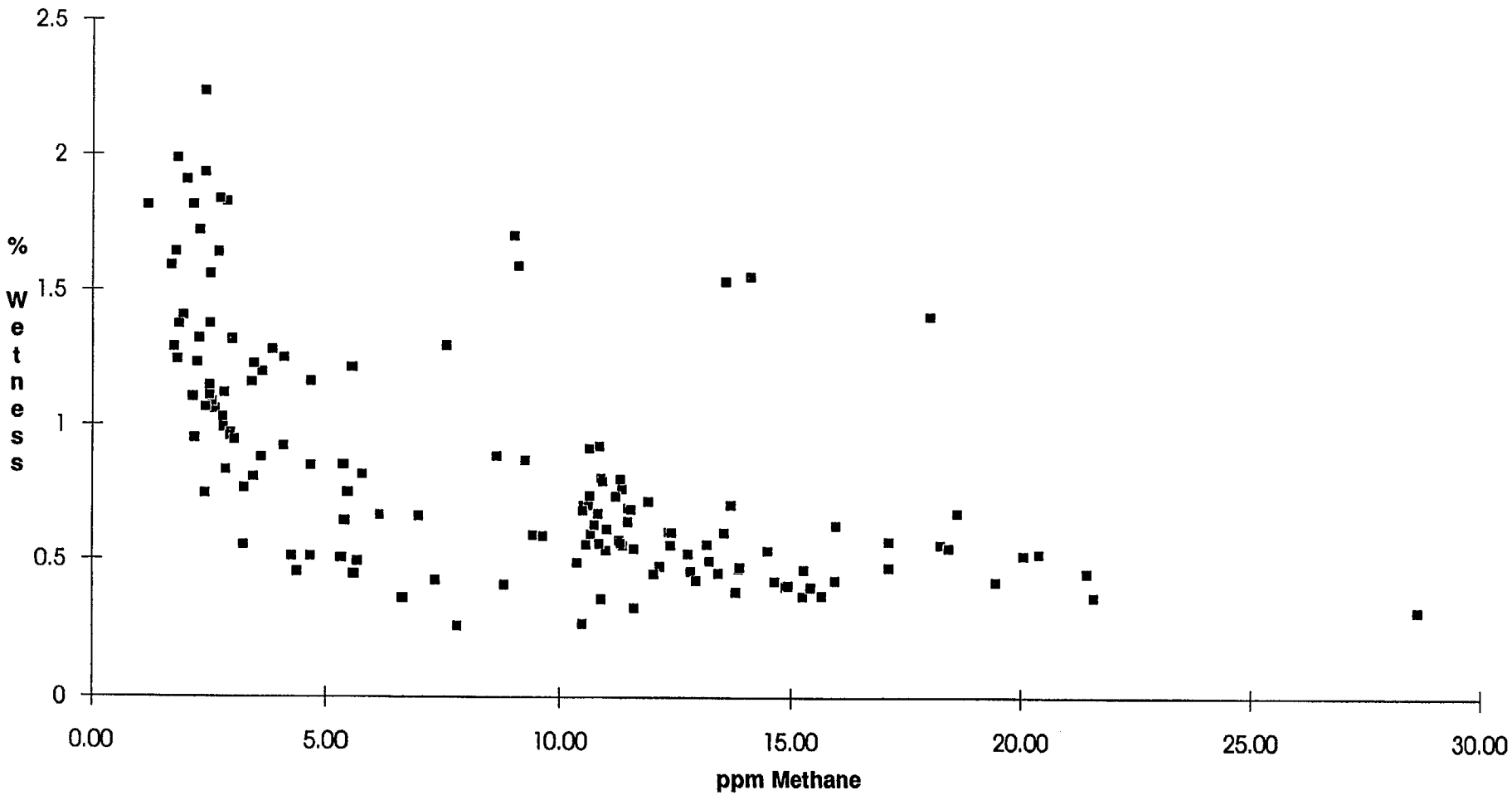


Line 109035 Ethane, Ethylene, Propane

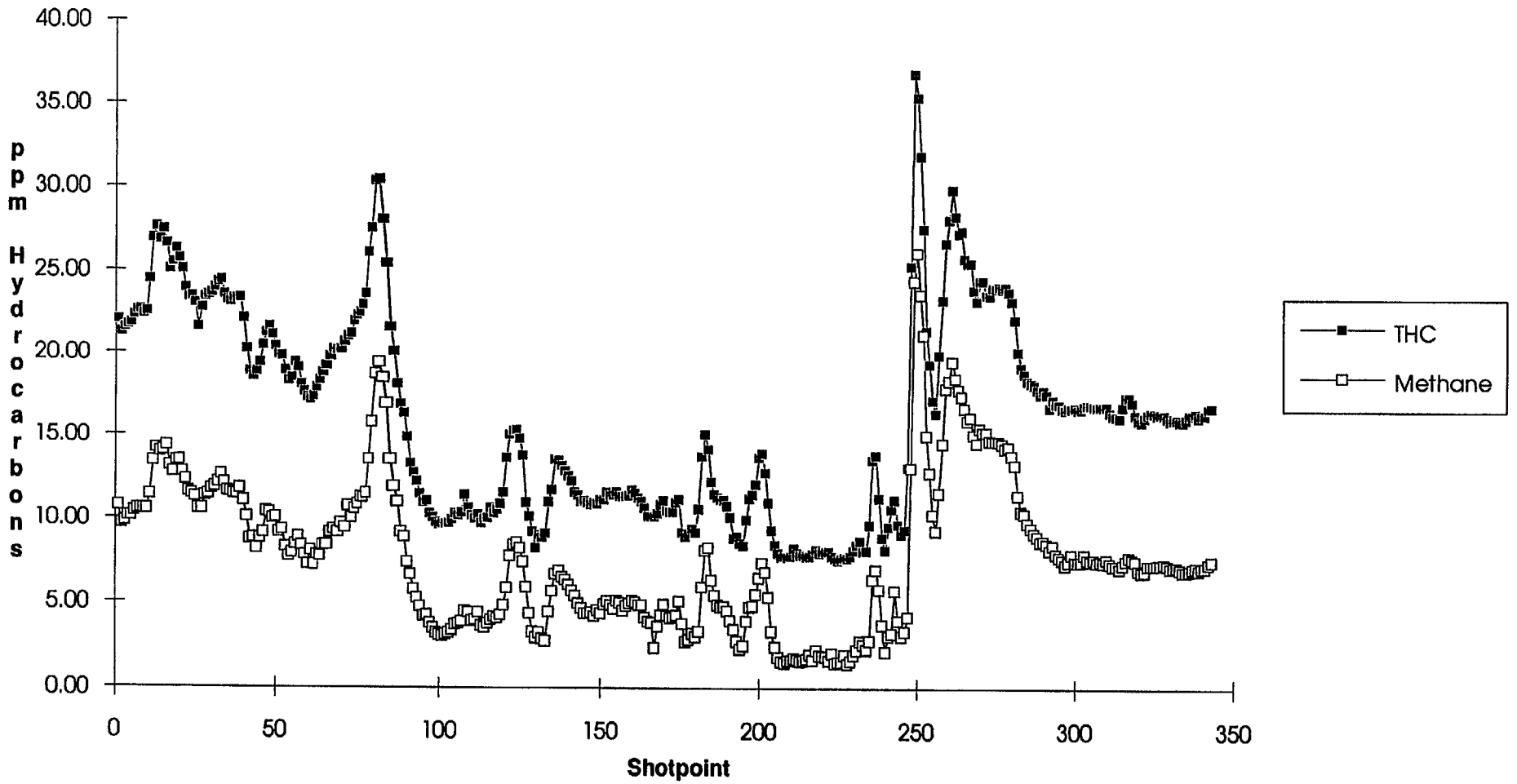



Line 109035 Depths, Altitudes
Shotpoint
0
20
40
60
80
100
120
140
160
0
100
200
300
400
500
600
Metres
F.Depth
W.Depth
Altitude
Calc. Alt.

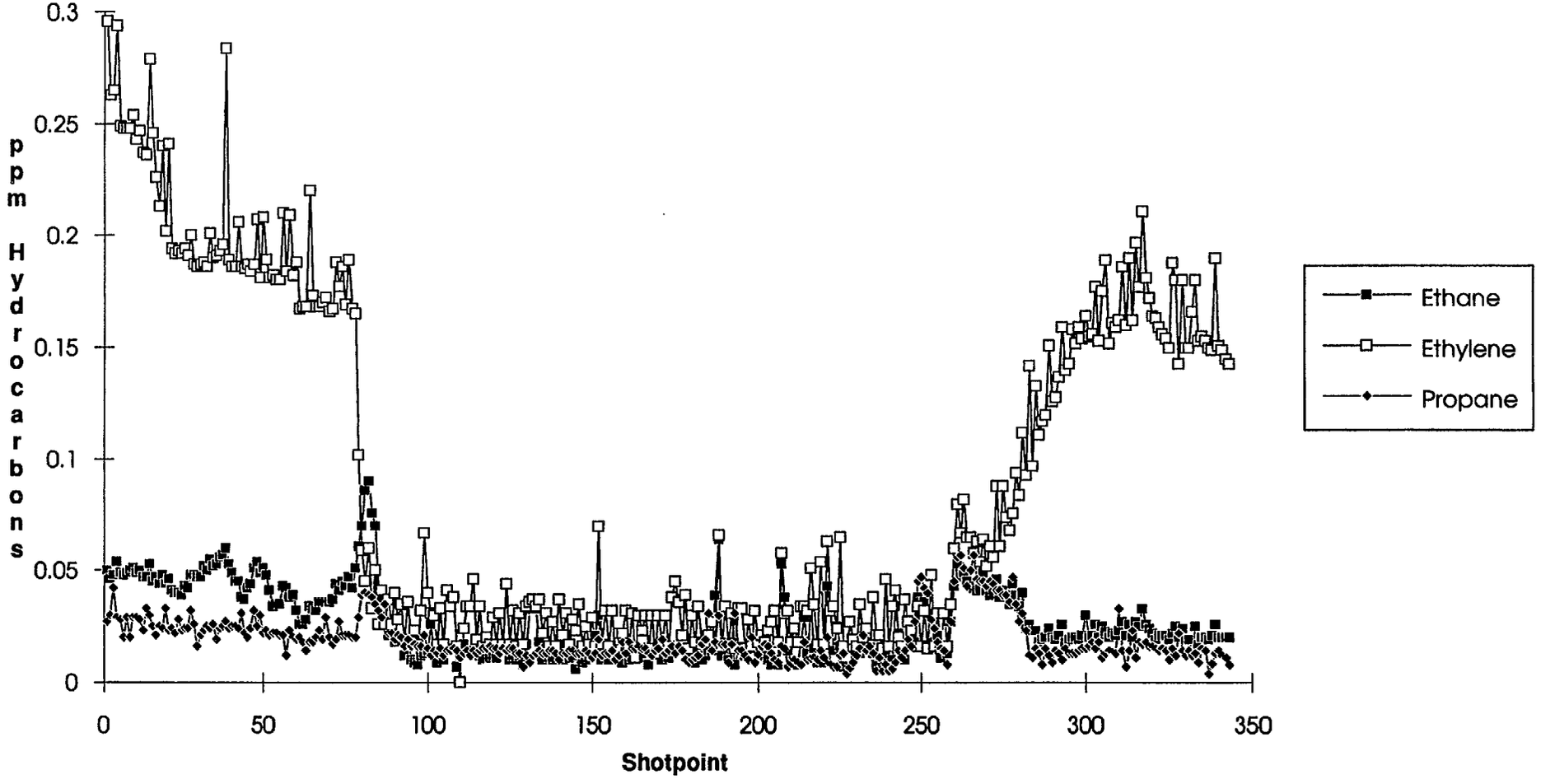
Line 109035 Methane v. %Wetness

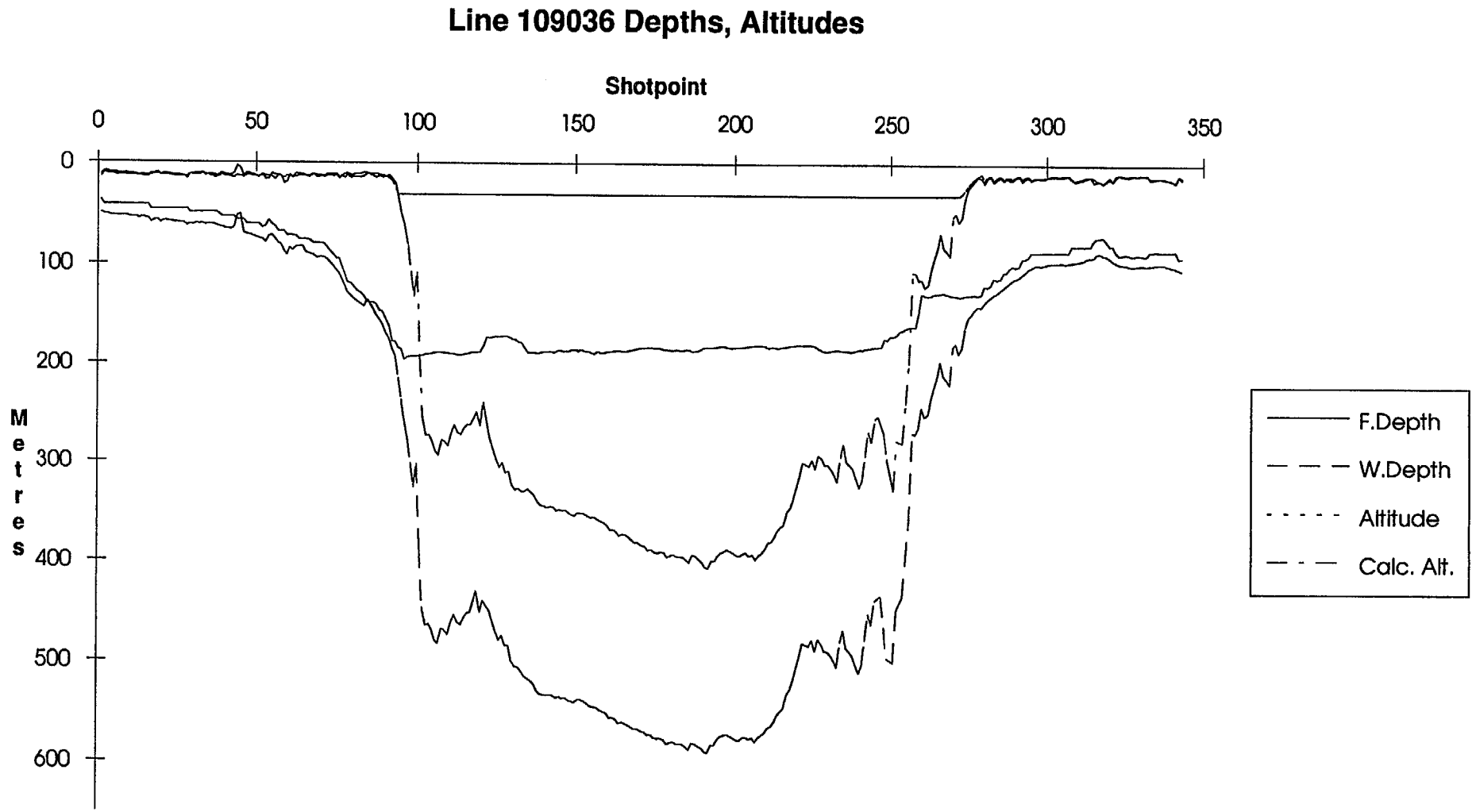


Line 109036 THC, Methane

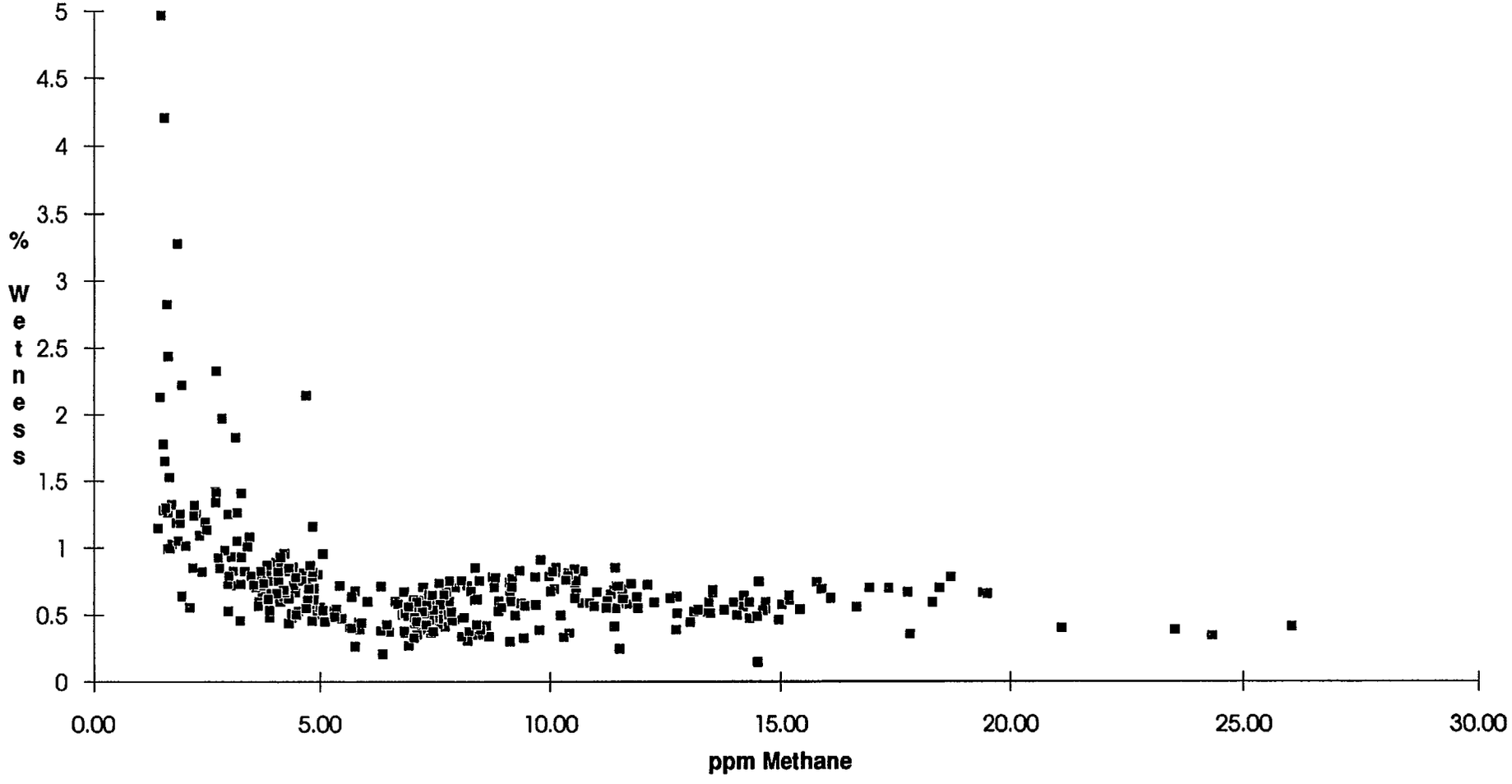


Line 109036 Ethane, Ethylene, Propane




Line 109036 Depths, Altitudes
Shotpoint
0
50
100
150
200
250
300
350
0
100
200
300
400
500
600
Metres
F.Depth
W.Depth
Altitude
Calc. Alt.

Line 109036 Methane v. %Wetness



Line Summary

Line Number	Sniff1
No. of Shotpoints	284

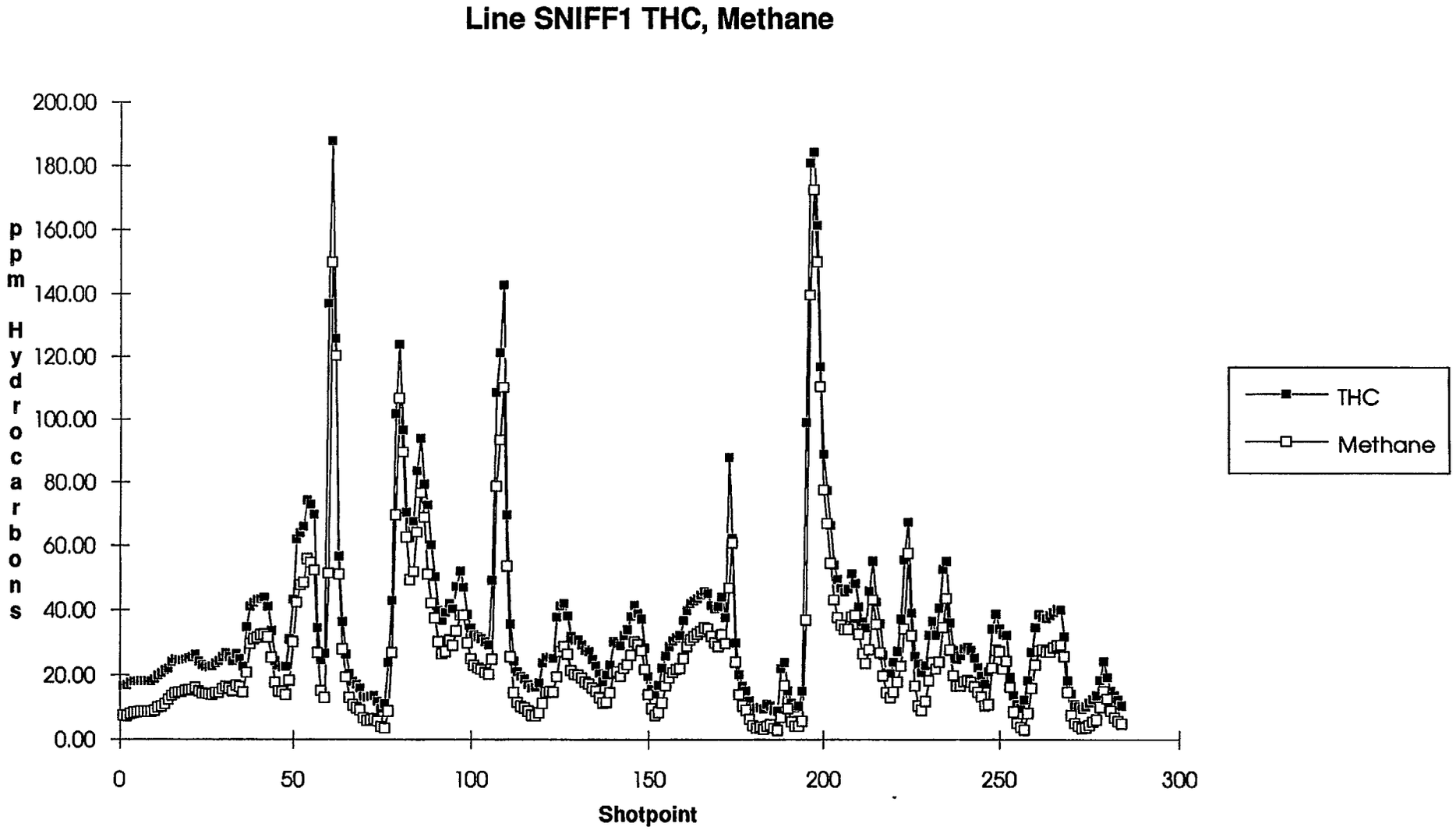
	Shotpoint	Date	Time	Latitude		Longitude	
Start	1	20-Apr-92	12:09:13	13	15.562	123	08.374
End	285	20-Apr-92	21:59:59	13	24.531	123	09.465

	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	36.384	25.443	0.070	0.049	0.067	0.030	0.012	0.003	0.003	0.042	0.011	0.021	0.641
Std. Dev.	28.534	24.509	0.096	0.036	0.094	0.017	0.019	0.008	0.006	0.020	0.007	0.014	0.338
Minimum	8.703	2.927	0.000	0.015	0.000	0.003	0.000	0.000	0.000	0.000	0.000	0.000	0.050
Maximum	188.015	172.628	0.851	0.173	0.784	0.088	0.137	0.070	0.047	0.121	0.044	0.058	1.908

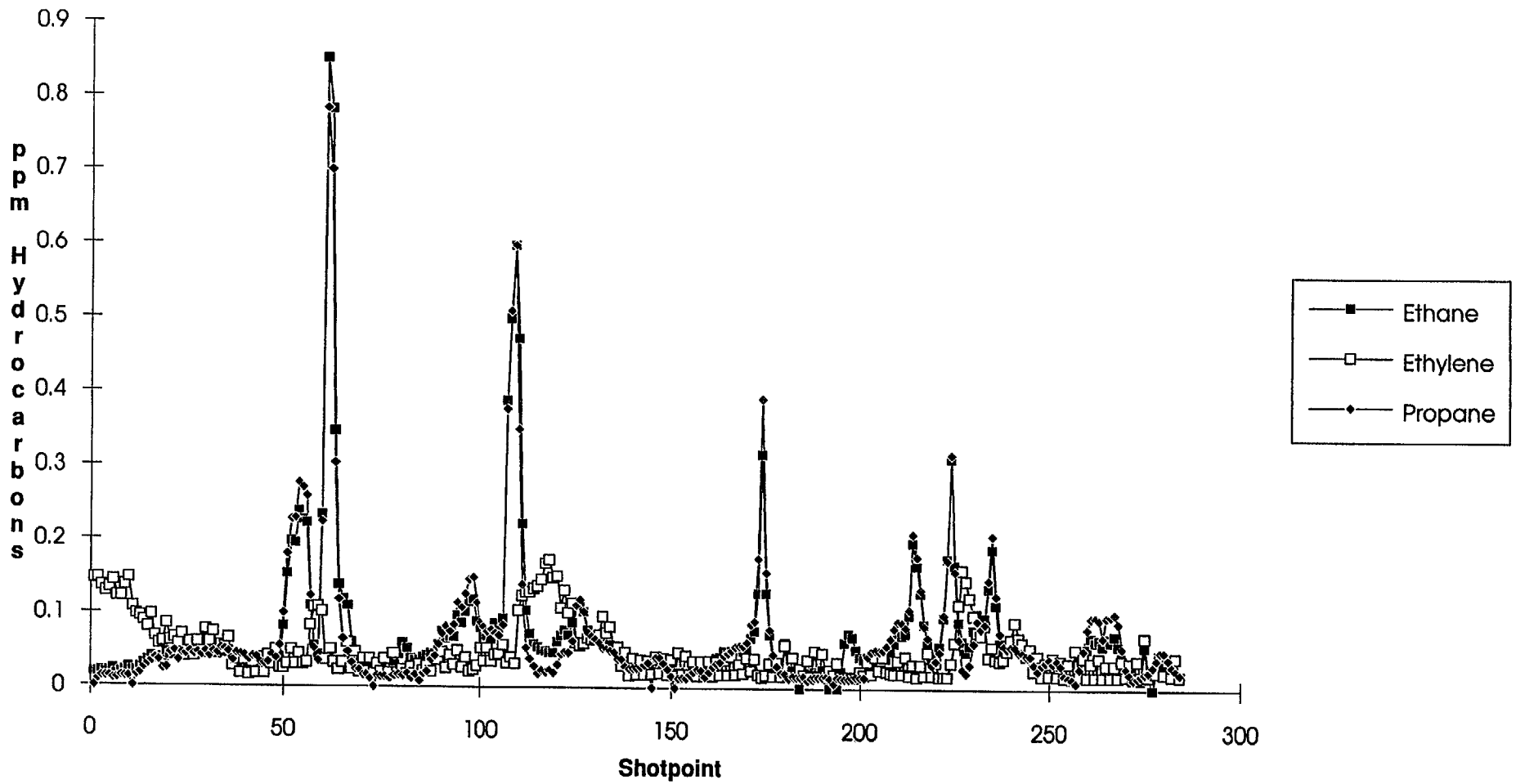
	Cond.	Temp.	F. Depth	W.Depth	Altitude	Calc. Alt.
Mean	55.015	23.007	145.433	216.255	19.294	70.836
Std. Dev.	0.903	0.595	22.431	125.715	7.707	116.899
Minimum	54.190	22.440	70.400	83.700	7.500	0.200
Maximum	58.210	25.100	177.000	559.800	30.800	397.600

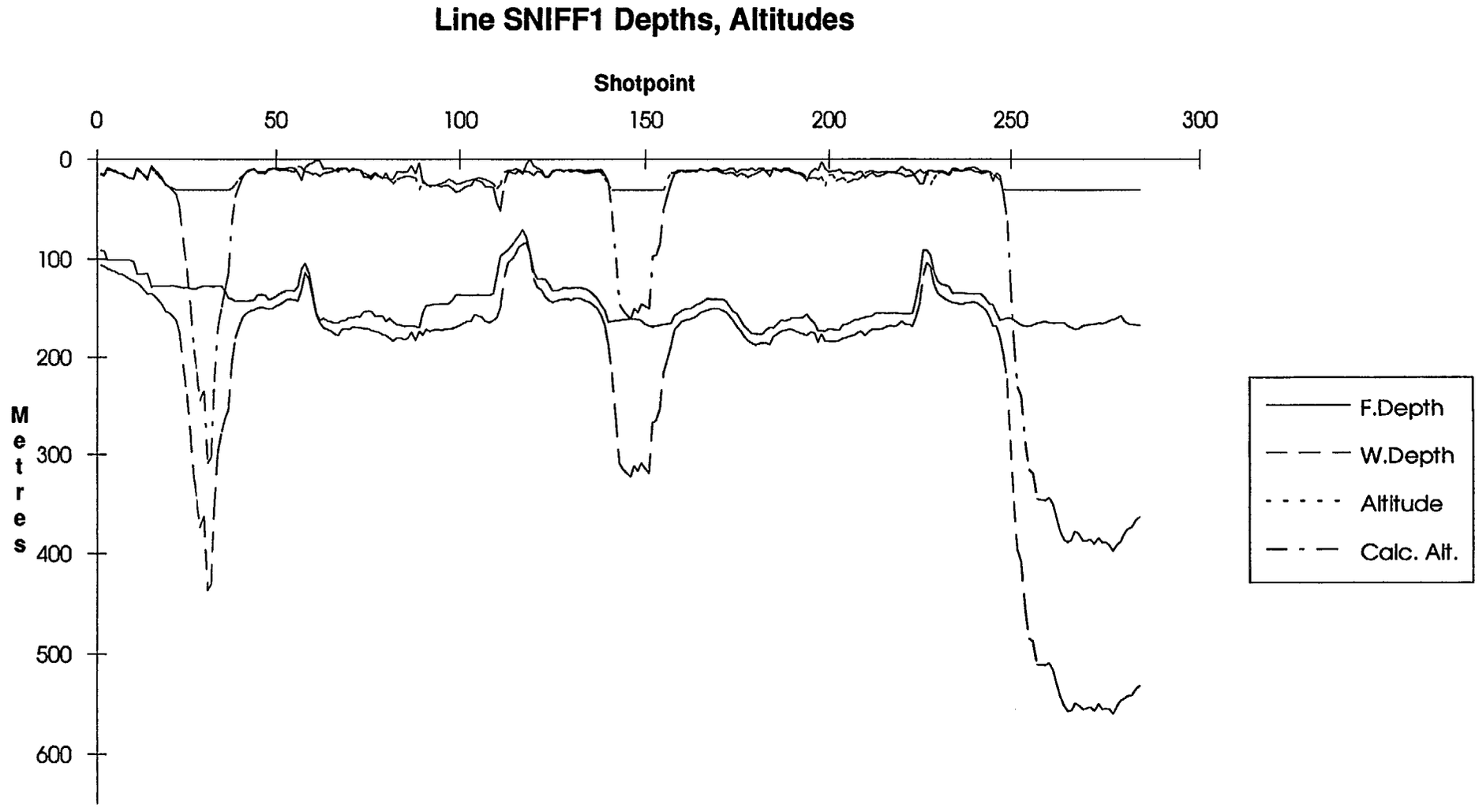
Notes

Four moderate THC and methane anomalies are seen at SP 62, SP 78, SP 110, and SP 200.
Twelve weak THC and methane anomalies occur between SP 40 and SP 280.
Five strong ethane and propane anomalies occur at SP 51, SP 62, SP 110, SP 75, and SP 223.
Four weak ethane and propane anomalies occur at SP 95, SP 215, SP 235 and SP 265.
Gas samples for carbon isotope analysis where taken between SP 98 and SP 104, SP 109 and SP 113, SP 201 and 212, SP 224 and SP 229, SP 236 and SP 239.
The fish hit bottom at SP 54 and SP 90.

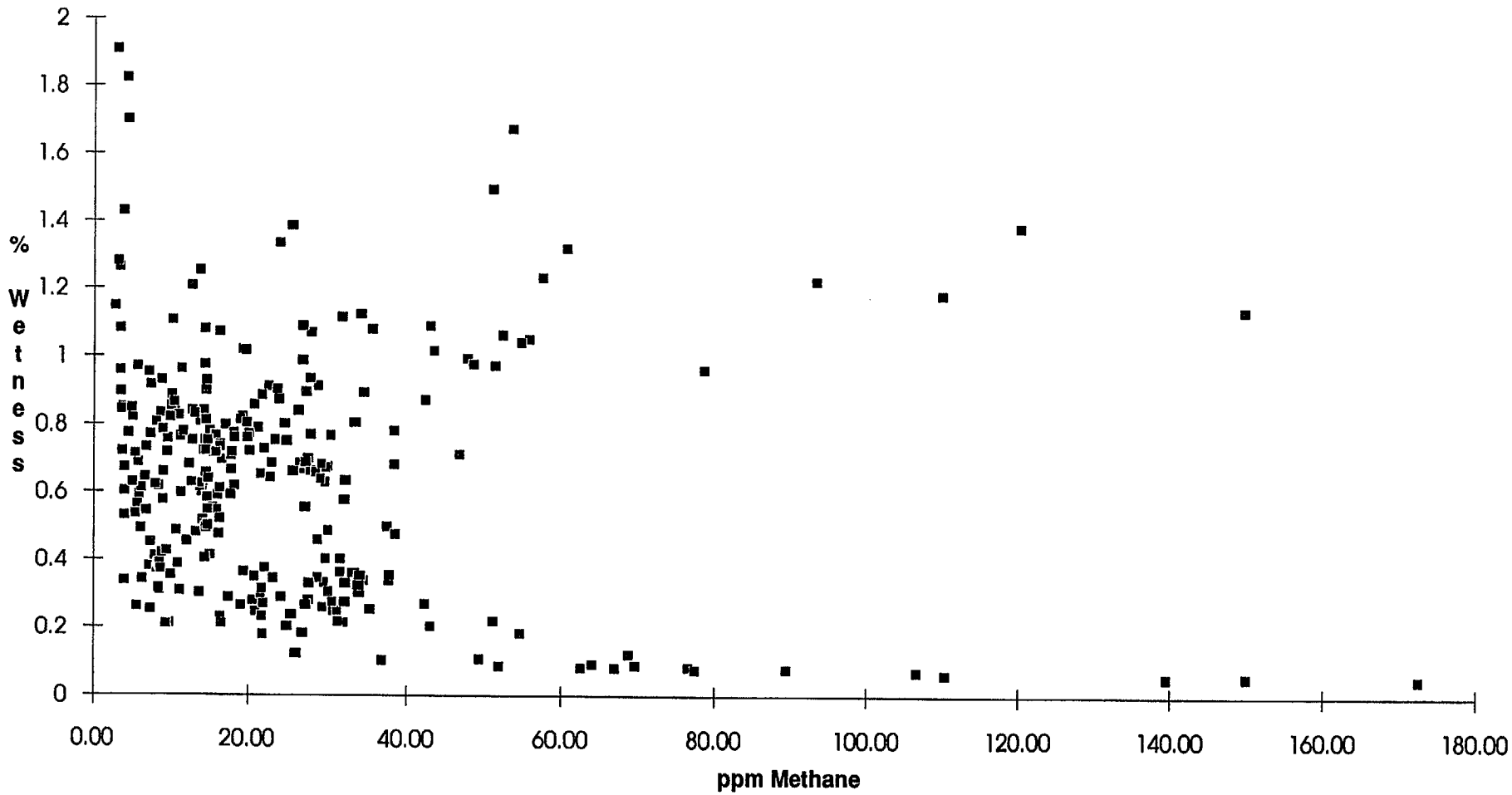

Line SNIFF1 THC, Methane
ppm Hydrocarbons
200.00
180.00
160.00
140.00
120.00
100.00
80.00
60.00
40.00
20.00
0.00
0
50
100
150
200
250
300
Shotpoint
THC
Methane

Line SNIFF1 Ethane, Ethylene, Propane




Line SNIFF1 Depths, Altitudes
Shotpoint
0
50
100
150
200
250
300
Metres
0
100
200
300
400
500
600
F.Depth
W.Depth
Altitude
Calc. Alt.

Line SNIFF1 Methane v. %Wetness



Line Summary

Line Number	109037
No. of Shotpoints	191

	Shotpoint	Date	Time	Latitude		Longitude	
Start	1	20-Apr-92	22:06:38	13	25.067	123	09.461
End	191	21-Apr-92	04:36:55	13	23.429	122	45.521

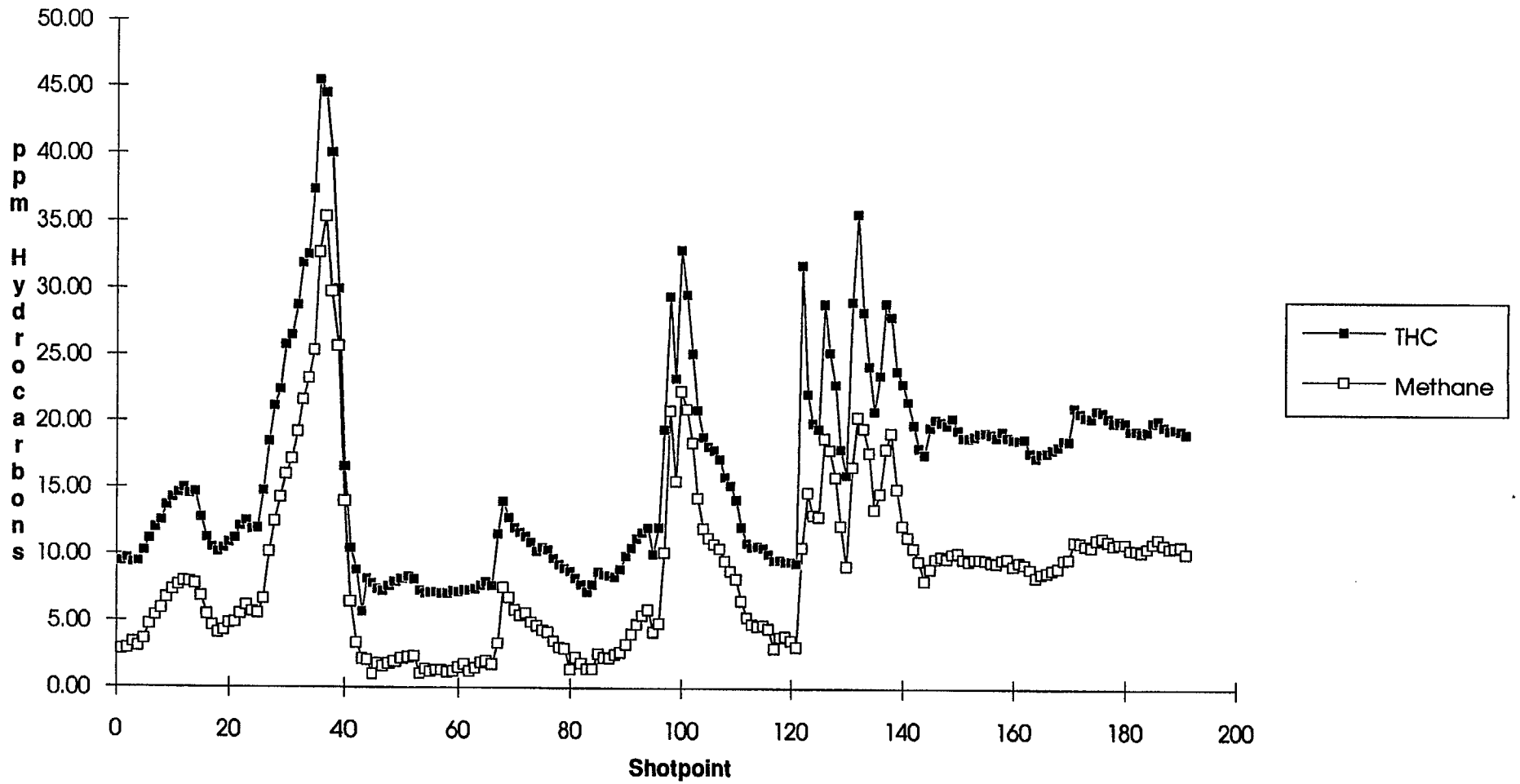
	THC	Methane	Ethane	Ethylene	Propane	Propylene	I-Butane	n-Butane	I-Pentane	n-Pentane	I-Hexane	n-Hexane	%Wetness
Mean	16.225	8.617	0.033	0.071	0.021	0.026	0.004	0.001	0.001	0.055	0.013	0.023	1.017
Std. Dev.	7.649	6.239	0.018	0.066	0.011	0.022	0.007	0.005	0.003	0.037	0.015	0.019	0.767
Minimum	5.656	0.998	0.008	0.013	0.004	0.000	0.000	0.000	0.000	0.021	0.000	0.000	0.134
Maximum	45.489	35.344	0.113	0.253	0.073	0.098	0.032	0.030	0.016	0.172	0.179	0.185	4.061

	Cond.	Temp.	F. Depth	W.Depth	Altitude	Calc. Alt.
Mean	56.768	24.185	147.924	337.132	26.510	189.405
Std. Dev.	2.338	1.577	45.197	193.818	7.153	170.693
Minimum	54.150	22.410	41.500	55.100	9.800	8.500
Maximum	61.160	27.160	198.700	593.400	30.900	431.400

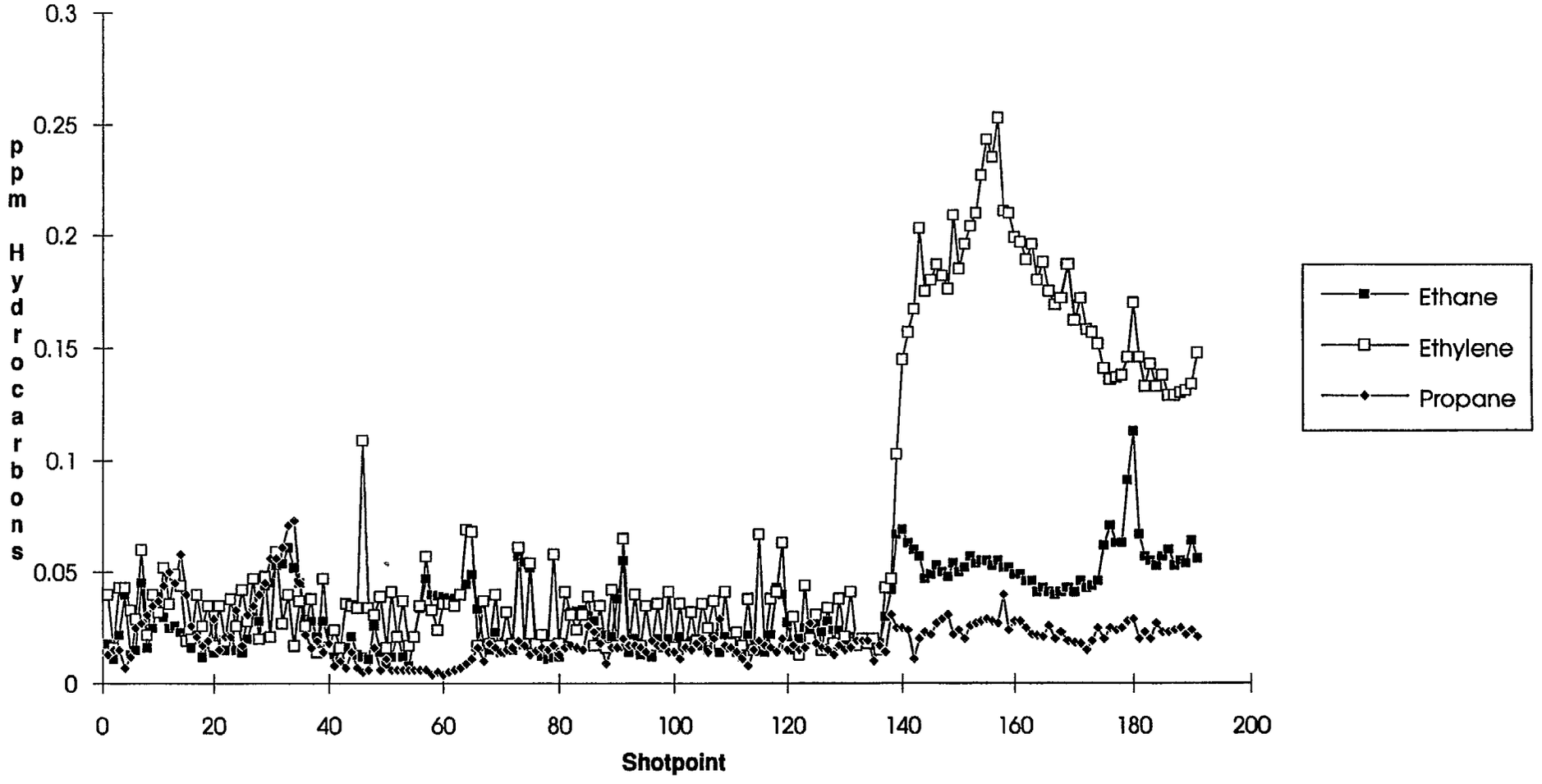
Notes

Three moderate THC and methane anomalies occur at SP 33, SP 100, and from SP 122 to SP 135. SP 33 has a weak ethane and propane anomaly also.
Two very weak THC and methane anomalies occur at SP 10 and SP 70.
A weak THC and methane anomaly occurs at SP 135 along with increases in in all hydrocarbons as the fish is raised through the surface waters.

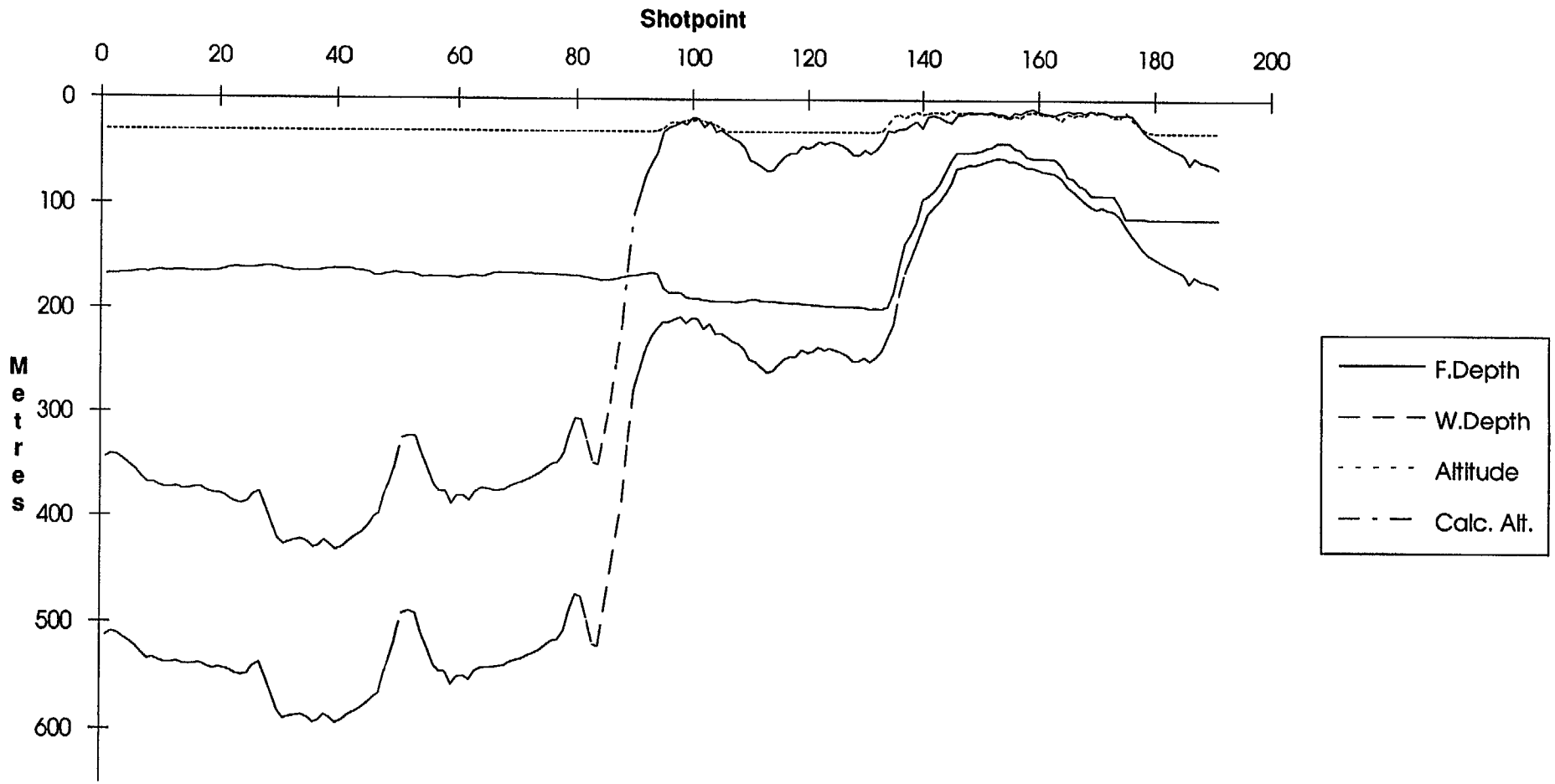
Line 109037 THC, Methane



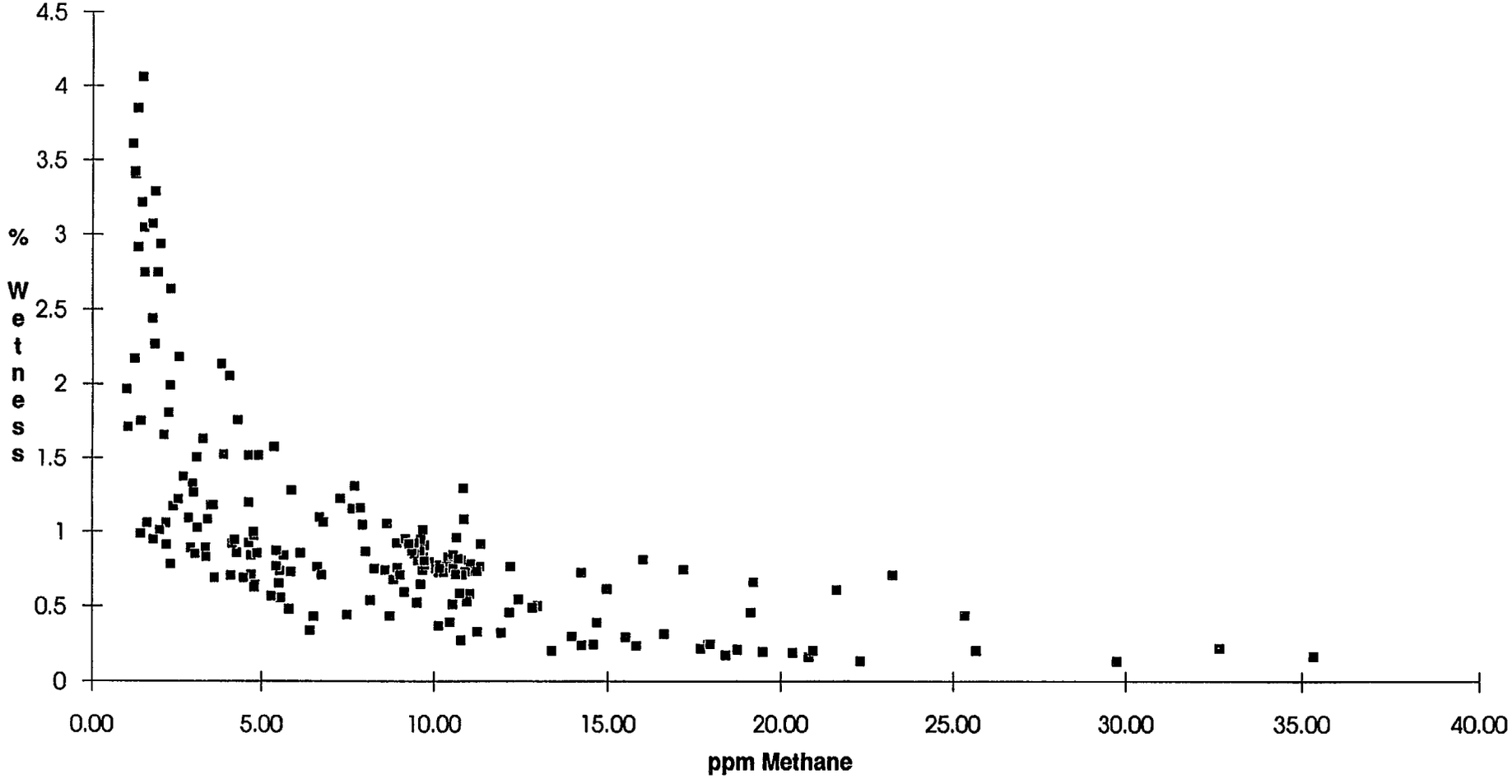
Line 109037 Ethane, Ethylene, Propane



Line 109037 Depths, Altitudes



Line 109037 Methane v. %Wetness



Line Summary

Line Number	109038
No. of Shotpoints	145

	Shotpoint	Date	Time	Latitude		Longitude	
Start	1	21-Apr-92	04:38:55	13	23.371	122	45.566
End	145	21-Apr-92	09:32:50	13	29.316	122	56.680

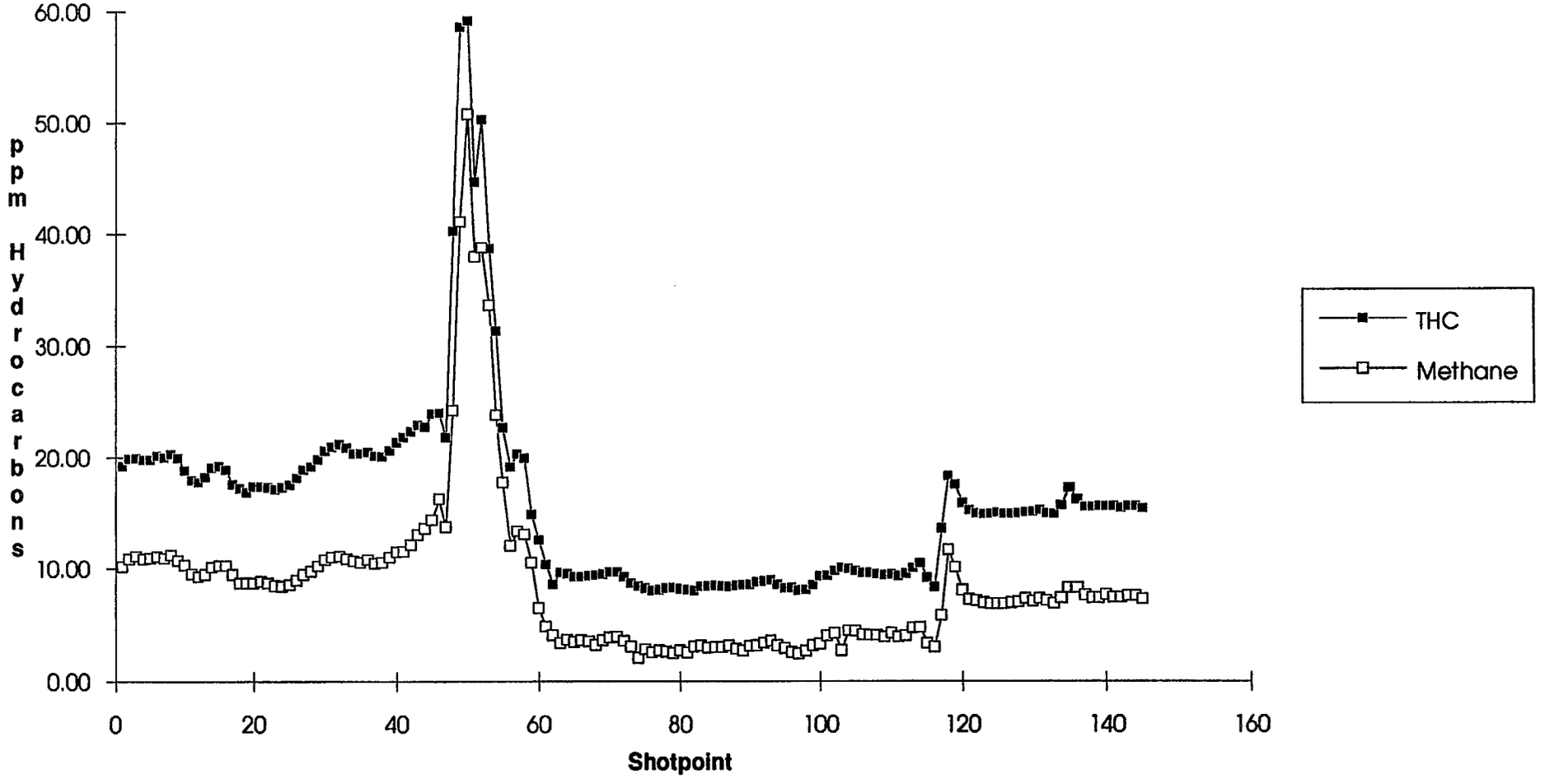
	THC	Methane	Ethane	Ethylene	Propane	Propylene	I-Butane	n-Butane	I-Pentane	n-Pentane	I-Hexane	n-Hexane	%Wetness
Mean	15.951	8.490	0.031	0.088	0.018	0.028	0.003	0.002	0.002	0.078	0.015	0.031	0.874
Std. Dev.	8.634	7.351	0.017	0.067	0.004	0.023	0.008	0.006	0.005	0.037	0.007	0.011	0.437
Minimum	8.079	2.046	0.008	0.015	0.004	0.000	0.000	0.000	0.000	0.035	0.000	0.000	0.083
Maximum	59.168	50.785	0.090	0.197	0.032	0.083	0.064	0.031	0.038	0.149	0.033	0.070	2.342

	Cond.	Temp.	F. Depth	W.Depth	Altitude	Calc. Alt.
Mean	57.982	25.006	145.703	340.976	28.630	195.282
Std. Dev.	1.856	1.222	46.468	168.078	5.589	170.777
Minimum	55.760	23.540	79.400	107.700	10.800	2.100
Maximum	60.380	26.620	198.000	584.900	30.900	505.500

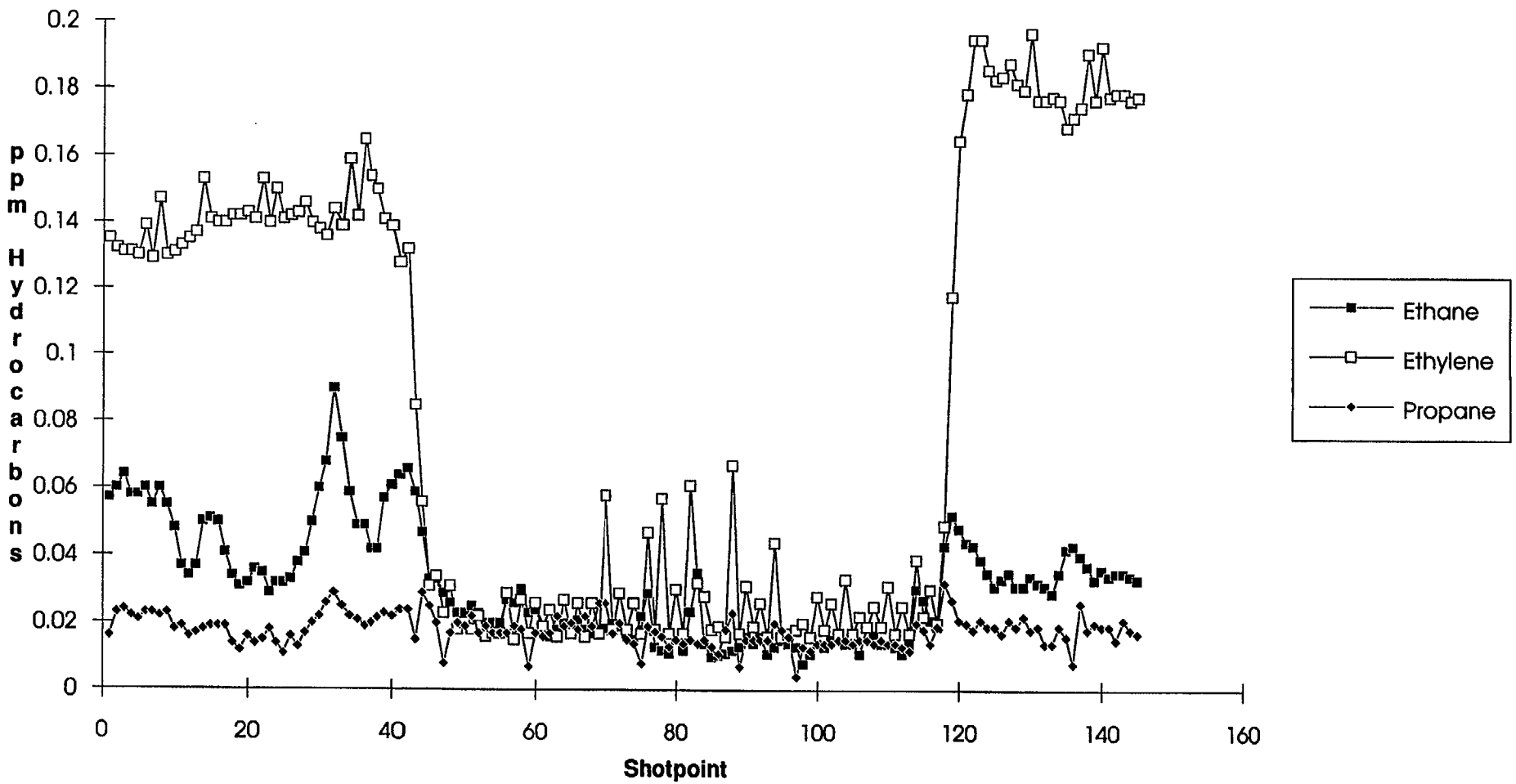
Notes

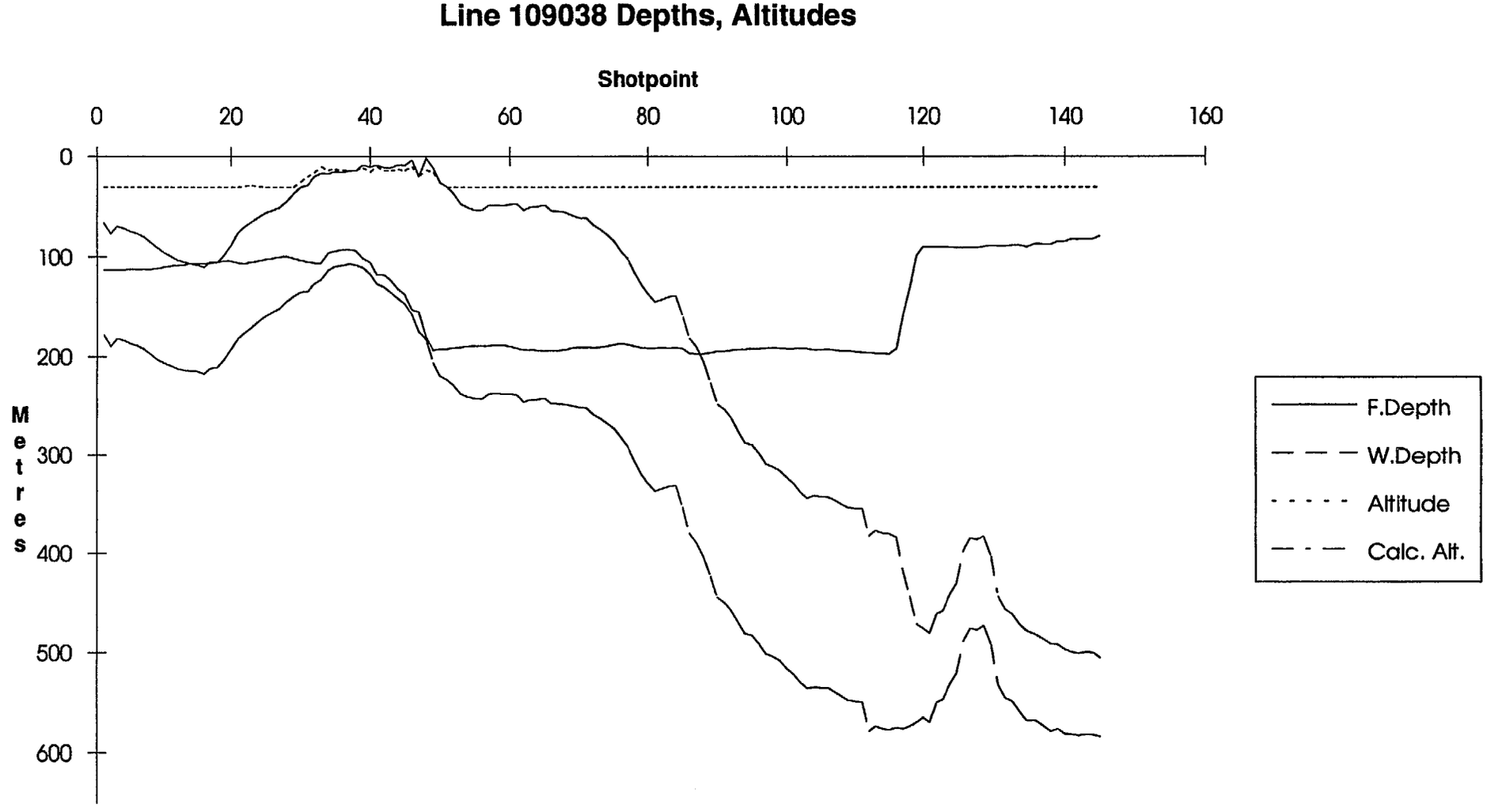
A moderate THC and methane anomaly occurs at SP 50
Hydrocarbon values before SP 45 and after SP 117 are increased due to the effects of surface waters..

Line 109038 THC, Methane

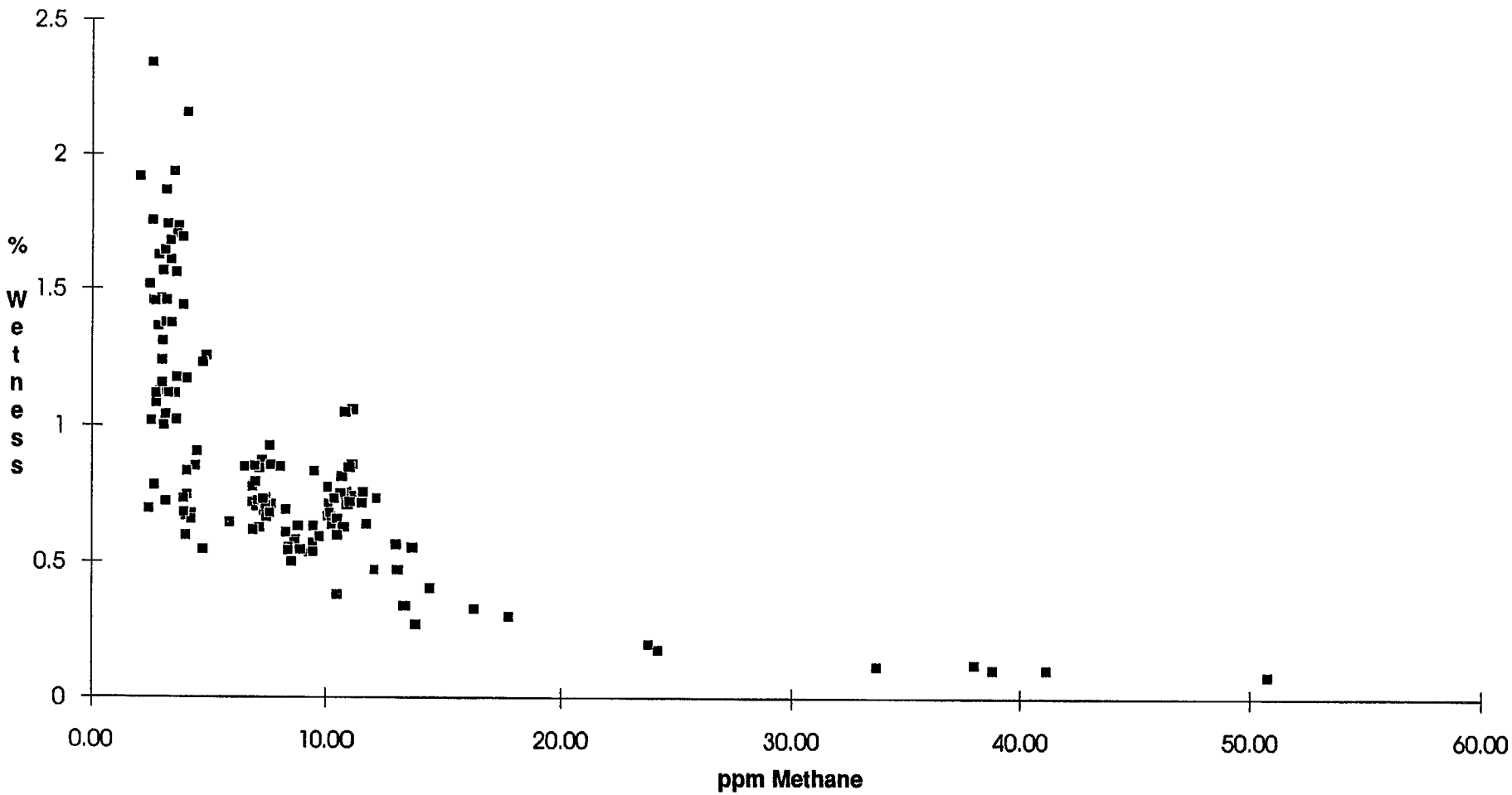


Line 109038 Ethane, Ethylene, Propane




Line 109038 Depths, Altitudes
Shotpoint
0
20
40
60
80
100
120
140
160
0
100
200
300
400
500
600
Metres
F.Depth
W.Depth
Altitude
Calc. Alt.

Line 109038 Methane v. %Wetness



Line Summary

Line Number	Sniff2
No. of Shotpoints	301

	Shotpoint	Date	Time	Latitude		Longitude	
Start	1	21-Apr-92	10:27:35	13	29.704	122	53.012
End	302	21-Apr-92	22:07:40	13	15.626	123	10.016

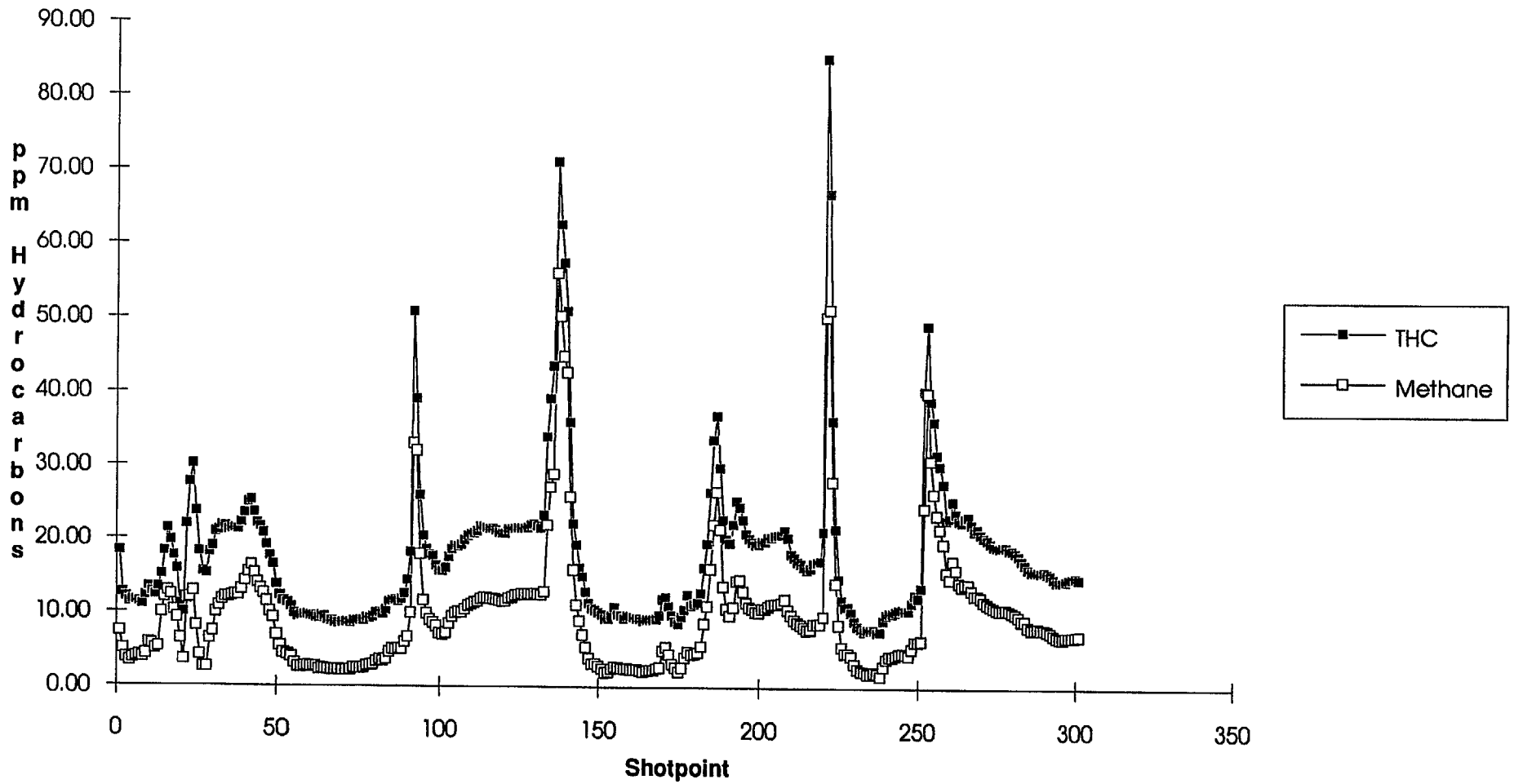
	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	17.893	9.573	0.031	0.061	0.023	0.021	0.002	0.002	0.001	0.052	0.011	0.017	0.732
Std. Dev.	10.076	8.289	0.028	0.050	0.027	0.018	0.006	0.006	0.003	0.020	0.007	0.013	0.388
Minimum	7.490	1.641	0.007	0.012	0.007	0.000	0.000	0.000	0.000	0.023	0.000	0.000	0.097
Maximum	85.230	55.996	0.284	0.265	0.267	0.088	0.044	0.050	0.028	0.178	0.070	0.048	2.414

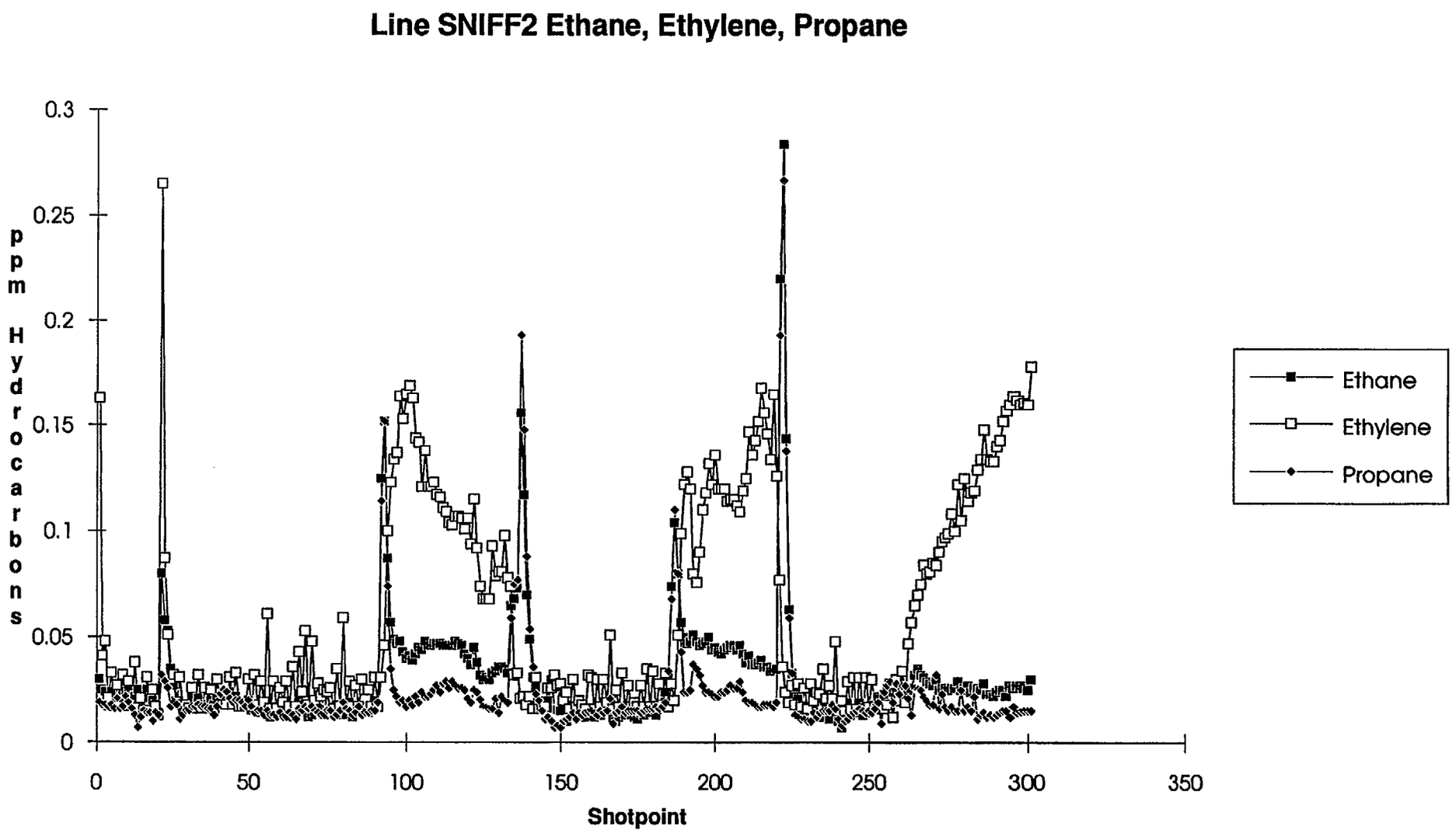
	Cond.	Temp.	F. Depth	W.Depth	Altitude	Calc. Alt.
Mean	55.218	23.119	153.821	196.763	17.463	42.999
Std. Dev.	1.173	0.760	41.451	101.407	7.094	73.868
Minimum	53.960	22.300	63.200	73.600	9.200	1.900
Maximum	57.840	24.820	250.600	532.200	30.800	353.000

Notes

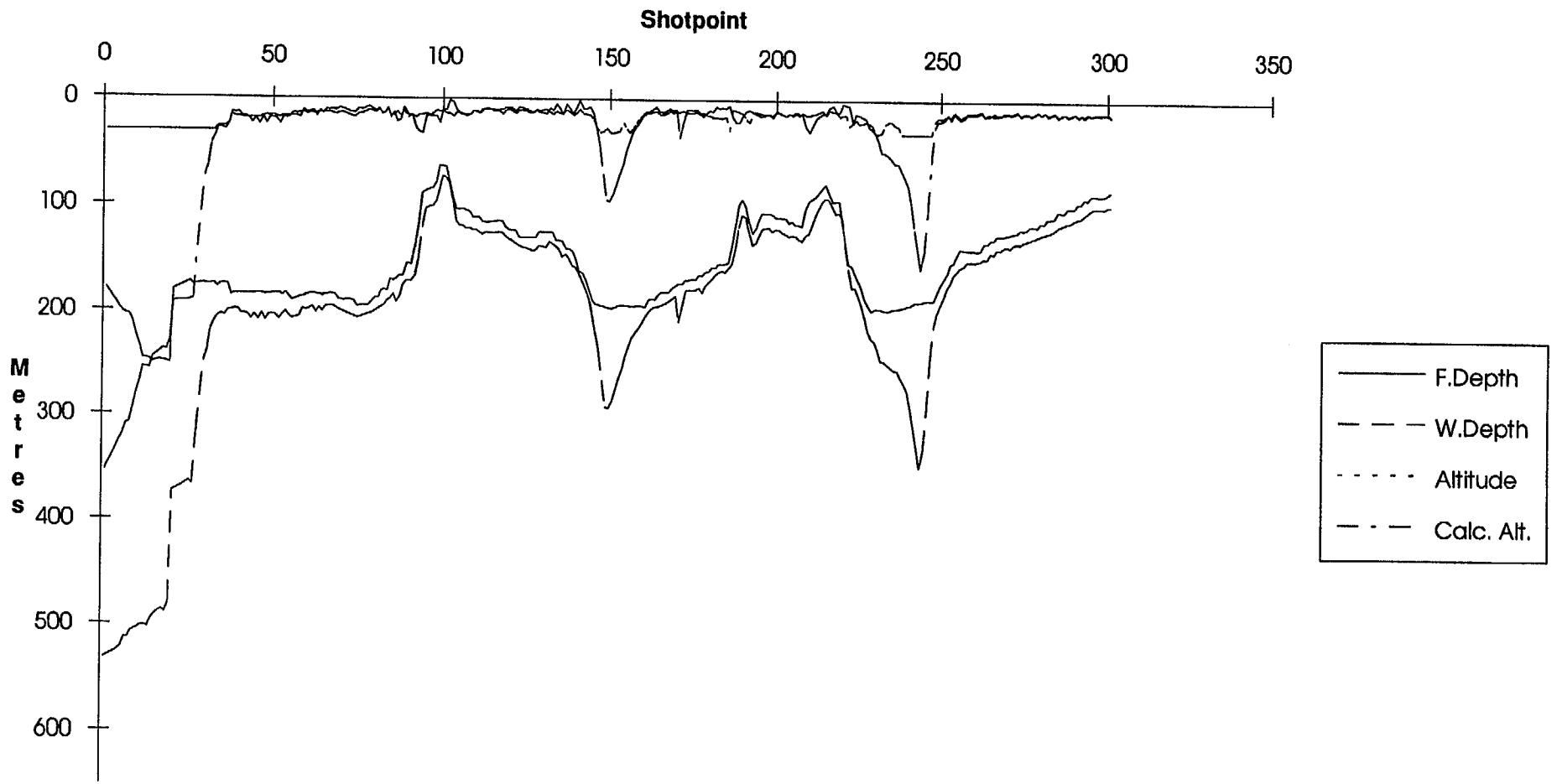
Seven weak to moderate THC and methane anomalies occur at SP 25, SP 40, SP 94, SP 140, SP 190, SP 225 and SP 255.
A strong ethane and propane anomaly occurs at SP 225.
Four weak ethane and propane anomalies occur at SP 25, SP 94, SP 140 and SP 190.
Hydrocarbon values increase as a result of the passage of the tow-fish through surface waters between SP 96 and SP 135, SP 190 and SP 224, and after SP 260.
Fish hit bottom at SP 183.

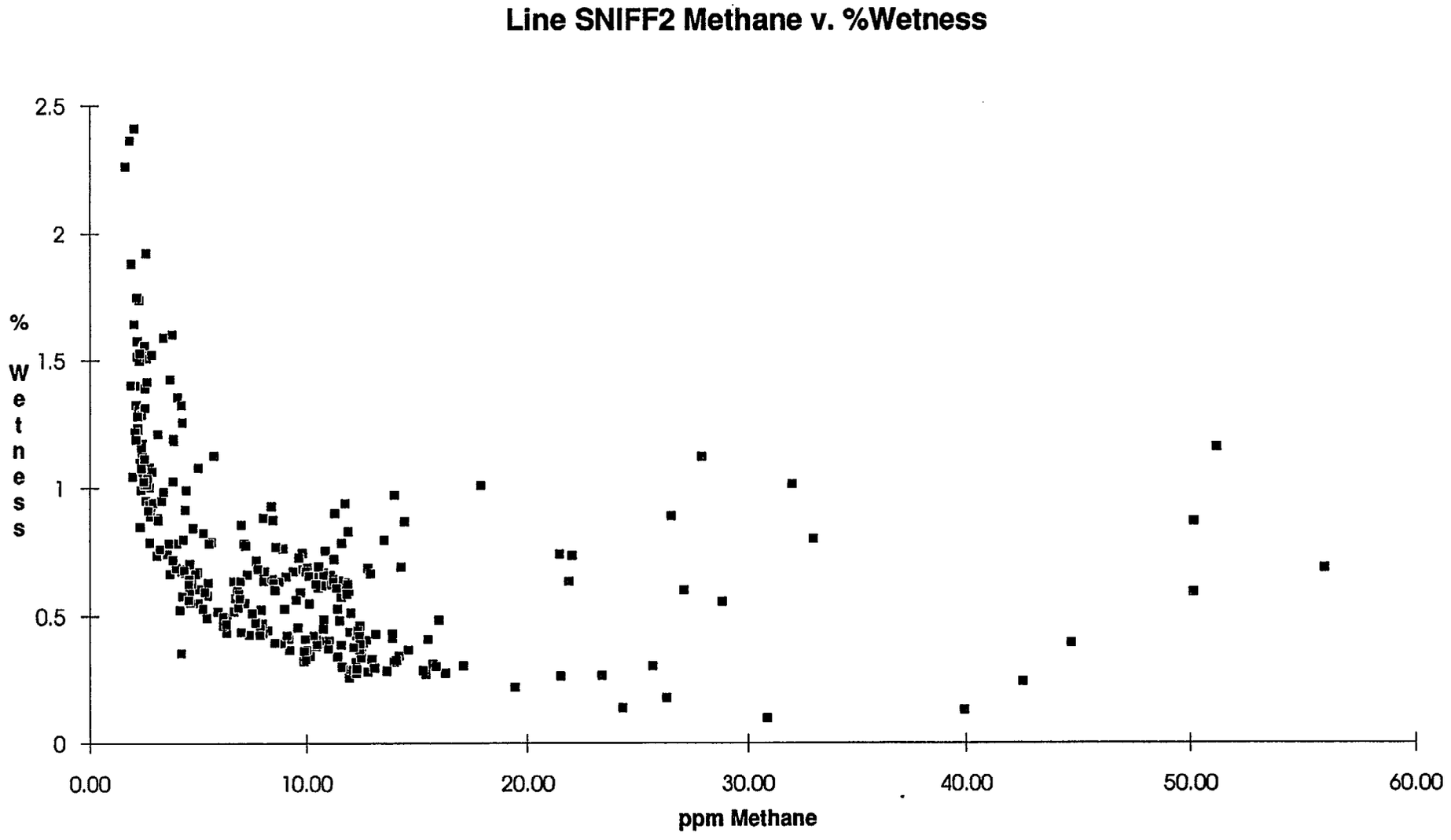
Line SNIFF2 THC, Methane




Line SNIFF2 Ethane, Ethylene, Propane
ppm Hydrocarbons
0.3
0.25
0.2
0.15
0.1
0.05
0
0
50
100
150
200
250
300
350
Shotpoint
Ethane
Ethylene
Propane

Line SNIFF2 Depths, Altitudes




Line SNIFF2 Methane v. %Wetness
2.5
2
1.5
1
0.5
0
% Wetness
0.00
10.00
20.00
30.00
40.00
50.00
60.00
ppm Methane

Line Summary

Line Number	109039
No. of Shotpoints	244

	Shotpoint	Date	Time	Latitude		Longitude	
Start	1	21-Apr-92	22:54:50	13	16.554	123	11.841
End	244	22-Apr-92	07:21:22	13	16.153	122	43.323

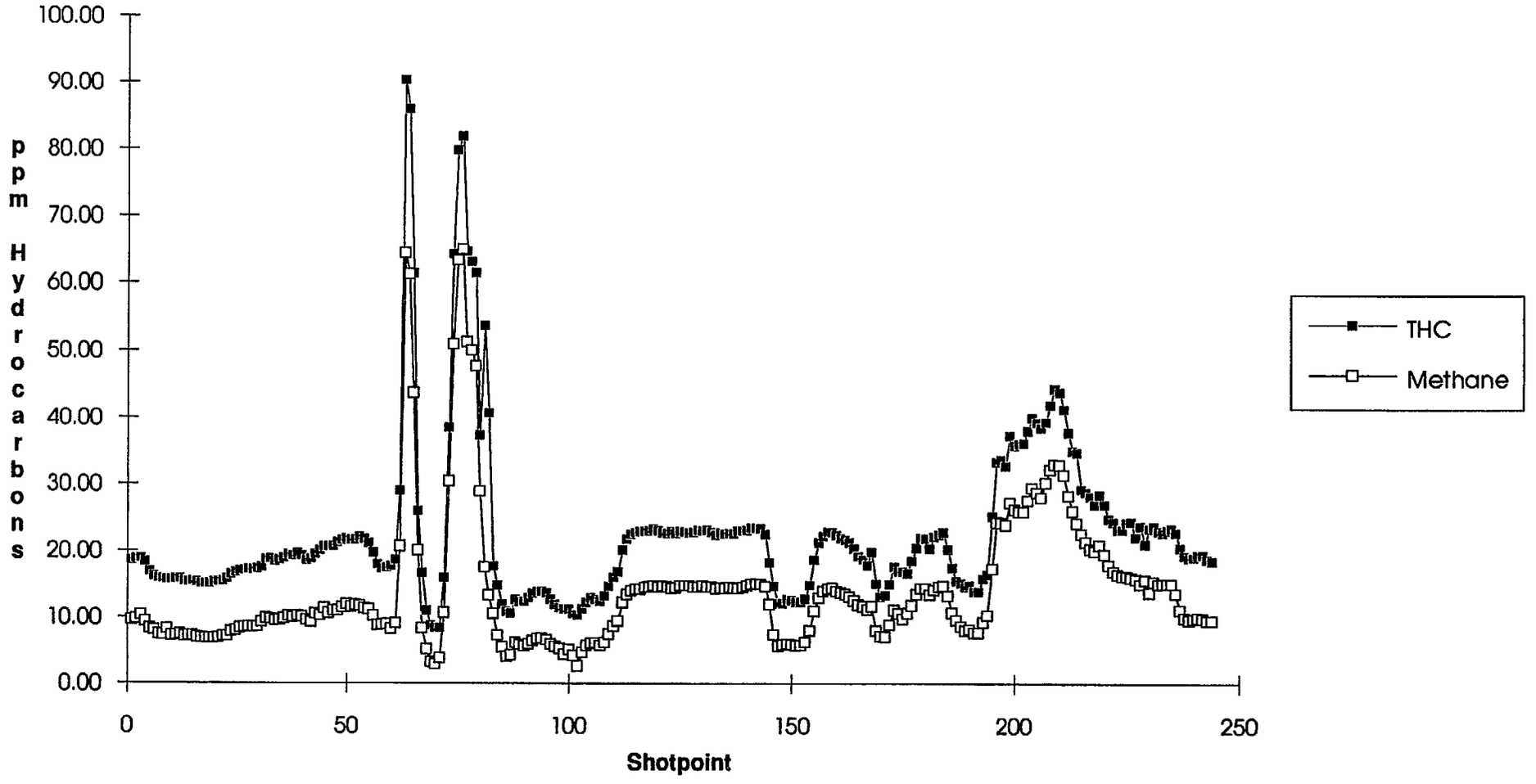
	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	22.490	13.906	0.032	0.060	0.028	0.027	0.008	0.005	0.001	0.062	0.008	0.033	0.593
Std. Dev.	12.418	10.318	0.029	0.052	0.033	0.019	0.012	0.012	0.002	0.030	0.007	0.026	0.297
Minimum	8.383	2.645	0.009	0.015	0.004	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.087
Maximum	90.429	64.996	0.300	0.193	0.339	0.094	0.078	0.069	0.021	0.203	0.029	0.191	2.001

	Cond.	Temp.	F. Depth	W.Depth	Altitude	Calc. Alt.
Mean	57.145	24.429	144.679	159.822	15.484	15.125
Std. Dev.	1.125	0.721	30.361	31.299	4.372	7.027
Minimum	55.990	23.680	78.400	91.500	9.900	1.800
Maximum	60.290	26.570	181.100	199.000	30.800	50.400

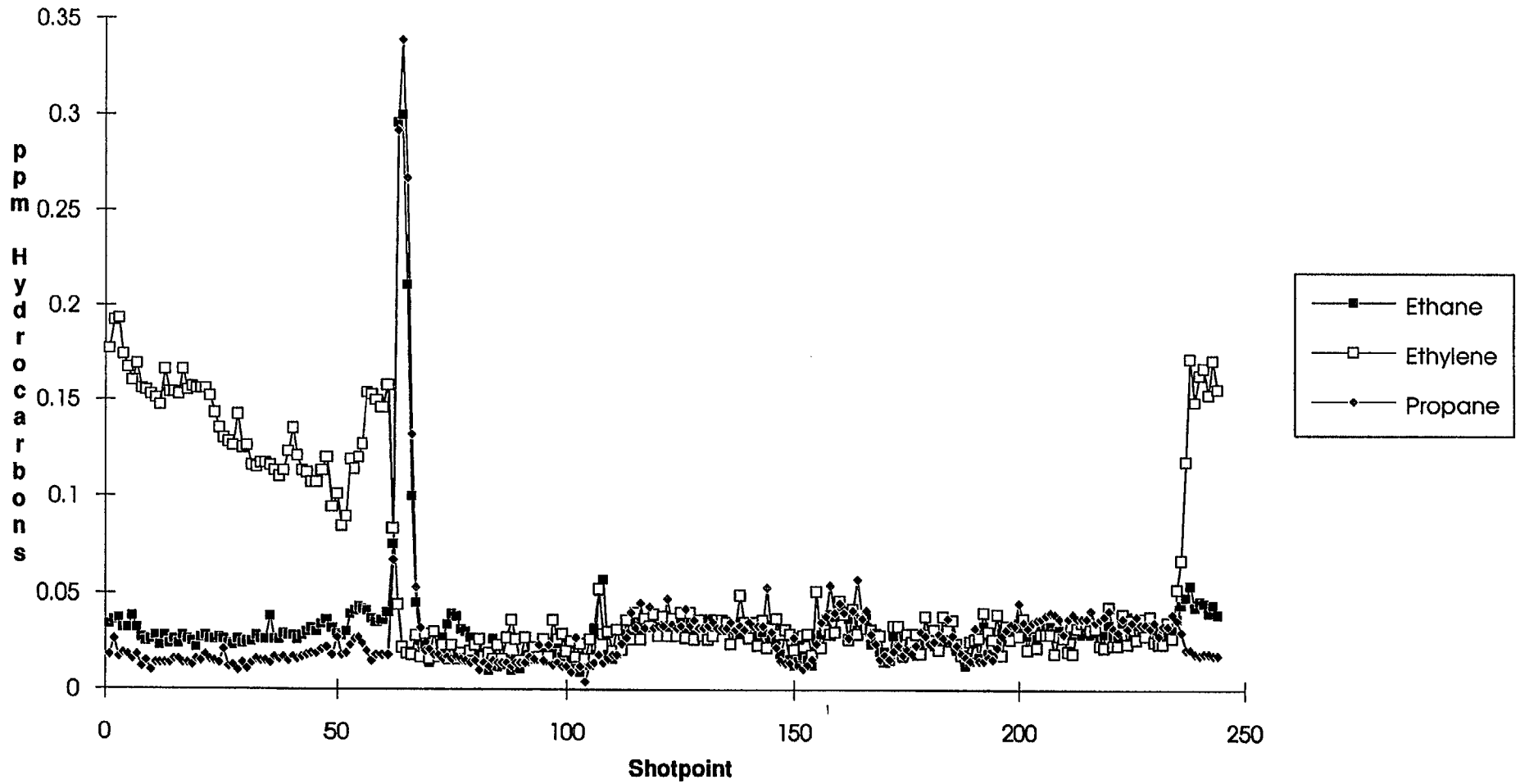
Notes

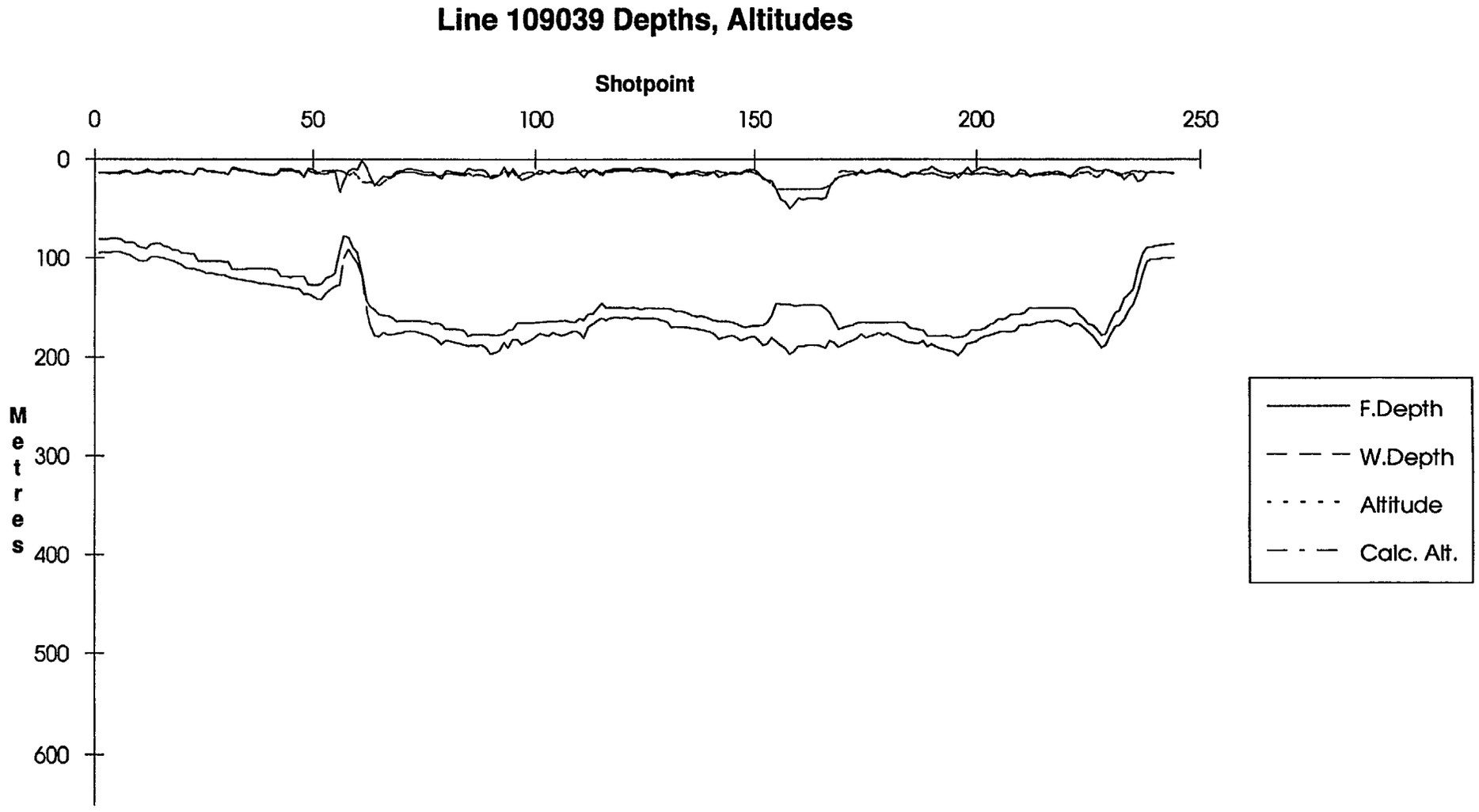
Two moderate THC and methane anomolies occur at SP 60 and SP 75 and a weak anomaly at SP200.
The anomaly at SP 60 also has a strong ethane and propane anomaly.
Thermoclinal influences probably effect hydrocarbon values before SP 60 and after SP 240.
A gas sample was taken between SP 78 and SP 84 for carbon isotope analysis.

Line 109039 THC, Methane

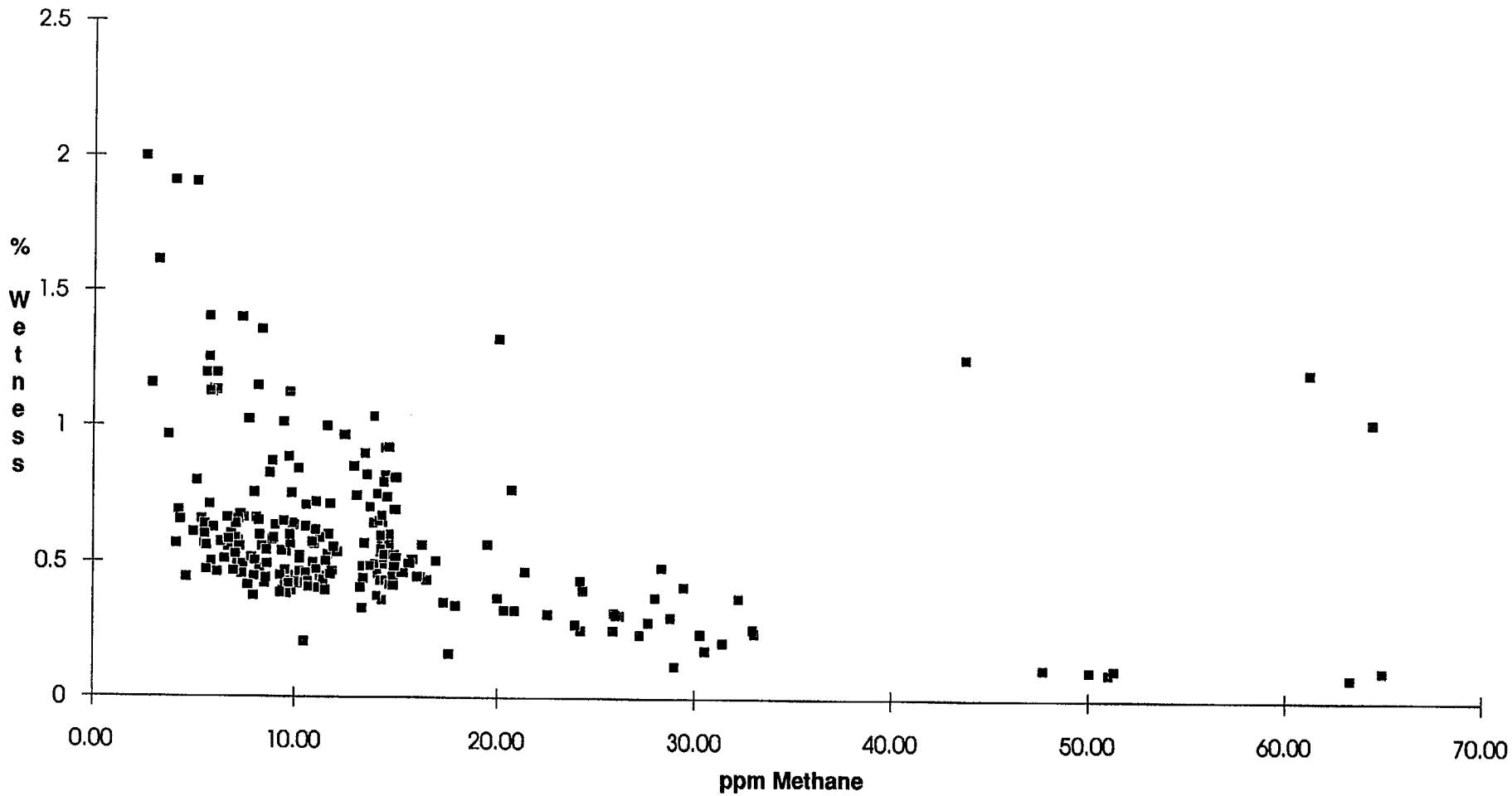


Line 109039 Ethane, Ethylene, Propane




Line 109039 Depths, Altitudes
Shotpoint
0
50
100
150
200
250
0
100
200
300
400
500
600
Metres
F.Depth
W.Depth
Altitude
Calc. Alt.

Line 109039 Methane v. %Wetness



Line Summary

Line Number	Sniff3
No. of Shotpoints	290

	Shotpoint	Date	Time	Latitude		Longitude	
Start	1	22-Apr-92	11:47:51	13	30.861	122	57.750
End	292	22-Apr-92	21:42:15	13	29.923	122	57.943

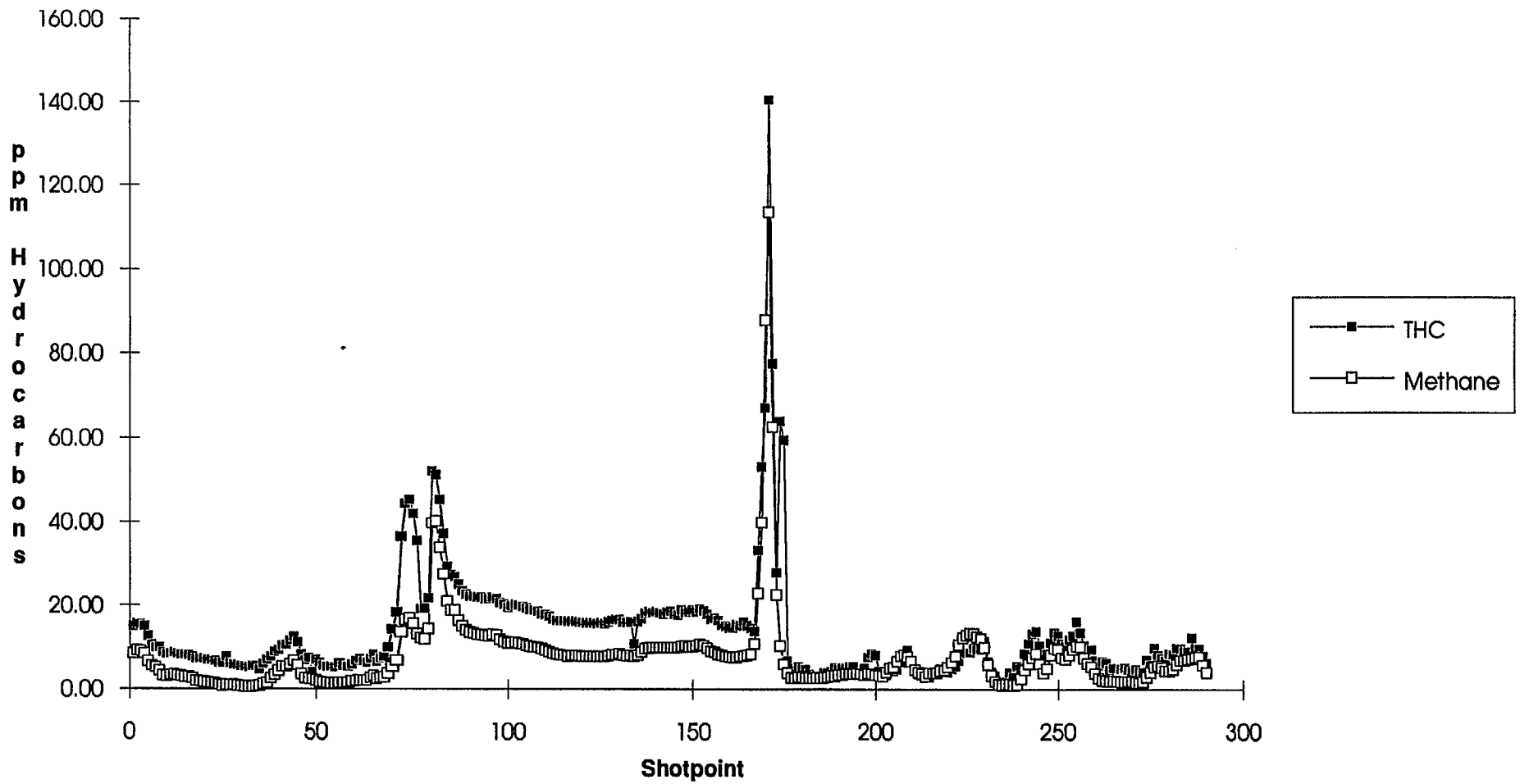
	THC	Methane	Ethane	Ethylene	Propane	Propylene	I-Butane	n-Butane	I-Pentane	n-Pentane	I-Hexane	n-Hexane	%Wetness
Mean	13.299	7.796	0.025	0.052	0.025	0.018	0.003	0.002	0.001	0.046	0.010	0.017	1.047
Std. Dev.	13.184	10.293	0.049	0.048	0.054	0.031	0.011	0.014	0.003	0.019	0.006	0.014	1.161
Minimum	1.816	0.520	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.014	0.000	0.000	0.077
Maximum	140.660	113.639	0.612	0.173	0.652	0.240	0.141	0.202	0.027	0.094	0.027	0.065	10.742

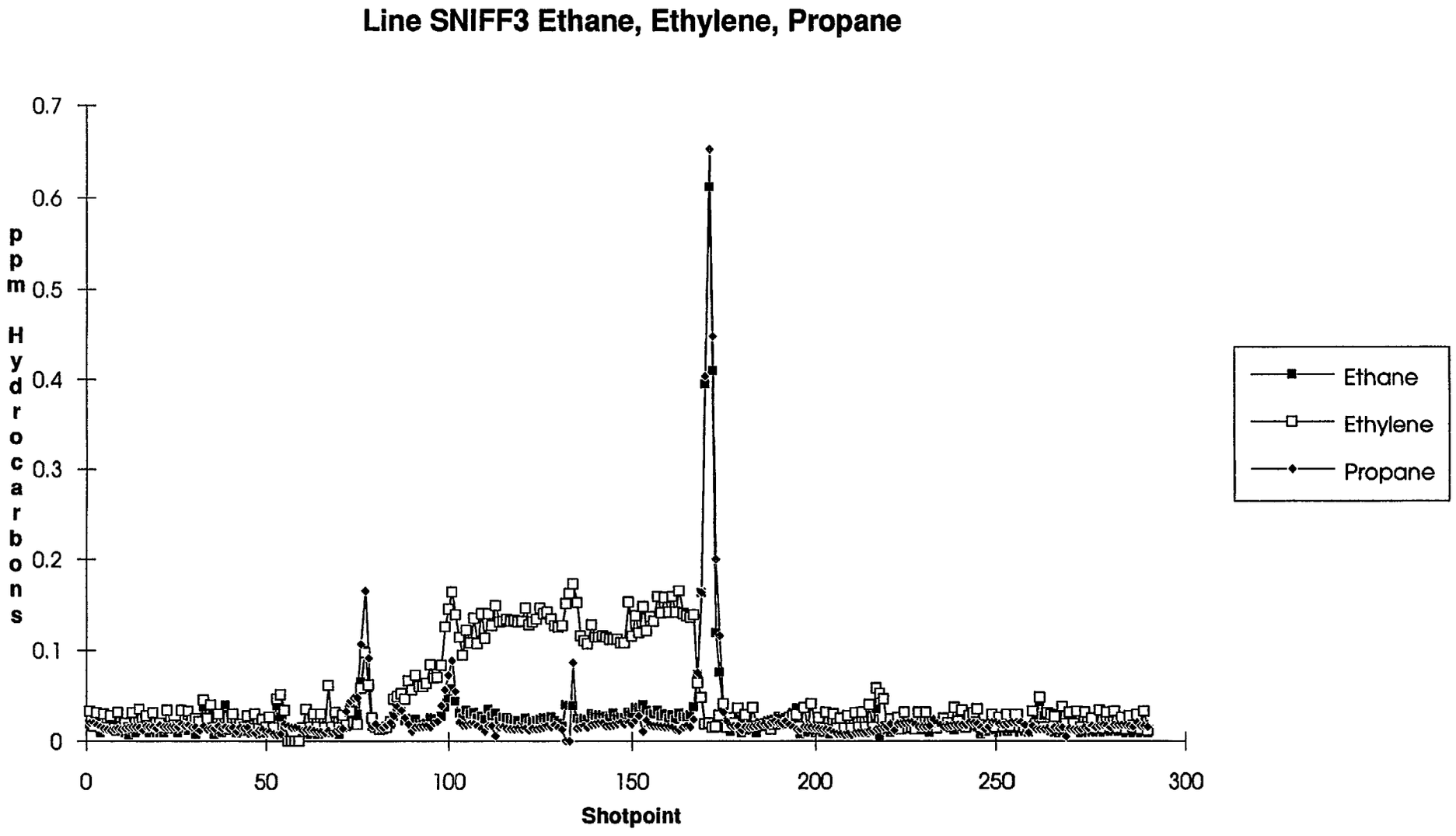
	Cond.	Temp.	F. Depth	W.Depth	Altitude	Calc. Alt.
Mean	54.968	22.960	170.433	329.330	23.588	159.461
Std. Dev.	1.215	0.793	42.632	185.506	8.351	159.110
Minimum	53.710	22.130	75.700	85.100	9.400	6.000
Maximum	57.530	24.630	215.500	590.140	30.800	400.200

Notes

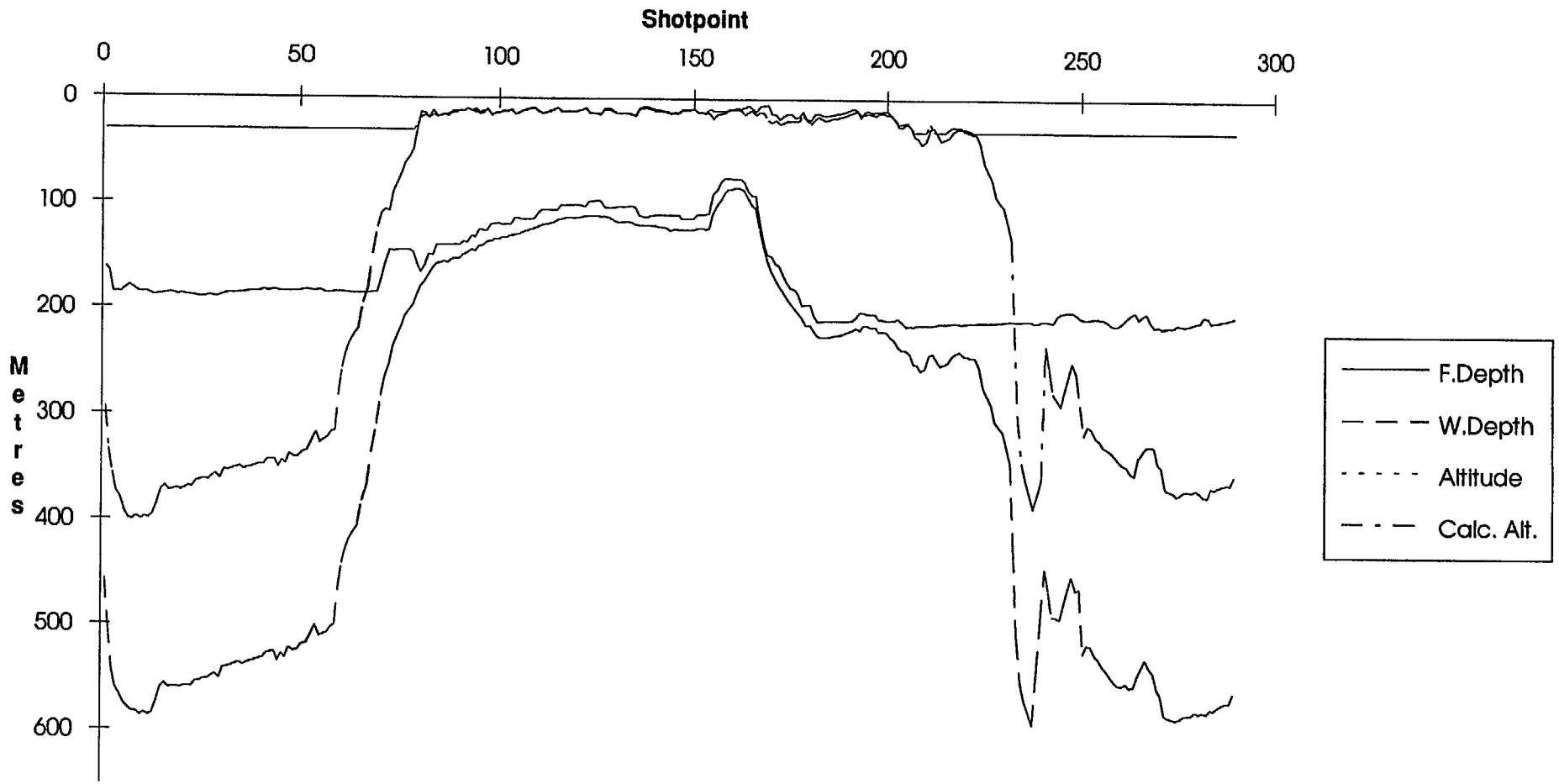
A strong THC and methane anomaly occurs at SP 170, along with two weak anomalies at SP 75 and SP 85.
A strong ethane and propane anomaly occurs at SP 170.
Between SP 95 and SP 165 the water shallows and hydrocarbon values are effected.
Gas samples for carbon isotope analysis where taken at SP 174 to SP 176.

Line SNIFF3 THC, Methane

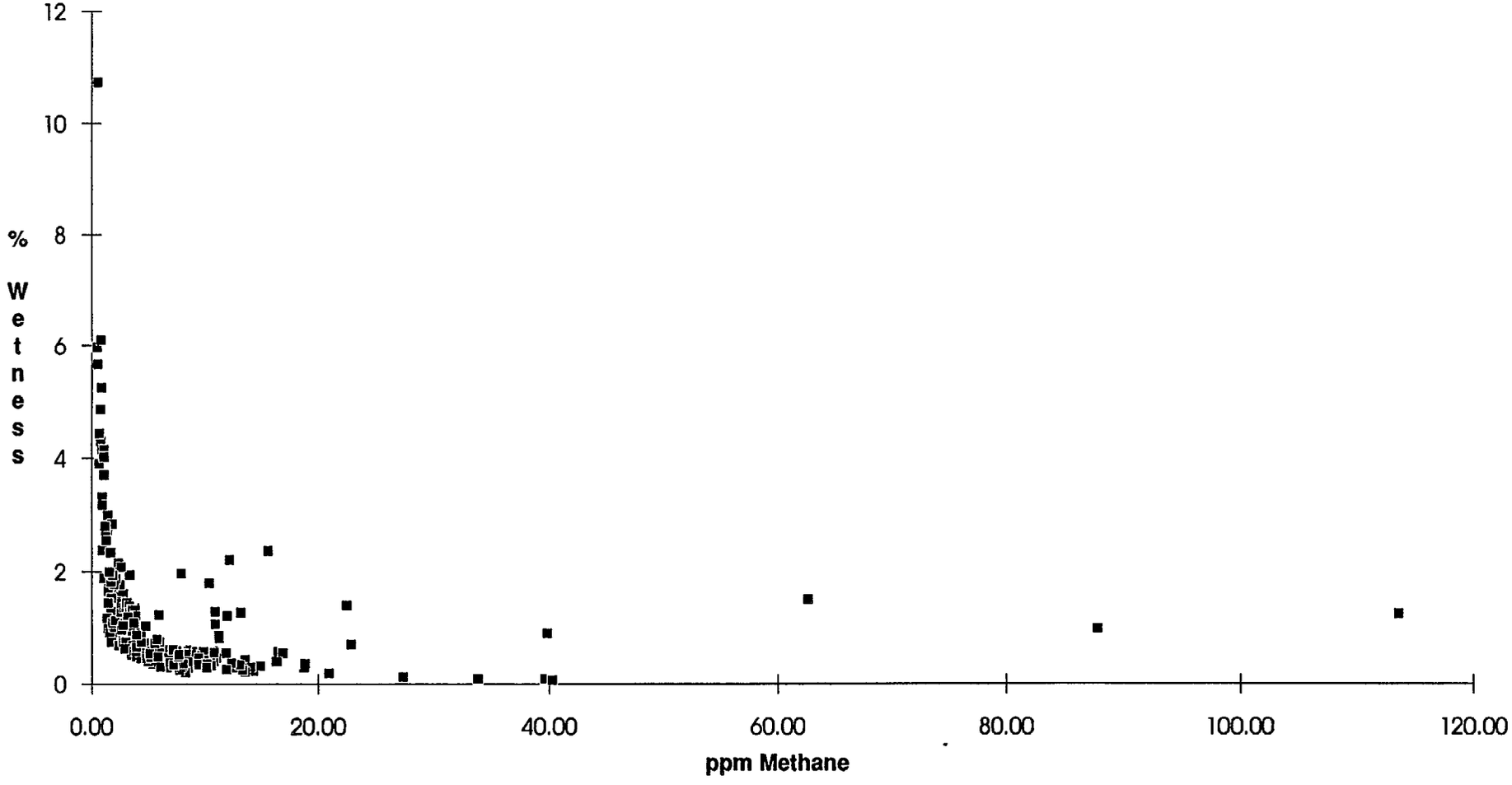



Line SNIFF3 Ethane, Ethylene, Propane
ppm Hydrocarbons
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
50
100
150
200
250
300
Shotpoint
Ethane
Ethylene
Propane

Line SNIFF3 Depths, Altitudes



Line SNIFF3 Methane v. %Wetness



Line Summary

Line Number	109040
No. of Shotpoints	122

	Shotpoint	Date	Time	Latitude		Longitude	
Start	1	22-Apr-92	07:23:21	13	16.293	122	43.422
End	123	22-Apr-92	11:45:52	13	31.005	122	57.653

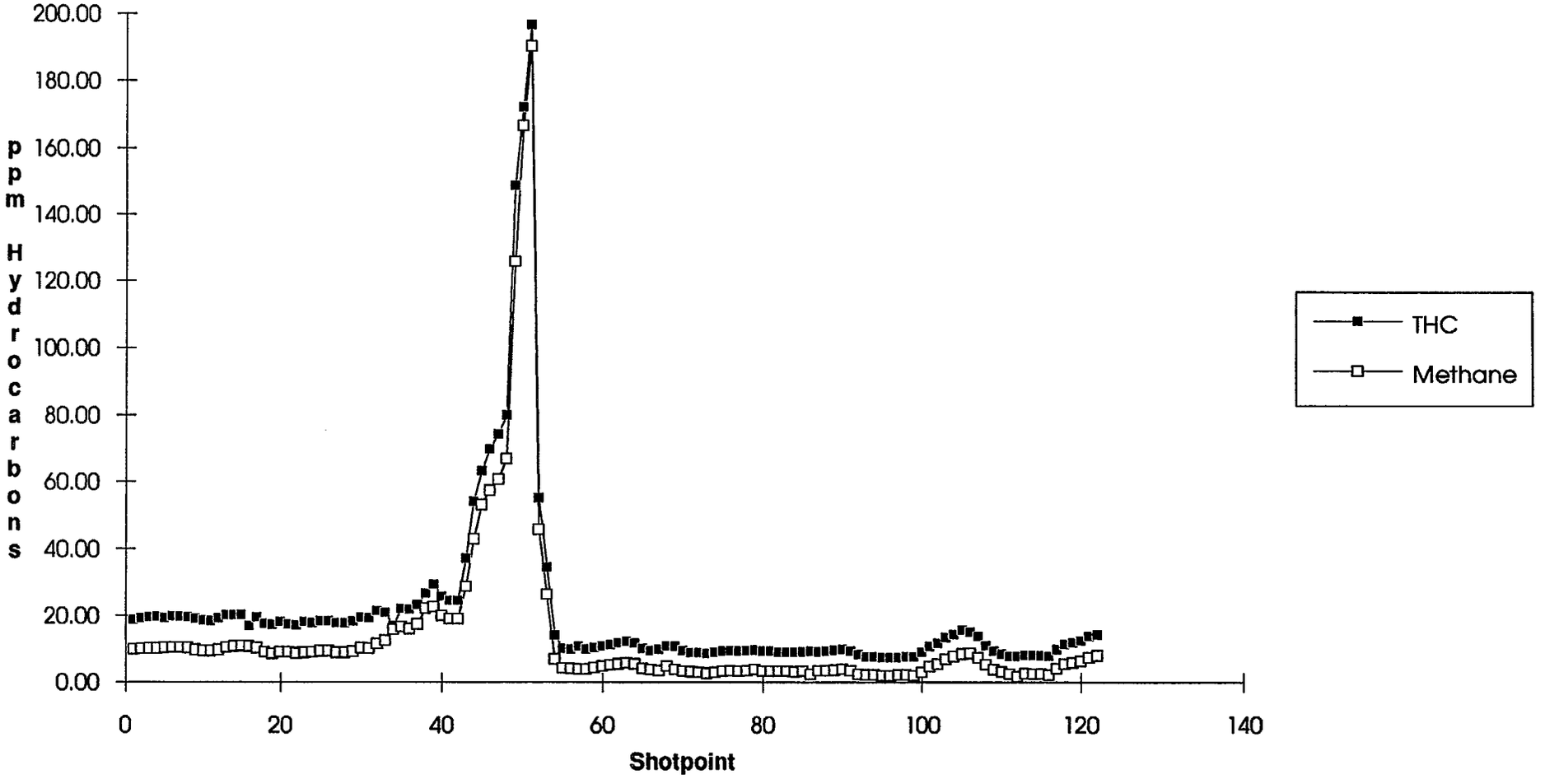
	THC	Methane	Ethane	Ethylene	Propane	Propylene	I-Butane	n-Butane	I-Pentane	n-Pentane	I-Hexane	n-Hexane	%Wetness
Mean	20.683	13.514	0.024	0.057	0.017	0.019	0.002	0.001	0.000	0.062	0.012	0.032	0.661
Std. Dev.	27.595	26.568	0.013	0.056	0.005	0.021	0.005	0.005	0.001	0.025	0.009	0.010	0.343
Minimum	7.517	1.888	0.007	0.008	0.004	0.000	0.000	0.000	0.000	0.017	0.000	0.000	0.034
Maximum	196.749	190.493	0.055	0.206	0.037	0.093	0.033	0.038	0.006	0.163	0.064	0.055	1.710

	Cond.	Temp.	F. Depth	W.Depth	Altitude	Calc. Alt.
Mean	56.359	23.926	165.594	310.489	26.821	144.905
Std. Dev.	2.163	1.440	46.605	171.874	7.017	141.150
Minimum	54.640	22.790	86.000	101.100	10.400	4.000
Maximum	60.280	26.510	205.800	584.900	30.900	380.500

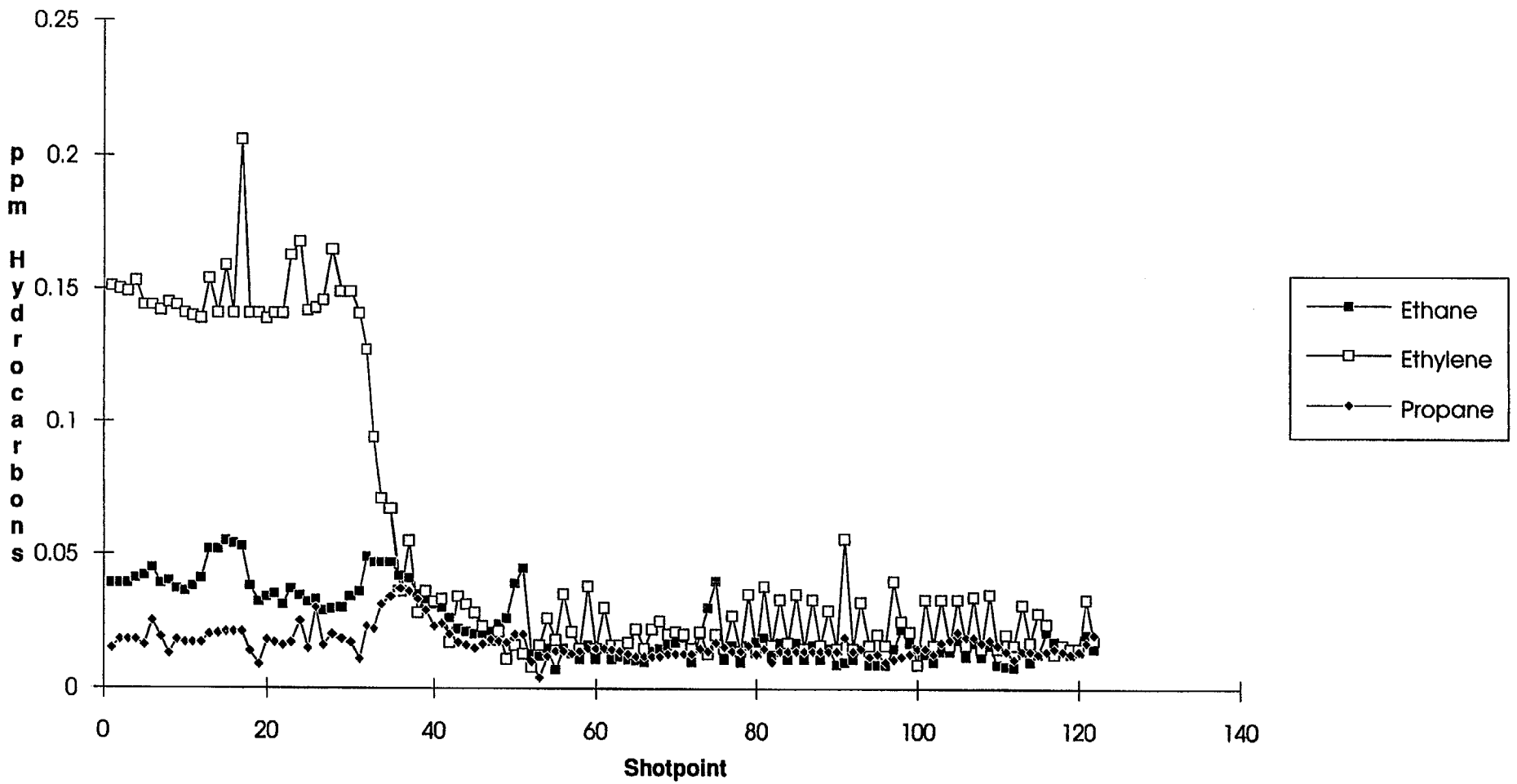
Notes

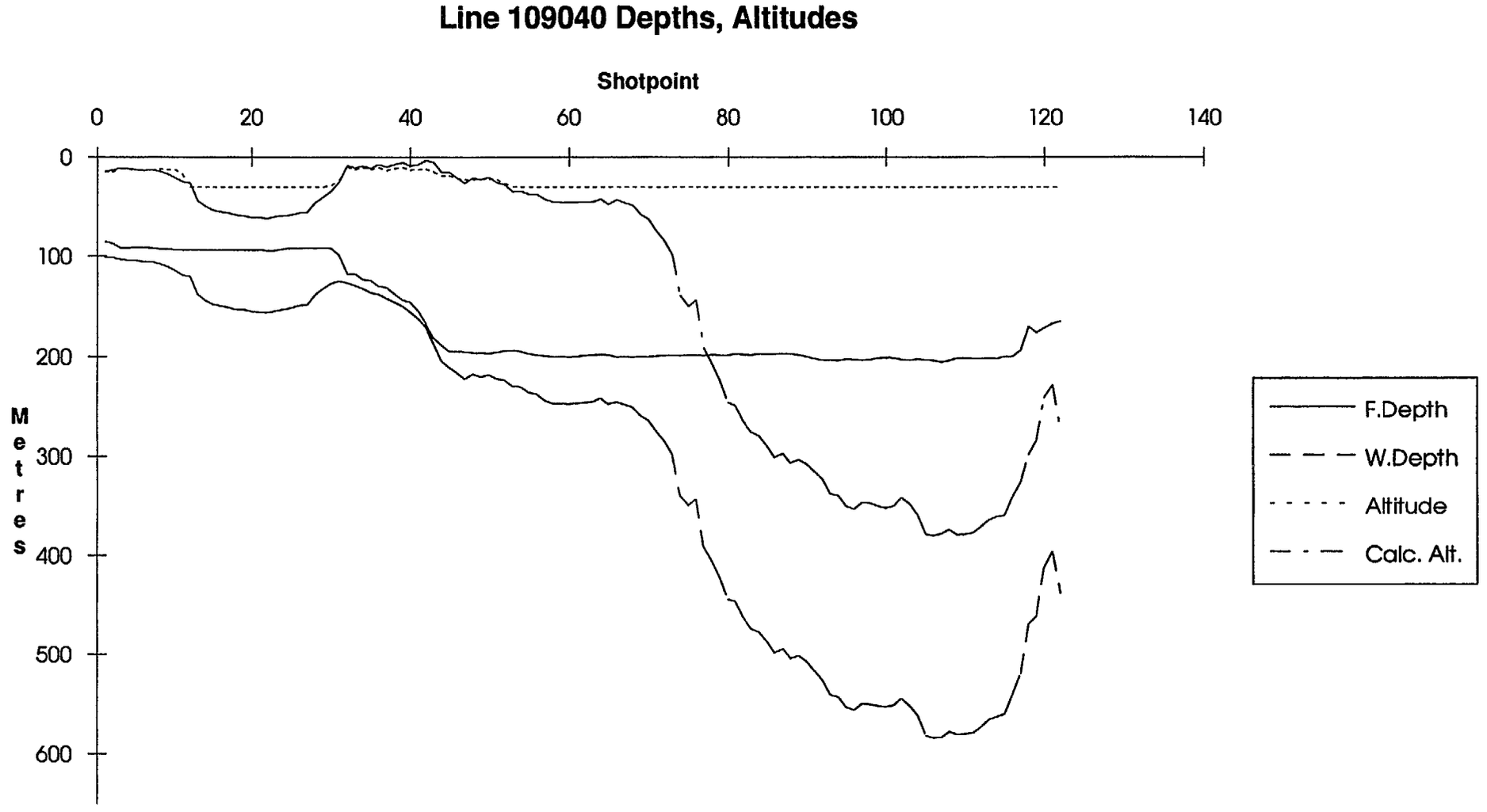
A strong THC and methane anomaly occurs at SP 50 along with a weak ethane anomaly.
Hydrocarbon values are influenced by the the thermocline before SP 35.
A gas sample was taken for carbon isotope analysis from SP 50 to SP 58.

Line 109040 THC, Methane

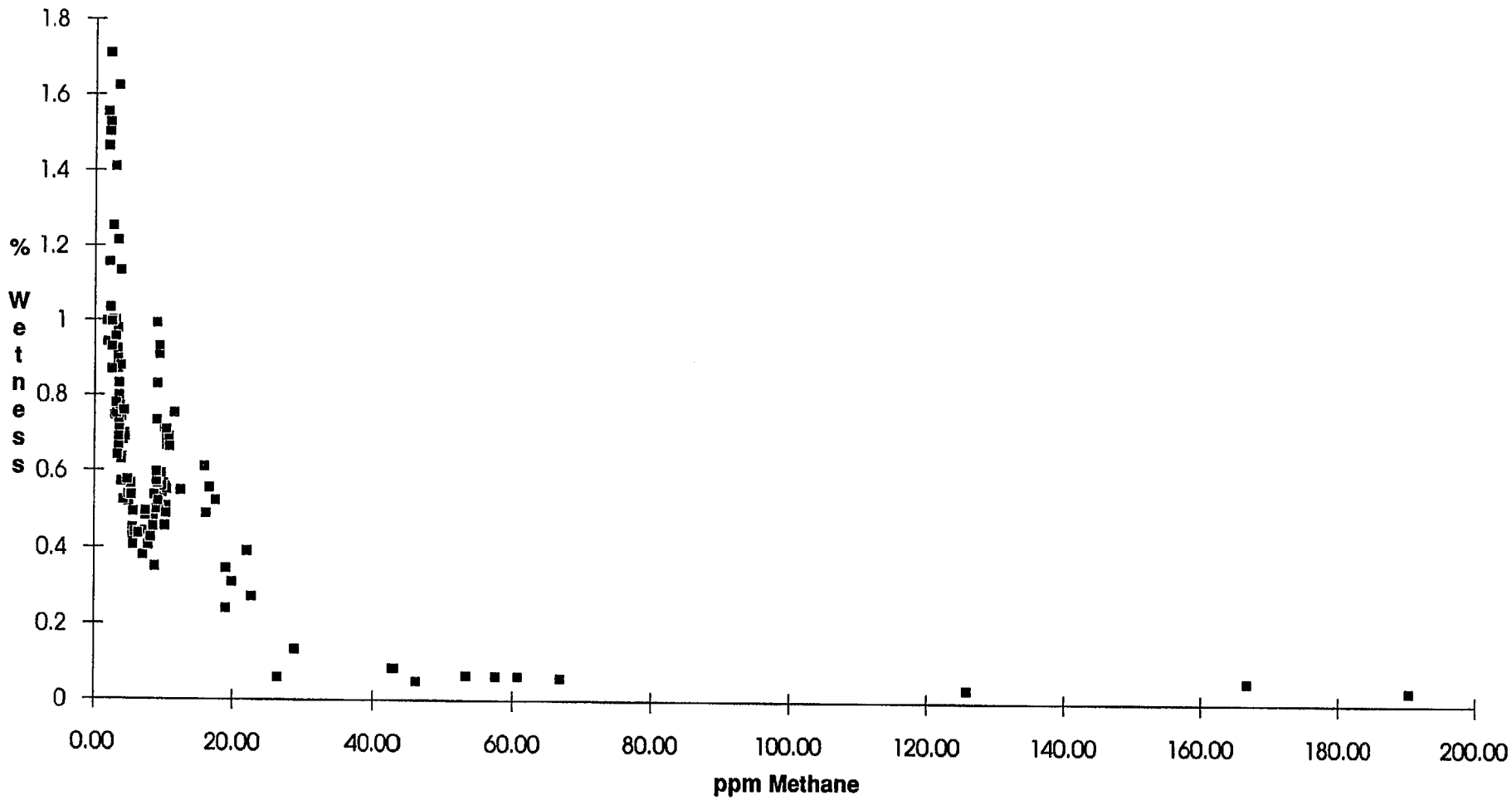


Line 109040 Ethane, Ethylene, Propane




Line 109040 Depths, Altitudes
Shotpoint
0
20
40
60
80
100
120
140
0
100
200
300
400
500
600
Metres
F.Depth
W.Depth
Altitude
Calc. Alt.

Line 109040 Methane v. %Wetness



Line Summary

Line Number	109041
No. of Shotpoints	122

	Shotpoint	Date	Time	Latitude		Longitude	
Start	1	22-Apr-92	21:44:14	13	29.931	122	58.096
End	122	23-Apr-92	01:50:32	13	13.992	123	02.006

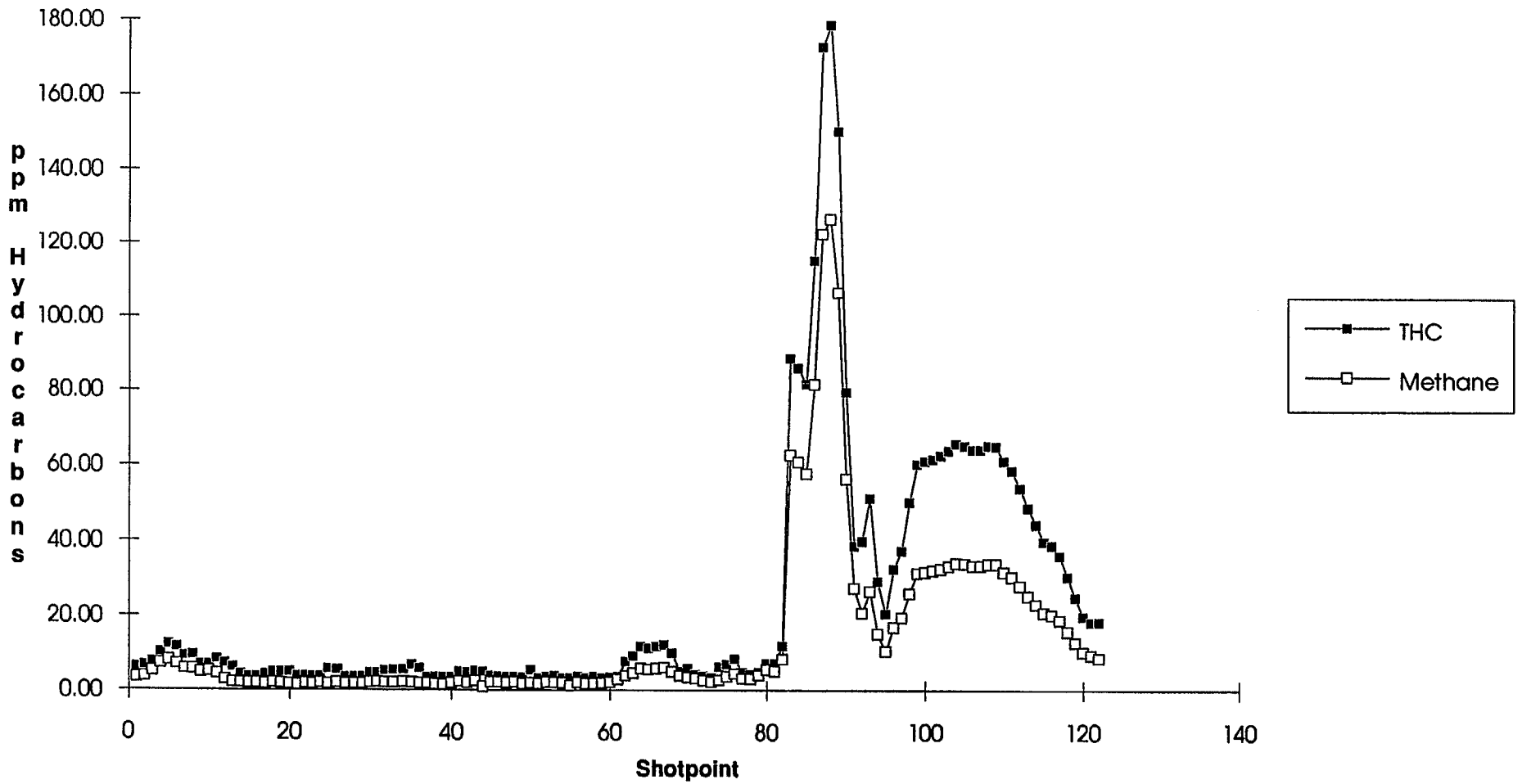
	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	23.901	14.001	0.024	0.026	0.024	0.006	0.004	0.001	0.000	0.024	0.008	0.011	0.889
Std. Dev.	33.651	22.542	0.017	0.021	0.023	0.009	0.006	0.004	0.001	0.014	0.005	0.011	0.627
Minimum	3.211	0.973	0.007	0.010	0.009	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.048
Maximum	178.655	126.555	0.069	0.130	0.100	0.049	0.024	0.019	0.012	0.088	0.019	0.038	4.326

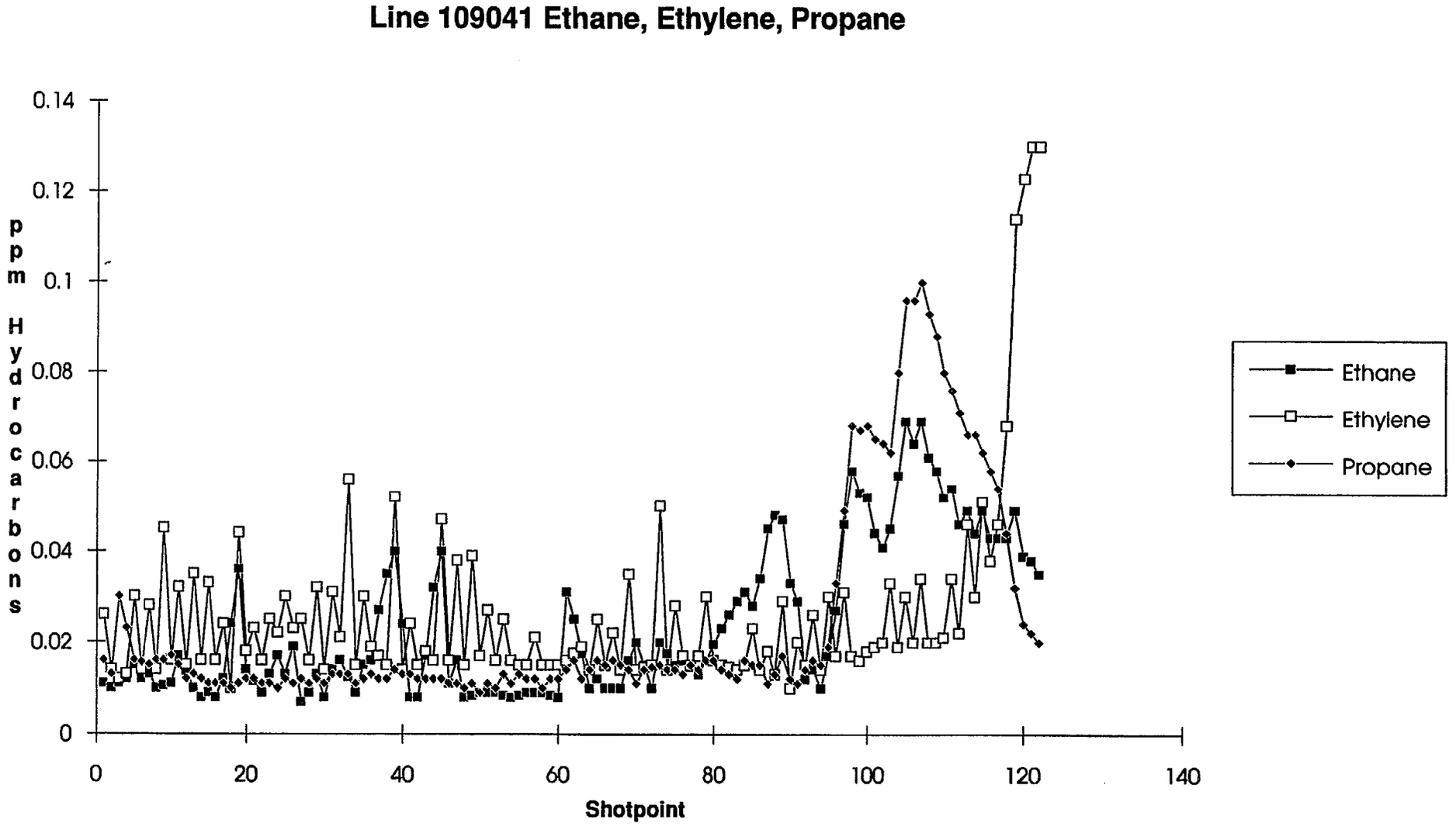
	Cond.	Temp.	F. Depth	W.Depth	Altitude	Calc. Alt.
Mean	55.269	23.161	181.441	351.723	24.061	170.290
Std. Dev.	1.018	0.672	22.919	168.105	8.345	151.867
Minimum	54.040	22.330	108.800	121.900	10.800	8.200
Maximum	59.400	25.890	206.600	600.900	30.800	402.900

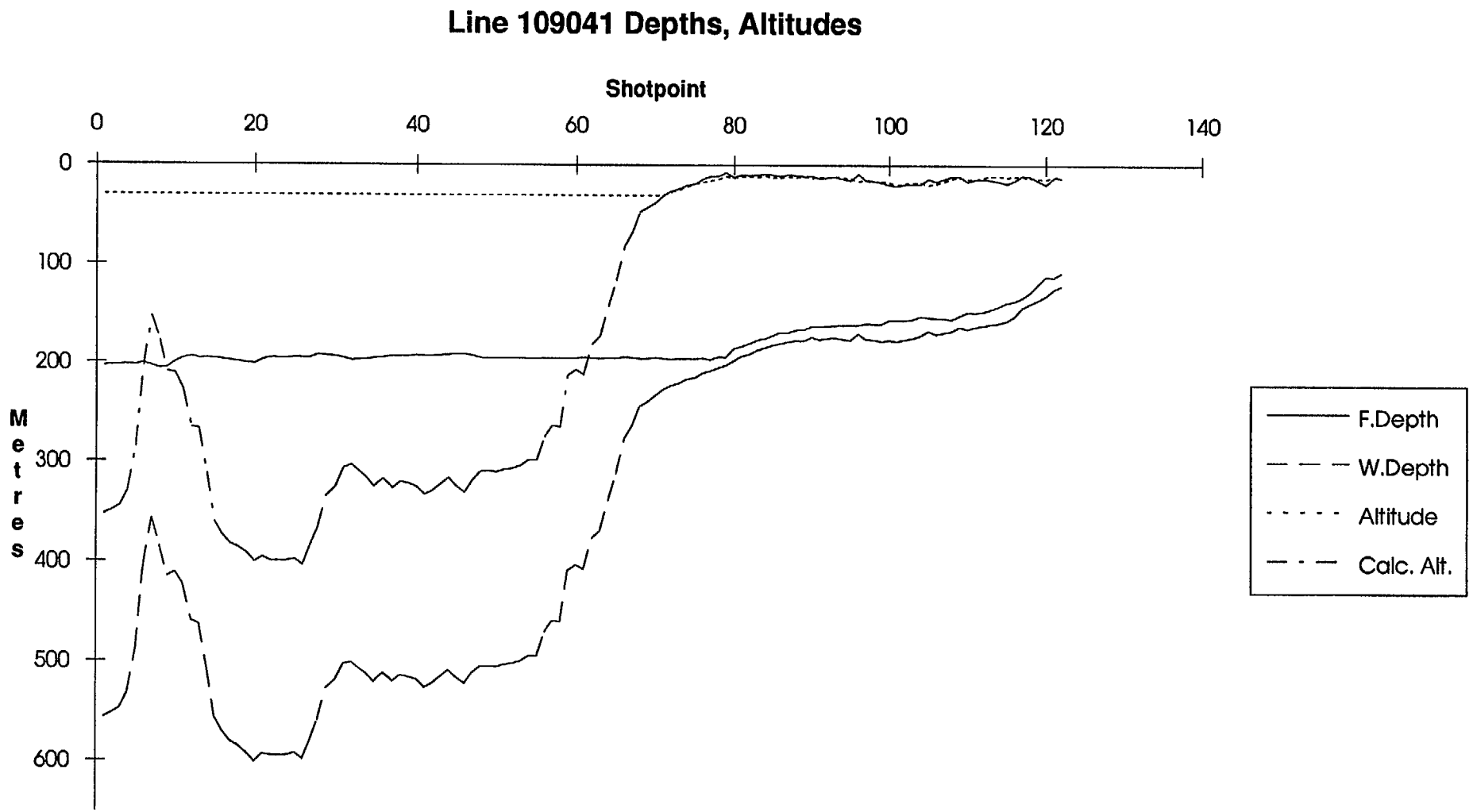
Notes

A strong THC and methane anomaly is seen at SP 84 with a corrispondingly weak ethane anomaly.
All hydrocarbon values ars seen to rise from SP 95 as the fish enters shallower water.
A gas sample for carbon isotope analysis was taken from SP 86 to SP 90.

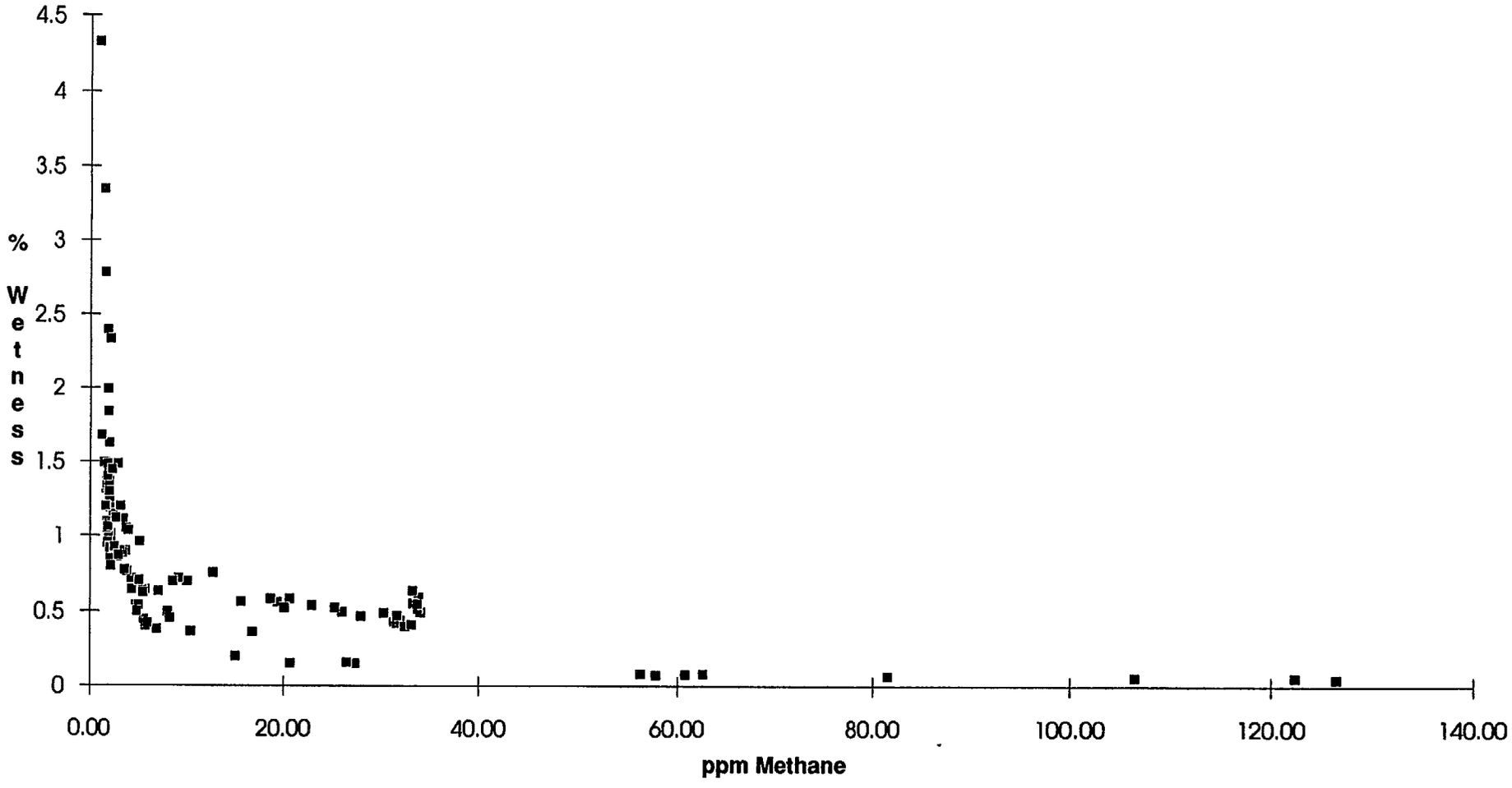
Line 109041 THC, Methane




Line 109041 Ethane, Ethylene, Propane
ppm Hydrocarbons
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
0
20
40
60
80
100
120
140
Shotpoint
Ethane
Ethylene
Propane


Line 109041 Depths, Altitudes
Shotpoint
0
20
40
60
80
100
120
140
0
100
200
300
400
500
600
Metres
F.Depth
W.Depth
Altitude
Calc. Alt.

Line 109041 Methane v. %Wetness



Line Summary

Line Number	109042
No. of Shotpoints	95

	Shotpoint	Date	Time	Latitude		Longitude	
Start	1	23-Apr-92	01:52:31	13	14.087	123	02.155
End	95	23-Apr-92	05:03:36	13	28.721	123	03.307

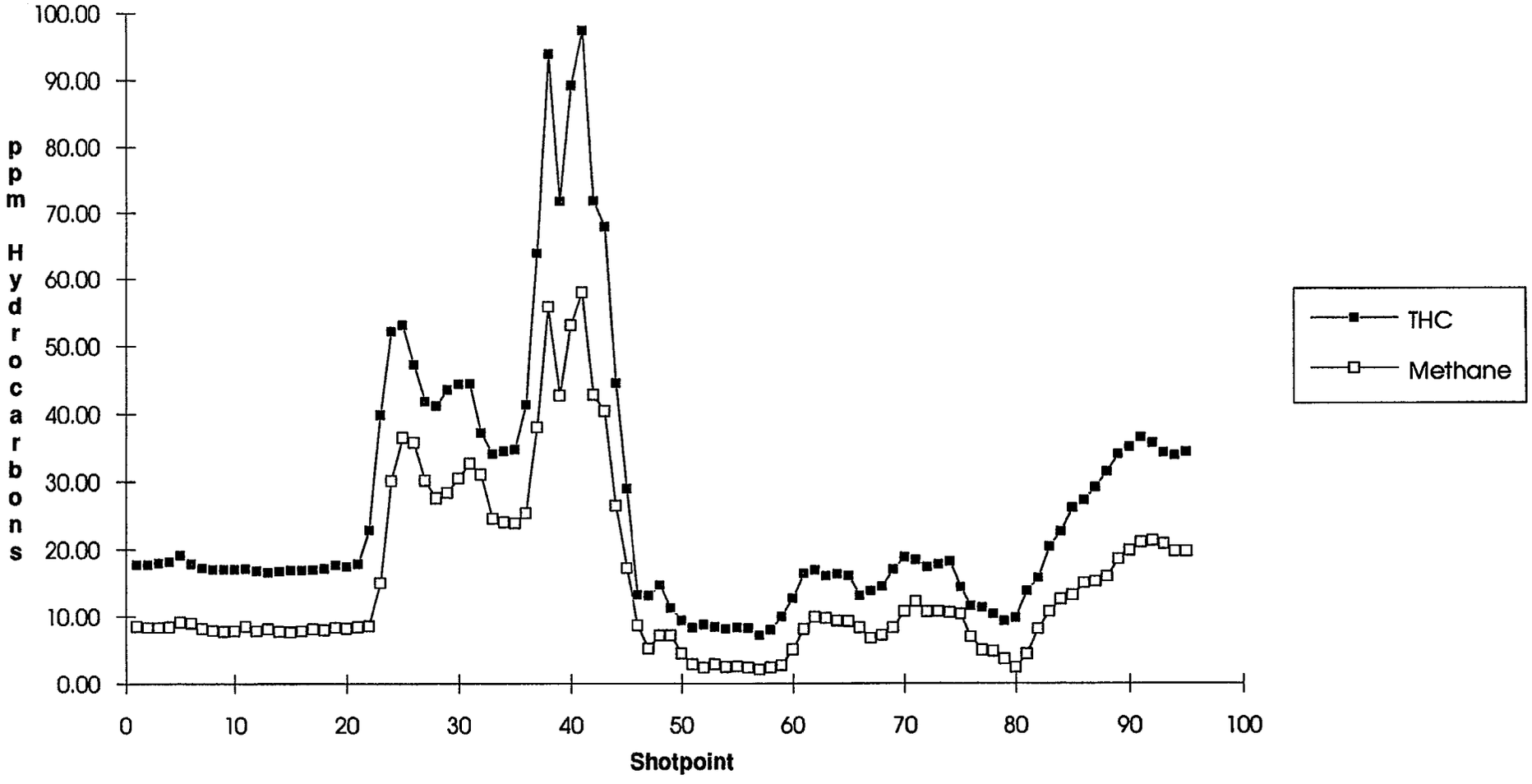
	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	26.152	14.855	0.033	0.067	0.027	0.020	0.006	0.000	0.002	0.060	0.011	0.030	0.542
Std. Dev.	19.179	12.633	0.031	0.058	0.029	0.021	0.010	0.003	0.003	0.034	0.007	0.013	0.310
Minimum	7.158	2.084	0.007	0.006	0.006	0.000	0.000	0.000	0.000	0.029	0.000	0.000	0.051
Maximum	97.364	57.943	0.124	0.181	0.156	0.083	0.070	0.029	0.012	0.138	0.024	0.064	1.637

	Cond.	Temp.	F. Depth	W.Depth	Altitude	Calc. Alt.
Mean	57.681	24.786	150.863	343.547	24.609	192.639
Std. Dev.	2.073	1.372	51.819	202.453	7.942	180.448
Minimum	55.740	23.510	65.900	86.400	9.500	0.500
Maximum	61.840	27.570	204.100	597.000	30.900	475.800

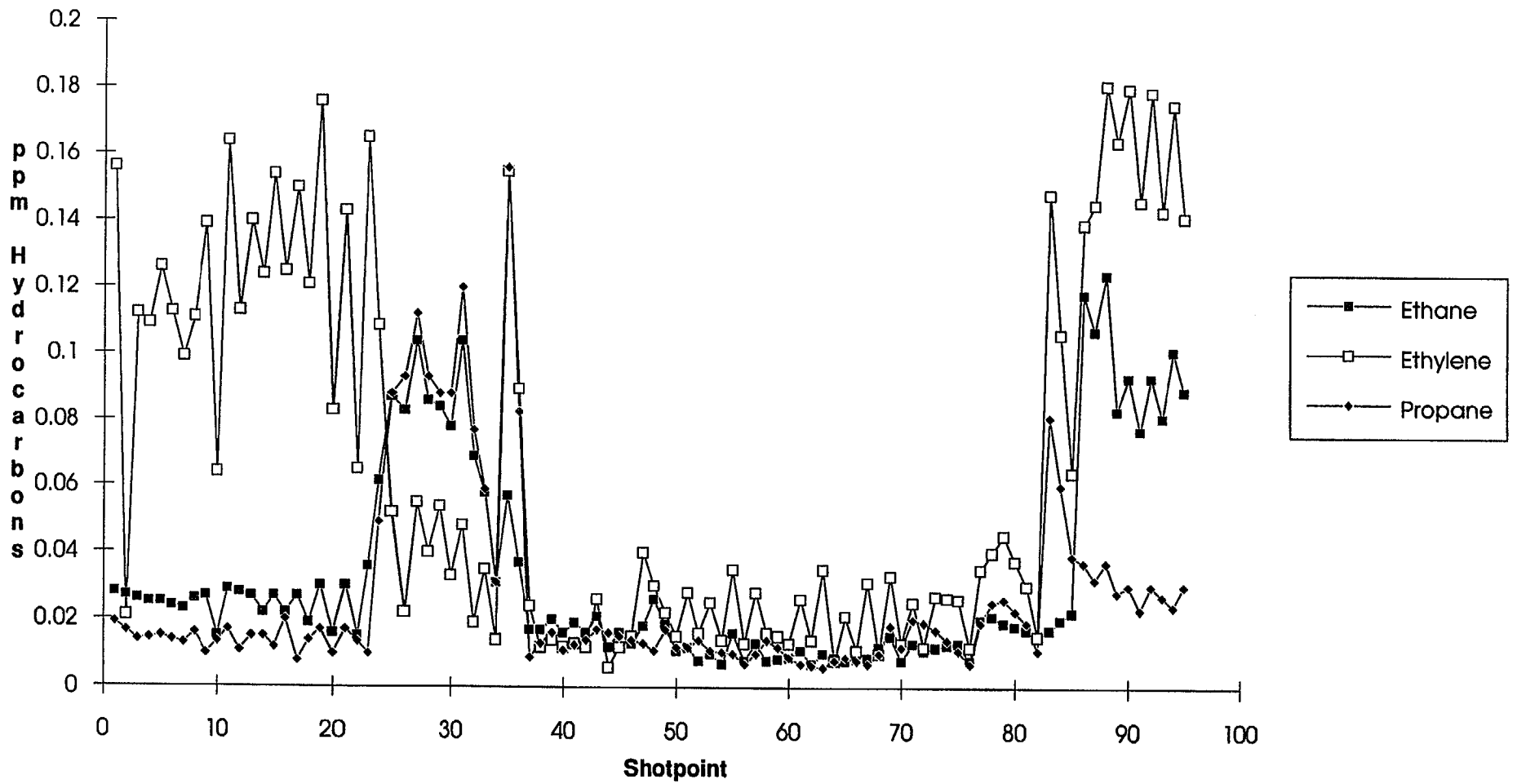
Notes

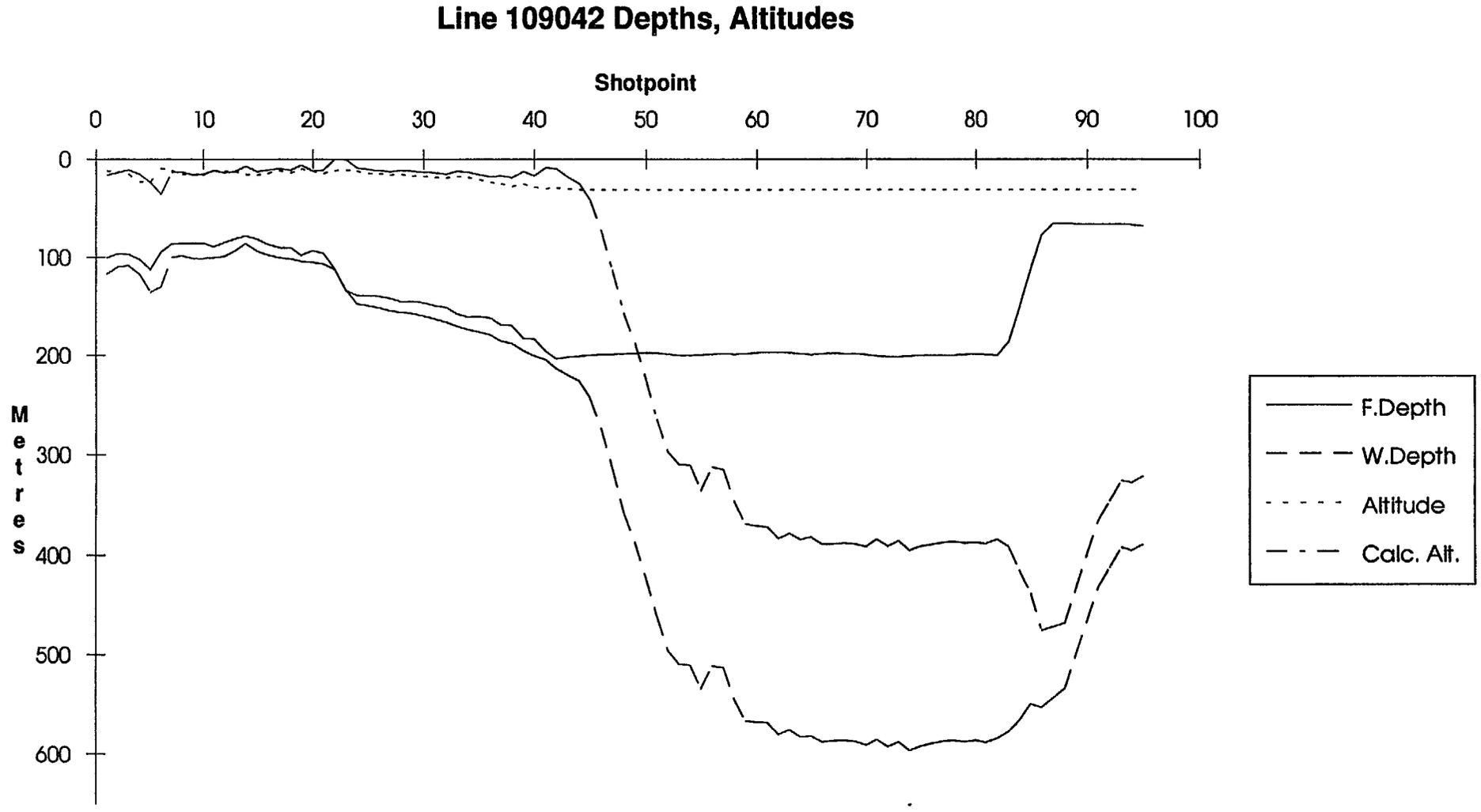
A moderate THC and methane anomaly is seen at SP 37, and a weak anomaly between SP 23 and SP 33, with a corrisponding weak ethane, propane and ethylene anomaly.
Thermoclinal influences on hydrocarbon values occur upto SP 23 and after SP 83.
Gas samples for carbon isotope analysis where taken between SP 30 and SP 35,and SP 38 and SP 34.

Line 109042 THC, Methane

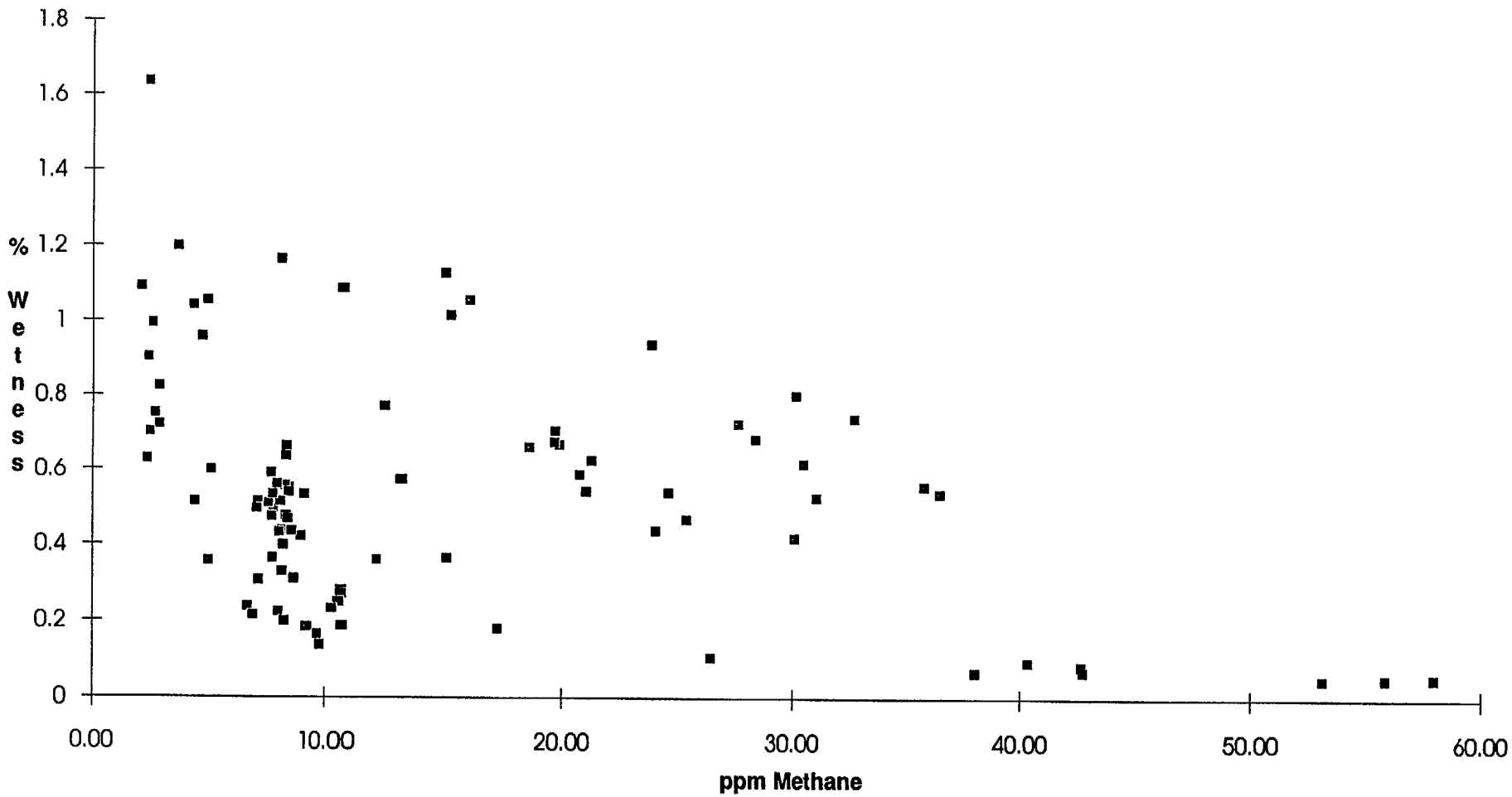


Line 109042 Ethane, Ethylene, Propane




Line 109042 Depths, Altitudes
Shotpoint
0
10
20
30
40
50
60
70
80
90
100
0
100
200
300
400
500
600
Metres
F.Depth
W.Depth
Altitude
Calc. Alt.

Line 109042 Methane v. %Wetness



Line Summary

Line Number	109043
No. of Shotpoints	150

	Shotpoint	Date	Time	Latitude		Longitude	
Start	1	23-Apr-92	05:32:43	13	27.397	123	04.746
End	150	23-Apr-92	10:34:40	13	10.623	123	07.616

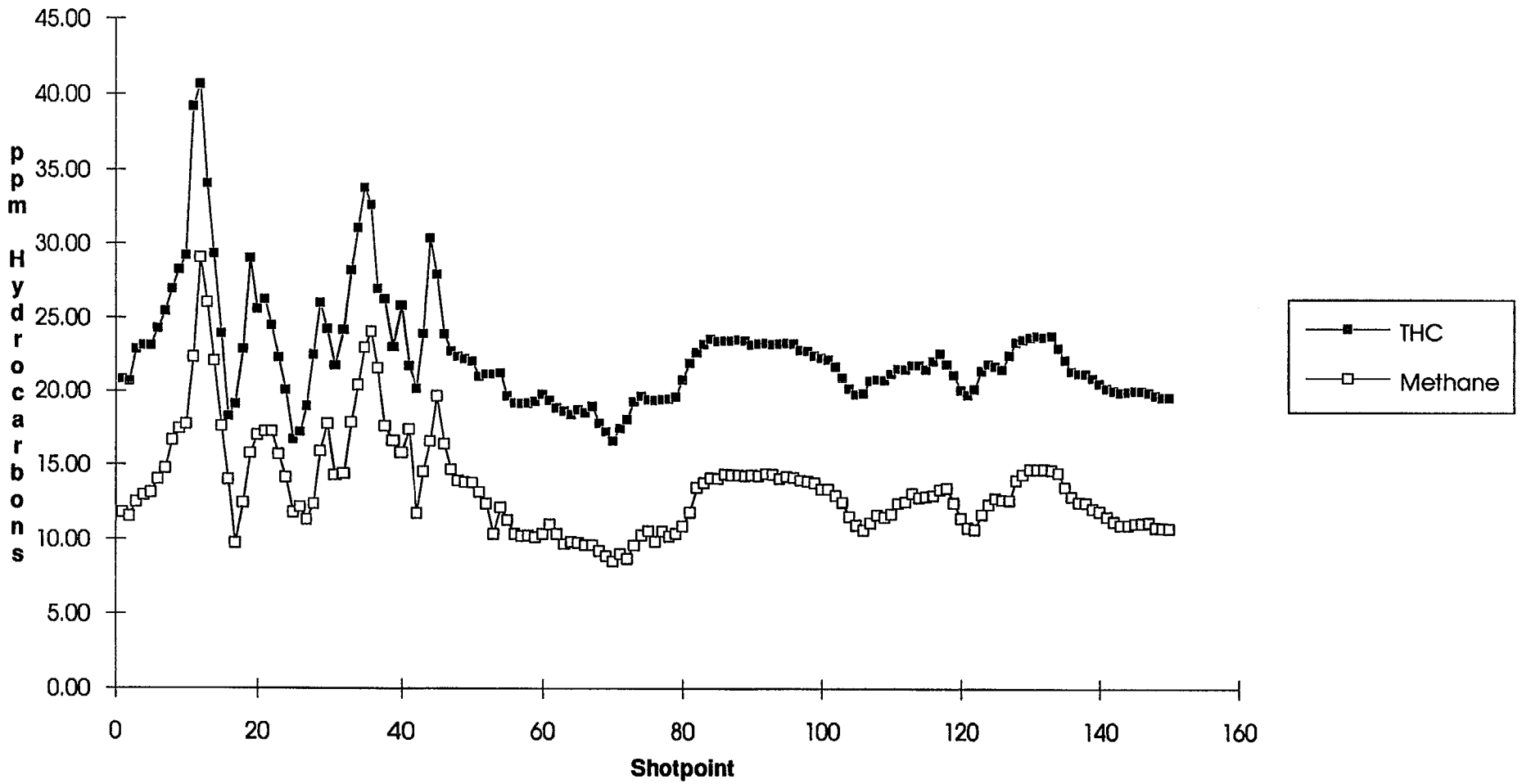
	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	22.396	13.437	0.026	0.061	0.021	0.021	0.002	0.000	0.000	0.062	0.011	0.035	0.362
Std. Dev.	3.756	3.351	0.012	0.033	0.014	0.012	0.005	0.000	0.001	0.015	0.007	0.012	0.148
Minimum	16.636	8.524	0.014	0.011	0.006	0.000	0.000	0.000	0.000	0.034	0.000	0.000	0.176
Maximum	40.650	29.067	0.090	0.133	0.096	0.056	0.026	0.000	0.008	0.100	0.039	0.081	1.032

	Cond.	Temp.	F. Depth	W.Depth	Altitude	Calc. Alt.
Mean	56.729	24.145	132.429	228.292	18.281	95.894
Std. Dev.	1.017	0.676	25.583	162.634	8.081	144.384
Minimum	55.080	23.040	107.000	122.700	9.300	7.200
Maximum	59.280	25.970	193.600	571.000	30.900	404.100

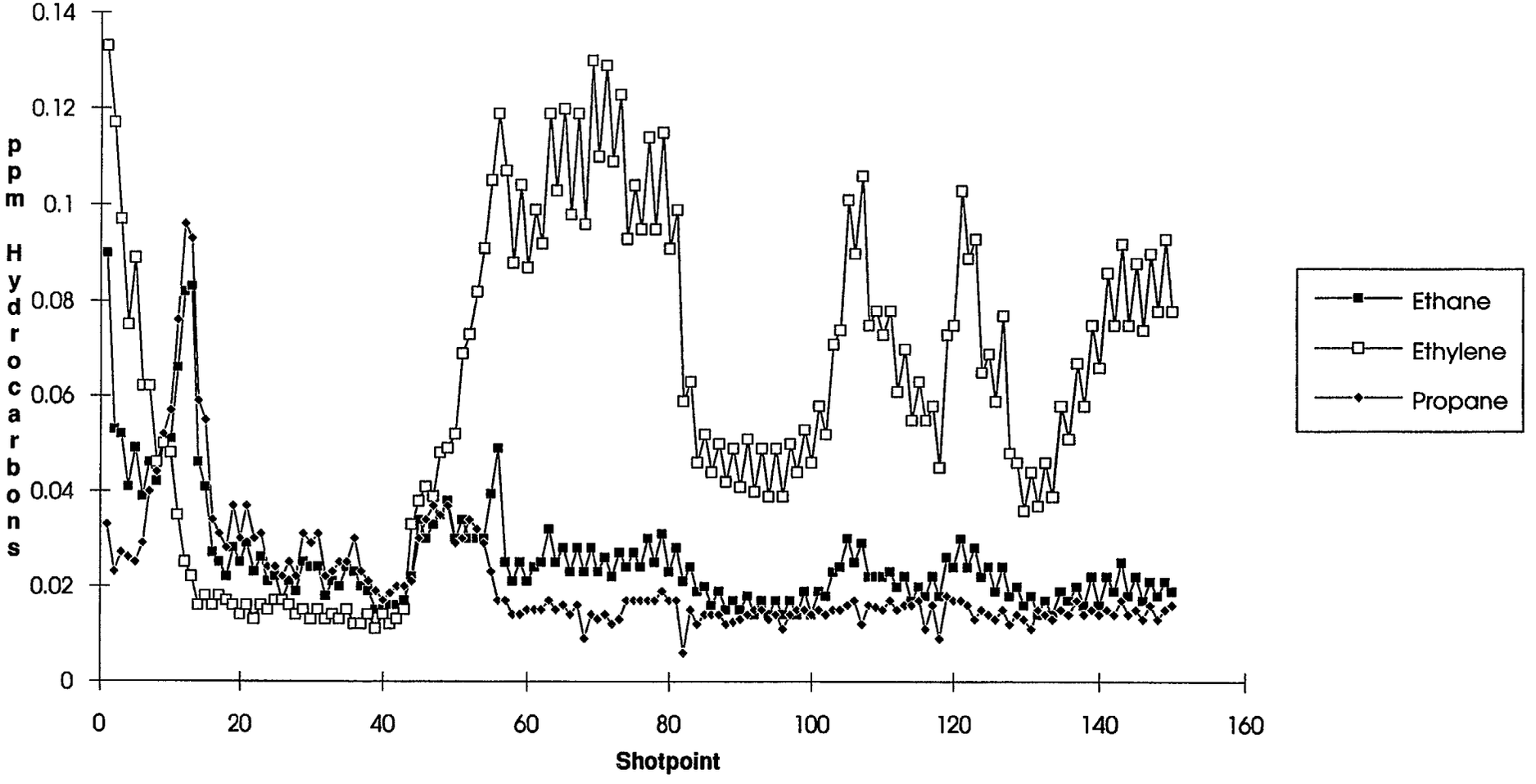
Notes

Two weak THC and methane anomalies are seen between SP 19 and SP 39.
Anomalies before SP 17 and after SP 40 relate to the fish being lowered and the raised through the water column.

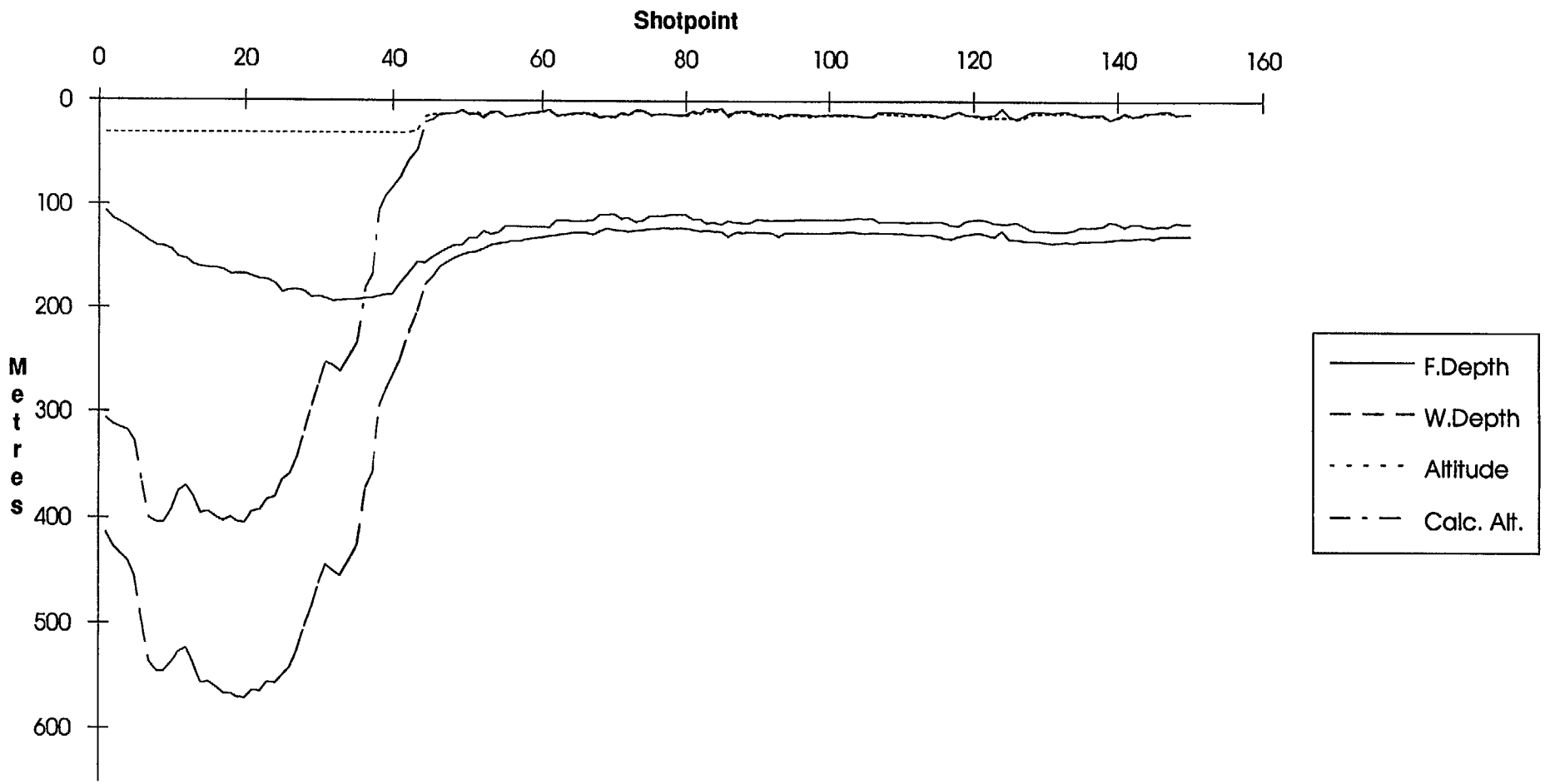
Line 109043 THC, Methane

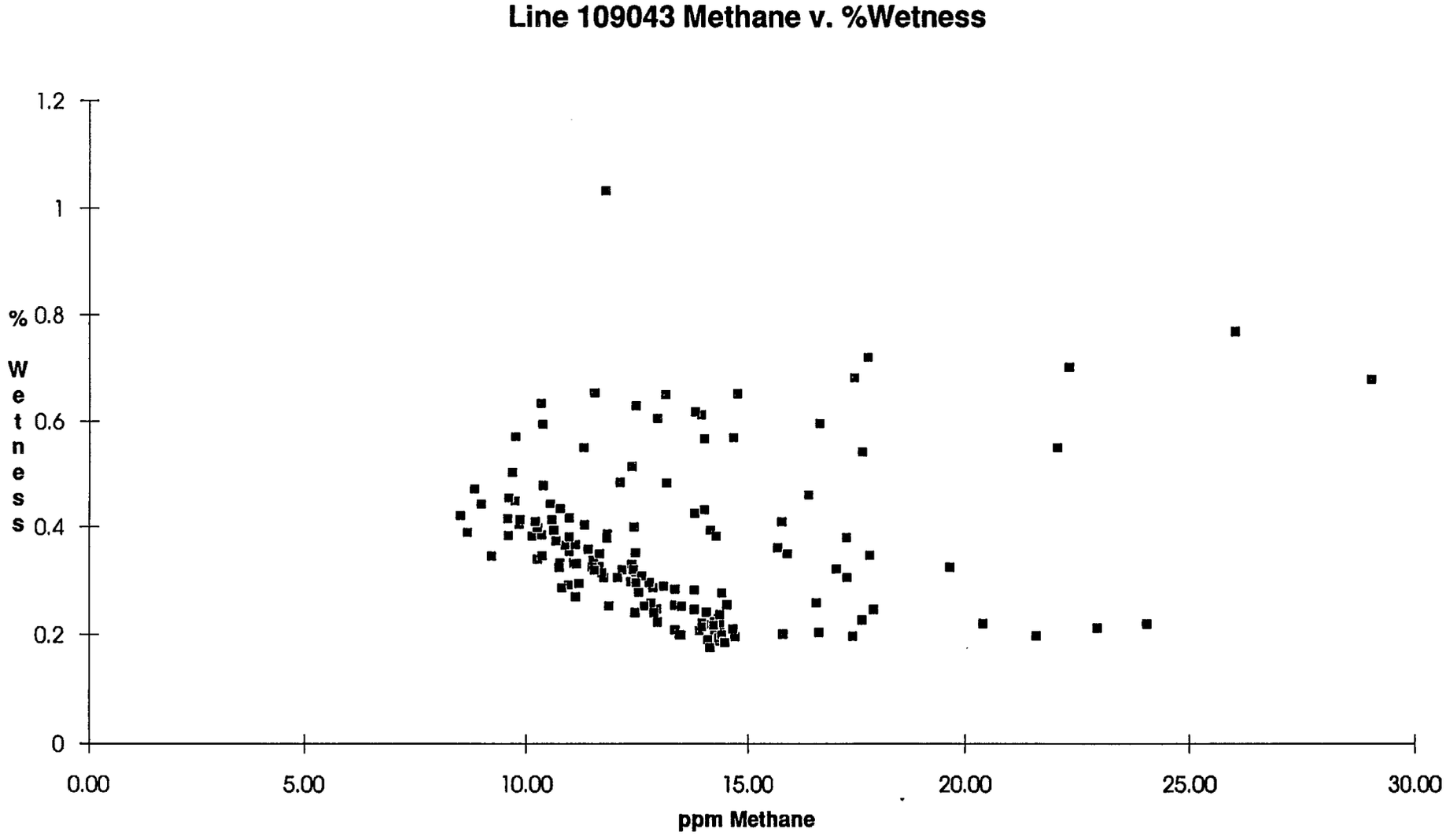


Line 109043 Ethane, Ethylene, Propane



Line 109043 Depths, Altitudes




Line 109043 Methane v. %Wetness
1.2
1
0.8
0.6
0.4
0.2
0
% Wetness
0.00
5.00
10.00
15.00
20.00
25.00
30.00
ppm Methane

Line Summary

Line Number	Sniff4
No. of Shotpoints	301

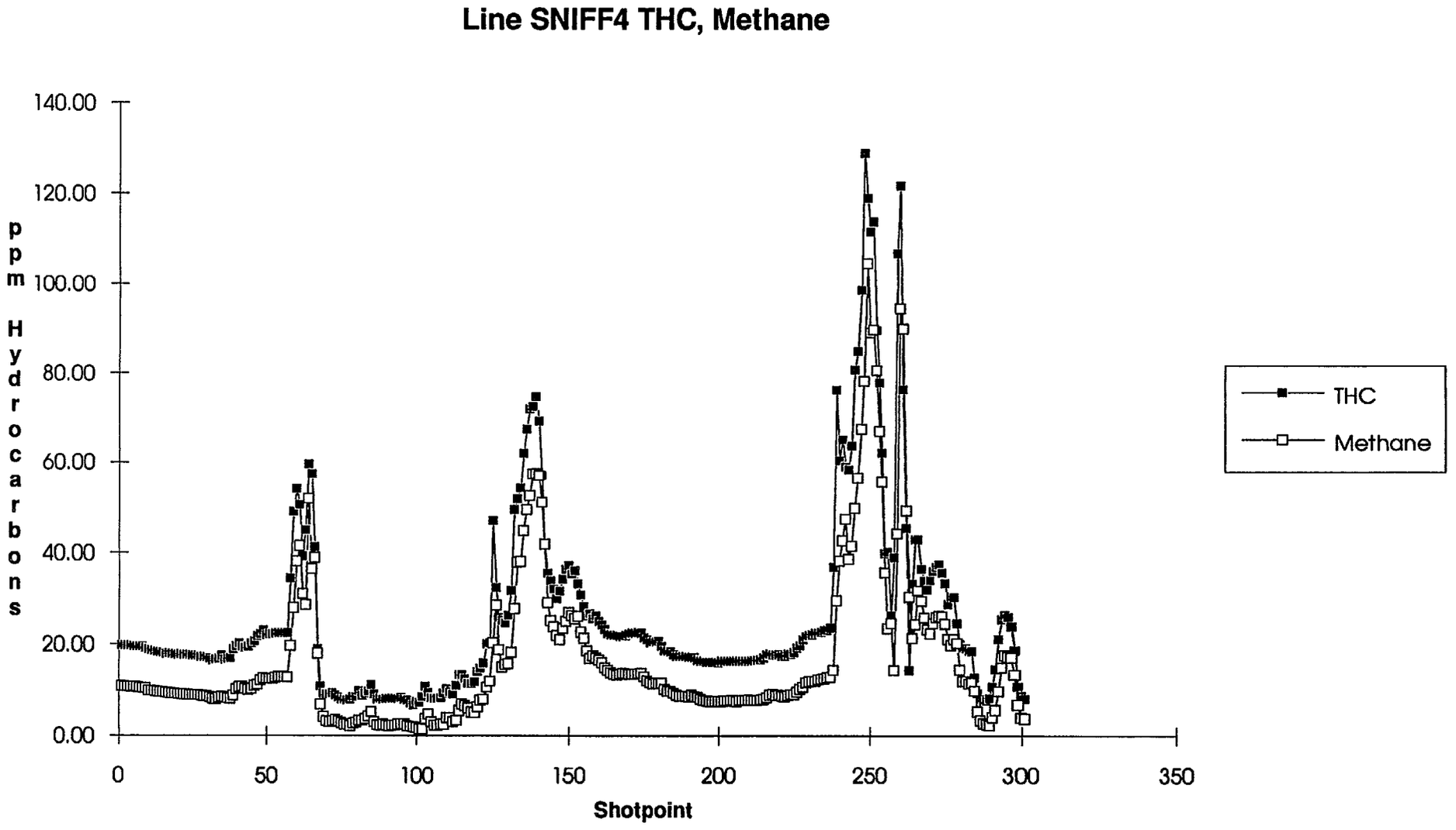
	Shotpoint	Date	Time	Latitude		Longitude	
Start	1	23-Apr-92	10:36:40	13	10.782	123	07.572
End	302	23-Apr-92	20:58:56	13	20.535	123	09.000

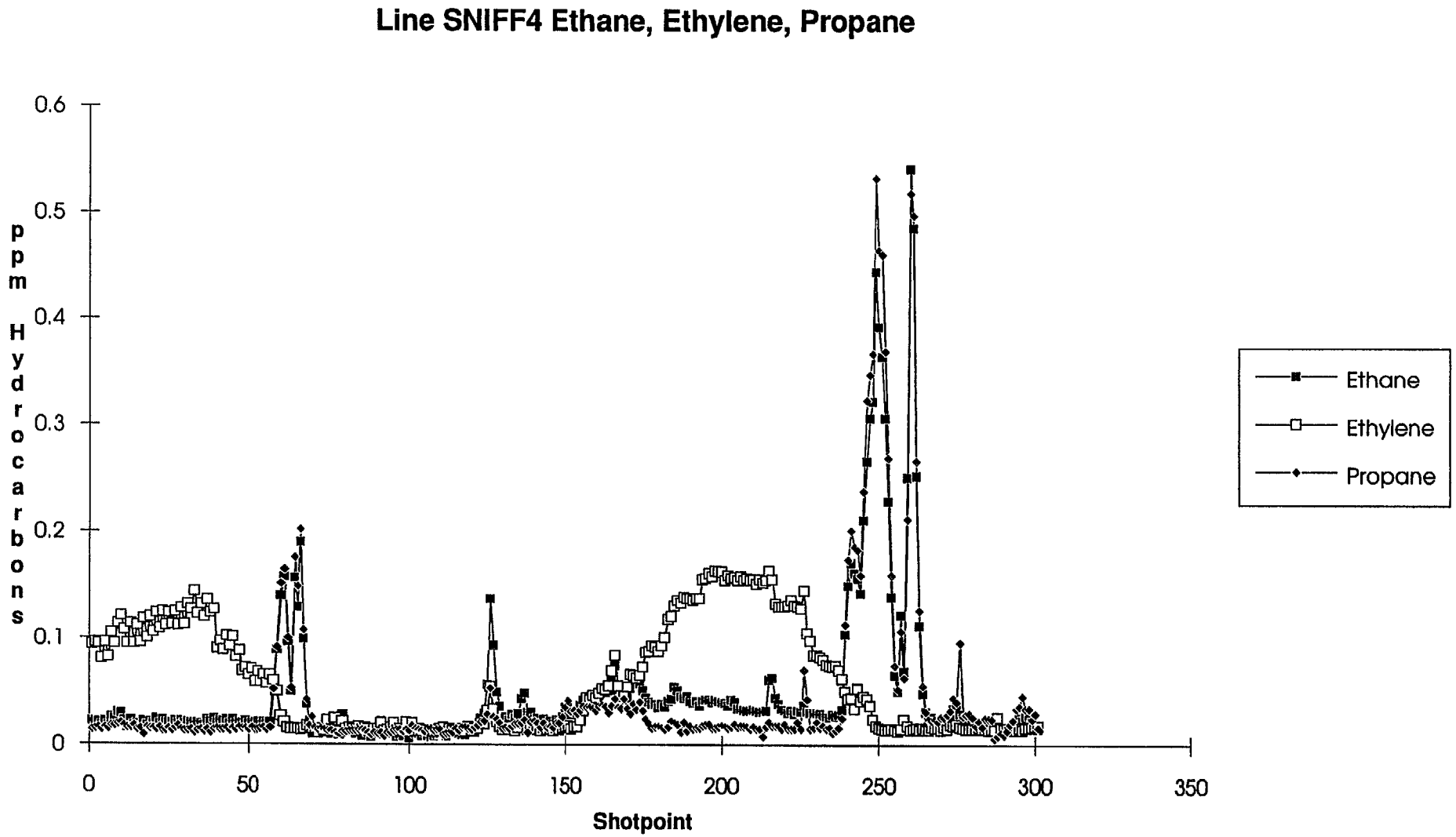
	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	25.885	16.375	0.047	0.059	0.043	0.019	0.007	0.001	0.002	0.051	0.009	0.021	0.598
Std. Dev.	20.872	17.074	0.071	0.051	0.081	0.017	0.019	0.006	0.006	0.023	0.007	0.015	0.369
Minimum	6.683	1.460	0.006	0.011	0.006	0.000	0.000	0.000	0.000	0.013	0.000	0.000	0.071
Maximum	128.761	104.564	0.541	0.164	0.532	0.079	0.129	0.039	0.037	0.100	0.038	0.053	3.578

	Cond.	Temp.	F. Depth	W.Depth	Altitude	Calc. Alt.
Mean	55.183	23.084	157.844	210.455	18.310	52.716
Std. Dev.	1.440	0.935	51.471	121.985	8.147	81.235
Minimum	53.700	22.100	101.600	113.400	8.400	0.900
Maximum	58.050	24.990	260.000	518.800	30.800	323.000

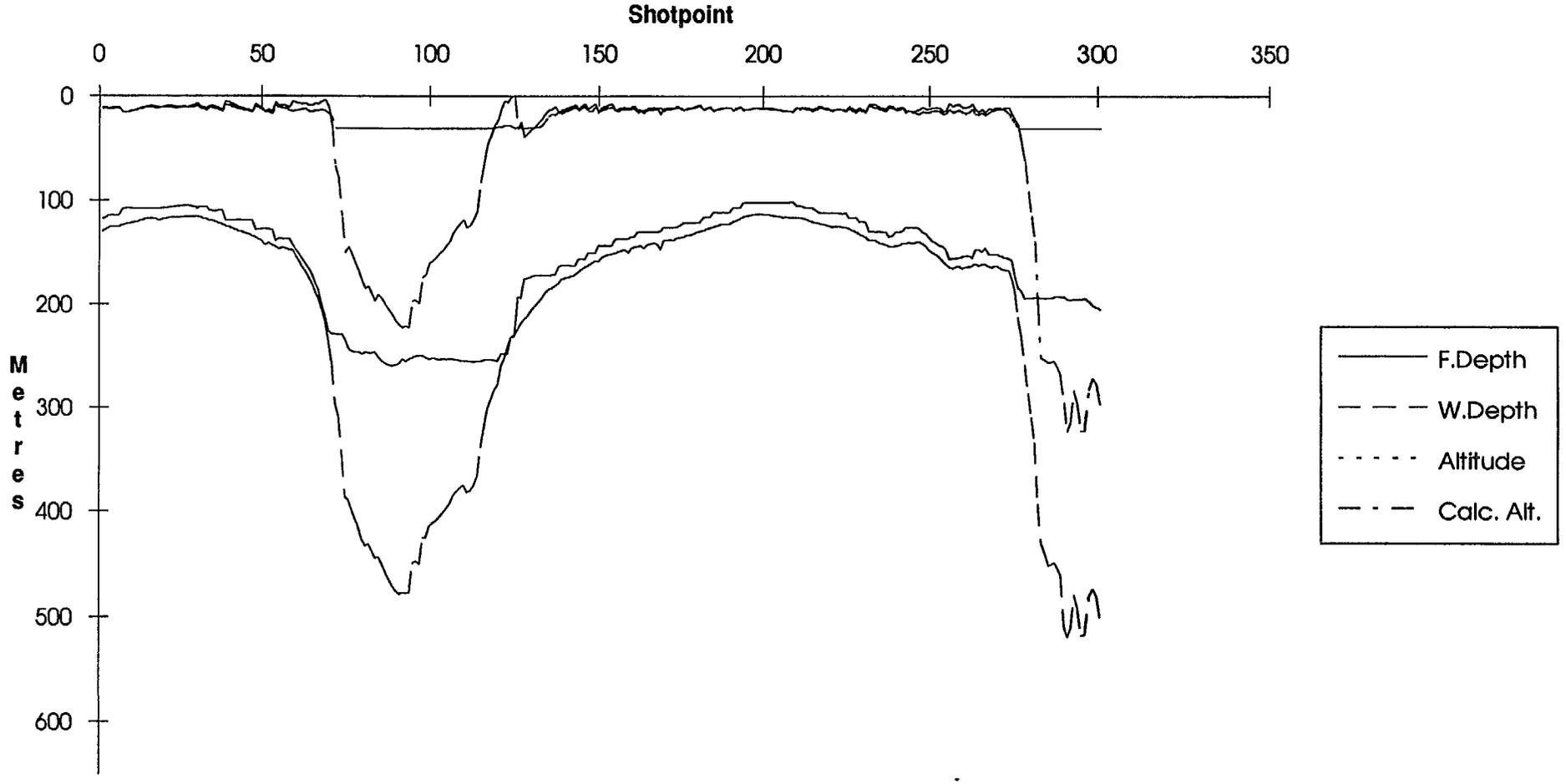
Notes

A strong THC and methane anomaly occurs at SP 245, and two moderate anomalies occur at SP 60 and SP 135, a weak anomaly occurs at SP 295.
Two strong ethane and propane anomalies occur at SP 60 and SP 245, a moderate ethane anomaly is seen at SP 125.
Elevated ethylene values prior to SP 57 and between SP 160 and SP 240 probably reflect thermoclinal influences.
Gas samples for carbon isotope analysis where taken at SP 56 to SP 63 and SP 243 to SP 257.
The fish hit bottom at SP 124.

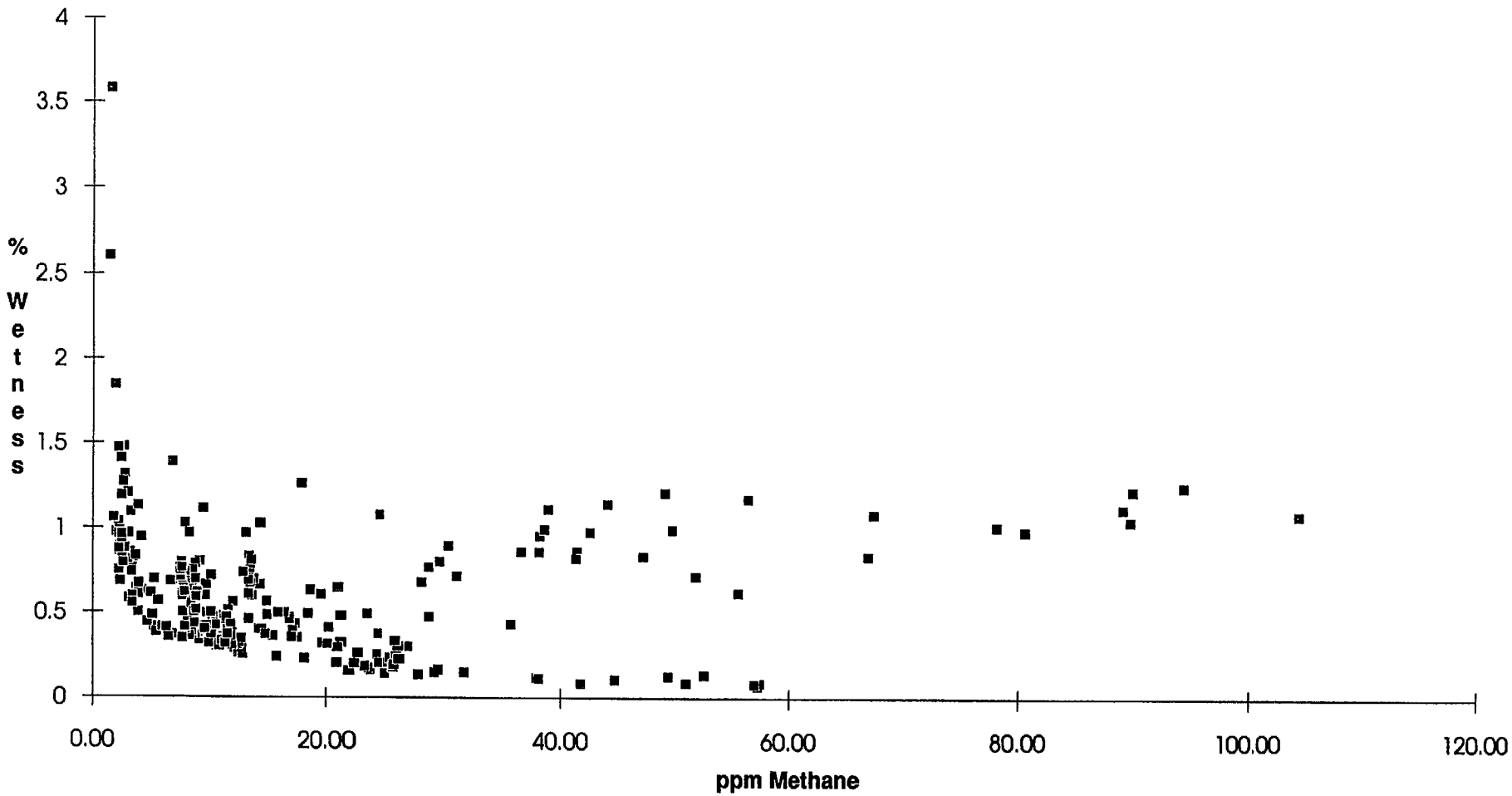

Line SNIFF4 THC, Methane
ppm Hydrocarbons
140.00
120.00
100.00
80.00
60.00
40.00
20.00
0.00
0
50
100
150
200
250
300
350
Shotpoint
THC
Methane


Line SNIFF4 Ethane, Ethylene, Propane
ppm Hydrocarbons
0.6
0.5
0.4
0.3
0.2
0.1
0
0
50
100
150
200
250
300
350
Shotpoint
Ethane
Ethylene
Propane

Line SNIFF4 Depths, Altitudes



Line SNIFF4 Methane v. %Wetness



Line Summary

Line Number	109044
No. of Shotpoints	179

	Shotpoint	Date	Time	Latitude		Longitude	
Start	1	23-Apr-92	21:09:05	13	20.404	123	09.747
End	179	24-Apr-92	03:17:46	13	15.836	122	43.376

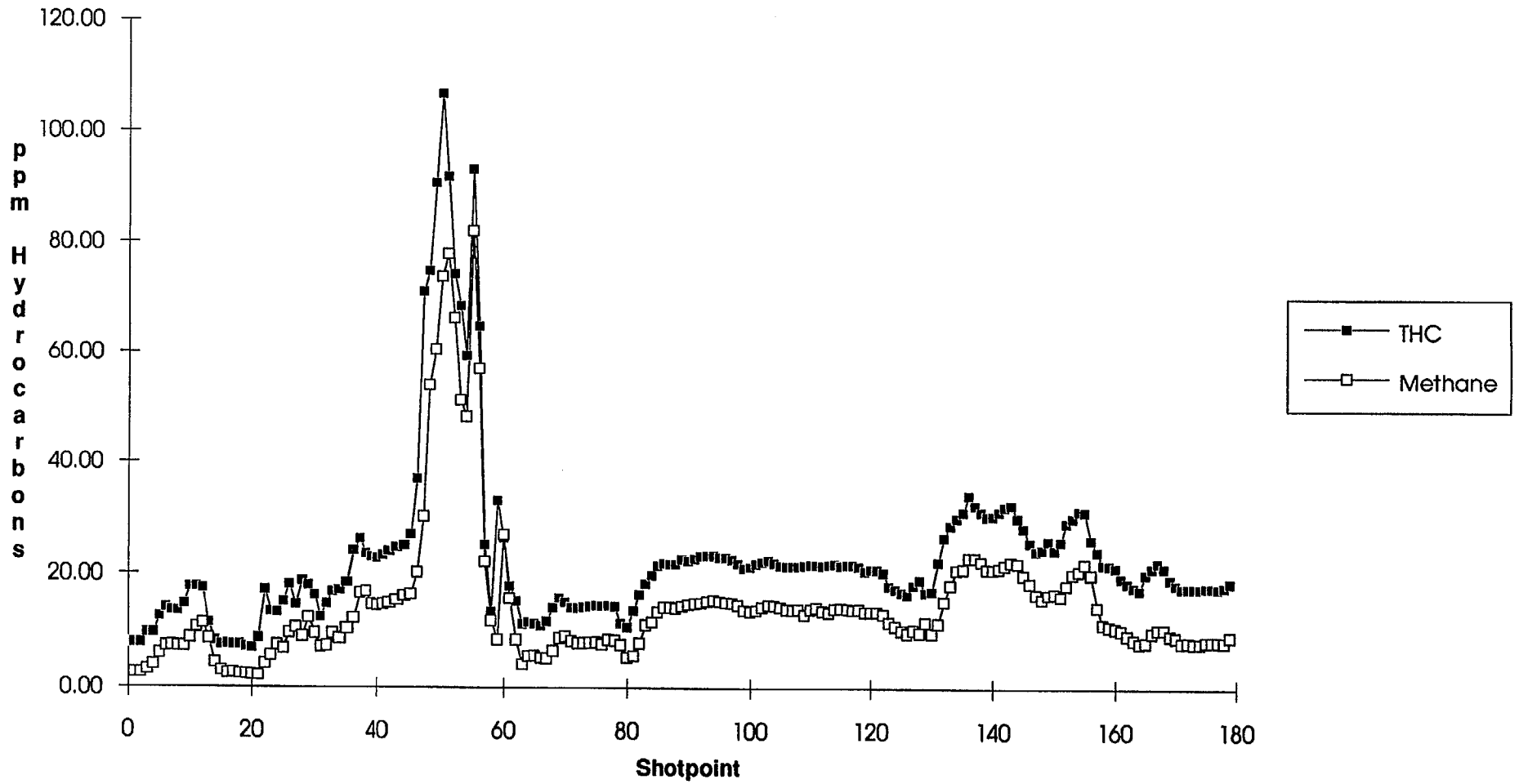
	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	23.082	14.507	0.039	0.044	0.046	0.021	0.010	0.002	0.001	0.047	0.006	0.022	0.644
Std. Dev.	15.443	12.713	0.055	0.065	0.067	0.046	0.018	0.006	0.006	0.035	0.007	0.014	0.292
Minimum	7.070	2.191	0.007	0.013	0.005	0.000	0.000	0.000	0.000	0.015	0.000	0.000	0.255
Maximum	106.724	82.112	0.391	0.362	0.456	0.512	0.112	0.036	0.036	0.200	0.028	0.057	2.010

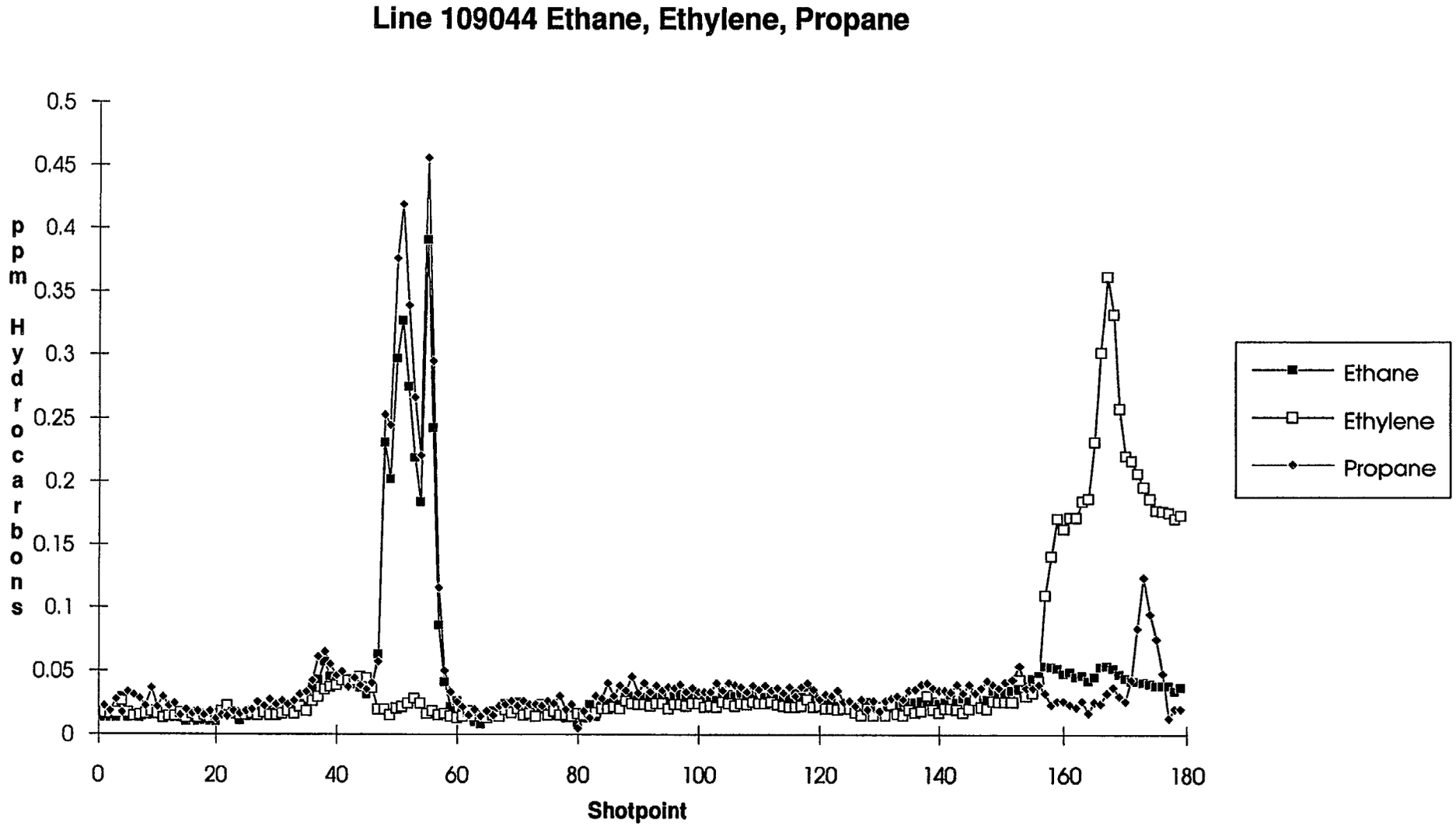
	Cond.	Temp.	F. Depth	W.Depth	Altitude	Calc. Alt.
Mean	56.352	23.901	154.049	194.126	16.987	40.096
Std. Dev.	2.209	1.489	36.103	93.278	6.954	71.123
Minimum	53.680	22.100	50.000	64.300	9.600	7.700
Maximum	61.970	27.700	204.600	517.400	30.800	314.400

Notes

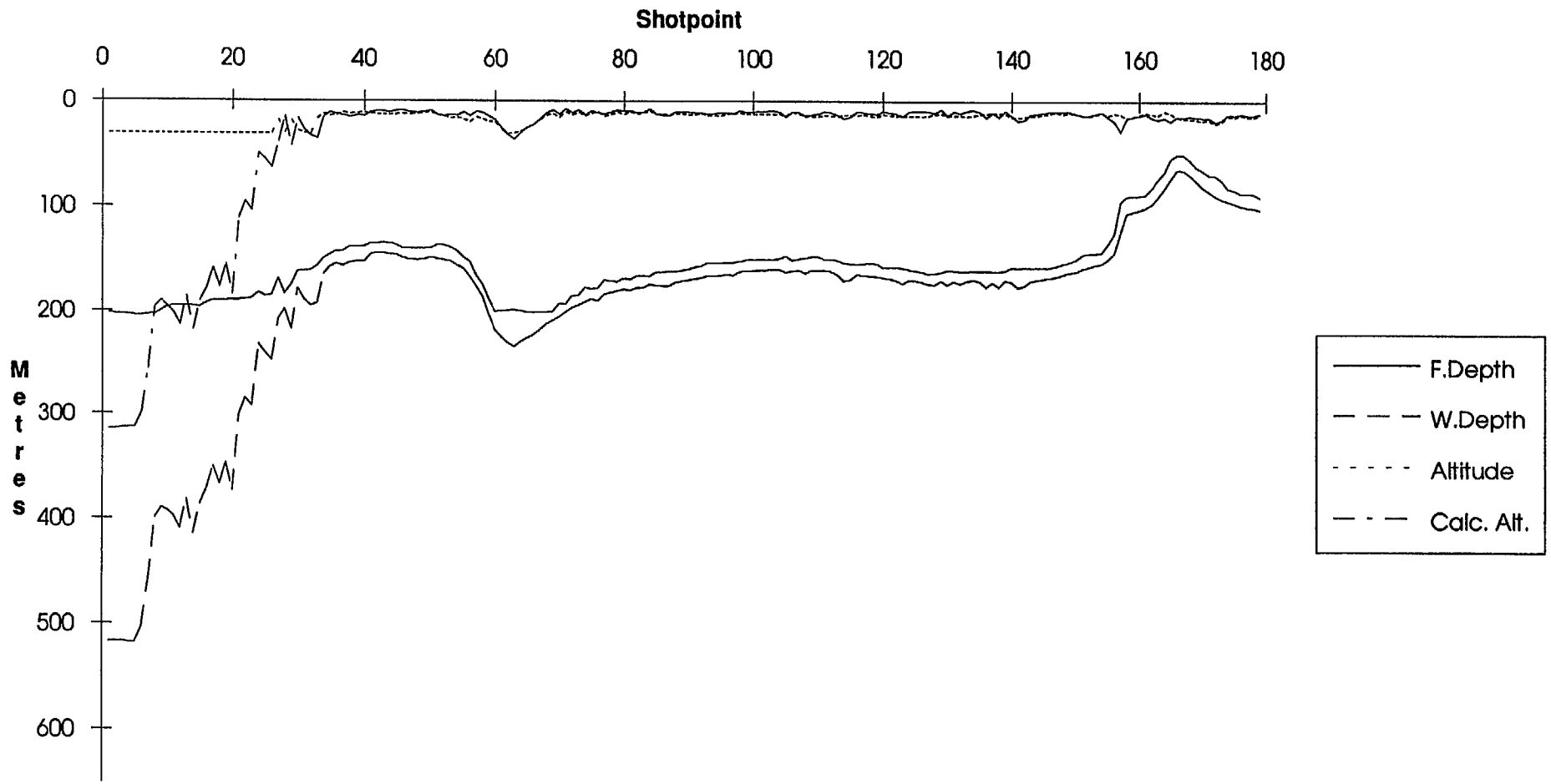
A strong THC and methane anomaly coupled with a strong ethane and propane is seen at SP 47.
A weak THC and methane anomaly is seen at SP 130.
The influence of shallowing water is seen after SP 157.
A gas sample was taken for carbon isotope analysis from SP 47 to SP 54.
The ship looped to avoid fishing boats early in the line.

Line 109044 THC, Methane

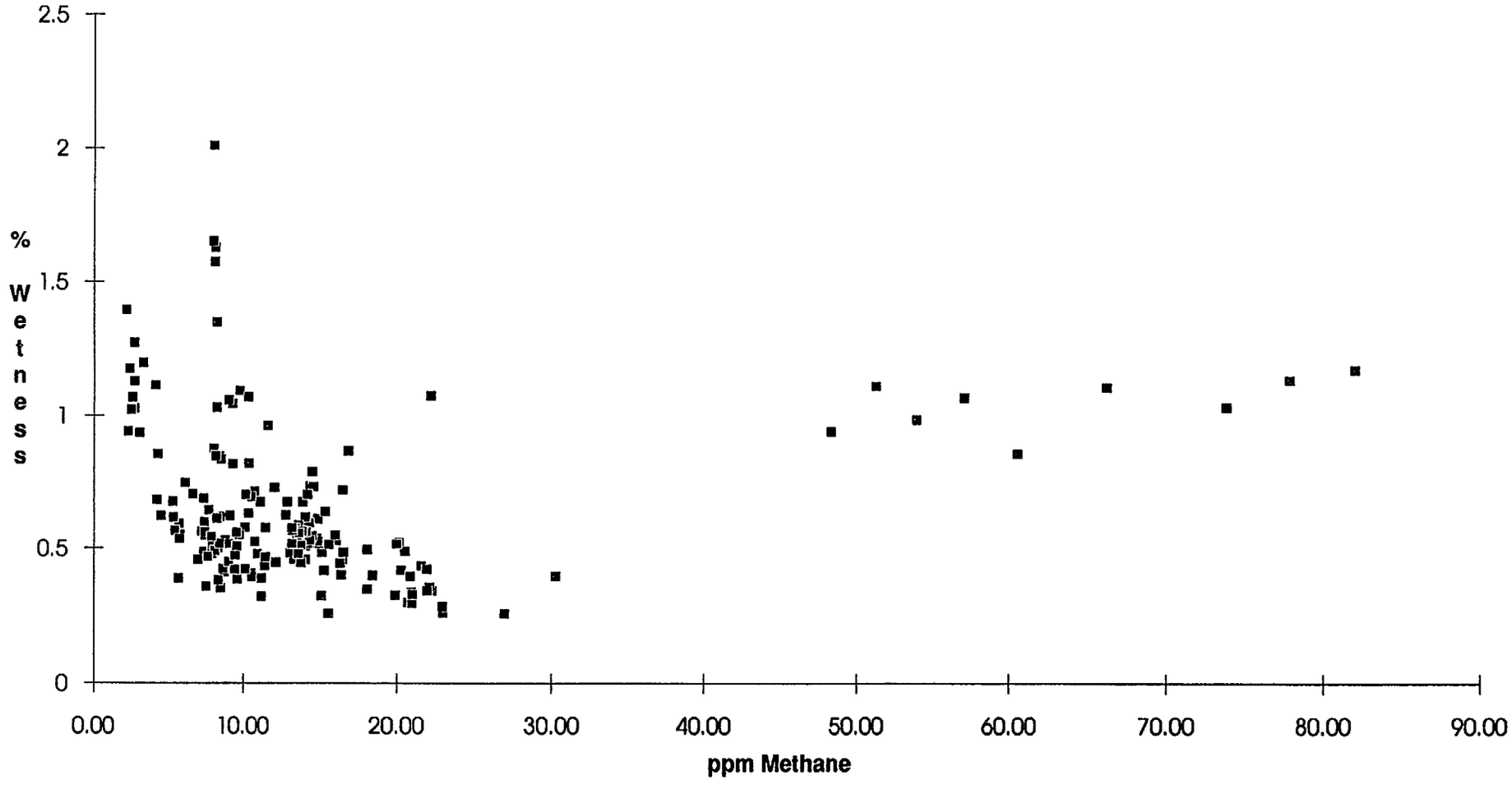



Line 109044 Ethane, Ethylene, Propane
ppm Hydrocarbons
0.5
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
0
20
40
60
80
100
120
140
160
180
Shotpoint
Ethane
Ethylene
Propane

Line 109044 Depths, Altitudes



Line 109044 Methane v. %Wetness



Line Summary

Line Number	109045
No. of Shotpoints	213

	Shotpoint	Date	Time	Latitude		Longitude	
Start	1	24-Apr-92	04:01:30	13	18.157	122	44.870
End	213	24-Apr-92	11:17:21	13	17.993	123	05.800

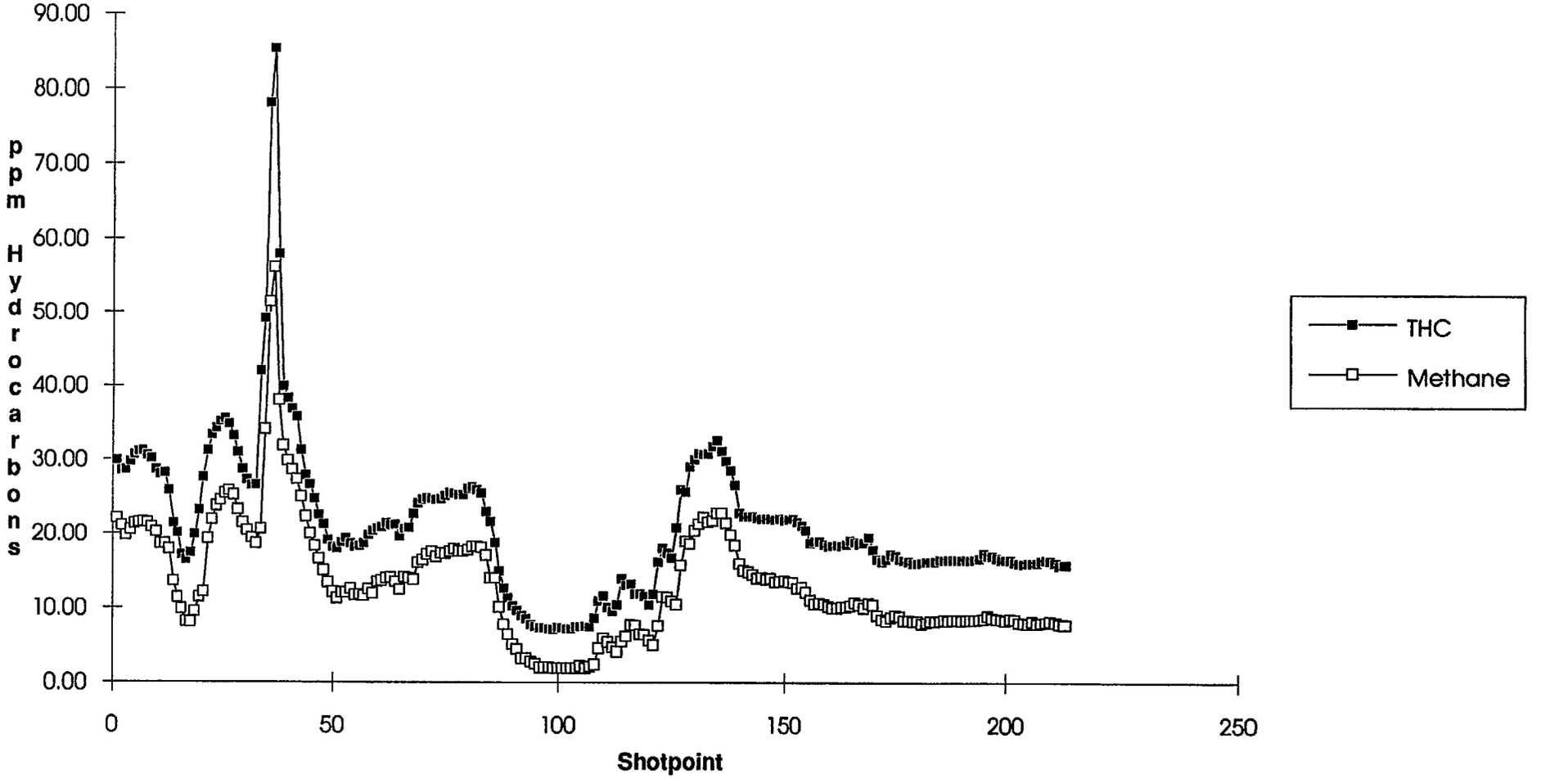
	THC	Methane	Ethane	Ethylene	Propane	Propylene	I-Butane	n-Butane	I-Pentane	n-Pentane	I-Hexane	n-Hexane	%Wetness
Mean	21.232	13.205	0.030	0.060	0.026	0.022	0.006	0.001	0.000	0.062	0.009	0.035	0.551
Std. Dev.	9.946	7.832	0.014	0.050	0.016	0.018	0.009	0.003	0.001	0.029	0.010	0.017	0.313
Minimum	7.104	1.858	0.004	0.008	0.008	0.000	0.000	0.000	0.000	0.028	0.000	0.000	0.061
Maximum	85.328	56.156	0.070	0.171	0.093	0.138	0.037	0.017	0.006	0.138	0.038	0.085	2.425

	Cond.	Temp.	F. Depth	W.Depth	Altitude	Calc. Alt.
Mean	57.245	24.525	148.114	355.015	23.877	206.946
Std. Dev.	0.964	0.626	34.469	192.688	8.374	206.964
Minimum	55.760	23.540	76.400	109.400	10.700	1.600
Maximum	60.400	26.620	204.000	964.100	30.900	866.500

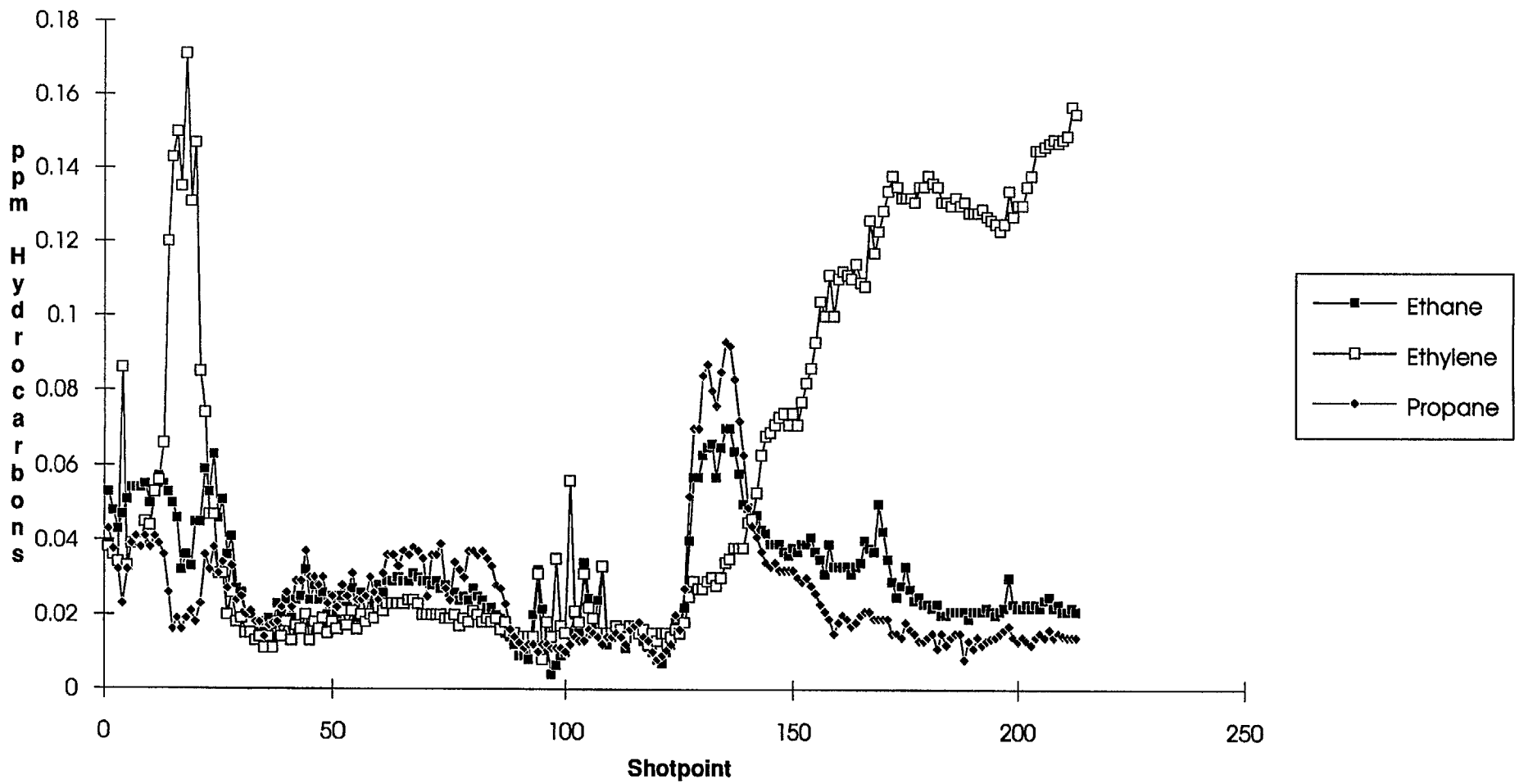
Notes

A moderate THC and methane anomoly is occurs at SP 37, a weak THC and methane anomoly coupled with a weak ethane and propane anomaly occurs at SP 70.
A weak THC , methane, propane and ethane anomaly occurs at SP 130.
Before SP 25 and after SP 130 the fish is lowered and then raised through surface waters.

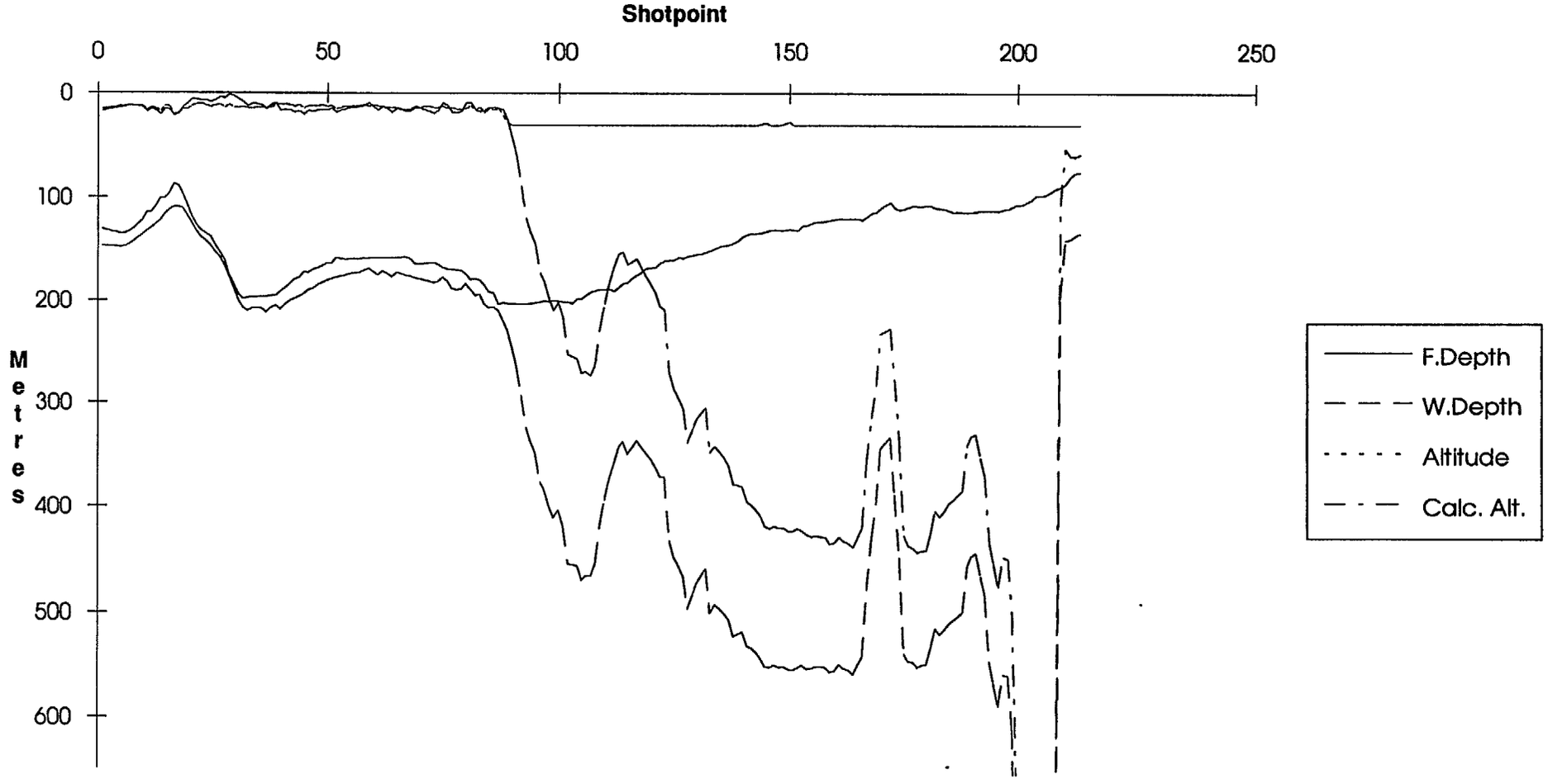
Line 109045 THC, Methane



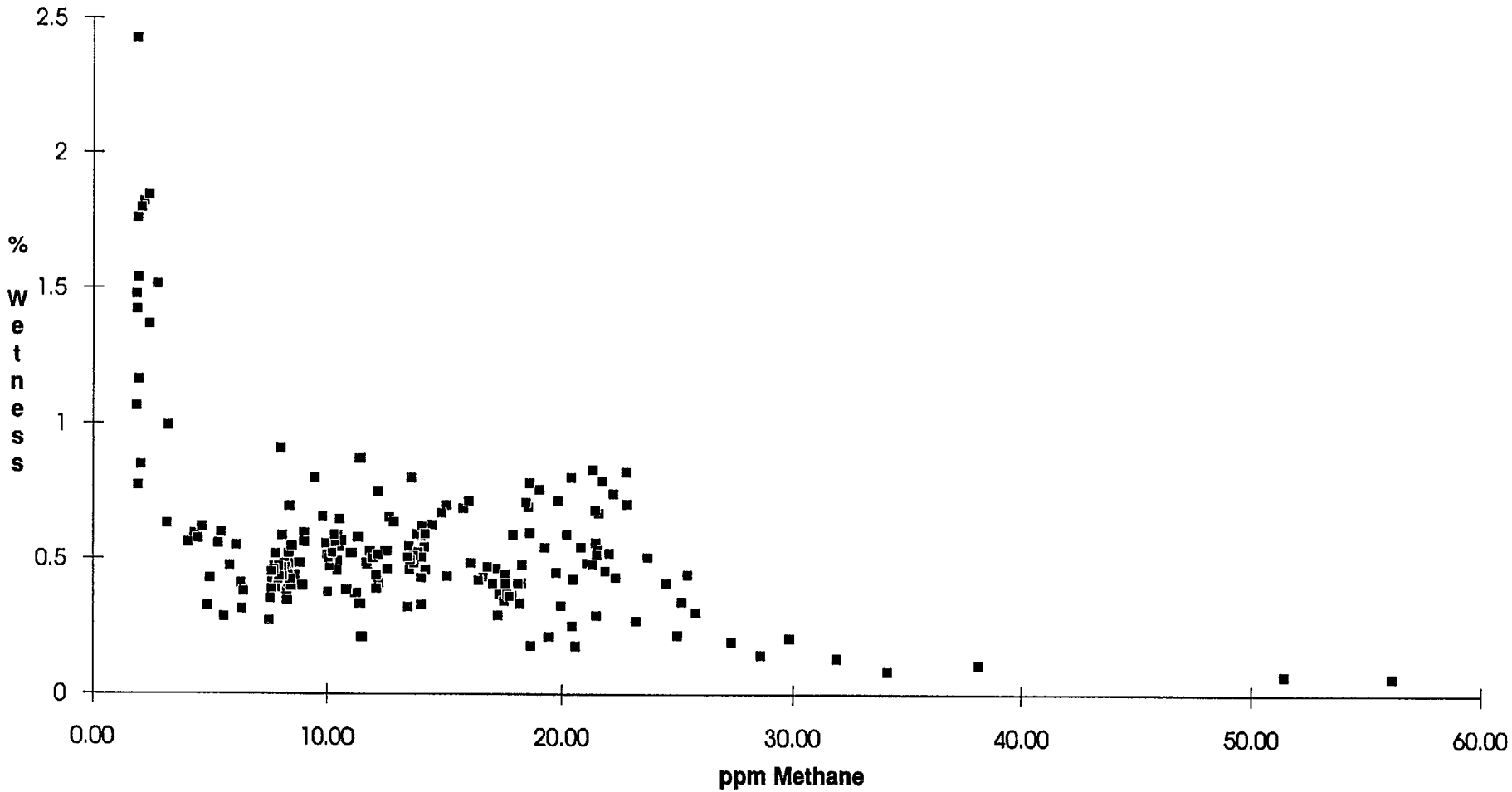
Line 109045 Ethane, Ethylene, Propane



Line 109045 Depths, Altitudes



Line 109045 Methane v. %Wetness



Line Summary

Line Number	Sniff5
No. of Shotpoints	97

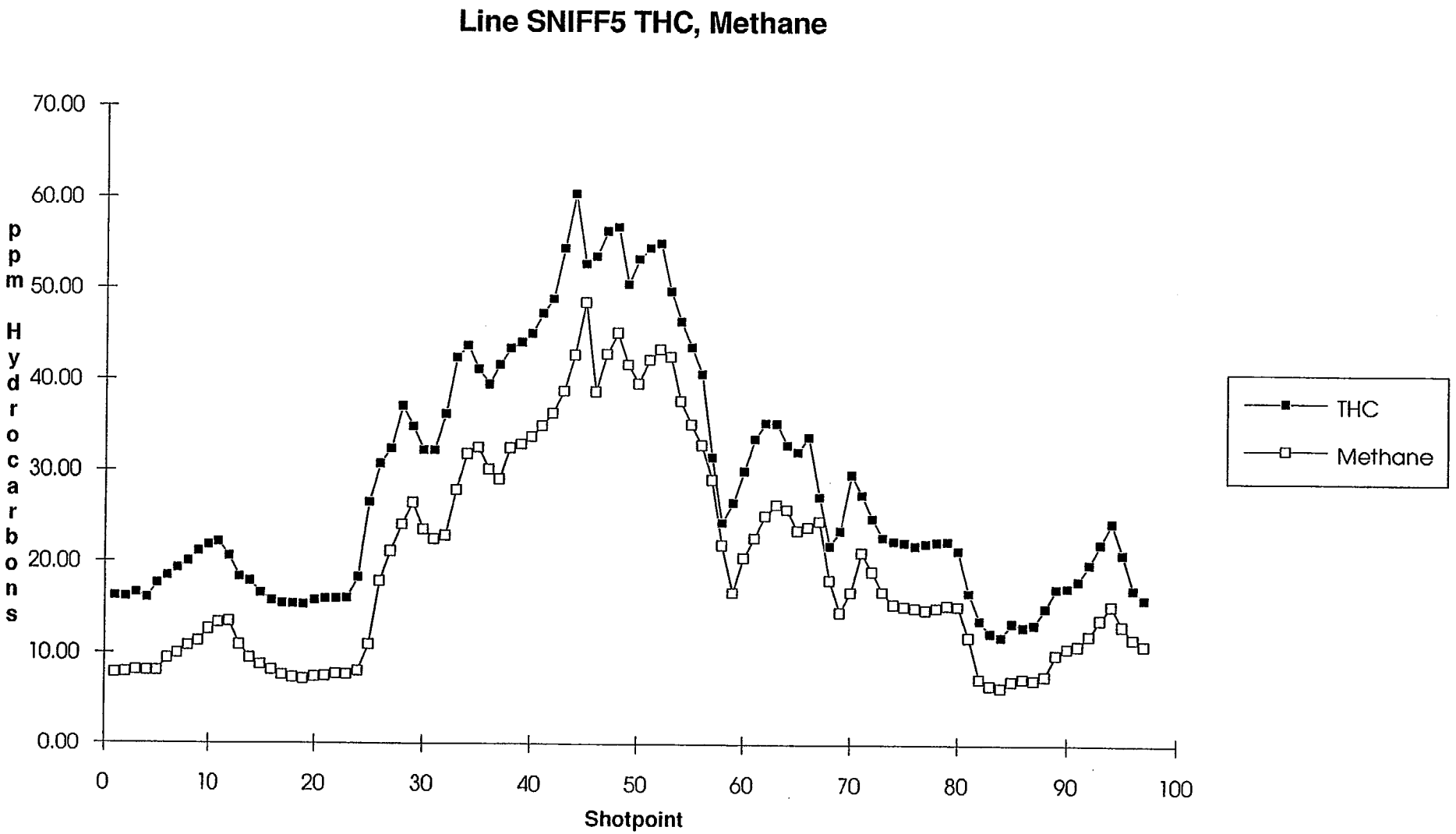
	Shotpoint	Date	Time	Latitude		Longitude	
Start	1	24-Apr-92	11:19:20	13	17.885	123	05.669
End	98	24-Apr-92	14:46:38	13	22.378	122	56.297

	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	28.628	19.807	0.036	0.050	0.036	0.020	0.006	0.002	0.001	0.050	0.008	0.031	0.465
Std. Dev.	13.290	11.768	0.018	0.051	0.026	0.020	0.012	0.014	0.002	0.026	0.007	0.011	0.286
Minimum	11.889	6.346	0.019	0.014	0.010	0.000	0.000	0.000	0.000	0.026	0.000	0.000	0.182
Maximum	60.401	48.444	0.101	0.180	0.135	0.161	0.091	0.131	0.007	0.116	0.026	0.052	2.444

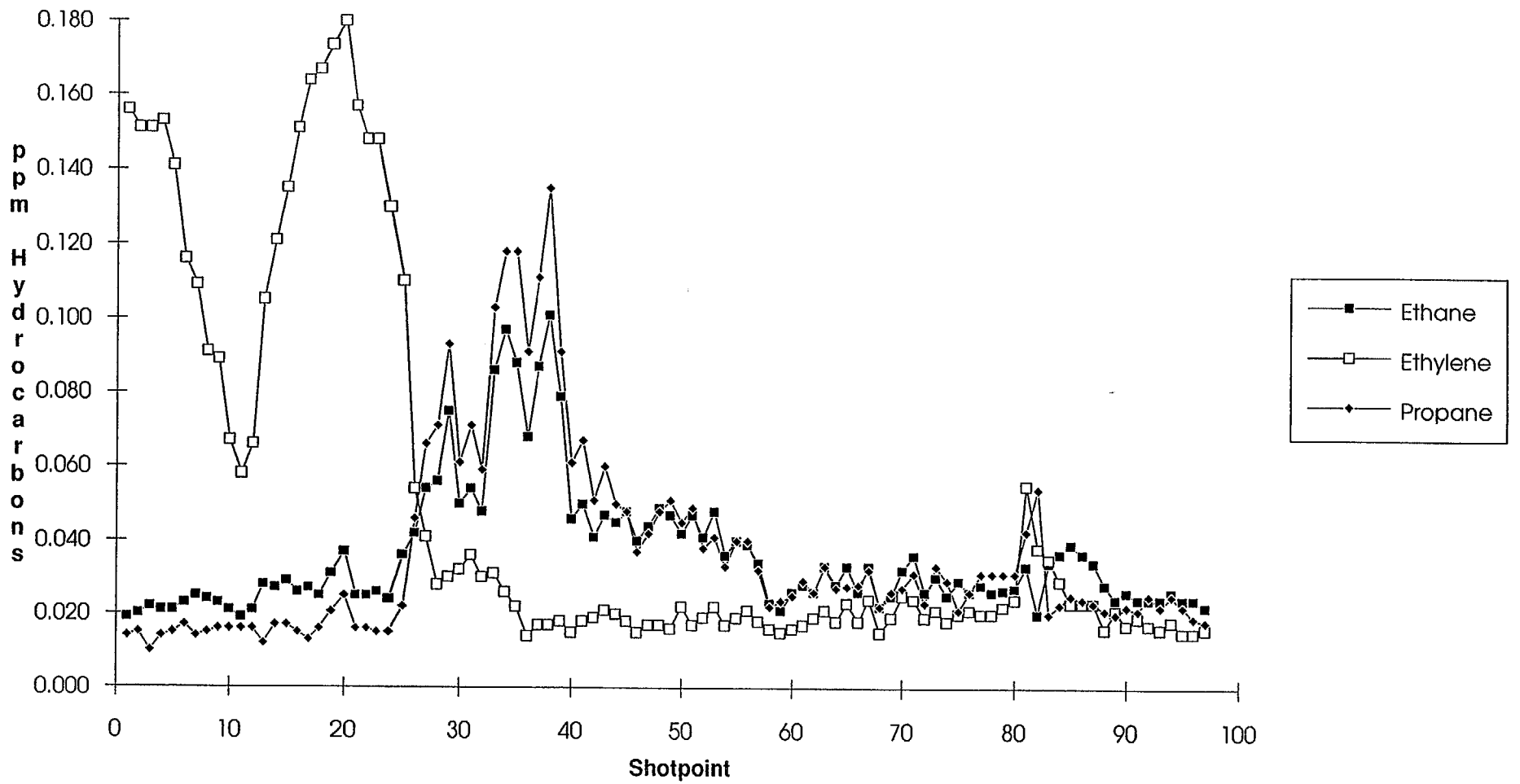
	Cond.	Temp.	F. Depth	W.Depth	Altitude	Calc. Alt.
Mean	55.525	23.371	150.453	166.795	17.020	16.518
Std. Dev.	1.332	0.882	33.170	31.080	4.258	9.758
Minimum	54.370	22.470	73.200	84.900	10.500	2.400
Maximum	58.650	25.430	190.700	212.000	30.900	59.900

Notes

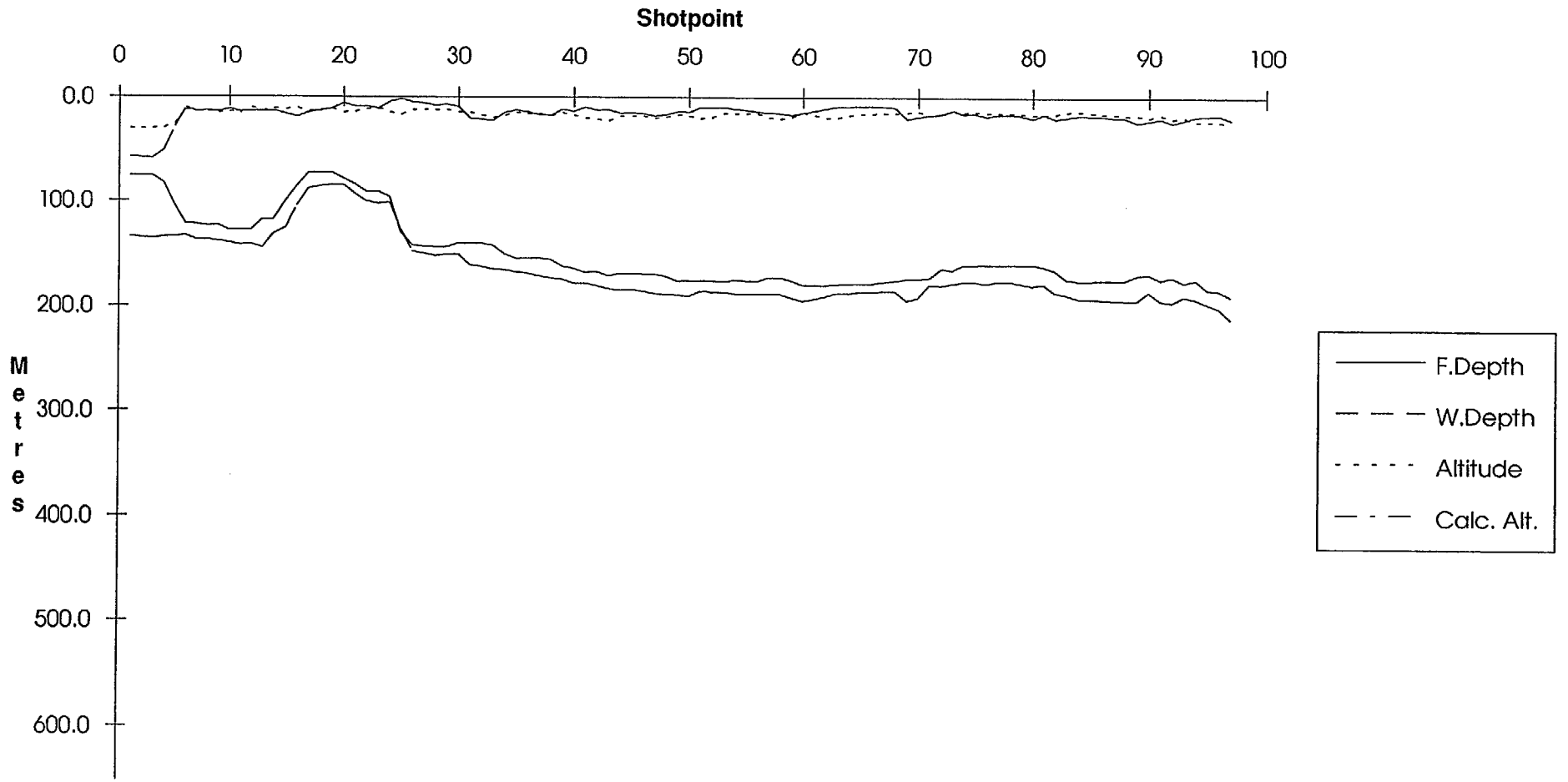
An extensive but weak THC and methane anomaly occurs between SP 25 and SP 70.
A moderate to weak ethane and propane anomaly occurs between SP 26 and SP 55.
Ethylene values prior to SP 26 reflect shallow water.
A gas sample for carbon isotope analysis was taken at SP 36 to SP 46.

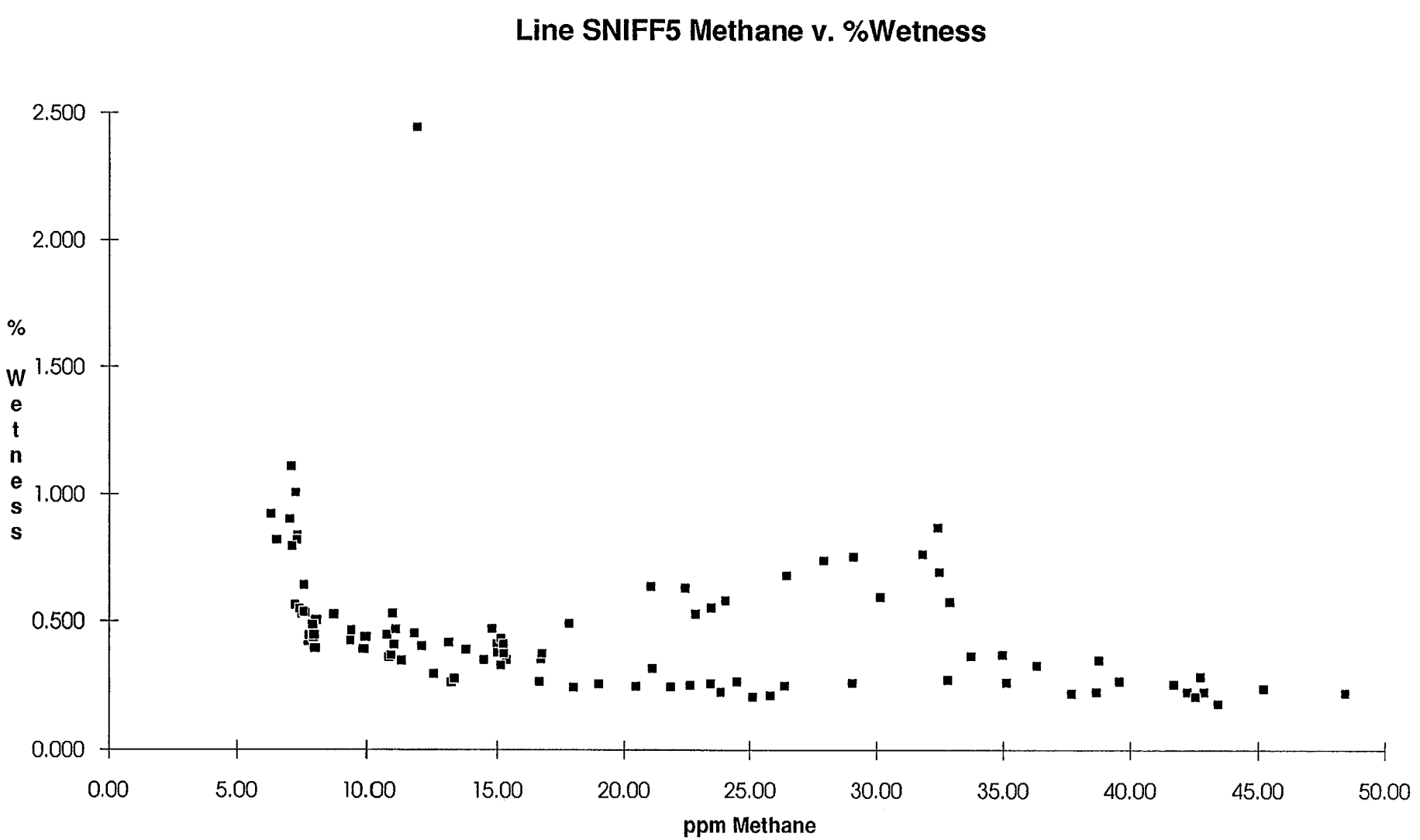

Line SNIFF5 THC, Methane
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
ppm Hydrocarbons
0
10
20
30
40
50
60
70
80
90
100
Shotpoint
THC
Methane

Line SNIFF5 Ethane, Ethylene, Propane



Line SNIFF5 Depths, Altitudes




Line SNIFF5 Methane v. %Wetness
2.500
2.000
1.500
1.000
0.500
0.000
% Wetness
0.00
5.00
10.00
15.00
20.00
25.00
30.00
35.00
40.00
45.00
50.00
ppm Methane

Line Summary

Line Number	109046
No. of Shotpoints	177

	Shotpoint	Date	Time	Latitude		Longitude	
Start	1	24-Apr-92	21:17:29	13	15.061	122	56.329
End	177	25-Apr-92	03:17:42	13	14.950	123	12.296

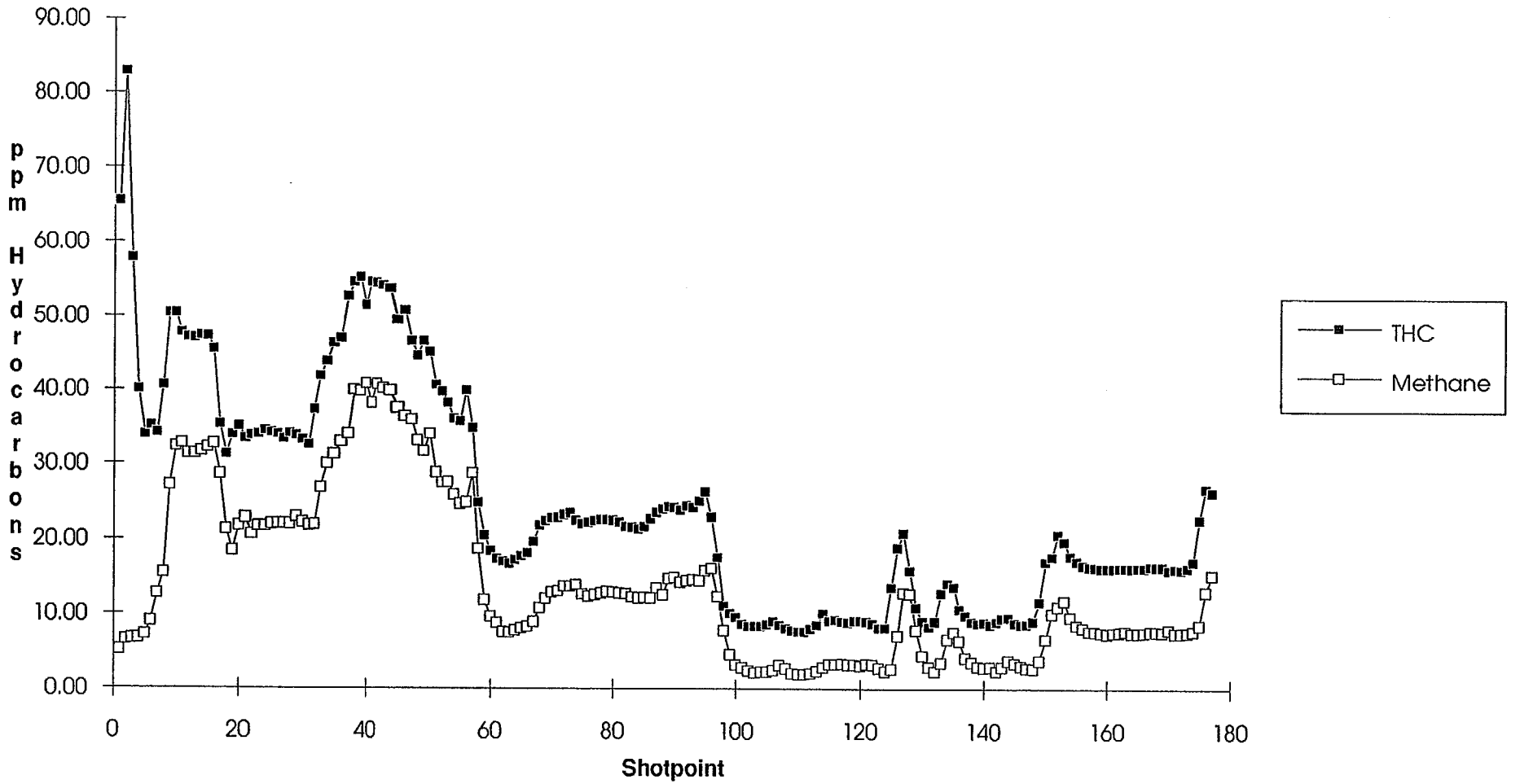
	THC	Methane	Ethane	Ethylene	Propane	Propylene	I-Butane	n-Butane	I-Pentane	n-Pentane	I-Hexane	n-Hexane	%Wetness
Mean	24.600	13.779	0.040	0.069	0.035	0.024	0.007	0.000	0.001	0.062	0.012	0.024	0.747
Std. Dev.	14.967	10.877	0.022	0.080	0.026	0.022	0.010	0.002	0.003	0.041	0.008	0.014	0.409
Minimum	7.644	1.976	0.007	0.014	0.008	0.000	0.000	0.000	0.000	0.026	0.000	0.000	0.241
Maximum	82.847	40.808	0.125	0.698	0.138	0.185	0.045	0.017	0.027	0.255	0.061	0.072	3.653

	Cond.	Temp.	F. Depth	W.Depth	Altitude	Calc. Alt.
Mean	56.438	23.940	140.746	234.059	20.345	93.285
Std. Dev.	1.923	1.276	38.798	162.127	7.975	133.260
Minimum	54.560	22.700	59.800	74.800	10.800	5.000
Maximum	60.870	26.890	196.600	669.200	30.900	481.300

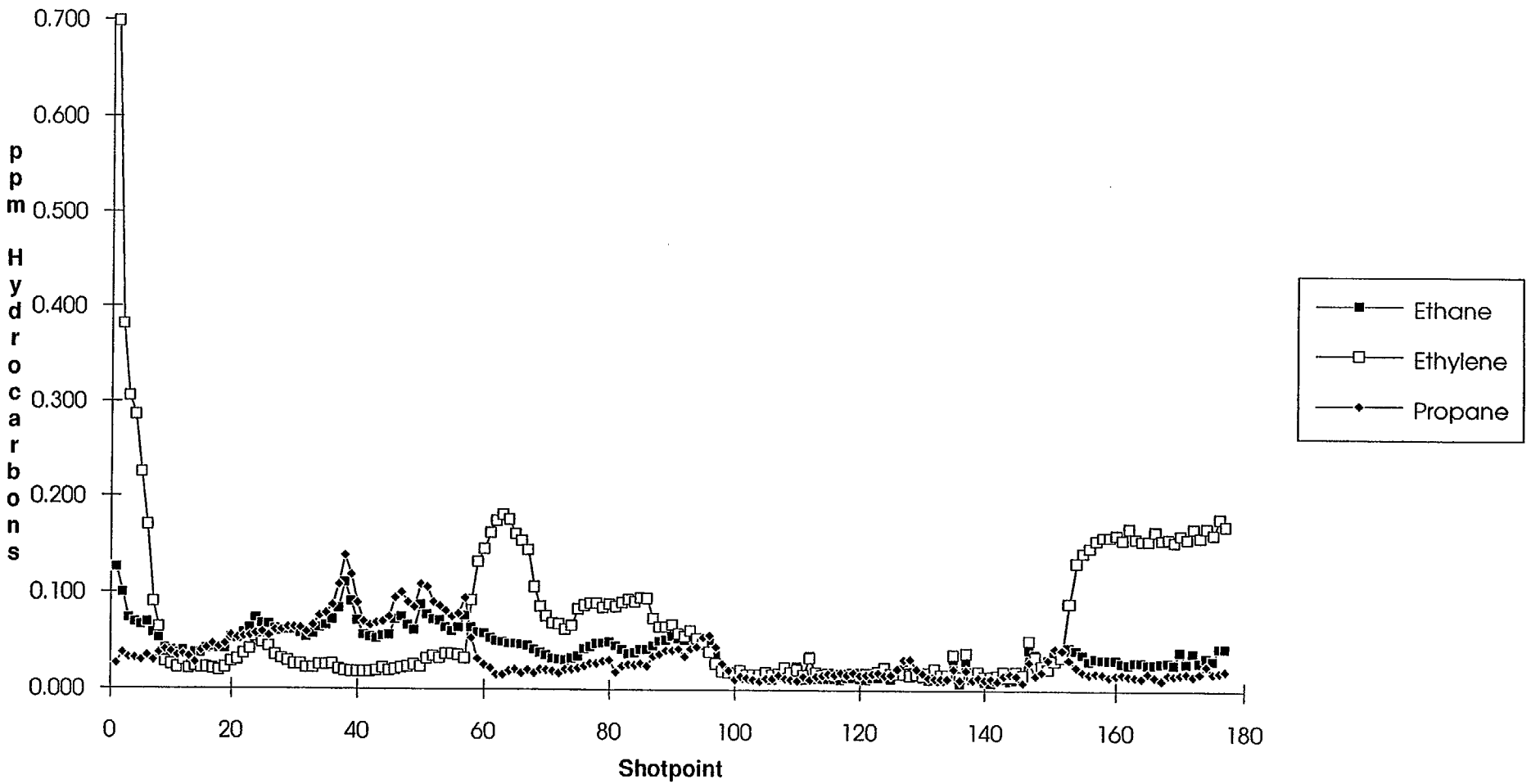
Notes

Two weak THC and methane anomalies are seen at SP 10 and SP 40 the latter having a weak Ehtane and propane anomaly.
Two very weak THC and methane anomalies are seen at SP 126 and SP 133.
The thermocline effects hydrocarbon values before SP 10 and after SP 150, and between SP 58 and SP 93.

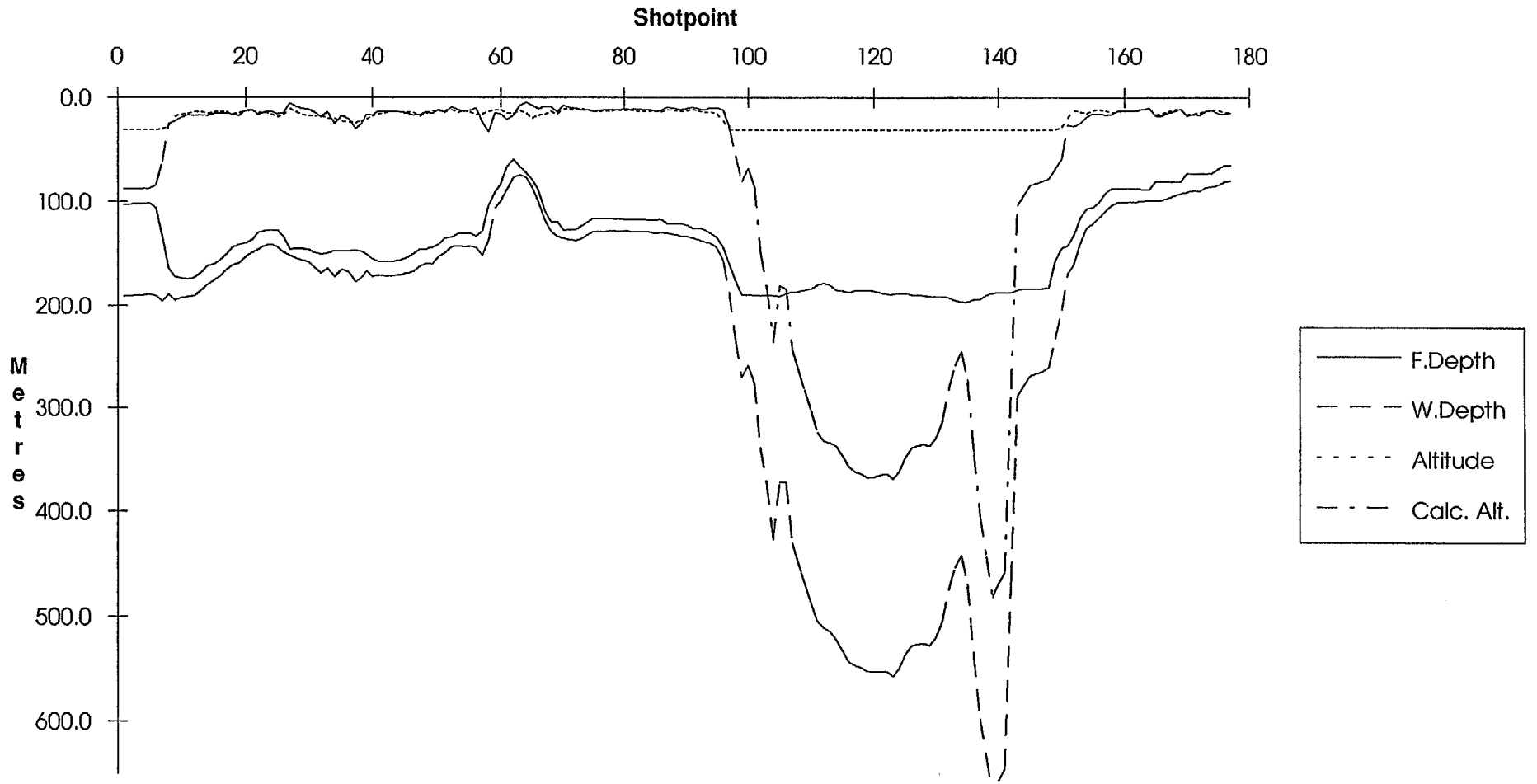
Line 109046 THC, Methane



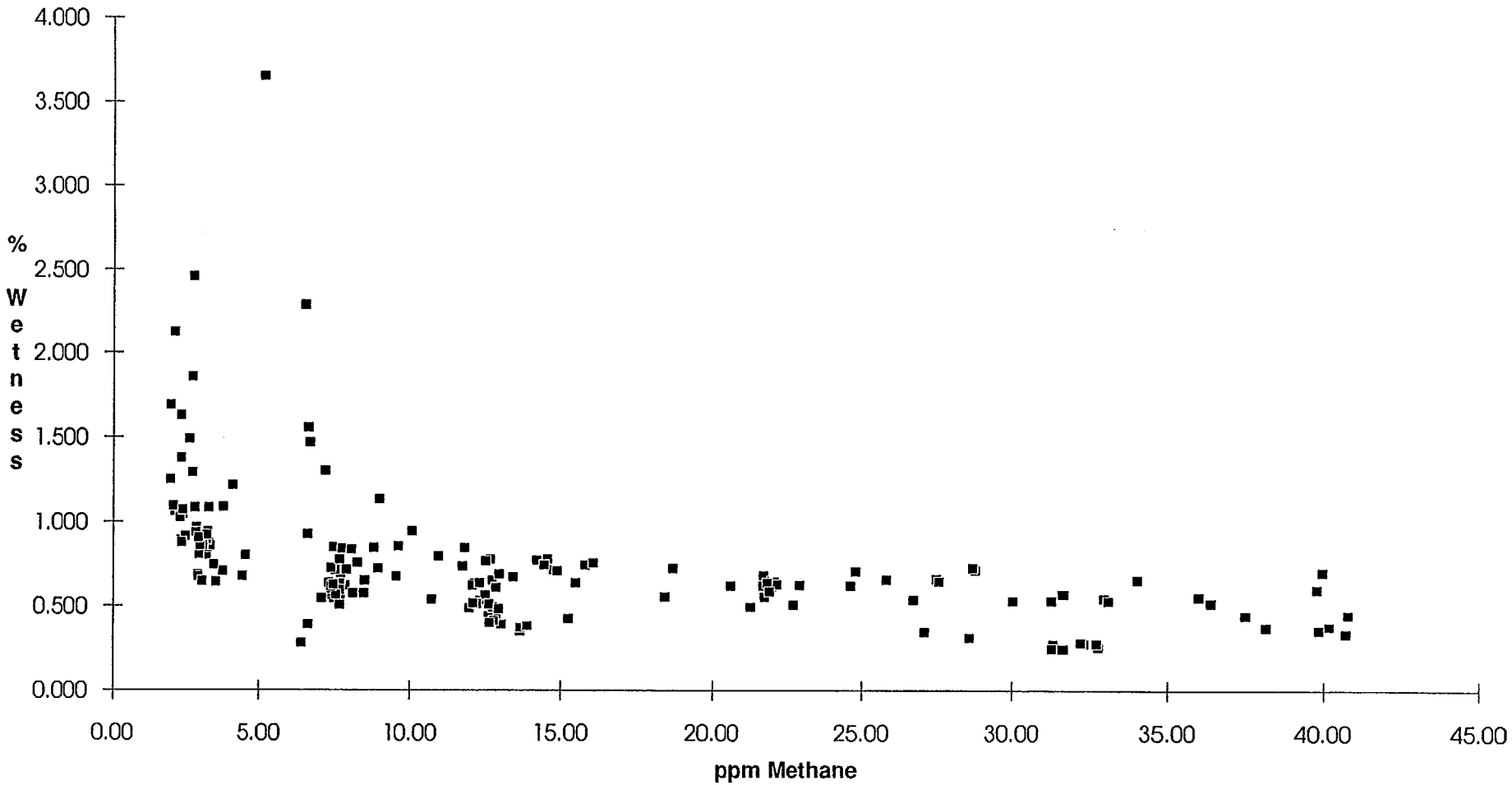
Line 109046 Ethane, Ethylene, Propane



Line 109046 Depths, Altitudes



Line 109046 Methane v. %Wetness



Line Summary

Line Number	109047
No. of Shotpoints	178

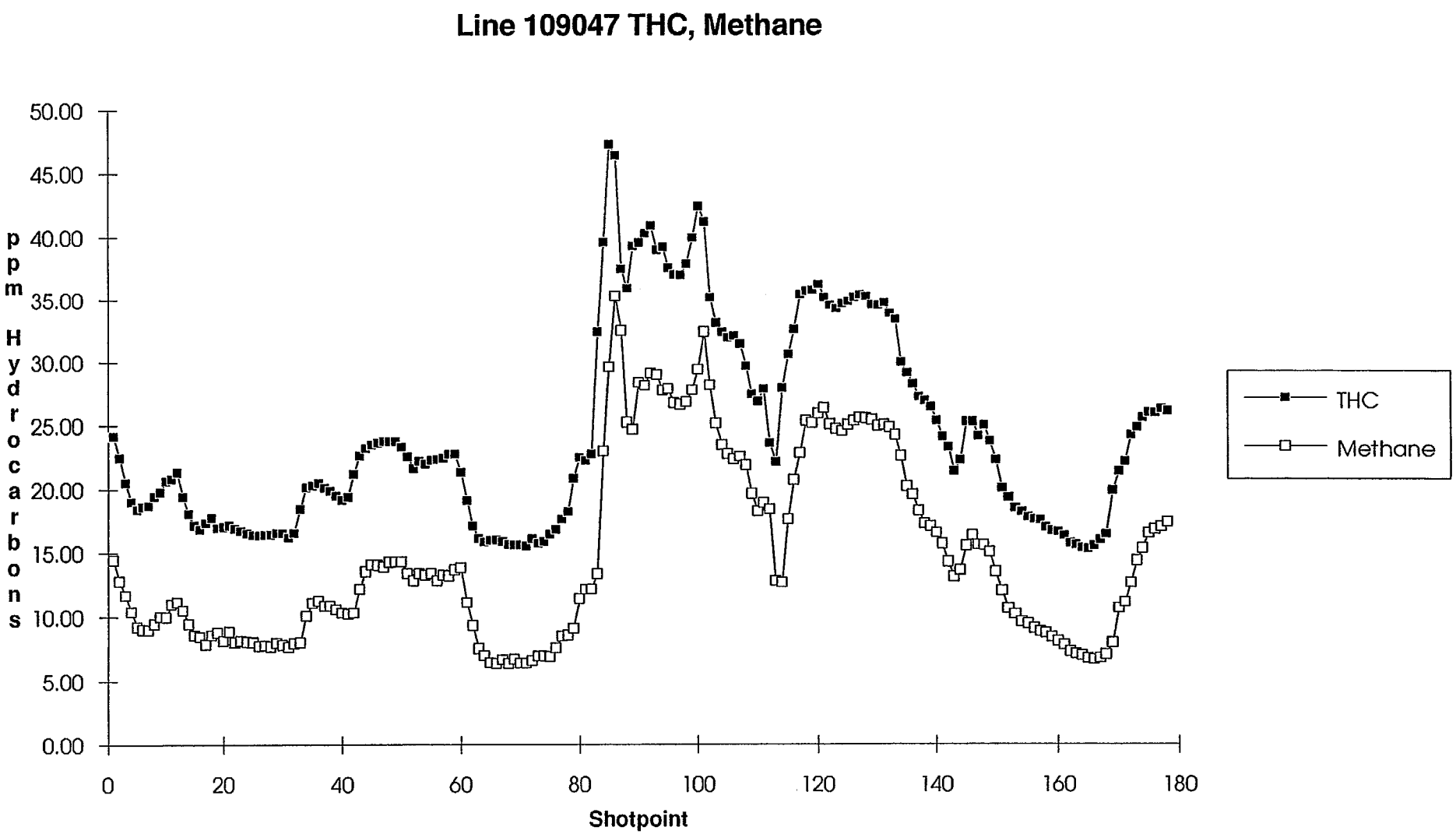
	Shotpoint	Date	Time	Latitude		Longitude	
Start	1	25-Apr-92	03:19:42	13	14.832	123	12.431
End	178	25-Apr-92	09:24:00	13	12.615	122	44.120

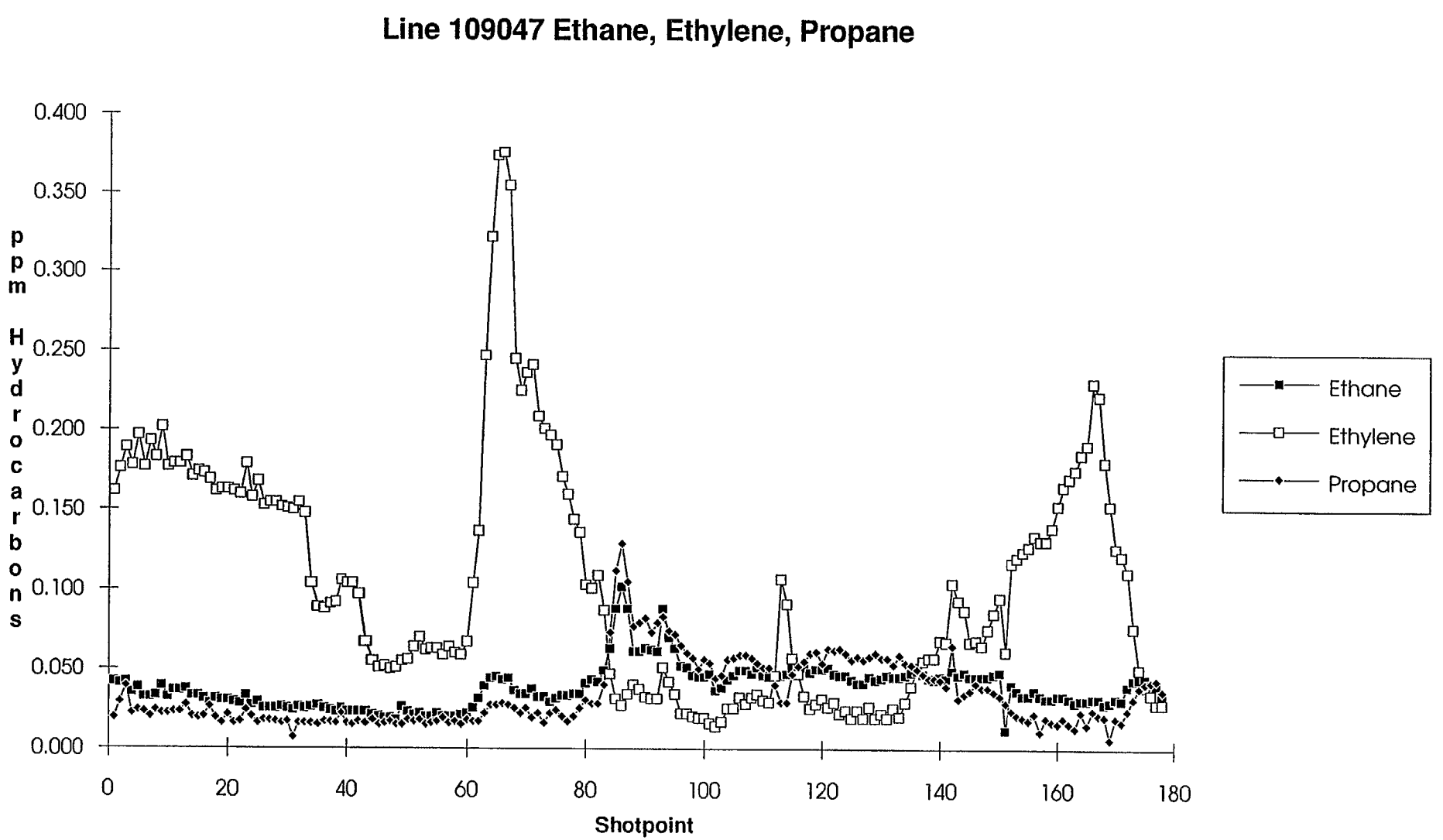
	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	24.378	14.867	0.038	0.104	0.035	0.033	0.008	0.001	0.000	0.087	0.012	0.035	0.563
Std. Dev.	7.878	7.265	0.014	0.075	0.021	0.023	0.010	0.004	0.001	0.053	0.010	0.014	0.165
Minimum	15.286	6.372	0.012	0.014	0.006	0.000	0.000	0.000	0.000	0.029	0.000	0.000	0.230
Maximum	47.268	35.282	0.102	0.376	0.129	0.134	0.044	0.039	0.007	0.239	0.052	0.076	1.255

	Cond.	Temp.	F. Depth	W.Depth	Altitude	Calc. Alt.
Mean	58.234	25.189	104.519	121.430	15.546	16.882
Std. Dev.	1.806	1.190	36.186	33.514	5.078	12.151
Minimum	55.640	23.460	21.100	57.300	9.900	0.000
Maximum	62.020	27.730	155.600	190.000	30.900	85.000

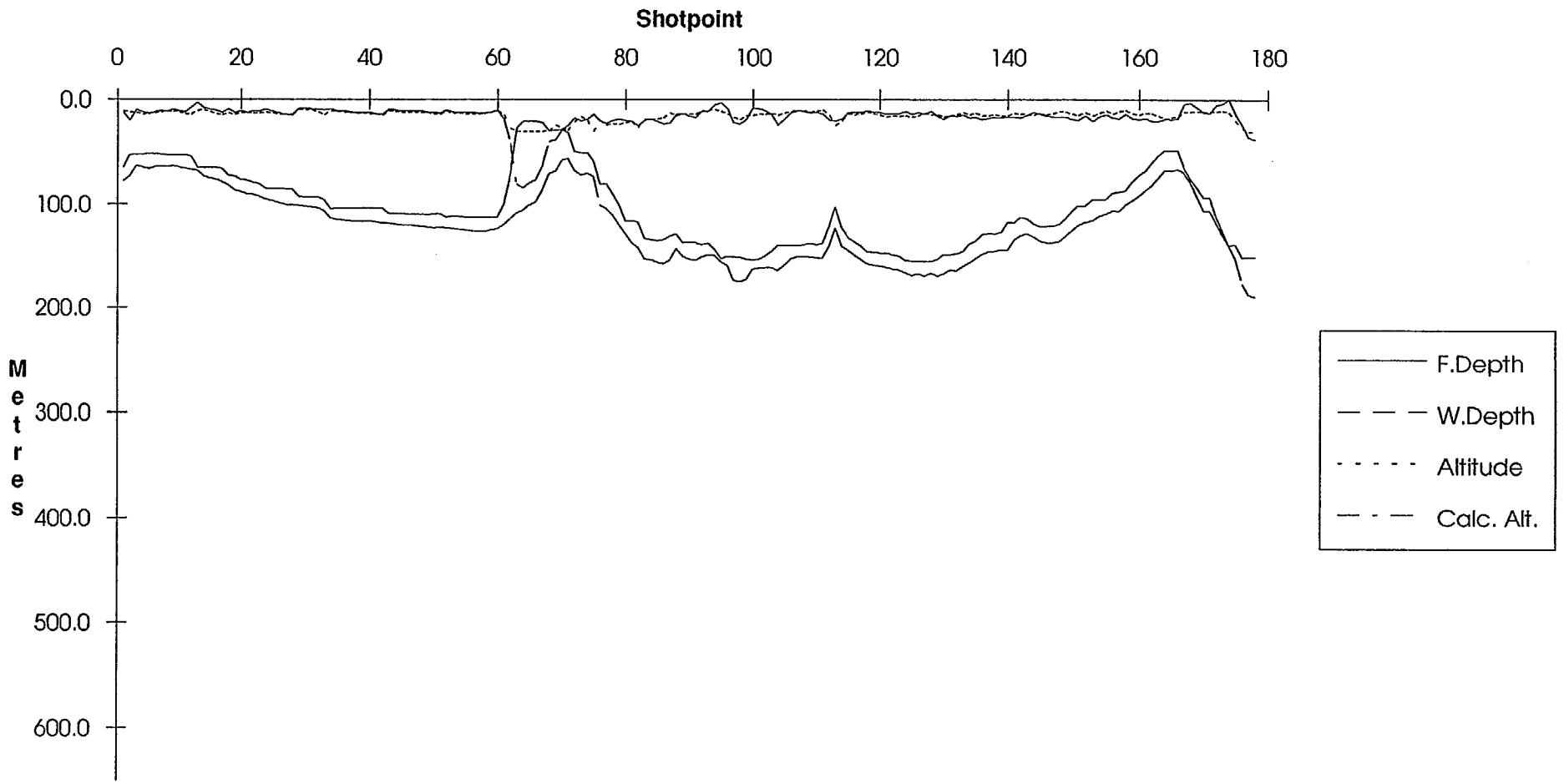
Notes

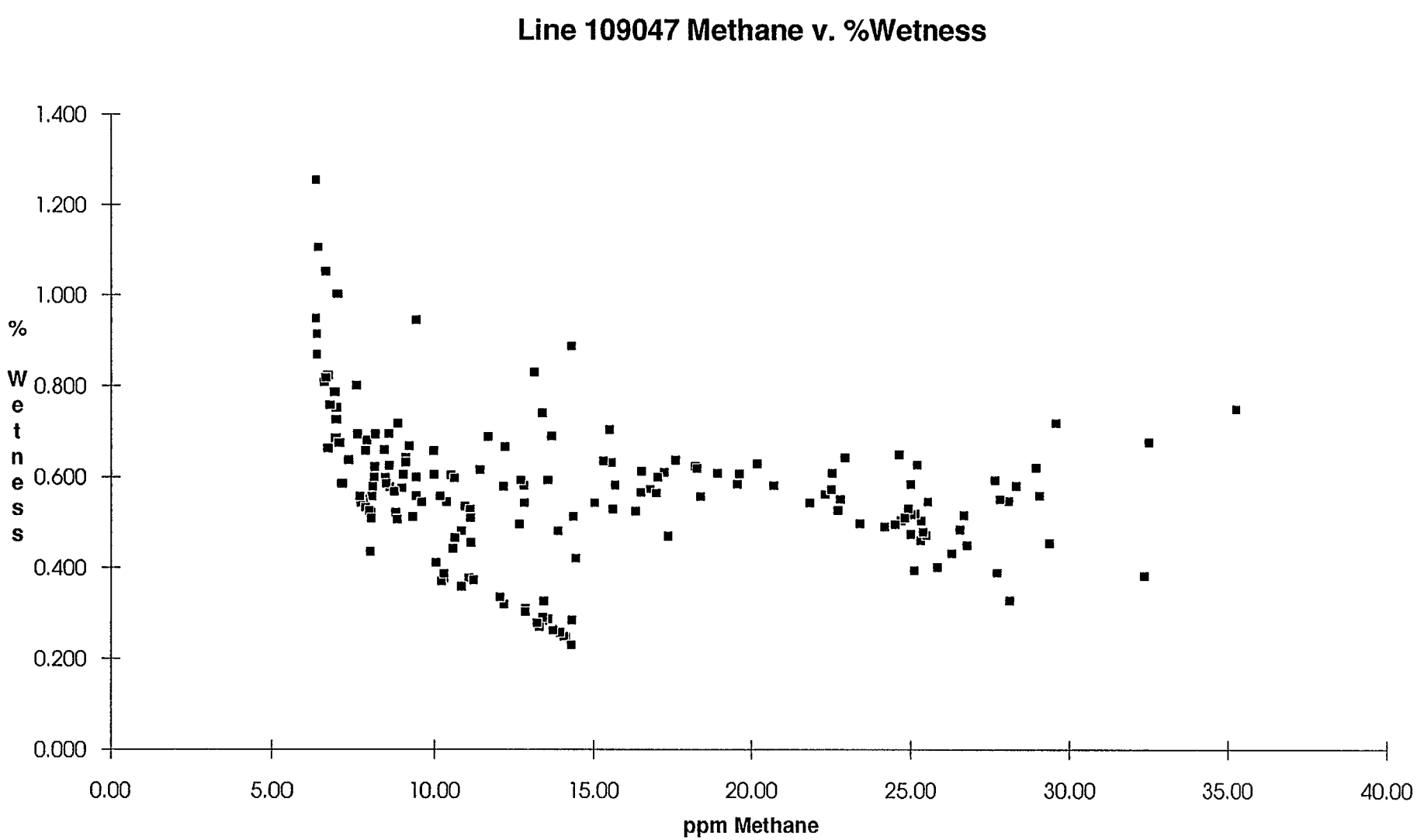
Two weak THC and methane anomalies are seen at SP 84 and SP 120, the former having a weak ethane and propane anomaly.
From SP 1 to SP 80 the fish passes down and through the the thermocline, the moderate ethylene anomaly at SP 63 is due to the fish being raised and then lowered through the thermocline.
The moderate ethylene anomaly at SP 63 is due to the fish being raised and then lowered through the thermocline as it passes over a platform.


Line 109047 THC, Methane
ppm Hydrocarbons
50.00
45.00
40.00
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00
0
20
40
60
80
100
120
140
160
180
Shotpoint
THC
Methane


Line 109047 Ethane, Ethylene, Propane
ppm Hydrocarbons
0.400
0.350
0.300
0.250
0.200
0.150
0.100
0.050
0.000
0
20
40
60
80
100
120
140
160
180
Shotpoint
Ethane
Ethylene
Propane

Line 109047 Depths, Altitudes




Line 109047 Methane v. %Wetness
1.400
1.200
1.000
0.800
0.600
0.400
0.200
0.000
% Wetness
0.00
5.00
10.00
15.00
20.00
25.00
30.00
35.00
40.00
ppm Methane

Line Summary

Line Number	109048
No. of Shotpoints	149

	Shotpoint	Date	Time	Latitude		Longitude	
Start	1	25-Apr-92	09:26:00	13	12.611	122	43.962
End	149	25-Apr-92	14:30:42	13	28.592	123	01.367

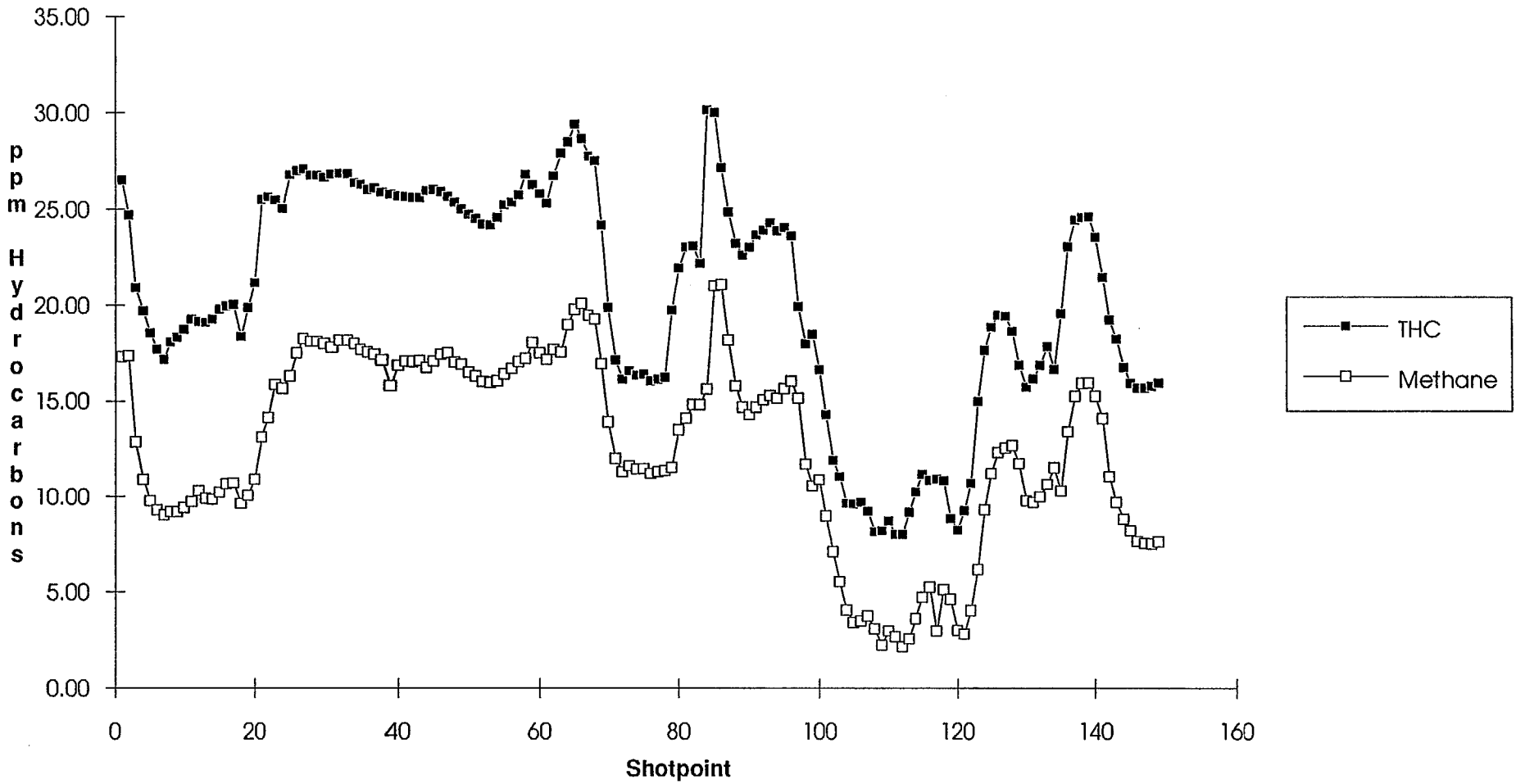
	THC	Methane	Ethane	Ethylene	Propane	Propylene	I-Butane	n-Butane	I-Pentane	n-Pentane	I-Hexane	n-Hexane	%Wetness
Mean	20.494	12.608	0.027	0.044	0.026	0.018	0.003	0.002	0.000	0.047	0.005	0.025	0.507
Std. Dev.	5.874	4.889	0.014	0.044	0.010	0.011	0.005	0.006	0.001	0.025	0.007	0.014	0.228
Minimum	7.988	2.150	0.005	0.008	0.007	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.102
Maximum	30.159	21.057	0.090	0.160	0.055	0.056	0.016	0.043	0.007	0.106	0.039	0.083	1.480

	Cond.	Temp.	F. Depth	W.Depth	Altitude	Calc. Alt.
Mean	55.766	23.521	147.396	274.468	19.367	127.075
Std. Dev.	1.236	0.809	32.788	178.272	8.098	175.277
Minimum	54.670	22.780	68.000	84.200	10.900	6.700
Maximum	58.630	25.400	196.200	603.100	30.900	501.400

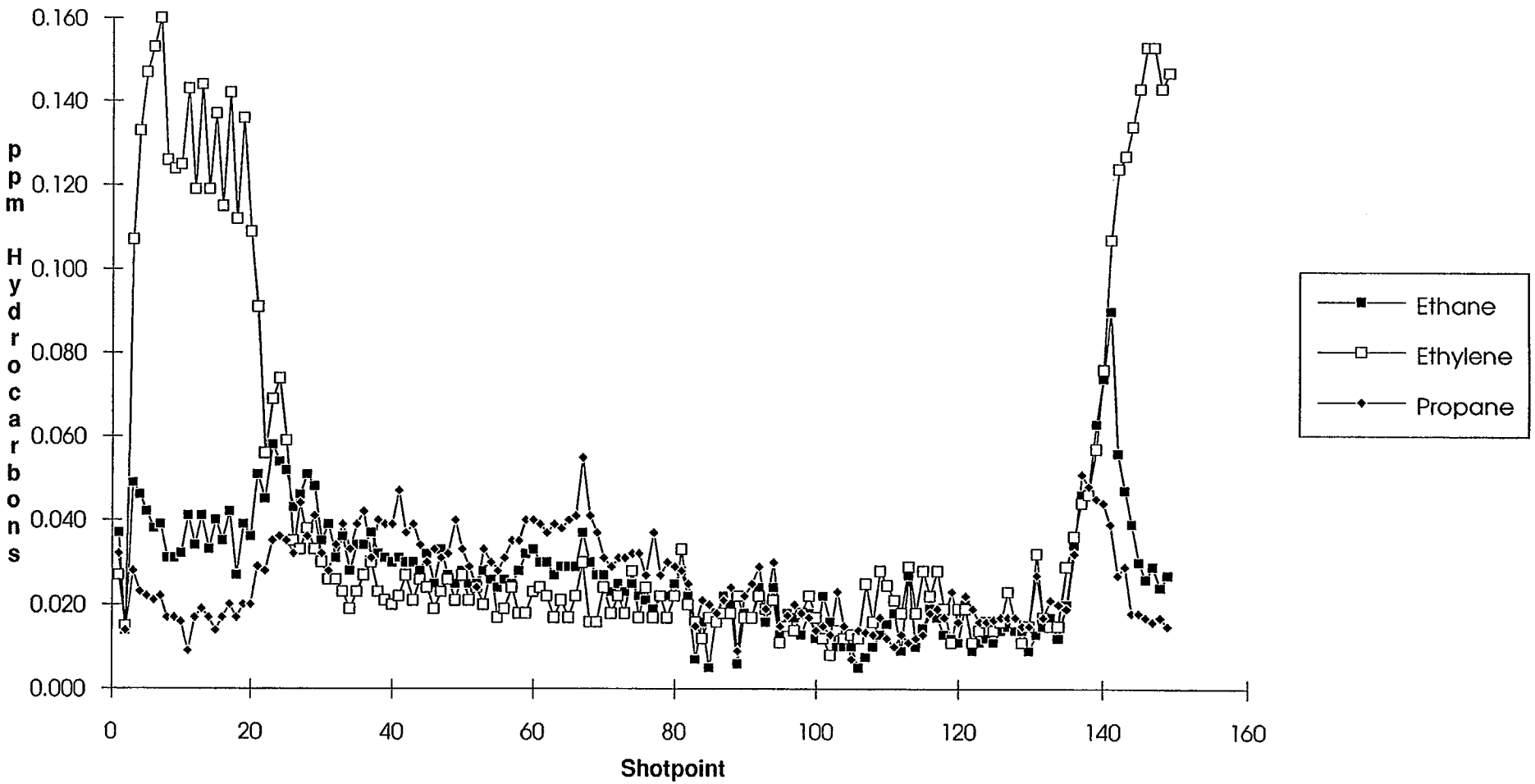
Notes

Four weak THC and methane anomalies occur at SP 65, SP 77, SP 117, and SP 125, the anomaly at SP 65 also has a very weak ethane and propane anomaly.
A weak THC, methane, ethane and propane anomaly occurs at SP 135 however this coinsides with the fish being raised through the water column.
Variations in fish depth influence hydrocarbon values before SP 28 and after SP 135.

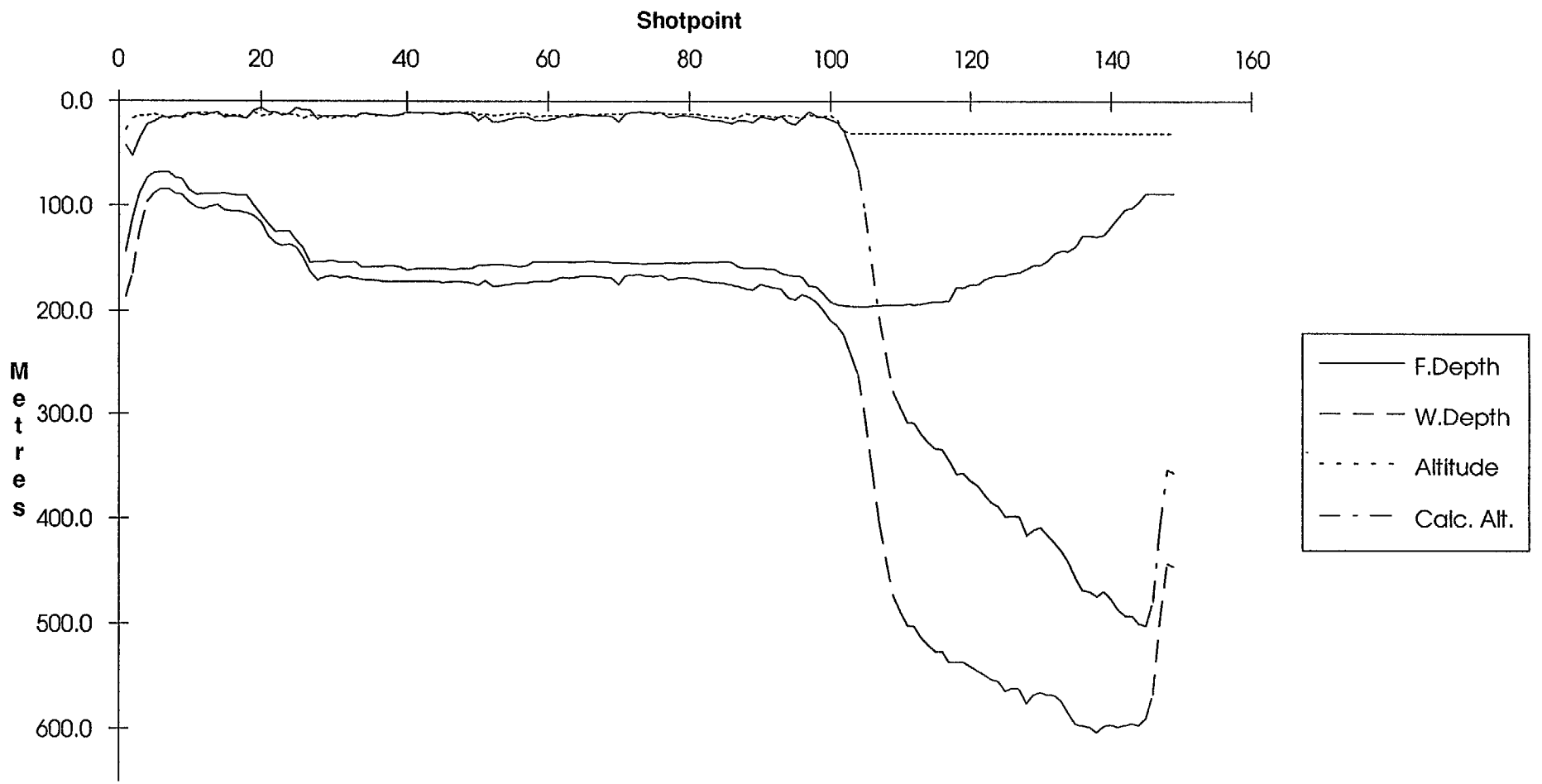
Line 109048 THC, Methane



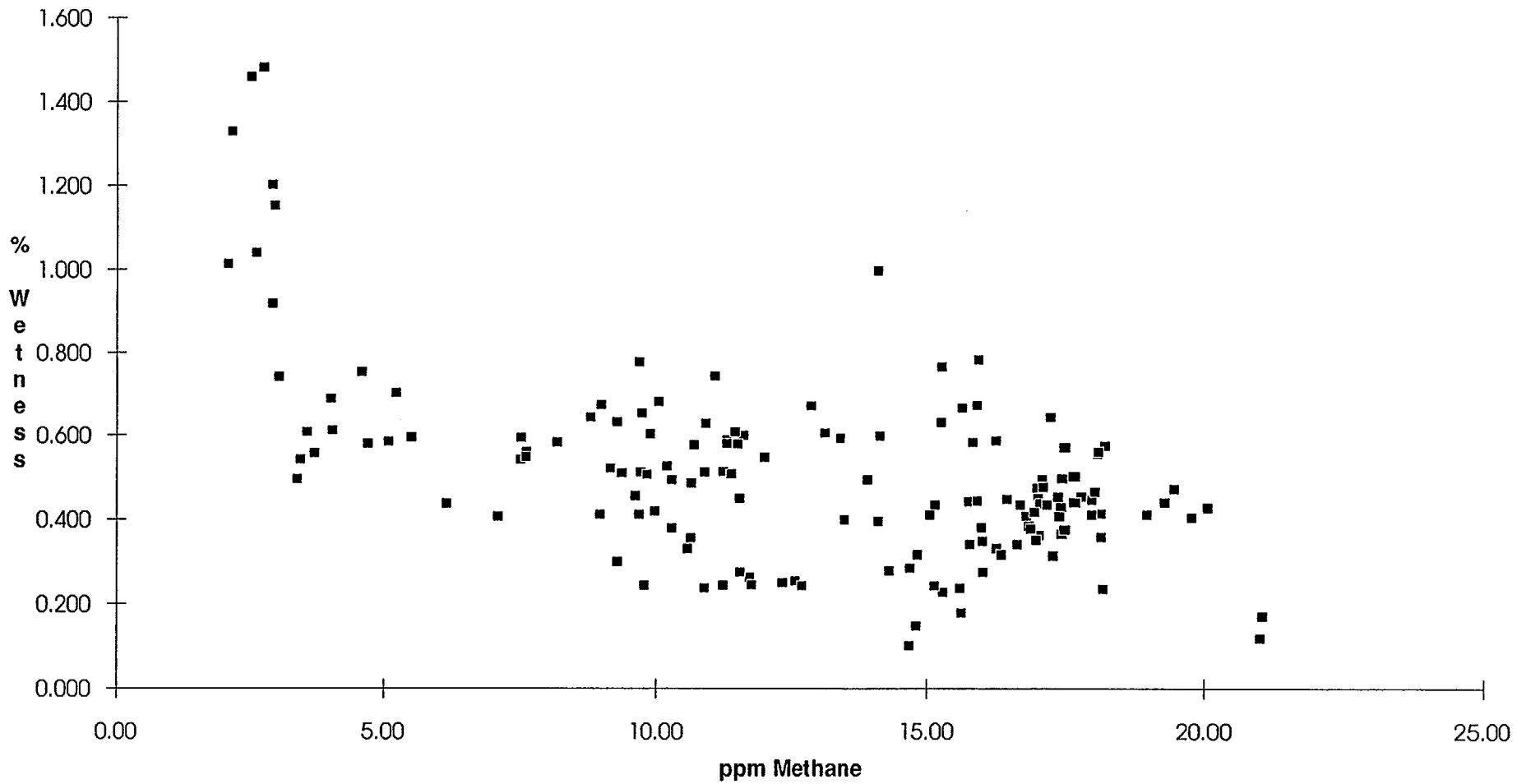
Line 109048 Ethane, Ethylene, Propane



Line 109048 Depths, Altitudes



Line 109048 Methane v. %Wetness



Line Summary

Line Number	sniff6
No. of Shotpoints	208

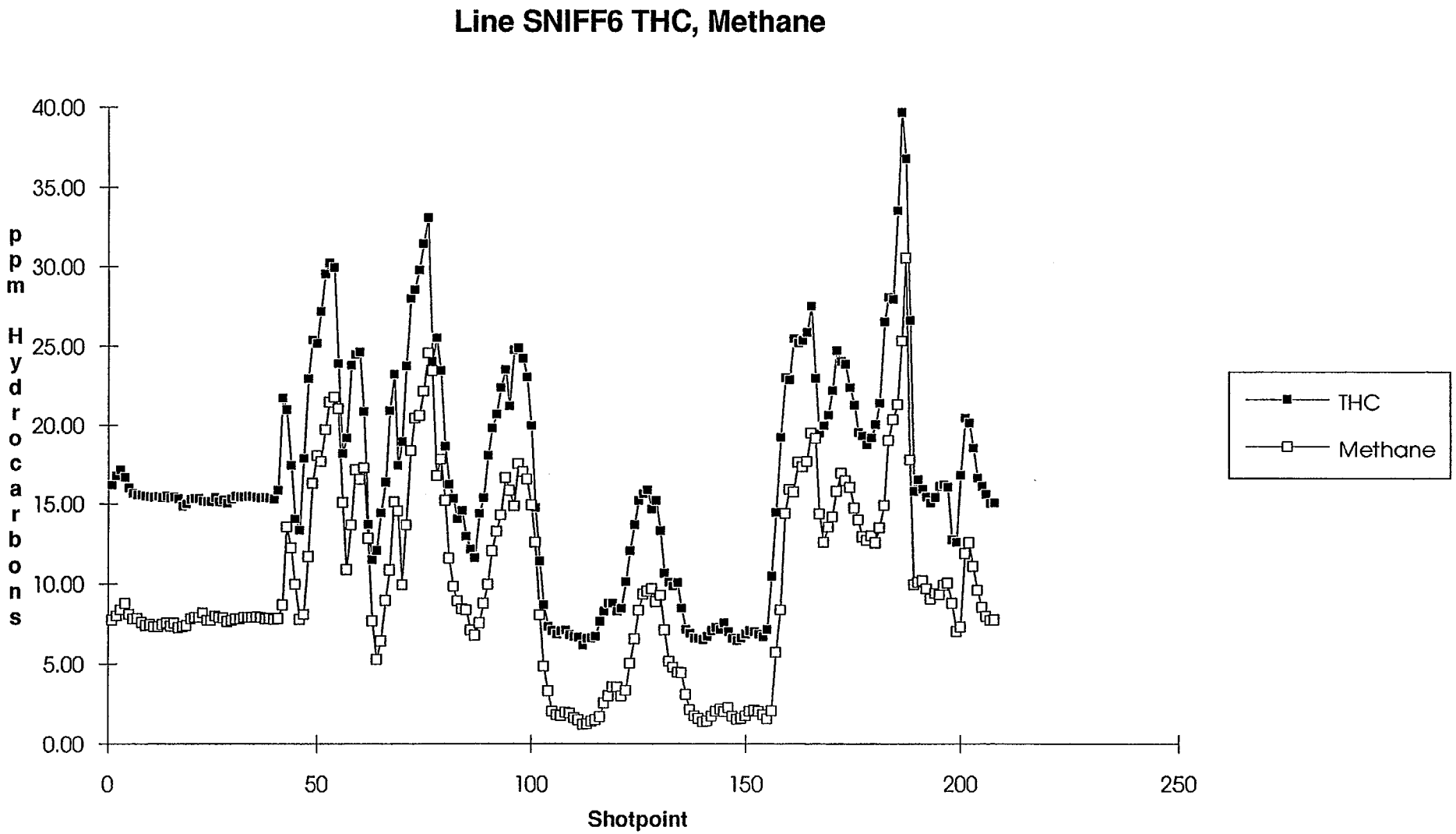
	Shotpoint	Date	Time	Latitude		Longitude	
Start	1	25-Apr-92	14:32:42	13	28.698	123	01.497
End	210	25-Apr-92	21:59:09	13	17.262	123	09.851

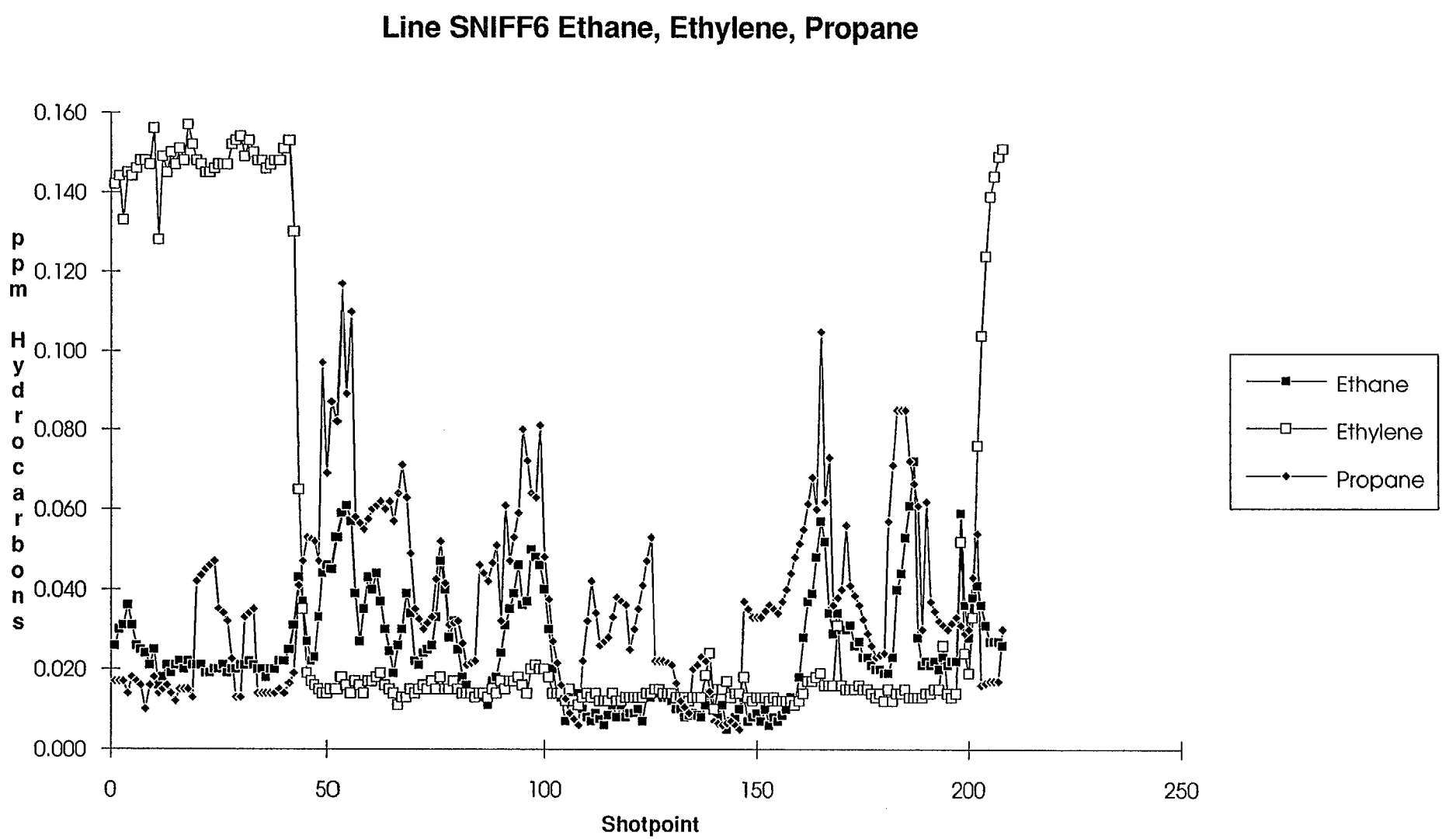
	THC	Methane	Ethane	Ethylene	Propane	Propylene	I-Butane	n-Butane	I-Pentane	n-Pentane	I-Hexane	n-Hexane	%Wetness
Mean	16.579	9.814	0.024	0.046	0.037	0.040	0.006	0.000	0.002	0.052	0.006	0.016	0.857
Std. Dev.	6.798	5.852	0.013	0.055	0.022	0.030	0.009	0.002	0.007	0.030	0.006	0.014	0.584
Minimum	6.172	1.212	0.005	0.010	0.005	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.334
Maximum	39.654	30.562	0.072	0.157	0.117	0.123	0.033	0.018	0.043	0.141	0.031	0.053	3.426

	Cond.	Temp.	F. Depth	W.Depth	Altitude	Calc. Alt.
Mean	55.194	23.107	140.377	507.120	30.046	366.783
Std. Dev.	1.469	0.962	28.592	116.977	3.671	116.314
Minimum	54.230	22.440	84.300	103.300	10.300	14.500
Maximum	58.160	25.070	160.700	598.000	30.900	508.600

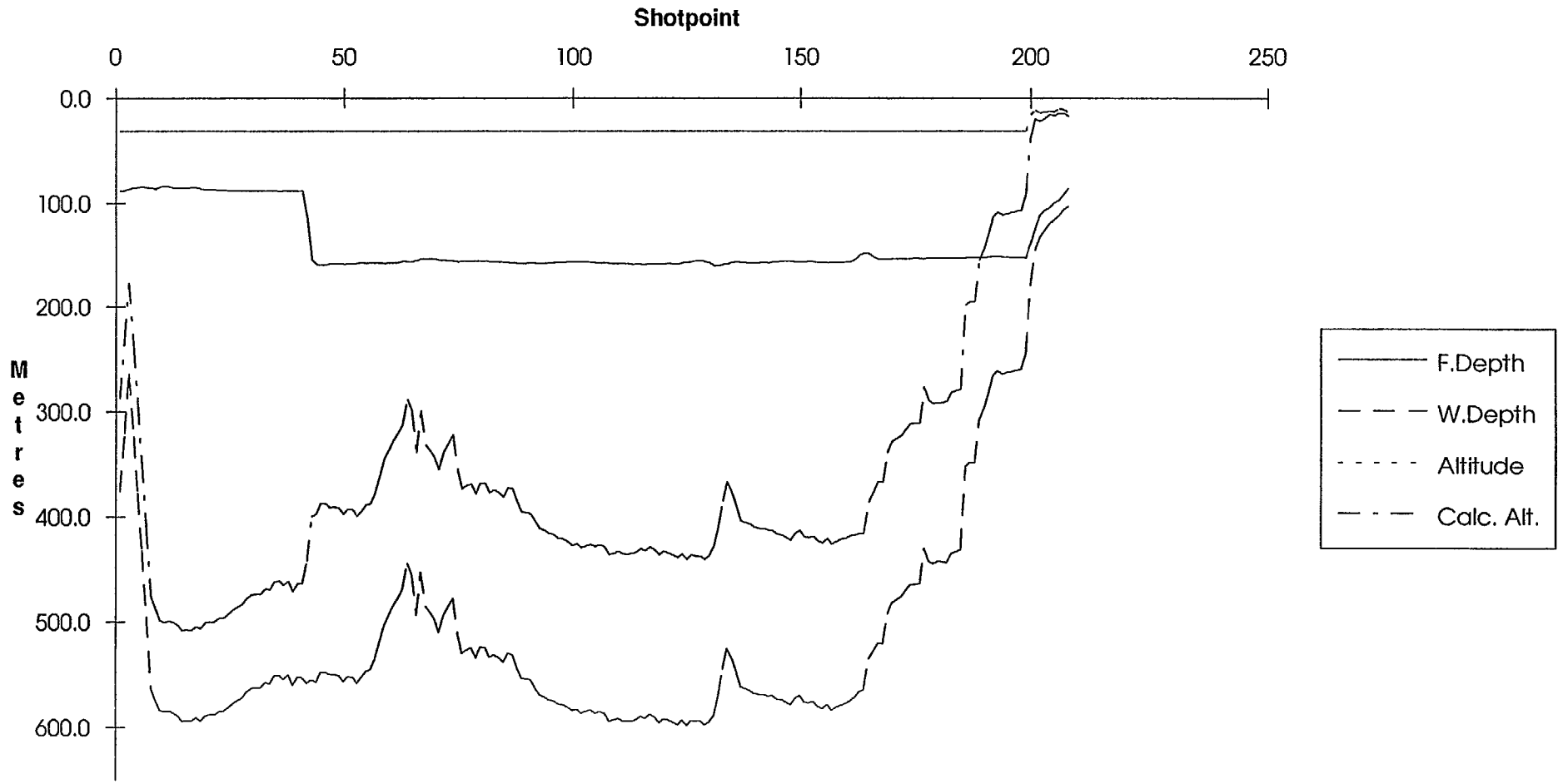
Notes

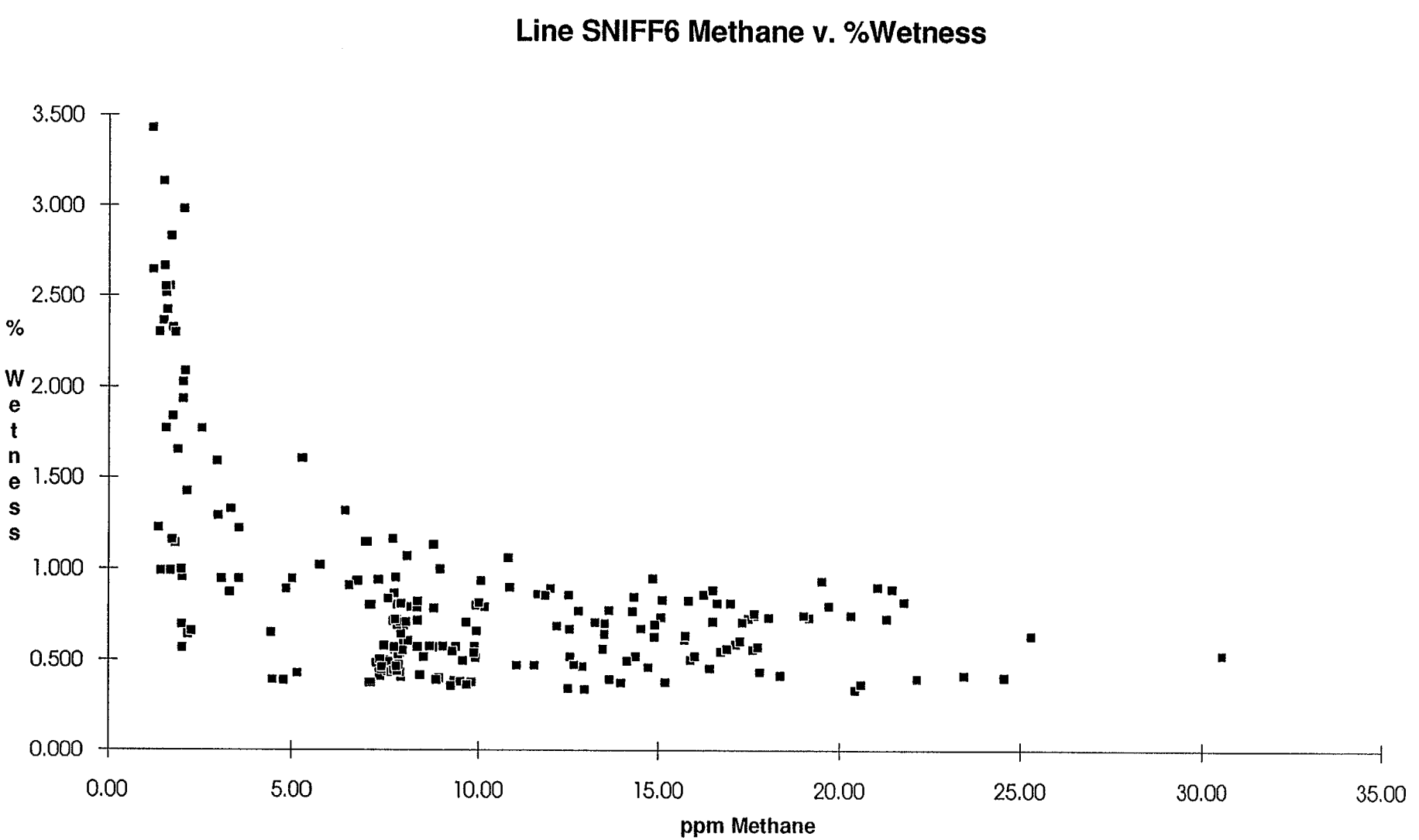
Six weak THC and methane anomalies can be seen at SP 50, SP 72, SP 92, SP 125, SP 112, and SP 190.
Five weak ethane and propane anomalies occur at SP 55, SP 75, SP 91, SP 165, and SP 185.
A weak propane anomaly is seen at SP 175.
Strong ethylene values prior to SP 45 and after SP 204 are probably related to thermoclinal influencs.


Line SNIFF6 THC, Methane
ppm Hydrocarbons
40.00
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00
0
50
100
150
200
250
Shotpoint
THC
Methane


Line SNIFF6 Ethane, Ethylene, Propane
ppm Hydrocarbons
0.160
0.140
0.120
0.100
0.080
0.060
0.040
0.020
0.000
0
50
100
150
200
250
Shotpoint
Ethane
Ethylene
Propane

Line SNIFF6 Depths, Altitudes




Line SNIFF6 Methane v. %Wetness
3.500
3.000
2.500
2.000
1.500
1.000
0.500
0.000
% Wetness
0.00
5.00
10.00
15.00
20.00
25.00
30.00
35.00
ppm Methane

Line Summary

Line Number	109049
No. of Shotpoints	92

	Shotpoint	Date	Time	Latitude		Longitude	
Start	1	25-Apr-92	22:35:12	13	14.715	123	12.067
End	92	26-Apr-92	01:38:50	13	07.339	123	04.450

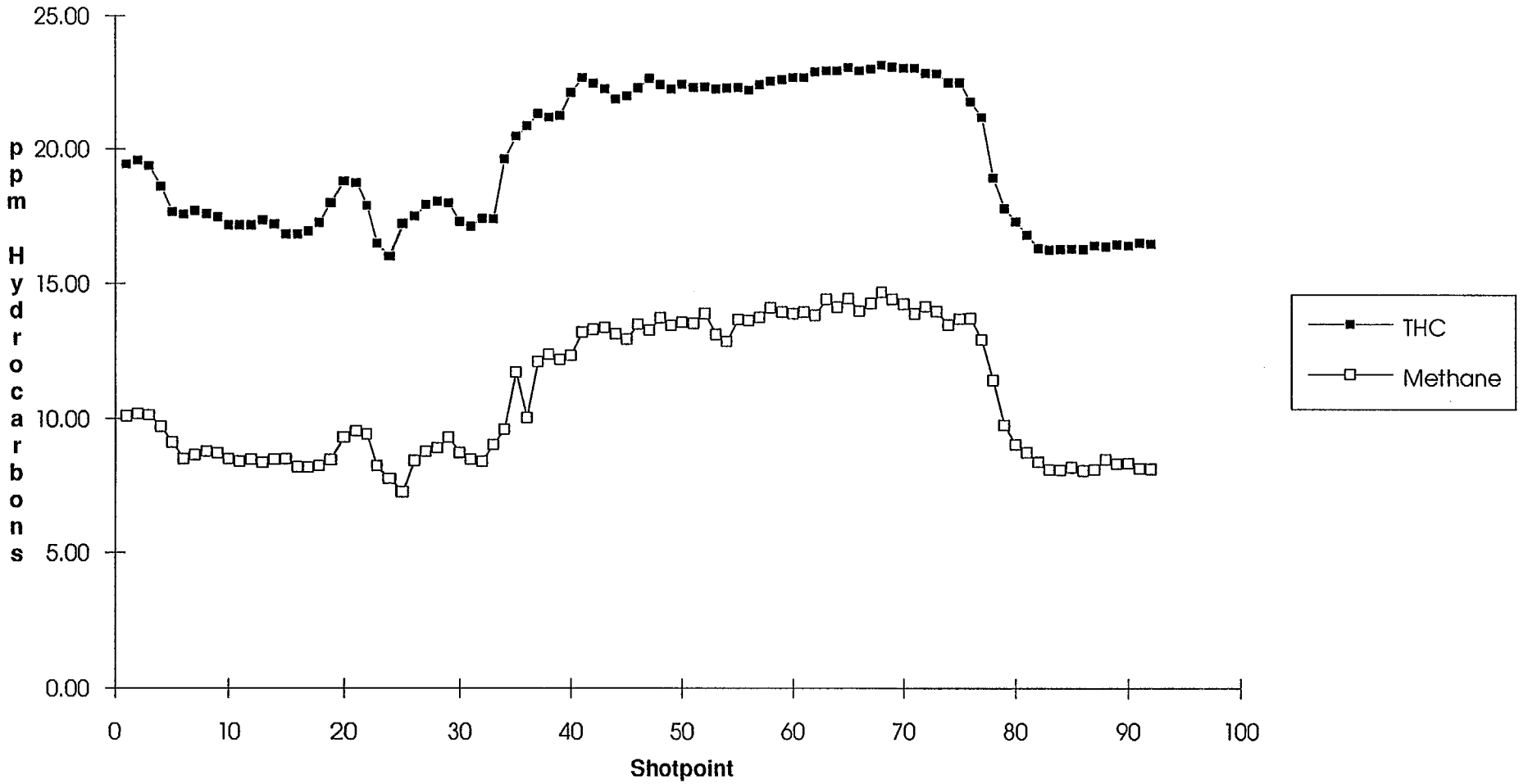
	THC	Methane	Ethane	Ethylene	Propane	Propylene	I-Butane	n-Butane	I-Pentane	n-Pentane	I-Hexane	n-Hexane	%Wetness
Mean	19.718	10.949	0.024	0.115	0.020	0.049	0.000	0.000	0.000	0.085	0.010	0.020	0.439
Std. Dev.	2.602	2.505	0.007	0.062	0.009	0.024	0.002	0.000	0.000	0.037	0.004	0.012	0.214
Minimum	16.045	7.266	0.013	0.042	0.007	0.015	0.000	0.000	0.000	0.045	0.000	0.000	0.195
Maximum	23.150	14.683	0.041	0.203	0.047	0.105	0.017	0.000	0.000	0.151	0.018	0.038	0.948

	Cond.	Temp.	F. Depth	W.Depth	Altitude	Calc. Alt.
Mean	57.703	24.757	91.147	104.826	12.823	13.691
Std. Dev.	1.652	1.094	27.968	27.914	1.623	2.349
Minimum	55.440	23.240	52.600	63.800	9.700	8.100
Maximum	59.900	26.220	124.800	141.000	19.800	19.700

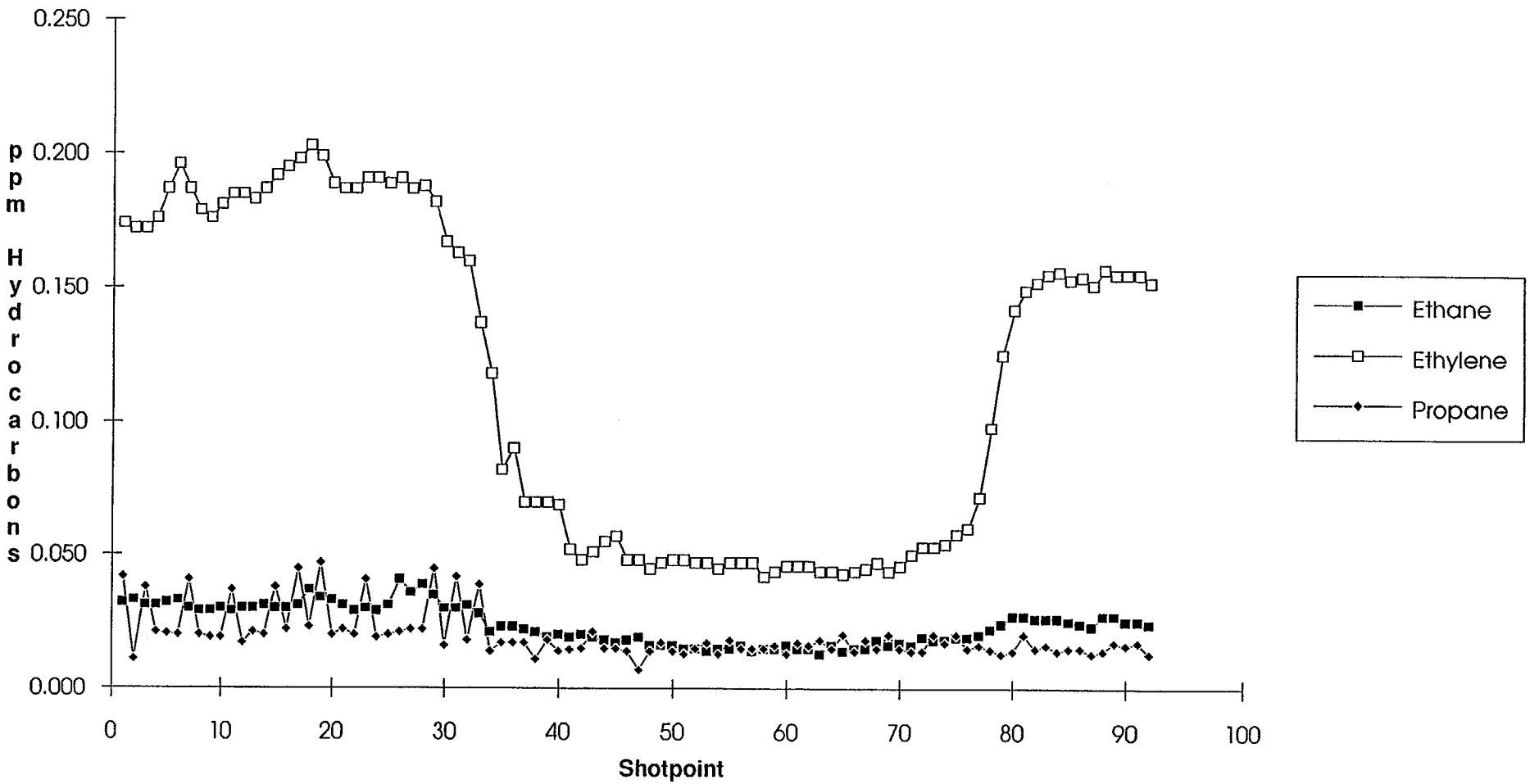
Notes

A weak THC and methane anomaly occurs between SP 33 and SP 77, the high ethylene values before and after these SP's maybe related to biogenic hydrocarbons in the surface waters.

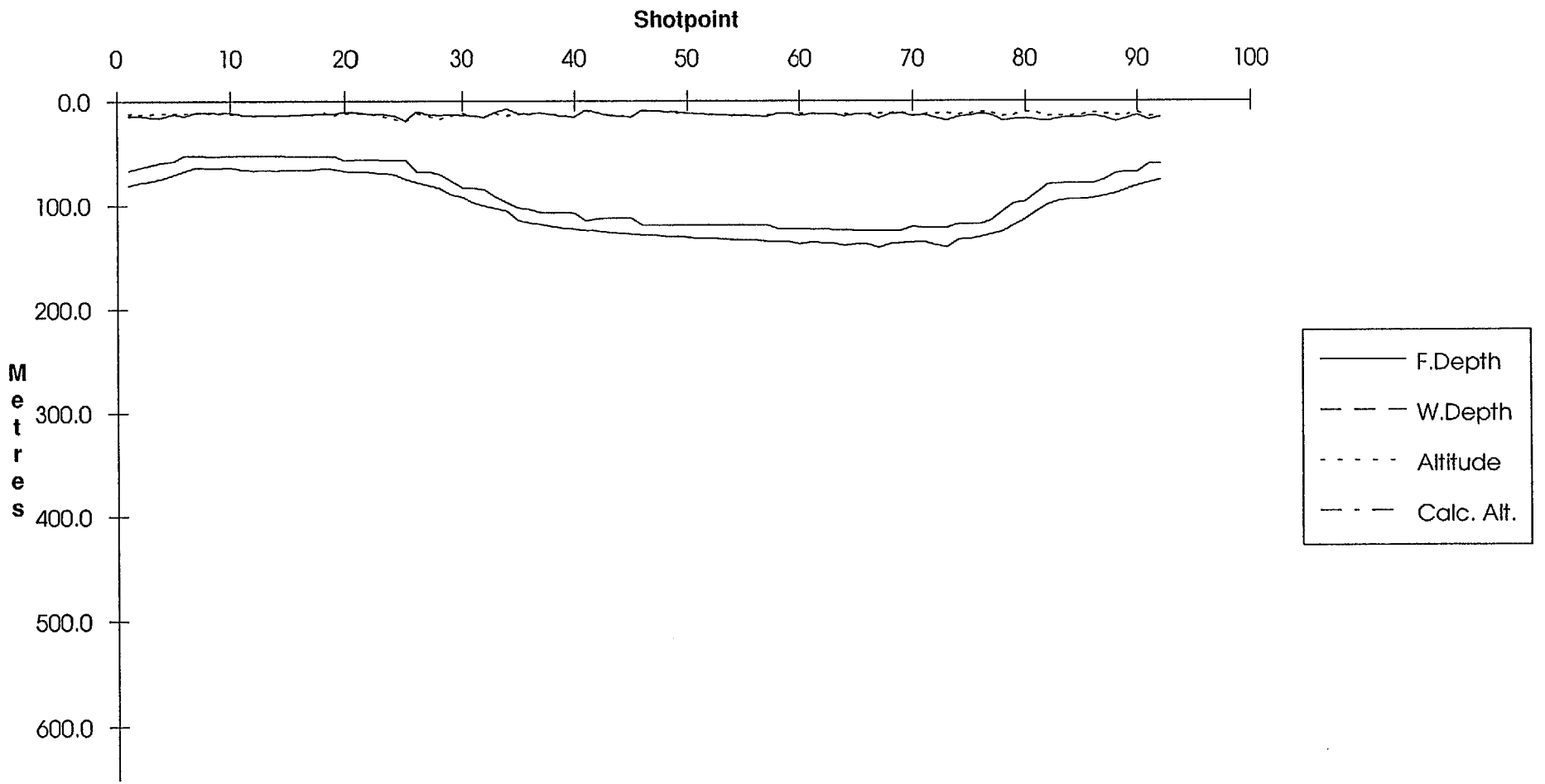
Line 109049 THC, Methane



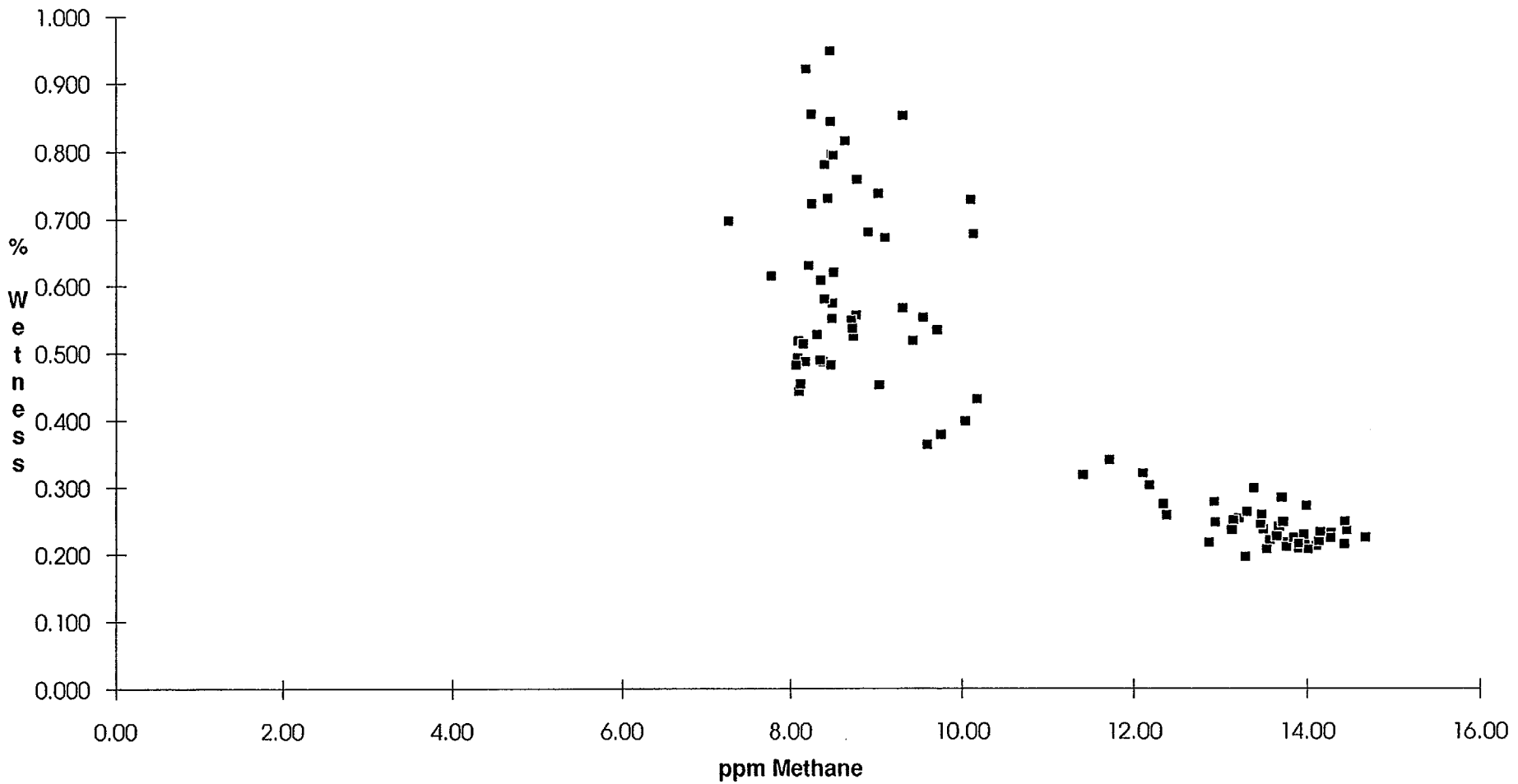
Line 109049 Ethane, Ethylene, Propane



Line 109049 Depths, Altitudes



Line 109049 Methane v. %Wetness



Line Summary

Line Number	109050
No. of Shotpoints	73

	Shotpoint	Date	Time	Latitude		Longitude	
Start	1	26-Apr-92	01:40:49	13	07.469	123	04.363
End	73	26-Apr-92	04:05:57	13	14.994	123	12.740

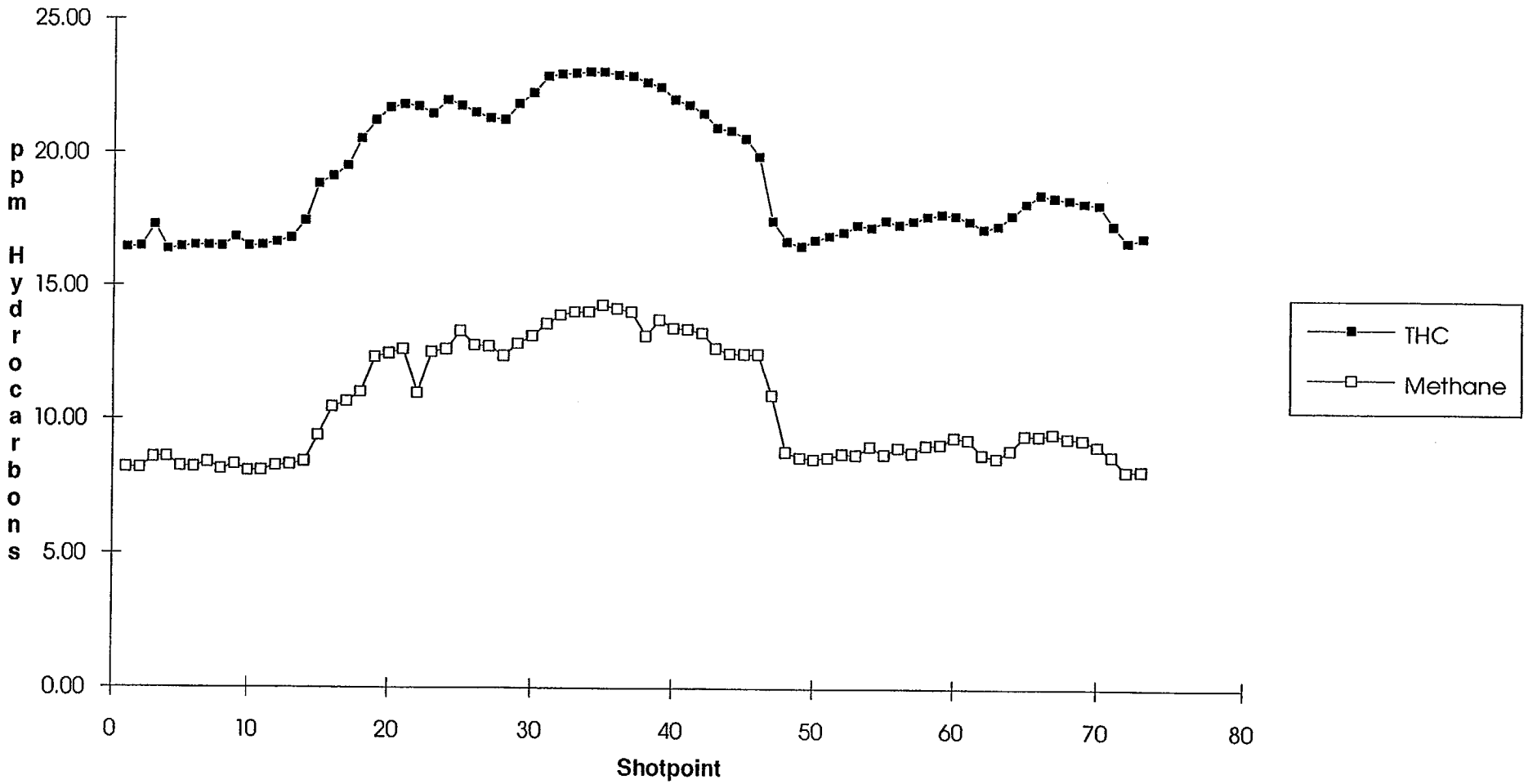
	THC	Methane	Ethane	Ethylene	Propane	Propylene	I-Butane	n-Butane	I-Pentane	n-Pentane	I-Hexane	n-Hexane	%Wetness
Mean	19.131	10.482	0.024	0.120	0.016	0.043	0.000	0.000	0.000	0.086	0.008	0.022	0.404
Std. Dev.	2.371	2.180	0.005	0.052	0.003	0.017	0.001	0.000	0.000	0.033	0.004	0.011	0.133
Minimum	16.367	8.065	0.012	0.039	0.008	0.010	0.000	0.000	0.000	0.045	0.000	0.000	0.158
Maximum	23.049	14.301	0.034	0.203	0.025	0.079	0.011	0.000	0.000	0.183	0.017	0.043	0.695

	Cond.	Temp.	F. Depth	W.Depth	Altitude	Calc. Alt.
Mean	58.595	25.367	90.110	103.747	12.675	13.645
Std. Dev.	1.525	1.012	21.366	21.076	1.503	2.615
Minimum	56.300	23.850	53.000	65.800	9.800	7.800
Maximum	60.520	26.650	118.400	130.300	18.000	25.900

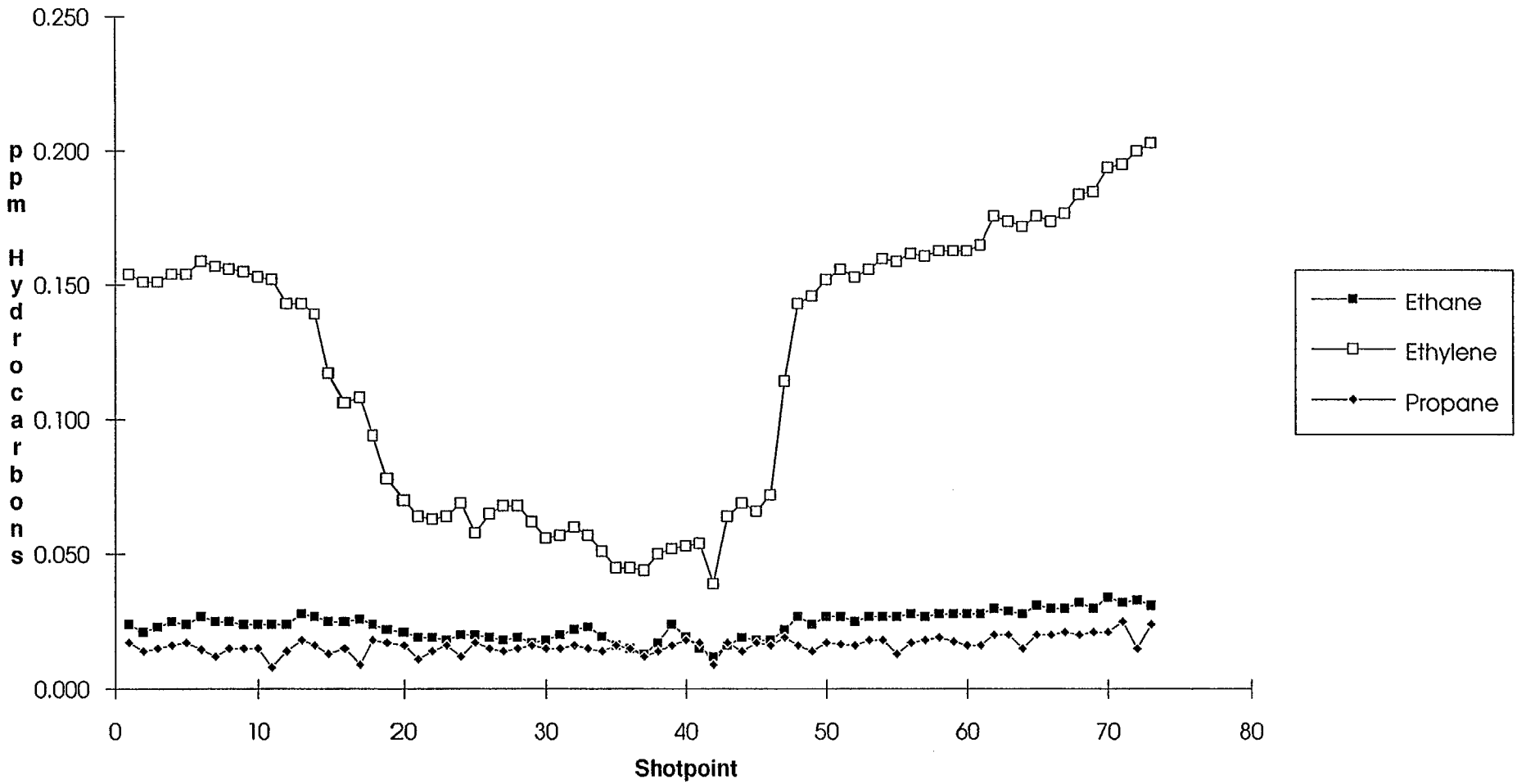
Notes

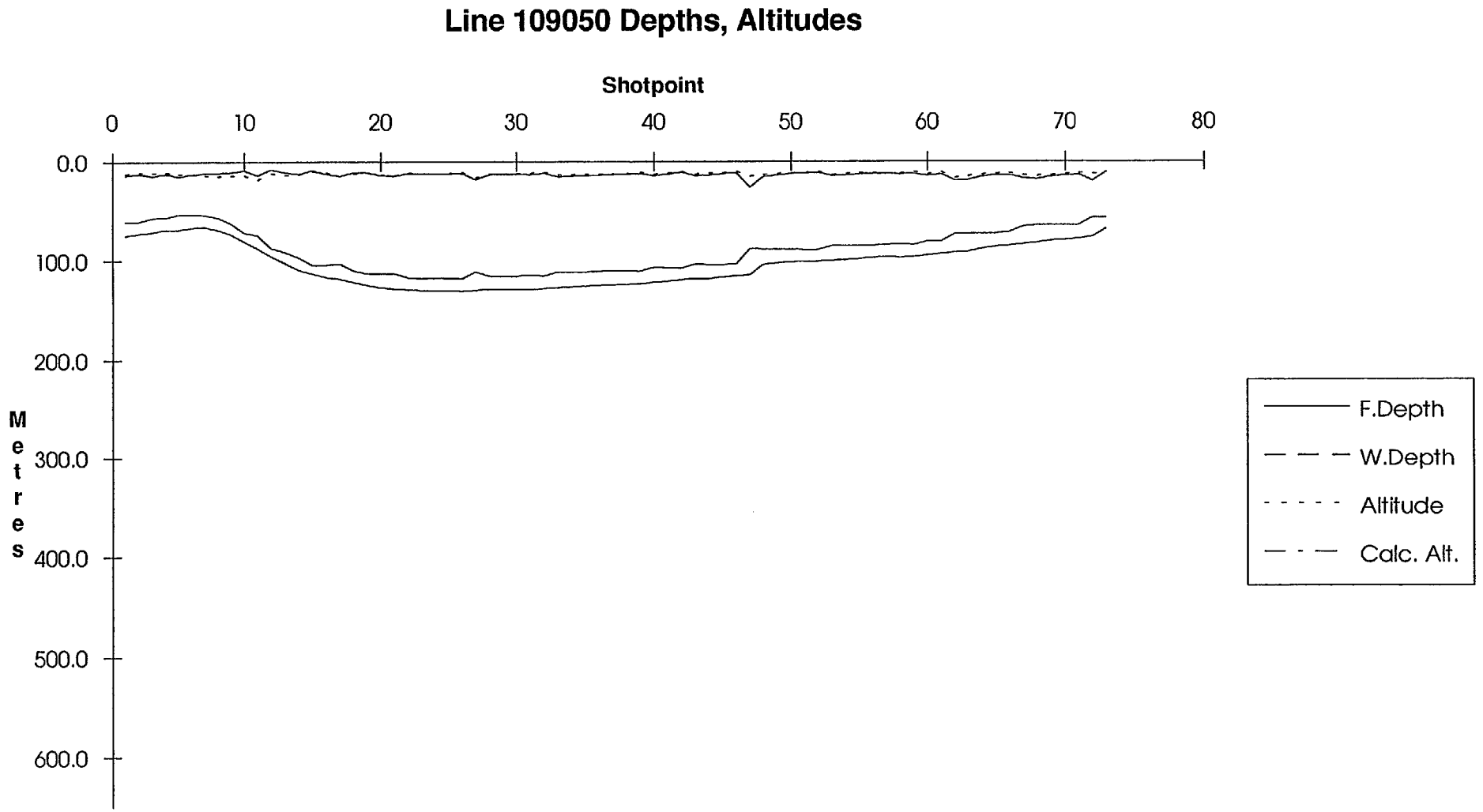
A weak THC and methane anomaly occurs between SP 15 and SP 47.
Higher levels of ethylene before SP 15 and after SP 47 are detected as the fish passes through surface waters.

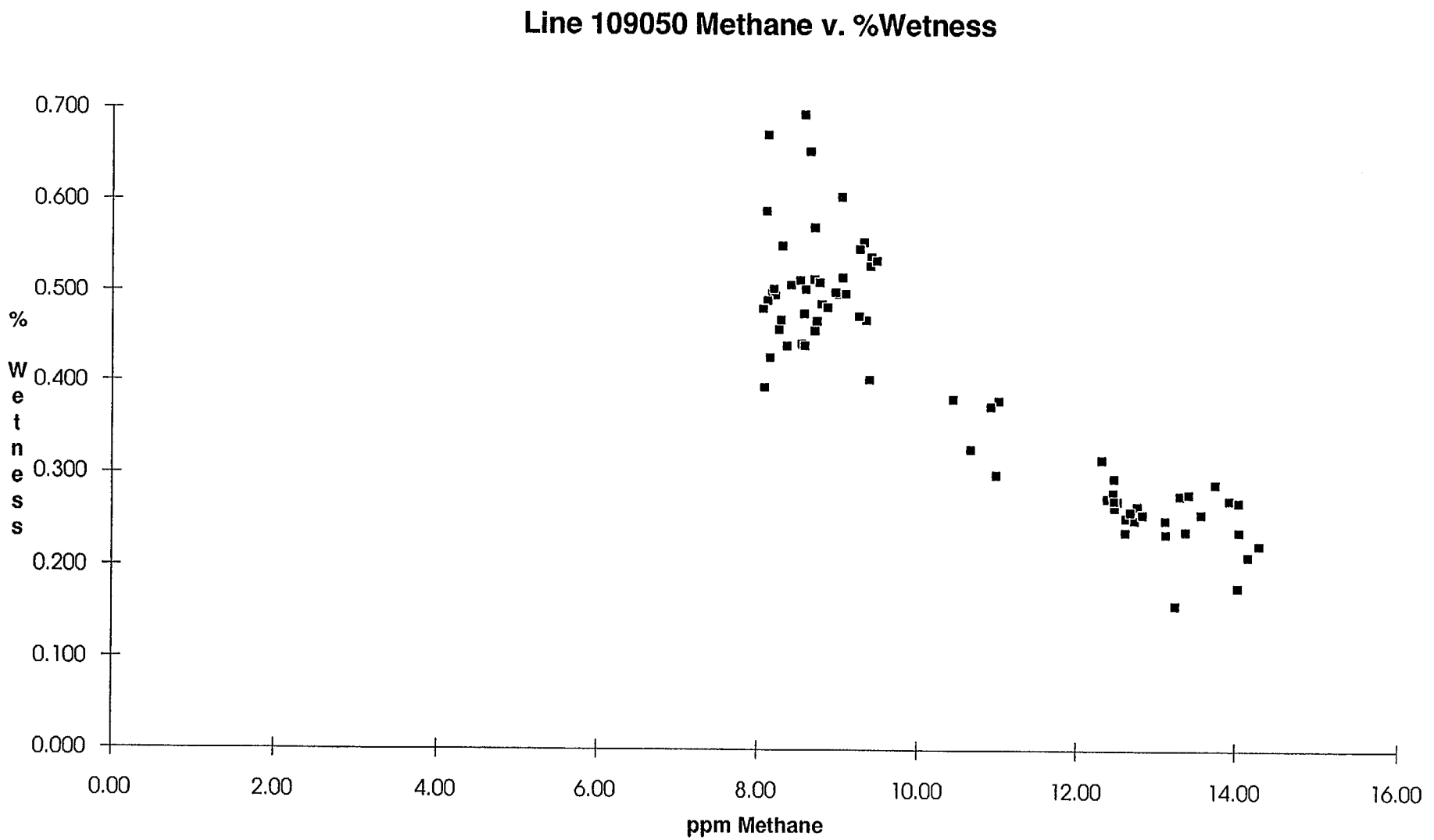
Line 109050 THC, Methane



Line 109050 Ethane, Ethylene, Propane




Line 109050 Depths, Altitudes
Shotpoint
0
10
20
30
40
50
60
70
80
0.0
100.0
200.0
300.0
400.0
500.0
600.0
Metres
F.Depth
W.Depth
Altitude
Calc. Alt.


Line 109050 Methane v. %Wetness
0.700
0.600
0.500
0.400
0.300
0.200
0.100
0.000
% Wetness
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
16.00
ppm Methane

Line Summary

Line Number	109051
No. of Shotpoints	124

	Shotpoint	Date	Time	Latitude		Longitude	
Start	1	26-Apr-92	04:07:56	13	15.114	123	12.859
End	125	26-Apr-92	08:21:38	13	16.247	123	05.882

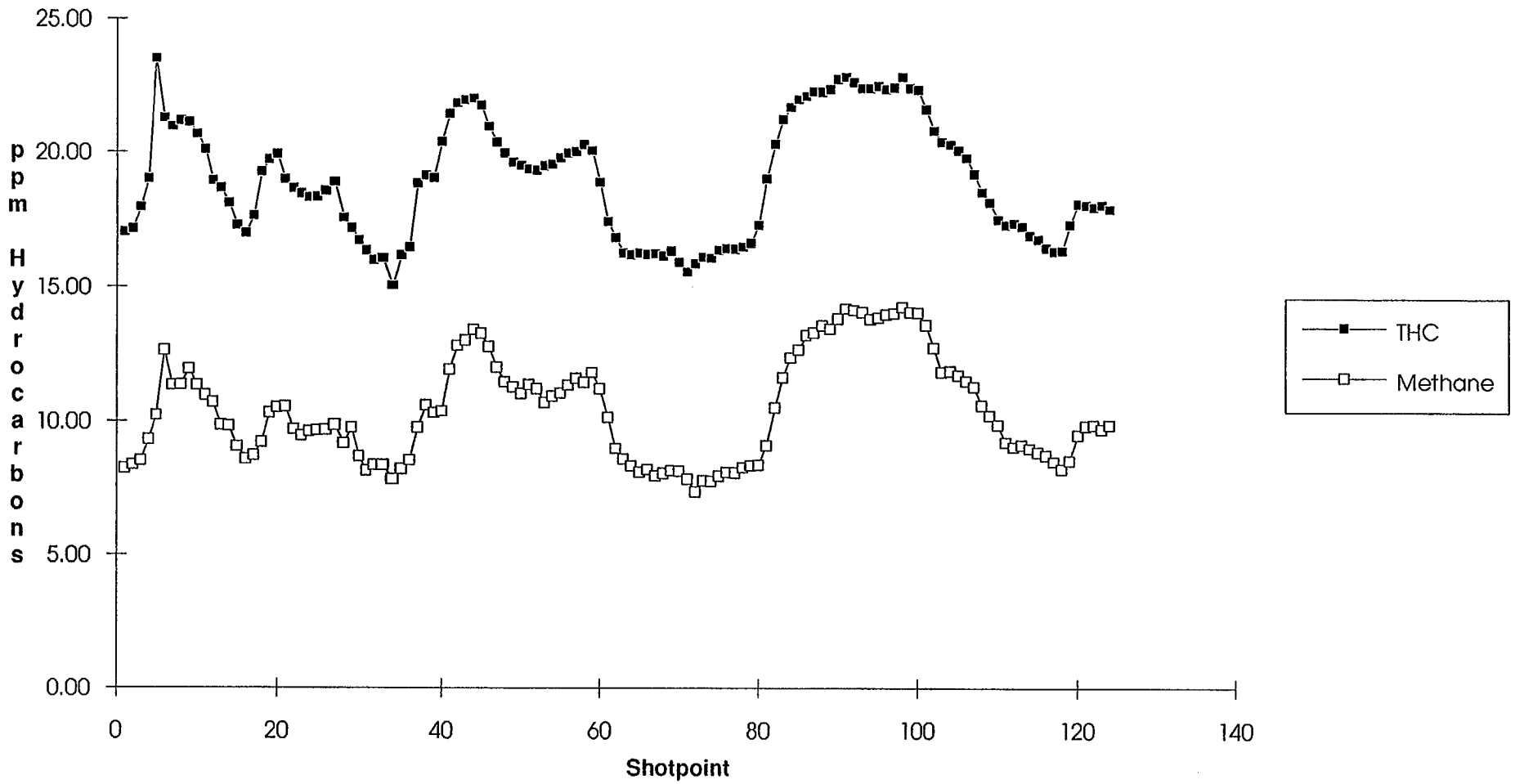
	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	19.002	10.438	0.027	0.121	0.017	0.039	0.003	0.001	0.000	0.085	0.011	0.024	0.476
Std. Dev.	2.200	1.951	0.009	0.043	0.007	0.015	0.018	0.005	0.001	0.023	0.004	0.011	0.206
Minimum	15.061	7.357	0.016	0.045	0.006	0.000	0.000	0.000	0.000	0.049	0.000	0.000	0.203
Maximum	23.505	14.264	0.063	0.202	0.059	0.084	0.189	0.030	0.005	0.148	0.023	0.046	1.637

	Cond.	Temp.	F. Depth	W.Depth	Altitude	Calc. Alt.
Mean	59.116	25.754	93.062	108.089	14.038	15.132
Std. Dev.	1.298	0.857	19.860	18.038	3.949	4.314
Minimum	56.590	24.100	45.000	67.800	9.700	8.700
Maximum	60.960	27.000	116.700	132.100	28.900	31.000

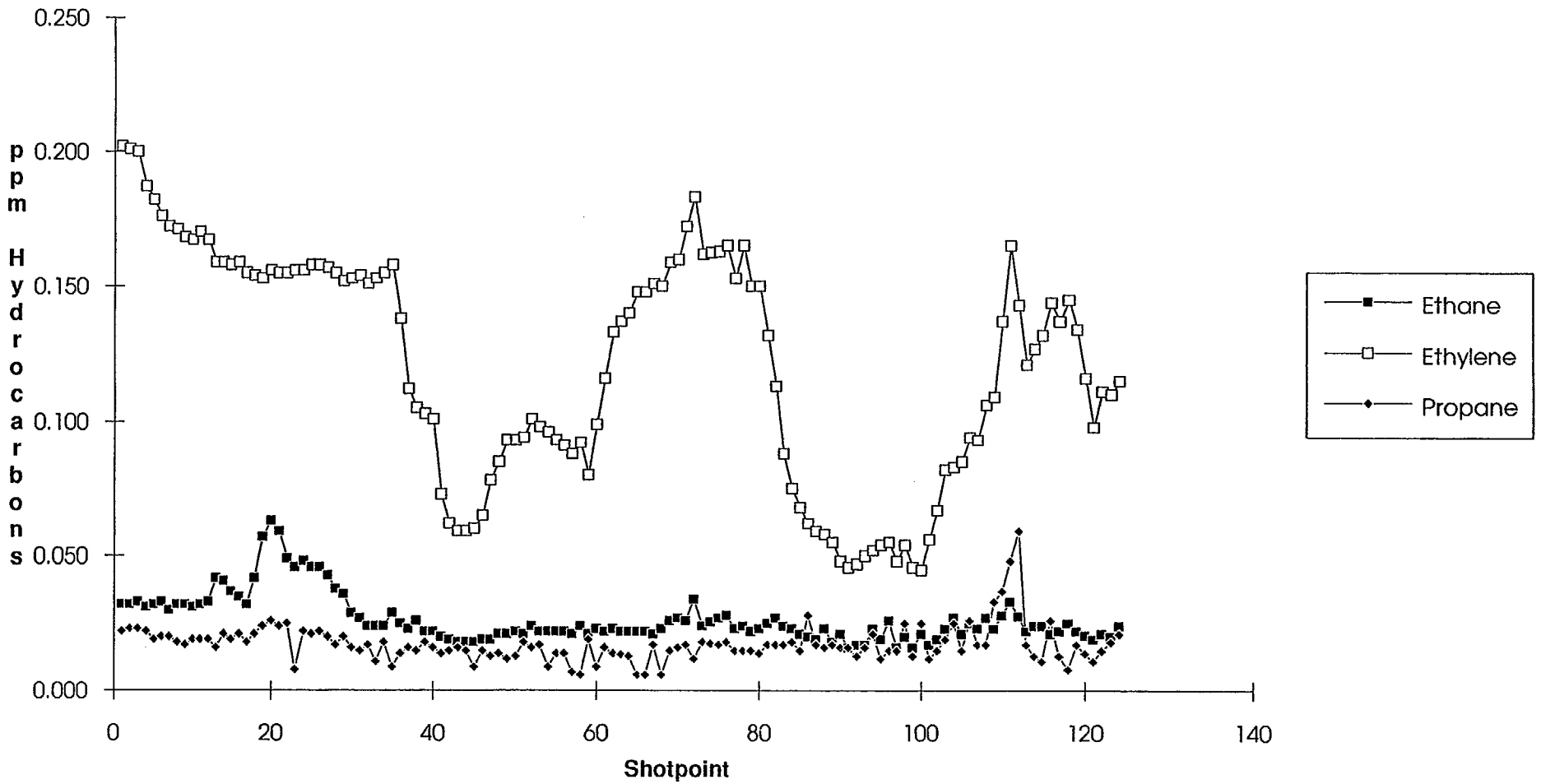
Notes

Four weak to very weak THC anomalies occur at SP 6, SP 19, SP 40 and SP 83.
A very weak ethane anomaly occurs at SP 19.
Ethylene values before SP 37, between SP 62 and SP 77 and after SP 100 reflect strongly the biogenic origin of this hydrocarbon in the surface waters.

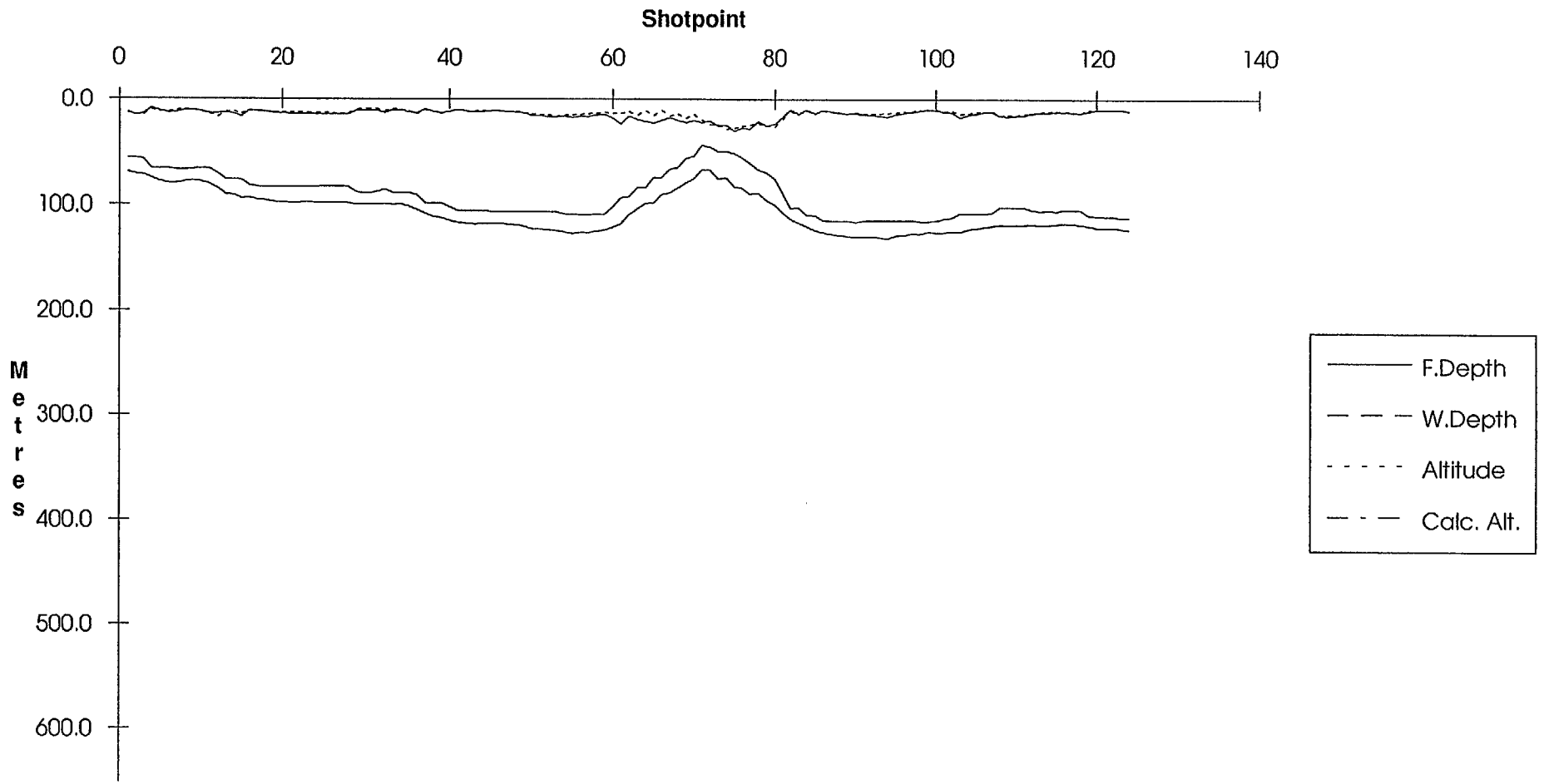
Line 109051 THC, Methane



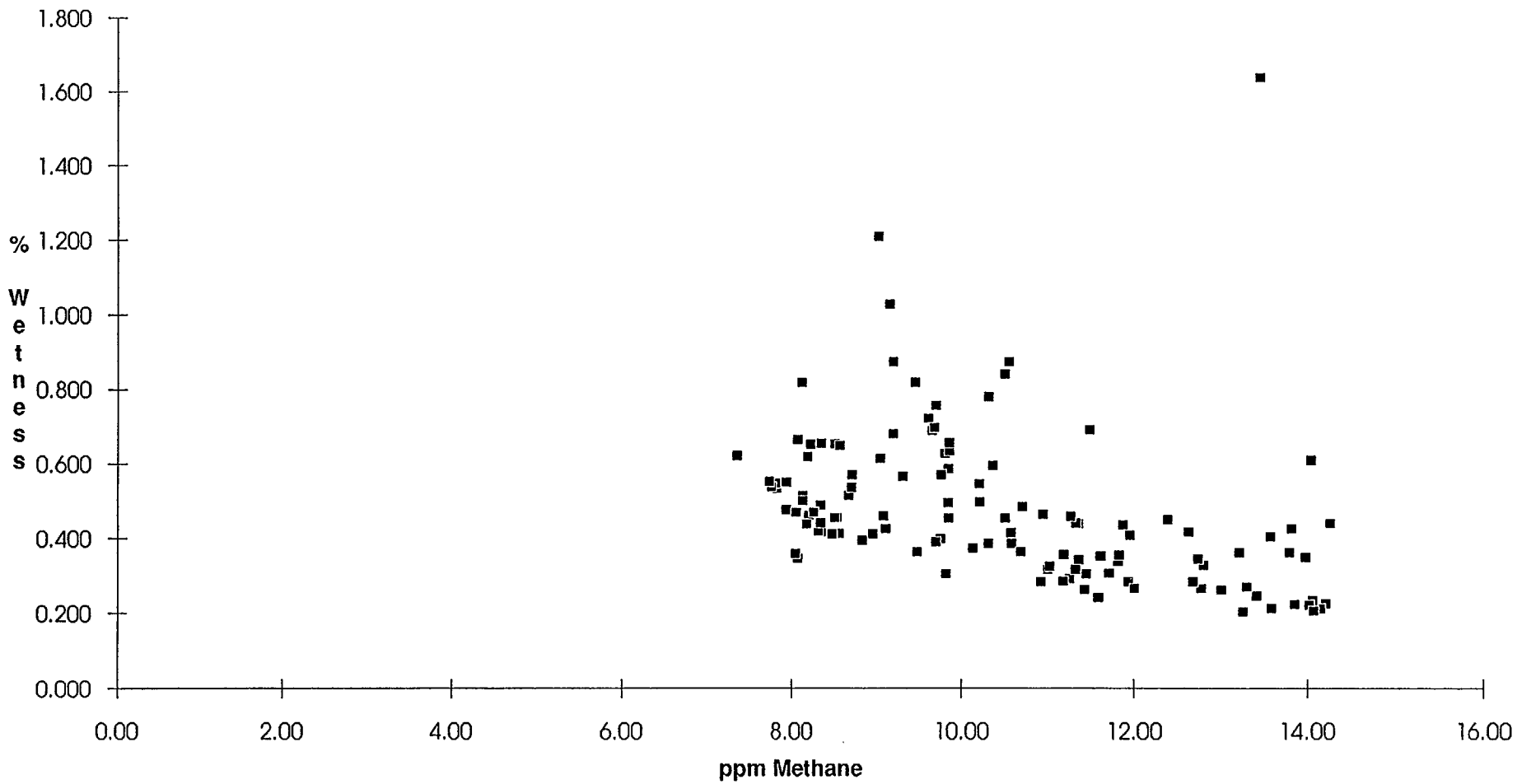
Line 109051 Ethane, Ethylene, Propane



Line 109051 Depths, Altitudes



Line 109051 Methane v. %Wetness



Line Summary

Line Number	109052
No. of Shotpoints	50

	Shotpoint	Date	Time	Latitude		Longitude	
Start	1	26-Apr-92	08:23:38	13	16.412	123	05.884
End	50	26-Apr-92	10:04:01	13	18.802	123	11.580

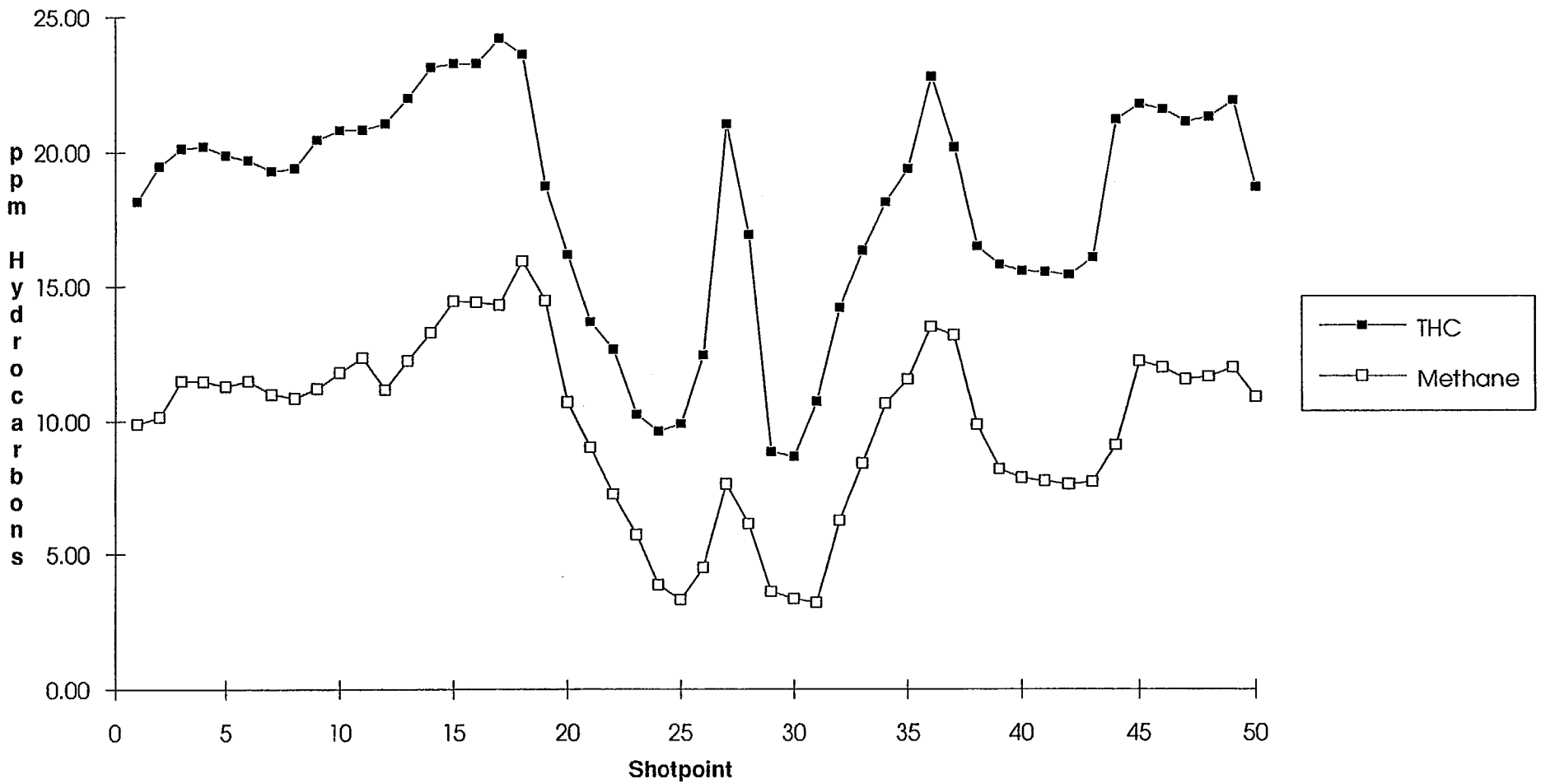
	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	18.032	9.861	0.028	0.074	0.021	0.024	0.004	0.000	0.000	0.067	0.008	0.025	0.564
Std. Dev.	4.239	3.282	0.011	0.054	0.011	0.017	0.008	0.001	0.001	0.027	0.005	0.012	0.213
Minimum	8.648	3.178	0.009	0.011	0.003	0.000	0.000	0.000	0.000	0.034	0.000	0.000	0.221
Maximum	24.174	15.961	0.057	0.175	0.050	0.060	0.041	0.004	0.006	0.121	0.020	0.041	1.226

	Cond.	Temp.	F. Depth	W.Depth	Altitude	Calc. Alt.
Mean	57.280	24.540	129.650	307.760	24.416	178.113
Std. Dev.	1.522	0.995	42.787	153.881	8.798	168.259
Minimum	55.310	23.260	62.000	124.900	9.800	6.800
Maximum	59.300	25.890	188.900	543.000	30.900	455.400

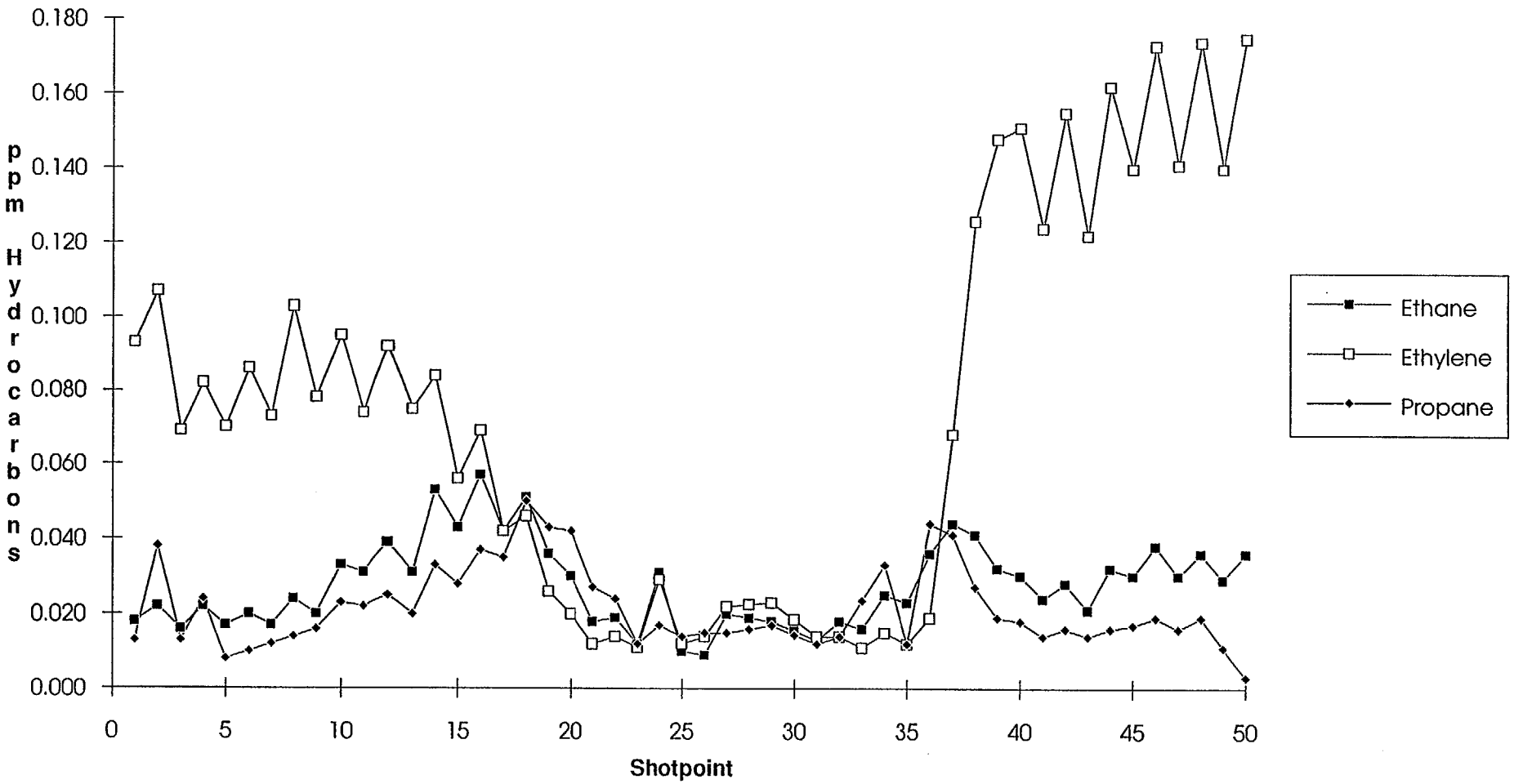
Notes

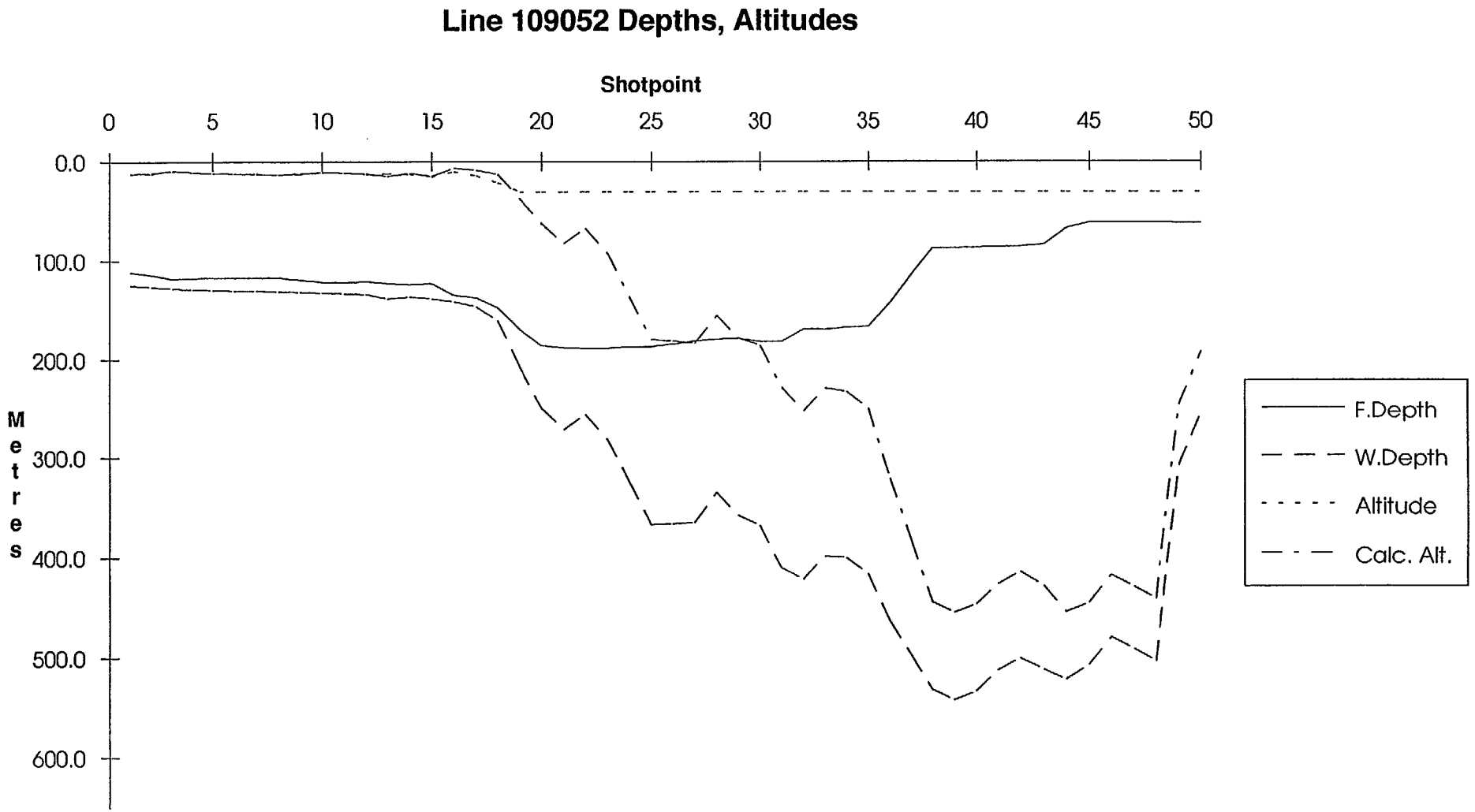
Three weak THC and methane anomalies occur at SP 17, SP 26, and SP 36,
A very weak ethane and propane anomaly occurs at SP 17.
Before SP 20 and after SP 36 hydrocarbon values are effected by the fish being lowered and then raised through the thermocline.

Line 109052 THC, Methane

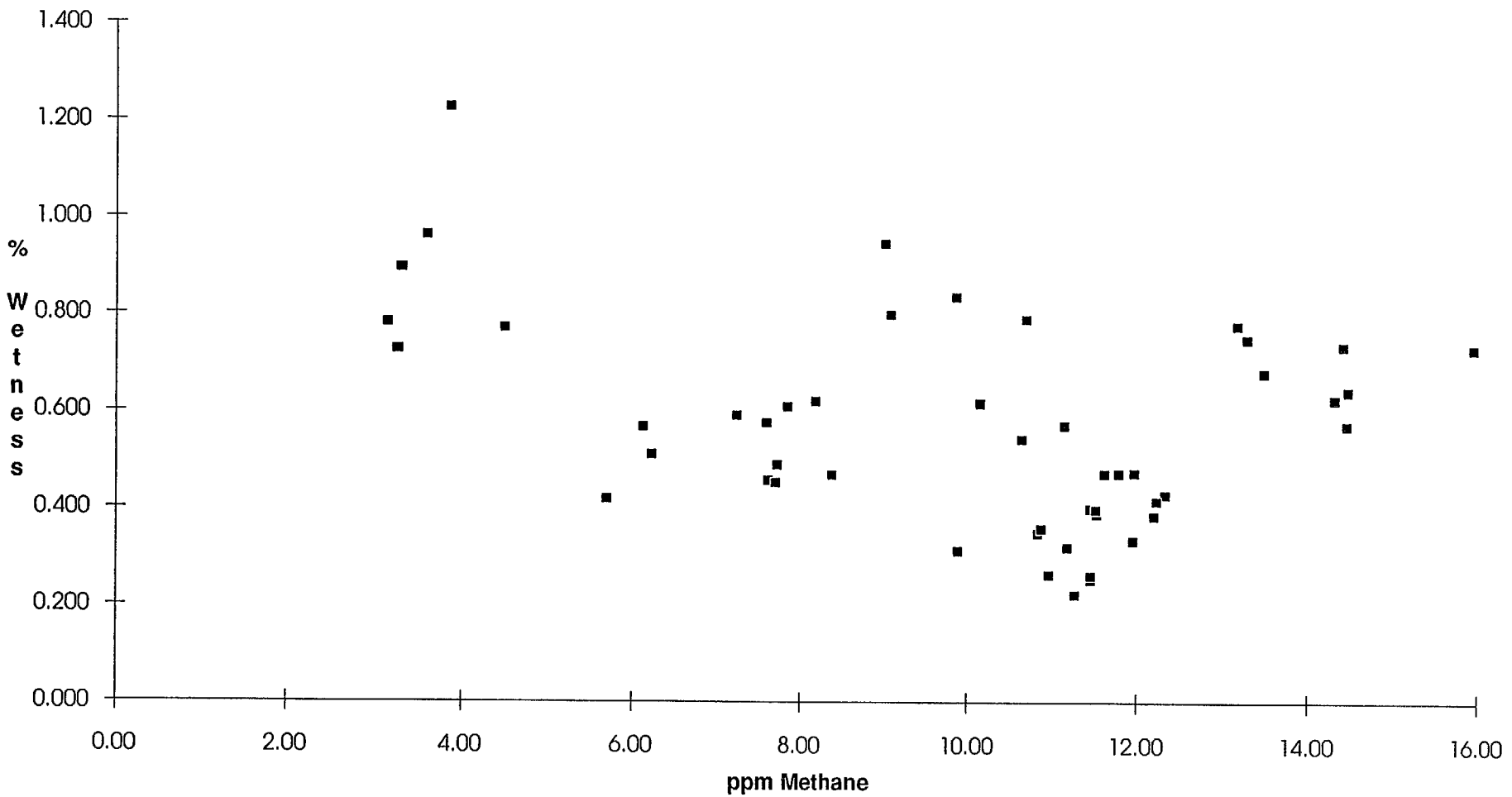


Line 109052 Ethane, Ethylene, Propane




Line 109052 Depths, Altitudes
Shotpoint
0
5
10
15
20
25
30
35
40
45
50
0.0
100.0
200.0
300.0
400.0
500.0
600.0
Metres
F.Depth
W.Depth
Altitude
Calc. Alt.

Line 109052 Methane v. %Wetness



Line Summary

Line Number	109053
No. of Shotpoints	77

	Shotpoint	Date	Time	Latitude		Longitude	
Start	1	26-Apr-92	10:06:00	13	18.635	123	11.578
End	77	26-Apr-92	12:39:59	13	17.913	123	01.052

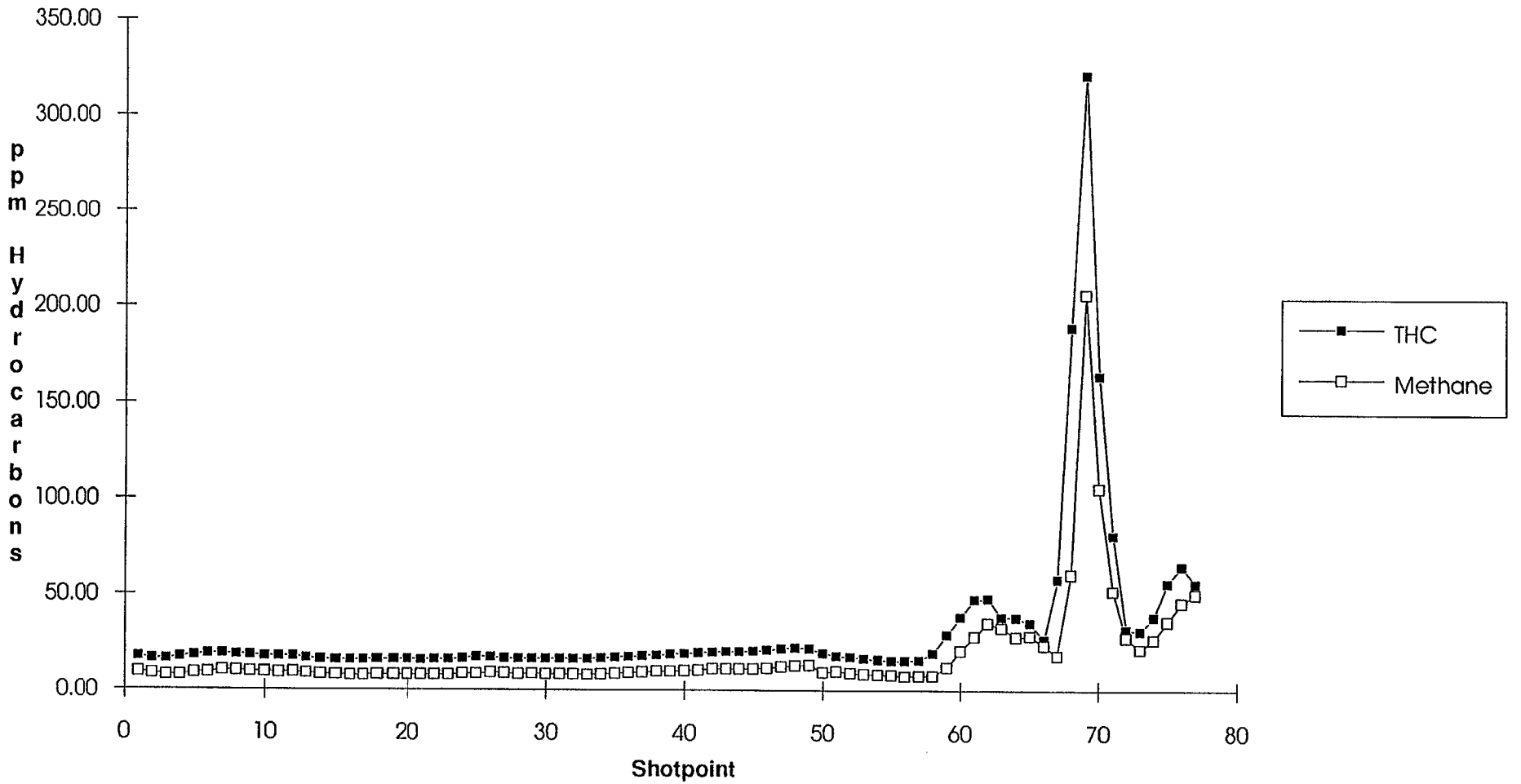
	THC	Methane	Ethane	Ethylene	Propane	Propylene	I-Butane	n-Butane	I-Pentane	n-Pentane	I-Hexane	n-Hexane	%Wetness
Mean	31.448	18.171	0.032	0.100	0.025	0.033	0.003	0.000	0.000	0.072	0.009	0.022	0.434
Std. Dev.	43.511	26.580	0.017	0.052	0.021	0.017	0.007	0.000	0.001	0.028	0.004	0.013	0.155
Minimum	15.678	7.618	0.013	0.011	0.008	0.005	0.000	0.000	0.000	0.026	0.000	0.000	0.049
Maximum	321.450	206.163	0.106	0.176	0.131	0.066	0.033	0.000	0.007	0.127	0.017	0.040	0.790

	Cond.	Temp.	F. Depth	W.Depth	Altitude	Calc. Alt.
Mean	57.330	24.556	118.357	137.224	14.930	19.125
Std. Dev.	1.491	0.970	33.477	31.261	5.484	22.579
Minimum	54.750	22.840	61.500	93.600	9.000	6.200
Maximum	59.260	25.840	191.300	223.100	30.900	160.900

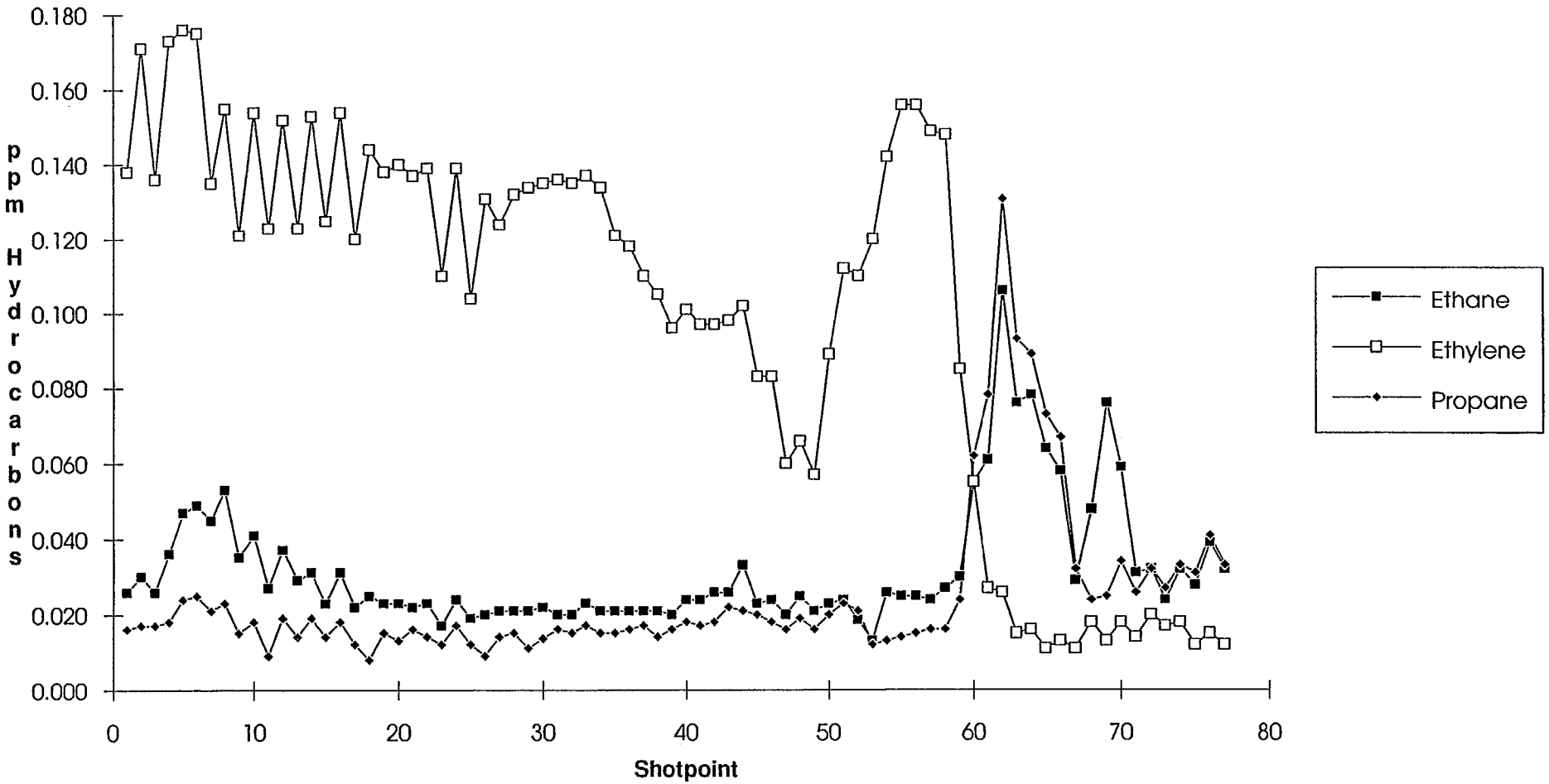
Notes

A strong THC and methane anomaly occurs at SP 69, with a corrispondingly weak ethane anomaly.
A weak THC and methane, along with a moderate ethane and propane anomaly occurs at SP 62.
Ethylene and other hydrocarbon values are subject to thermoclinal influence before SP 60.
A gas sample was taken for carbon isotope analysis from SP 62 to SP 76.

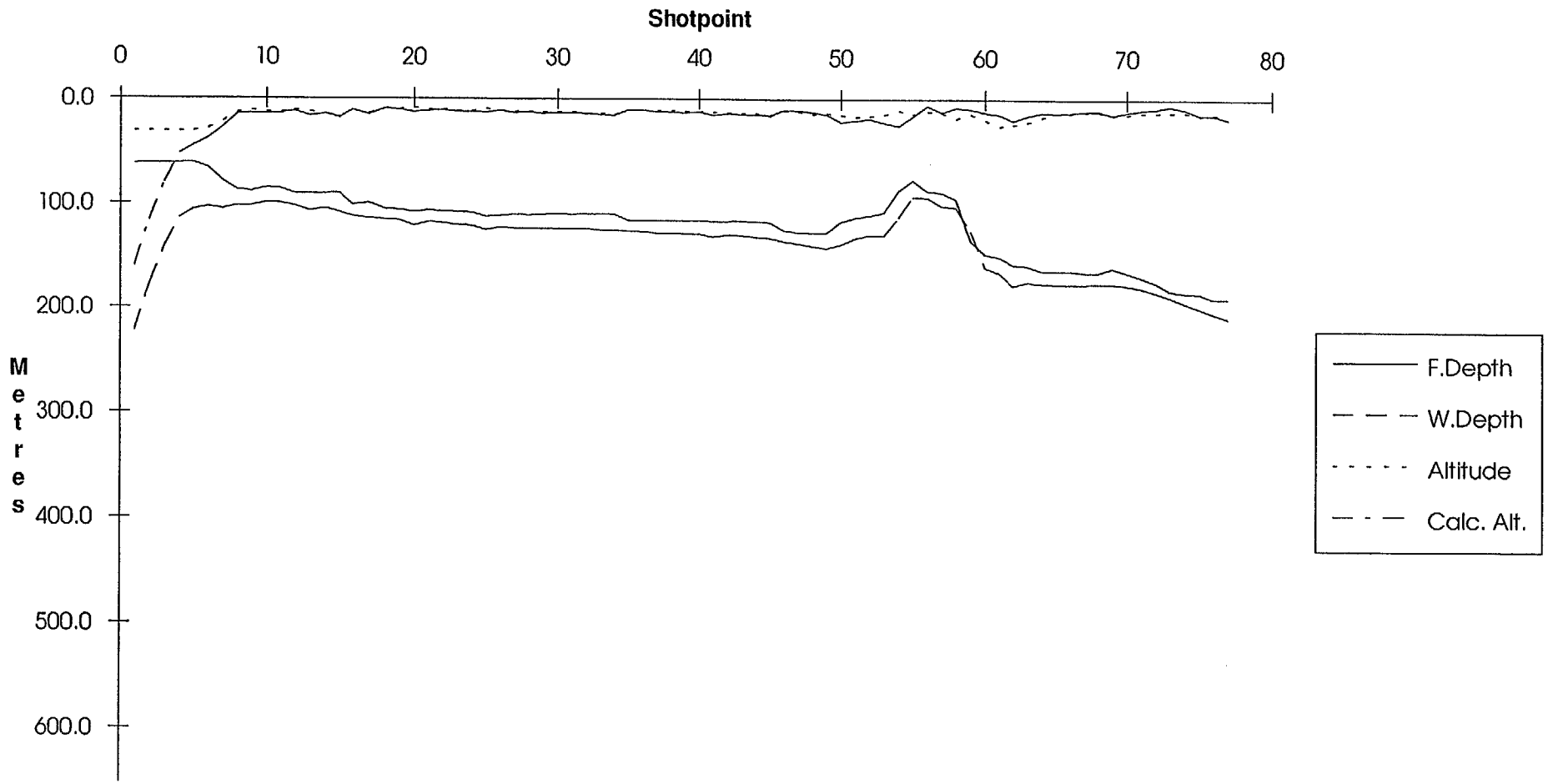
Line 109053 THC, Methane



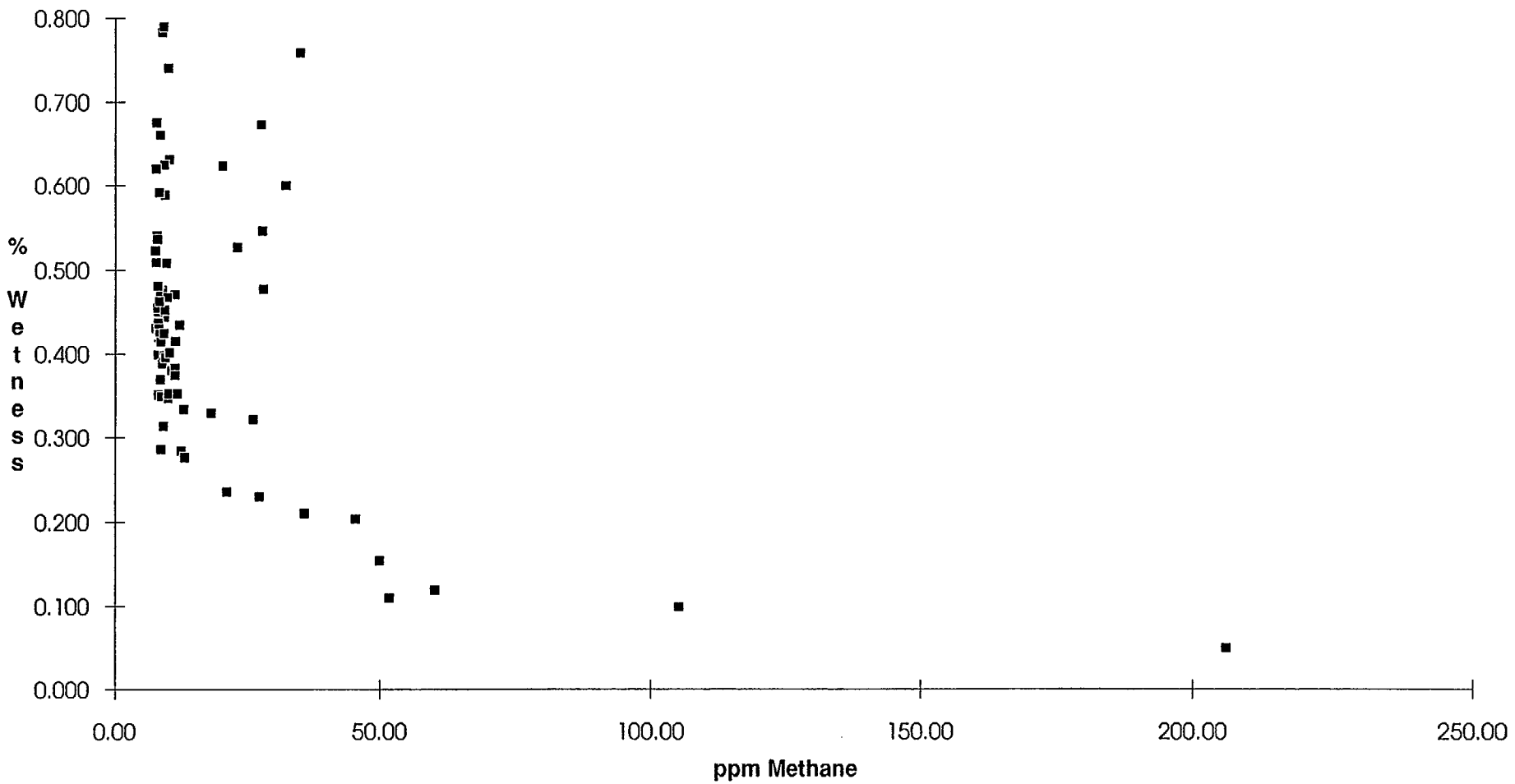
Line 109053 Ethane, Ethylene, Propane



Line 109053 Depths, Altitudes



Line 109053 Methane v. %Wetness



Line Summary

Line Number	sniff7
No. of Shotpoints	292

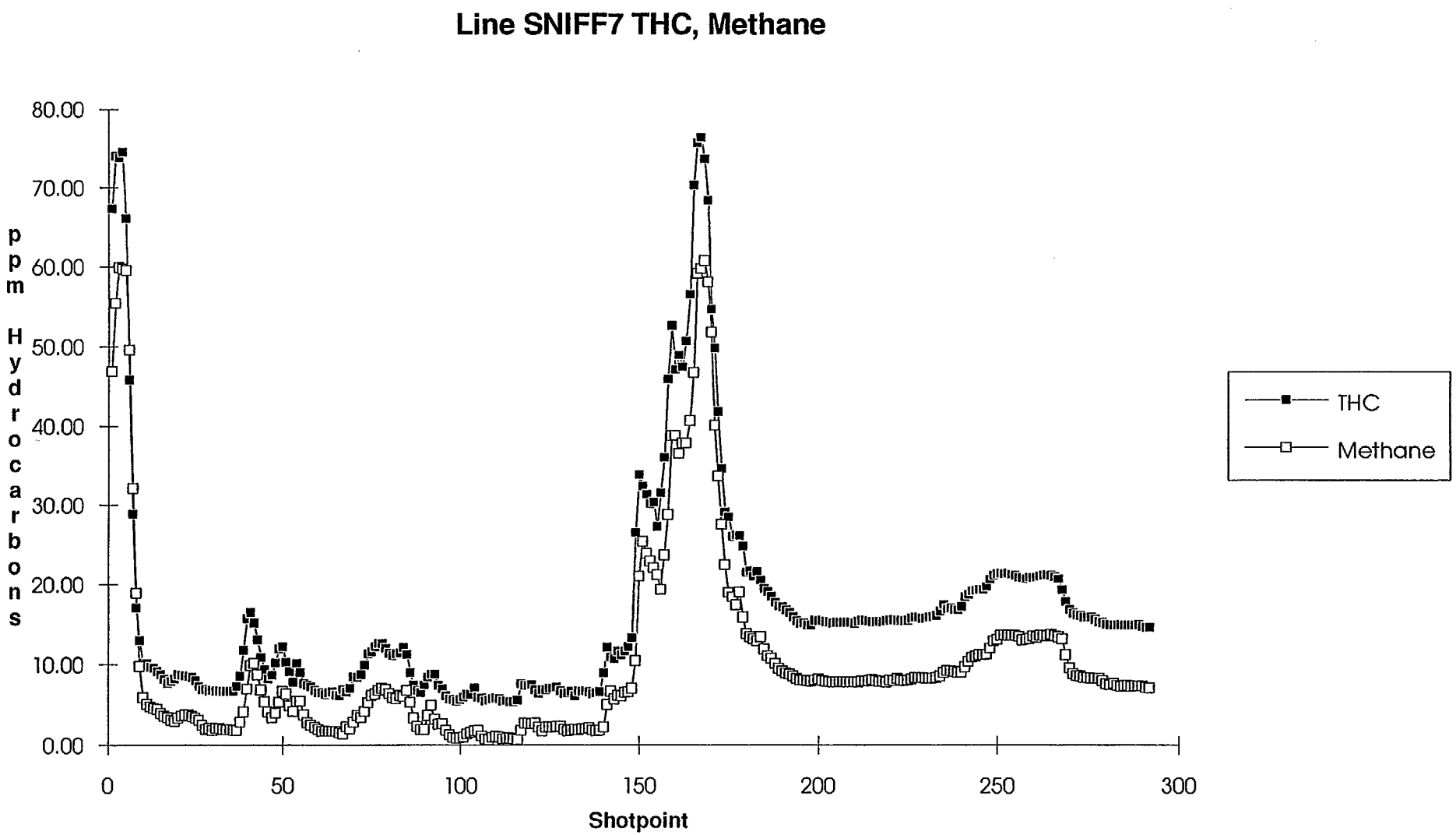
	Shotpoint	Date	Time	Latitude		Longitude	
Start	1	26-Apr-92	12:42:17	13	18.074	123	01.184
End	293	26-Apr-92	22:40:51	13	03.591	123	15.557

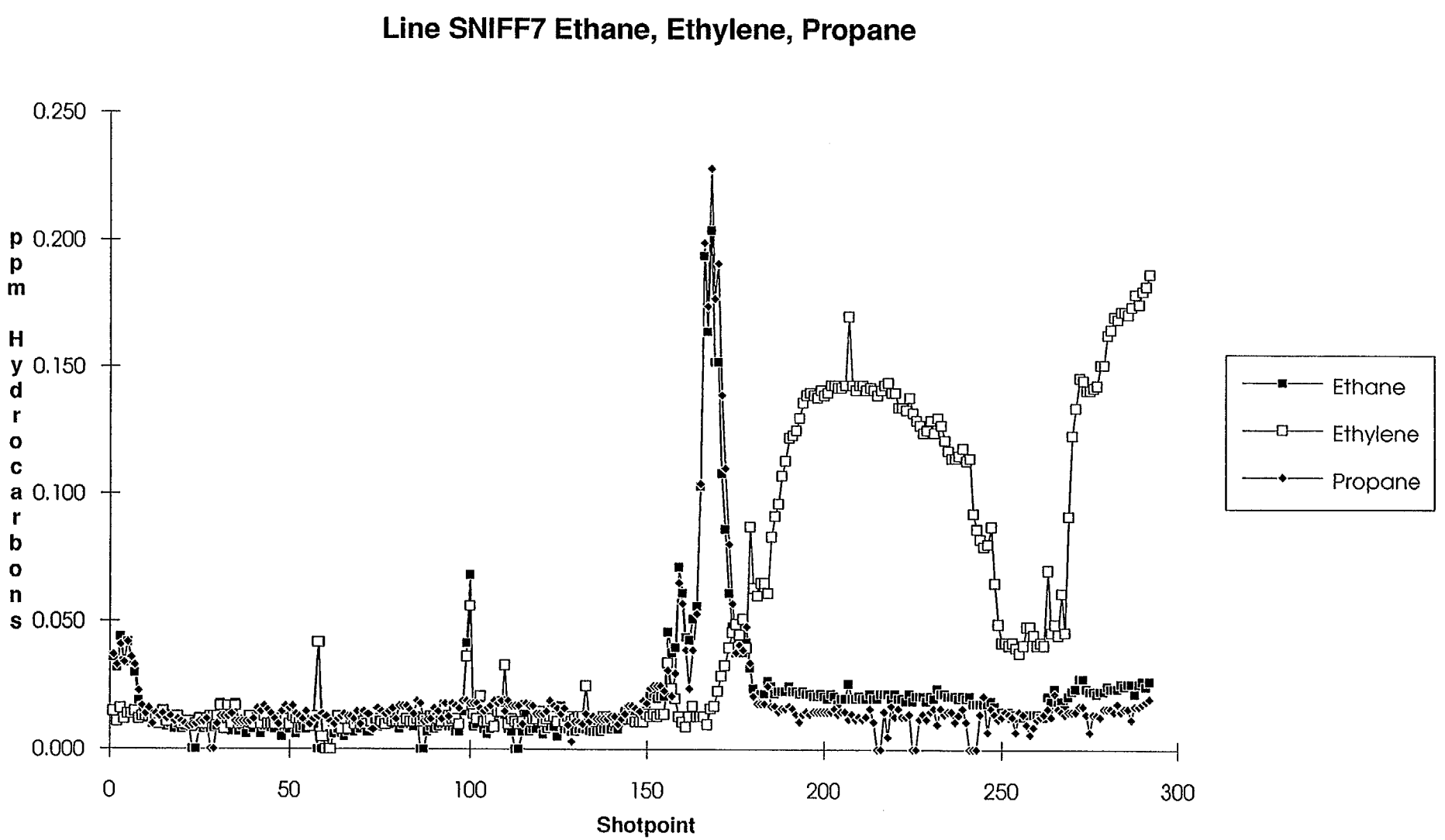
	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	16.729	10.099	0.021	0.054	0.020	0.021	0.004	0.000	0.001	0.049	0.005	0.017	0.817
Std. Dev.	13.959	11.978	0.025	0.056	0.027	0.020	0.009	0.001	0.002	0.024	0.006	0.013	1.248
Minimum	5.382	0.693	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.016	0.000	0.000	0.114
Maximum	76.236	60.690	0.204	0.187	0.228	0.084	0.054	0.014	0.015	0.125	0.022	0.047	11.513

	Cond.	Temp.	F. Depth	W.Depth	Altitude	Calc. Alt.
Mean	55.268	23.168	163.739	295.436	22.185	134.872
Std. Dev.	1.401	0.906	52.232	174.961	9.012	134.222
Minimum	53.960	22.300	41.500	58.600	9.700	8.000
Maximum	58.730	25.450	222.400	569.700	30.800	361.000

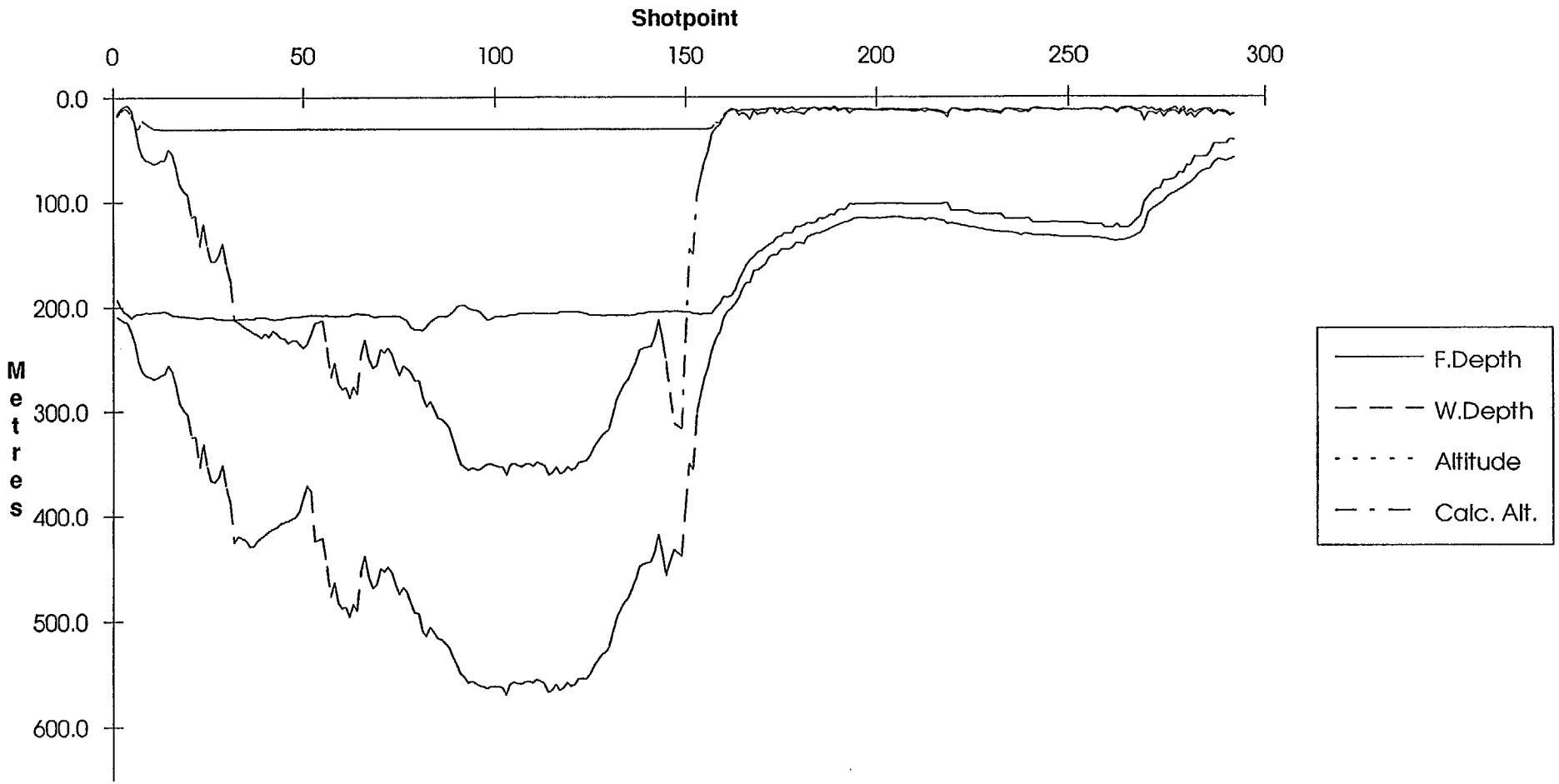
Notes

Two moderate THC and methane anomalies occur at SP 5 and SP 165.
A weak ethane and propane anomaly occurs at SP 5, a strong anomaly occurs at SP 165.
Increased ethylene values after SP 170 reflect thermoclinal influences as the fish is raised into shallower waters.
Gas samples for carbon isotope analysis where taken at SP 1 to SP 3 and SP 166 to SP 172.

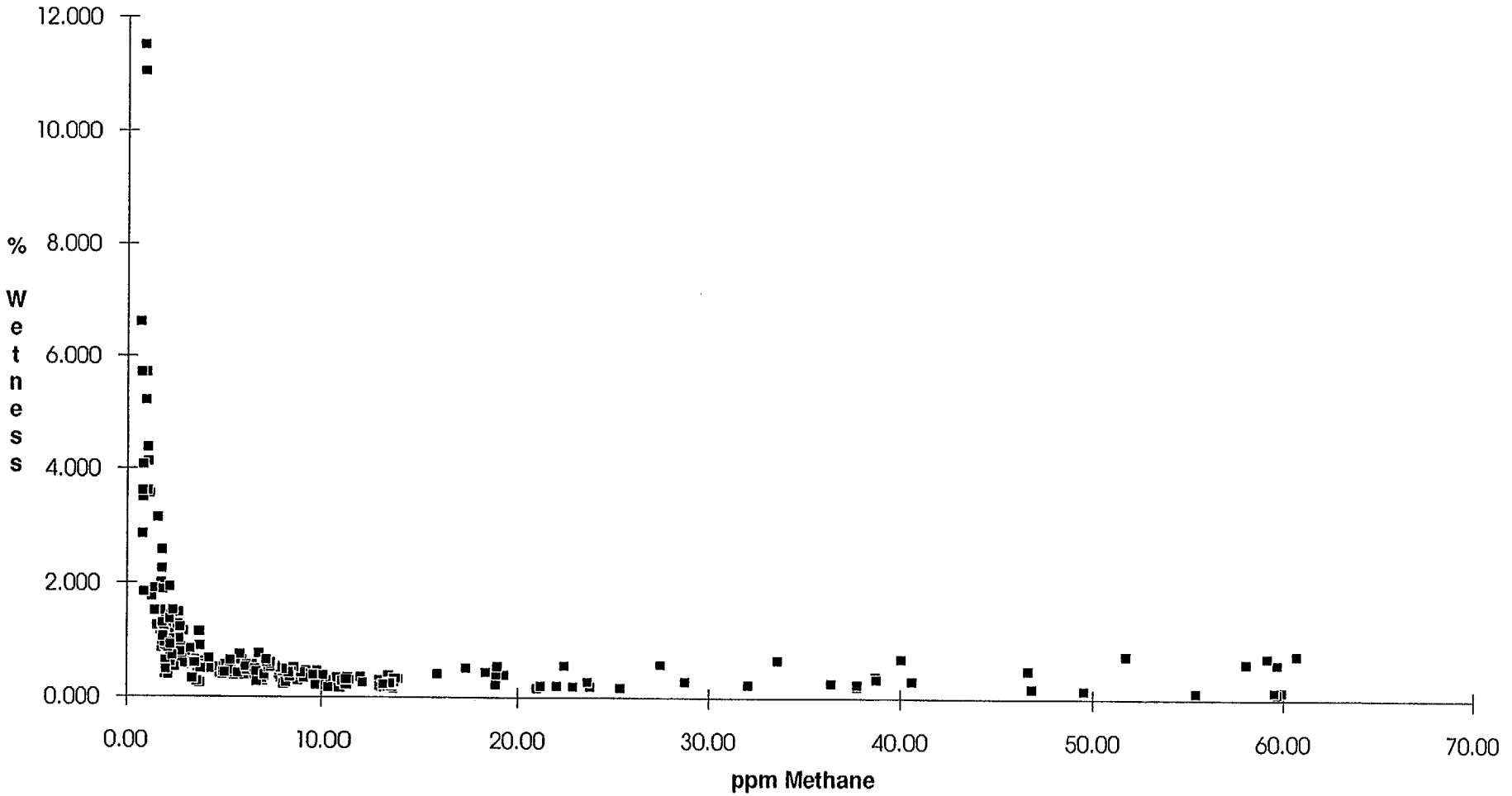

Line SNIFF7 THC, Methane
ppm Hydrocarbons
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
0
50
100
150
200
250
300
Shotpoint
THC
Methane


Line SNIFF7 Ethane, Ethylene, Propane
ppm Hydrocarbons
0.250
0.200
0.150
0.100
0.050
0.000
0
50
100
150
200
250
300
Shotpoint
Ethane
Ethylene
Propane

Line SNIFF7 Depths, Altitudes



Line SNIFF7 Methane v. %Wetness



Line Summary

Line Number	109054
No. of Shotpoints	55

	Shotpoint	Date	Time	Latitude		Longitude	
Start	1	26-Apr-92	22:49:09	13	03.128	123	15.993
End	55	27-Apr-92	00:37:25	12	59.489	123	10.245

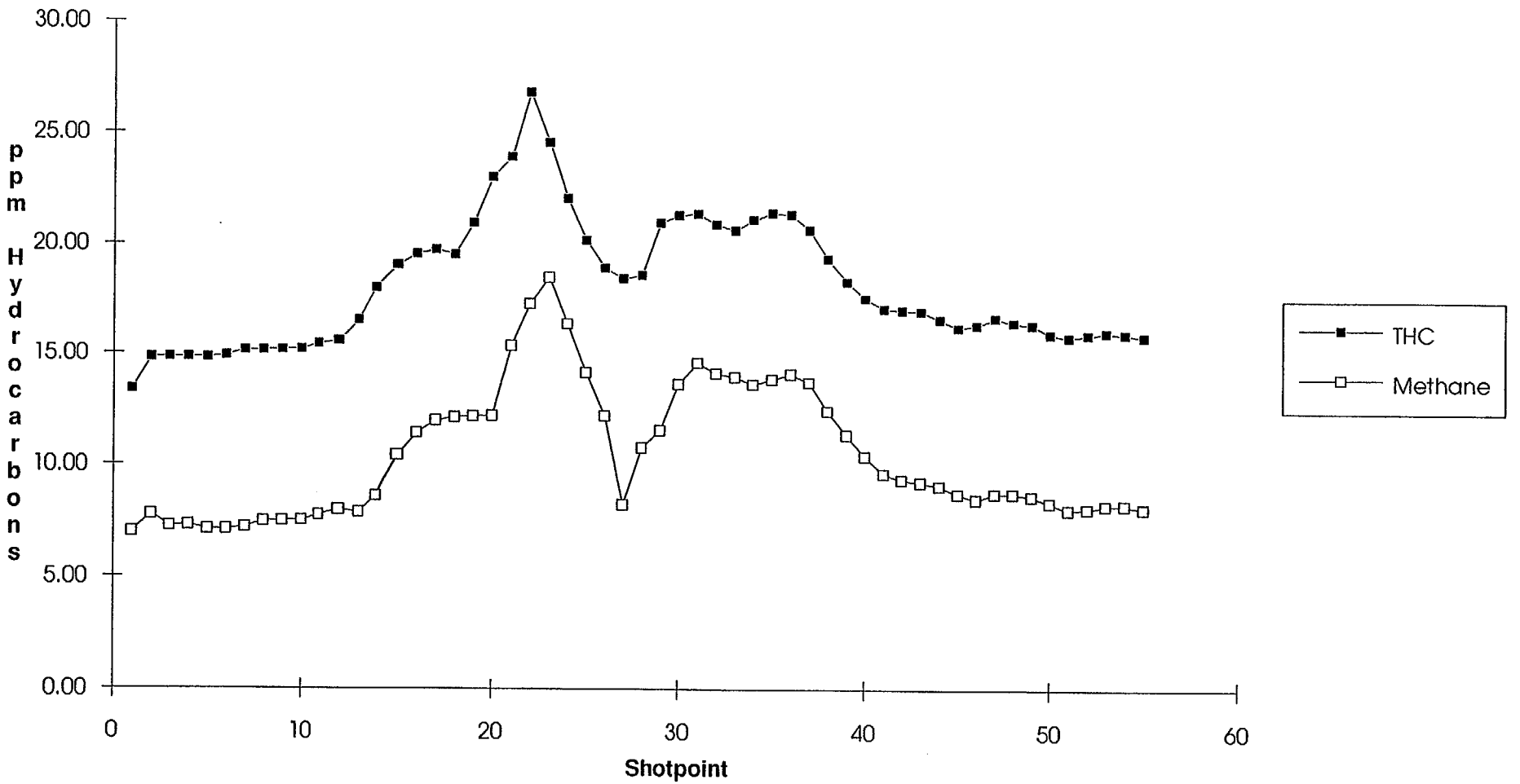
	THC	Methane	Ethane	Ethylene	Propane	Propylene	I-Butane	n-Butane	I-Pentane	n-Pentane	I-Hexane	n-Hexane	%Wetness
Mean	18.161	10.467	0.020	0.103	0.015	0.043	0.000	0.000	0.000	0.073	0.007	0.020	0.365
Std. Dev.	2.947	2.987	0.004	0.057	0.002	0.020	0.000	0.001	0.000	0.029	0.004	0.010	0.131
Minimum	13.355	7.004	0.012	0.020	0.009	0.007	0.000	0.000	0.000	0.034	0.000	0.000	0.167
Maximum	26.794	18.482	0.033	0.198	0.019	0.089	0.000	0.005	0.000	0.132	0.012	0.032	0.671

	Cond.	Temp.	F. Depth	W.Depth	Altitude	Calc. Alt.
Mean	57.103	24.375	102.705	122.106	16.527	19.752
Std. Dev.	1.776	1.174	37.846	42.644	4.371	11.711
Minimum	53.820	22.250	41.200	59.500	9.300	4.000
Maximum	59.250	25.840	186.300	206.100	30.800	58.200

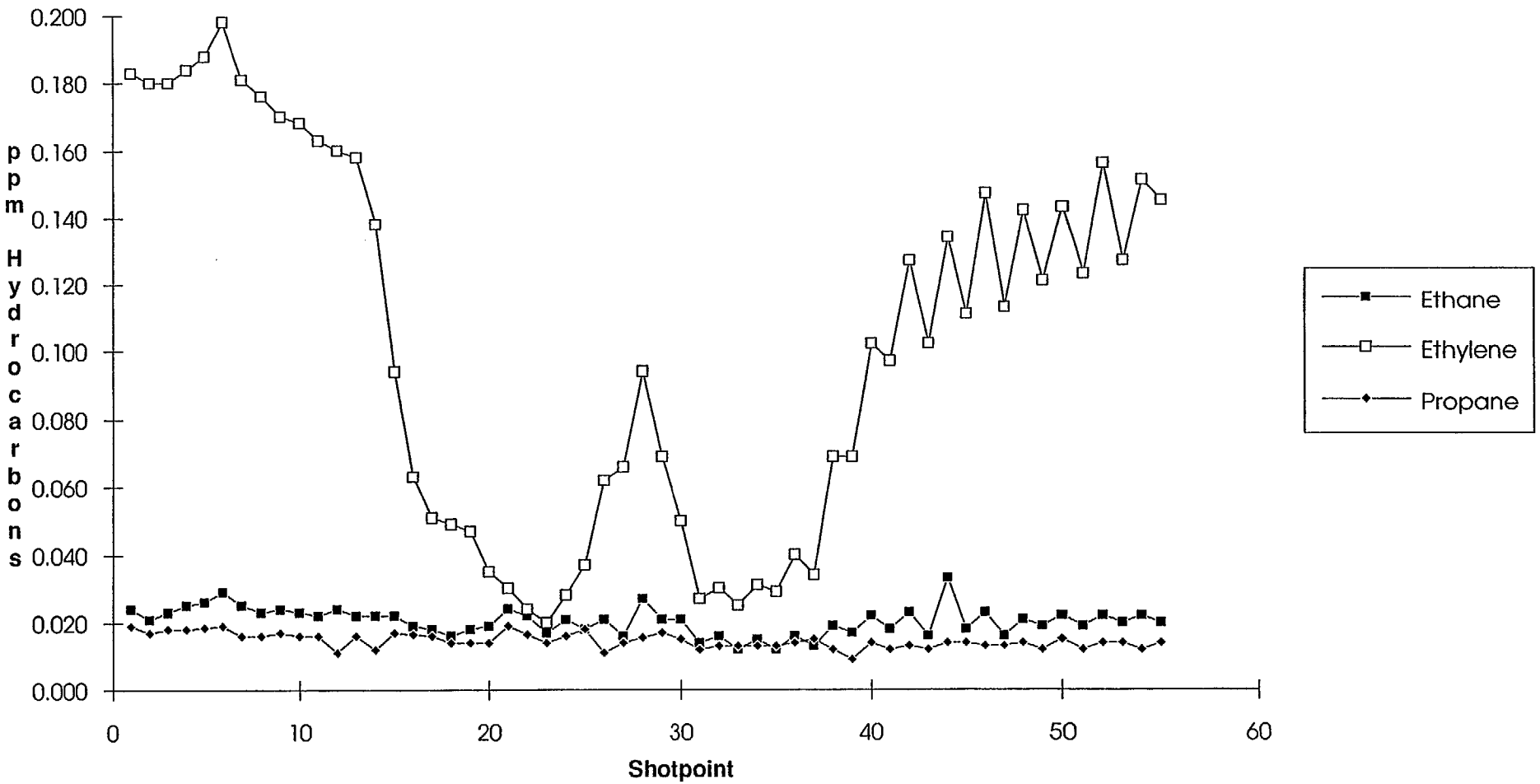
Notes

Two weak hydrocarbon anomalies occur at SP 22 and SP 32.
Thermoclinal influence on hydrocarbon values occurs before SP 16, between SP 25 and SP31, and after SP 38.

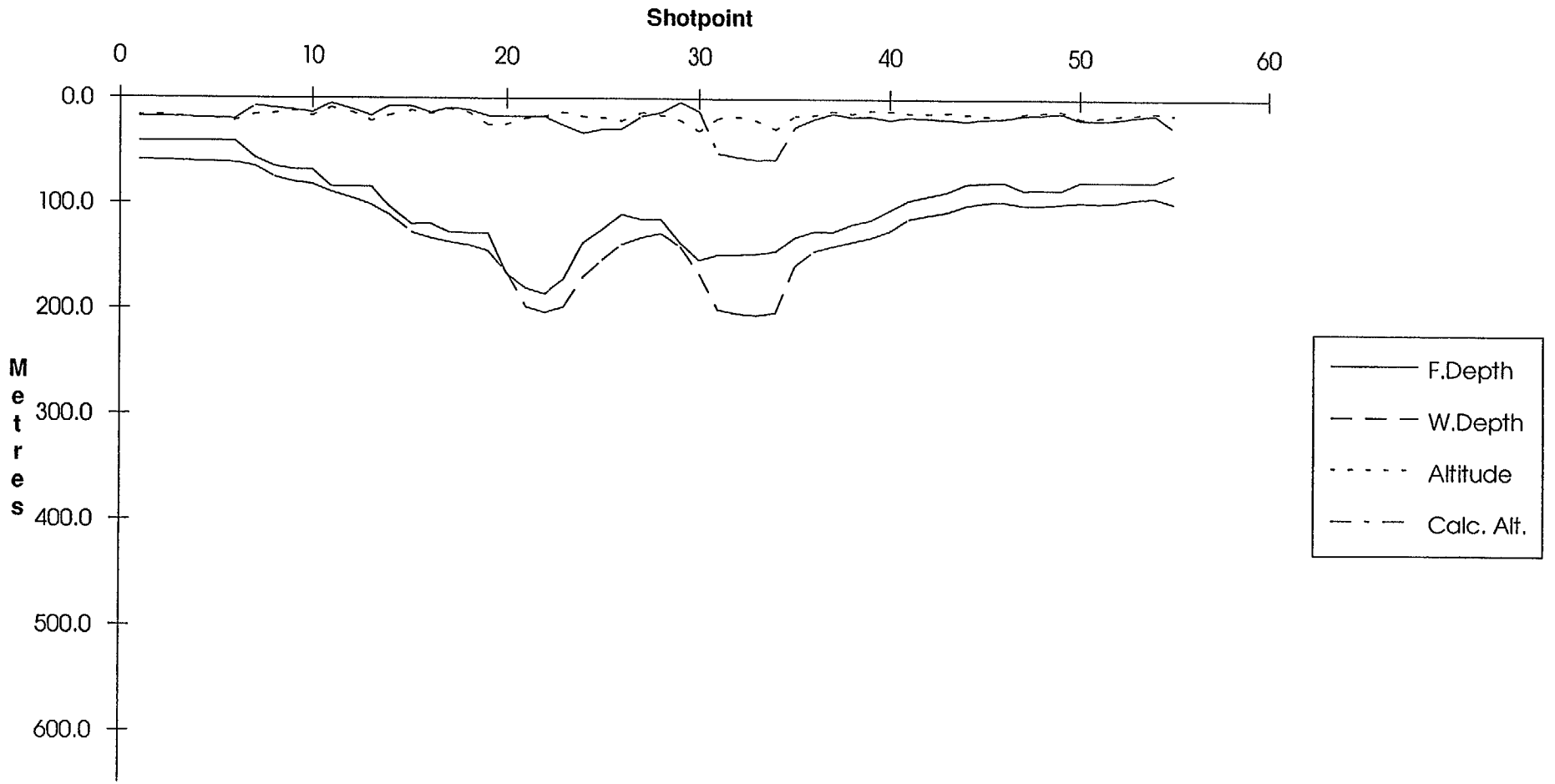
Line 109054 THC, Methane



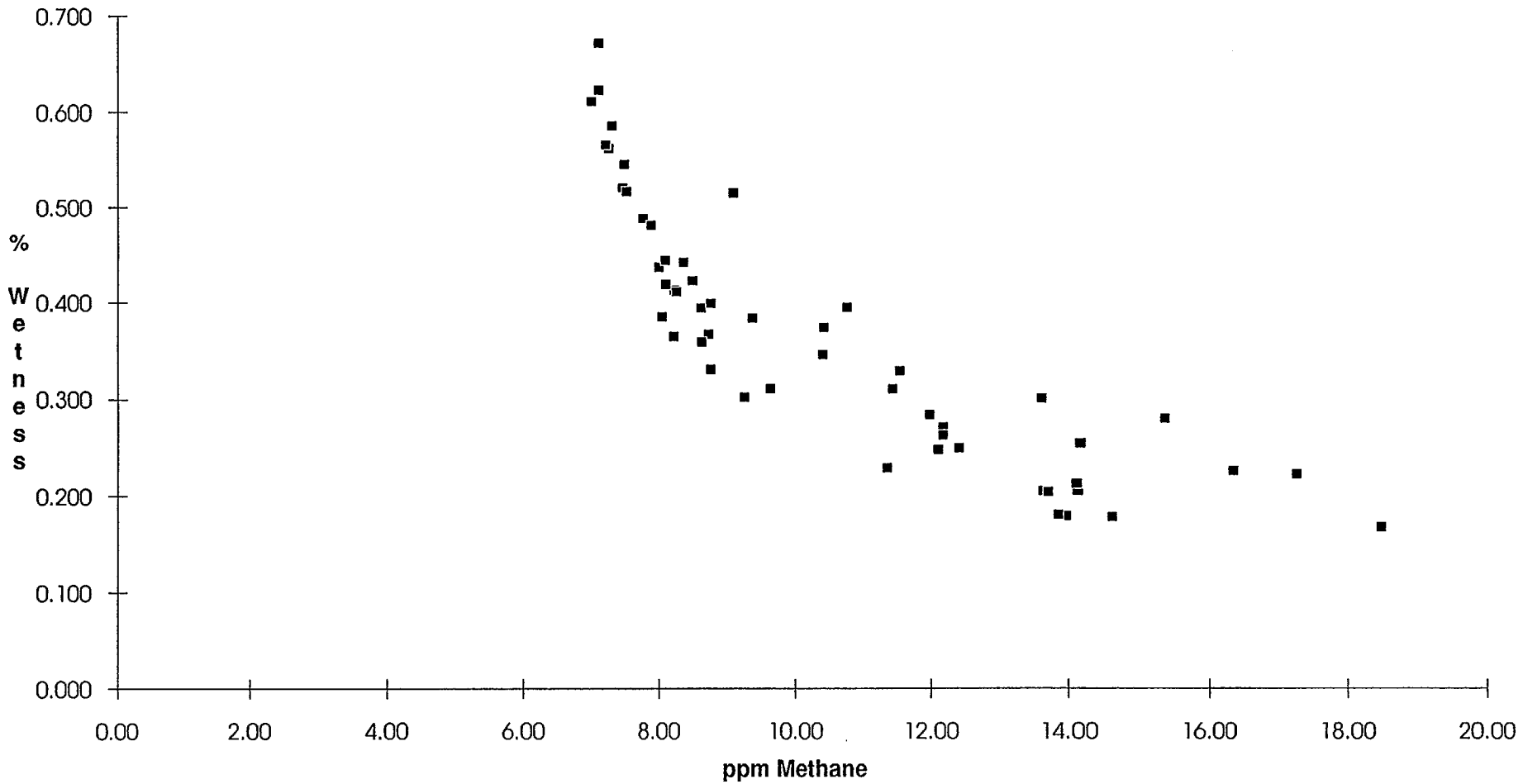
Line 109054 Ethane, Ethylene, Propane



Line 109054 Depths, Altitudes



Line 109054 Methane v. %Wetness



Line Summary

Line Number	109055
No. of Shotpoints	57

	Shotpoint	Date	Time	Latitude		Longitude	
Start	1	27-Apr-92	00:39:25	12	59.626	123	10.116
End	57	27-Apr-92	02:34:35	13	05.718	123	16.280

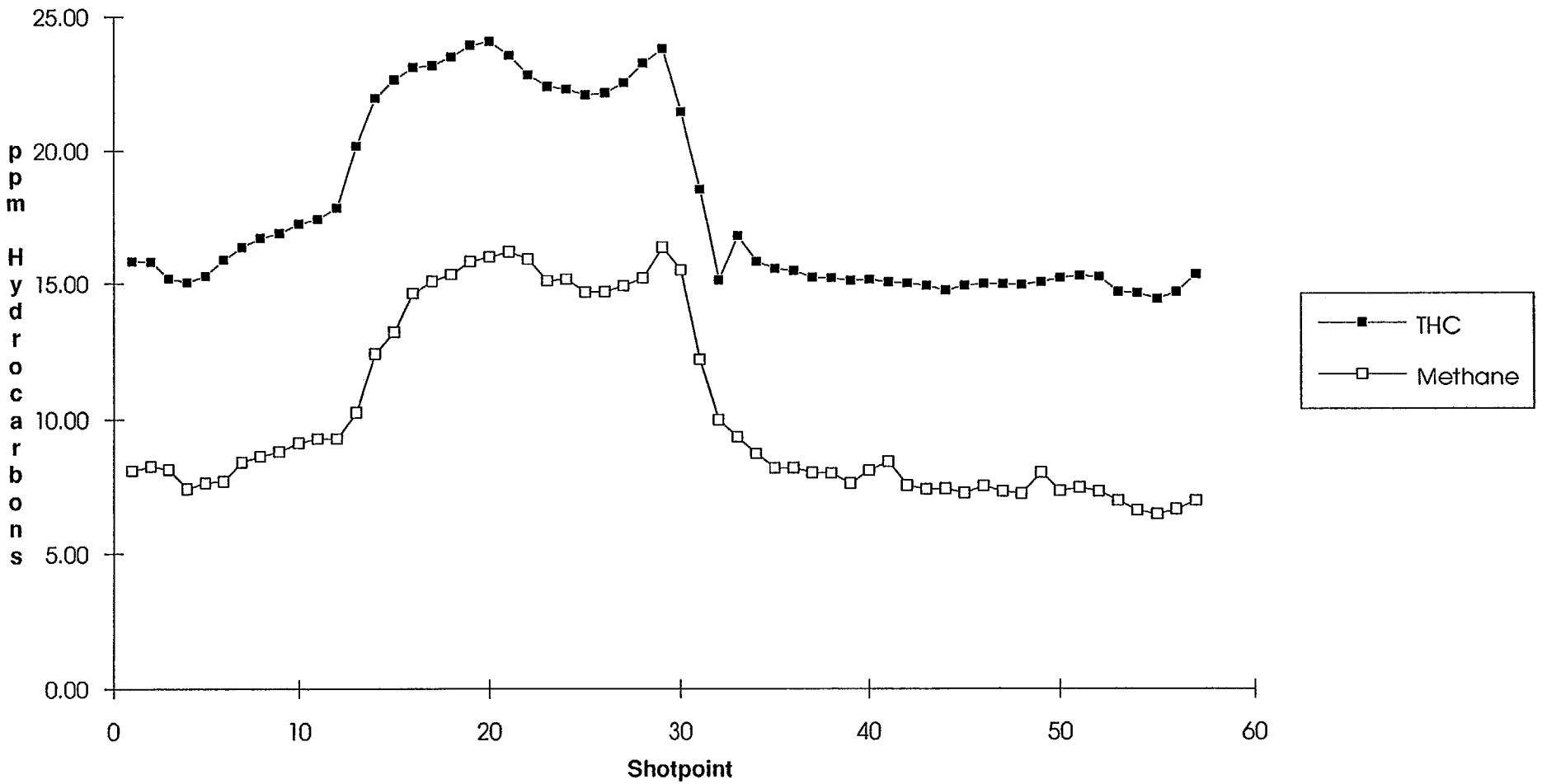
	THC	Methane	Ethane	Ethylene	Propane	Propylene	I-Butane	n-Butane	I-Pentane	n-Pentane	I-Hexane	n-Hexane	%Wetness
Mean	17.828	10.162	0.020	0.117	0.014	0.040	0.003	0.001	0.000	0.095	0.008	0.019	0.430
Std. Dev.	3.480	3.401	0.007	0.069	0.004	0.022	0.008	0.003	0.000	0.050	0.004	0.011	0.235
Minimum	14.409	6.489	0.006	0.006	0.006	0.008	0.000	0.000	0.000	0.035	0.000	0.000	0.125
Maximum	24.071	16.358	0.035	0.262	0.024	0.091	0.044	0.016	0.000	0.217	0.021	0.040	1.128

	Cond.	Temp.	F. Depth	W.Depth	Altitude	Calc. Alt.
Mean	58.163	25.096	88.739	102.511	12.875	13.965
Std. Dev.	2.111	1.402	41.880	41.395	1.745	4.733
Minimum	54.730	22.810	24.800	36.500	9.500	1.800
Maximum	61.070	27.030	153.400	169.100	16.700	33.000

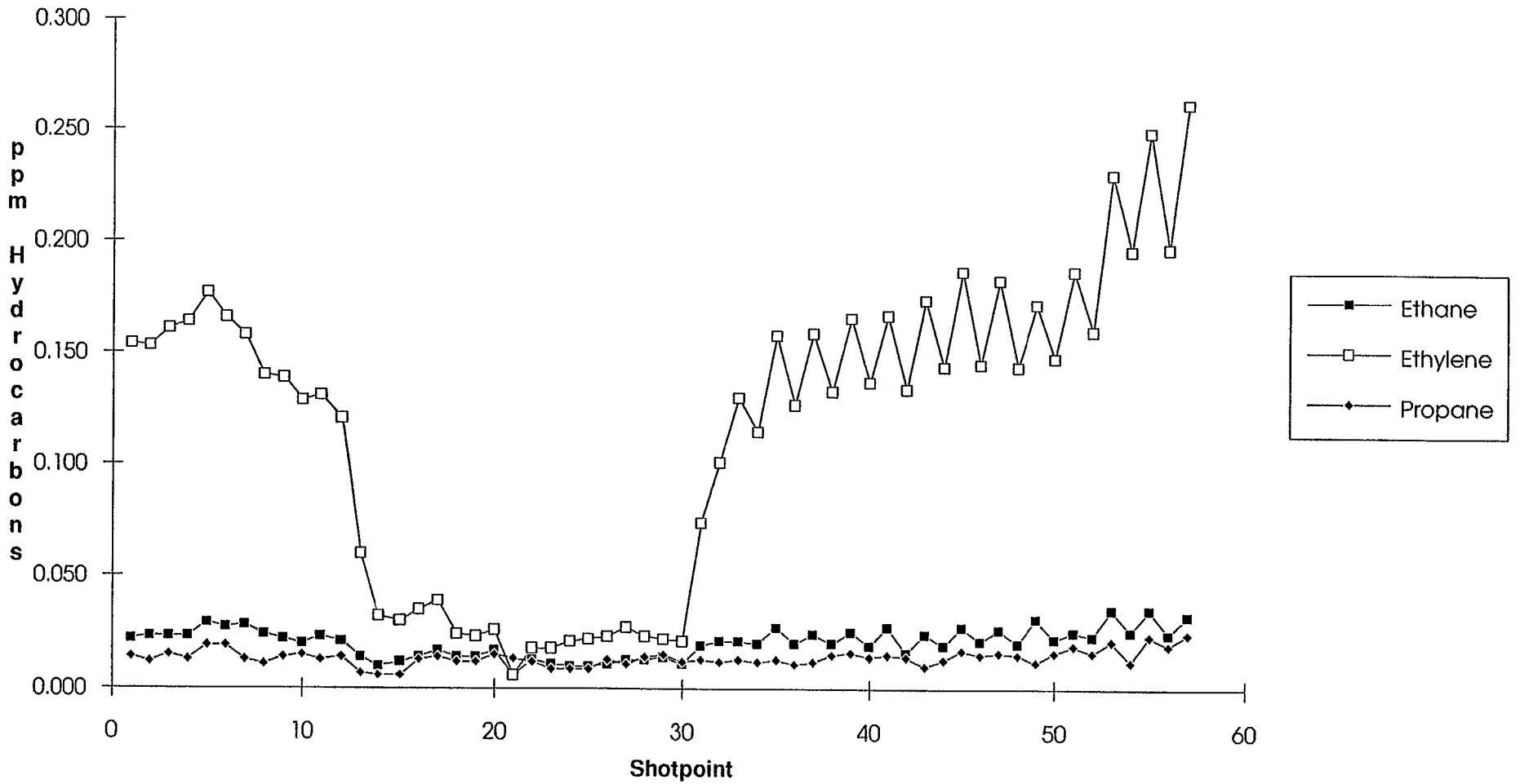
Notes

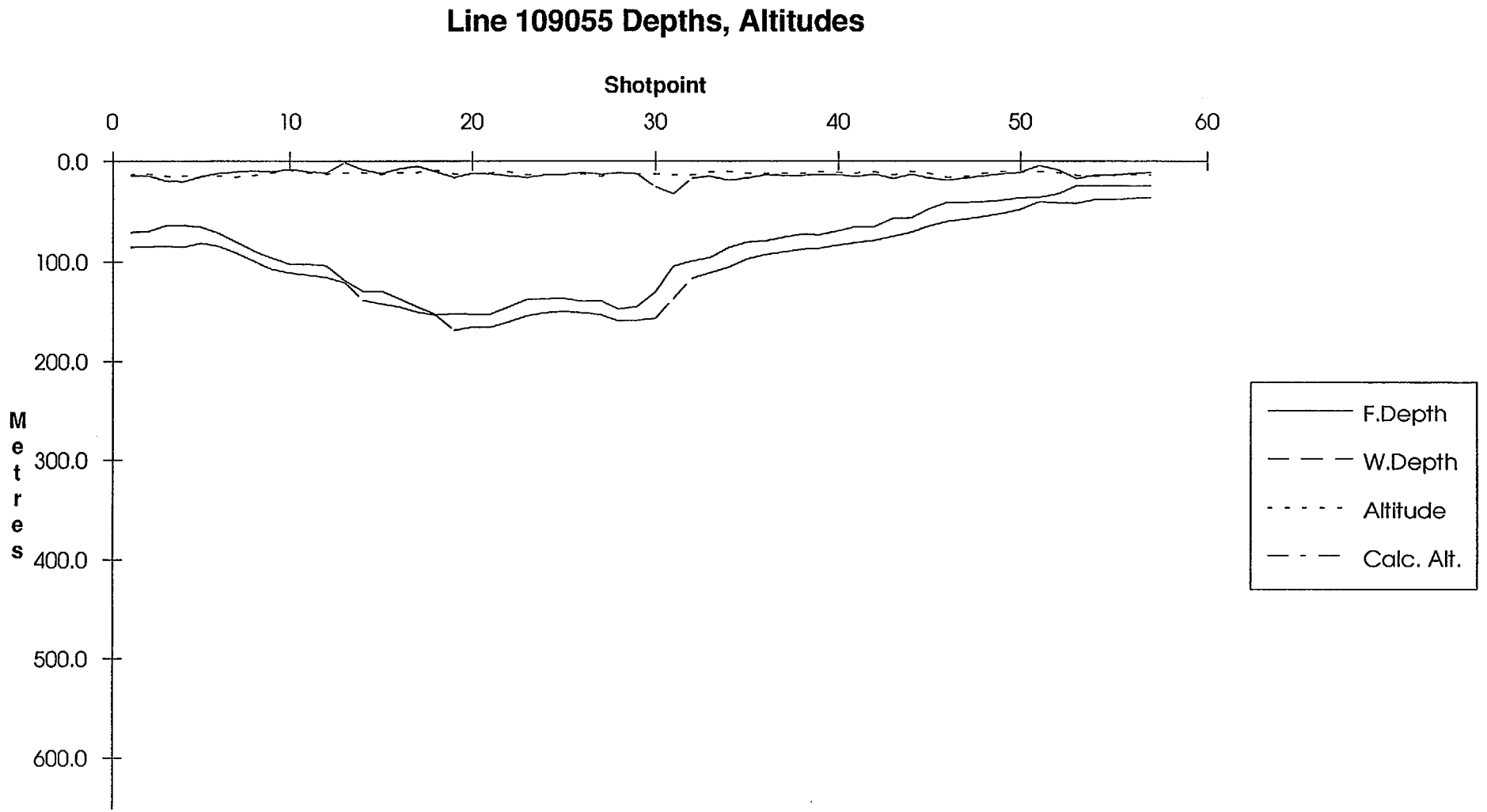
A weak THC and methane anomaly is seen between SP 13 and SP 31
Before SP 13 and after SP 31 ethane propane and ethylene values are seen to increase.

Line 109055 THC, Methane

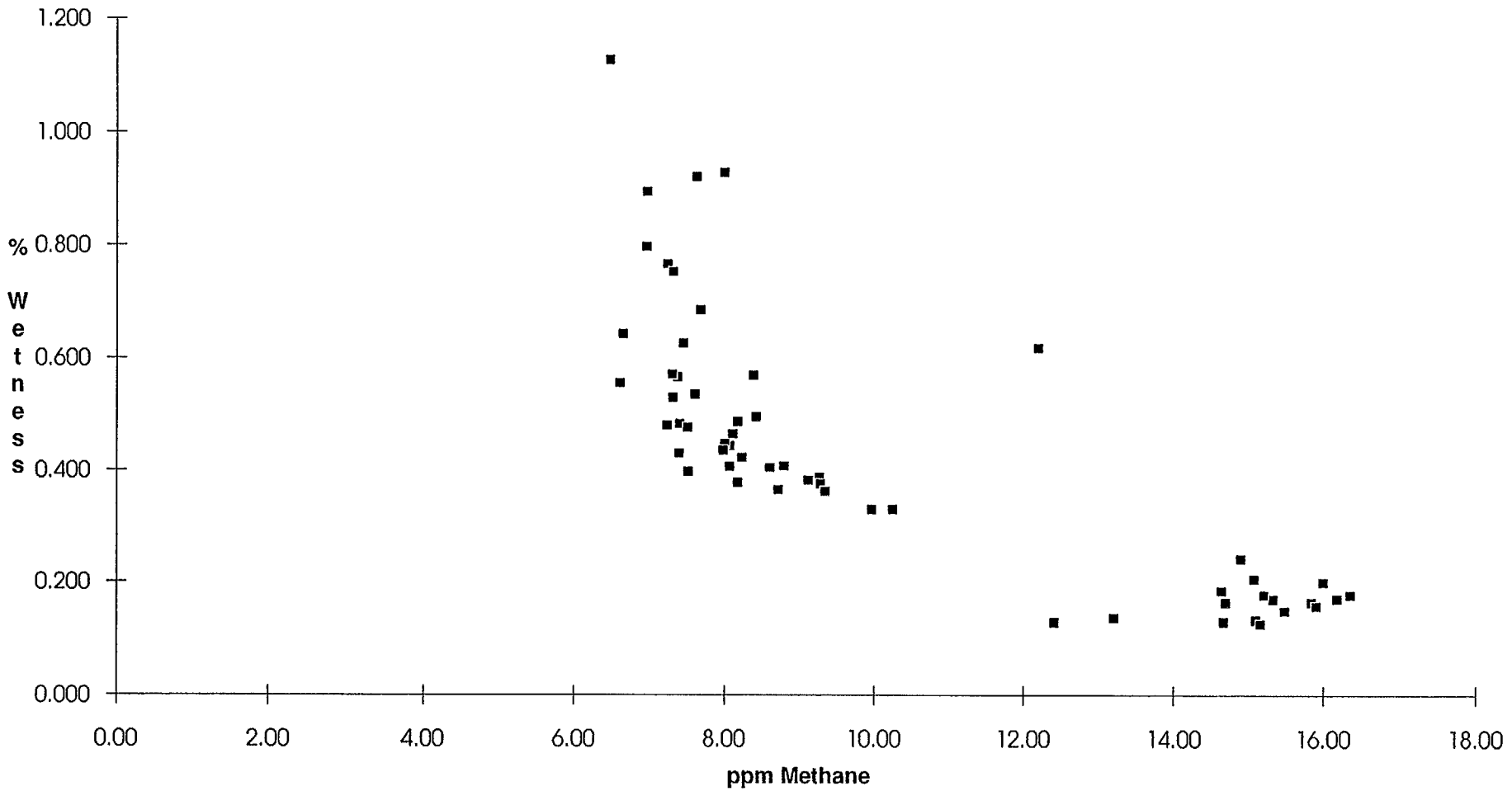


Line 109055 Ethane, Ethylene, Propane




Line 109055 Depths, Altitudes
Shotpoint
0
10
20
30
40
50
60
0.0
100.0
200.0
300.0
400.0
500.0
600.0
Metres
F.Depth
W.Depth
Altitude
Calc. Alt.

Line 109055 Methane v. %Wetness



Line Summary

Line Number	109056
No. of Shotpoints	69

	Shotpoint	Date	Time	Latitude		Longitude	
Start	1	27-Apr-92	02:45:04	13	06.514	123	15.779
End	69	27-Apr-92	05:06:11	13	05.372	123	08.047

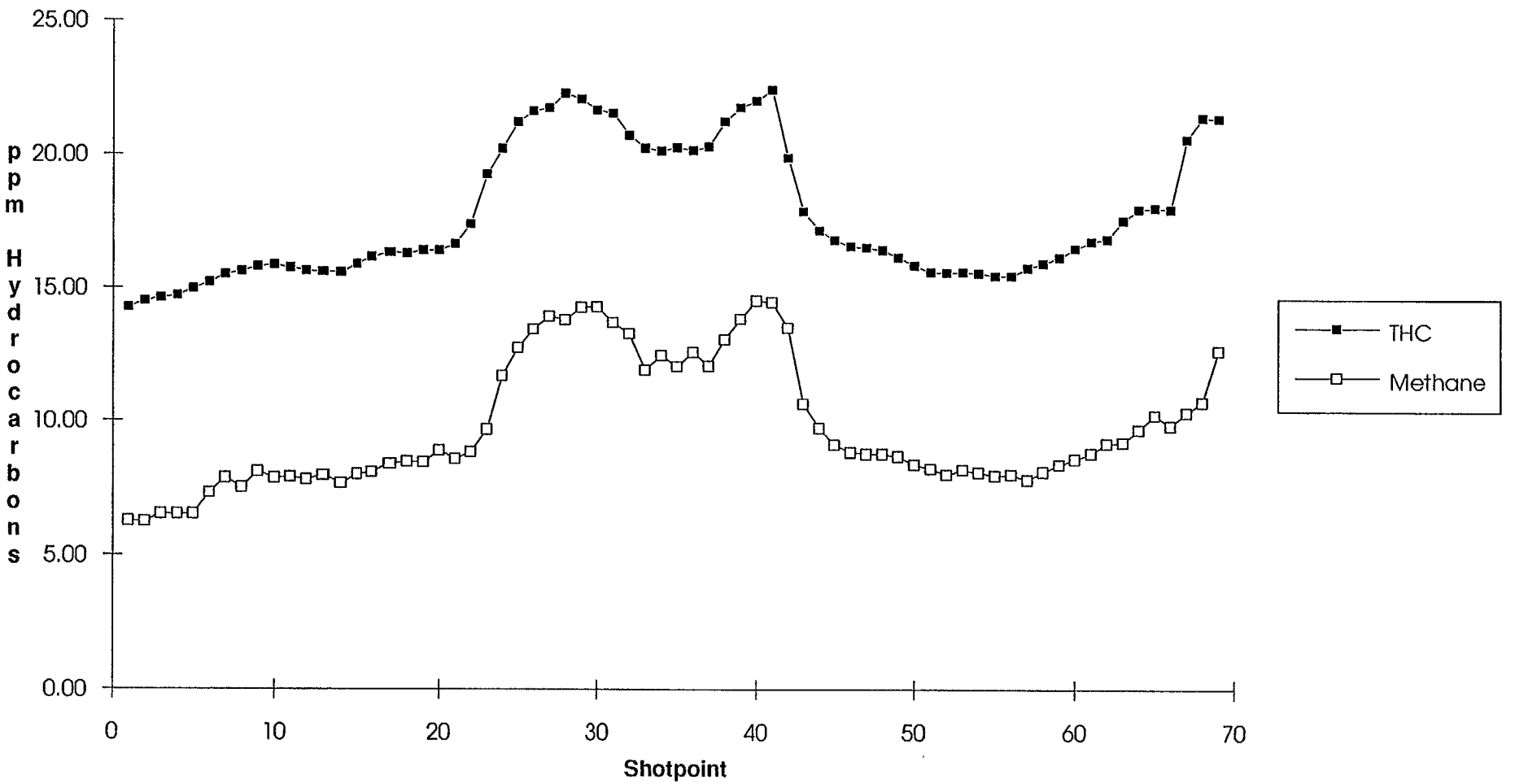
	THC	Methane	Ethane	Ethylene	Propane	Propylene	I-Butane	n-Butane	I-Pentane	n-Pentane	I-Hexane	n-Hexane	%Wetness
Mean	17.756	9.790	0.023	0.124	0.016	0.049	0.010	0.004	0.000	0.088	0.008	0.022	0.588
Std. Dev.	2.503	2.416	0.006	0.058	0.007	0.023	0.018	0.009	0.000	0.048	0.004	0.011	0.328
Minimum	14.270	6.244	0.014	0.036	0.005	0.015	0.000	0.000	0.000	0.000	0.000	0.000	0.161
Maximum	22.434	14.545	0.040	0.268	0.047	0.114	0.084	0.036	0.000	0.223	0.018	0.046	1.473

	Cond.	Temp.	F. Depth	W.Depth	Altitude	Calc. Alt.
Mean	58.567	25.388	94.920	110.099	14.701	15.188
Std. Dev.	1.618	1.073	31.282	30.257	3.681	5.334
Minimum	55.750	23.520	25.000	40.500	9.900	4.600
Maximum	61.050	27.000	136.300	147.500	30.900	38.800

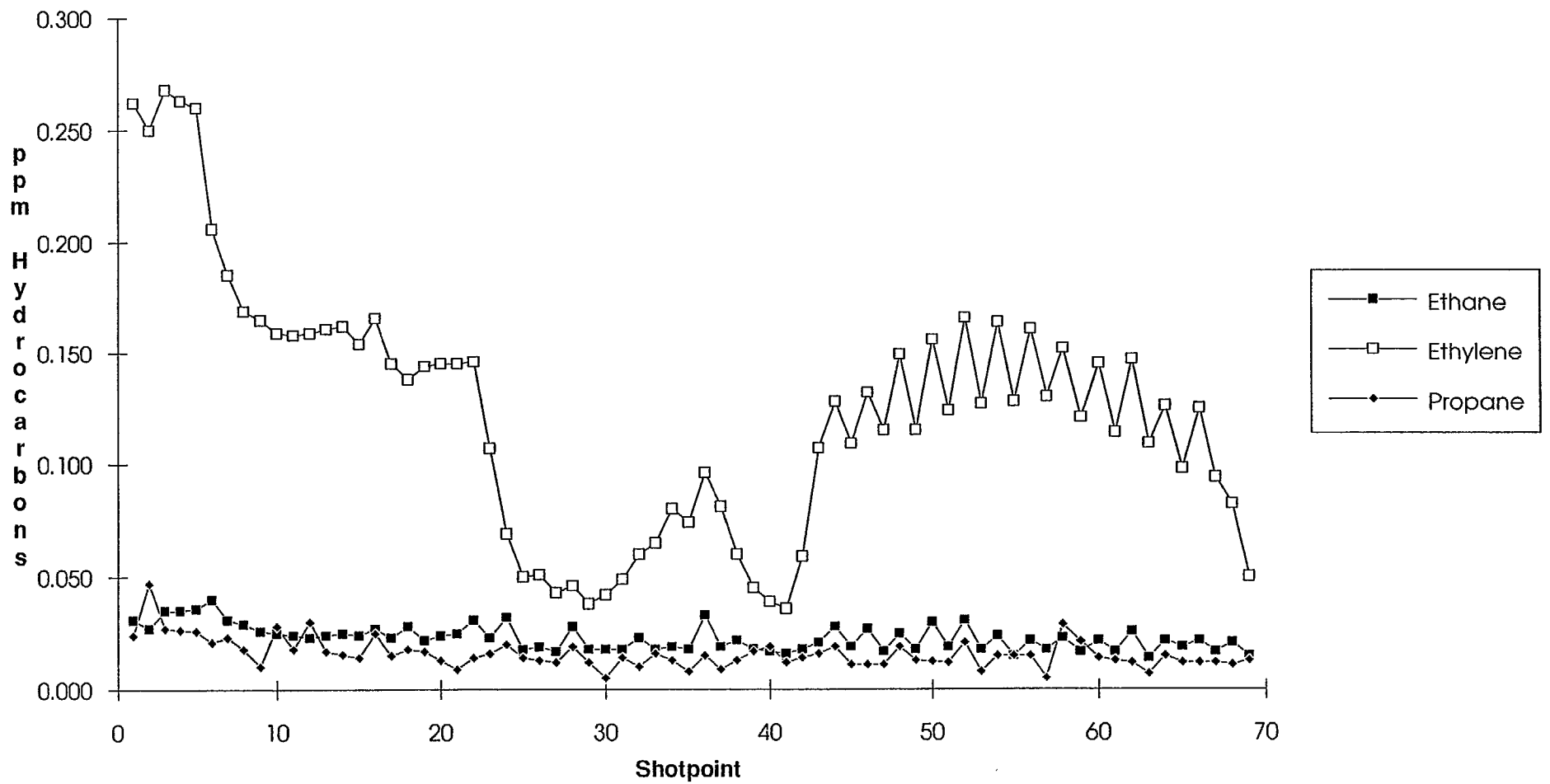
Notes

Three weak THC and methane anomalies occur at SP 24, SP 38, and SP 67.
Increased ethylene values prior to SP 22, between SP 34 and SP 39, and between SP 43 and SP 66, reflects the passage of the tow-fish through surface waters.

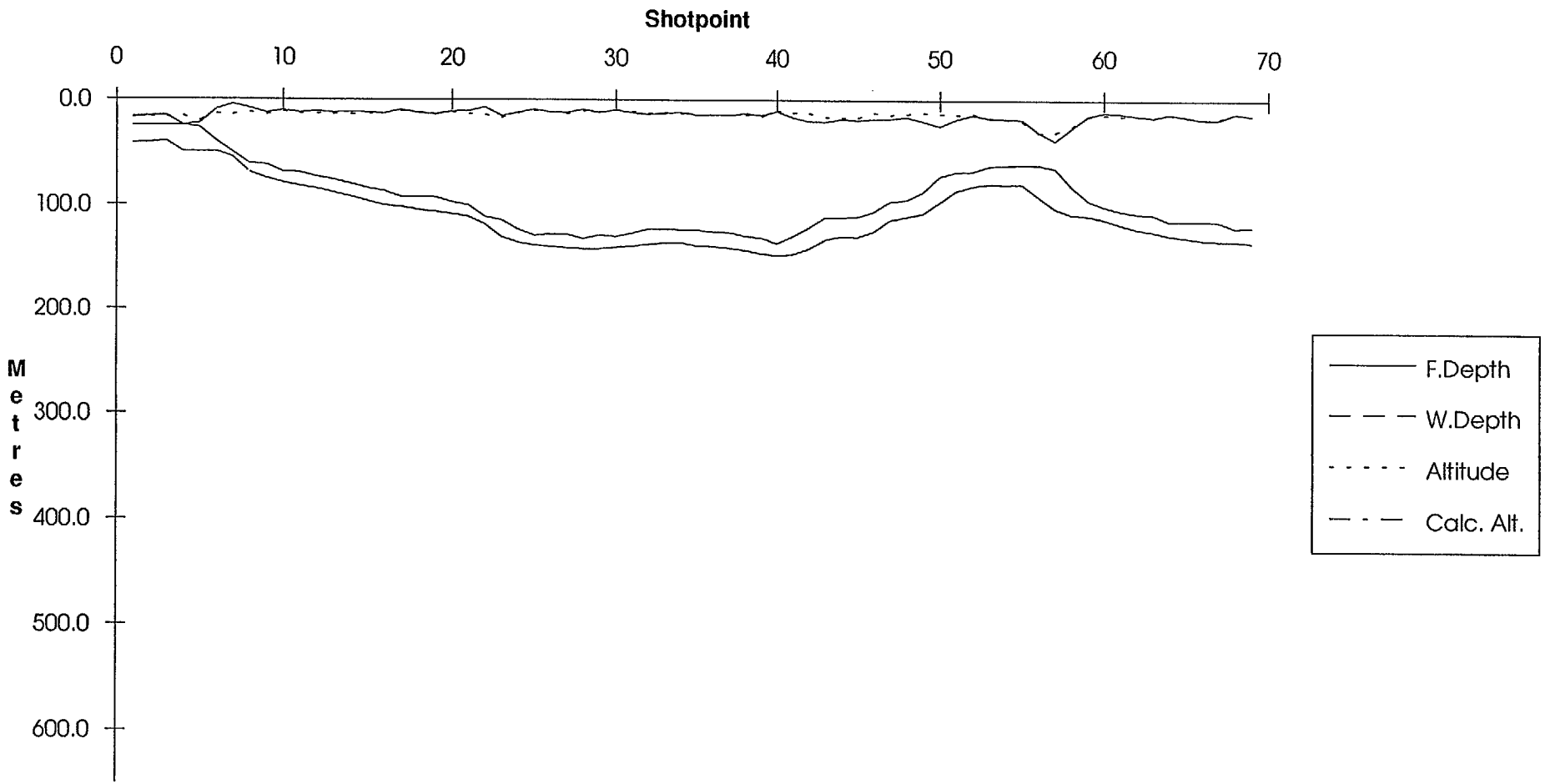
Line 109056 THC, Methane



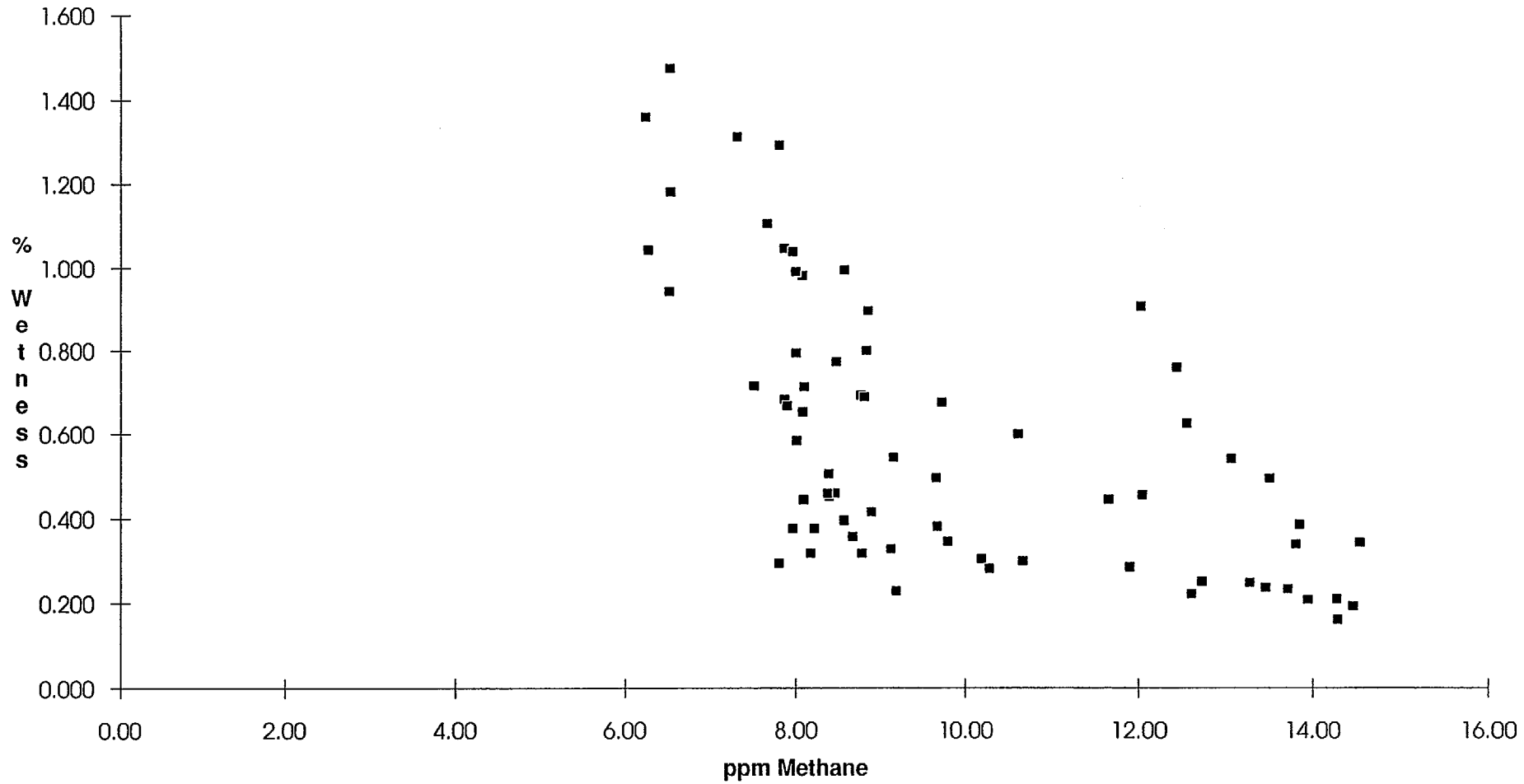
Line 109056 Ethane, Ethylene, Propane



Line 109056 Depths, Altitudes



Line 109056 Methane v. %Wetness



Line Summary

Line Number	snlff8
No. of Shotpoints	389

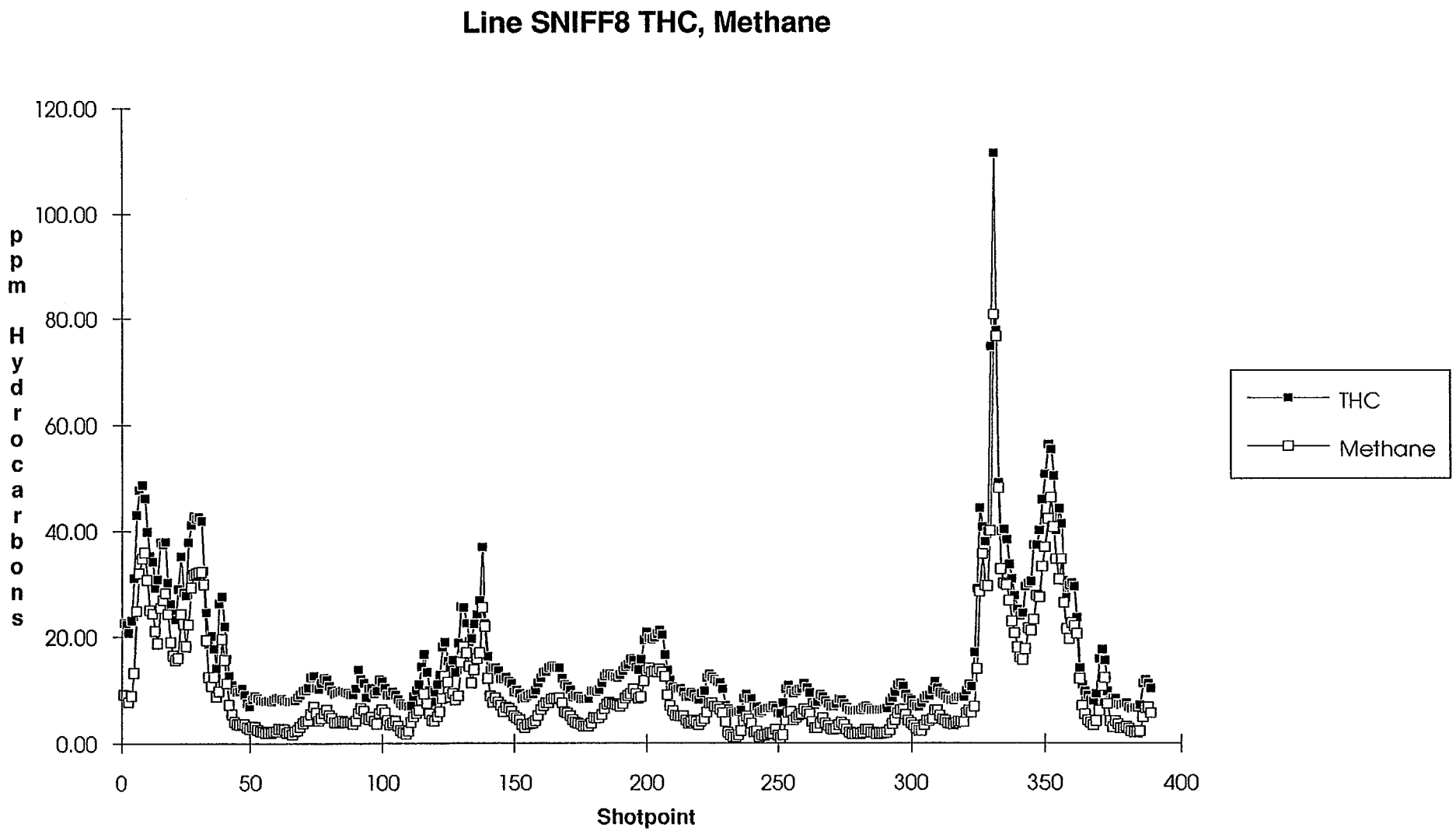
	Shotpoint	Date	Time	Latitude		Longitude	
Start	1	27-Apr-92	08:58:47	13	13.348	122	59.066
End	391	27-Apr-92	22:36:39	13	21.243	123	10.762

	THC	Methane	Ethane	Ethylene	Propane	Propylene	I-Butane	n-Butane	I-Pentane	n-Pentane	I-Hexane	n-Hexane	%Wetness
Mean	15.728	9.463	0.022	0.021	0.023	0.009	0.005	0.000	0.002	0.036	0.006	0.016	0.676
Std. Dev.	12.551	10.391	0.030	0.064	0.032	0.011	0.010	0.002	0.004	0.024	0.006	0.012	0.470
Minimum	5.566	0.982	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.013	0.000	0.000	0.000
Maximum	111.269	80.630	0.328	0.877	0.326	0.115	0.071	0.029	0.023	0.324	0.065	0.048	3.627

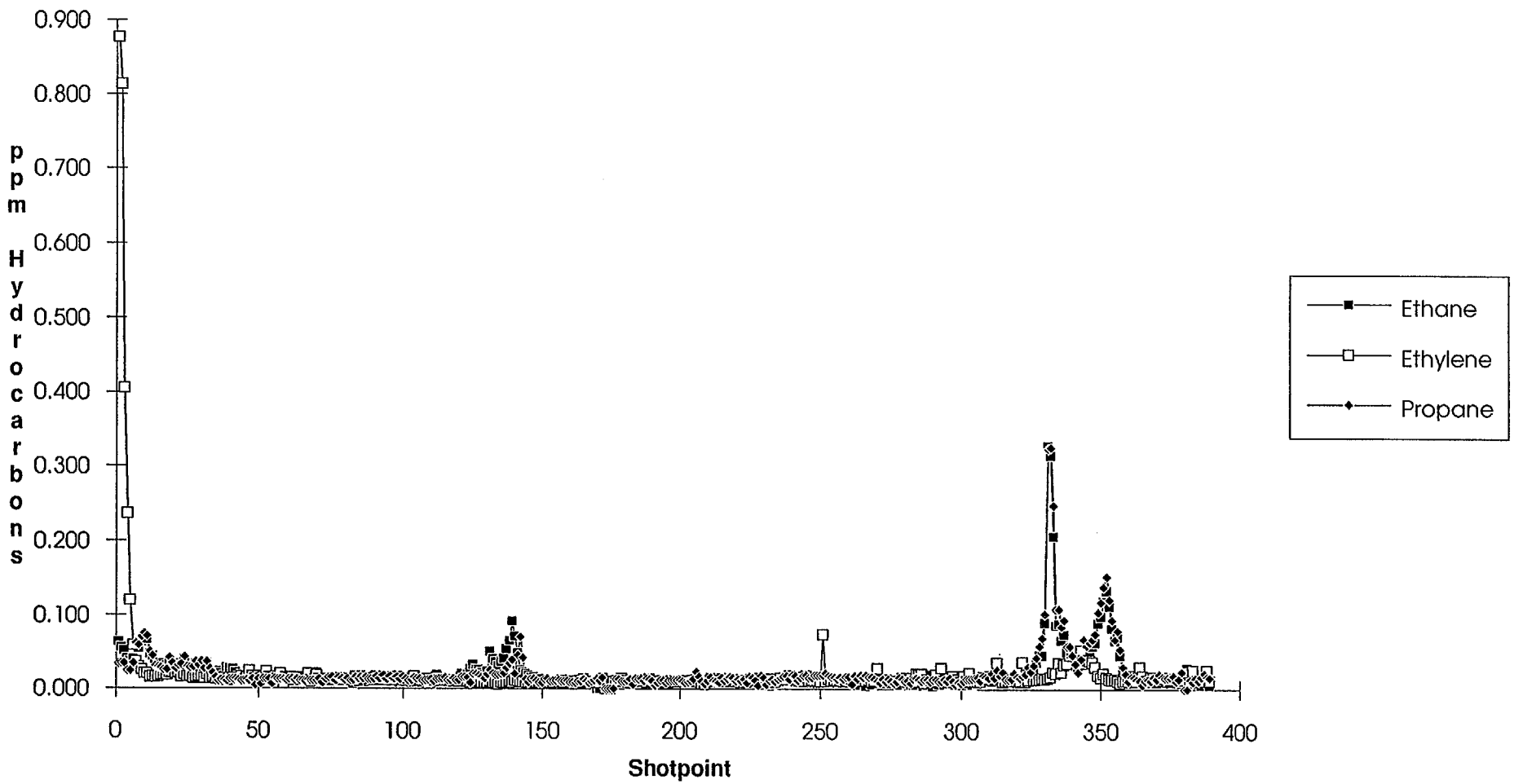
	Cond.	Temp.	F. Depth	W.Depth	Altitude	Calc. Alt.
Mean	54.338	22.580	206.852	427.806	27.770	220.959
Std. Dev.	0.699	0.488	22.997	142.028	6.124	123.500
Minimum	53.810	22.190	138.200	149.600	9.500	7.100
Maximum	62.410	28.070	225.800	569.800	30.900	347.600

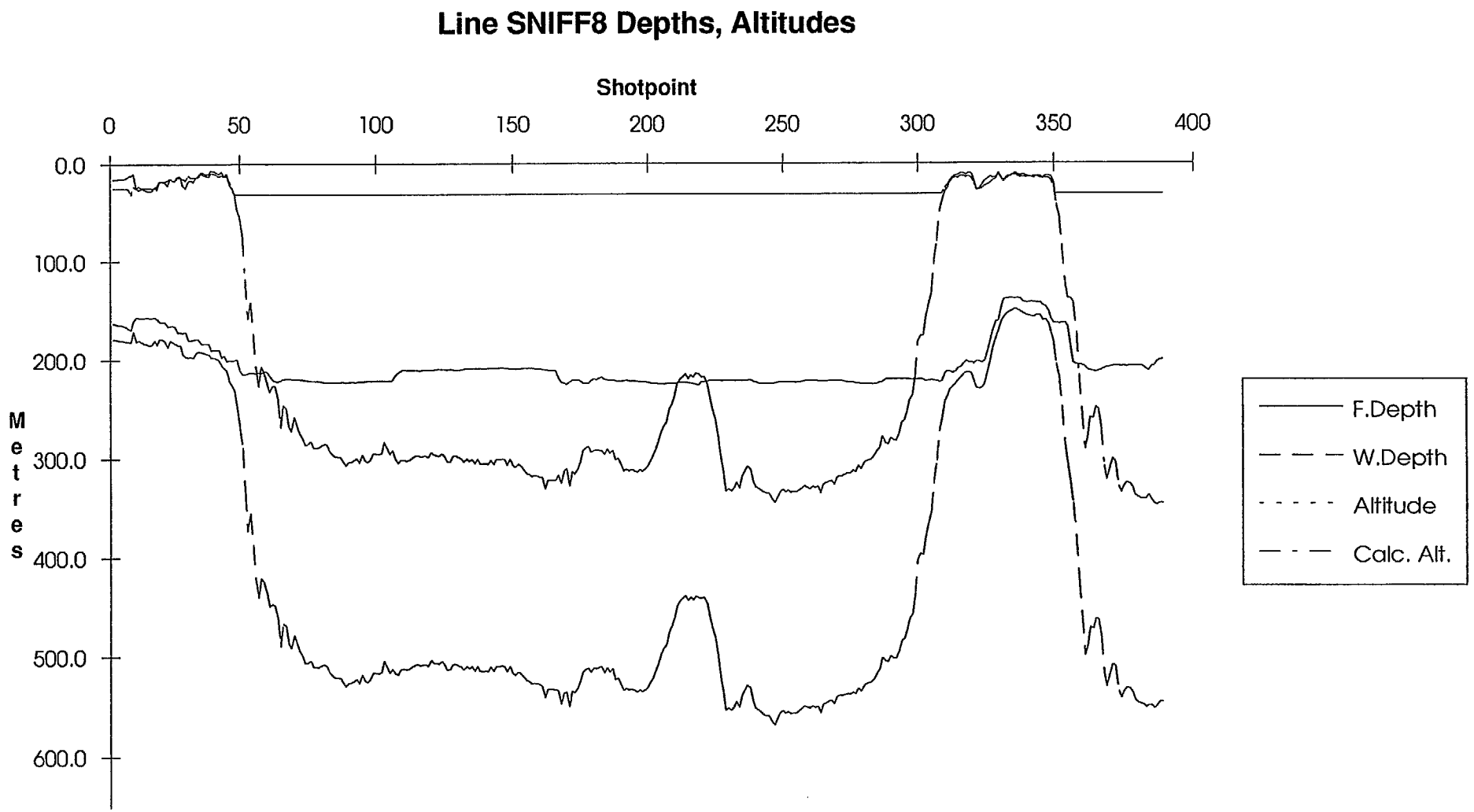
Notes

A strong THC and methane anomaly occurs at SP 329, three weak anomalies occur at SP 10, SP 135 and SP 350.
Two strong ethane and propane anomalies occur at SP 329 and SP 350, two moderate anomalies occur at SP 10 and SP 135.
The strong ethylene value at the start of the line is probably related to the fish hitting the bottom .
Gas samples for carbon isotope analysis where taken at SP 6 to SP 15 and SP 333 to SP 340.

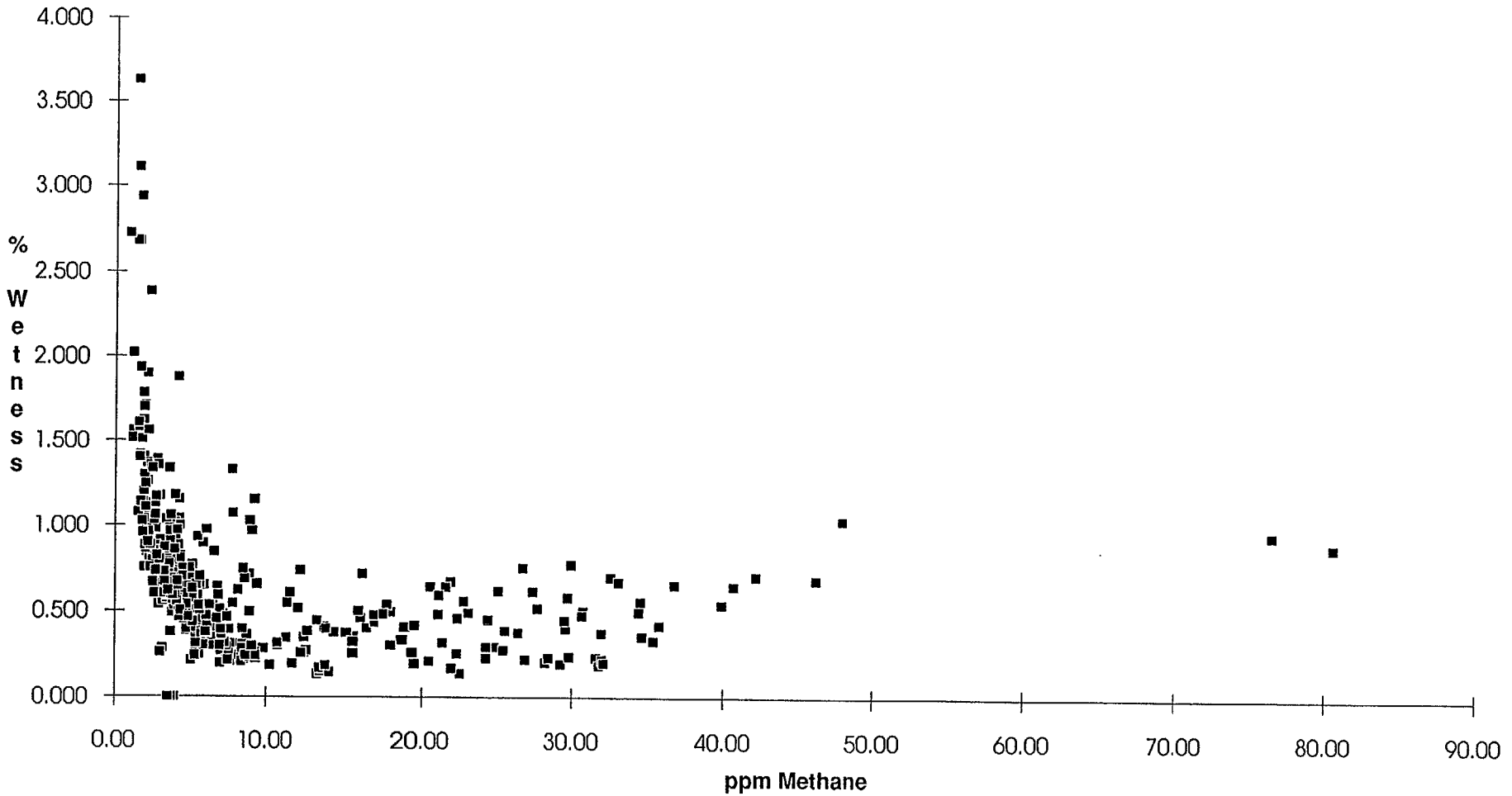

Line SNIFF8 THC, Methane
120.00
100.00
80.00
60.00
40.00
20.00
0.00
ppm Hydrocarbons
0
50
100
150
200
250
300
350
400
Shotpoint
THC
Methane

Line SNIFF8 Ethane, Ethylene, Propane




Line SNIFF8 Depths, Altitudes
Shotpoint
0
50
100
150
200
250
300
350
400
0.0
100.0
200.0
300.0
400.0
500.0
600.0
Metres
F.Depth
W.Depth
Altitude
Calc. Alt.

Line SNIFF8 Methane v. %Wetness



Line Summary

Line Number	109058
No. of Shotpoints	198

	Shotpoint	Date	Time	Latitude		Longitude	
Start	1	27-Apr-92	22:38:38	13	21.253	123	10.921
End	199	28-Apr-92	05:32:23	13	17.362	122	45.003

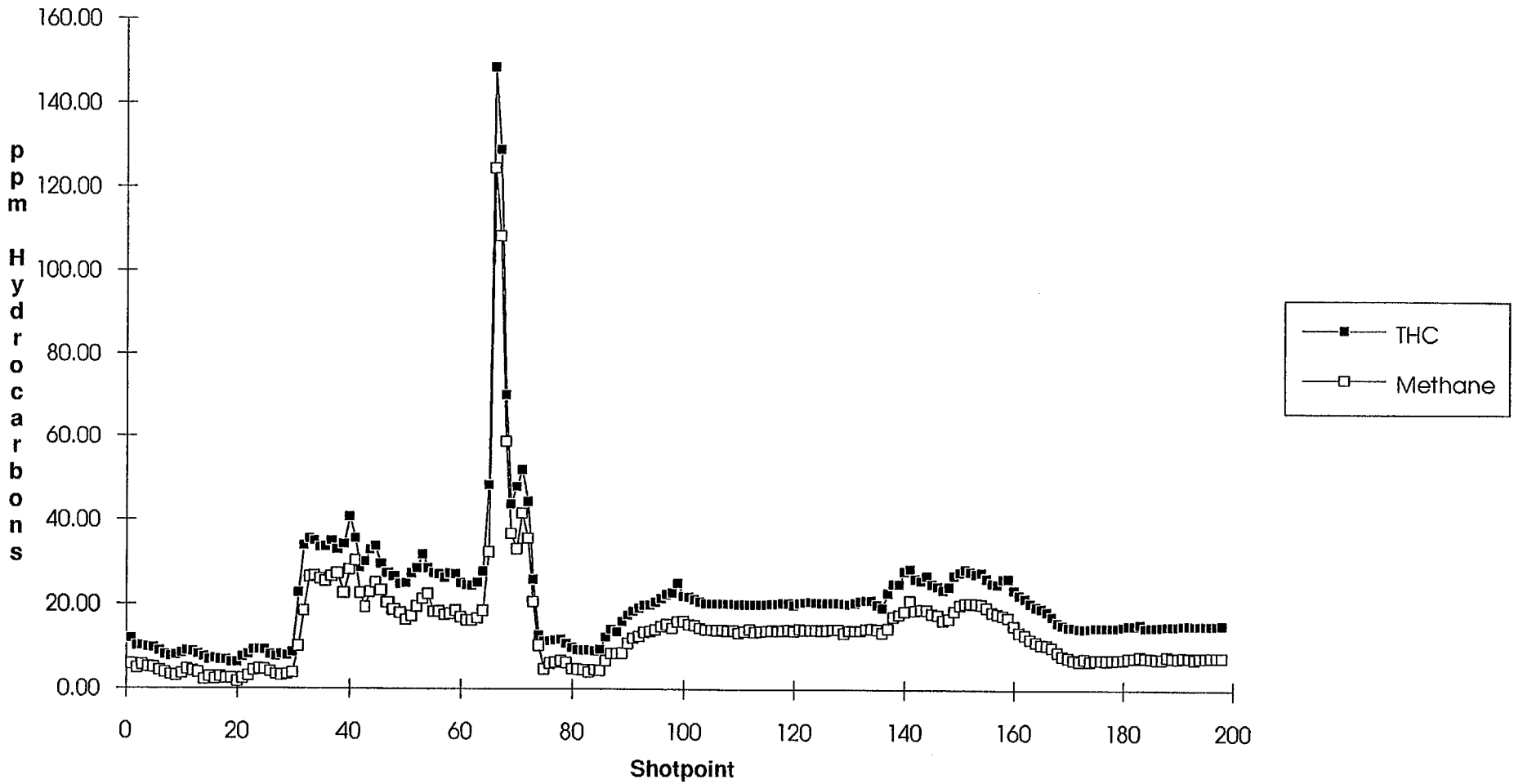
	THC	Methane	Ethane	Ethylene	Propane	Propylene	I-Butane	n-Butane	I-Pentane	n-Pentane	I-Hexane	n-Hexane	%Wetness
Mean	21.438	14.285	0.038	0.052	0.040	0.020	0.015	0.003	0.001	0.053	0.006	0.022	0.670
Std. Dev.	15.158	13.141	0.056	0.061	0.078	0.019	0.021	0.008	0.006	0.038	0.005	0.012	0.282
Minimum	6.198	1.658	0.006	0.011	0.005	0.000	0.000	0.000	0.000	0.018	0.000	0.000	0.164
Maximum	148.579	124.662	0.600	0.202	0.840	0.075	0.205	0.055	0.062	0.171	0.021	0.049	2.690

	Cond.	Temp.	F. Depth	W.Depth	Altitude	Calc. Alt.
Mean	57.317	24.574	148.491	194.313	19.069	45.881
Std. Dev.	2.221	1.497	39.598	88.599	7.909	67.609
Minimum	54.350	22.620	49.900	63.800	10.500	7.500
Maximum	61.970	27.700	208.200	564.400	30.900	364.100

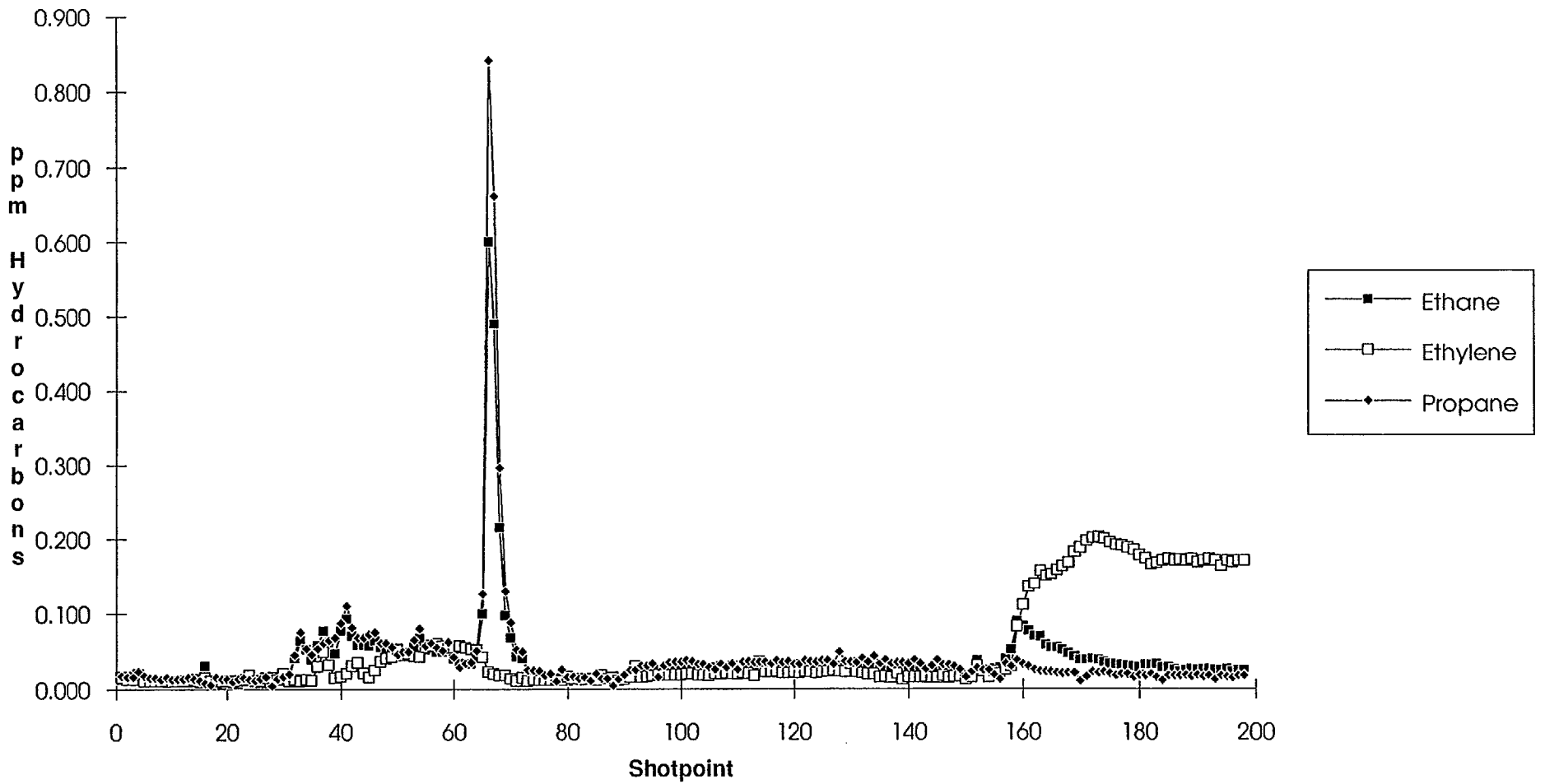
Notes

A strong THC, methane, ethane and propane anomally occurs at SP 65.
A weak THC, methane, ethane and propane anomaly occurs at SP 40.
A weak THC and methane anomaly occurs at SP 140.
Increased hydrocarbon values from SP 159 are as a result of water shallowing and the fish being raised through the thermocline.
A gas sample was taken for carbon isotope analysis from SP 66 to SP 73.

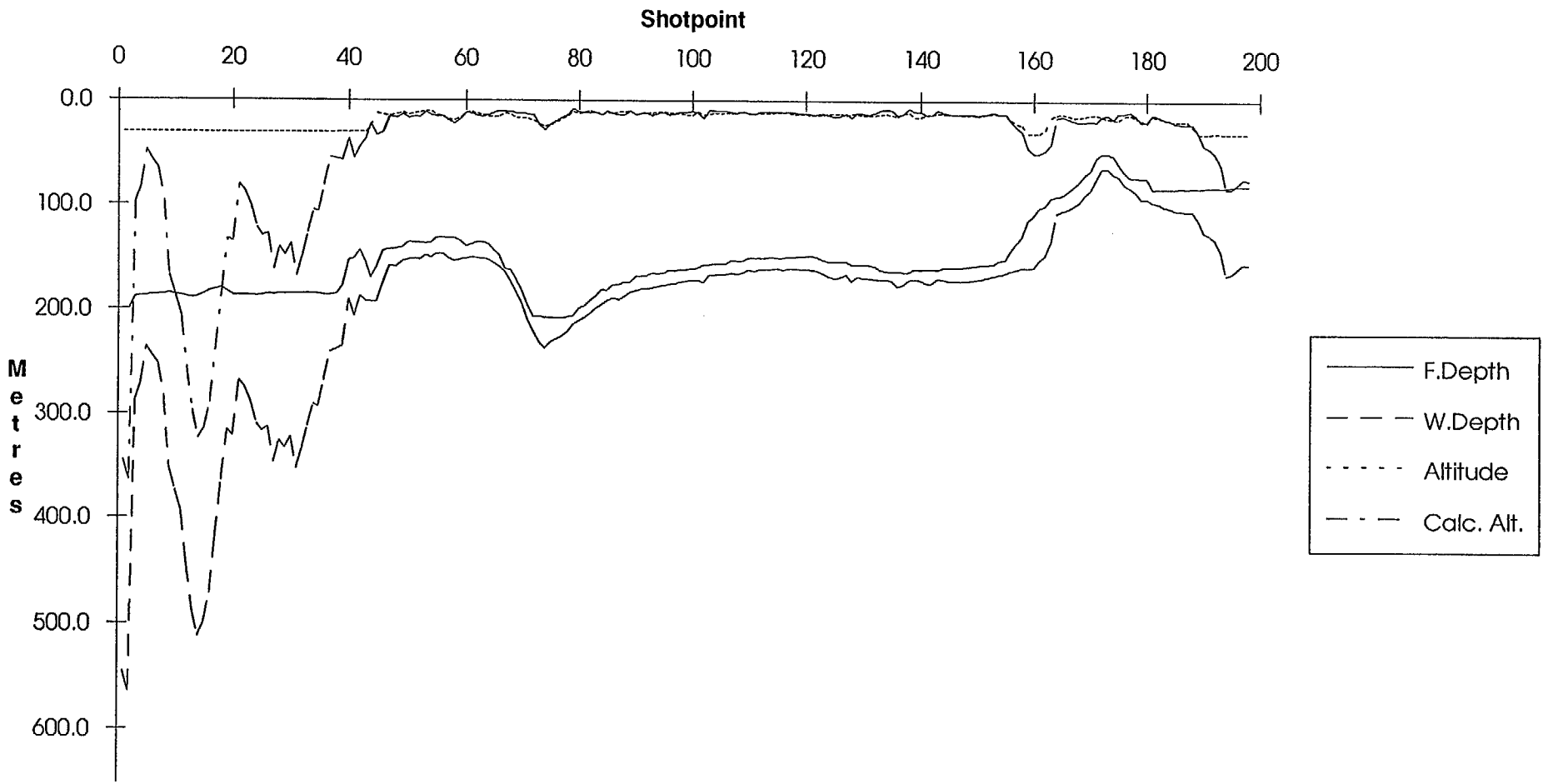
Line 109058 THC, Methane



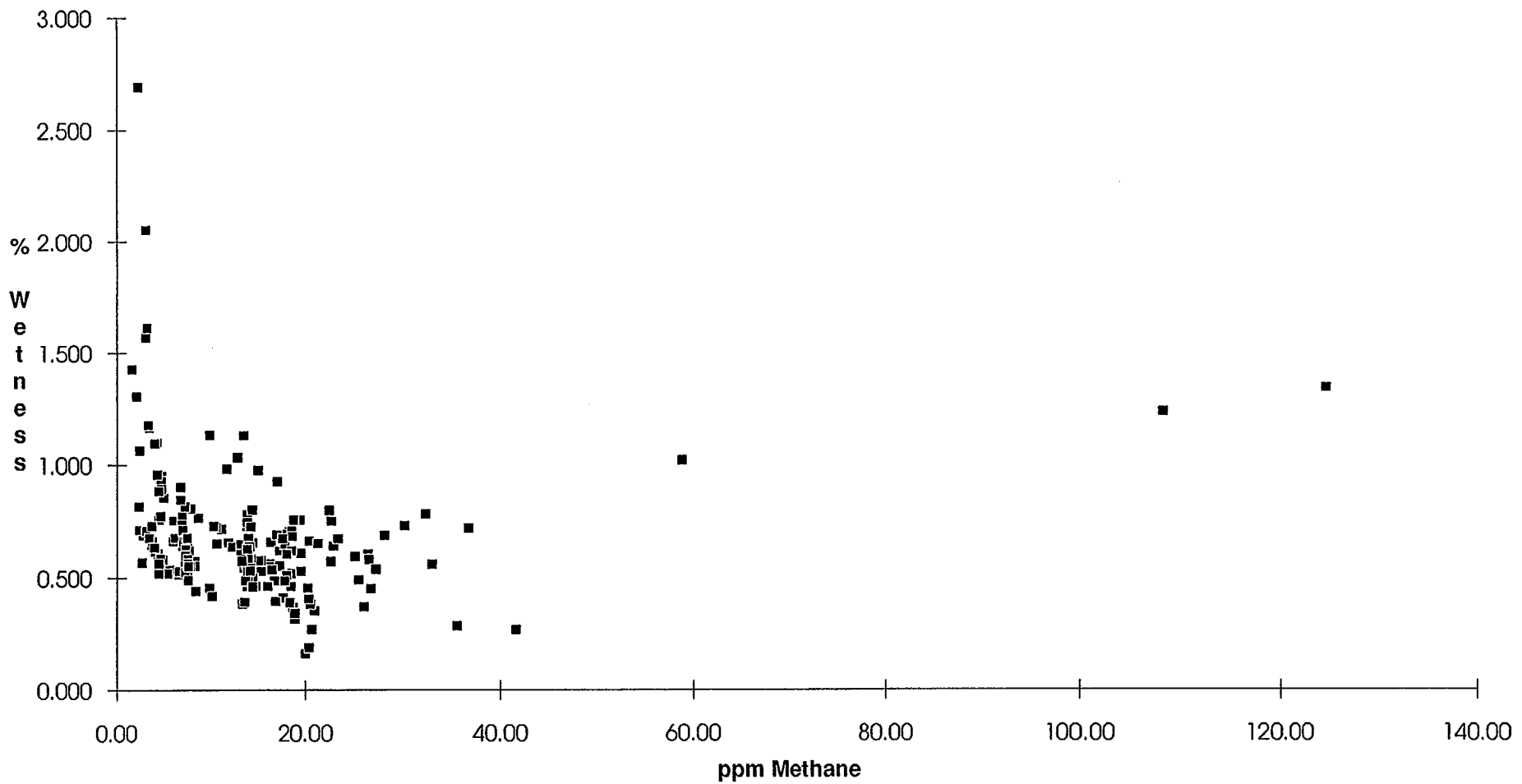
Line 109058 Ethane, Ethylene, Propane



Line 109058 Depths, Altitudes



Line 109058 Methane v. %Wetness



Line Summary

Line Number	109059
No. of Shotpoints	125

	Shotpoint	Date	Time	Latitude		Longitude	
Start	1	28-Apr-92	05:38:45	13	17.907	122	45.003
End	125	28-Apr-92	09:50:34	13	23.112	123	00.534

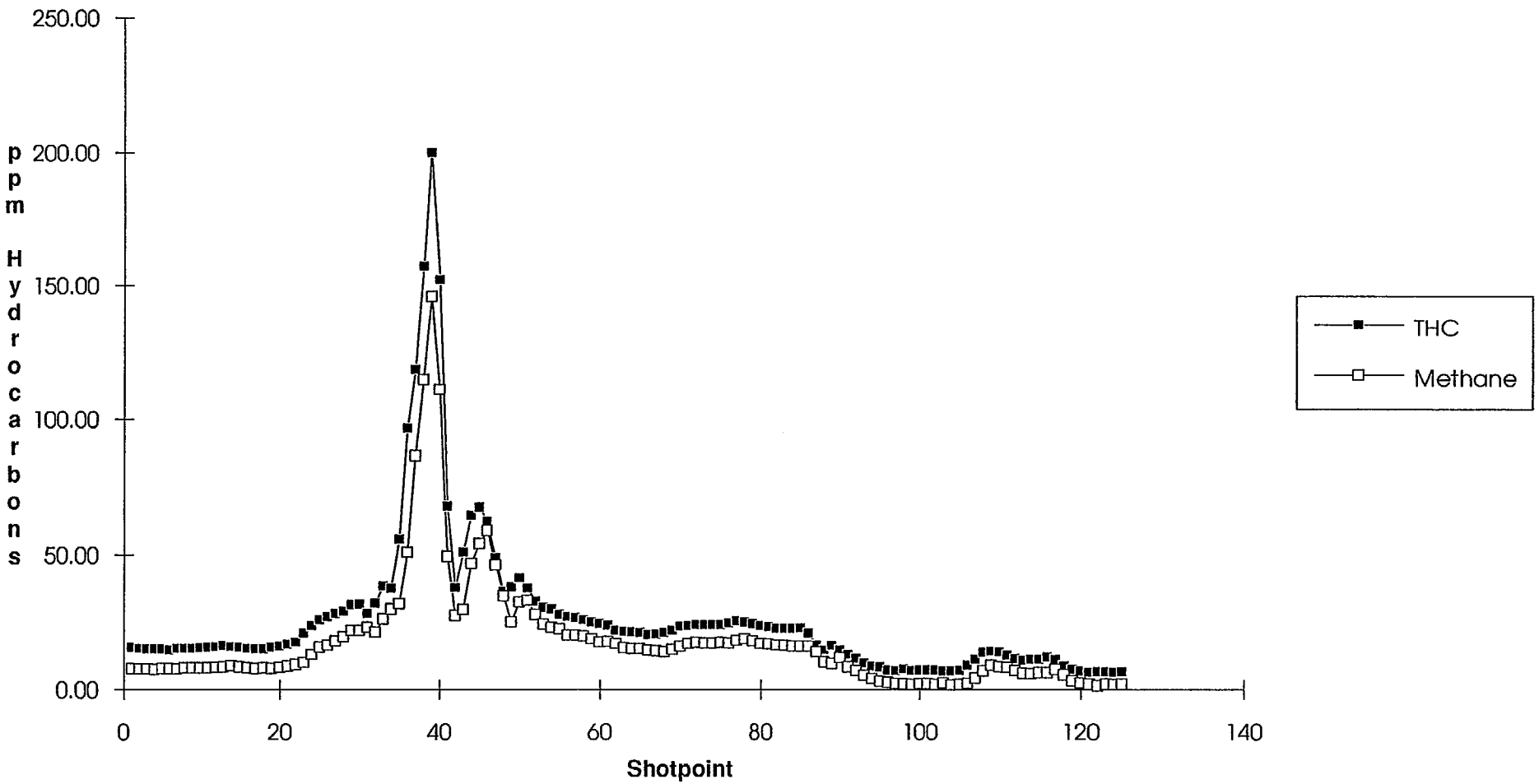
	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	26.118	17.684	0.024	0.045	0.021	0.015	0.003	0.000	0.000	0.056	0.005	0.032	0.470
Std. Dev.	28.385	21.413	0.014	0.059	0.009	0.018	0.005	0.002	0.001	0.035	0.007	0.012	0.299
Minimum	6.478	1.427	0.006	0.008	0.004	0.000	0.000	0.000	0.000	0.025	0.000	0.000	0.032
Maximum	200.025	145.878	0.089	0.172	0.039	0.063	0.015	0.018	0.006	0.150	0.025	0.059	1.992

	Cond.	Temp.	F. Depth	W.Depth	Altitude	Calc. Alt.
Mean	56.874	24.324	160.110	222.964	20.406	62.833
Std. Dev.	2.164	1.455	42.008	102.809	8.561	79.404
Minimum	54.870	22.980	81.600	104.100	9.400	1.500
Maximum	61.510	27.430	206.300	467.300	30.900	263.700

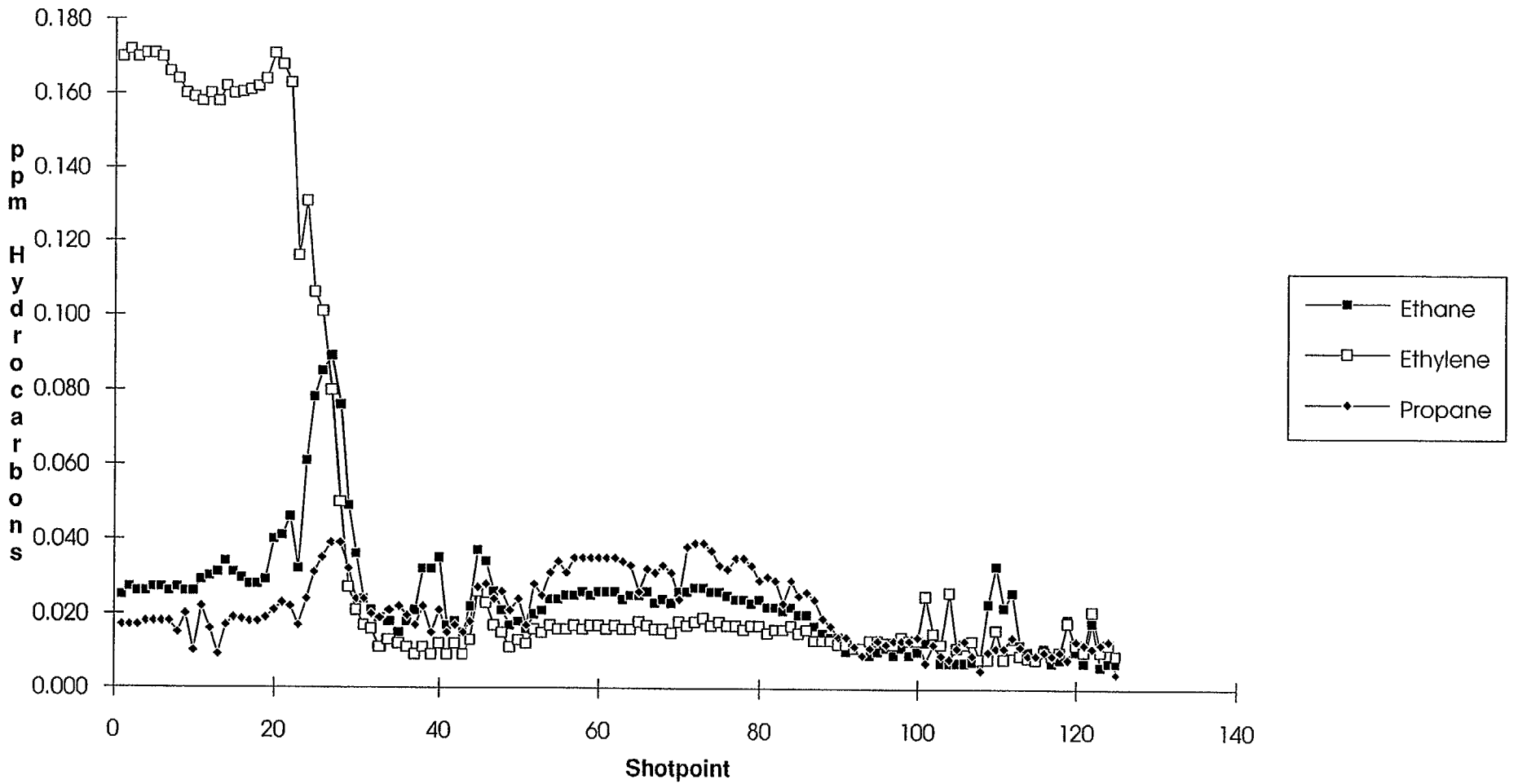
Notes

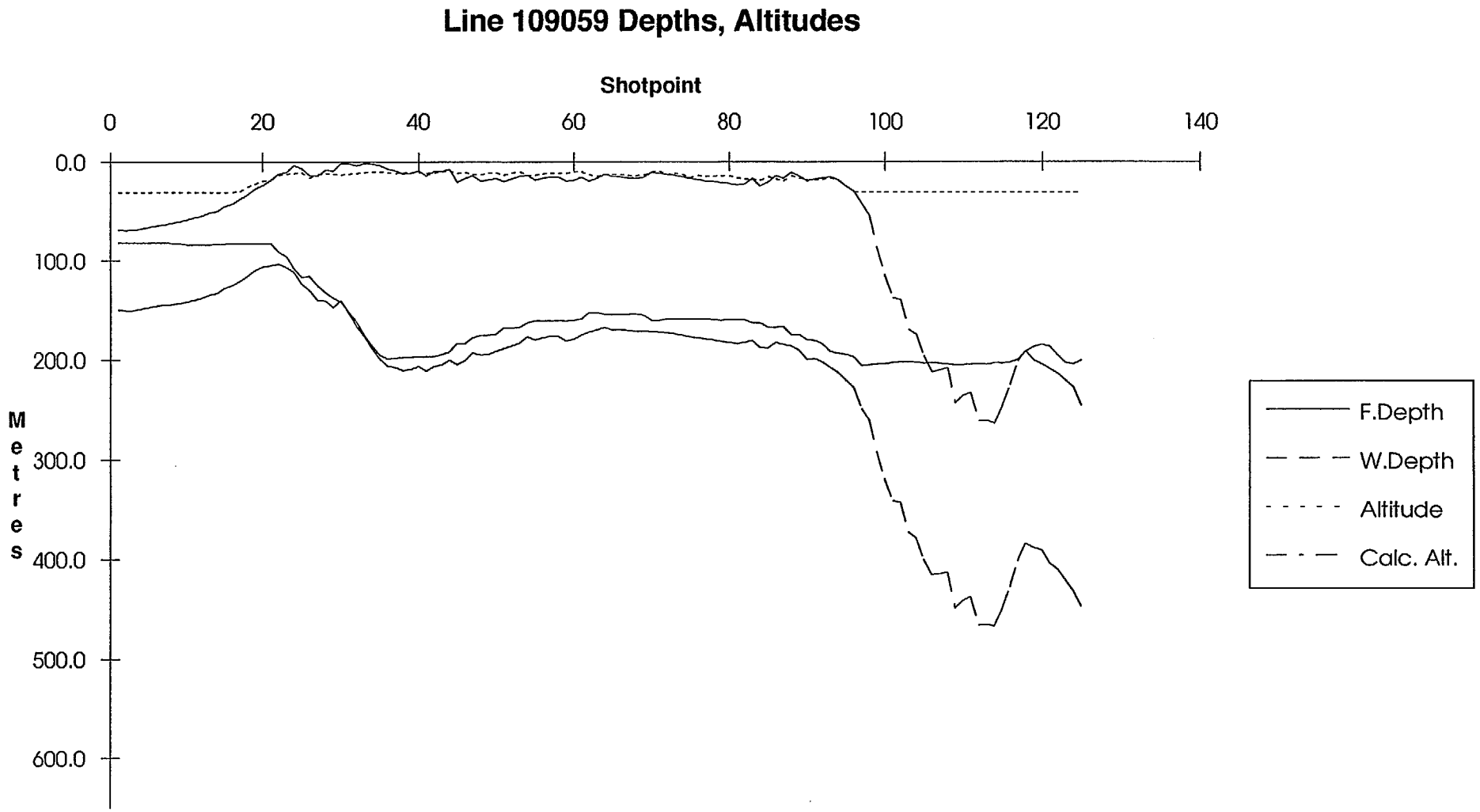
A strong THC and methane anomaly coupled with a weak ethane anomaly occurs at SP 37.
A weak THC, methane , ethane and propane anomaly occurs at SP 46.
A very weak THC , methane, ethane and propane anomaly occurs at SP 110.
A weak ethane and propane anomaly occurs at SP 24.
Gas samples for carbon isotope analysis where taken at SP 35 to 42 and from SP 48 to 52.

Line 109059 THC, Methane

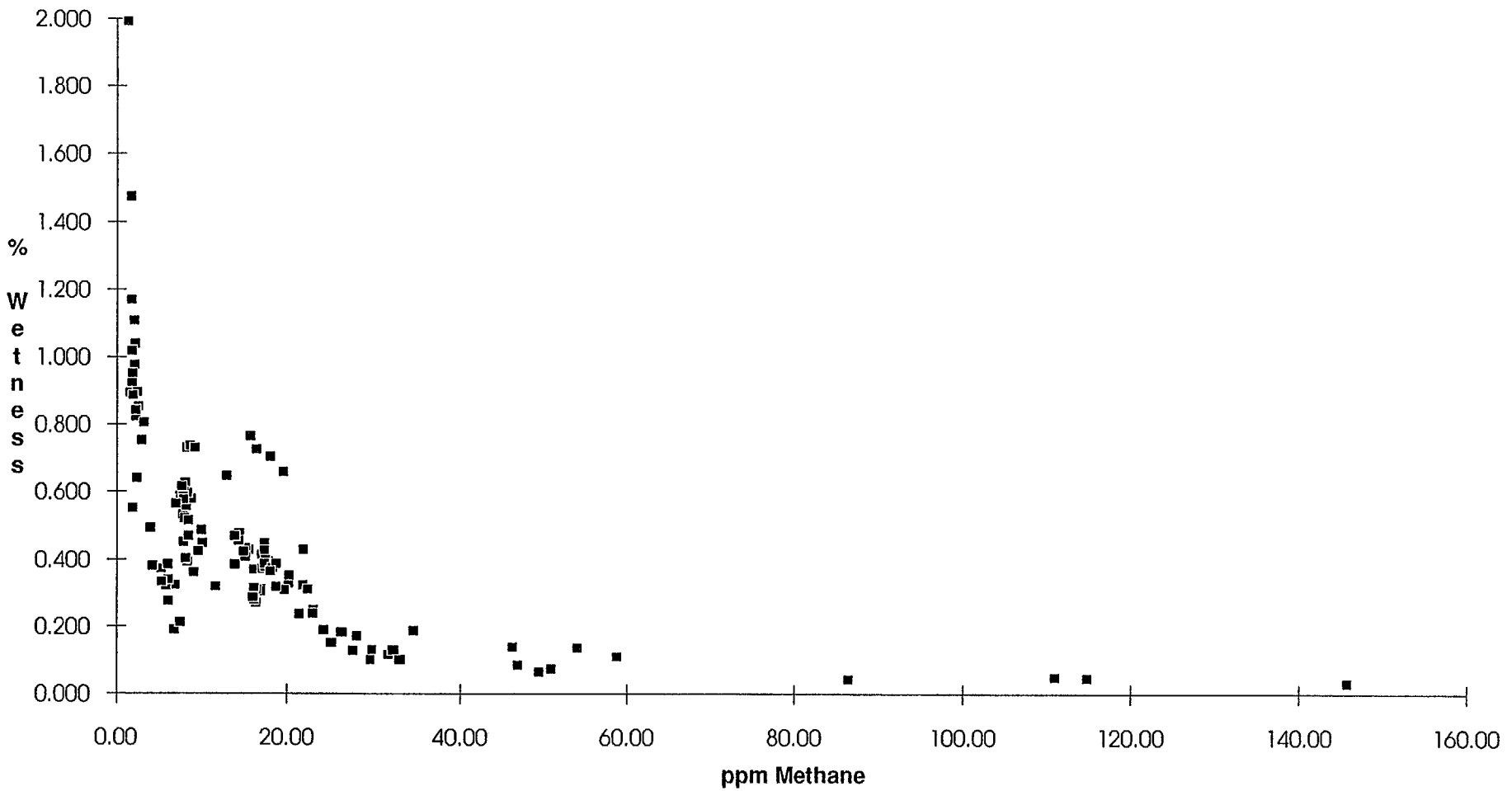


Line 109059 Ethane, Ethylene, Propane




Line 109059 Depths, Altitudes
Shotpoint
0
20
40
60
80
100
120
140
0.0
100.0
200.0
300.0
400.0
500.0
600.0
Metres
F.Depth
W.Depth
Altitude
Calc. Alt.

Line 109059 Methane v. %Wetness



Line Summary

Line Number	Sniff9
No. of Shotpoints	381

	Shotpoint	Date	Time	Latitude		Longitude	
Start	2	28-Apr-92	09:54:33	13	23.099	123	00.173
End	384	28-Apr-92	22:54:43	13	27.716	122	51.864

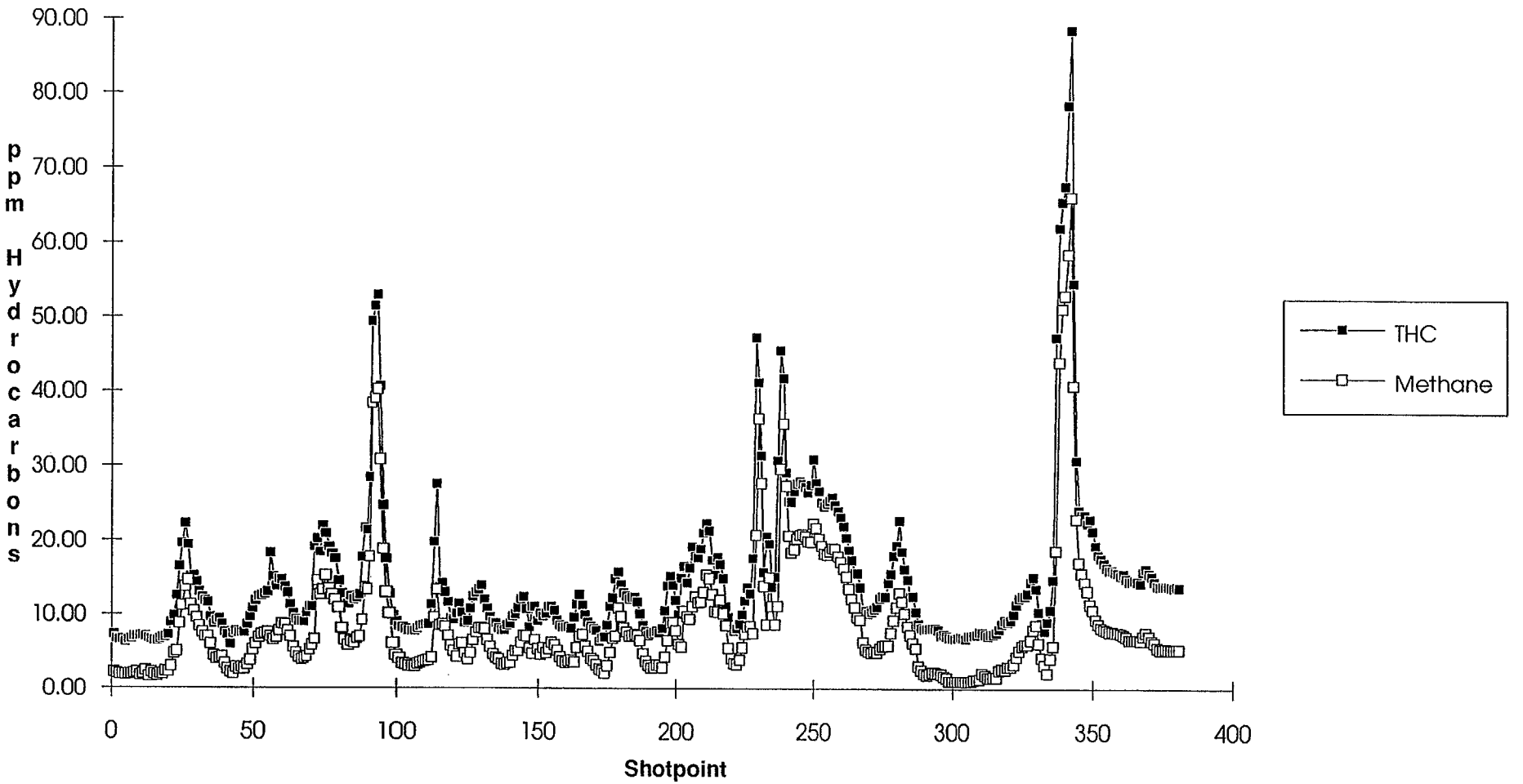
	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	14.677	8.391	0.018	0.031	0.017	0.008	0.010	0.001	0.001	0.042	0.004	0.018	0.844
Std. Dev.	10.374	8.466	0.019	0.074	0.010	0.022	0.012	0.005	0.004	0.041	0.006	0.013	0.831
Minimum	5.894	0.941	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Maximum	88.548	66.158	0.195	0.405	0.095	0.140	0.055	0.047	0.017	0.249	0.024	0.053	7.476

	Cond.	Temp.	F. Depth	W.Depth	Altitude	Calc. Alt.
Mean	54.699	22.811	191.016	374.159	27.886	183.180
Std. Dev.	1.349	0.887	49.151	111.682	6.332	128.508
Minimum	53.470	21.960	4.600	173.200	8.700	4.800
Maximum	60.810	26.840	228.800	522.400	30.900	470.600

Notes

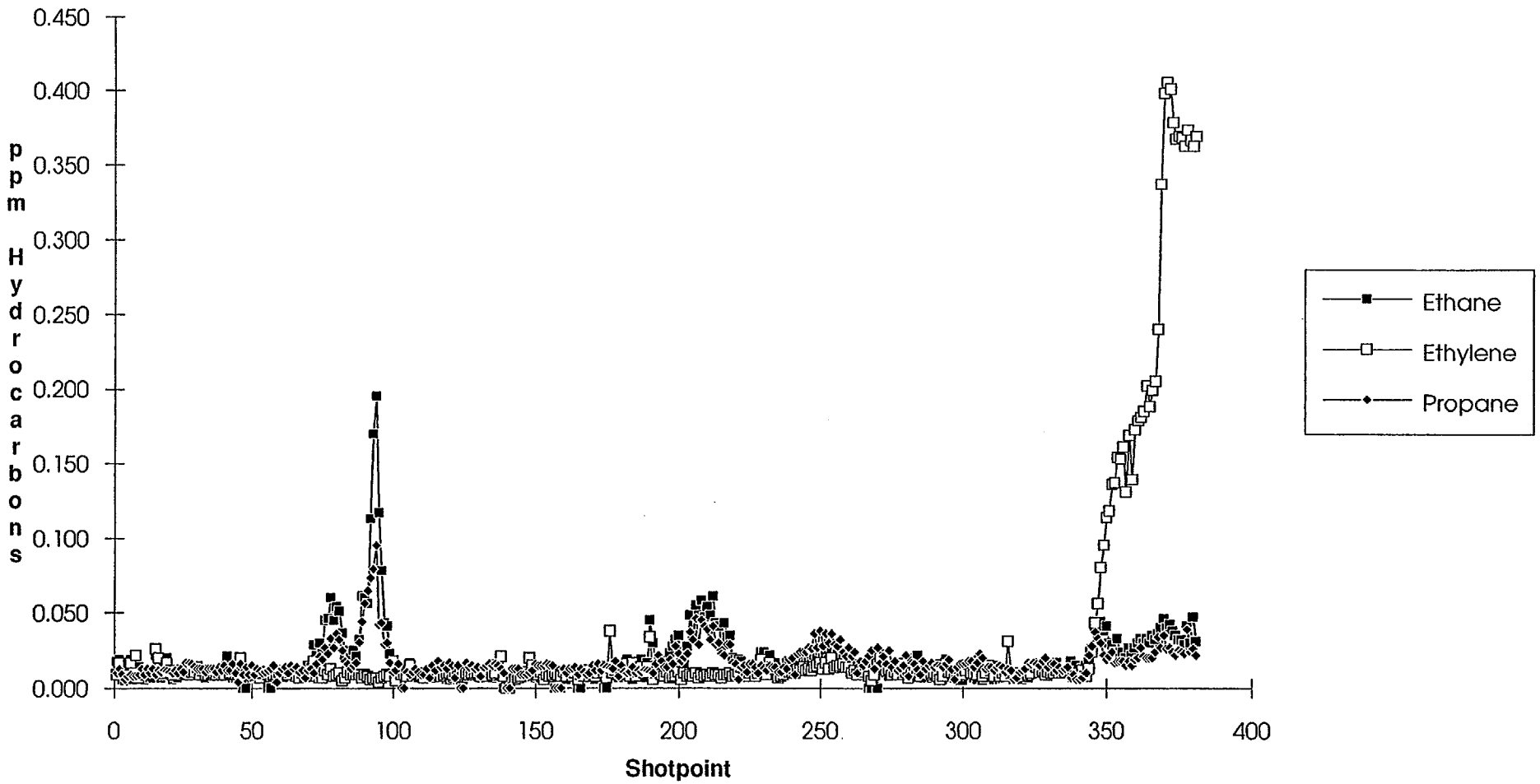
A moderate THC and methane anomaly occurs at SP 340, three weak to moderate anomalies are seen at SP 92, SP 230 and SP 240, numerous weak anomalies occur throughout the line.
A strong ethane and methane occurs at SP 92, three weak anomalies occur at SP 80,SP 210, and SP 250.
The strong ethylene value after SP 350 is related to the fish being raised through the thermocline.
Gas samples for carbon isotope analysis where taken at SP 342 to SP 346

Line SNIFF9 THC, Methane

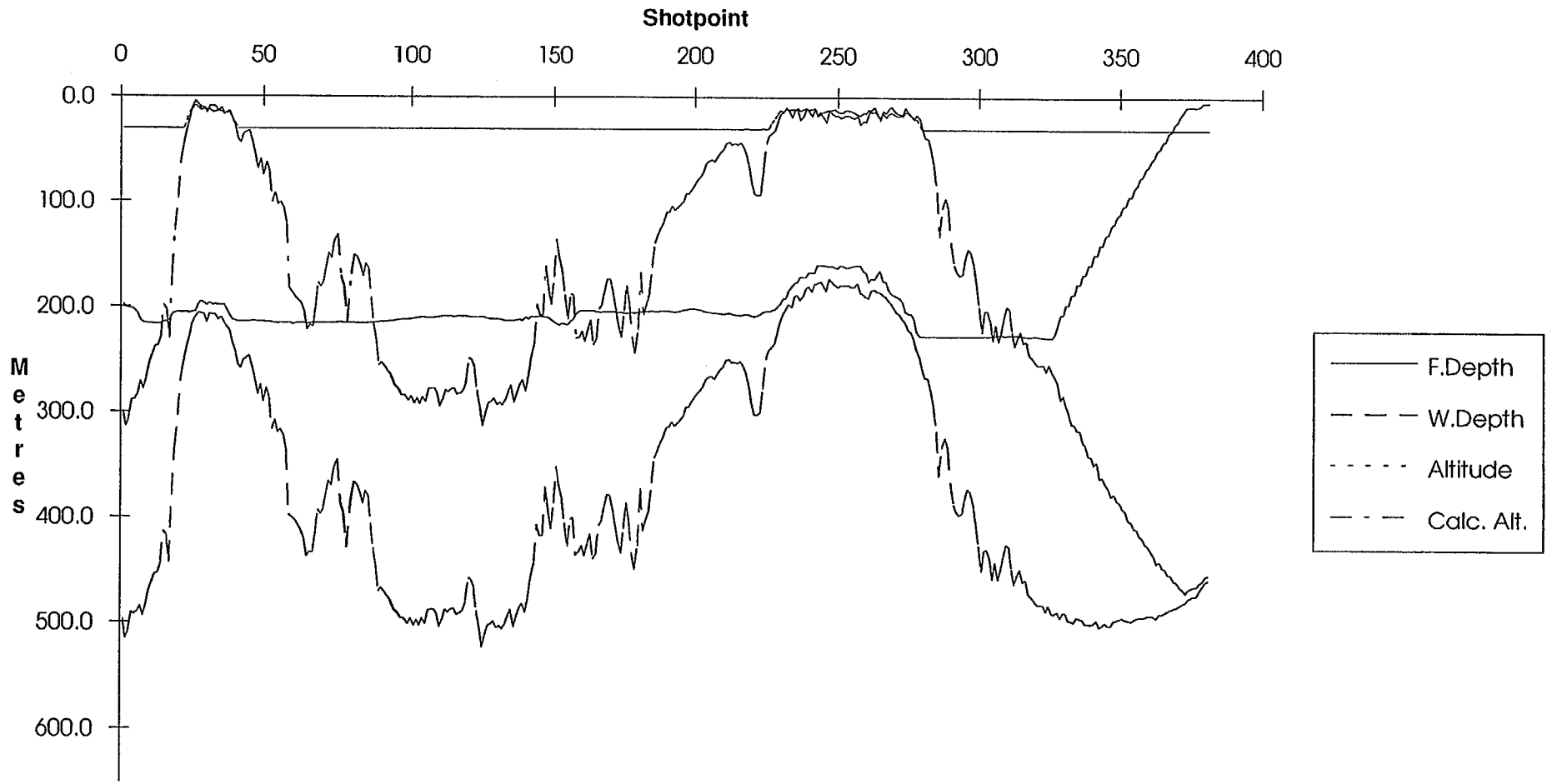


R9209204

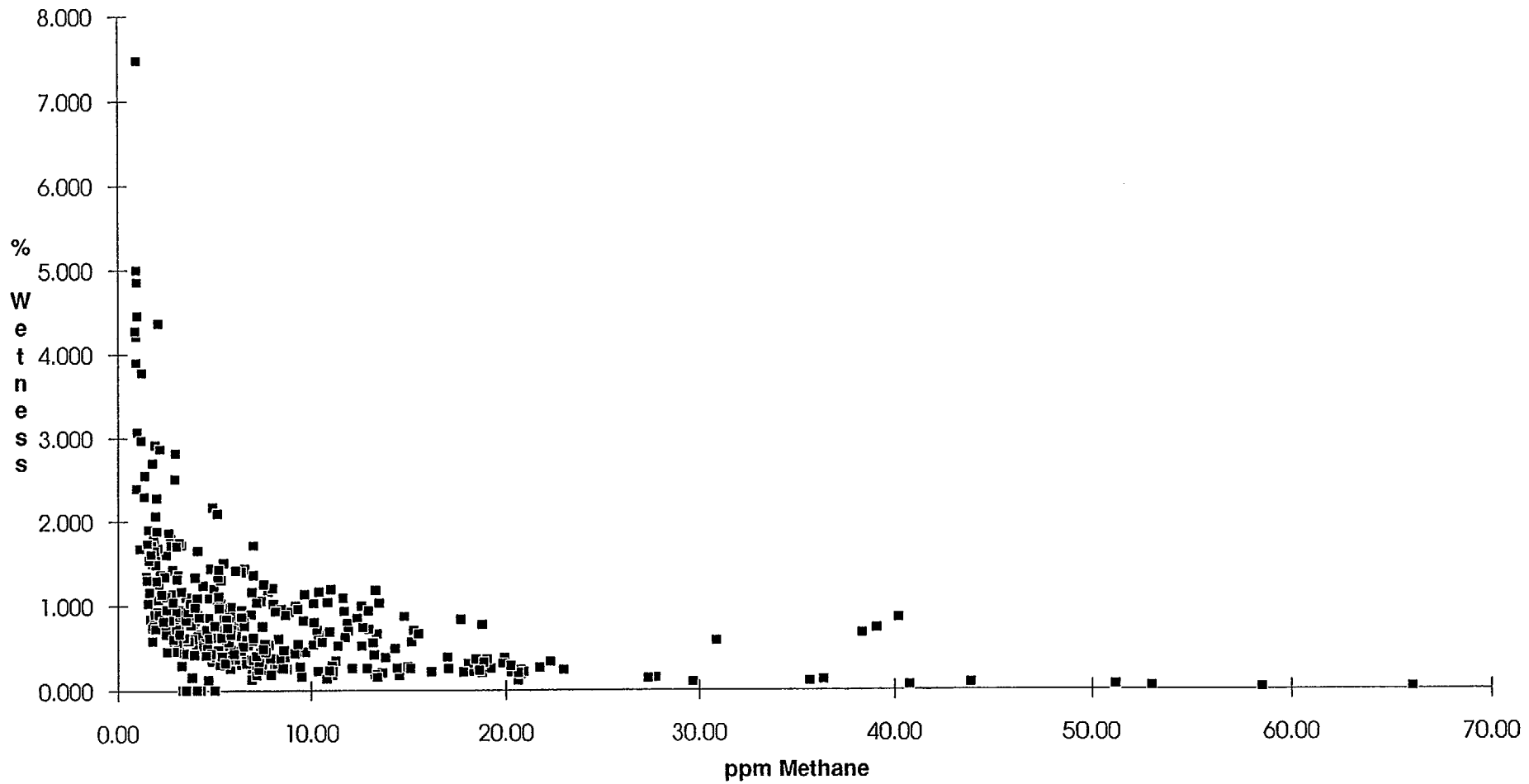
Line SNIFF9 Ethane, Ethylene, Propane



Line SNIFF9 Depths, Altitudes



Line SNIFF9 Methane v. %Wetness



Line Summary

Line Number	Sniff9A
No. of Shotpoints	130

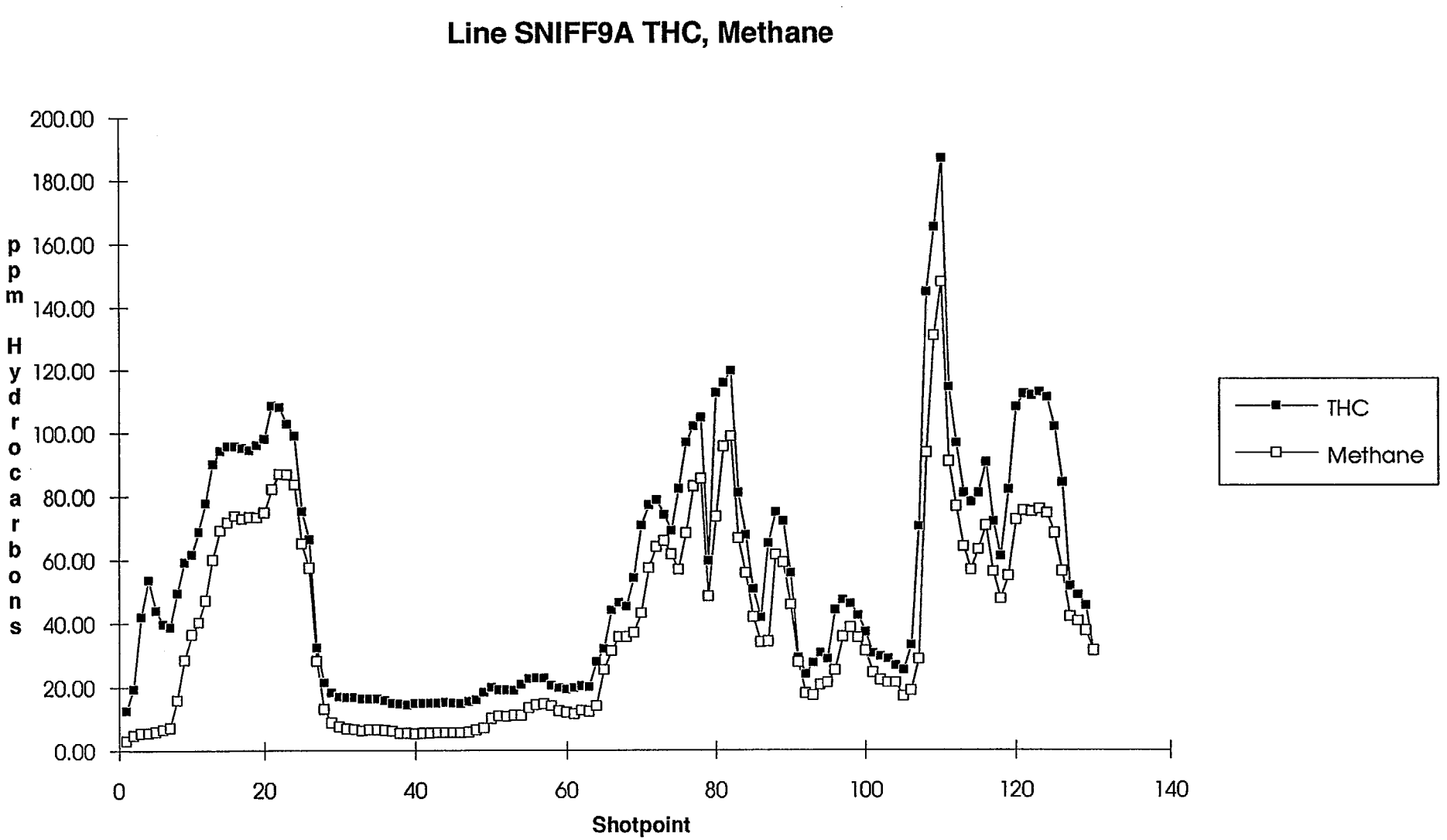
	Shotpoint	Date	Time	Latitude		Longitude	
Start	1	28-Apr-92	23:33:12	13	27.720	122	51.524
End	130	29-Apr-92	04:02:47	13	33.718	122	49.703

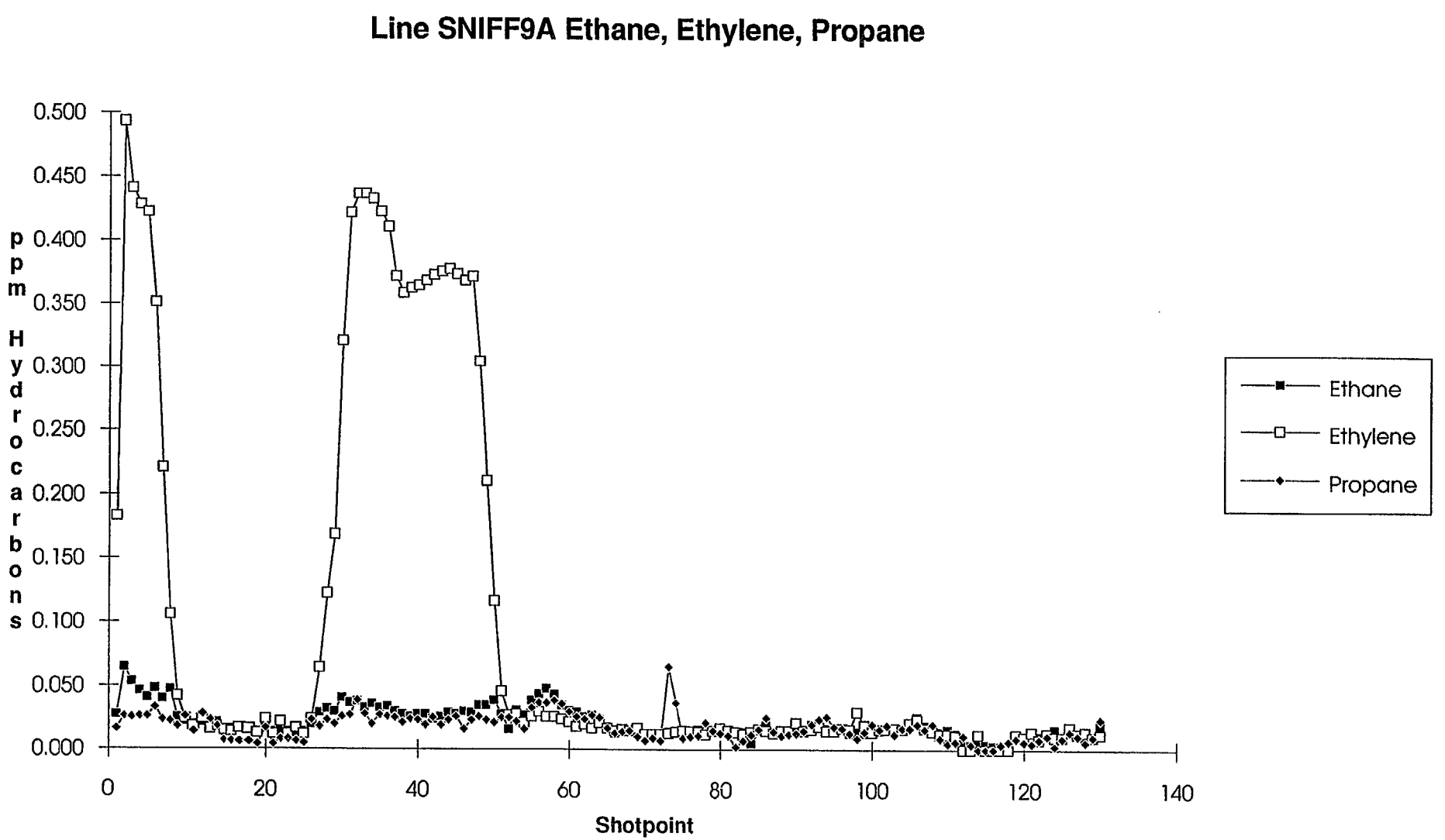
	THC	Methane	Ethane	Ethylene	Propane	Propylene	I-Butane	n-Butane	I-Pentane	n-Pentane	I-Hexane	n-Hexane	%Wetness
Mean	55.776	39.125	0.021	0.094	0.017	0.034	0.018	0.004	0.003	0.074	0.008	0.026	0.471
Std. Dev.	37.094	30.577	0.011	0.148	0.010	0.045	0.014	0.008	0.004	0.080	0.006	0.008	0.606
Minimum	12.487	3.138	0.003	0.000	0.000	0.000	0.000	0.000	0.000	0.013	0.000	0.000	0.007
Maximum	186.621	147.890	0.064	0.493	0.065	0.166	0.071	0.040	0.029	0.259	0.023	0.043	3.506

	Cond.	Temp.	F. Depth	W.Depth	Altitude	Calc. Alt.
Mean	57.303	24.593	116.362	384.691	30.907	268.335
Std. Dev.	2.138	1.405	51.174	113.638	0.031	98.185
Minimum	55.360	23.290	9.700	180.200	30.800	53.200
Maximum	62.070	27.750	151.000	527.400	31.000	412.200

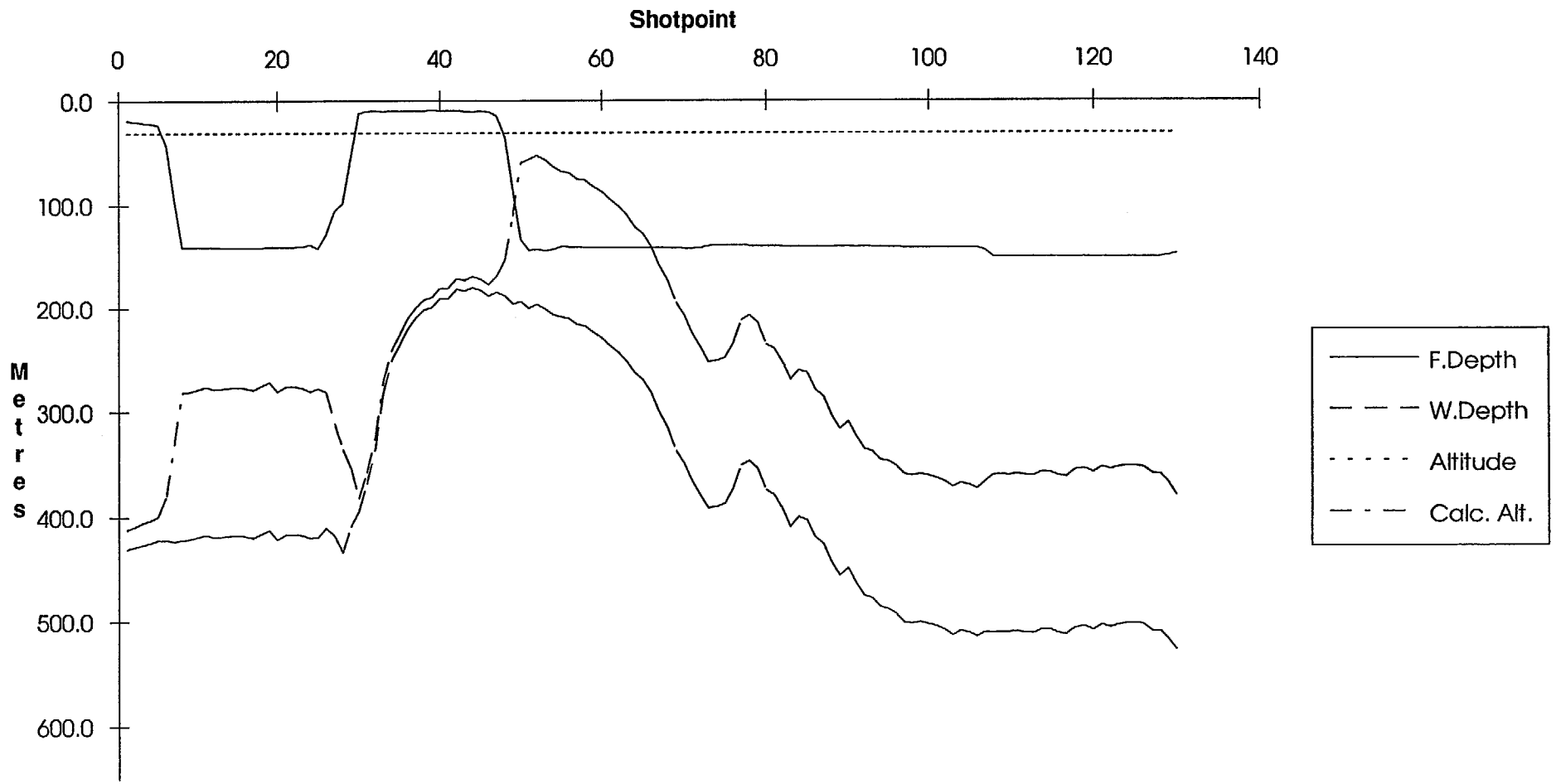
Notes

A strong THC and methane anomaly occurs at SP 110, three moderate anomalies are seen at SP 20, SP 80, and SP 120, a weak anomaly occurs at SP 95.
Increased ethylene values prior to SP 10 and between SP 25 and 50 are related to the fish being raised and lowered through the surface waters.
Gas samples for carbon isotope analysis whee taken at SP 13 to SP 28, SP 69 to SP 81, SP 81 to 86, SP 88 to SP 91, and SP 111 to SP 128.

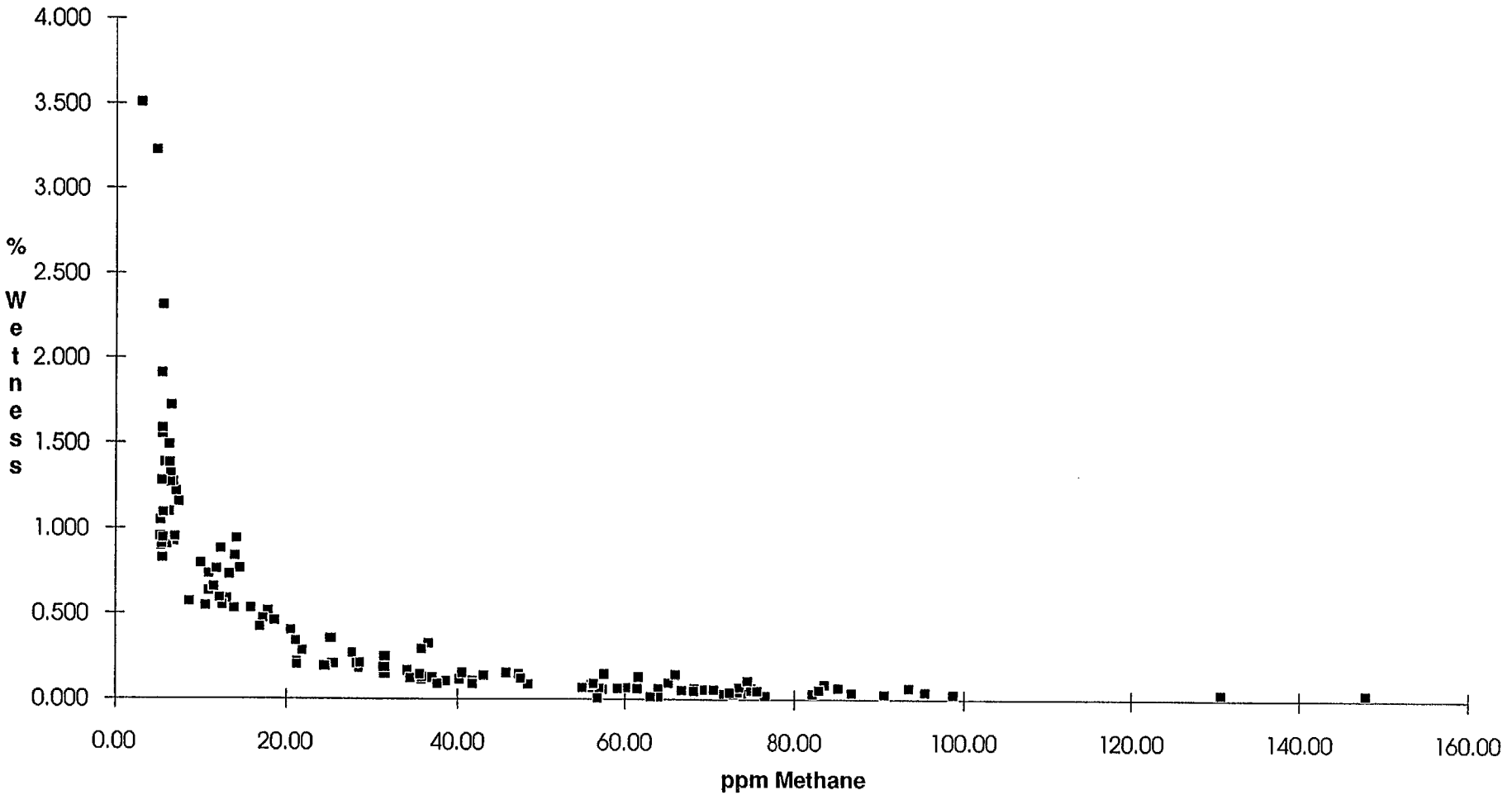

Line SNIFF9A THC, Methane
ppm Hydrocarbons
200.00
180.00
160.00
140.00
120.00
100.00
80.00
60.00
40.00
20.00
0.00
0
20
40
60
80
100
120
140
Shotpoint
THC
Methane


Line SNIFF9A Ethane, Ethylene, Propane
ppm Hydrocarbons
0.500
0.450
0.400
0.350
0.300
0.250
0.200
0.150
0.100
0.050
0.000
0
20
40
60
80
100
120
140
Shotpoint
Ethane
Ethylene
Propane

Line SNIFF9A Depths, Altitudes



Line SNIFF9A Methane v. %Wetness



Line Summary

Line Number	109060
No. of Shotpoints	75

	Shotpoint	Date	Time	Latitude		Longitude	
Start	1	29-Apr-92	05:03:24	13	38.166	122	47.698
End	75	29-Apr-92	07:34:36	13	33.238	122	38.428

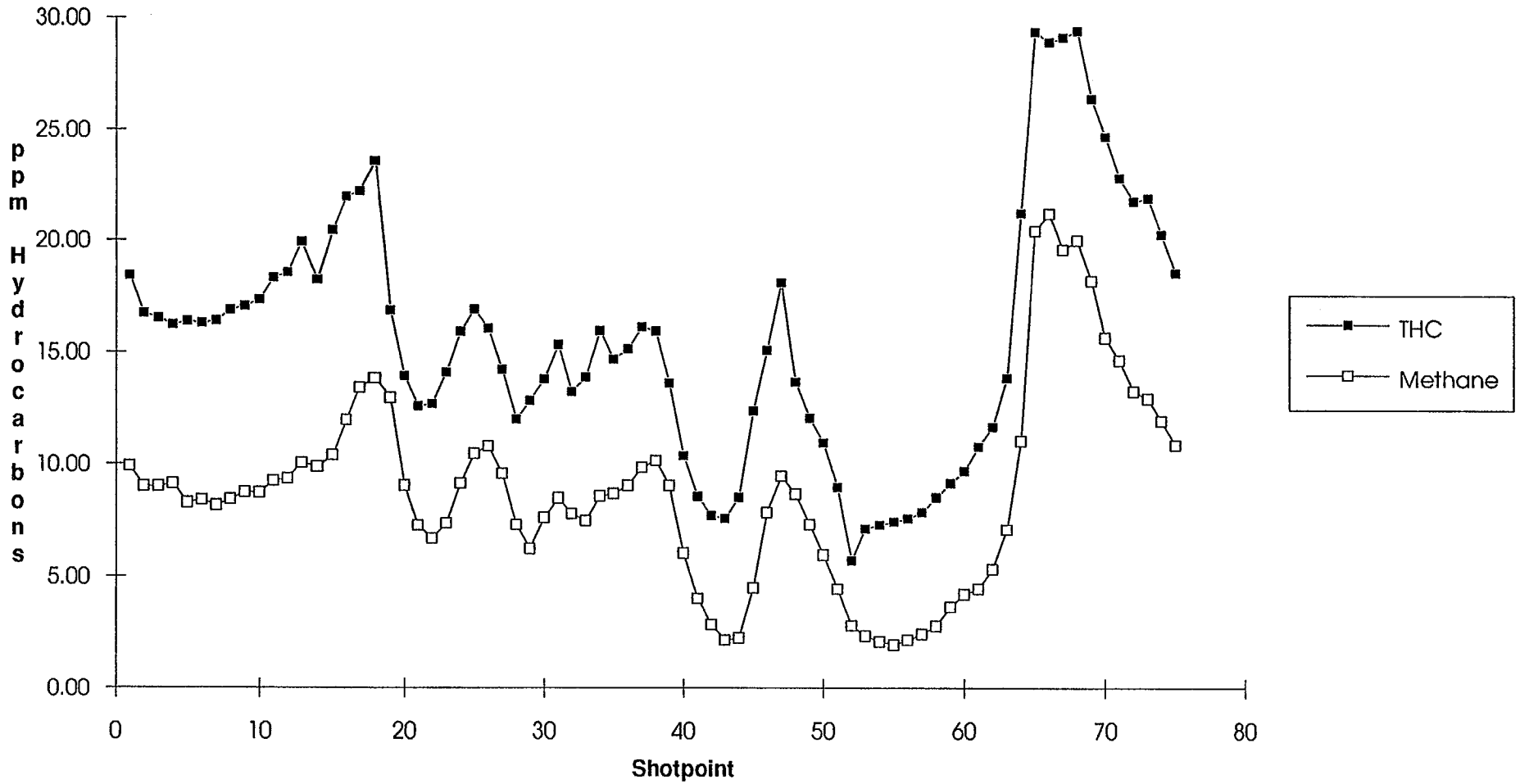
	THC	Methane	Ethane	Ethylene	Propane	Propylene	I-Butane	n-Butane	I-Pentane	n-Pentane	I-Hexane	n-Hexane	%Wetness
Mean	15.616	8.743	0.028	0.057	0.020	0.014	0.002	0.002	0.001	0.061	0.008	0.027	0.685
Std. Dev.	5.666	4.410	0.020	0.060	0.011	0.015	0.005	0.006	0.003	0.033	0.007	0.007	0.332
Minimum	5.688	1.945	0.008	0.009	0.004	0.000	0.000	0.000	0.000	0.031	0.000	0.013	0.262
Maximum	29.390	21.179	0.094	0.176	0.087	0.055	0.019	0.022	0.010	0.130	0.025	0.048	1.830

	Cond.	Temp.	F. Depth	W.Depth	Altitude	Calc. Alt.
Mean	57.789	24.939	148.307	295.031	26.660	146.613
Std. Dev.	1.861	1.237	50.189	174.326	6.594	133.460
Minimum	56.240	23.910	57.300	74.800	11.900	2.100
Maximum	60.940	27.050	194.900	547.600	30.900	352.800

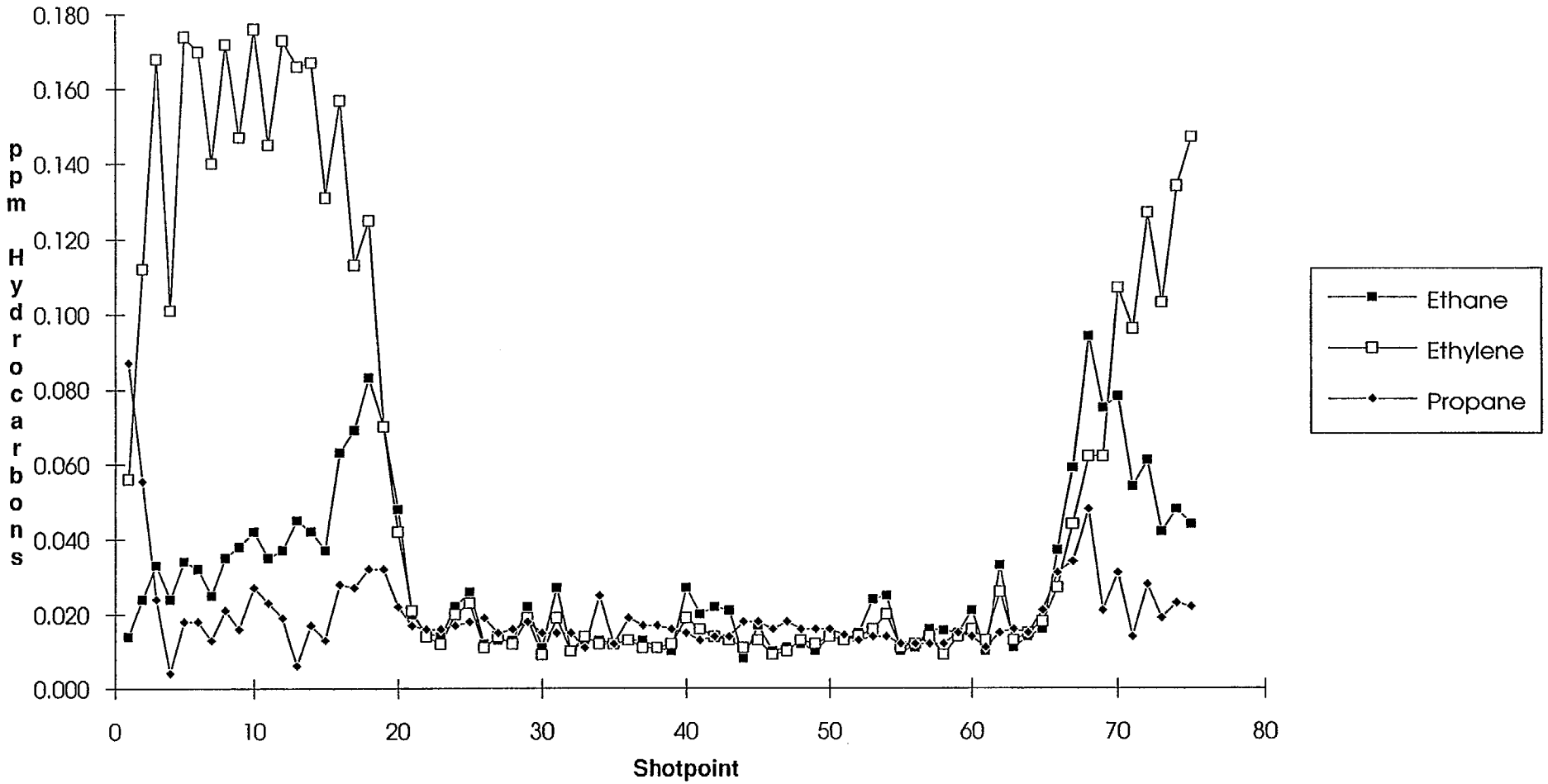
Notes

Two weak THC and methane anomalies occur at SP 24 and SP 47, the former having a weak ethane and propane anomaly.
Prior to SP 18 and after SP 62 hydrocarbon values increase due to the influence of the thermocline as the fish is lowered and then raised through it.

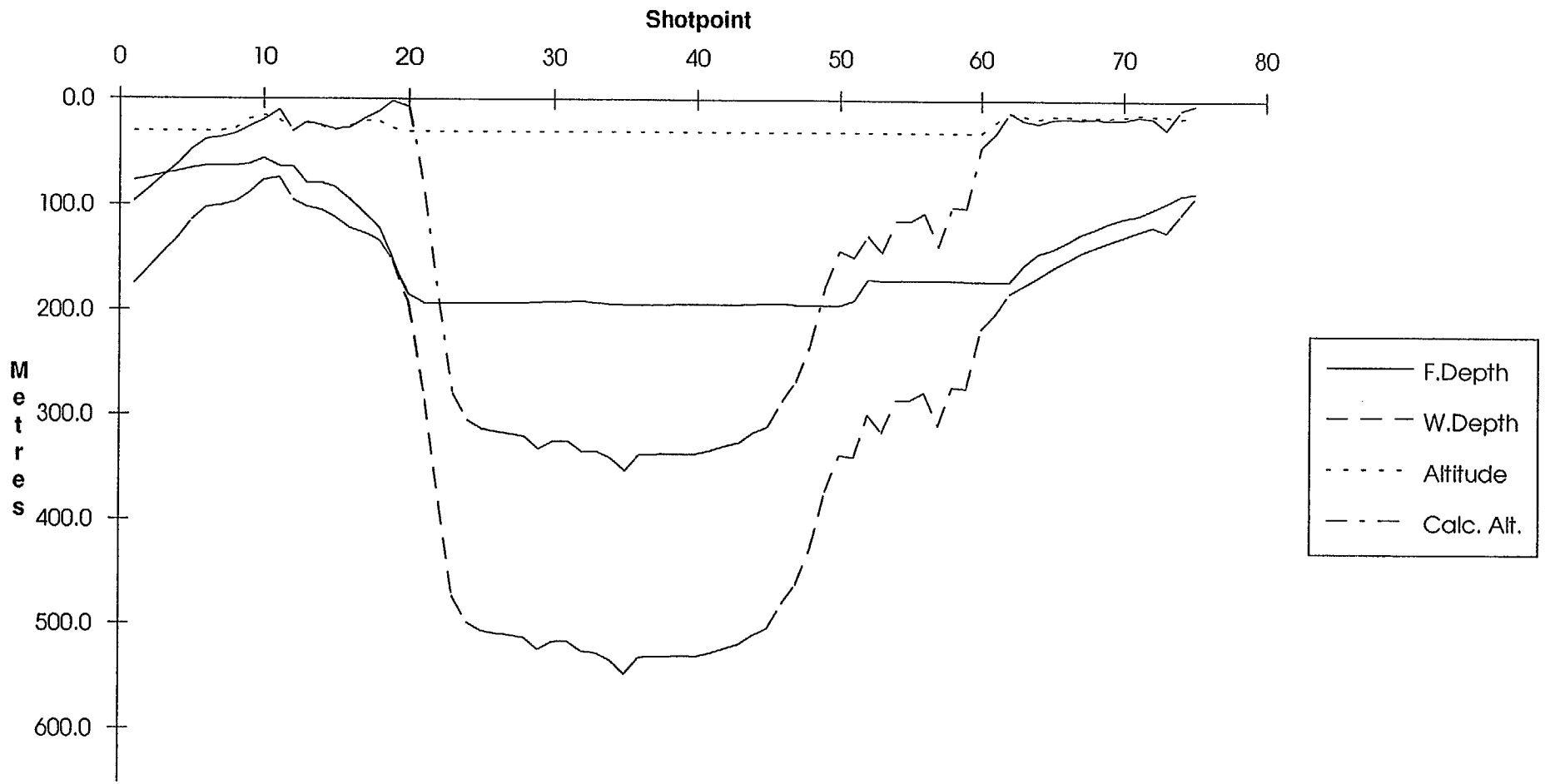
Line 109060 THC, Methane



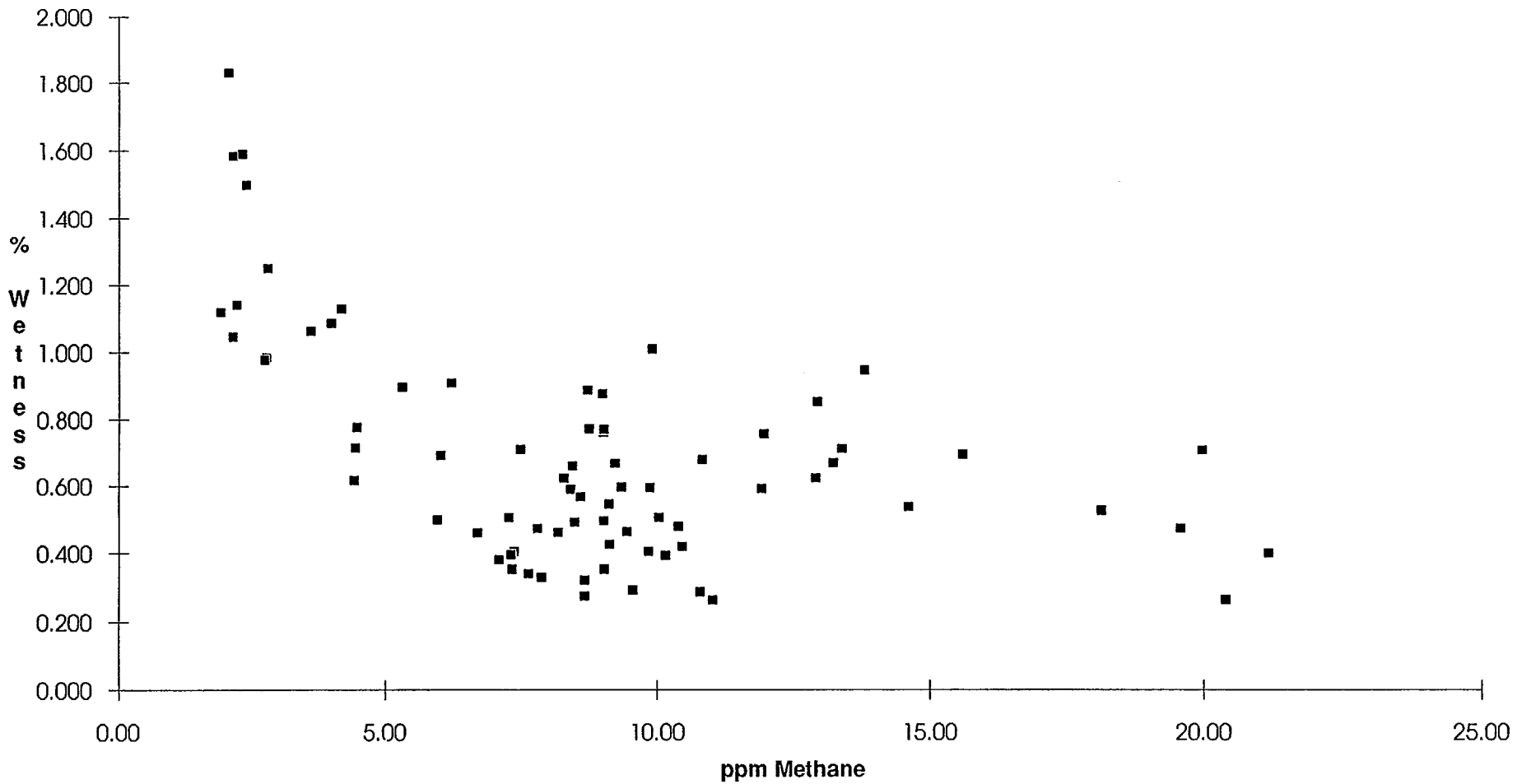
Line 109060 Ethane, Ethylene, Propane



Line 109060 Depths, Altitudes



Line 109060 Methane v. %Wetness



Line Summary

Line Number	109061
No. of Shotpoints	80

	Shotpoint	Date	Time	Latitude		Longitude	
Start	1	29-Apr-92	07:36:36	13	33.109	122	38.335
End	82	29-Apr-92	10:22:36	13	37.866	122	48.122

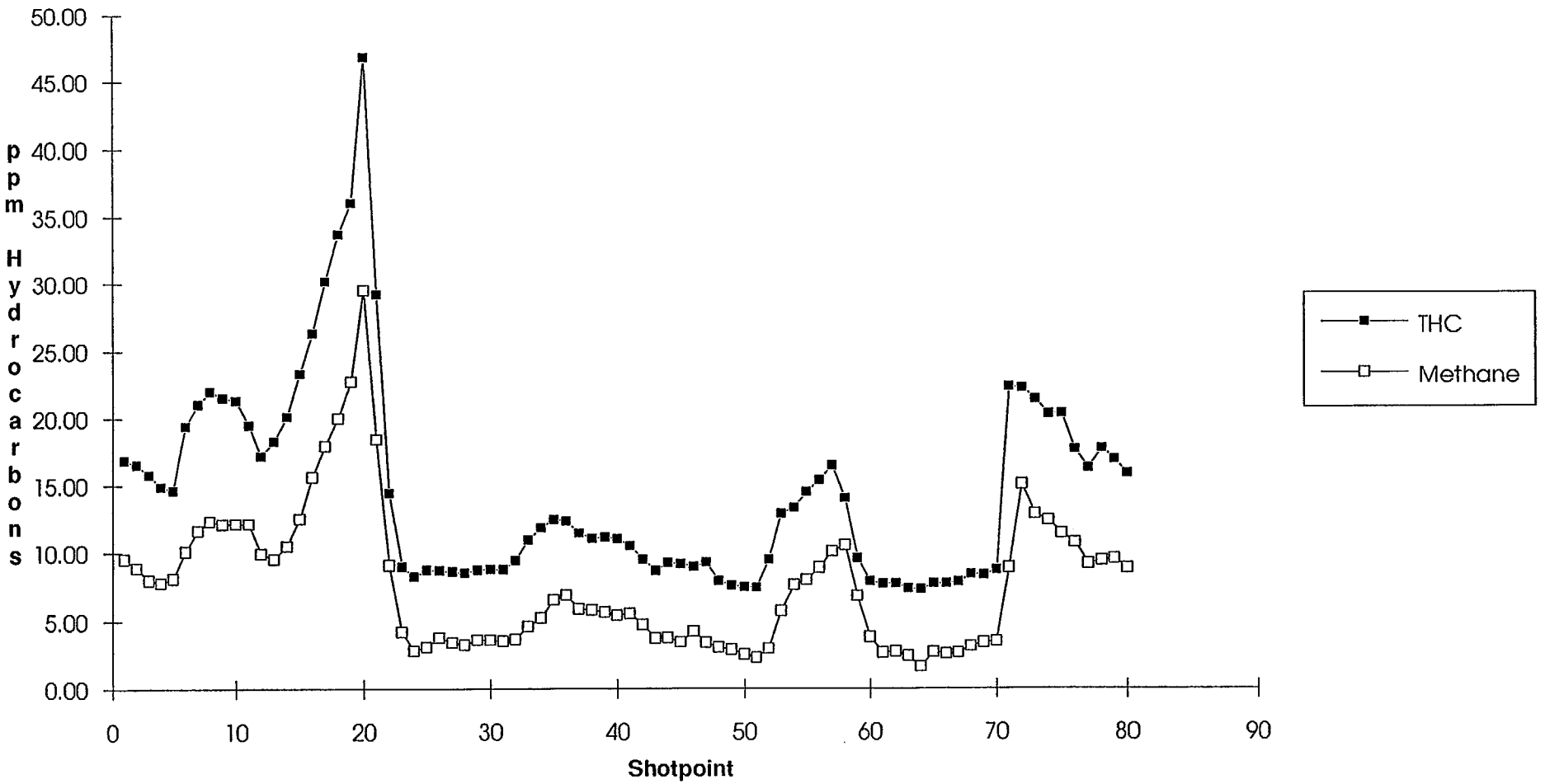
	THC	Methane	Ethane	Ethylene	Propane	Propylene	I-Butane	n-Butane	I-Pentane	n-Pentane	I-Hexane	n-Hexane	%Wetness
Mean	14.473	7.624	0.024	0.055	0.016	0.014	0.002	0.001	0.001	0.057	0.007	0.026	0.672
Std. Dev.	7.496	5.189	0.018	0.064	0.008	0.014	0.005	0.006	0.002	0.032	0.006	0.007	0.386
Minimum	7.342	1.632	0.000	0.007	0.000	0.000	0.000	0.000	0.000	0.022	0.000	0.000	0.066
Maximum	46.779	29.512	0.077	0.206	0.032	0.049	0.036	0.045	0.007	0.134	0.022	0.046	2.637

	Cond.	Temp.	F. Depth	W.Depth	Altitude	Calc. Alt.
Mean	56.885	24.321	157.024	367.542	26.610	210.885
Std. Dev.	1.869	1.245	54.092	171.953	6.977	140.174
Minimum	55.280	23.240	54.600	70.200	10.100	0.400
Maximum	60.560	26.790	198.300	549.200	30.900	398.400

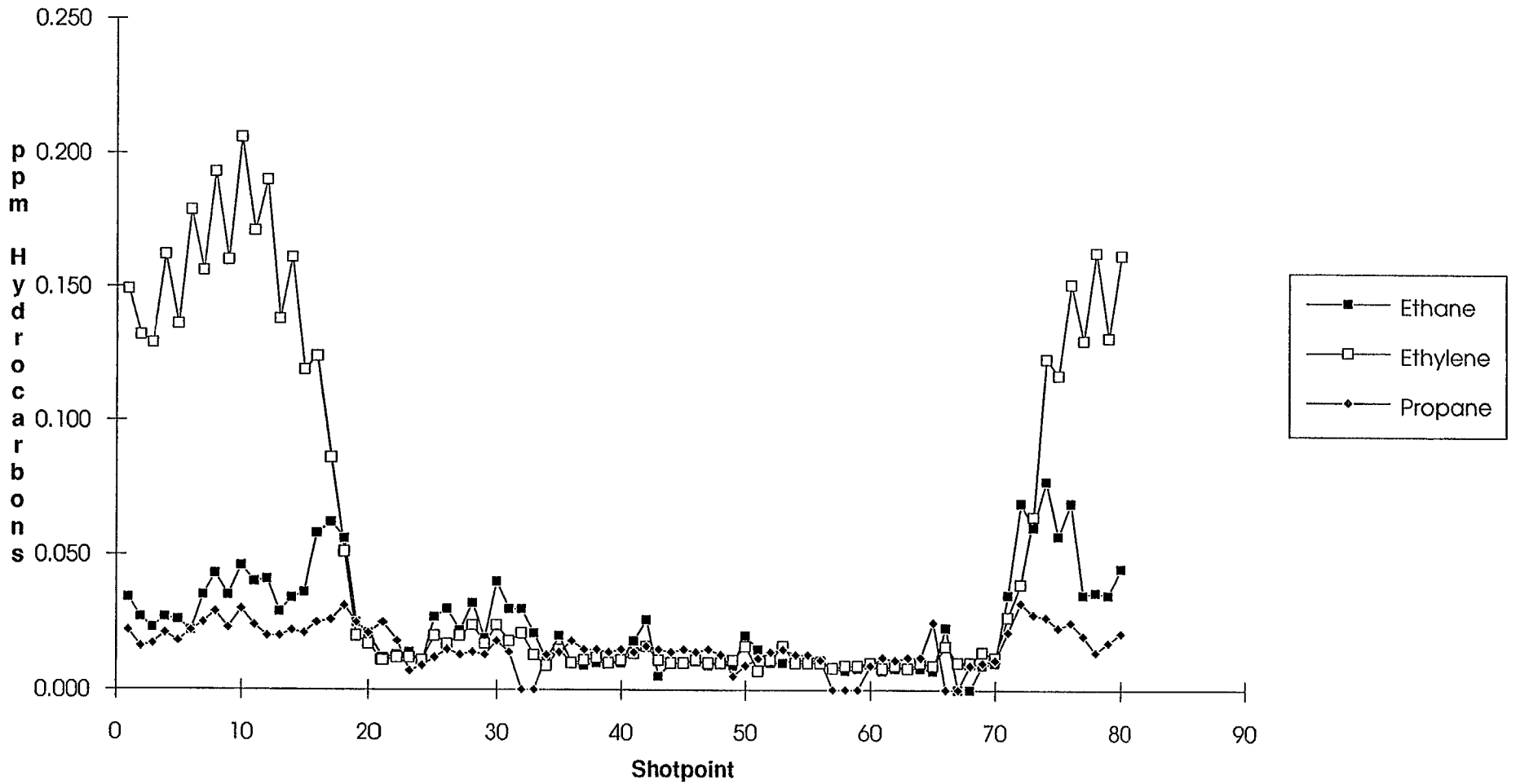
Notes

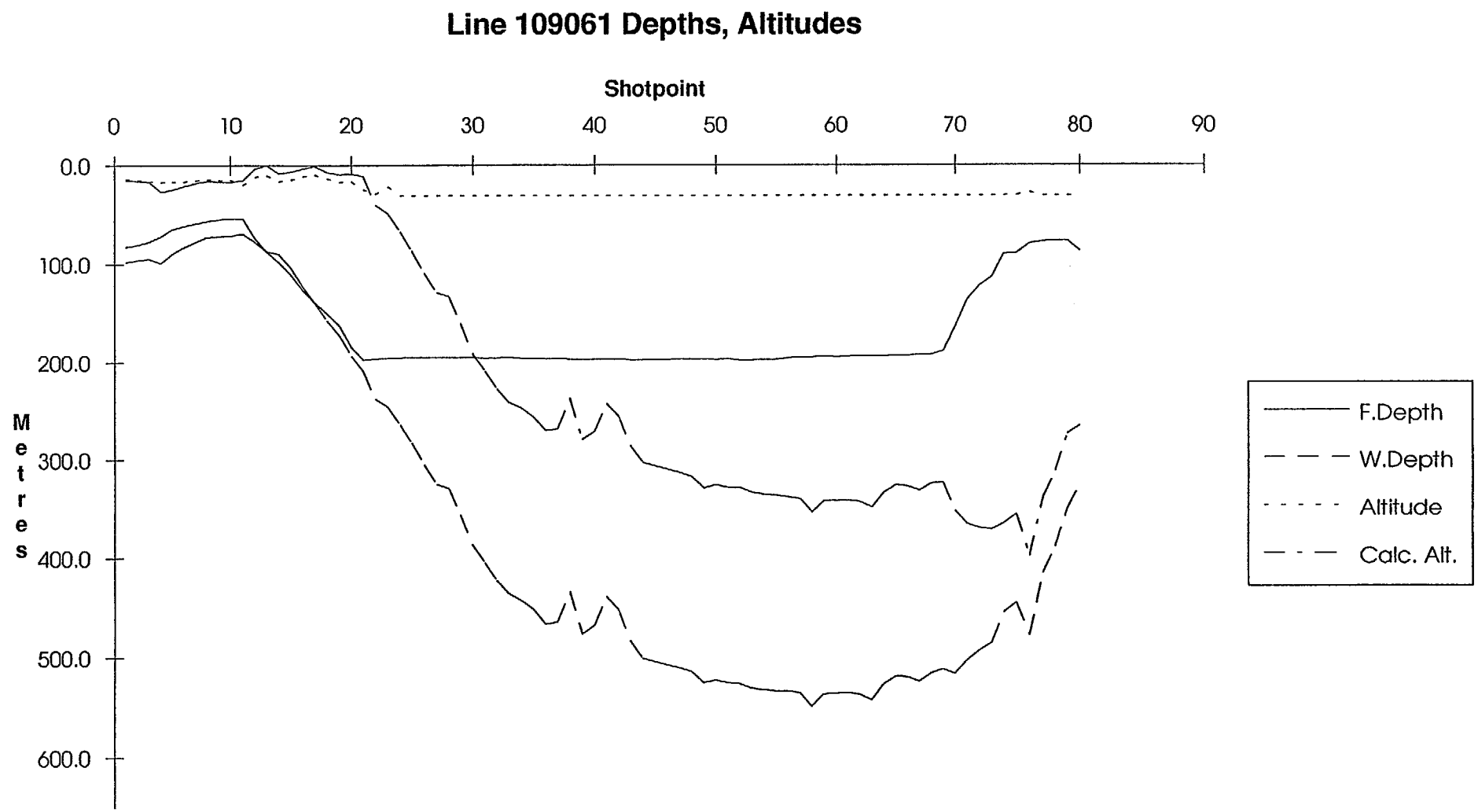
Two weak THC and methane anomalies are seen at SP 19 and SP 55.
High hydrocarbon readings prior to SP 18 and after SP 70 are related to the fish being lowered and then raised through the thermocline.

Line 109061 THC, Methane

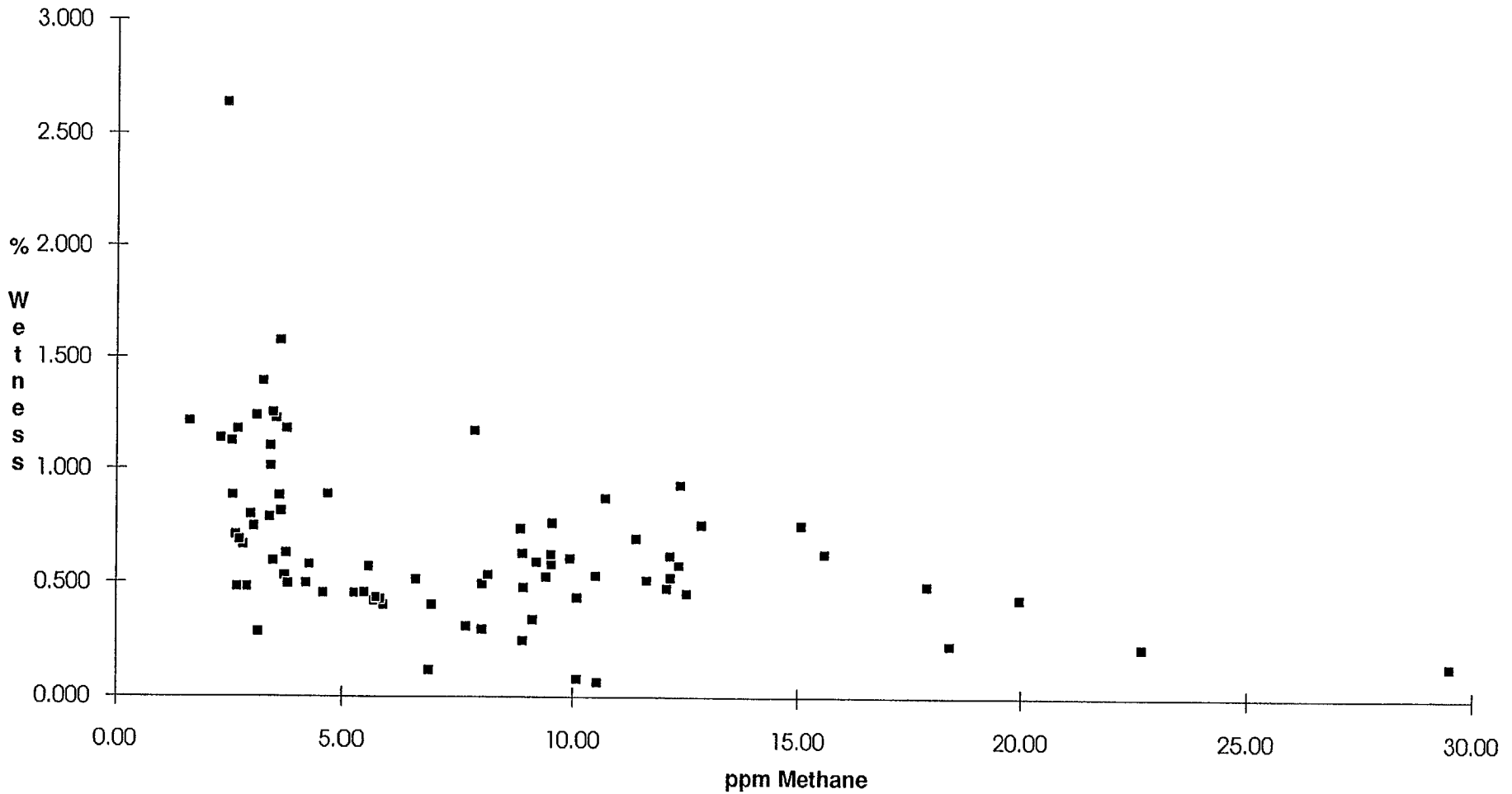


Line 109061 Ethane, Ethylene, Propane




Line 109061 Depths, Altitudes
Shotpoint
0
10
20
30
40
50
60
70
80
90
0.0
100.0
200.0
300.0
400.0
500.0
600.0
Metres
F.Depth
W.Depth
Altitude
Calc. Alt.

Line 109061 Methane v. %Wetness



Line Summary

Line Number	109062
No. of Shotpoints	275

	Shotpoint	Date	Time	Latitude		Longitude	
Start	1	29-Apr-92	10:24:36	13	37.711	122	48.147
End	275	29-Apr-92	19:43:18	13	02.805	122	35.754

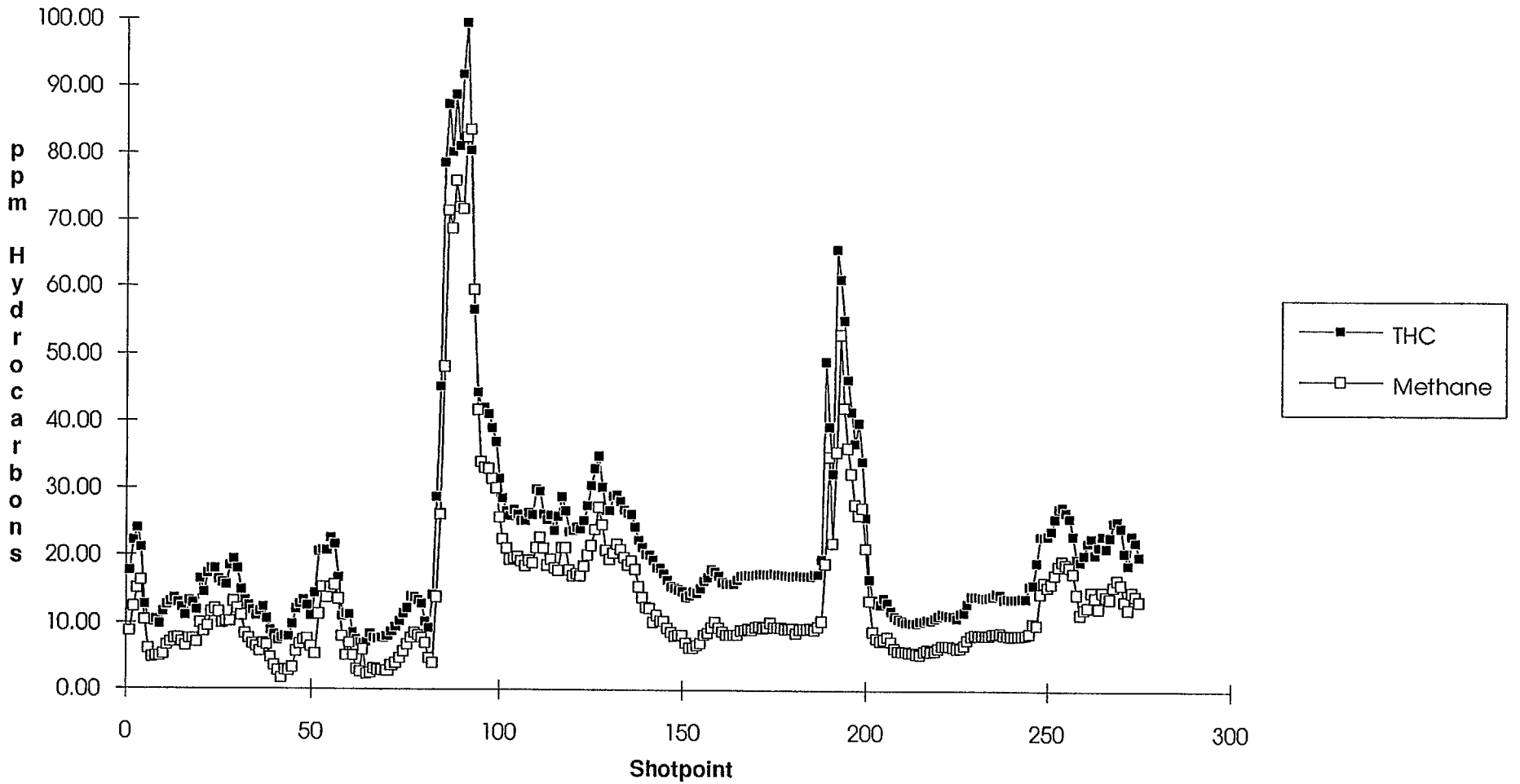
	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	21.088	14.130	0.023	0.050	0.017	0.014	0.006	0.002	0.001	0.049	0.004	0.021	0.473
Std. Dev.	14.728	13.054	0.012	0.057	0.007	0.017	0.009	0.006	0.003	0.027	0.005	0.013	0.303
Minimum	6.933	1.663	0.007	0.005	0.005	0.000	0.000	0.000	0.000	0.021	0.000	0.000	0.057
Maximum	99.504	83.597	0.084	0.326	0.044	0.101	0.053	0.052	0.018	0.196	0.023	0.057	2.119

	Cond.	Temp.	F. Depth	W.Depth	Altitude	Calc. Alt.
Mean	55.444	23.327	159.451	483.892	23.609	325.002
Std. Dev.	1.241	0.814	44.373	438.686	8.607	438.796
Minimum	53.460	21.960	39.000	58.700	9.300	6.300
Maximum	59.130	25.750	212.100	1824.100	30.900	1697.800

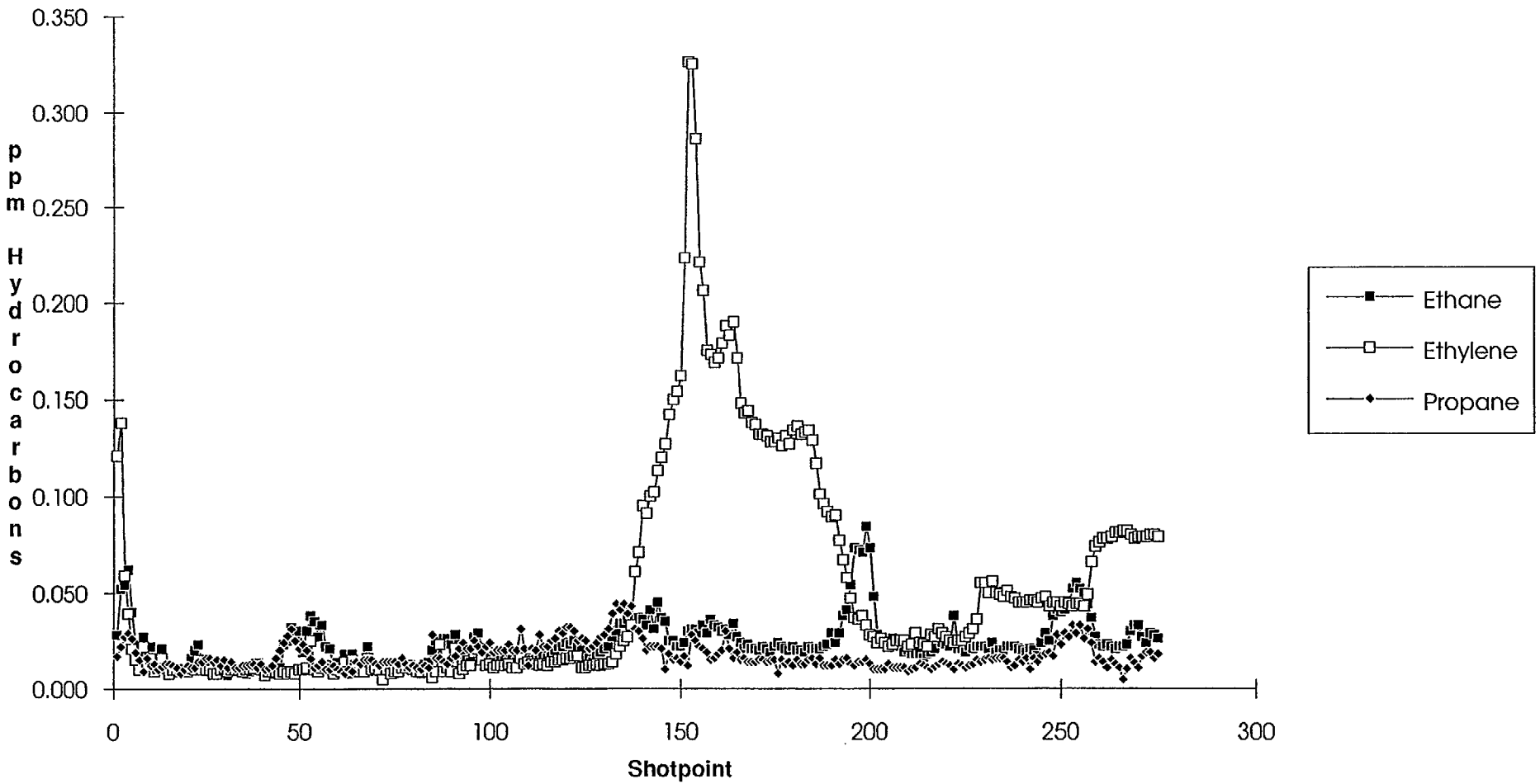
Notes

Two moderate THC and methane anomalies are noted at SP 75 and SP 185 the latter having a weak ethane anomaly.
The moderate ethylene anomaly at SP 150 corresponds to the fish being raised and then lowered through the thermocline as water depth shallows and then deepens.
Gas samples for carbon isotope analysis where taken at SP 89 to SP 99.

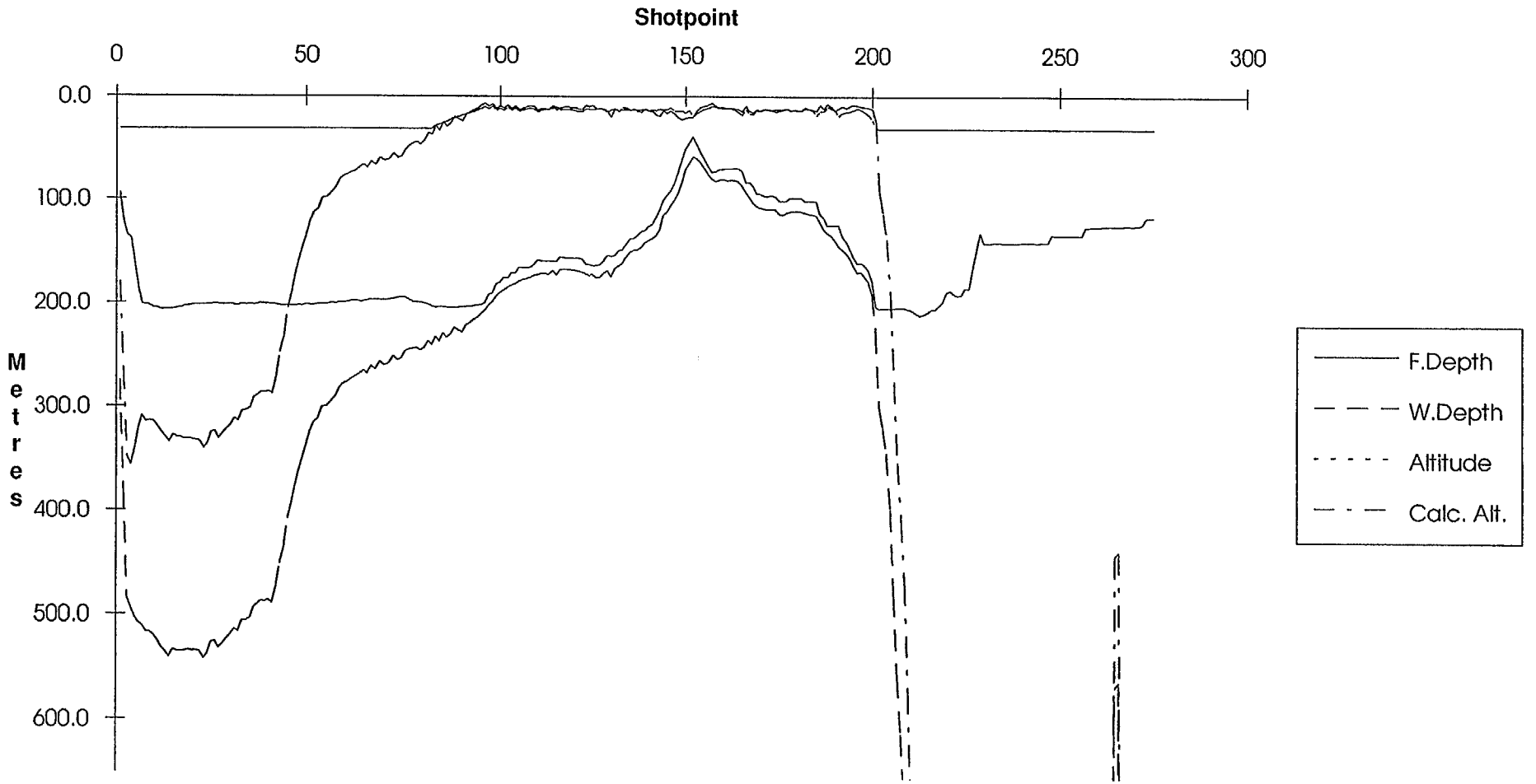
Line 109062 THC, Methane



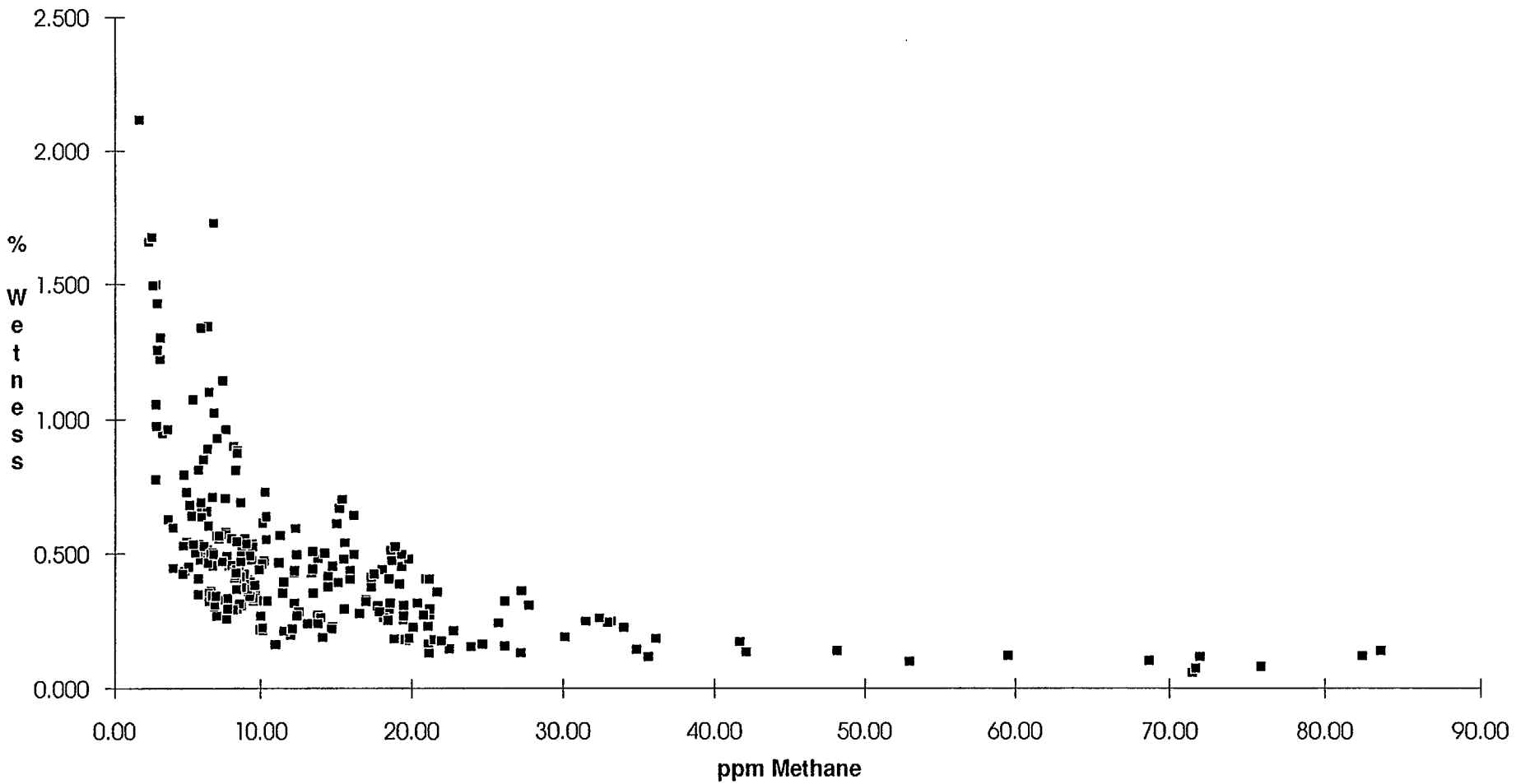
Line 109062 Ethane, Ethylene, Propane



Line 109062 Depths, Altitudes



Line 109062 Methane v. %Wetness



Line Summary

Line Number	109069
No. of Shotpoints	100

	Shotpoint	Date	Time	Latitude		Longitude	
Start	1	1-May-92	17:53:42	13	14.516	122	59.991
End	100	1-May-92	21:55:26	13	17.303	122	59.747

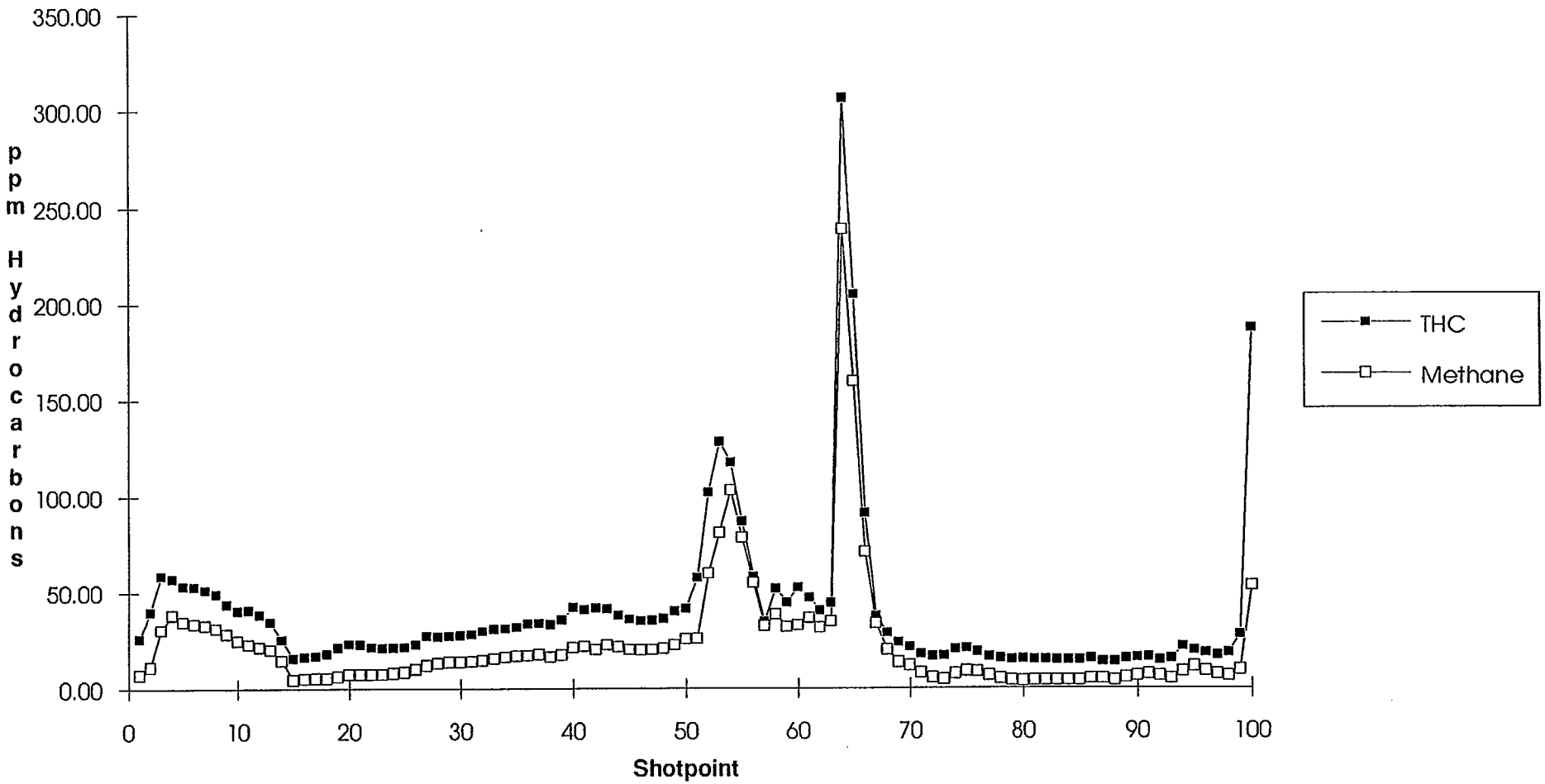
	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	39.035	22.700	0.054	0.056	0.046	0.027	0.010	0.002	0.005	0.054	0.013	0.025	0.595
Std. Dev.	41.203	31.538	0.059	0.092	0.067	0.026	0.017	0.008	0.005	0.035	0.007	0.015	0.319
Minimum	13.362	3.825	0.010	0.007	0.006	0.000	0.000	0.000	0.000	0.020	0.000	0.000	0.053
Maximum	306.120	238.646	0.361	0.452	0.389	0.141	0.088	0.037	0.028	0.183	0.044	0.062	1.882

	Cond.	Temp.	F. Depth	W.Depth	Altitude	Calc. Alt.
Mean	54.674	22.823	153.123	184.085	21.226	30.973
Std. Dev.	1.445	0.955	38.776	11.123	7.692	33.317
Minimum	53.760	22.190	49.500	170.400	9.700	2.600
Maximum	59.390	25.920	210.000	215.500	30.900	129.000

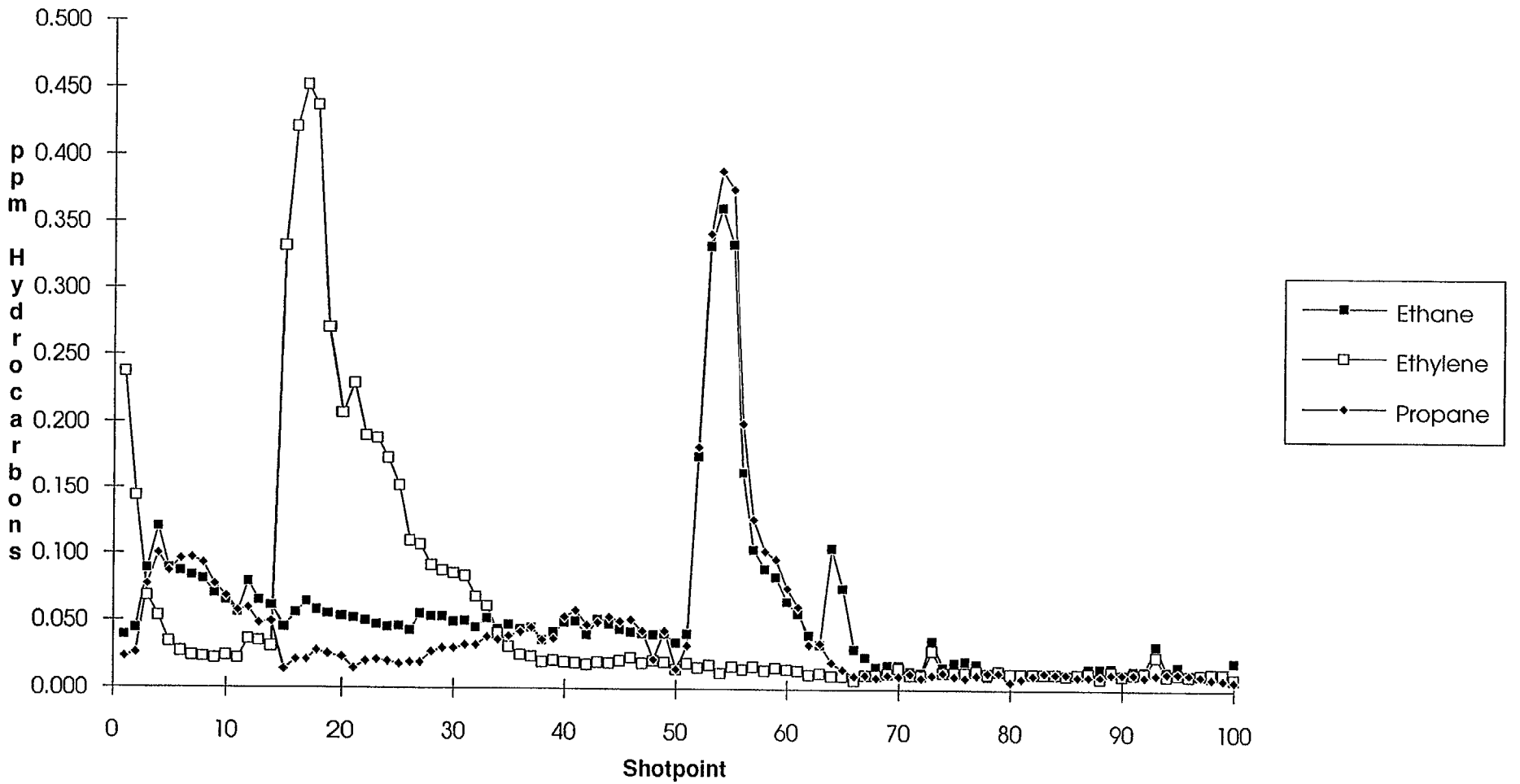
Notes

Two moderate THC and methane anomalies are seen at SP 53 and SP 98,a strong anomaly occurs at SP 65.
A strong ethane and methane anomaly occurs at SP 53 and a moderate ethane anomaly at SP 65.
Gas samples for carbon isotope analysis where taken from SP 52 to SP 58 and from SP 64 to SP 67.

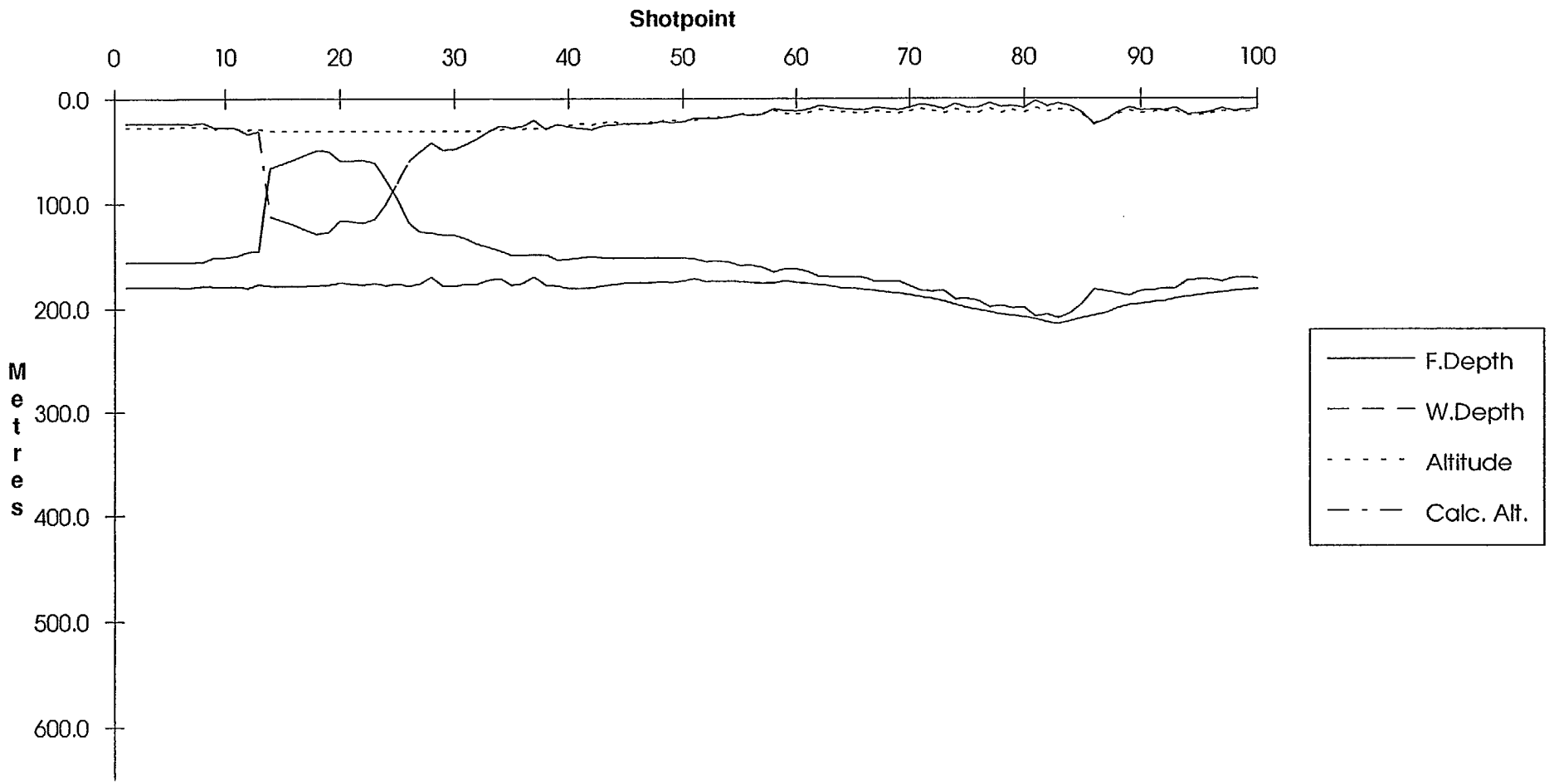
Line 109069 THC, Methane



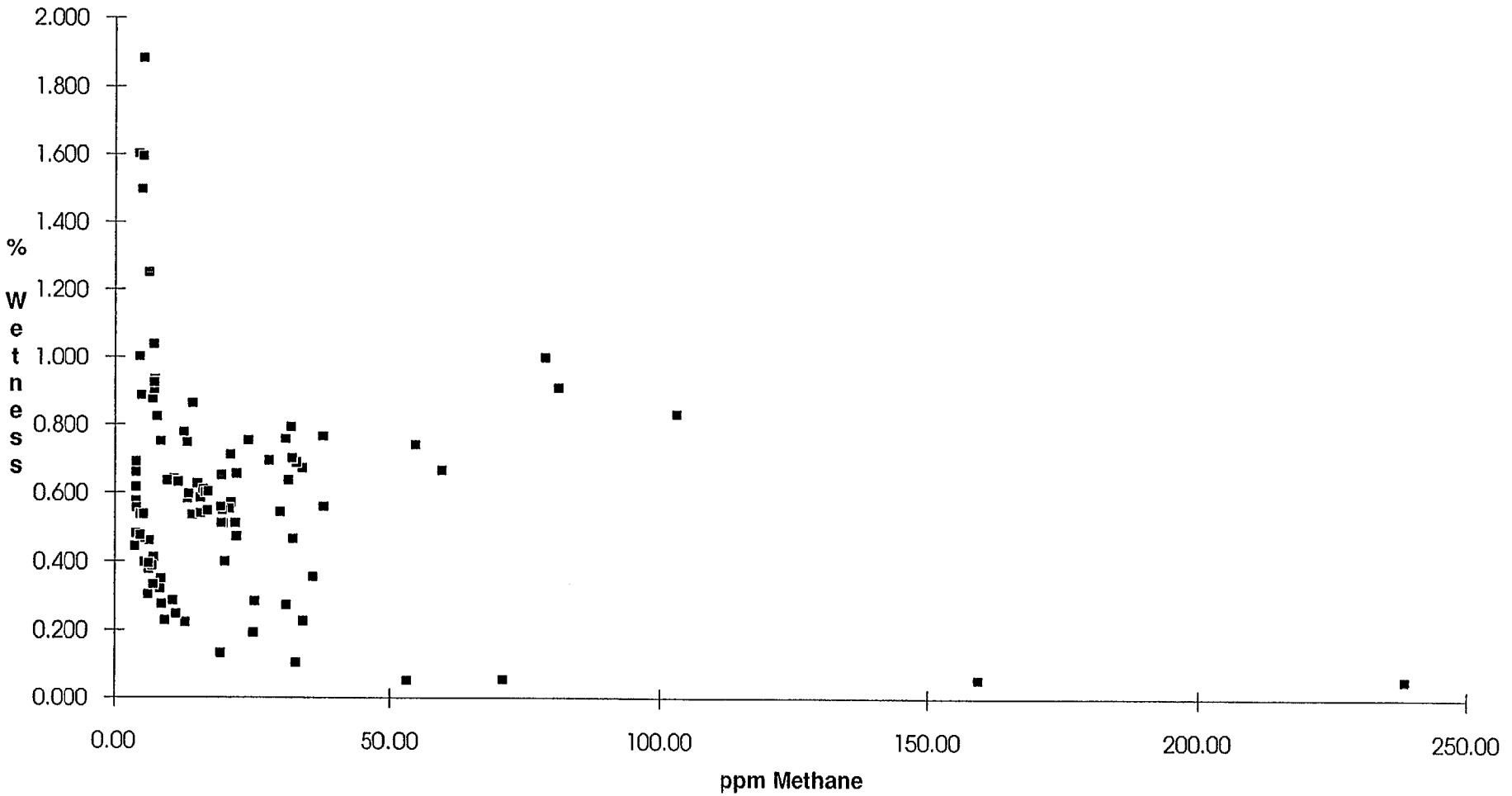
Line 109069 Ethane, Ethylene, Propane



Line 109069 Depths, Altitudes



Line 109069 Methane v. %Wetness



Line Summary

Line Number	VP109069
No. of Shotpoints	153

	Shotpoint	Date	Time	Latitude		Longitude	
Start	1	1-May-92	21:57:26	13	17.208	122	59.775
End	154	2-May-92	03:15:33	13	18.600	123	00.023

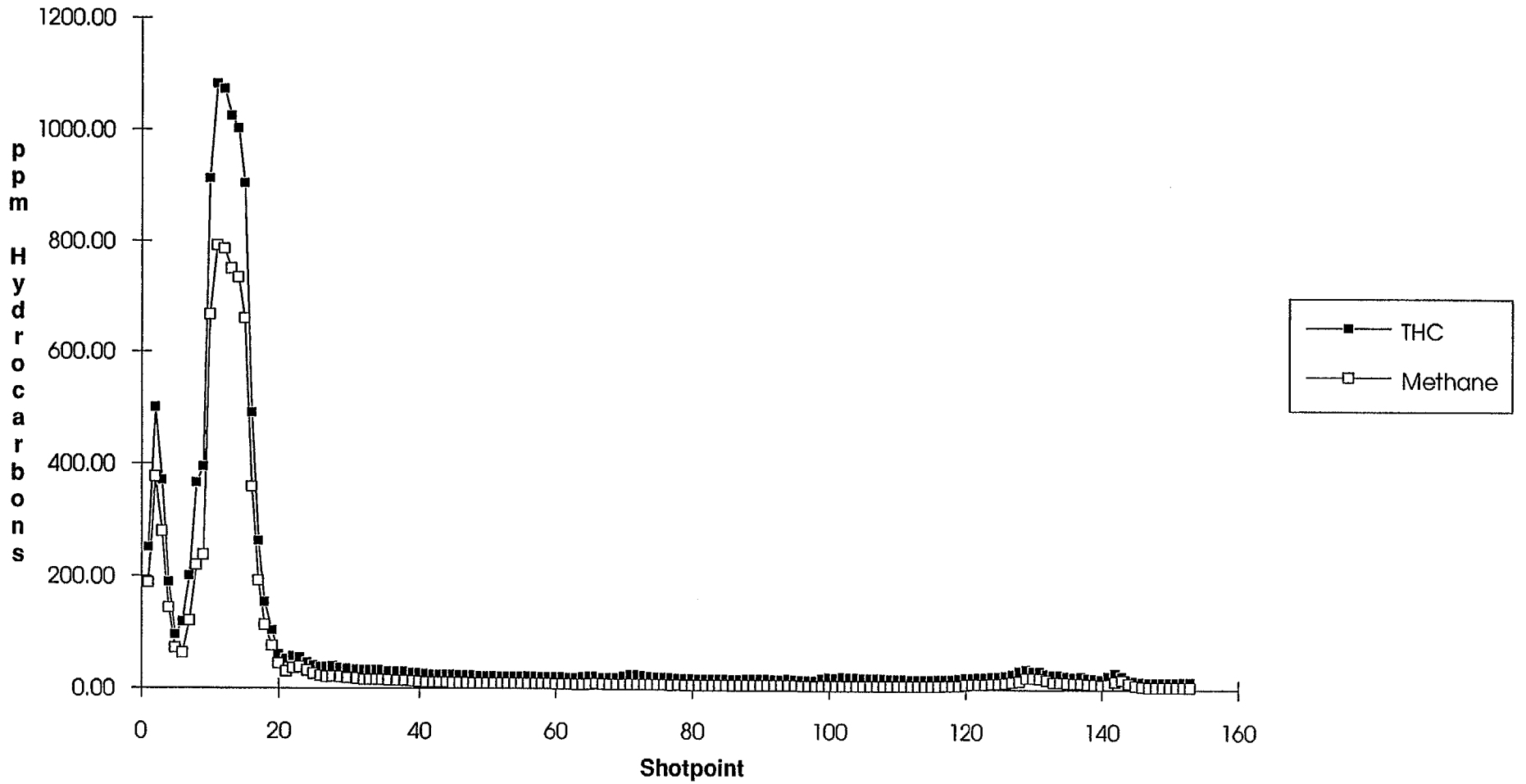
	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	82.302	53.514	0.044	0.125	0.020	0.044	0.007	0.004	0.001	0.099	0.014	0.029	0.652
Std. Dev.	202.772	149.436	0.050	0.104	0.008	0.034	0.012	0.010	0.003	0.061	0.009	0.012	0.388
Minimum	12.656	3.979	0.008	0.000	0.004	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.031
Maximum	1082.414	792.065	0.343	0.394	0.048	0.140	0.056	0.049	0.022	0.207	0.053	0.061	1.702

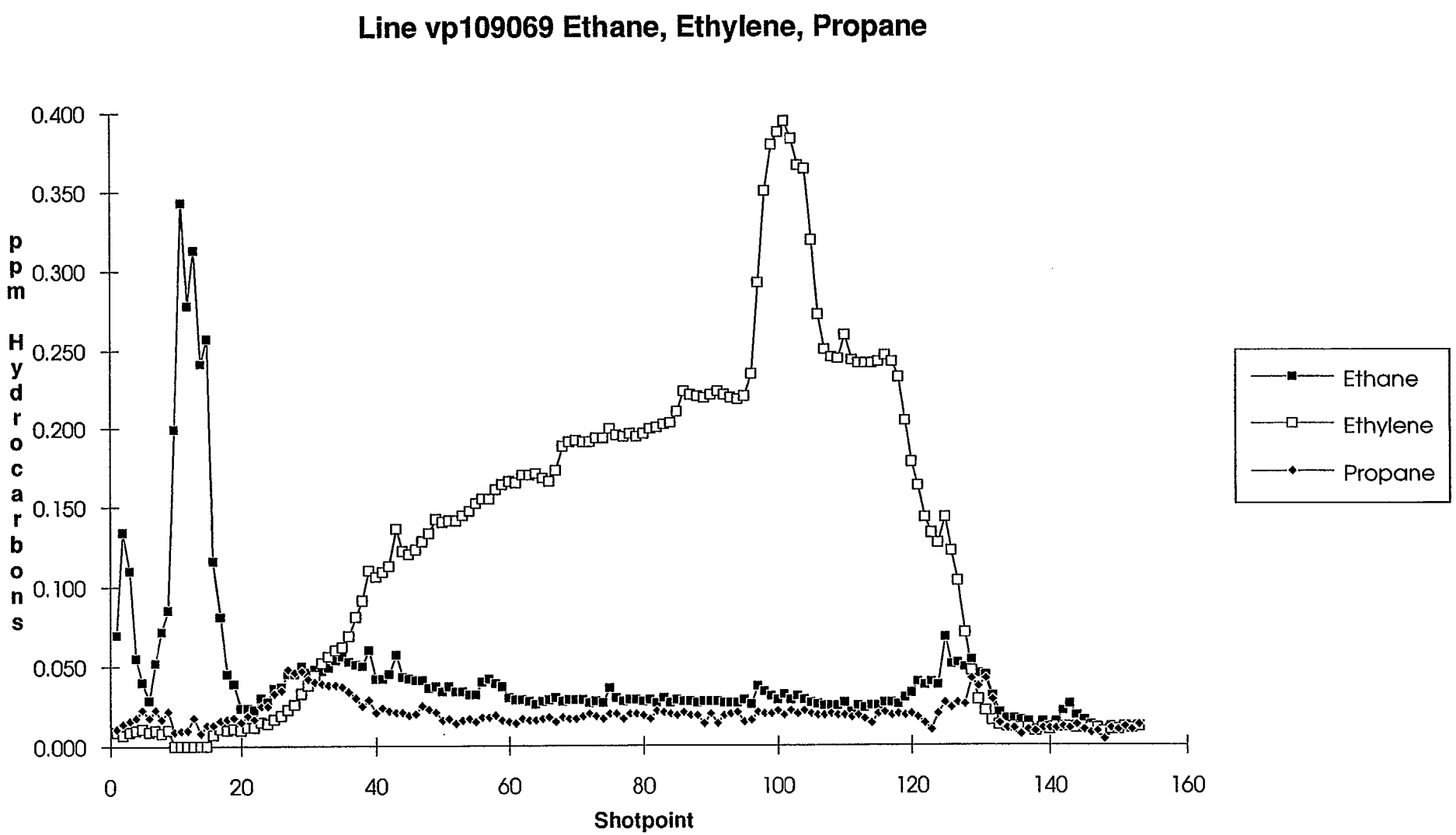
	Cond.	Temp.	F. Depth	W.Depth	Altitude	Calc. Alt.
Mean	57.963	25.032	101.981	179.999	25.767	78.032
Std. Dev.	2.818	1.869	58.839	7.531	8.113	57.557
Minimum	53.740	22.270	9.300	149.500	7.200	2.400
Maximum	62.460	28.020	203.000	210.200	31.000	170.400

Notes

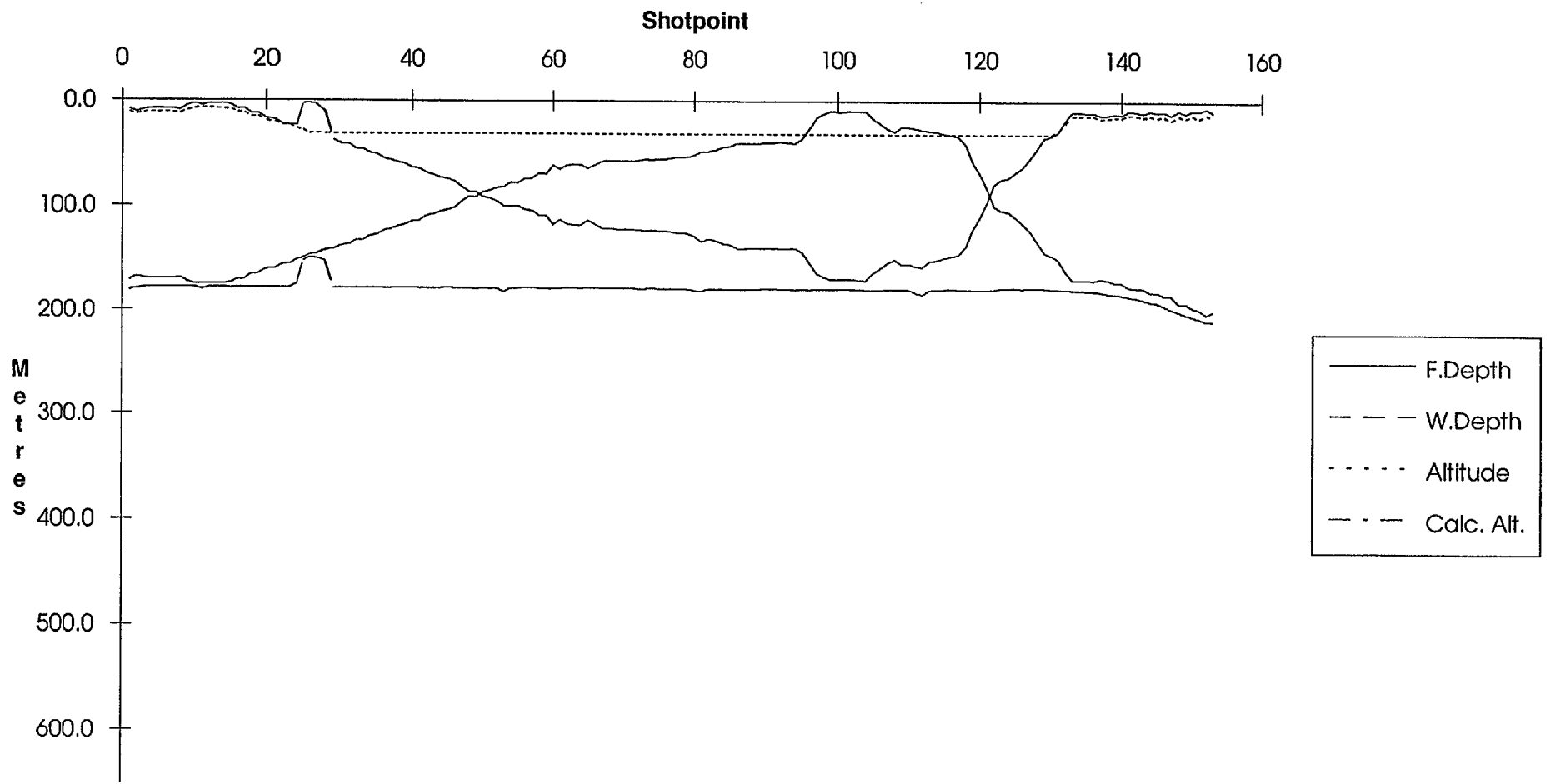
Two strong THC and methane anomalies occur at SP 3 and SP 12, both have correspondingly strong ethane anomalies.
The strong ethylene anomaly between SP 25 and SP 130 relates to the fish being raised and then lowered through the surface waters.
A gas sample for carbon isotope analysis was taken from SP 1 to SP 20.

Line vp109069 THC, Methane

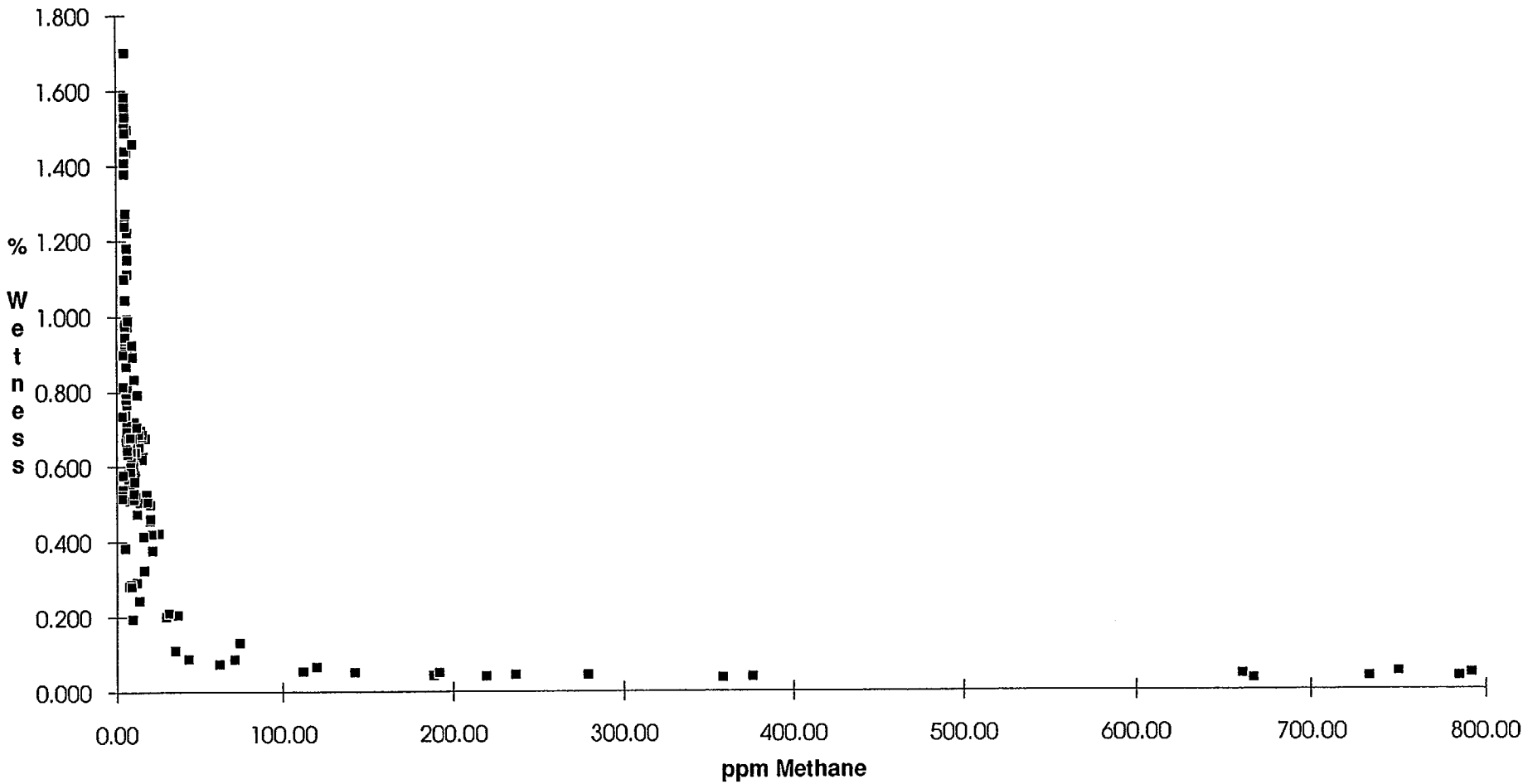



Line vp109069 Ethane, Ethylene, Propane
ppm Hydrocarbons
0.400
0.350
0.300
0.250
0.200
0.150
0.100
0.050
0.000
0
20
40
60
80
100
120
140
160
Shotpoint
Ethane
Ethylene
Propane

Line vp109069 Depths, Altitudes



Line vp109069 Methane v. %Wetness



Line Summary

Line Number	109070
No. of Shotpoints	62

	Shotpoint	Date	Time	Latitude		Longitude	
Start	1	2-May-92	03:17:32	13	18.662	123	00.083
End	62	2-May-92	05:25:22	13	18.907	123	02.530

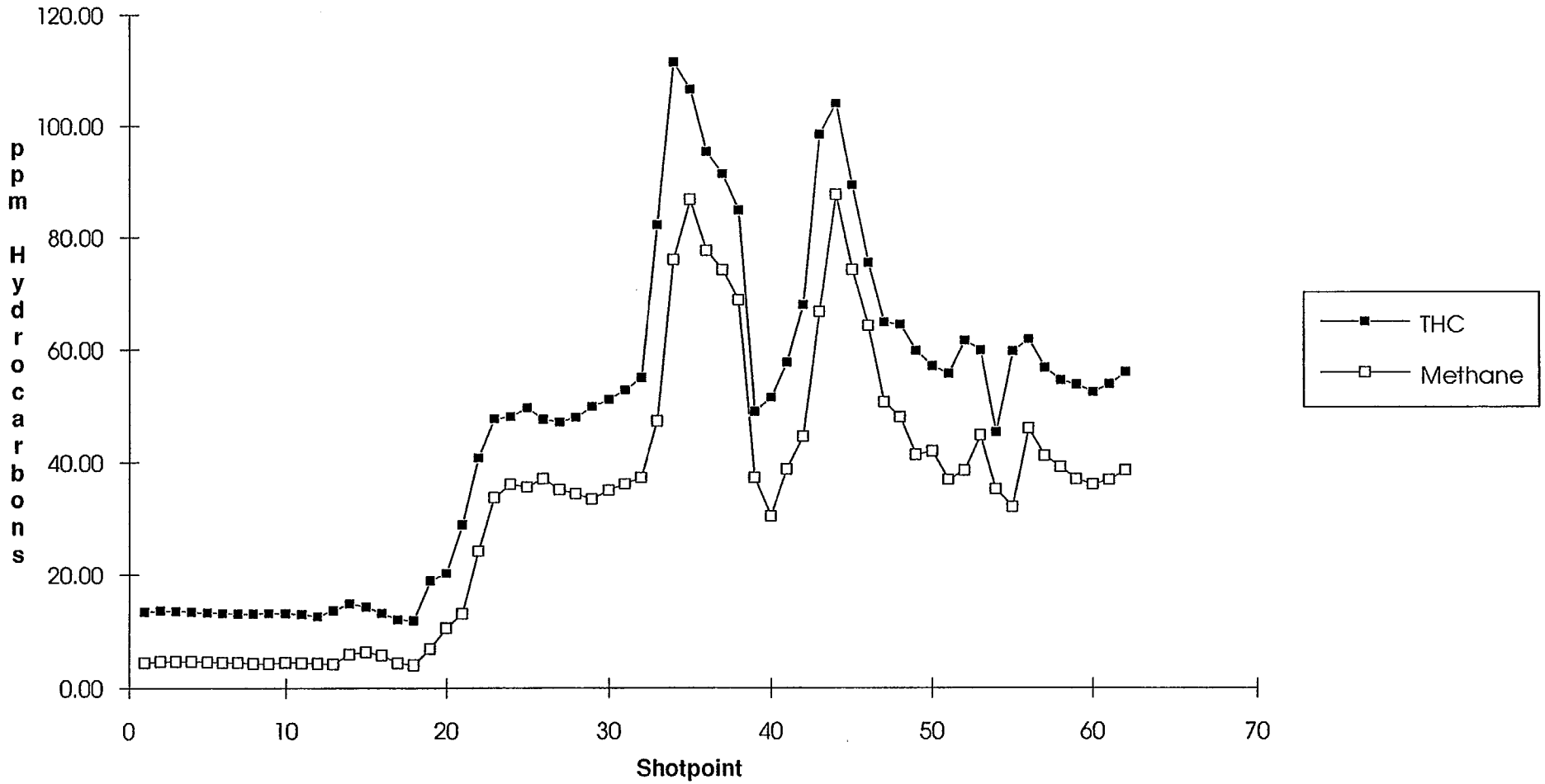
	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	47.194	32.400	0.115	0.025	0.133	0.017	0.036	0.006	0.008	0.041	0.008	0.034	0.825
Std. Dev.	28.166	23.722	0.110	0.014	0.124	0.008	0.031	0.013	0.009	0.008	0.009	0.015	0.309
Minimum	11.801	3.922	0.008	0.010	0.009	0.000	0.000	0.000	0.000	0.026	0.000	0.000	0.266
Maximum	111.556	87.486	0.393	0.053	0.431	0.042	0.120	0.057	0.024	0.061	0.039	0.064	1.765

	Cond.	Temp.	F. Depth	W.Depth	Altitude	Calc. Alt.
Mean	56.622	24.168	165.247	175.410	13.084	10.191
Std. Dev.	0.685	0.470	32.577	32.513	2.341	2.834
Minimum	55.370	23.290	138.400	148.300	8.900	3.300
Maximum	57.570	24.820	231.300	239.800	19.300	17.400

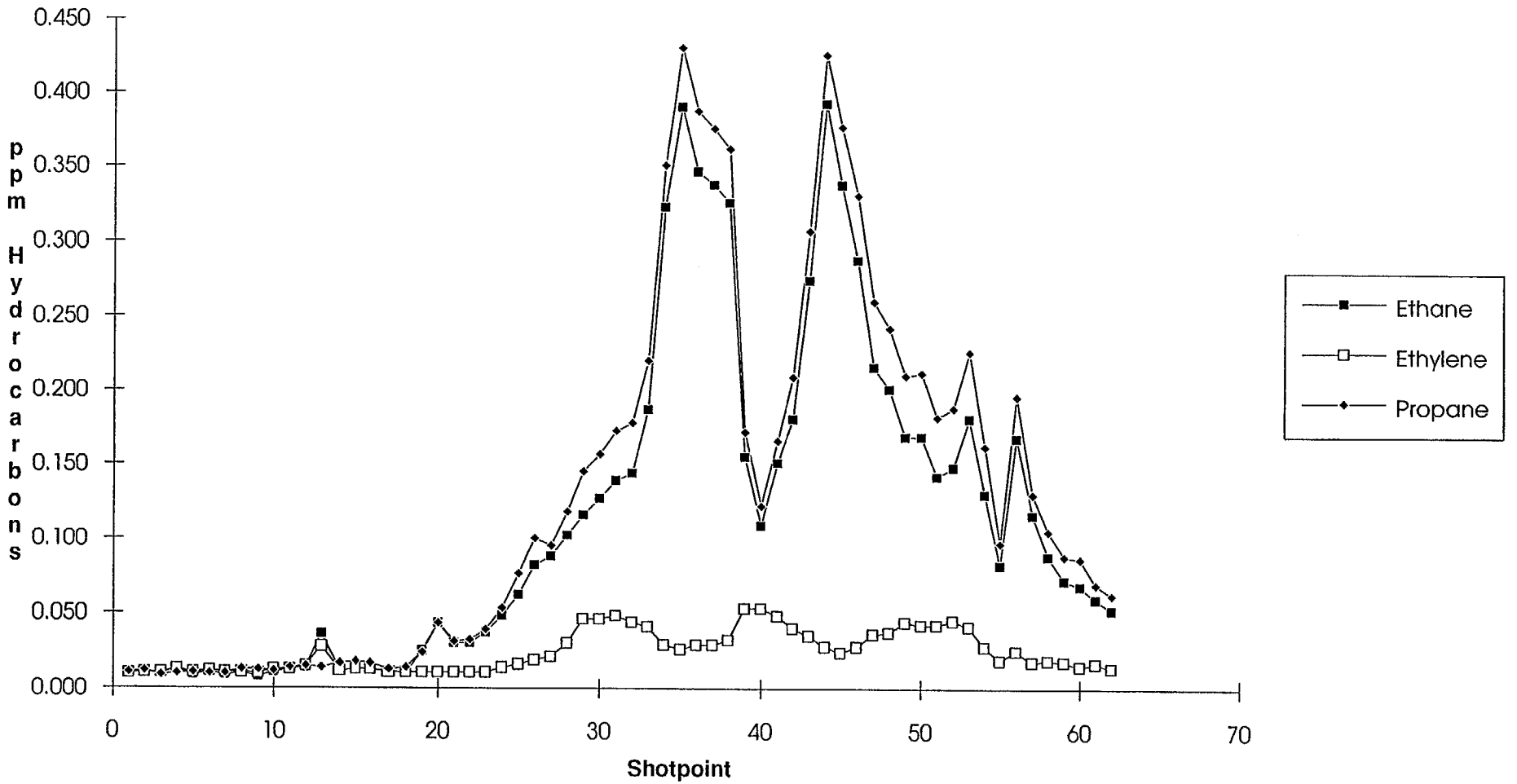
Notes

Two moderate THC, methane, ethane and propane anomalies are seen at SP 32 and SP 42.
Gas samples for carbon isotope analysis where taken between SP 35 and SP 55.

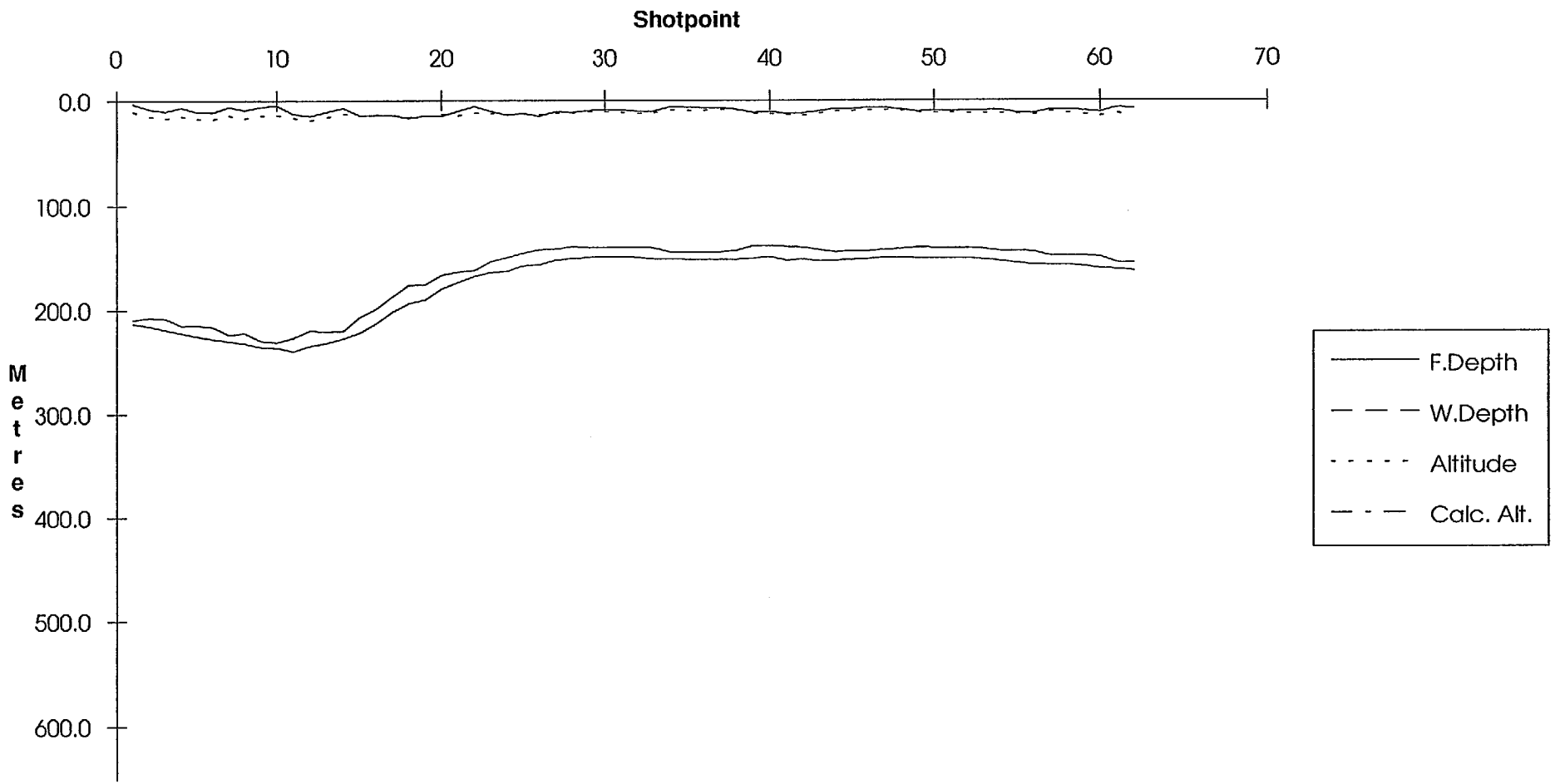
Line 109070 THC, Methane



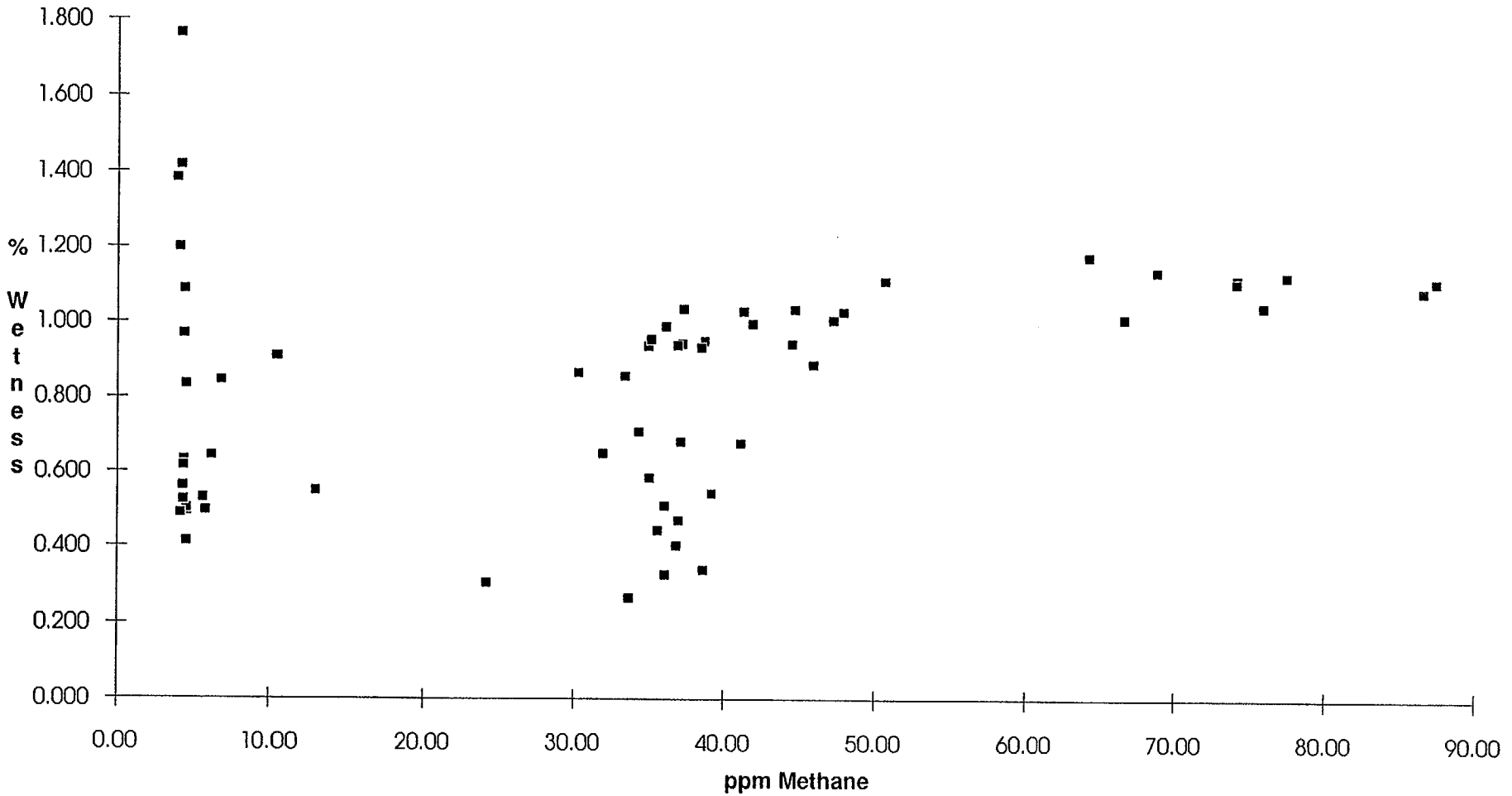
Line 109070 Ethane, Ethylene, Propane



Line 109070 Depths, Altitudes



Line 109070 Methane v. %Wetness



Line Summary

Line Number	VP109070
No. of Shotpoints	84

	Shotpoint	Date	Time	Latitude		Longitude	
Start	1	2-May-92	05:27:46	13	18.882	123	02.508
End	84	2-May-92	08:24:26	13	18.890	123	03.582

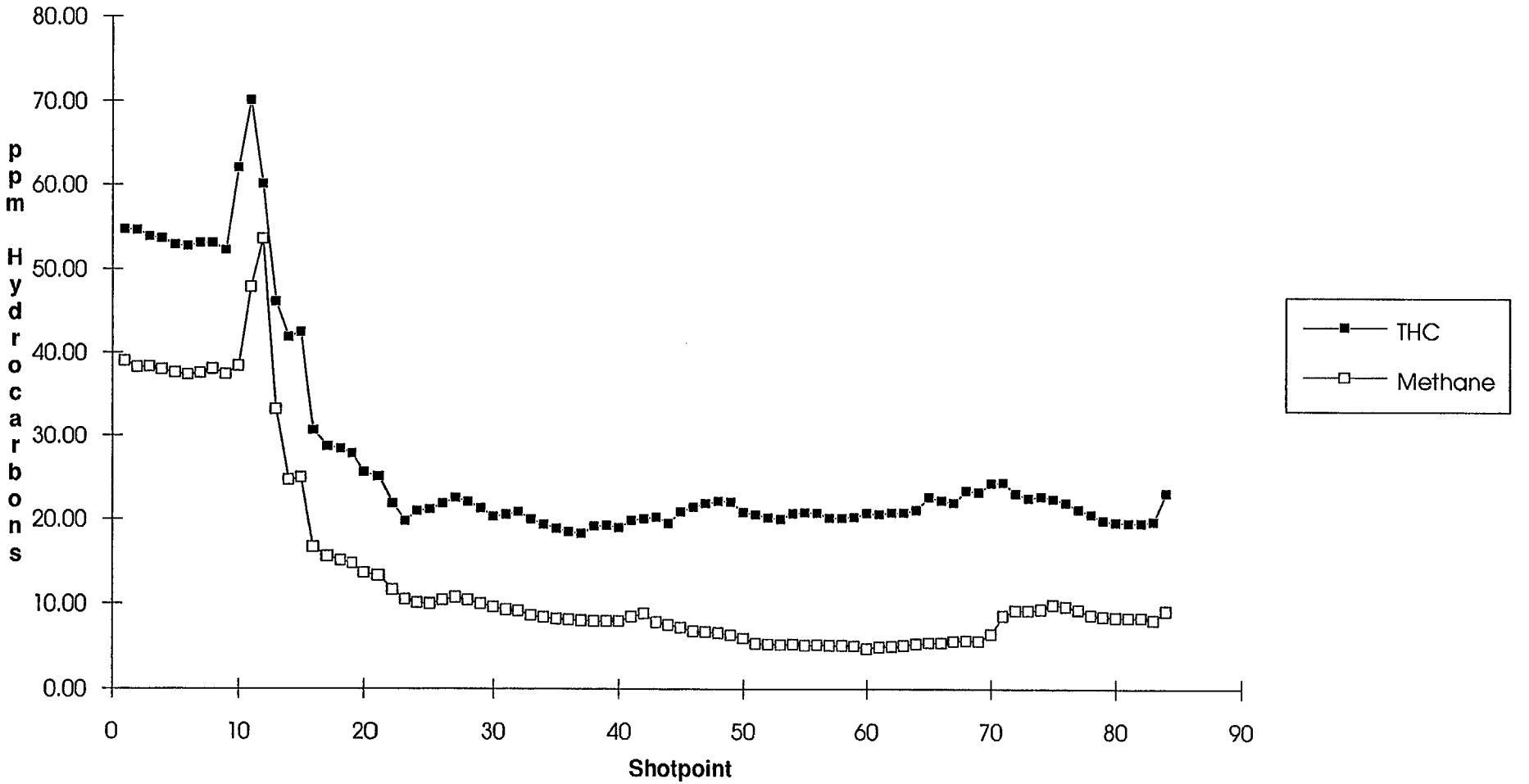
	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	27.282	13.519	0.040	0.148	0.033	0.055	0.005	0.000	0.001	0.123	0.014	0.044	0.635
Std. Dev.	12.873	11.945	0.027	0.083	0.036	0.034	0.010	0.000	0.003	0.063	0.011	0.019	0.188
Minimum	18.300	4.793	0.021	0.012	0.005	0.009	0.000	0.000	0.000	0.027	0.000	0.000	0.291
Maximum	70.122	53.633	0.203	0.335	0.238	0.145	0.052	0.000	0.016	0.266	0.047	0.105	1.026

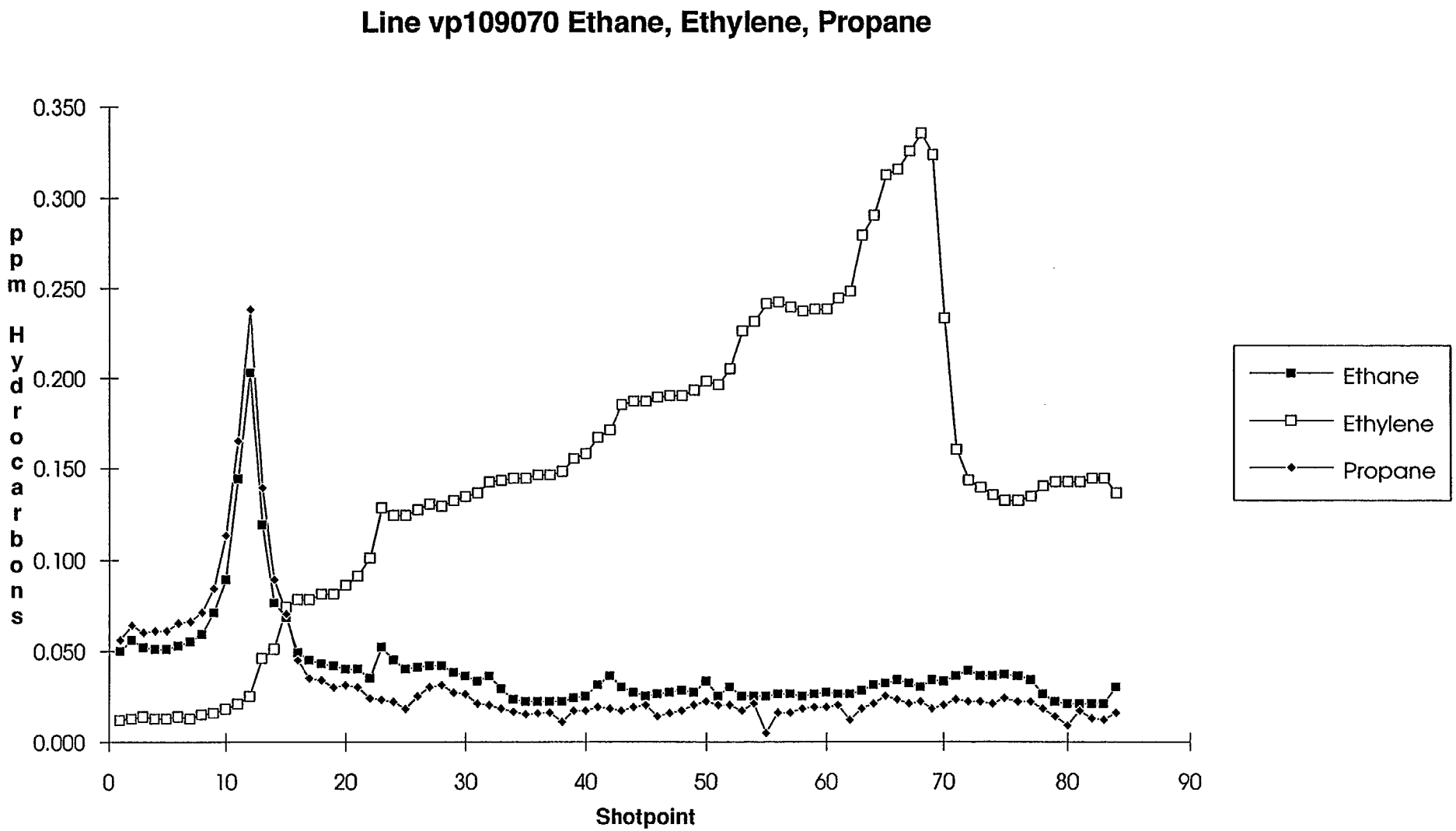
	Cond.	Temp.	F. Depth	W.Depth	Altitude	Calc. Alt.
Mean	60.003	26.422	85.346	157.506	28.694	72.167
Std. Dev.	2.004	1.348	43.055	3.249	5.119	42.945
Minimum	56.260	23.910	7.200	150.200	12.700	5.400
Maximum	62.770	28.290	153.800	164.900	31.000	149.300

Notes

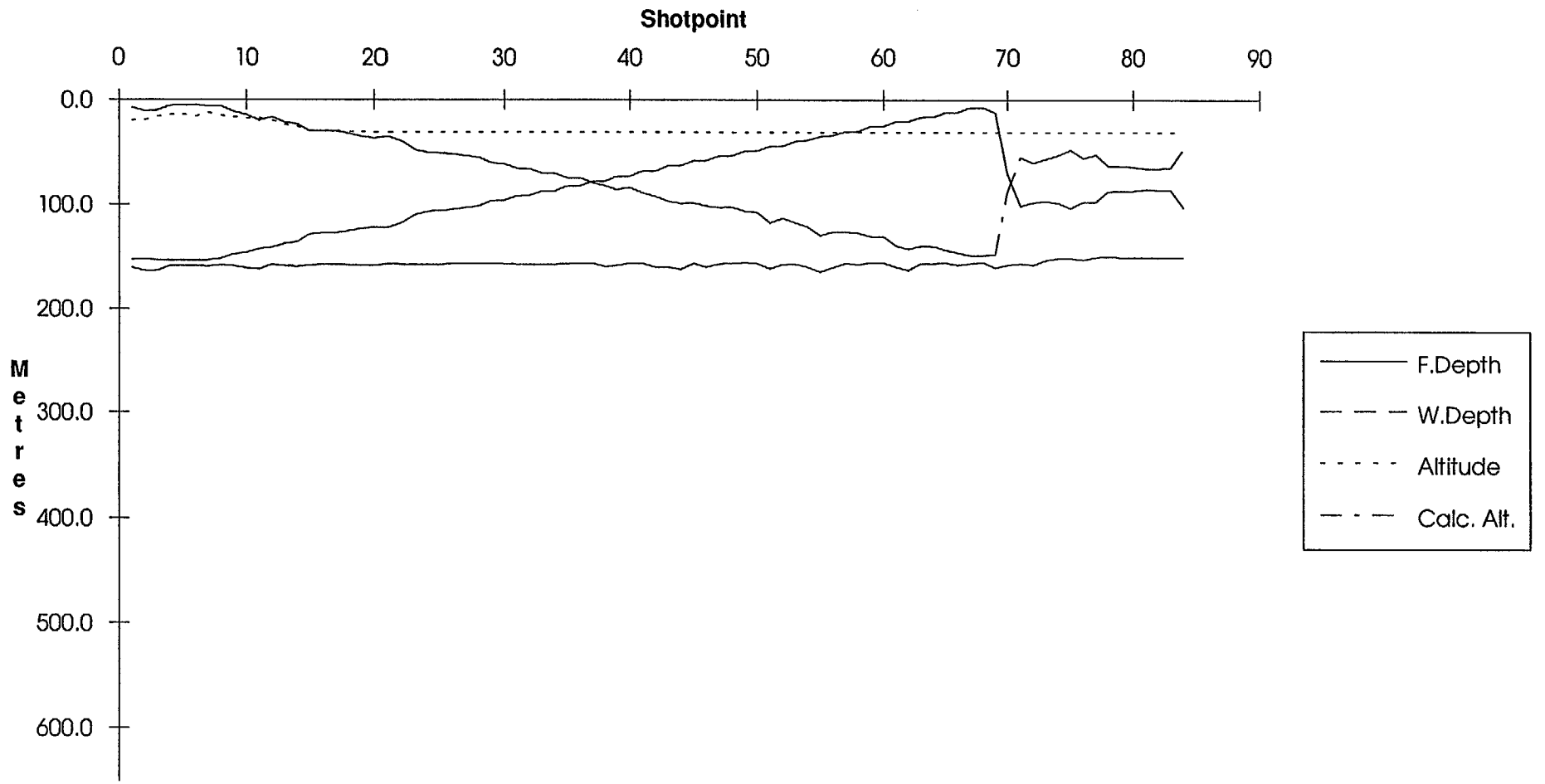
A weak THC, methane, ethane, and propane anomaly occurs at SP 12.
The increase in ethylene after SP 13 relates to the fish being raised and then lowered through the water column.

Line vp109070 THC, Methane

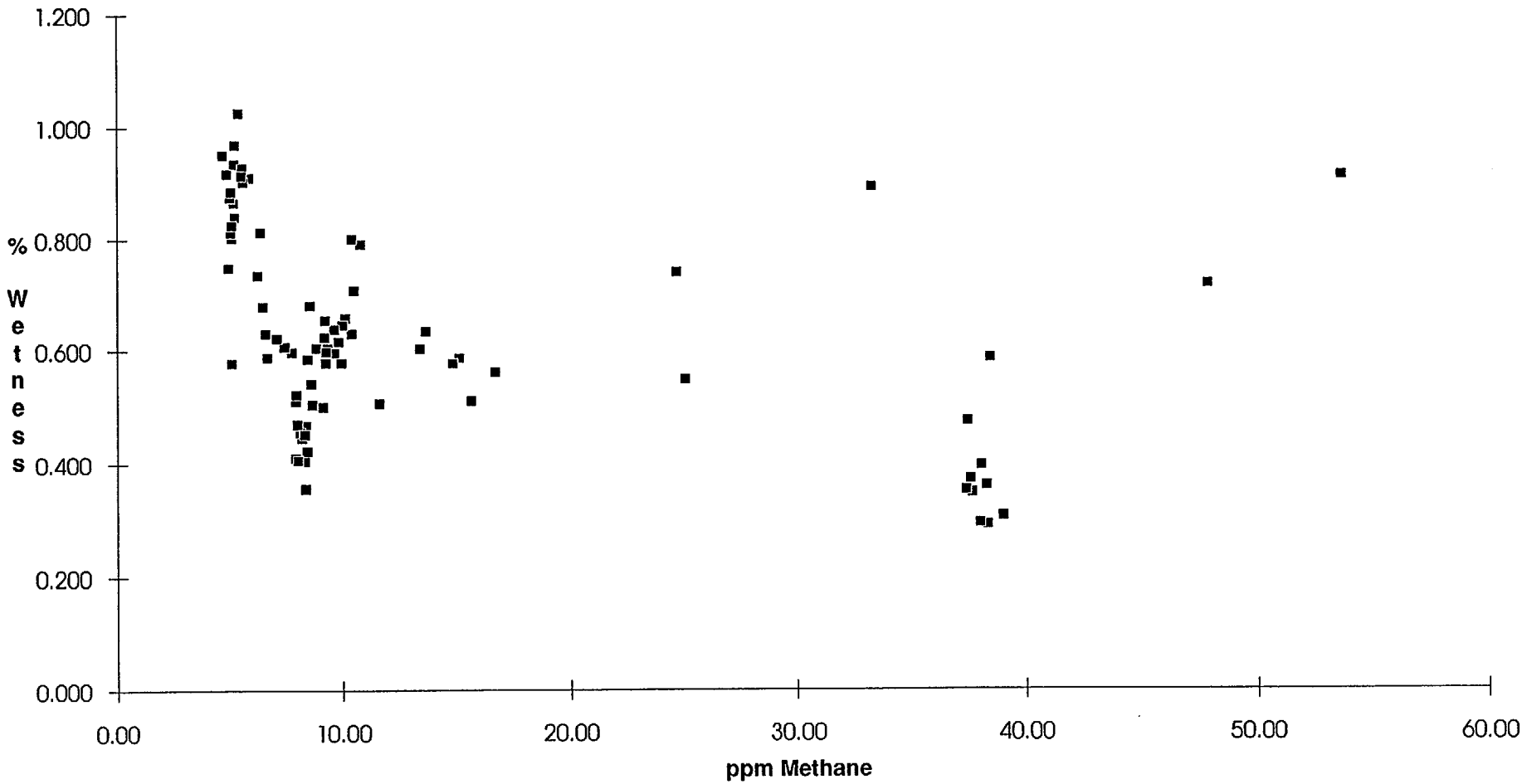



Line vp109070 Ethane, Ethylene, Propane
ppm Hydrocarbons
0.350
0.300
0.250
0.200
0.150
0.100
0.050
0.000
0
10
20
30
40
50
60
70
80
90
Shotpoint
Ethane
Ethylene
Propane

Line vp109070 Depths, Altitudes



Line vp109070 Methane v. %Wetness



Line Summary

Line Number	VP109071
No. of Shotpoints	74

	Shotpoint	Date	Time	Latitude		Longitude	
Start	1	2-May-92	08:26:27	13	18.845	123	03.638
End	74	2-May-92	10:54:47	13	18.746	123	03.814

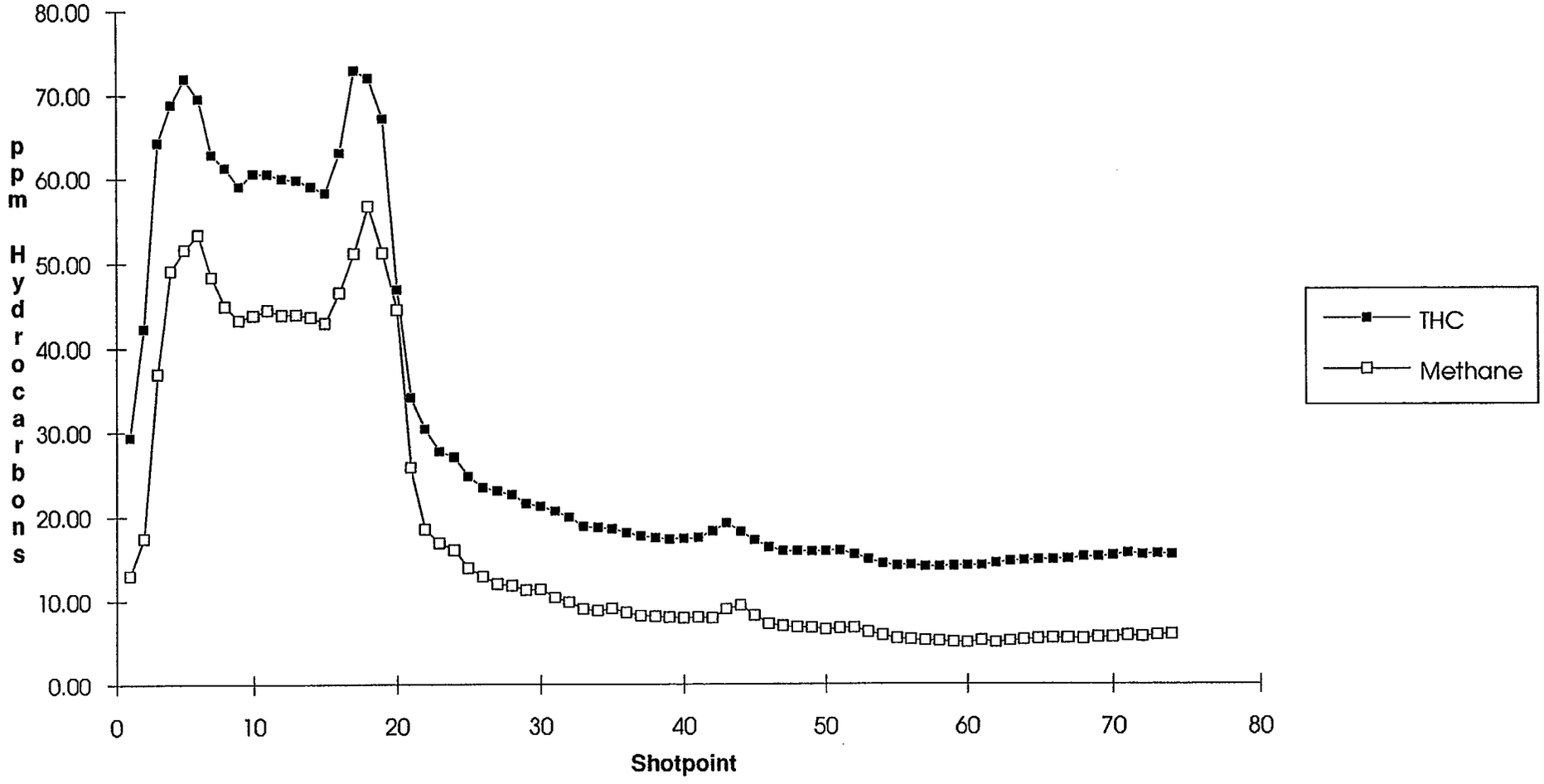
	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	29.380	17.840	0.063	0.146	0.064	0.054	0.014	0.001	0.004	0.122	0.014	0.042	0.735
Std. Dev.	20.128	16.981	0.058	0.094	0.075	0.035	0.023	0.005	0.006	0.066	0.010	0.017	0.169
Minimum	14.055	5.000	0.018	0.018	0.011	0.005	0.000	0.000	0.000	0.037	0.000	0.000	0.399
Maximum	72.820	56.604	0.238	0.349	0.272	0.141	0.085	0.025	0.022	0.250	0.043	0.095	1.091

	Cond.	Temp.	F. Depth	W.Depth	Altitude	Calc. Alt.
Mean	58.517	25.404	84.547	150.211	25.336	65.674
Std. Dev.	1.694	1.100	46.970	0.433	8.997	46.975
Minimum	55.730	23.600	6.700	149.500	8.300	5.400
Maximum	60.610	26.790	144.700	152.000	30.900	144.000

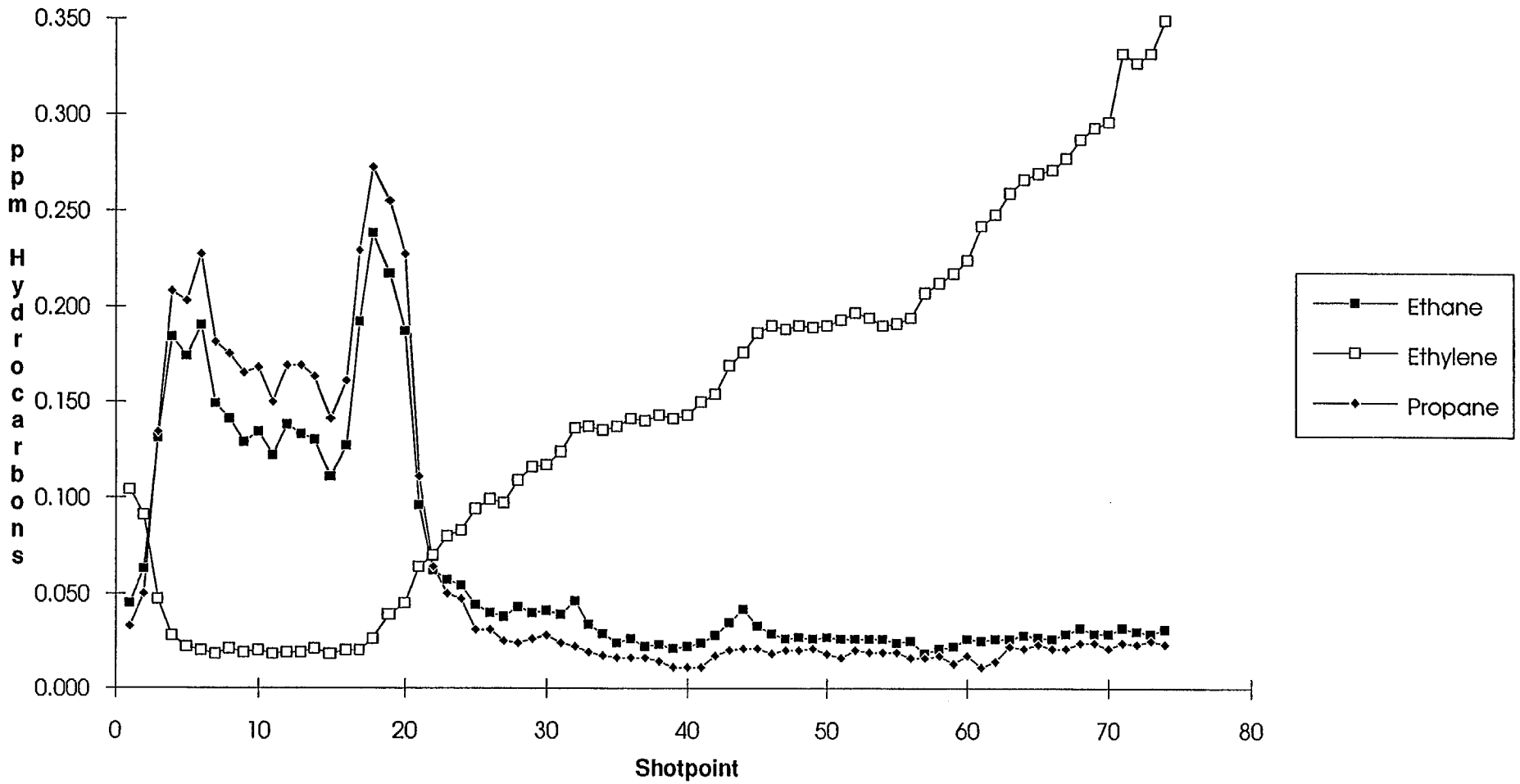
Notes

A weak THC, methane, ethane and propane anomaly occurs between SP 3 and SP 22
Ethylene values increase after SP 22 due to the fish being raised through the thermocline
A gas sample for carbon isotope analysis was taken at SP 1 to SP 20.

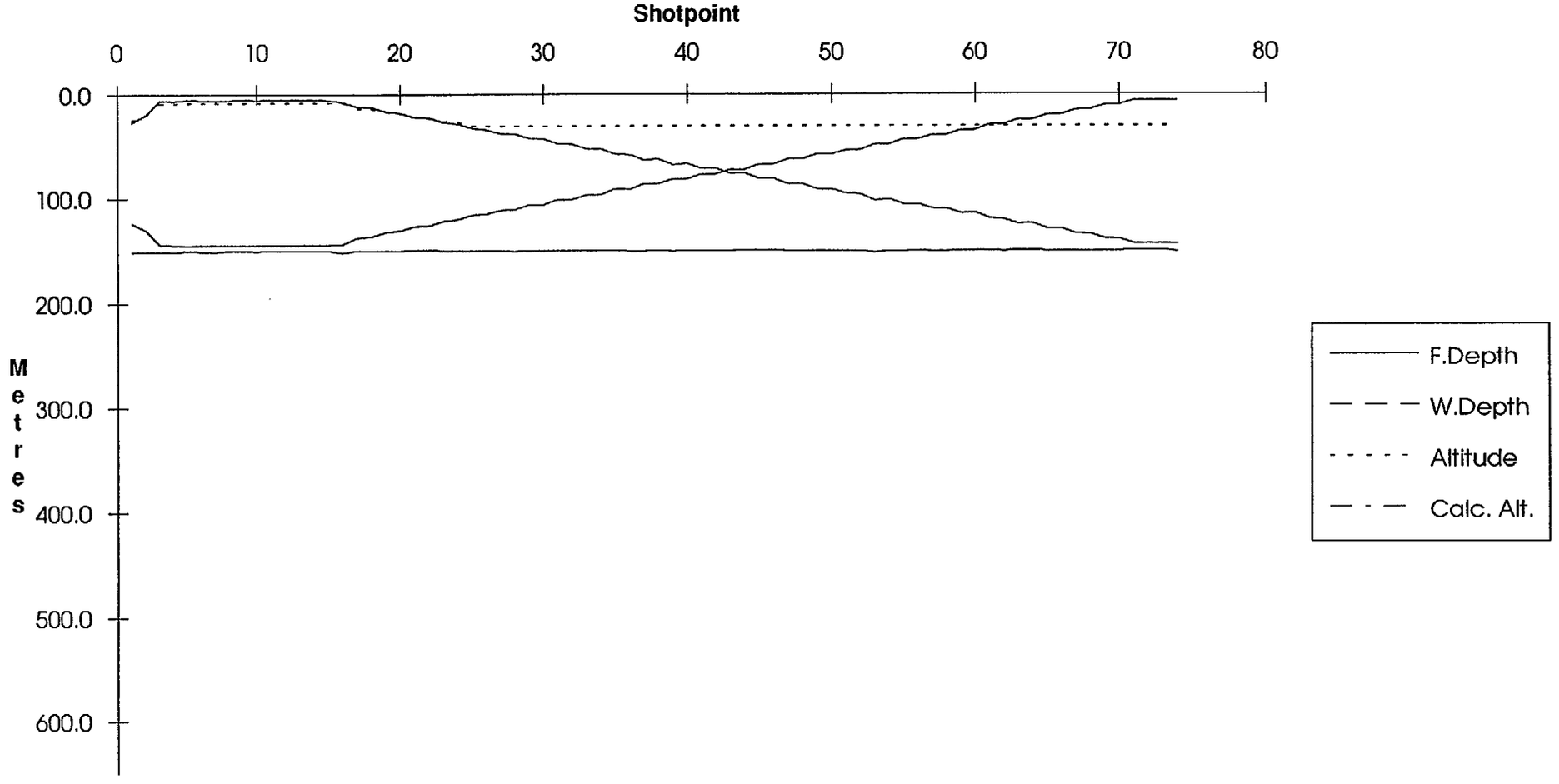
Line VP109071 THC, Methane

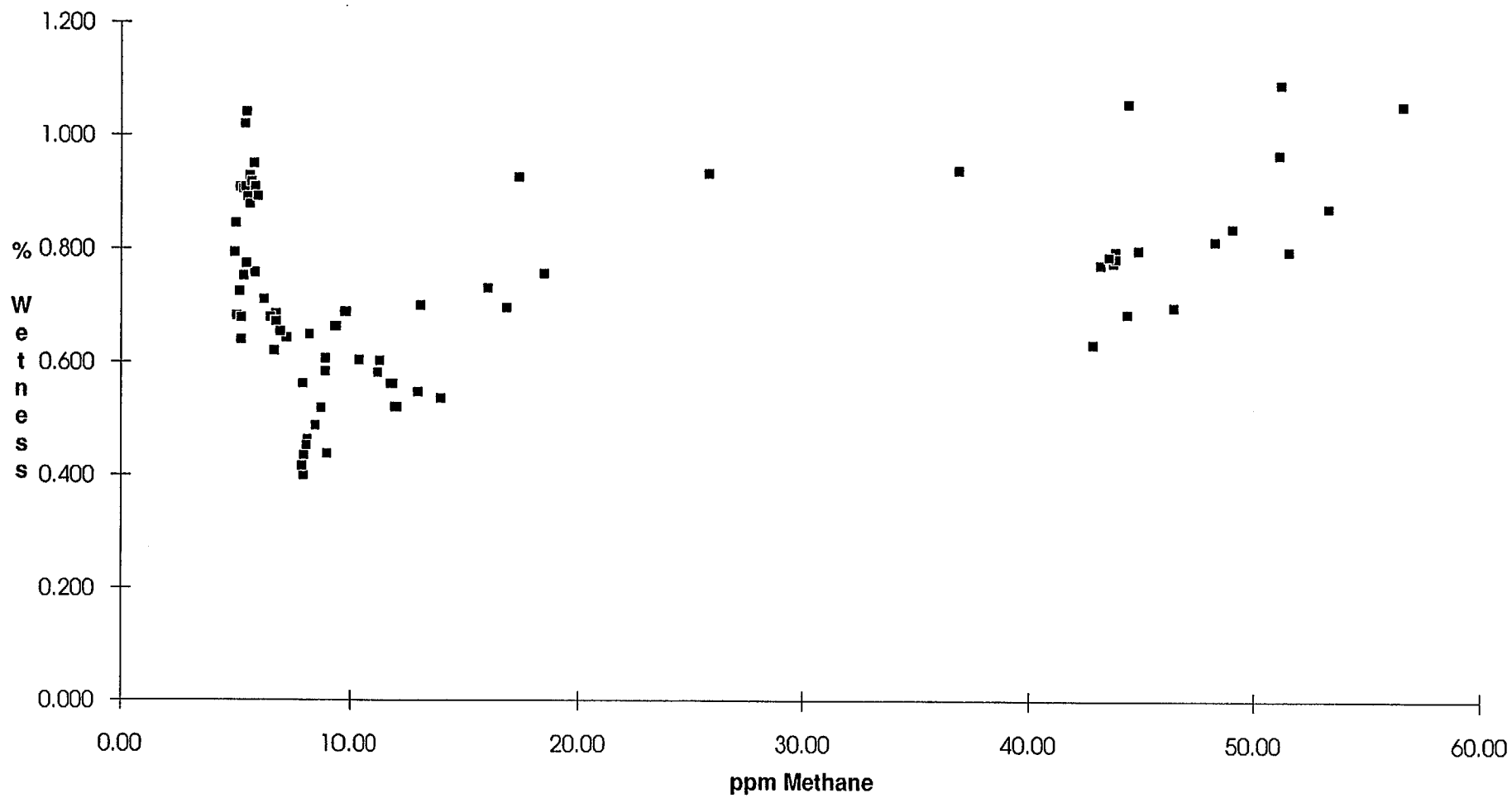


Line VP109071 Ethane, Ethylene, Propane



Line VP109071 Depths, Altitudes




Line VP109071 Methane v. %Wetness
1.200
1.000
0.800
0.600
0.400
0.200
0.000
% Wetness
0.00
10.00
20.00
30.00
40.00
50.00
60.00
ppm Methane

Line Summary

Line Number	VP109072
No. of Shotpoints	122

	Shotpoint	Date	Time	Latitude		Longitude	
Start	1	2-May-92	10:56:46	13	18.828	123	03.835
End	122	2-May-92	15:05:58	13	19.439	122	53.083

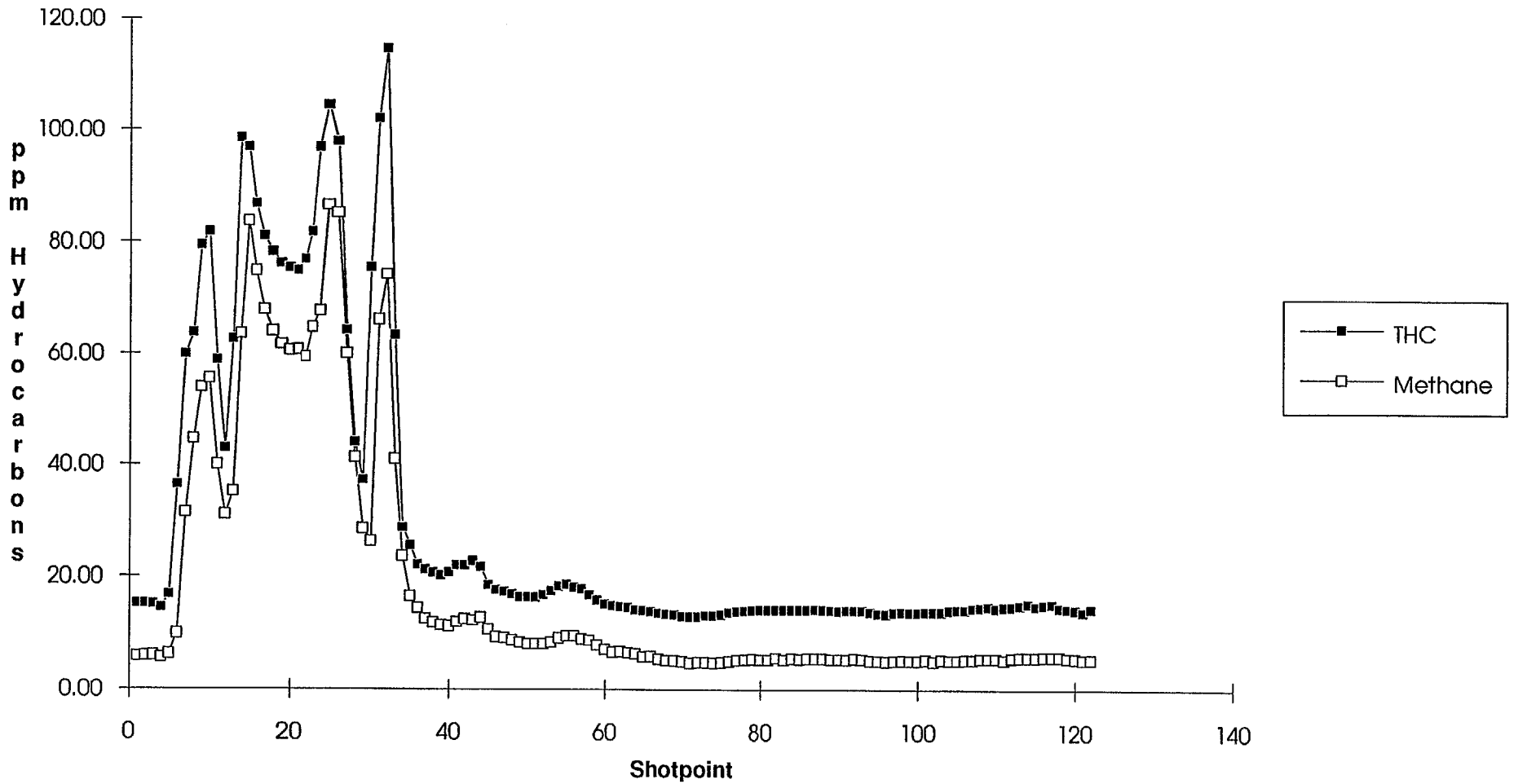
	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	29.385	18.032	0.077	0.214	0.077	0.070	0.017	0.004	0.006	0.151	0.012	0.043	0.864
Std. Dev.	27.190	22.400	0.097	0.138	0.113	0.044	0.031	0.010	0.010	0.080	0.012	0.019	0.199
Minimum	12.936	4.796	0.019	0.017	0.007	0.004	0.000	0.000	0.000	0.029	0.000	0.000	0.437
Maximum	114.703	86.617	0.435	0.474	0.500	0.183	0.163	0.042	0.051	0.270	0.048	0.100	1.517

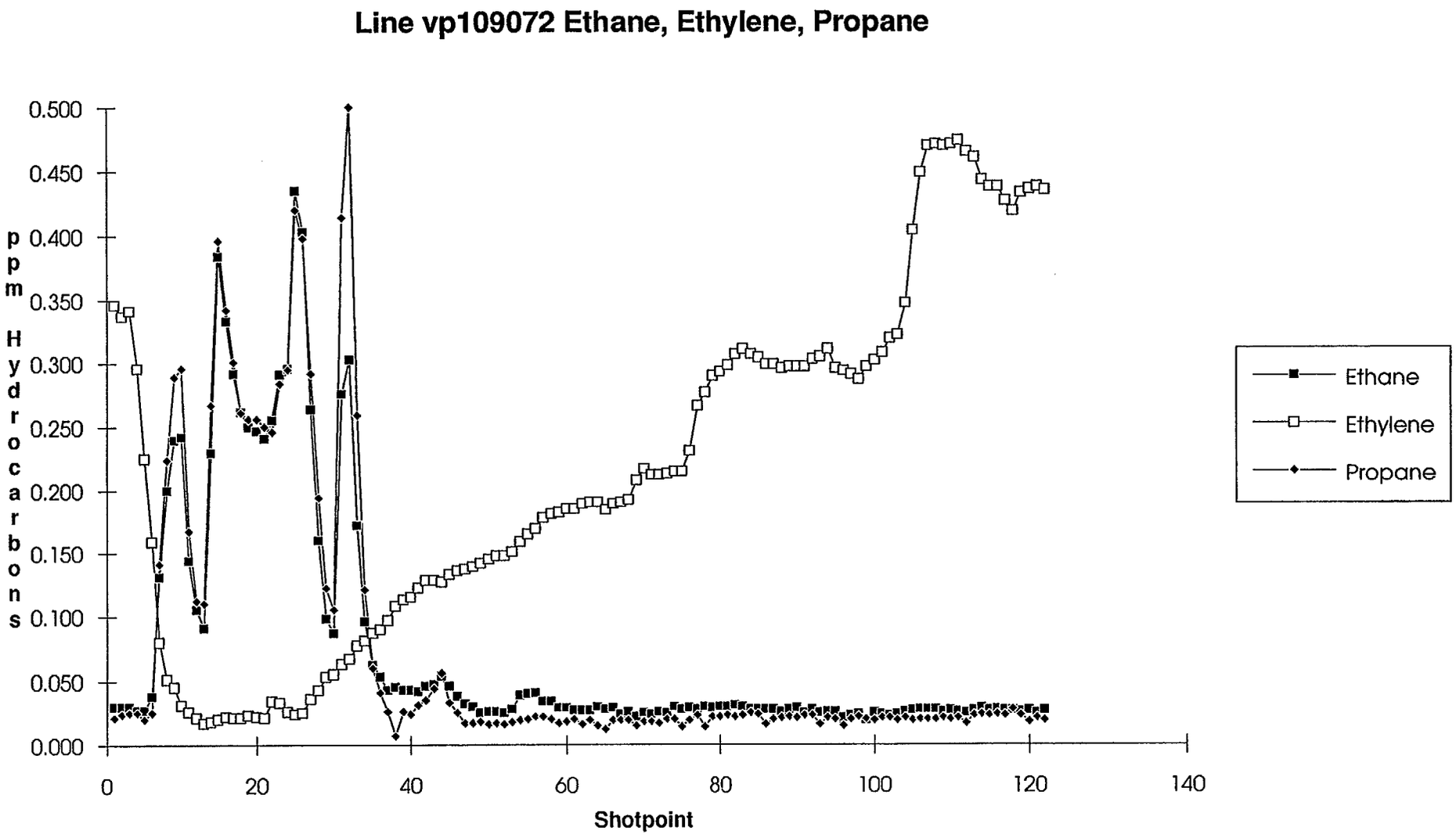
	Cond.	Temp.	F. Depth	W.Depth	Altitude	Calc. Alt.
Mean	58.414	25.303	61.662	161.325	27.348	99.675
Std. Dev.	2.067	1.358	53.506	16.144	7.109	62.426
Minimum	54.700	22.840	6.900	146.700	8.900	4.900
Maximum	61.130	27.050	148.900	226.600	31.000	216.000

Notes

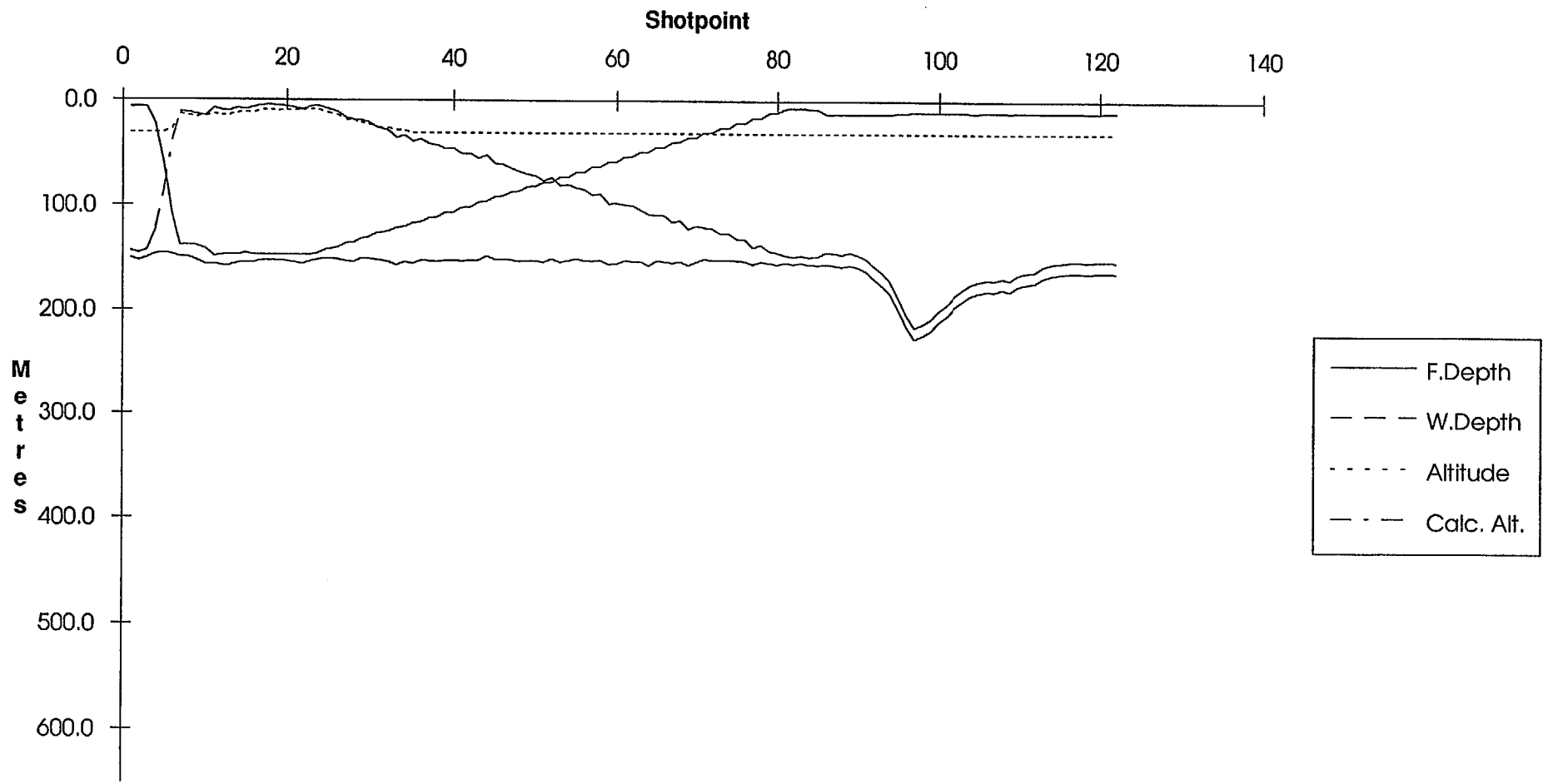
A moderate THC, methane, ethane, and propane anomaly occurs between SP 5 and SP 35
Ethylene values increase as the fish is raised through the thermocline from SP 30
A gas sample for carbon isotope analysis was taken from SP 9 to SP 25.

Line vp109072 THC, Methane

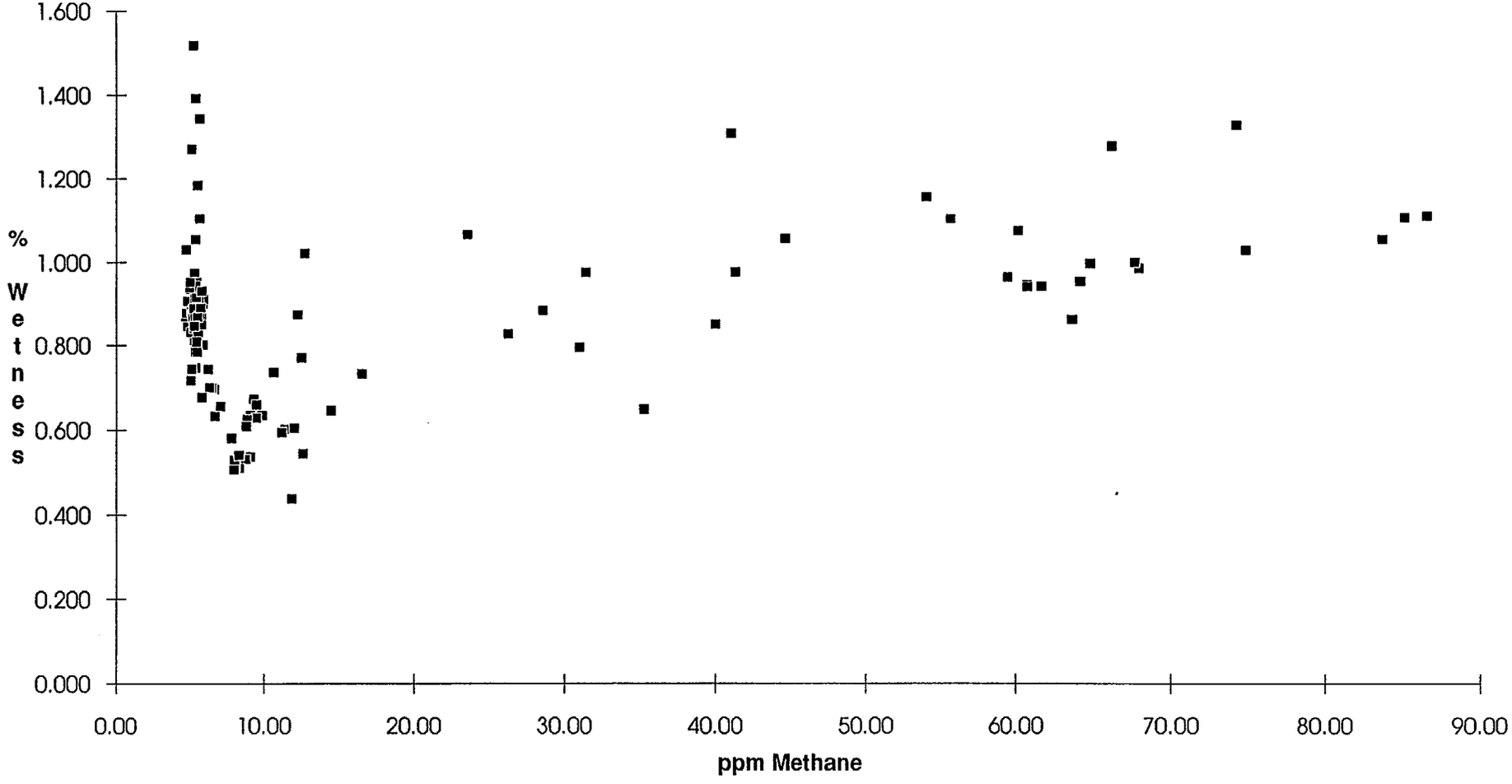



Line vp109072 Ethane, Ethylene, Propane
ppm Hydrocarbons
0.500
0.450
0.400
0.350
0.300
0.250
0.200
0.150
0.100
0.050
0.000
0
20
40
60
80
100
120
140
Shotpoint
Ethane
Ethylene
Propane

Line vp109072 Depths, Altitudes



Line vp109072 Methane v. %Wetness



Line Summary

Line Number	109073
No. of Shotpoints	77

	Shotpoint	Date	Time	Latitude		Longitude	
Start	1	2-May-92	15:08:18	13	19.485	122	52.709
End	78	2-May-92	17:50:37	13	25.238	122	46.260

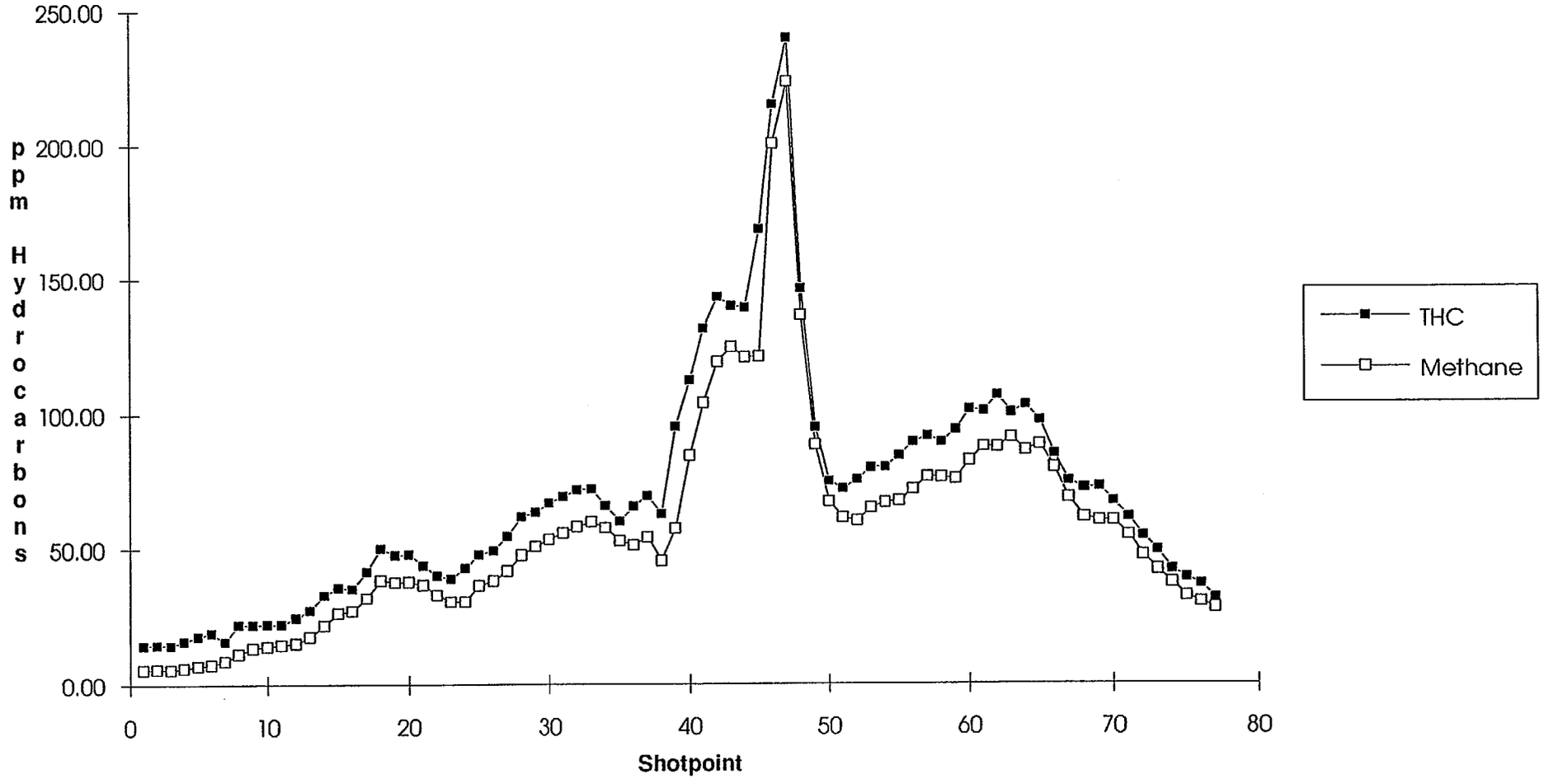
	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	69.395	56.933	0.024	0.035	0.020	0.019	0.002	0.000	0.002	0.042	0.005	0.027	0.182
Std. Dev.	43.620	40.213	0.008	0.079	0.006	0.022	0.004	0.000	0.008	0.043	0.017	0.015	0.246
Minimum	14.490	5.636	0.012	0.006	0.004	0.000	0.000	0.000	0.000	0.018	0.000	0.000	0.025
Maximum	239.633	223.452	0.053	0.385	0.036	0.109	0.016	0.000	0.048	0.212	0.118	0.091	1.178

	Cond.	Temp.	F. Depth	W.Depth	Altitude	Calc. Alt.
Mean	54.576	22.767	185.065	206.579	15.918	21.668
Std. Dev.	1.492	1.005	51.424	25.869	5.897	33.607
Minimum	53.720	22.160	10.700	163.300	9.000	2.600
Maximum	60.550	26.730	235.900	253.600	30.900	156.300

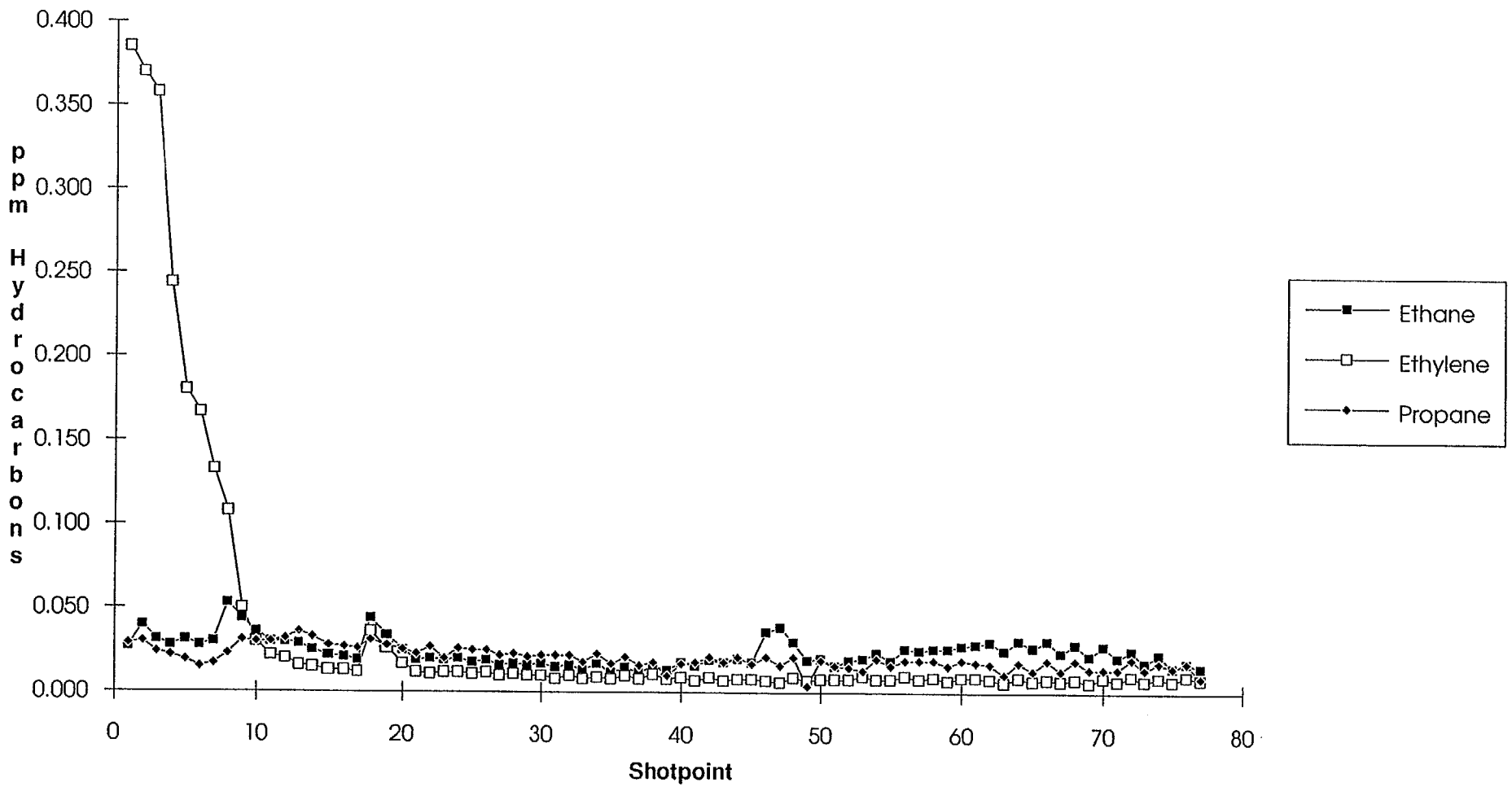
Notes

A strong THC and methane anomaly peaks at SP 47, anomalous values occur throughout the SP range 20 to 70.
A weak ethane anomaly occurs at SP 47.
The strong ethylene value prior to SP 8 is related to the fish being lowered through the thermocline.
Gas samples for carbon isotope analysis where taken between SP 30 to SP 57 and SP 63 to 78.

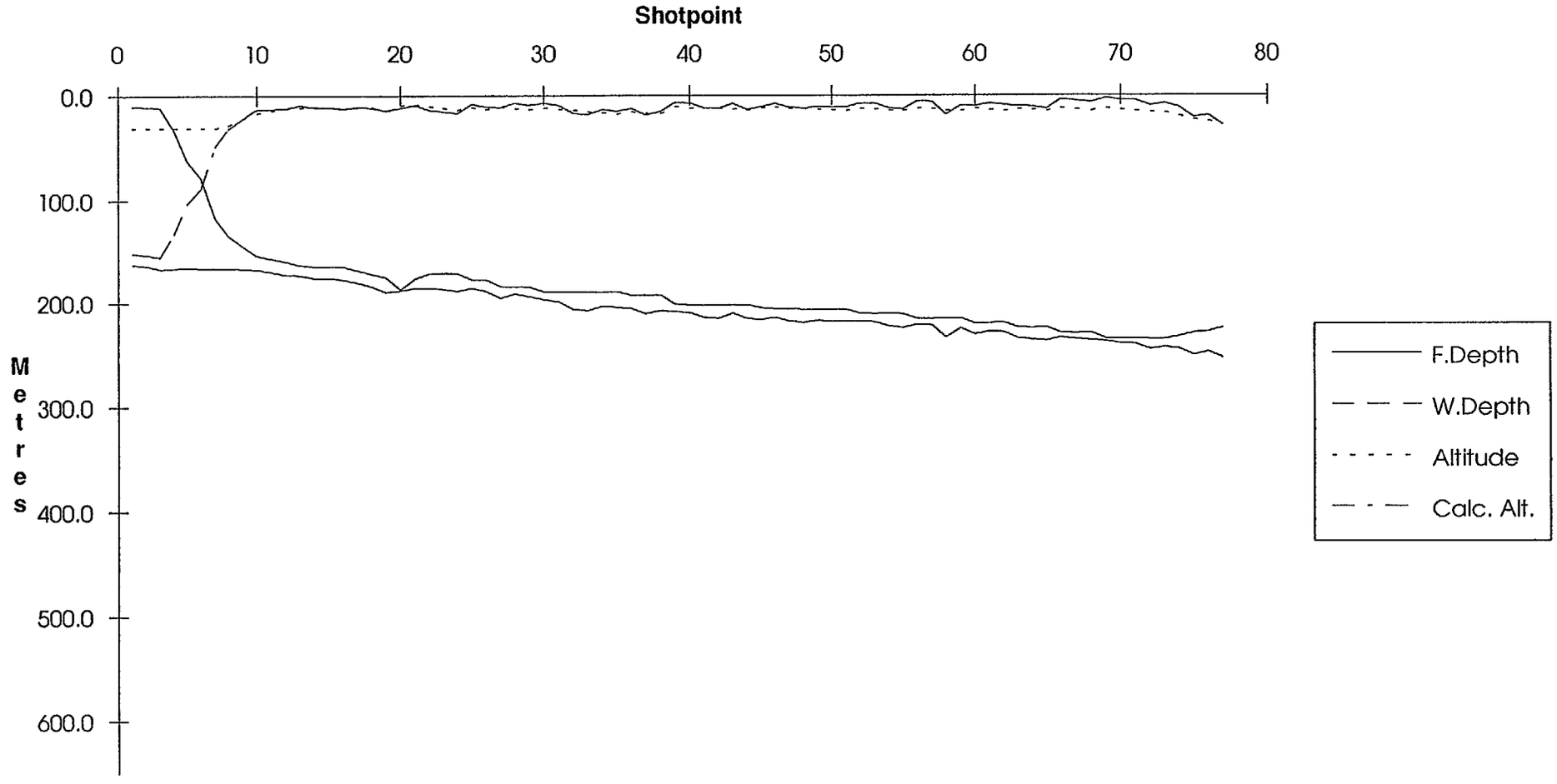
Line 109073 THC, Methane



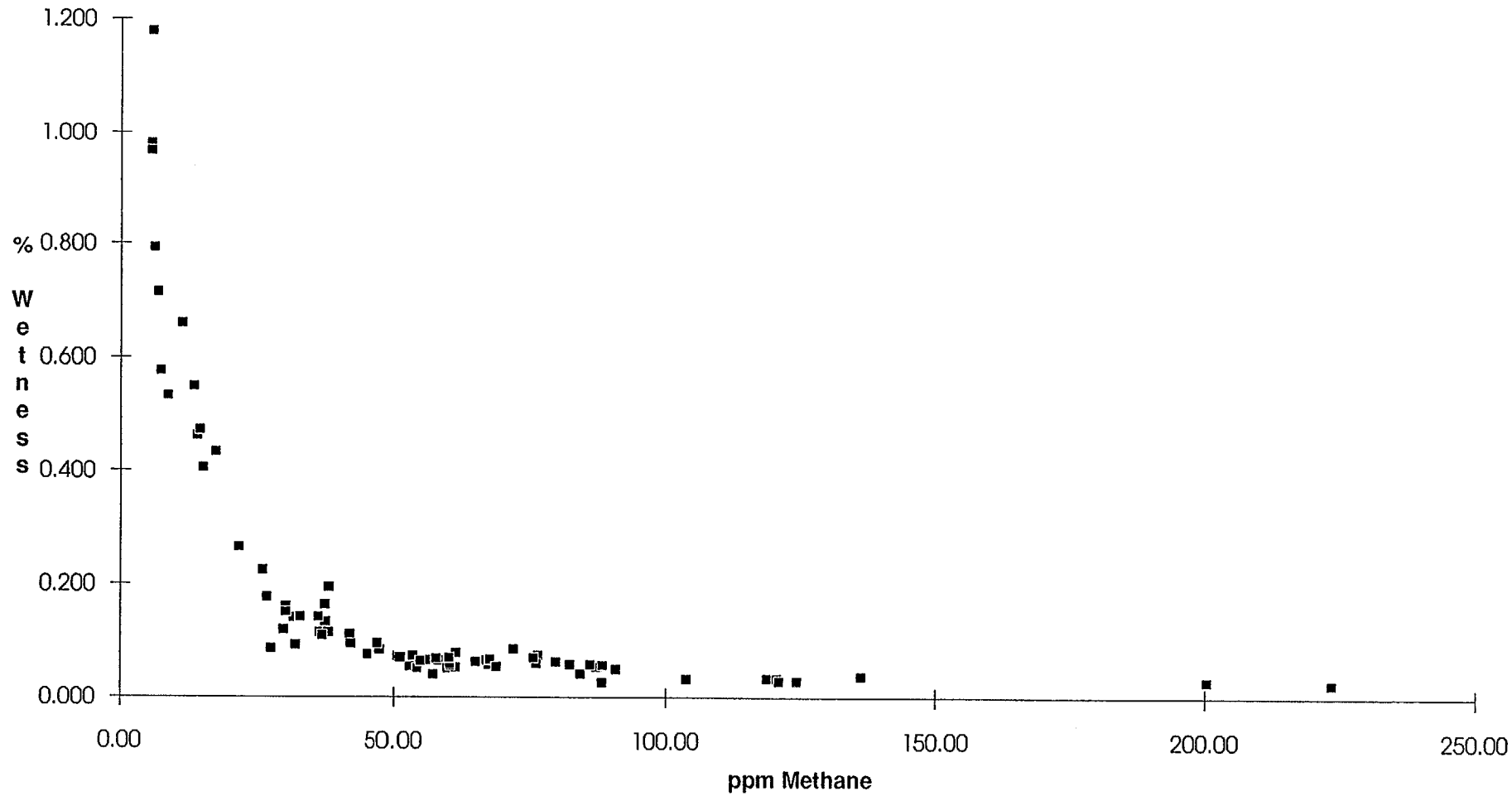
Line 109073 Ethane, Ethylene, Propane



Line 109073 Depths, Altitudes



Line 109073 Methane v. %Wetness



Line Summary

Line Number	109074
No. of Shotpoints	50

	Shotpoint	Date	Time	Latitude		Longitude	
Start	1	2-May-92	17:52:38	13	25.251	122	46.132
End	50	2-May-92	19:31:16	13	19.693	122	46.653

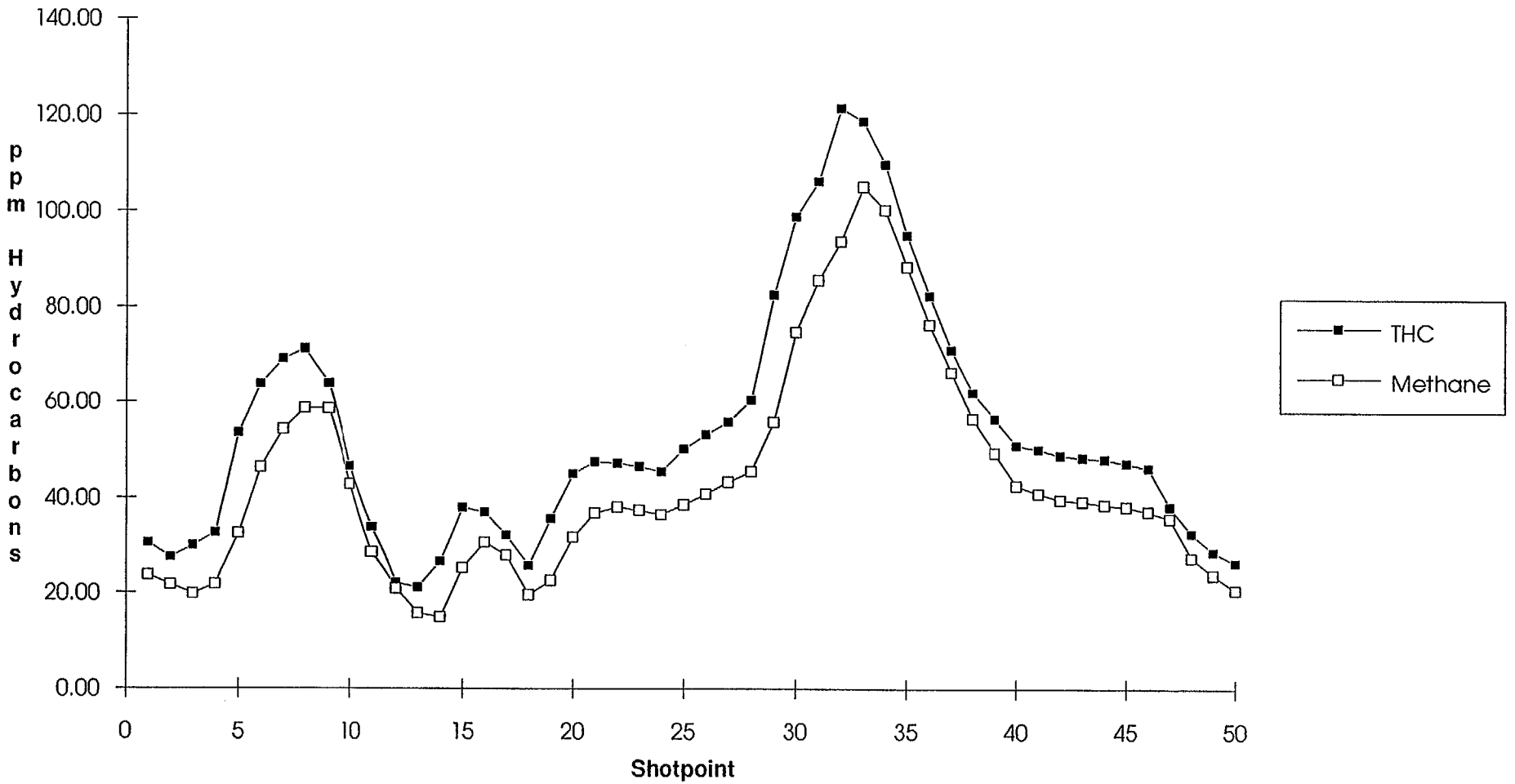
	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	53.647	43.422	0.016	0.010	0.016	0.015	0.002	0.000	0.000	0.026	0.000	0.026	0.095
Std. Dev.	25.340	22.457	0.005	0.003	0.004	0.008	0.005	0.000	0.000	0.004	0.001	0.010	0.040
Minimum	20.997	14.880	0.011	0.005	0.009	0.000	0.000	0.000	0.000	0.018	0.000	0.000	0.026
Maximum	121.406	105.162	0.030	0.022	0.024	0.026	0.025	0.000	0.000	0.035	0.009	0.046	0.193

	Cond.	Temp.	F. Depth	W.Depth	Altitude	Calc. Alt.
Mean	54.253	22.525	199.694	213.524	15.366	13.840
Std. Dev.	0.122	0.087	20.055	23.032	4.449	5.779
Minimum	53.930	22.300	163.100	172.600	9.600	5.400
Maximum	54.400	22.620	230.300	254.000	28.700	29.600

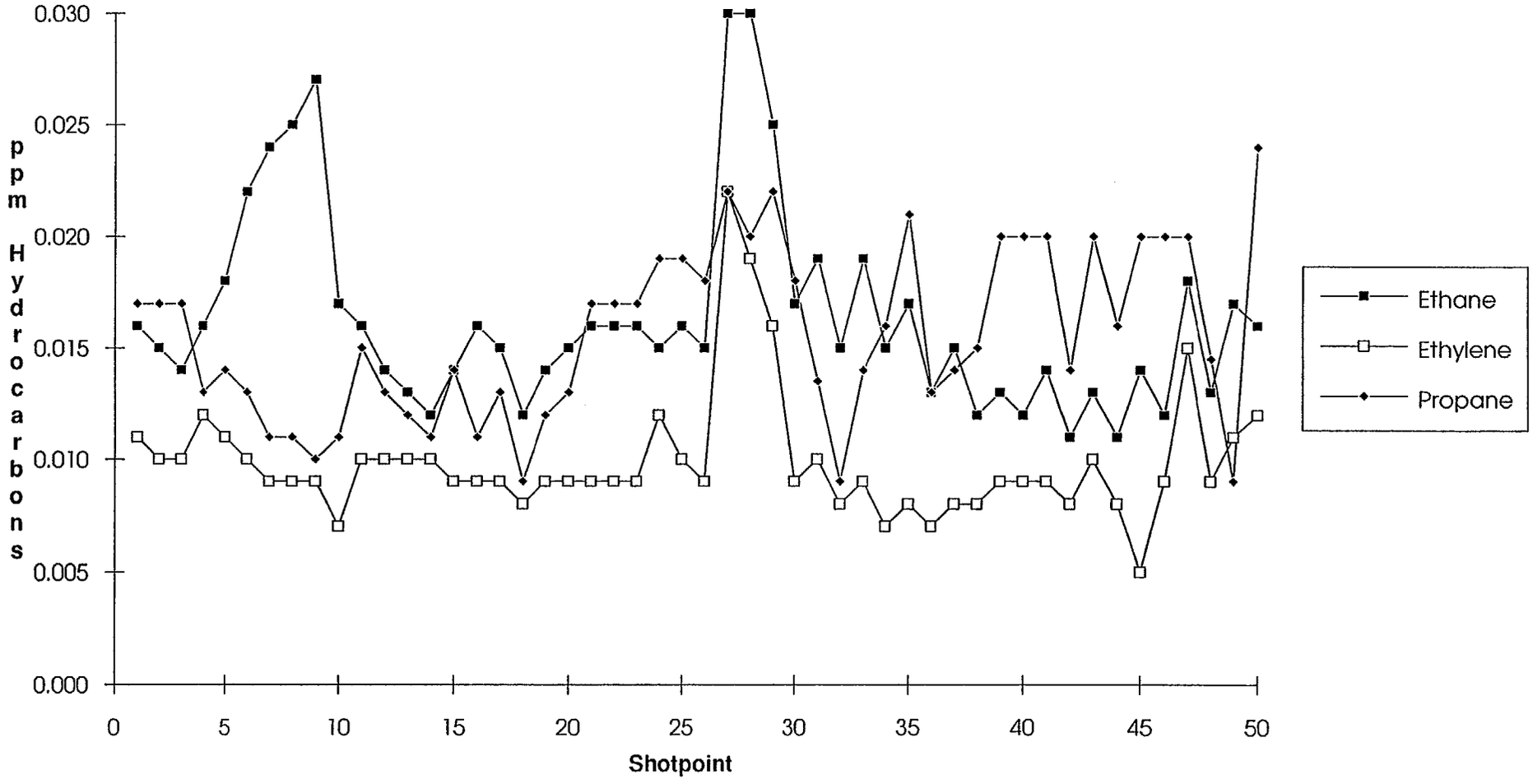
Notes

Two weak THC and methane anomalies occur at SP 7 and SP 16, a moderate anomaly occurs at SP 32.
A weak ethane anomaly occurs at SP 7,and a weak ethane, propane and ethylene anomaly occurs at SP 27.
A gas sample for carbon isotope analysis was taken from SP 7 to SP 11 and SP 28 to SP 48.

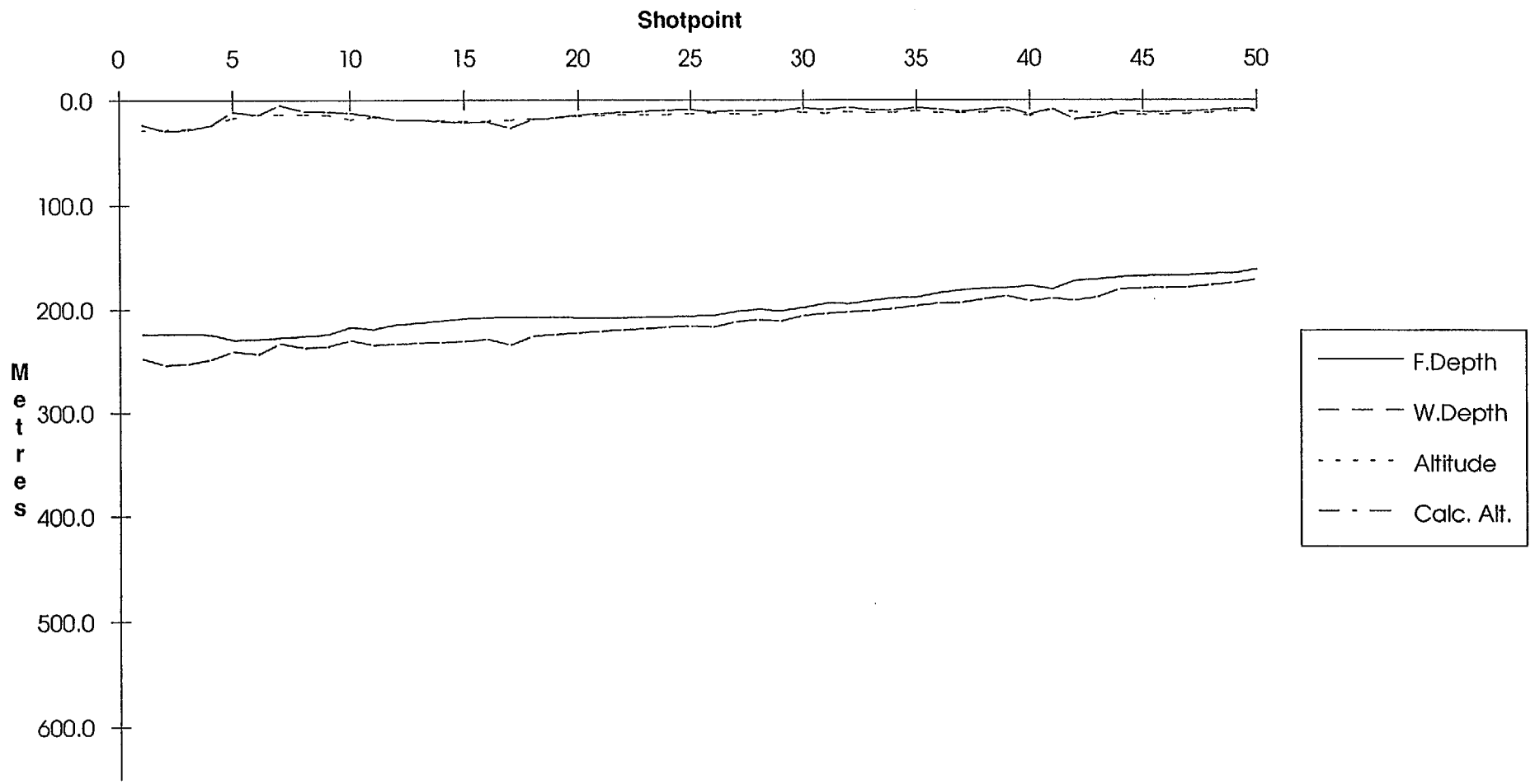
Line 109074 THC, Methane



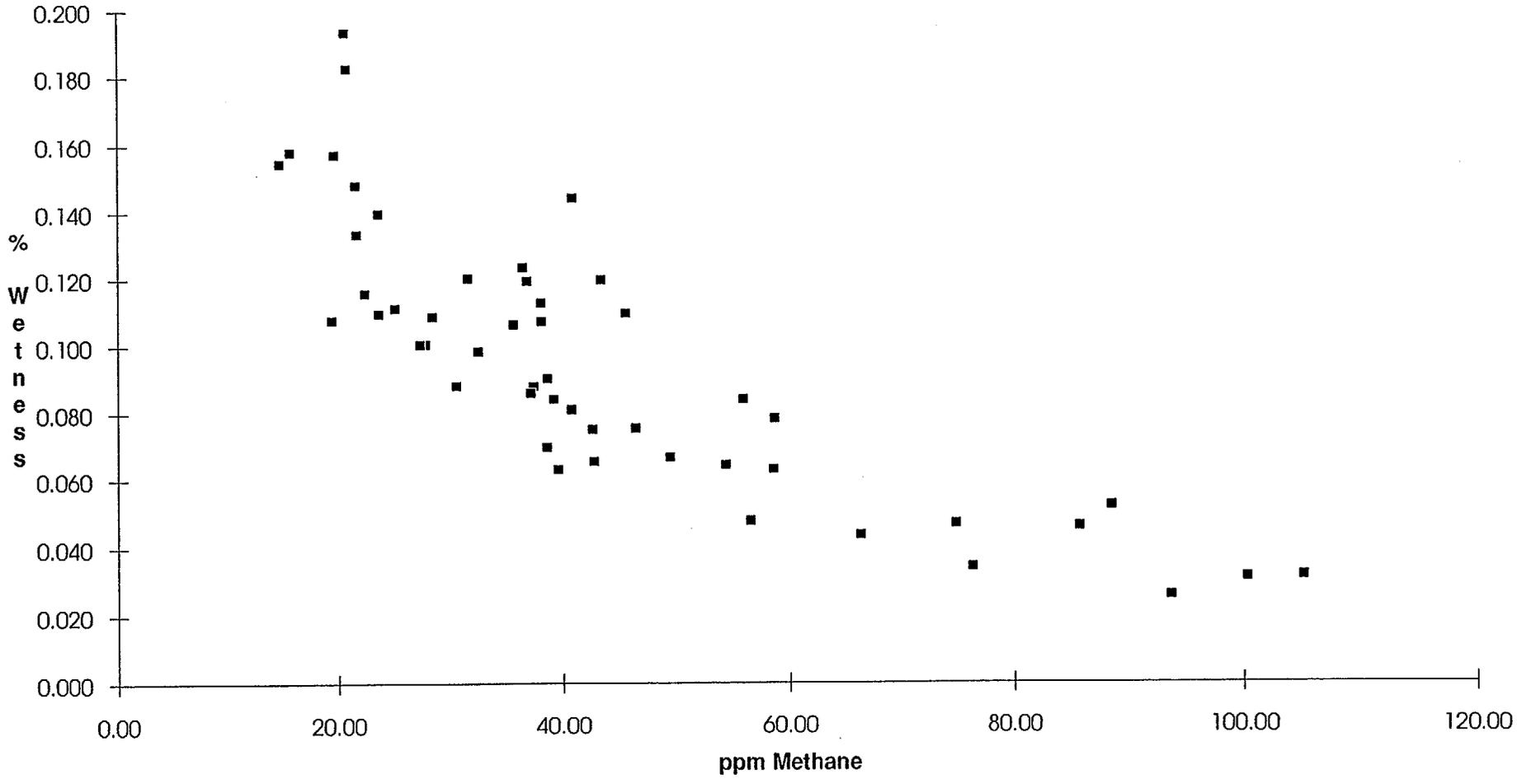
Line 109074 Ethane, Ethylene, Propane



Line 109074 Depths, Altitudes



Line 109074 Methane v. %Wetness



Line Summary

Line Number	109075
No. of Shotpoints	60

	Shotpoint	Date	Time	Latitude		Longitude	
Start	1	2-May-92	19:33:17	13	19.691	122	46.482
End	60	2-May-92	21:34:41	13	22.484	122	46.612

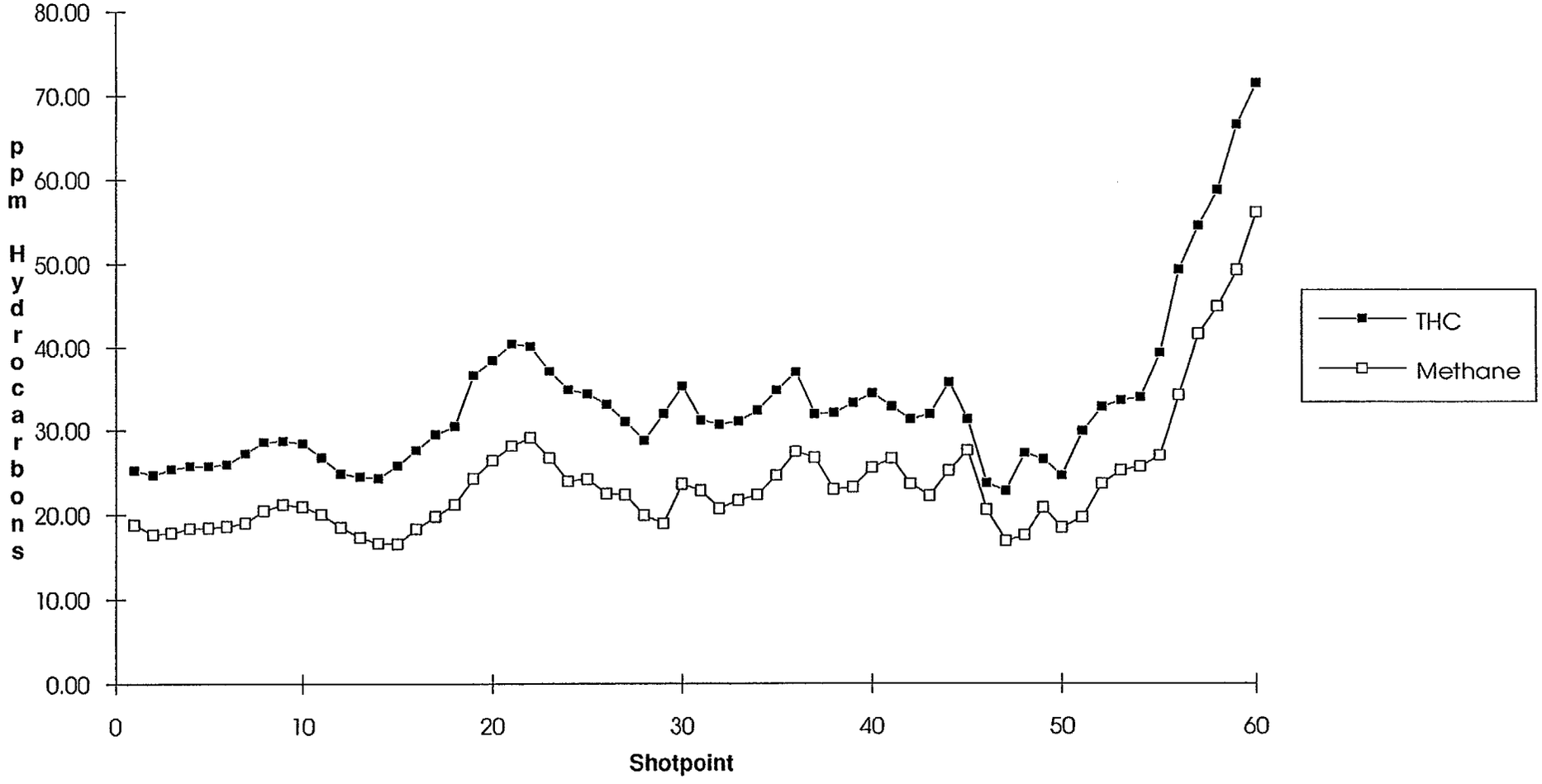
	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	33.068	23.843	0.039	0.028	0.029	0.017	0.011	0.002	0.001	0.032	0.002	0.024	0.362
Std. Dev.	9.576	7.549	0.021	0.018	0.010	0.012	0.009	0.005	0.002	0.007	0.004	0.009	0.173
Minimum	22.694	16.545	0.012	0.007	0.014	0.000	0.000	0.000	0.000	0.019	0.000	0.000	0.087
Maximum	71.293	55.989	0.075	0.063	0.042	0.058	0.051	0.017	0.006	0.049	0.019	0.038	0.684

	Cond.	Temp.	F. Depth	W.Depth	Altitude	Calc. Alt.
Mean	54.677	22.812	149.690	160.668	13.180	10.990
Std. Dev.	0.502	0.343	24.834	24.150	1.775	2.442
Minimum	53.620	22.100	123.200	134.600	8.200	3.500
Maximum	55.530	23.400	208.400	218.500	18.400	17.300

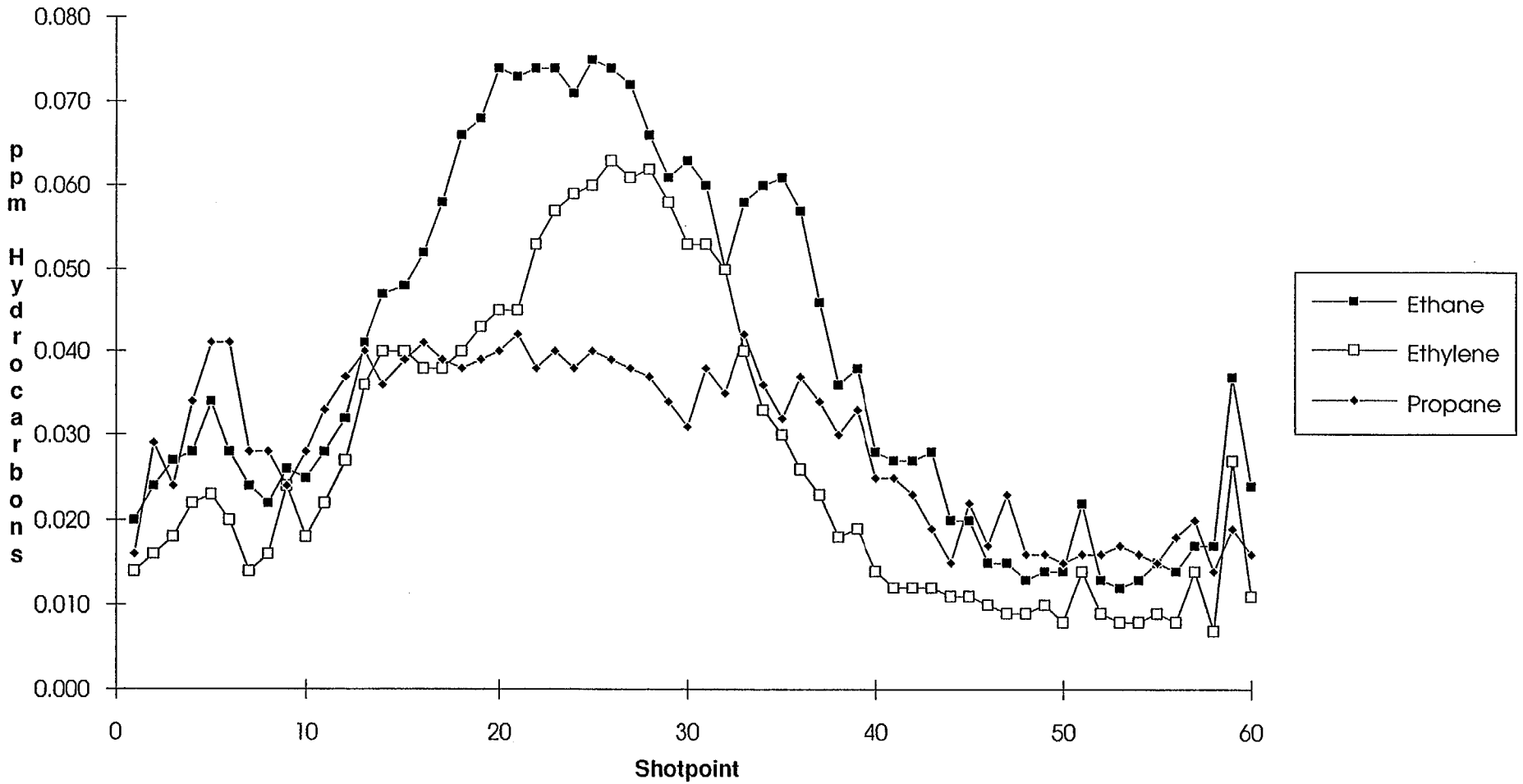
Notes

Two weak THC and methane anomalies occur at SP 22 and SP 56.
A weak to moderate ethane, propane and ethylene anomaly occurs between SP 11 and SP 37.
A weak ethane, propane and ethylene anomaly occurs at SP 58.
Gas samples for carbon isotope analysis where taken at SP 58 to 60.

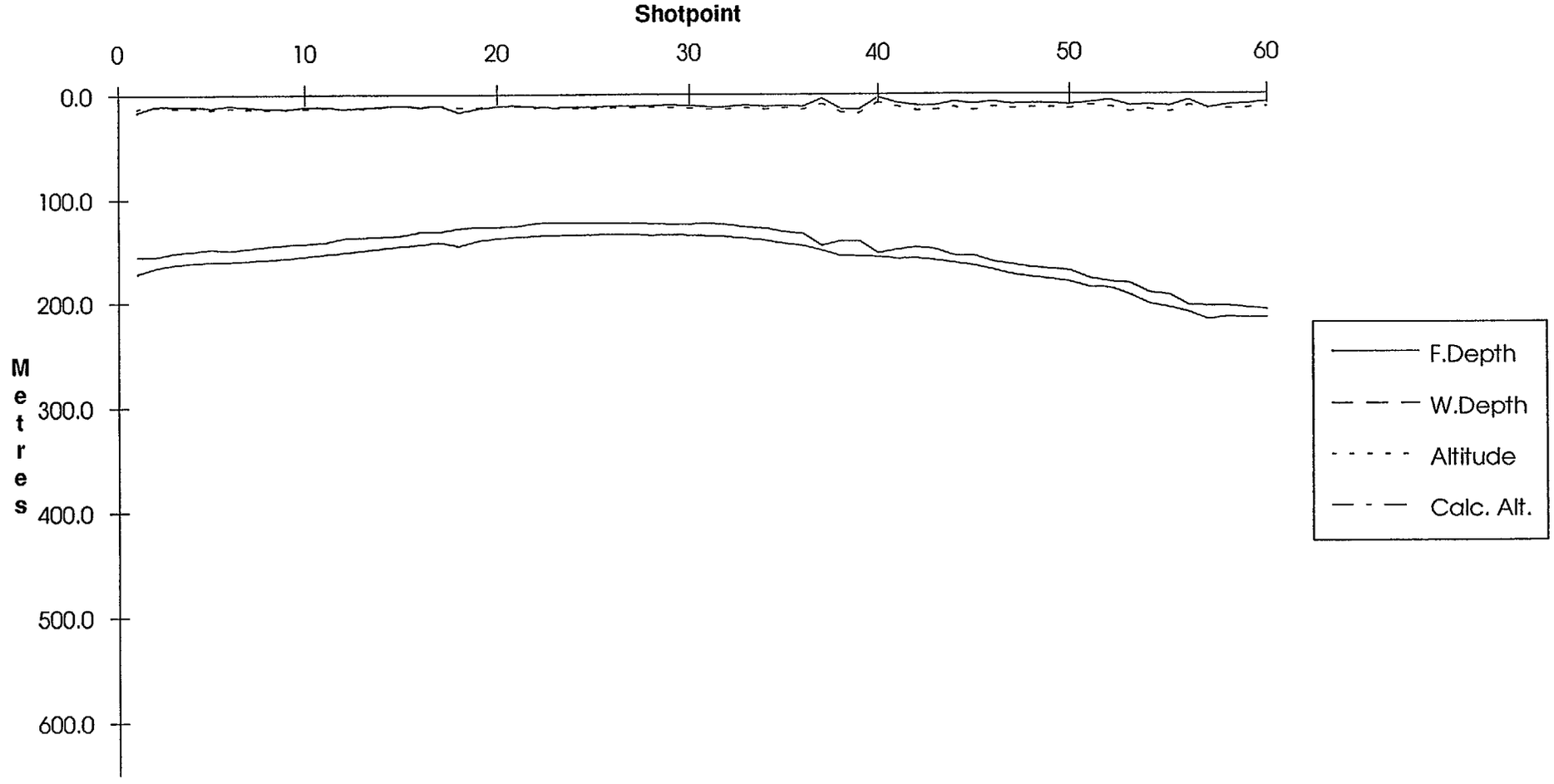
Line 109075 THC, Methane



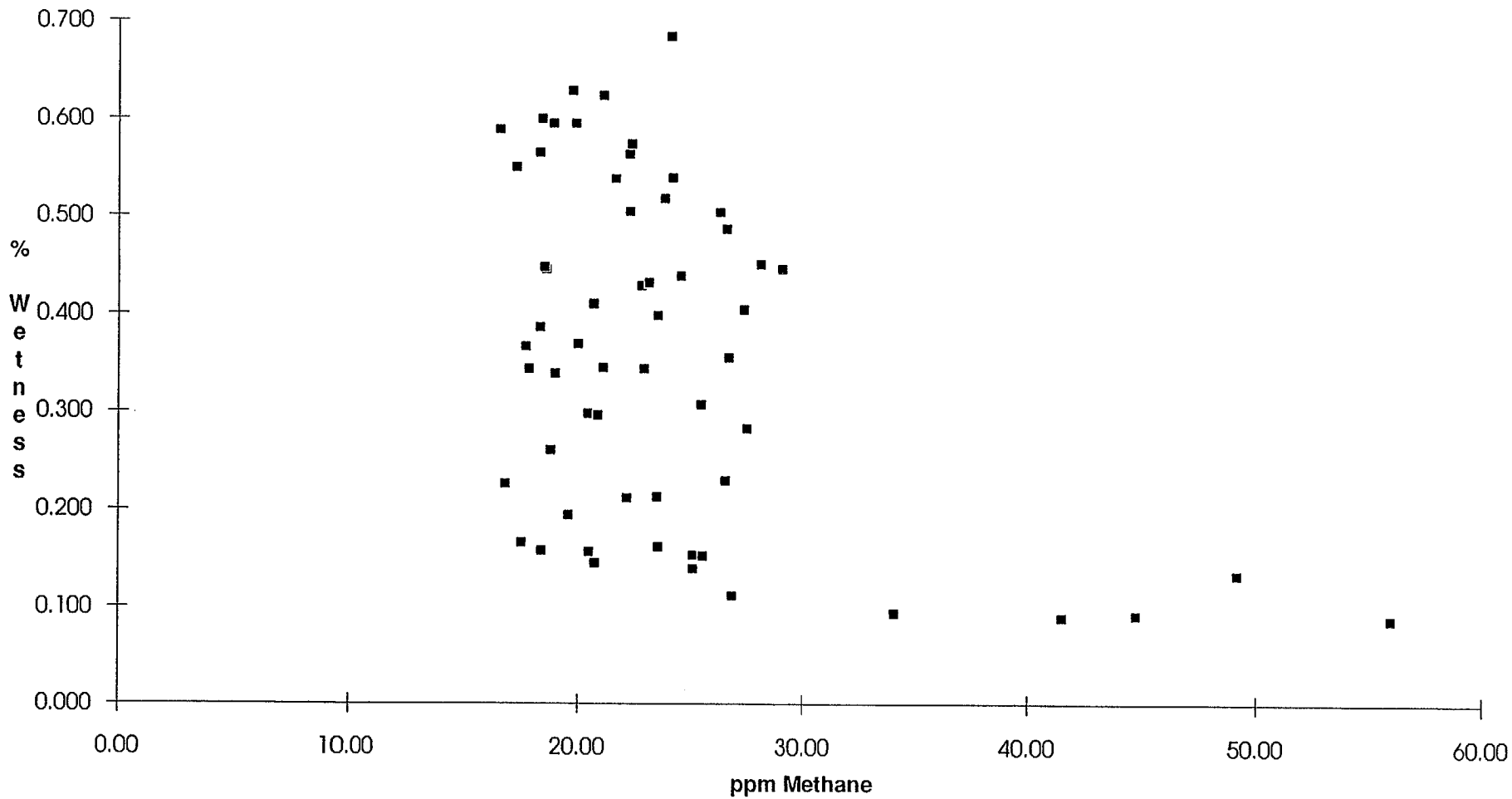
Line 109075 Ethane, Ethylene, Propane



Line 109075 Depths, Altitudes



Line 109075 Methane v. %Wetness



Line Summary

Line Number	VP109075
No. of Shotpoints	116

	Shotpoint	Date	Time	Latitude		Longitude	
Start	1	2-May-92	21:36:41	13	22.403	122	46.745
End	117	3-May-92	01:34:17	13	22.901	122	47.389

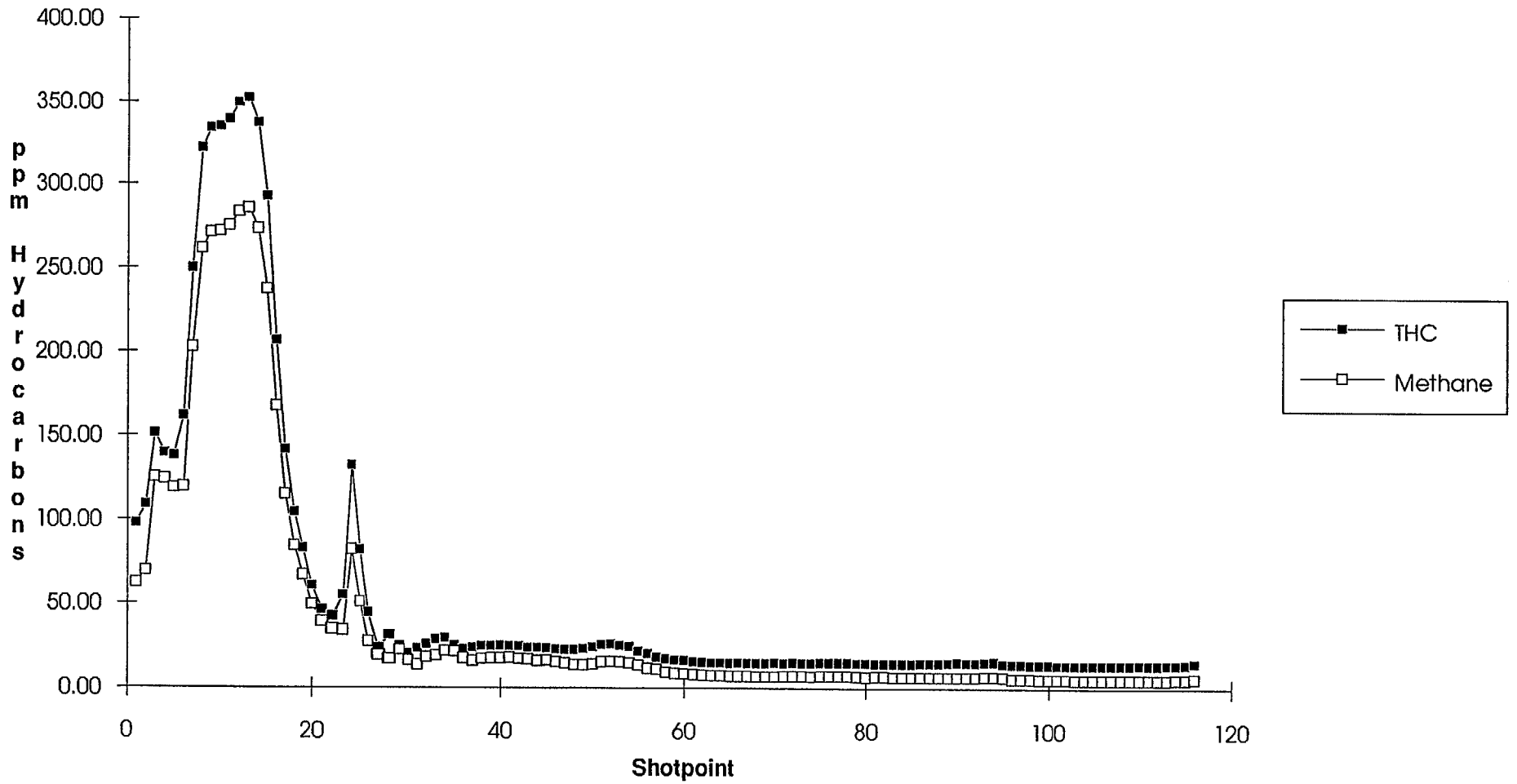
	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	54.500	39.837	0.032	0.124	0.020	0.045	0.003	0.000	0.000	0.092	0.004	0.024	0.511
Std. Dev.	86.730	71.701	0.015	0.109	0.007	0.036	0.005	0.001	0.000	0.073	0.006	0.013	0.334
Minimum	13.310	4.786	0.014	0.000	0.007	0.000	0.000	0.000	0.000	0.013	0.000	0.000	0.029
Maximum	352.389	285.878	0.085	0.333	0.043	0.149	0.021	0.013	0.005	0.255	0.027	0.078	1.288

	Cond.	Temp.	F. Depth	W.Depth	Altitude	Calc. Alt.
Mean	57.235	24.494	108.186	215.868	27.748	107.686
Std. Dev.	2.950	1.967	66.139	2.295	7.003	67.026
Minimum	53.350	21.900	5.300	212.400	9.100	2.000
Maximum	61.660	27.430	210.300	223.000	31.000	214.300

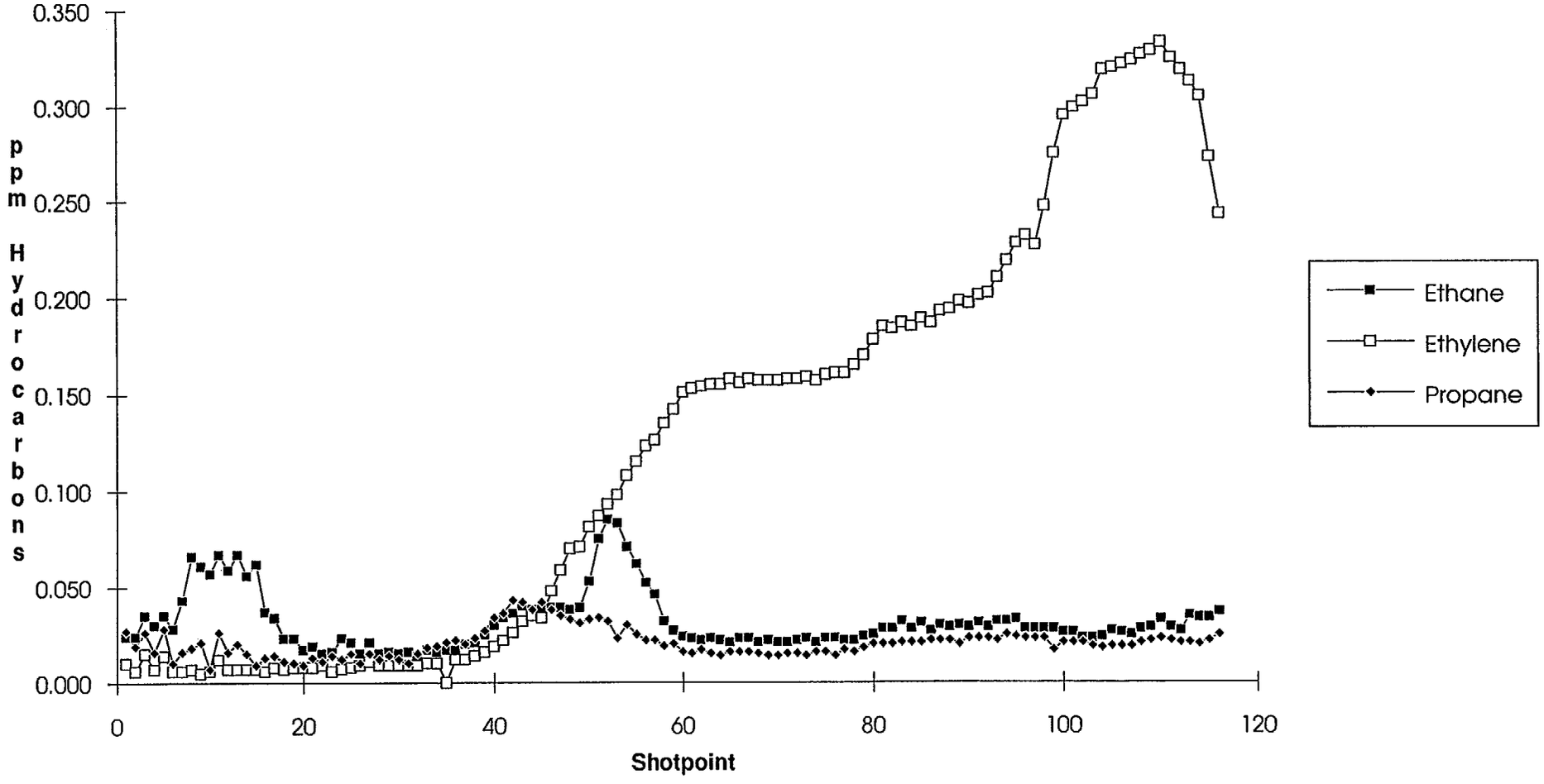
Notes

A strong THC and methane anomally occurs between SP 2 and SP 18, a weak anomaly occurs at SP 24.
A weak ethane anomaly occurs between SP 7 and SP 17, and at SP 54 .
Ethylene values increase as the fish is raised through the thermocline from SP 42 onwards.
A gas sample for carbon isotope analysis was taken from SP 3 to SP 26.

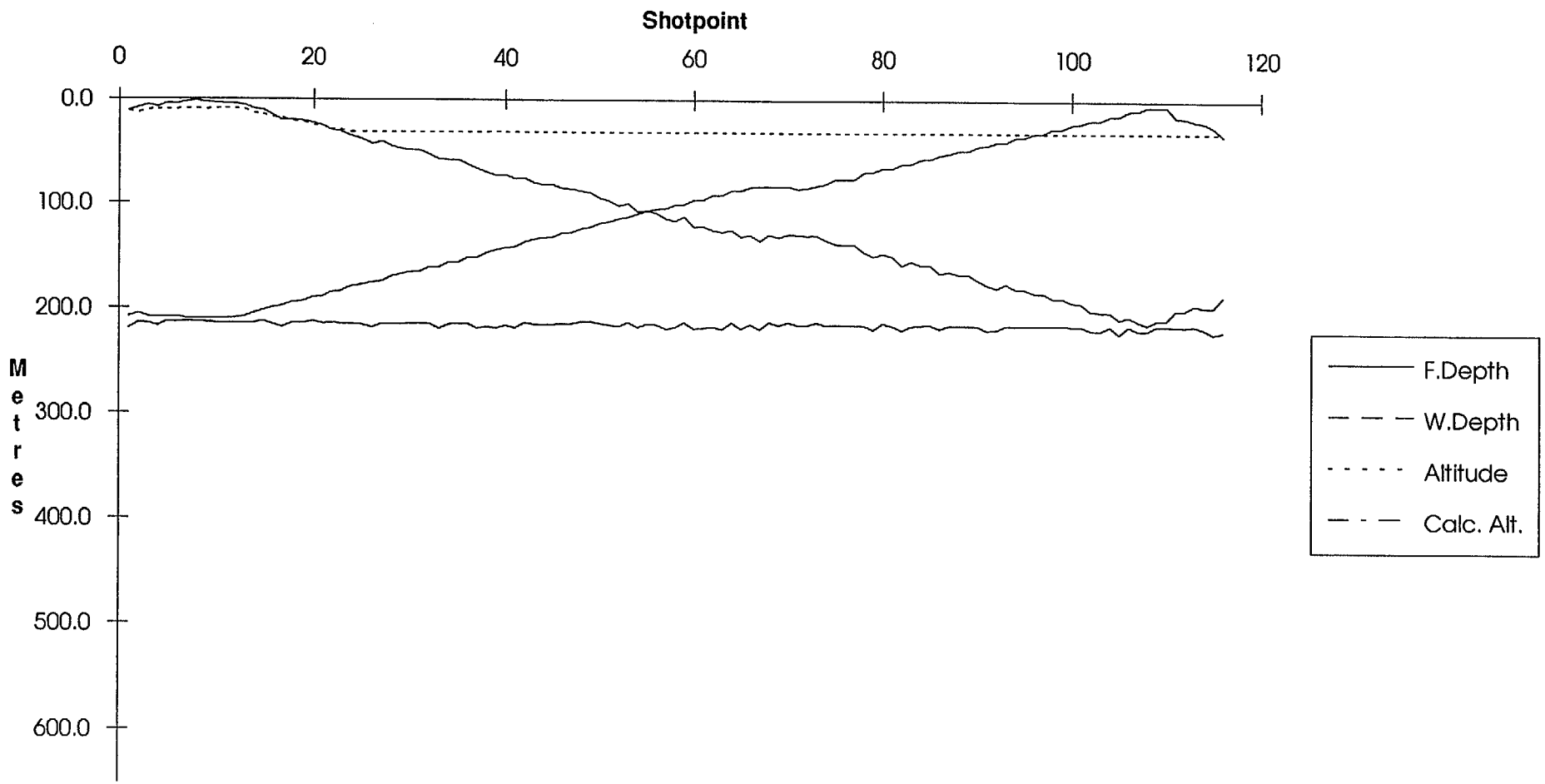
Line vp109075 THC, Methane



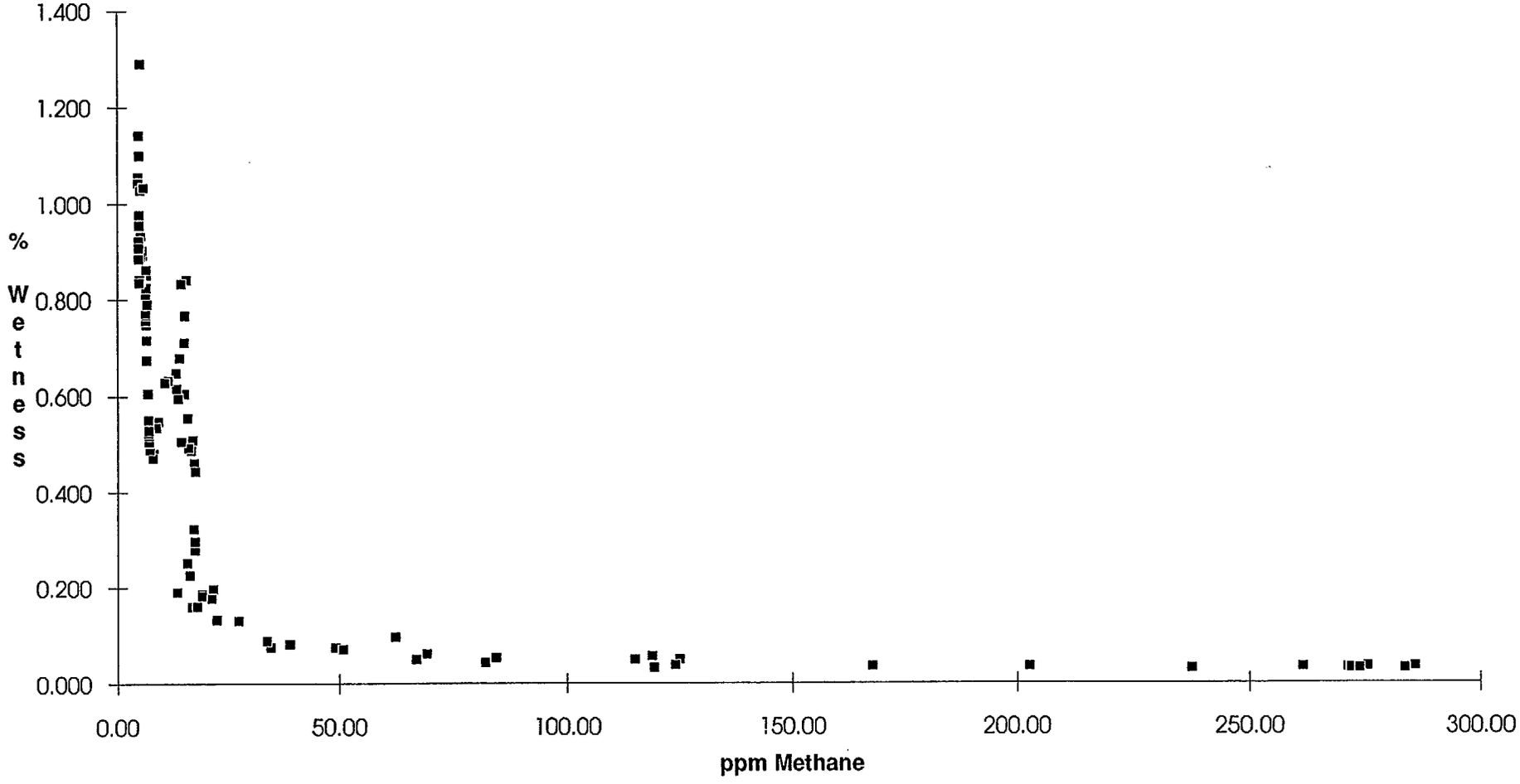
Line vp109075 Ethane, Ethylene, Propane



Line vp109075 Depths, Altitudes



Line vp109075 Methane v. %Wetness



Line Summary

Line Number	VP109076
No. of Shotpoints	107

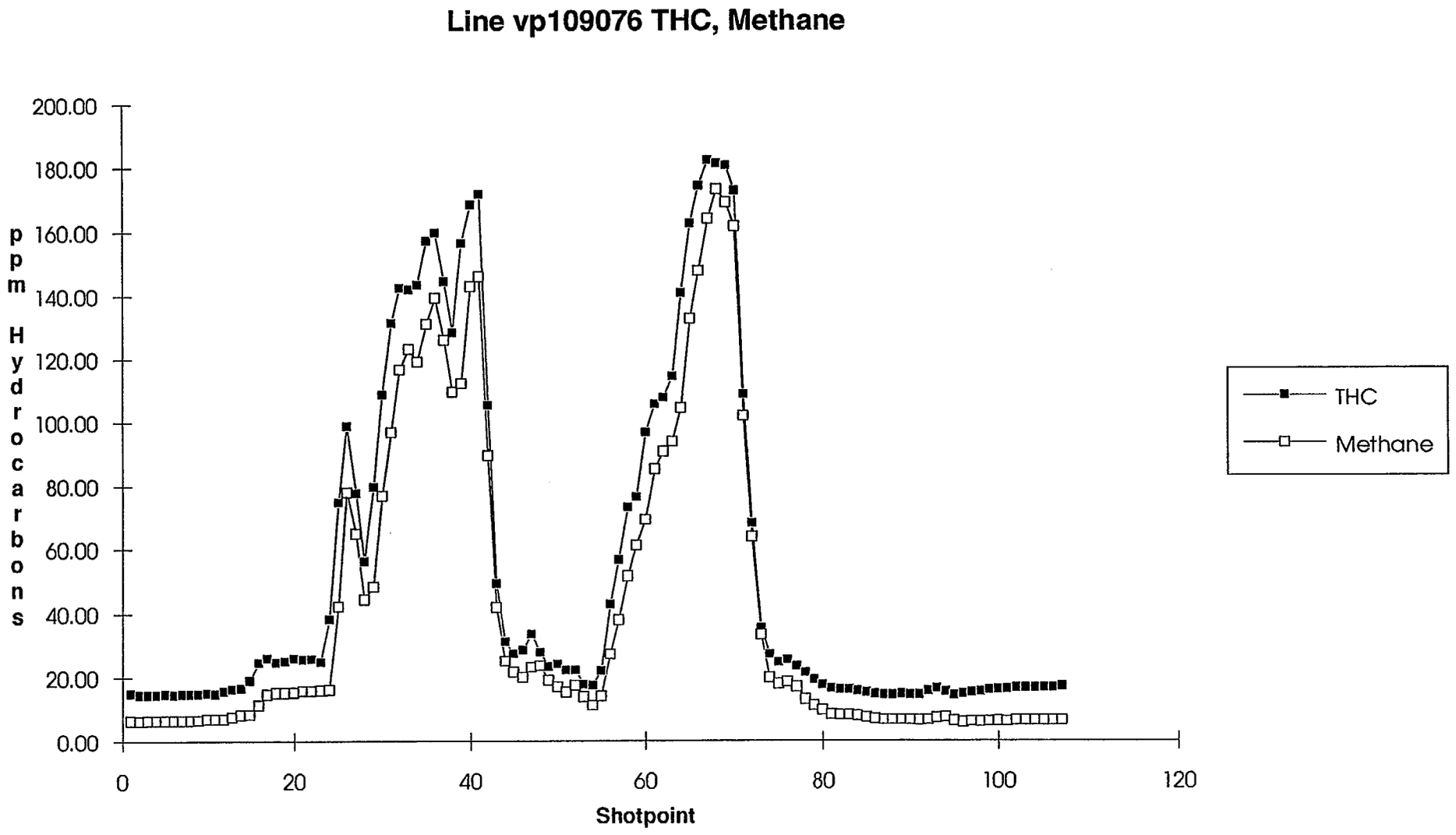
	Shotpoint	Date	Time	Latitude		Longitude	
Start	1	3-May-92	01:42:03	13	23.251	122	47.374
End	107	3-May-92	05:19:41	13	28.994	122	48.094

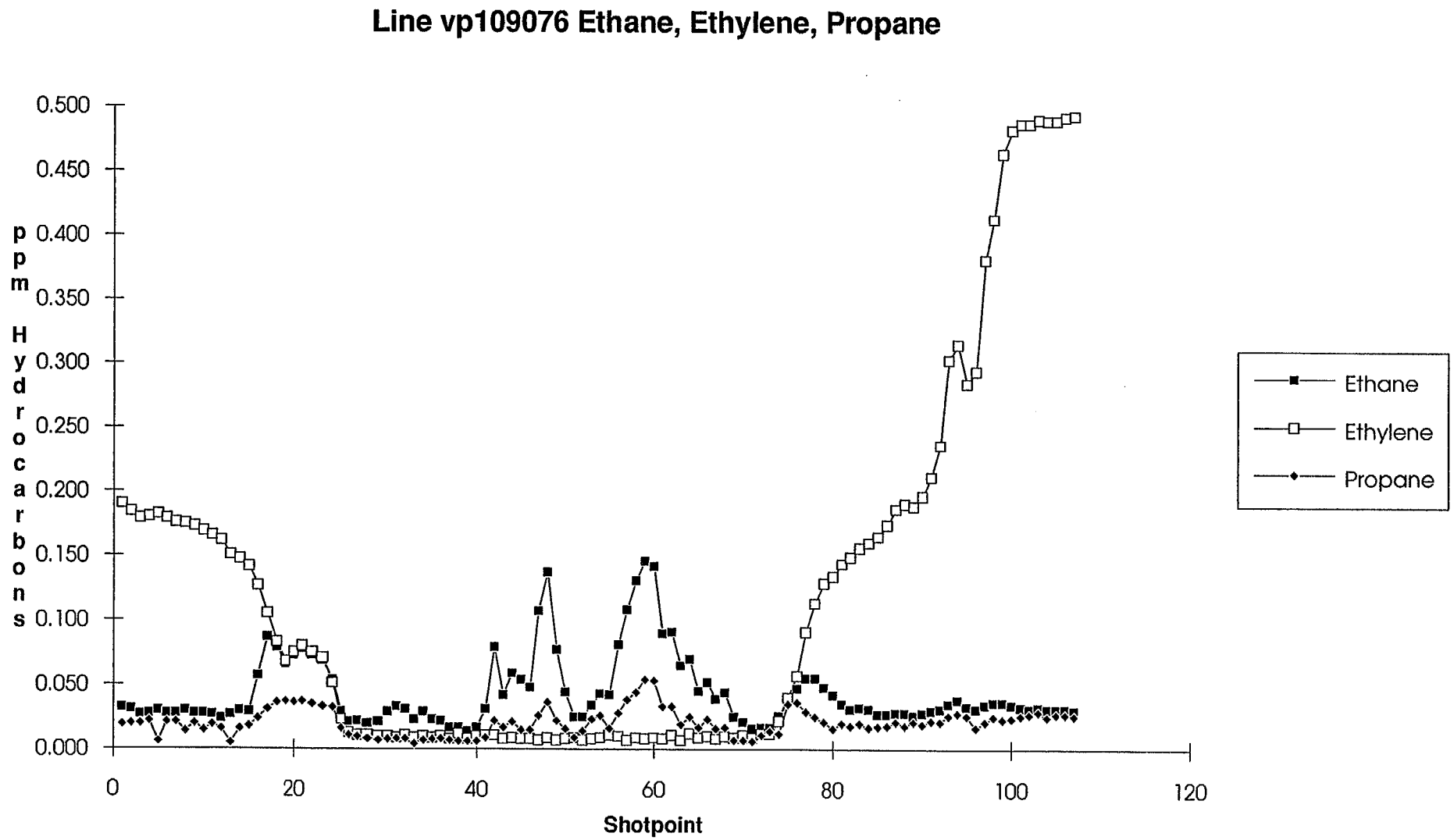
	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	53.567	40.879	0.043	0.120	0.021	0.033	0.014	0.001	0.007	0.090	0.006	0.034	0.536
Std. Dev.	54.124	48.555	0.028	0.145	0.010	0.032	0.043	0.005	0.007	0.081	0.010	0.017	0.426
Minimum	14.381	6.009	0.014	0.007	0.004	0.000	0.000	0.000	0.000	0.016	0.000	0.000	0.016
Maximum	182.476	173.245	0.146	0.493	0.054	0.116	0.392	0.032	0.030	0.287	0.061	0.115	2.723

	Cond.	Temp.	F. Depth	W.Depth	Altitude	Calc. Alt.
Mean	58.347	25.282	129.733	261.244	30.294	131.607
Std. Dev.	2.862	1.869	73.412	15.708	2.223	70.939
Minimum	54.750	22.870	11.800	219.900	20.500	1.300
Maximum	63.700	28.870	269.000	274.500	31.000	260.900

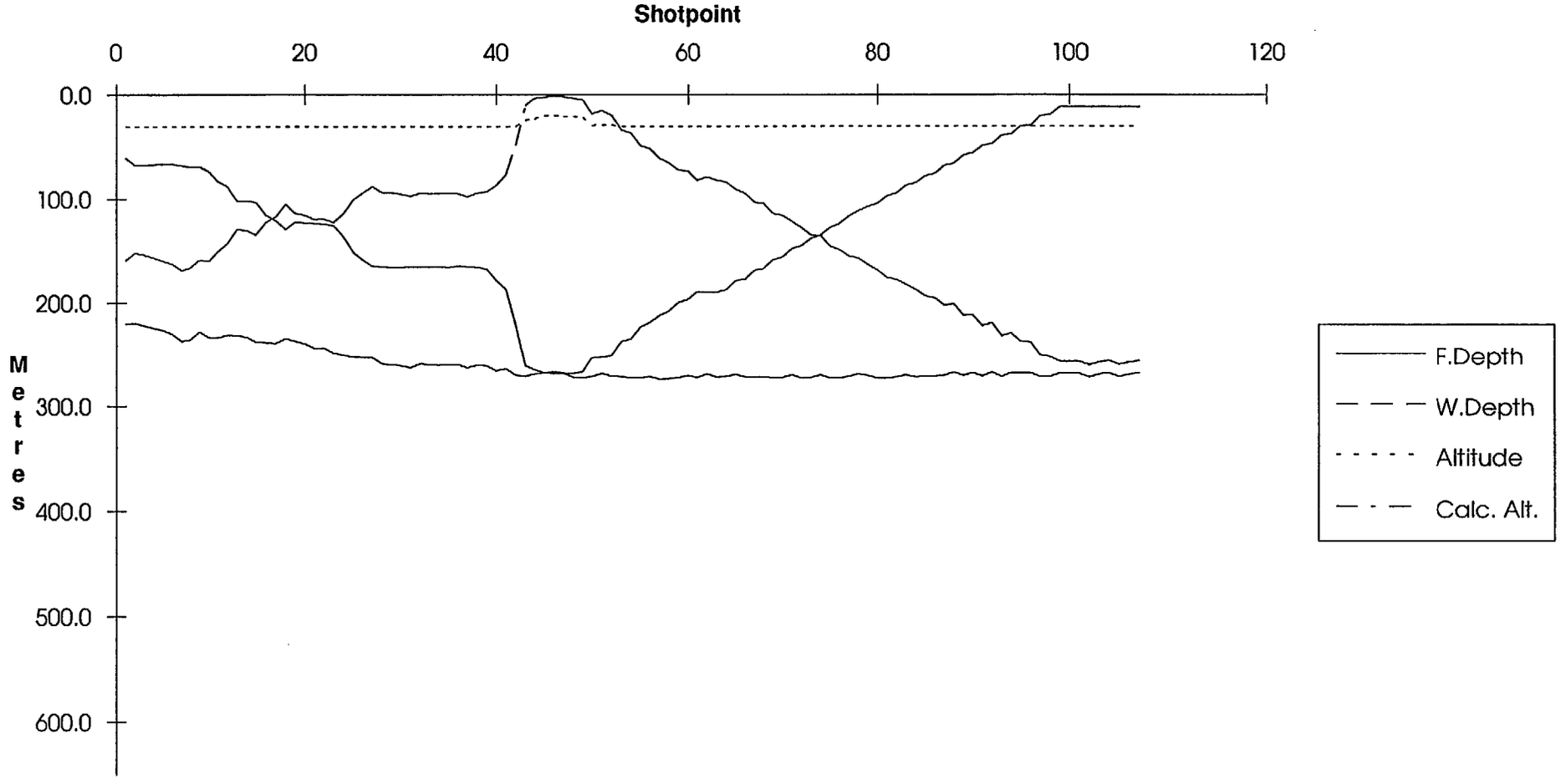
Notes

Two moderate to strong THC and methane anomalies occur at SP 26 and SP 56.
Two weak ethane and propane anomalies occur at SP 46 and SP 60.
Elevated ethylene values prior to SP 25 and after SP 76 are related to the fish being lowered and then raised through the thermocline.
Gas samples for carbon isotope analysis where taken between SP 33 and SP 43, and SP 59 and SP 75.

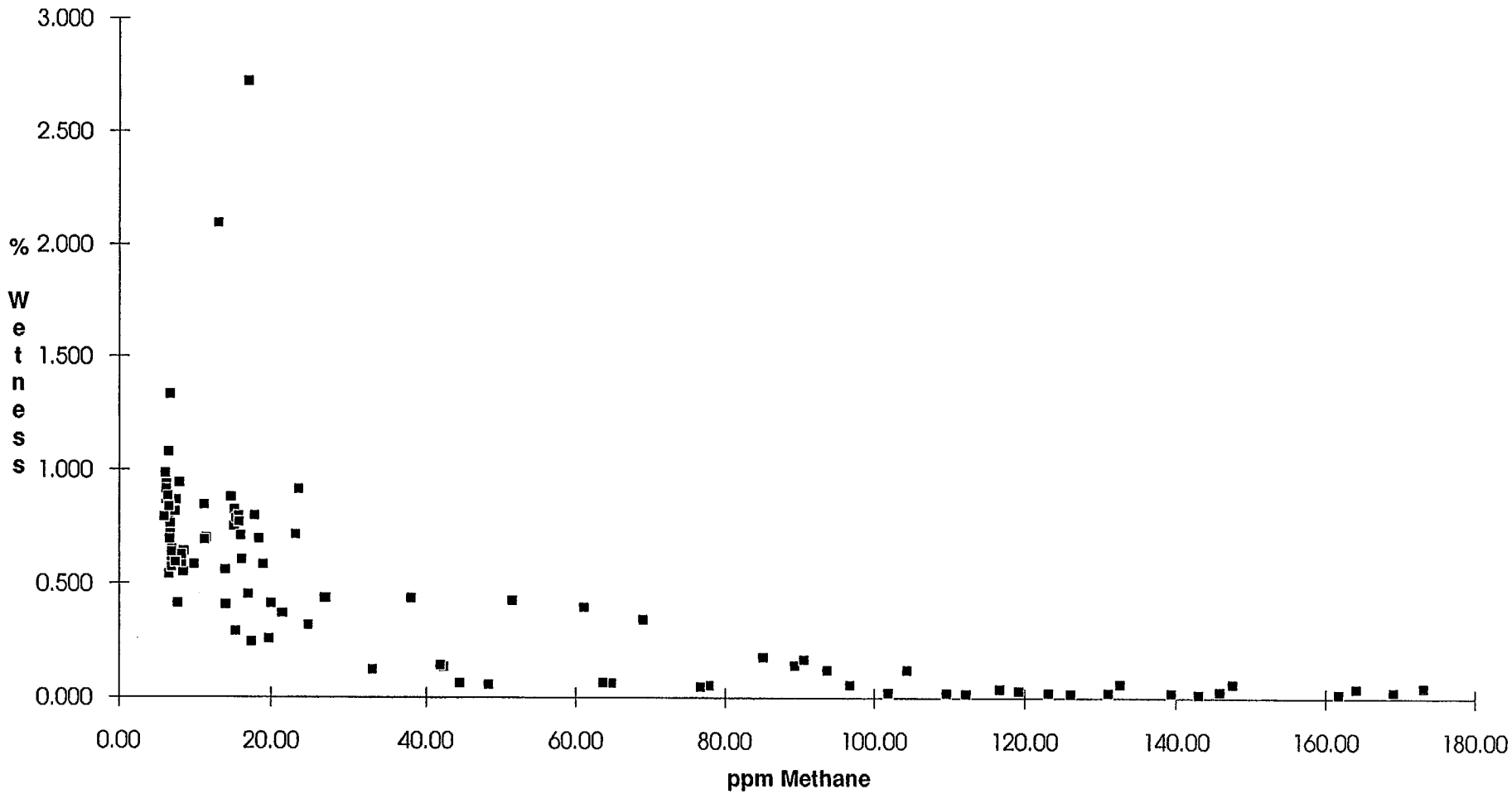

Line vp109076 THC, Methane
ppm Hydrocarbons
200.00
180.00
160.00
140.00
120.00
100.00
80.00
60.00
40.00
20.00
0.00
0
20
40
60
80
100
120
Shotpoint
THC
Methane


Line vp109076 Ethane, Ethylene, Propane
ppm Hydrocarbons
0.500
0.450
0.400
0.350
0.300
0.250
0.200
0.150
0.100
0.050
0.000
0
20
40
60
80
100
120
Shotpoint
Ethane
Ethylene
Propane

Line vp109076 Depths, Altitudes



Line vp109076 Methane v. %Wetness



Line Summary

Line Number	VP109077
No. of Shotpoints	74

	Shotpoint	Date	Time	Latitude		Longitude	
Start	1	3-May-92	06:47:45	13	27.667	122	57.881
End	74	3-May-92	09:16:00	13	26.822	123	00.067

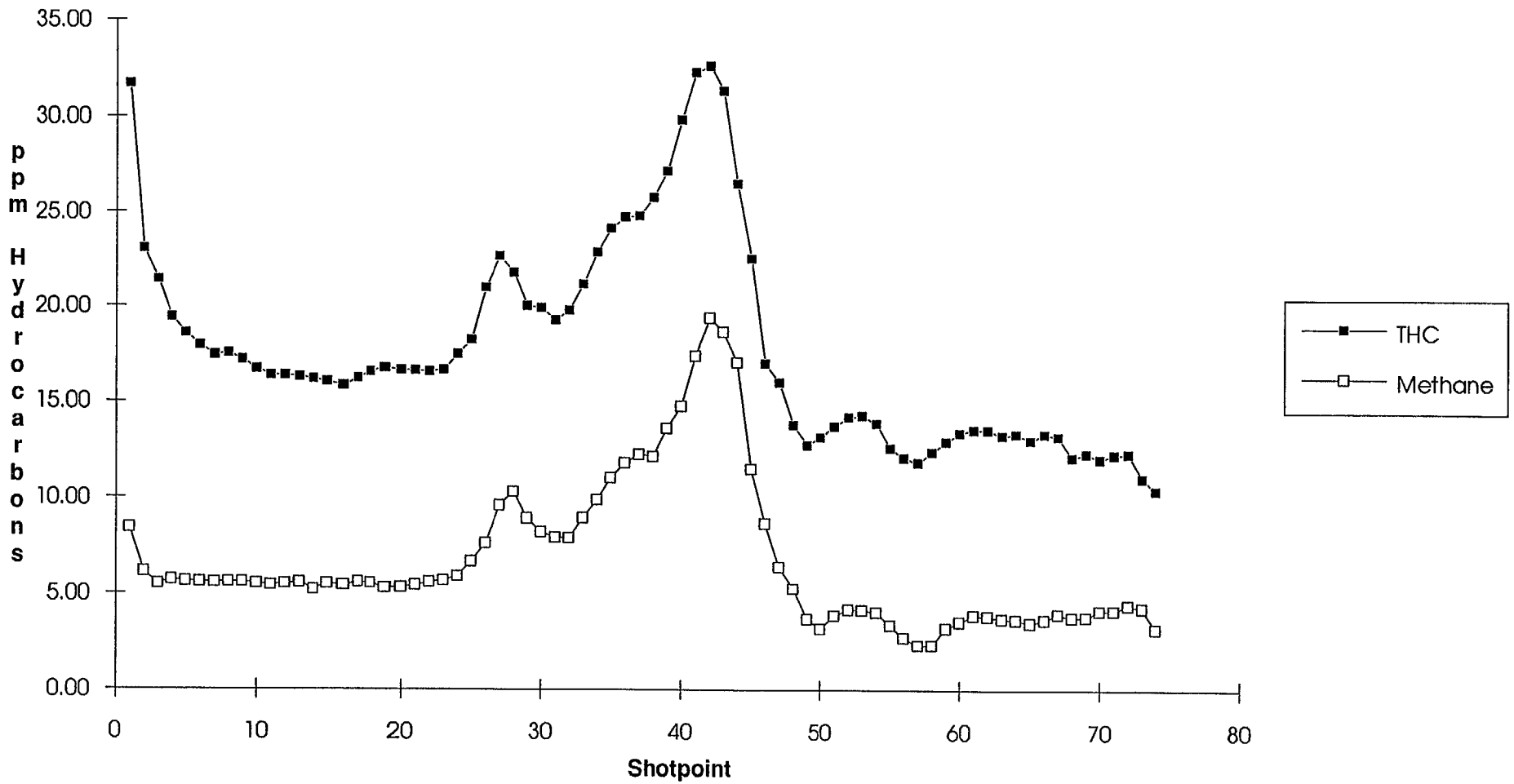
	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	17.836	6.712	0.029	0.145	0.020	0.055	0.003	0.000	0.005	0.131	0.012	0.047	0.838
Std. Dev.	5.500	3.893	0.019	0.166	0.009	0.055	0.005	0.000	0.006	0.090	0.013	0.017	0.363
Minimum	10.393	2.321	0.007	0.008	0.010	0.002	0.000	0.000	0.000	0.032	0.000	0.000	0.373
Maximum	32.682	19.425	0.127	1.074	0.052	0.386	0.017	0.000	0.023	0.437	0.043	0.093	2.561

	Cond.	Temp.	F. Depth	W.Depth	Altitude	Calc. Alt.
Mean	58.093	25.167	124.461	589.889	30.901	466.003
Std. Dev.	3.633	2.447	91.477	12.240	0.082	93.046
Minimum	53.980	22.390	11.800	525.200	30.800	314.700
Maximum	64.850	29.800	276.800	609.000	31.000	586.900

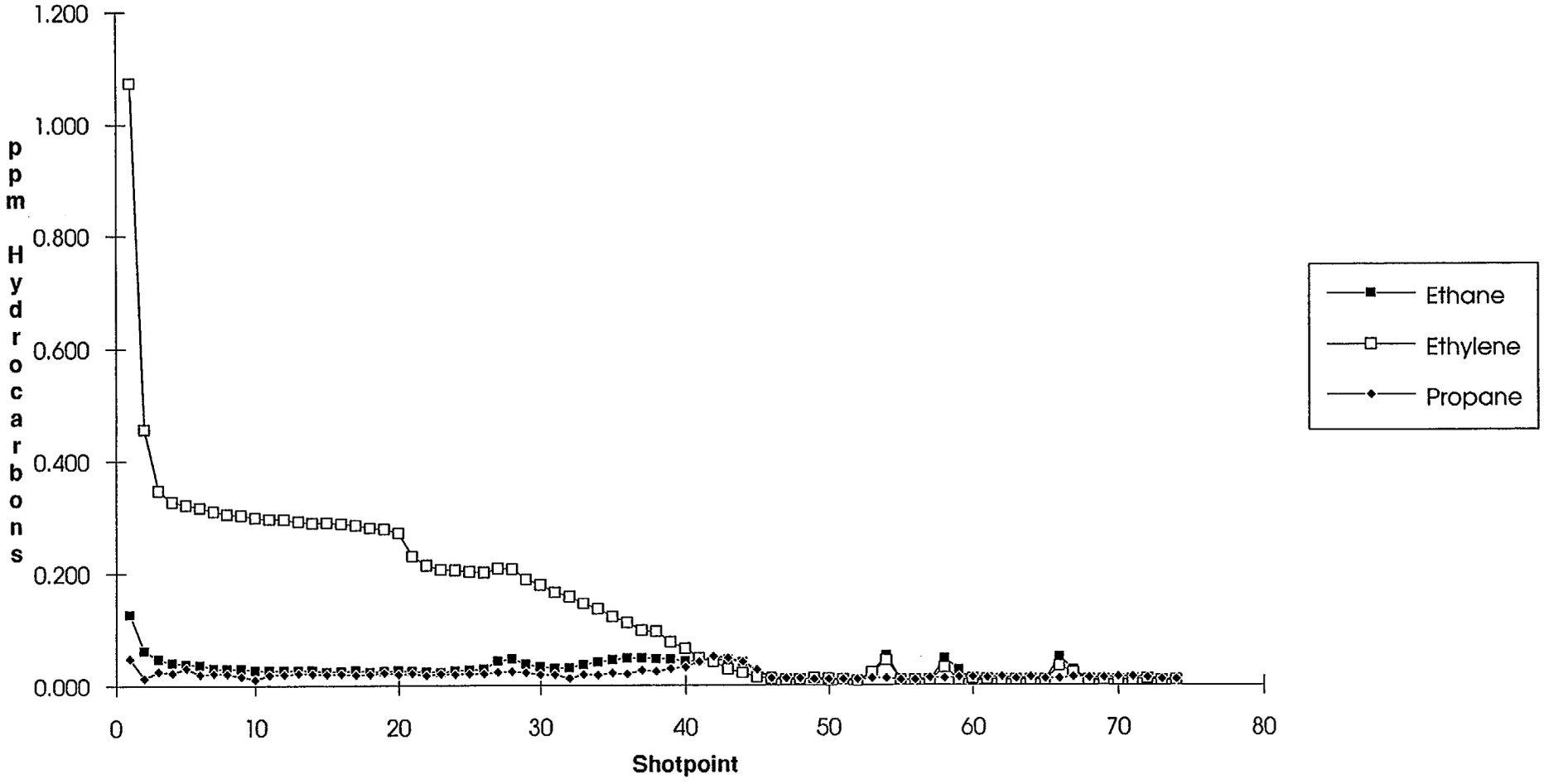
Notes

A weak THC and methane anomaly occurs at SP 40
Elevated hydrocarbon values prior to SP 37 relate to the fish being lowered through the thermocline.

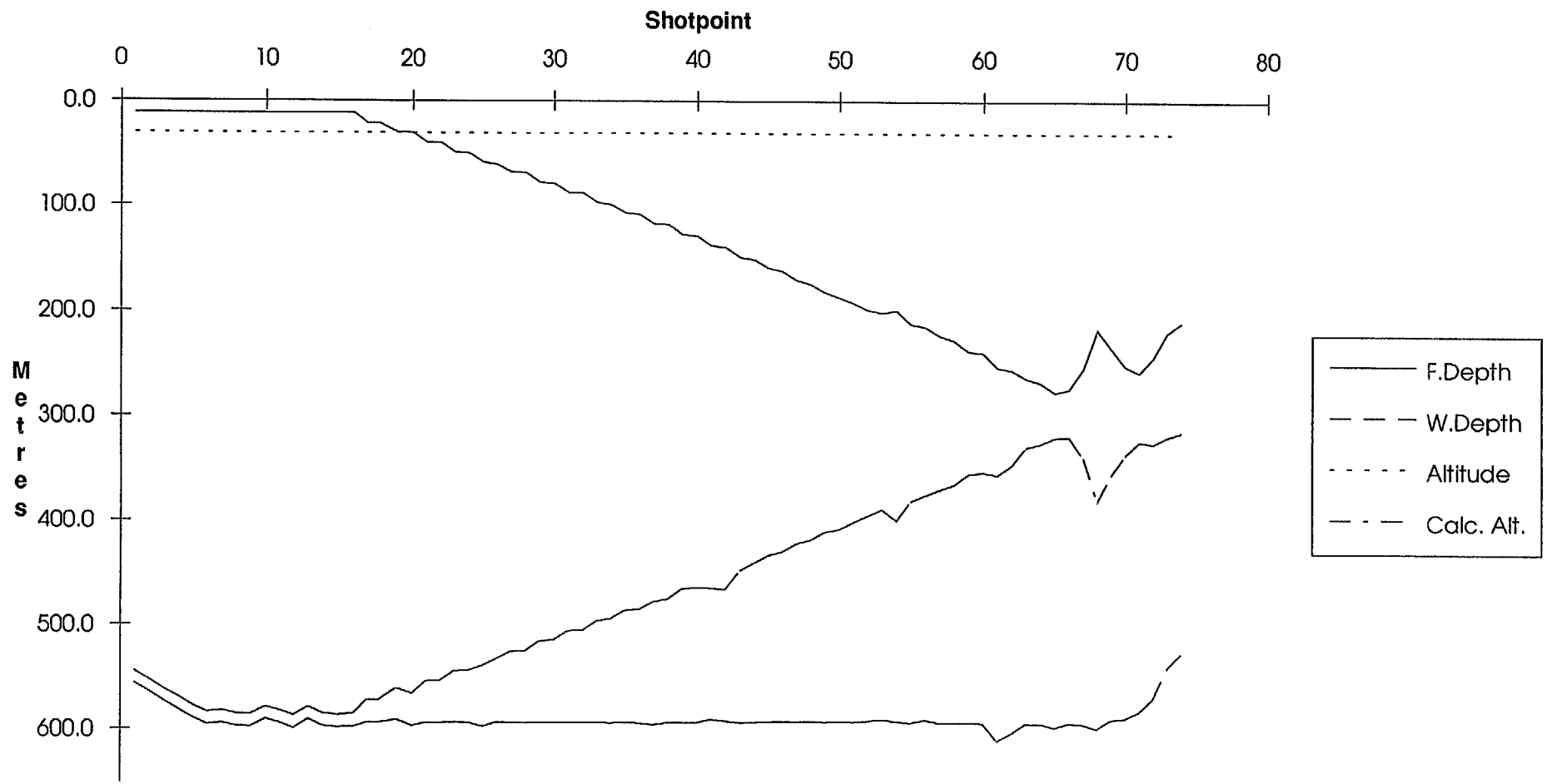
Line vp109077 THC, Methane



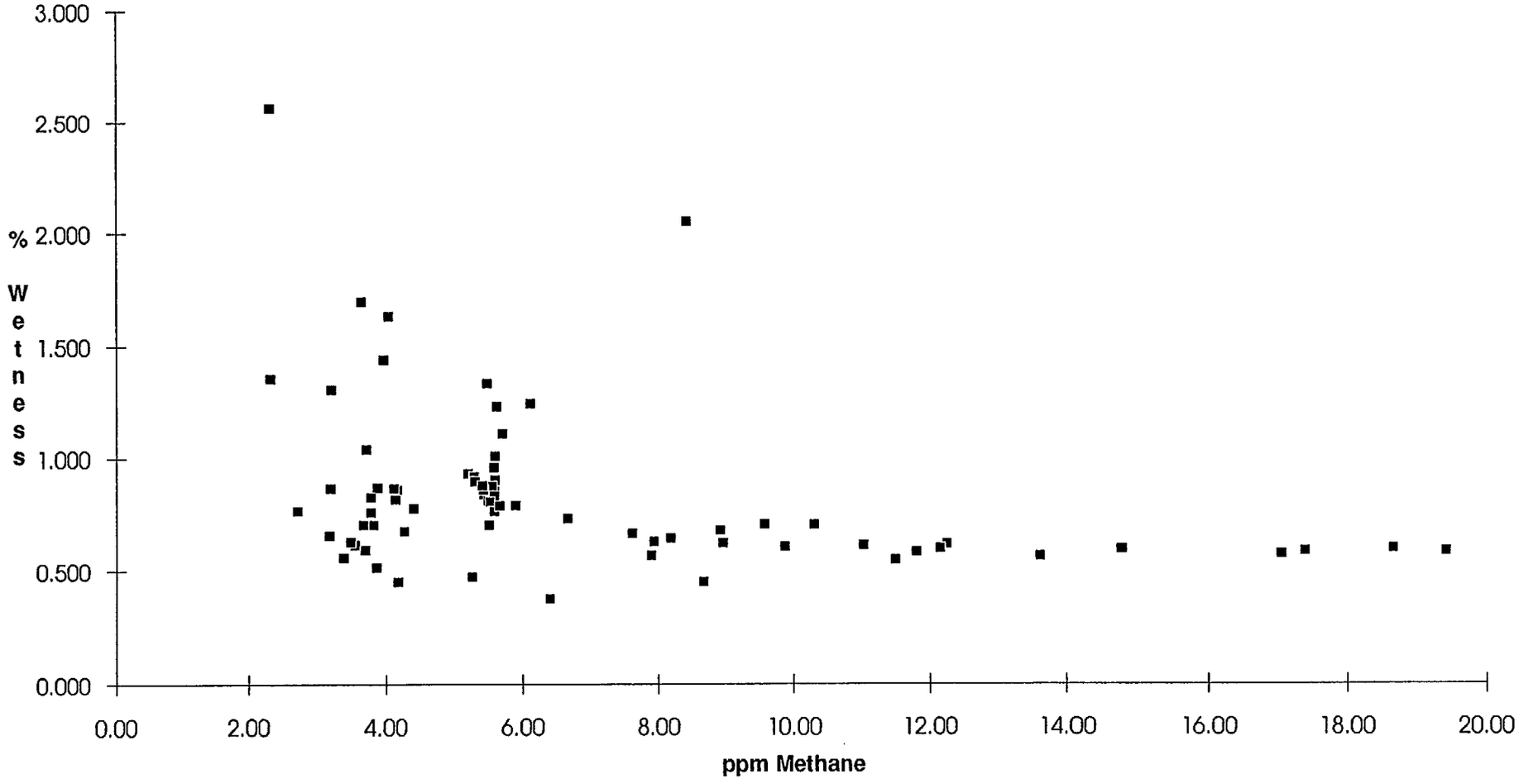
Line vp109077 Ethane, Ethylene, Propane



Line vp109077 Depths, Altitudes



Line vp109077 Methane v. %Wetness



Line Summary

Line Number	VP109078
No. of Shotpoints	93

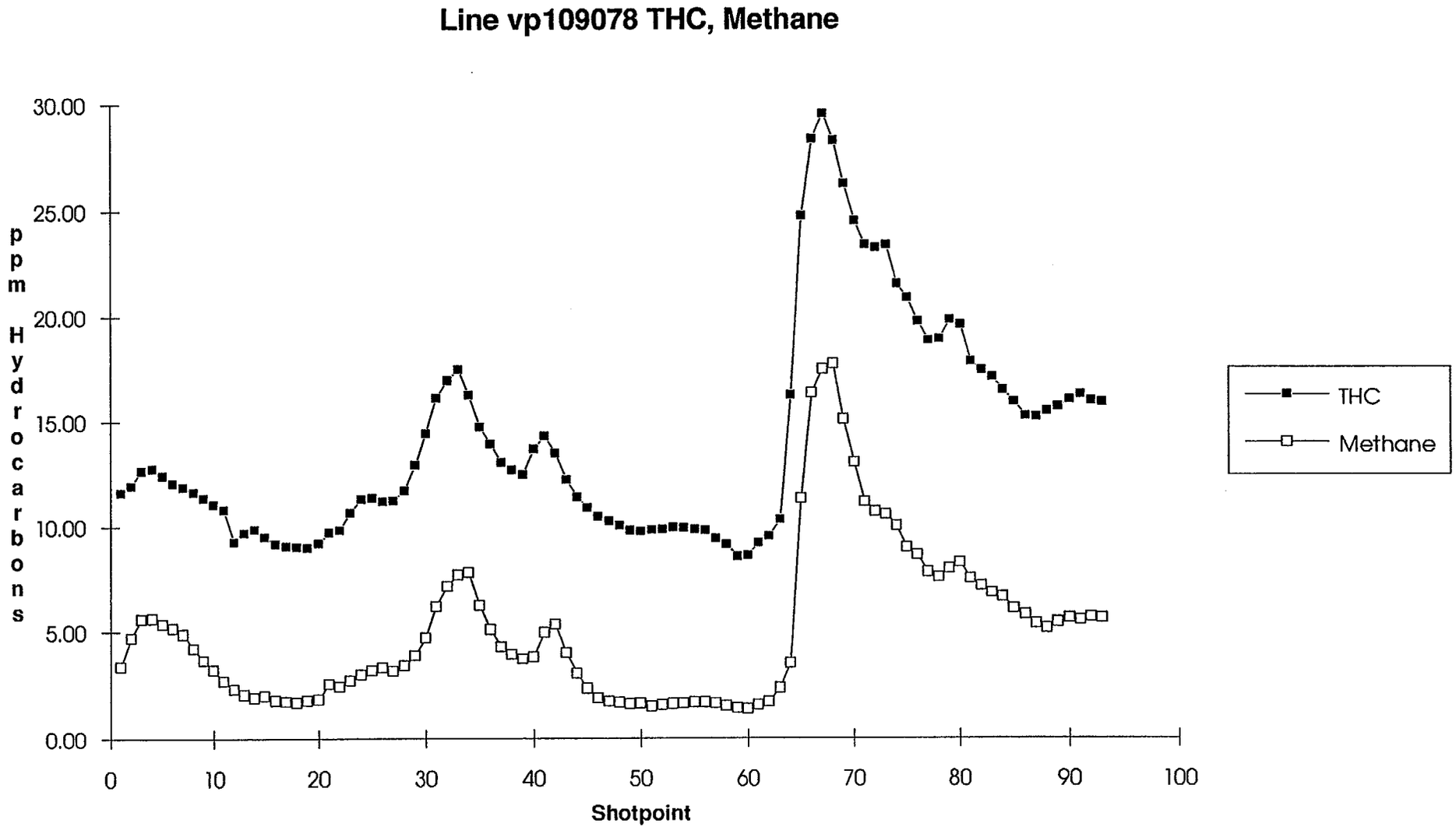
	Shotpoint	Date	Time	Latitude		Longitude	
Start	1	3-May-92	09:18:02	13	26.696	123	00.053
End	93	3-May-92	12:22:52	13	23.590	122	59.976

	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	14.097	5.040	0.019	0.064	0.015	0.025	0.001	0.000	0.000	0.079	0.008	0.039	0.811
Std. Dev.	5.049	3.677	0.014	0.086	0.010	0.024	0.004	0.000	0.001	0.061	0.015	0.015	0.359
Minimum	8.561	1.383	0.006	0.007	0.000	0.000	0.000	0.000	0.000	0.030	0.000	0.000	0.354
Maximum	29.522	17.722	0.050	0.314	0.052	0.091	0.018	0.000	0.005	0.250	0.062	0.080	2.129

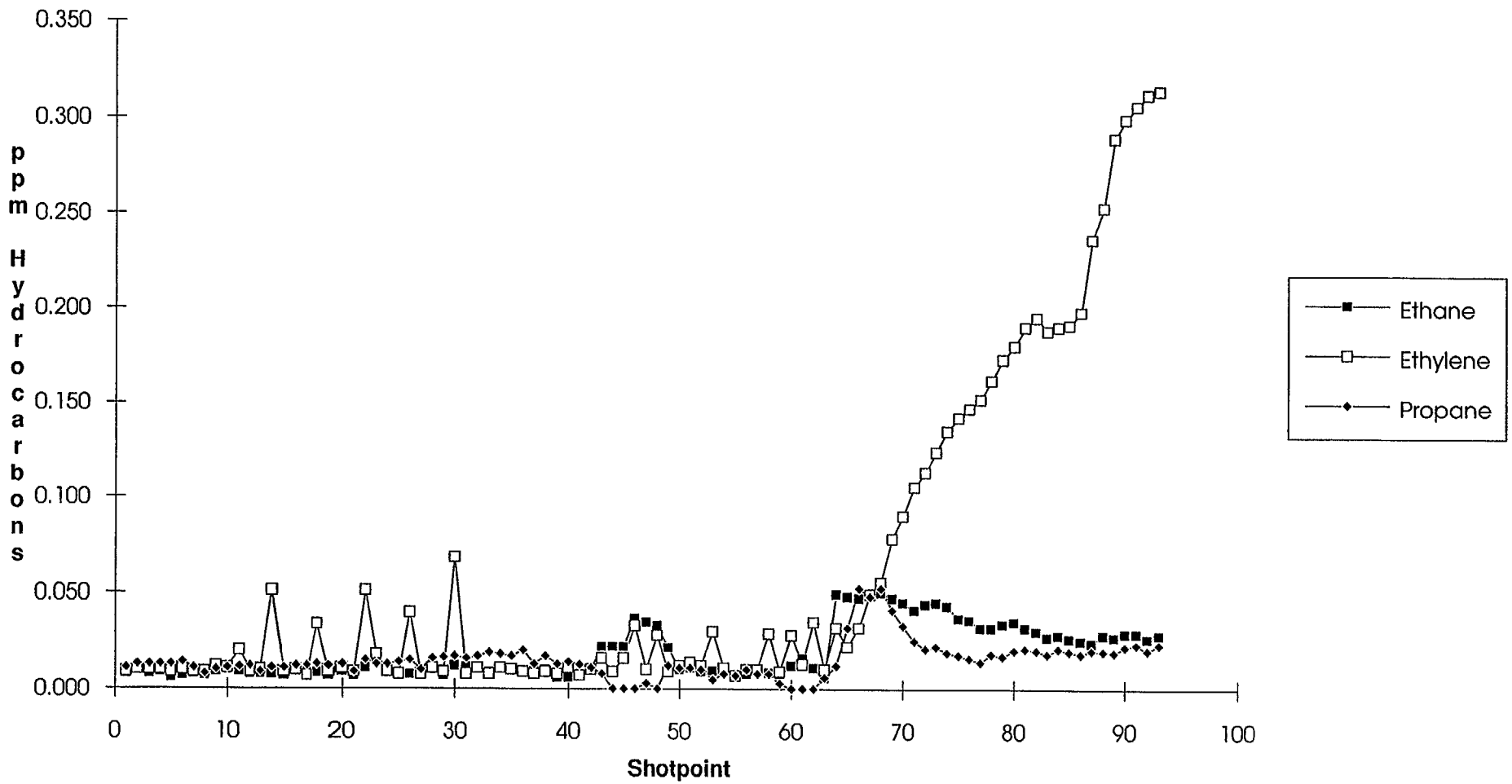
	Cond.	Temp.	F. Depth	W.Depth	Altitude	Calc. Alt.
Mean	55.375	23.284	175.591	510.539	30.832	334.959
Std. Dev.	1.885	1.234	79.683	7.472	0.047	78.764
Minimum	53.750	22.190	11.700	487.400	30.800	224.200
Maximum	59.360	25.940	283.200	532.800	30.900	500.700

Notes

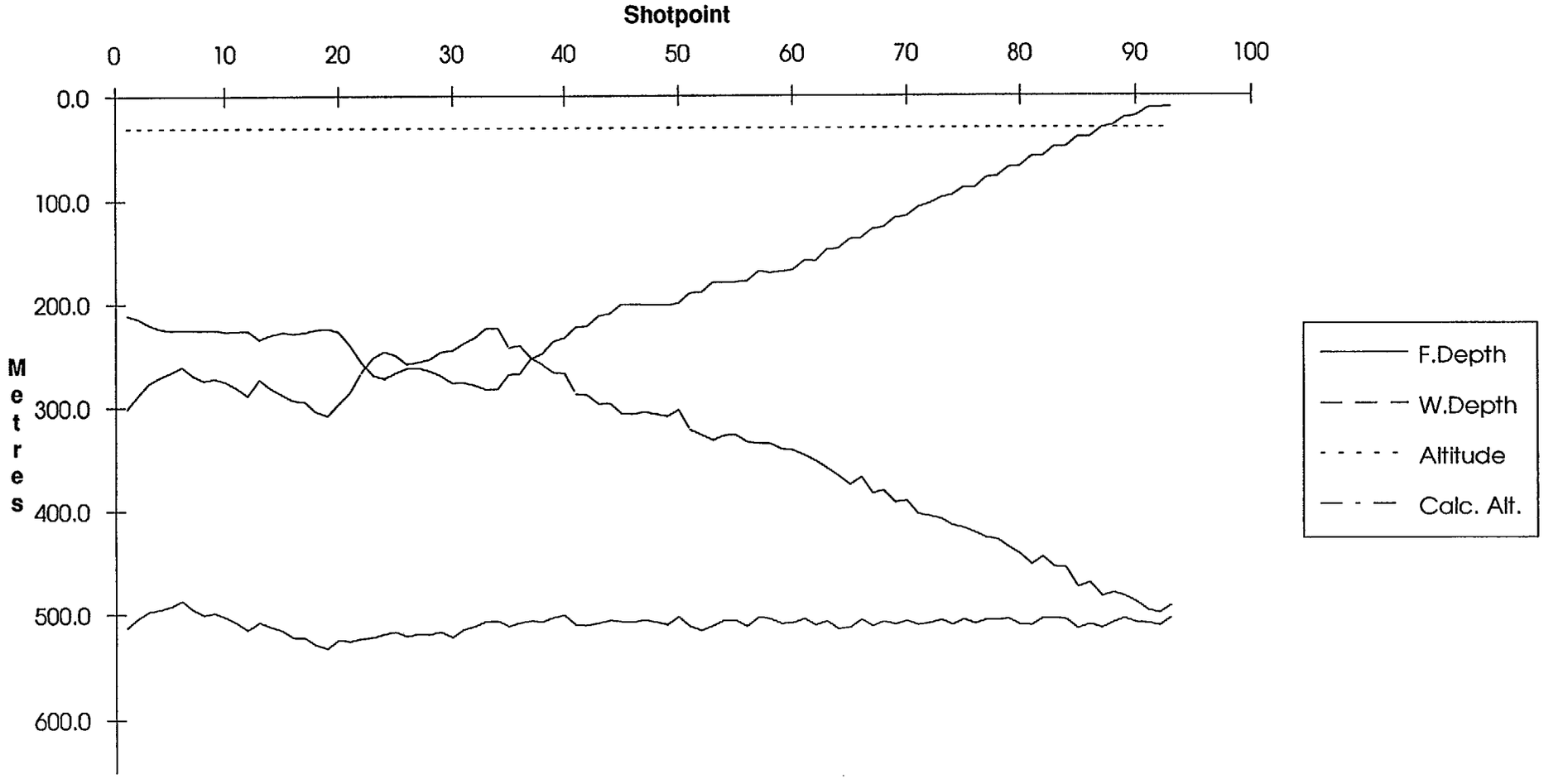
A weak THC, methane, ethane and propane anomaly occurs at SP 67.
A weak THC and methane anomaly occurs at SP 34.
Increased hydrocarbon levels after SP 67 relate to the fish passing through the thermocline.


Line vp109078 THC, Methane
ppm Hydrocarbons
30.00
25.00
20.00
15.00
10.00
5.00
0.00
0
10
20
30
40
50
60
70
80
90
100
Shotpoint
THC
Methane

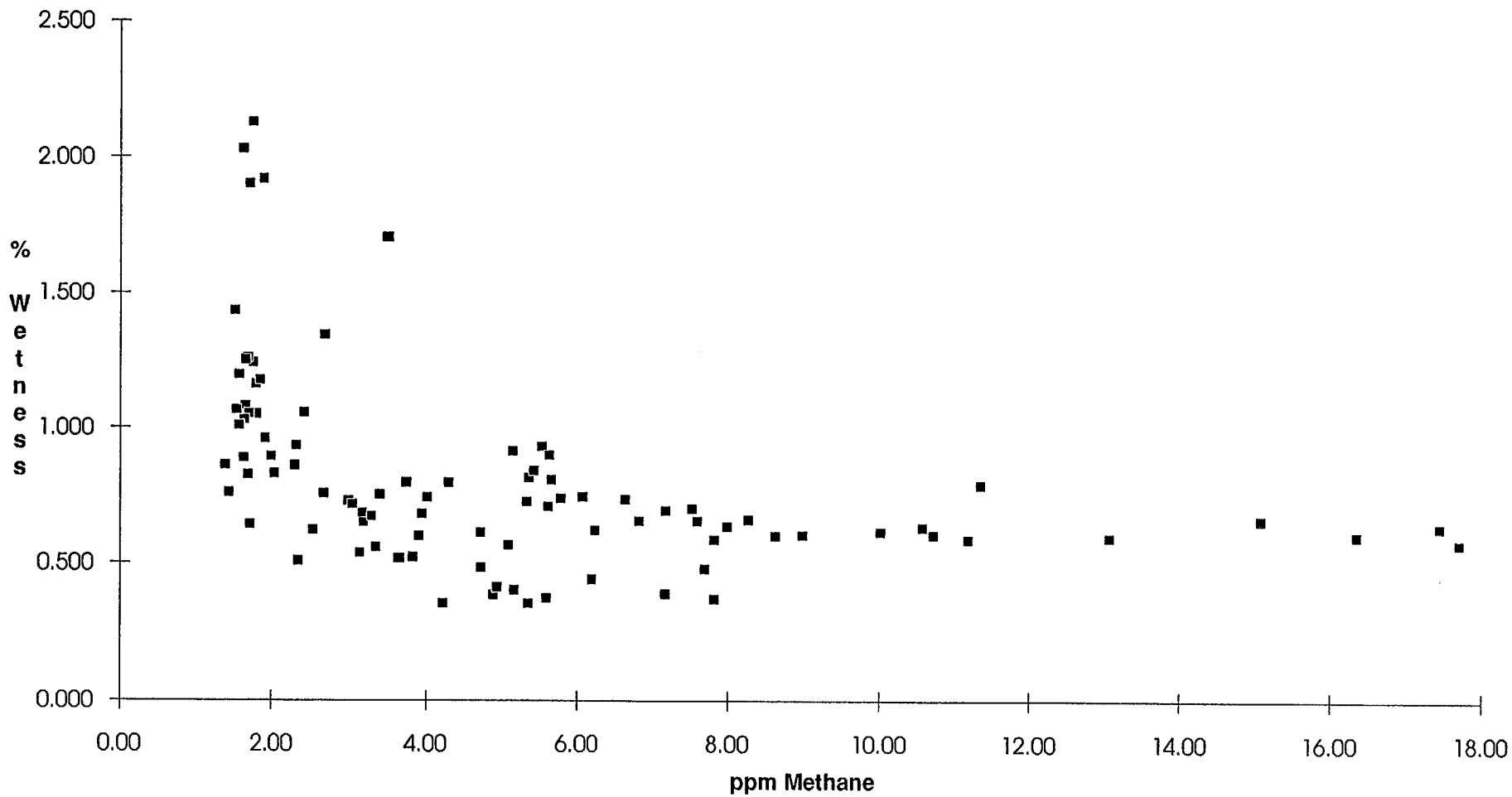
Line vp109078 Ethane, Ethylene, Propane



Line vp109078 Depths, Altitudes



Line vp109078 Methane v. %Wetness



Line Summary

Line Number	109079
No. of Shotpoints	47

	Shotpoint	Date	Time	Latitude		Longitude	
Start	1	3-May-92	12:24:52	13	23.564	123	00.003
End	47	3-May-92	14:00:50	13	15.843	123	01.934

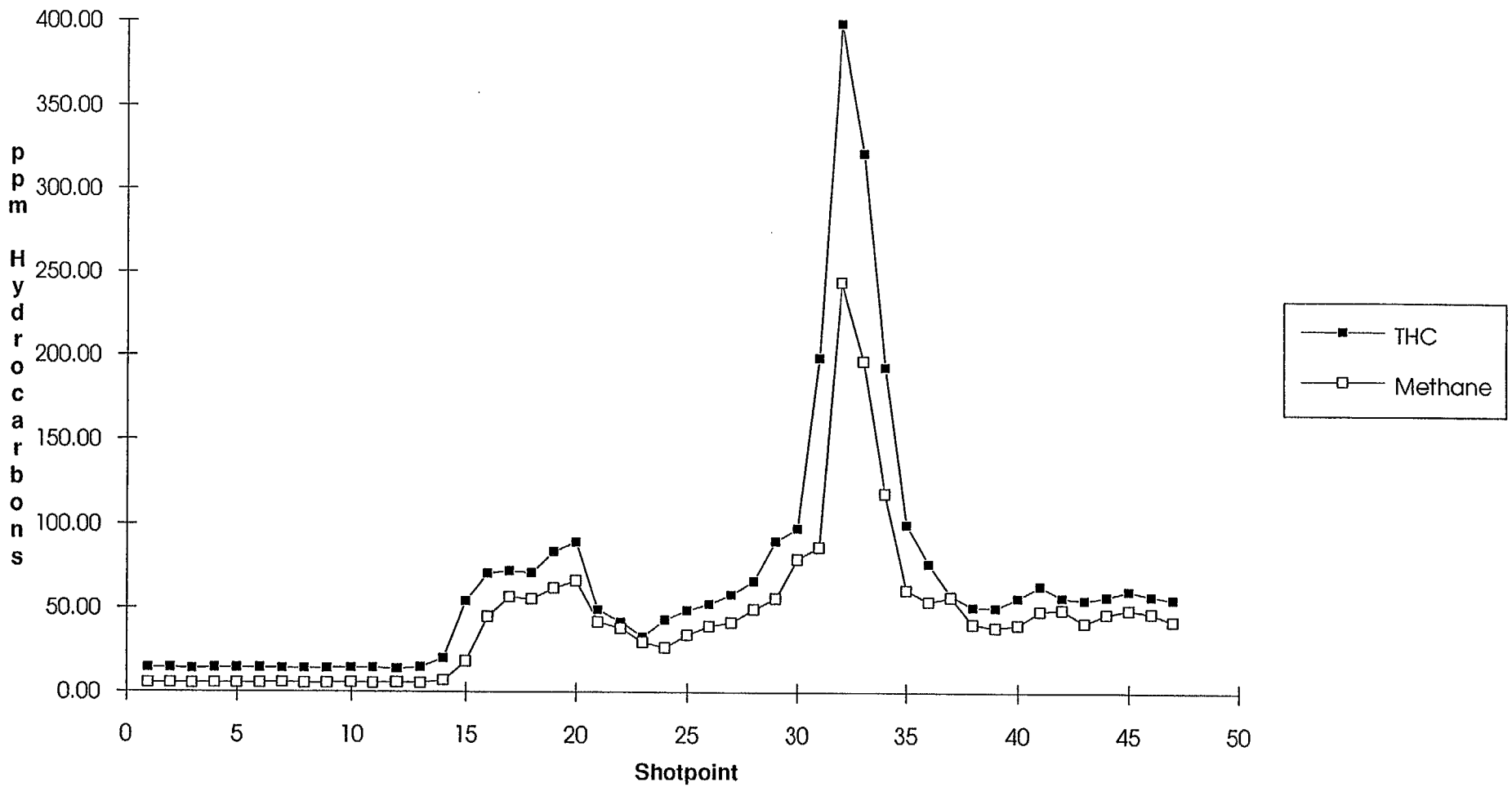
	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	66.834	44.339	0.142	0.098	0.162	0.038	0.037	0.025	0.011	0.086	0.007	0.032	0.751
Std. Dev.	74.402	45.653	0.208	0.124	0.234	0.032	0.053	0.040	0.016	0.084	0.010	0.016	0.265
Minimum	14.120	5.340	0.021	0.009	0.018	0.000	0.000	0.000	0.000	0.012	0.000	0.010	0.147
Maximum	399.000	244.227	1.057	0.311	1.139	0.094	0.206	0.250	0.090	0.257	0.045	0.079	1.307

	Cond.	Temp.	F. Depth	W.Depth	Altitude	Calc. Alt.
Mean	56.067	23.782	111.109	218.438	20.562	107.347
Std. Dev.	1.944	1.288	57.555	99.698	8.746	153.483
Minimum	54.540	22.620	11.100	135.700	10.500	4.100
Maximum	59.470	26.000	161.100	486.900	30.900	475.700

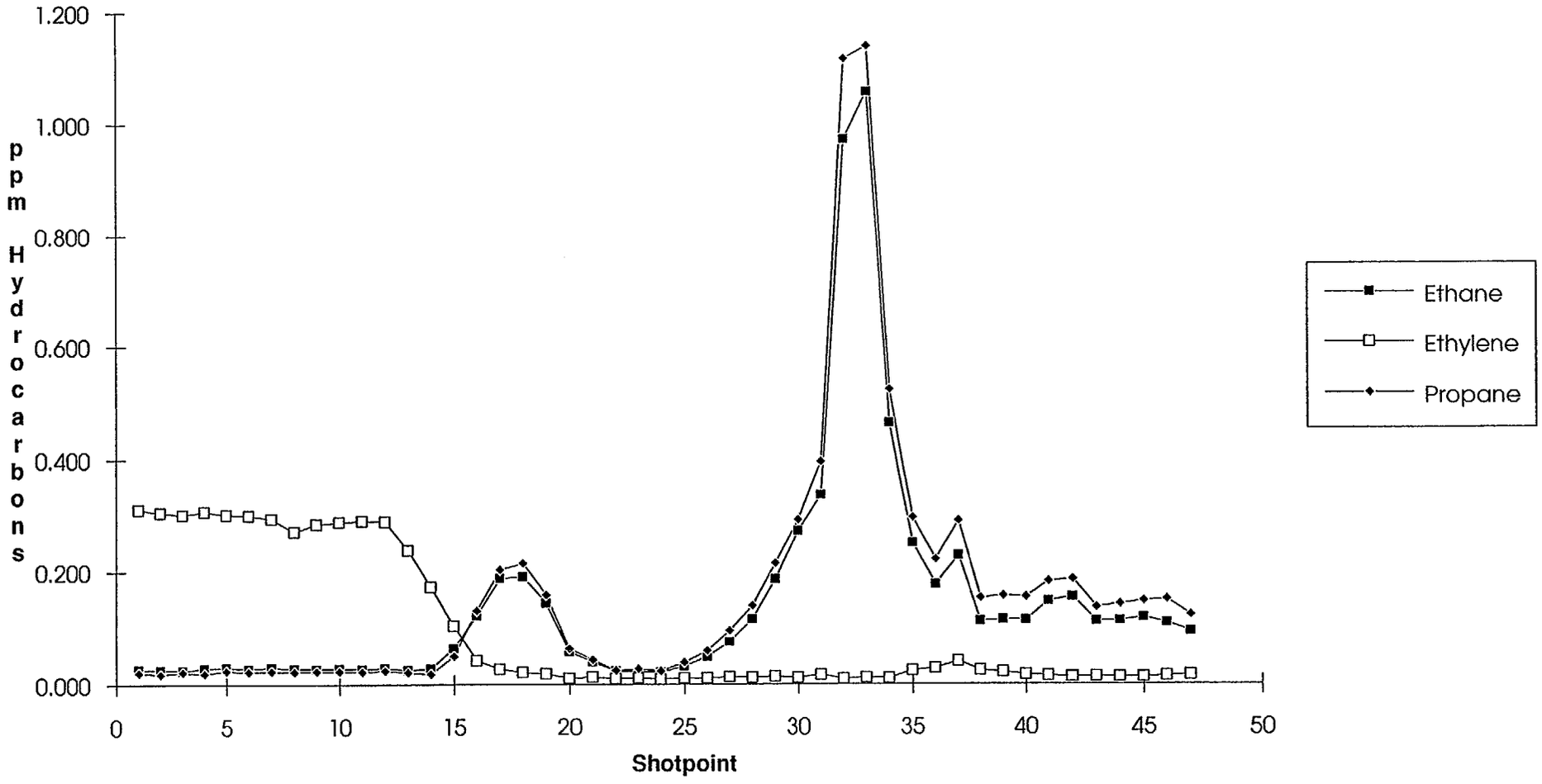
Notes

Two THC, methane, ethane and propane, anomalies occur at SP 17 (moderate) and SP 32 (strong)
Gas samples for carbon isotope analysis where taken at SP 16 to 22 and SP 22 to SP 28.

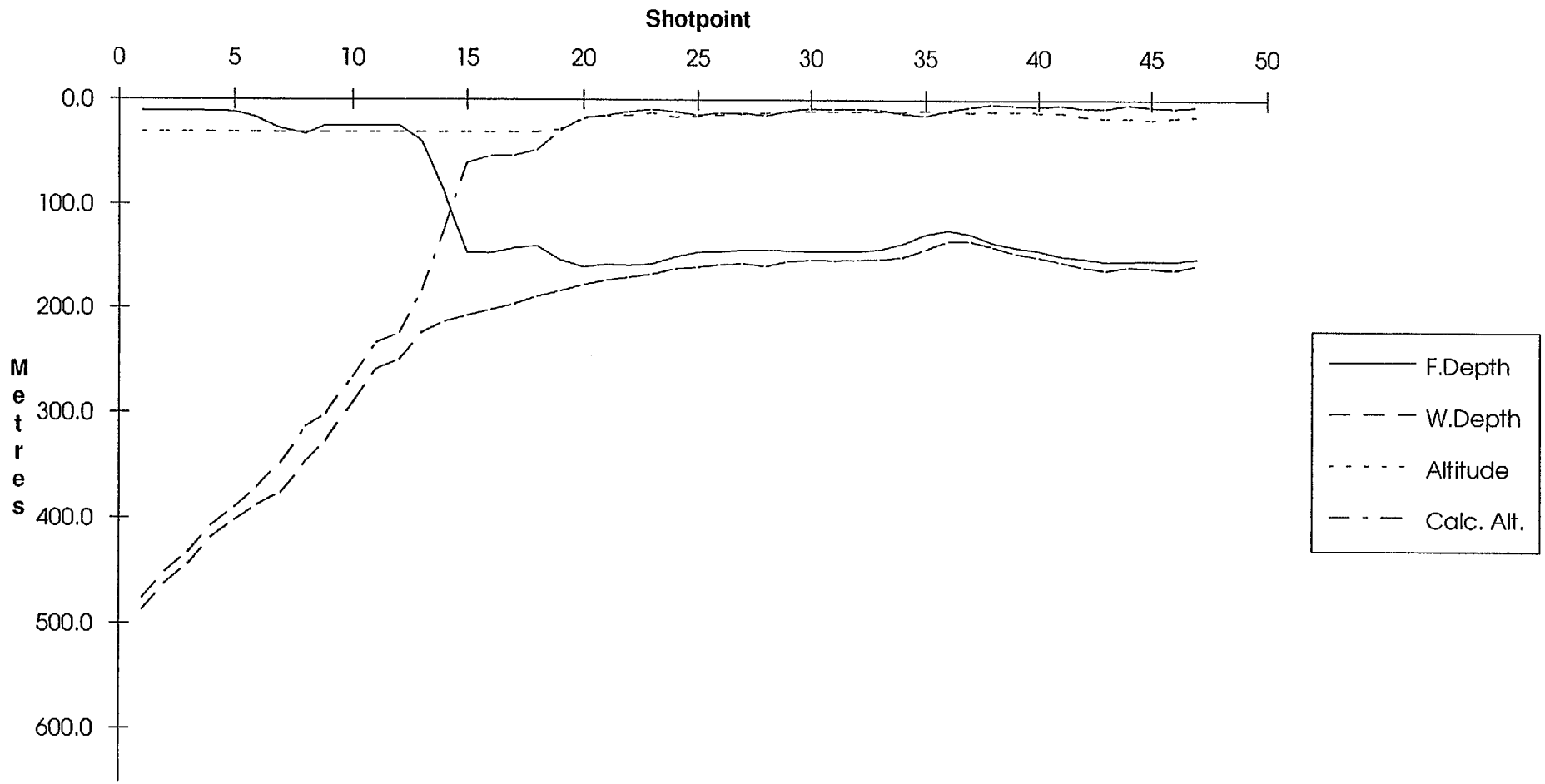
Line 109079 THC, Methane



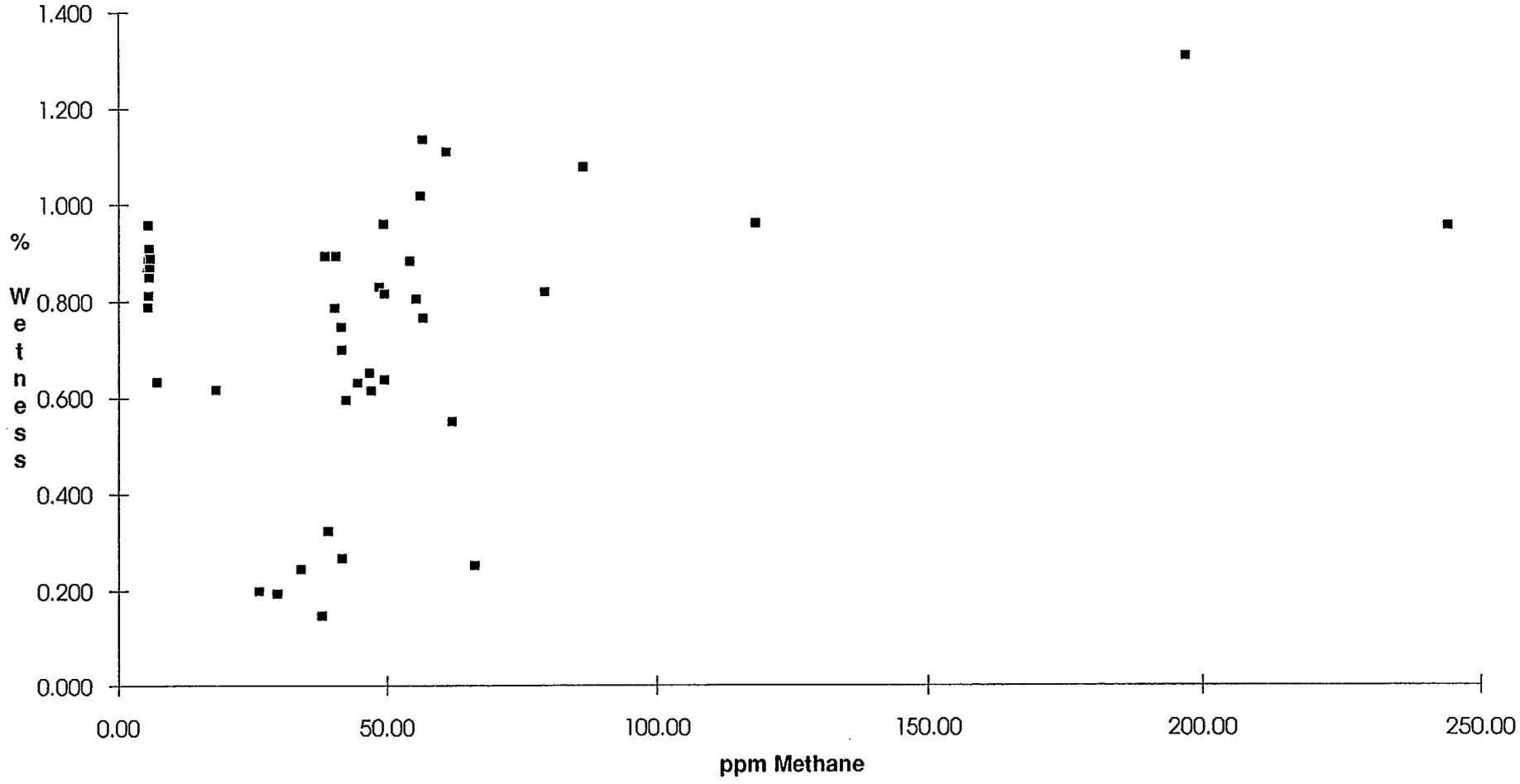
Line 109079 Ethane, Ethylene, Propane



Line 109079 Depths, Altitudes



Line 109079 Methane v. %Wetness



APPENDIX III (PART A). TAYABAS BAY LINE SUMMARY SHEETS AND INDIVIDUAL LINE PLOTS.

Line Summary

Line Number	109021
No. of Shotpoints	269

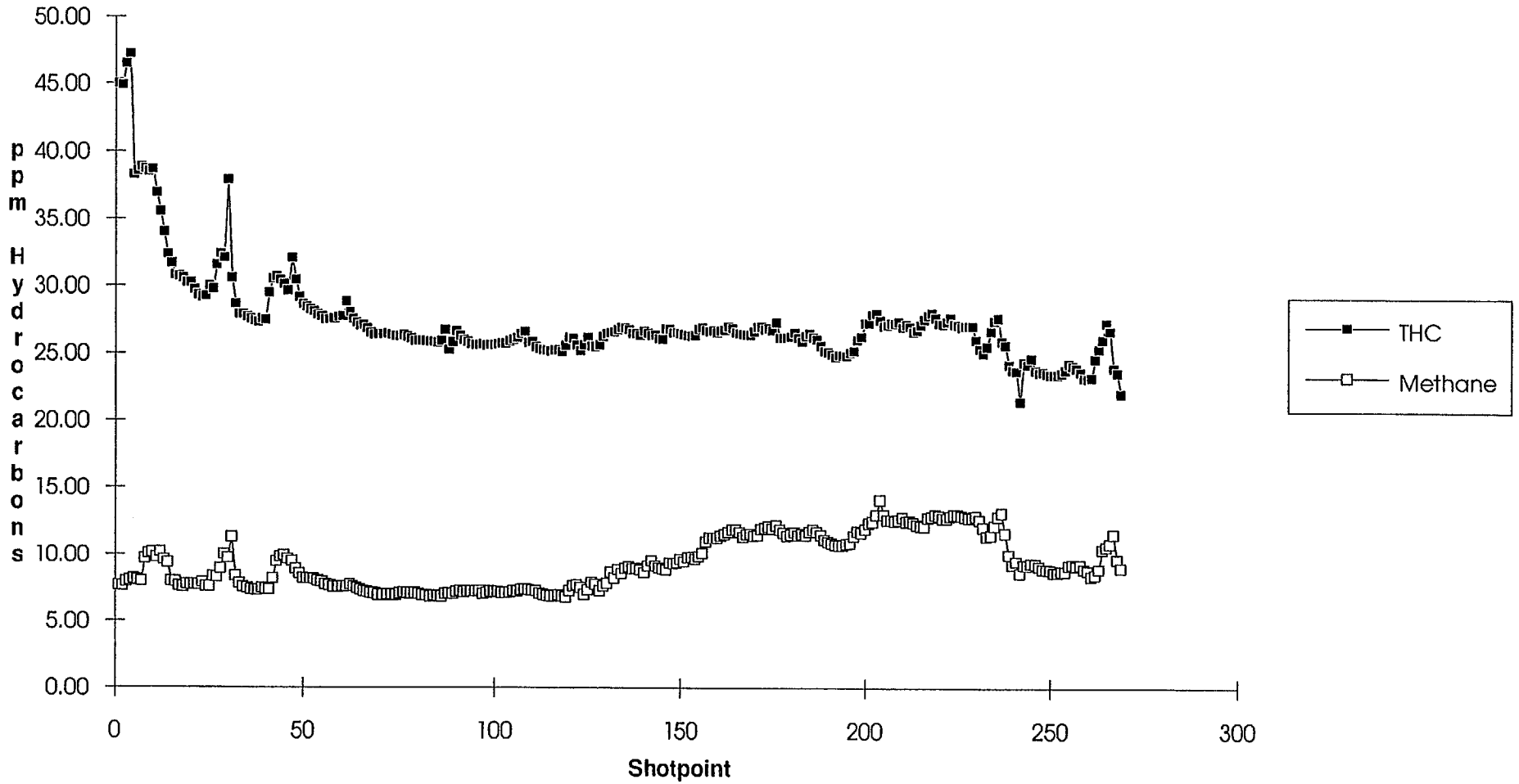
	Shotpoint	Date	Time	Latitude		Longitude	
Start	1	12-Apr-92	10:54:50	13	47.103	121	53.698
End	272	12-Apr-92	20:39:40	13	13.996	122	29.028

	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	27.316	9.345	0.057	0.432	0.029	0.128	0.016	0.001	0.009	0.148	0.113	0.045	1.165
Std. Dev.	3.565	2.031	0.013	0.238	0.014	0.072	0.012	0.003	0.008	0.074	0.068	0.015	0.432
Minimum	21.406	6.762	0.039	0.189	0.007	0.039	0.000	0.000	0.000	0.060	0.039	0.016	0.548
Maximum	47.261	14.118	0.106	1.465	0.080	0.509	0.039	0.025	0.028	0.314	0.306	0.119	2.313

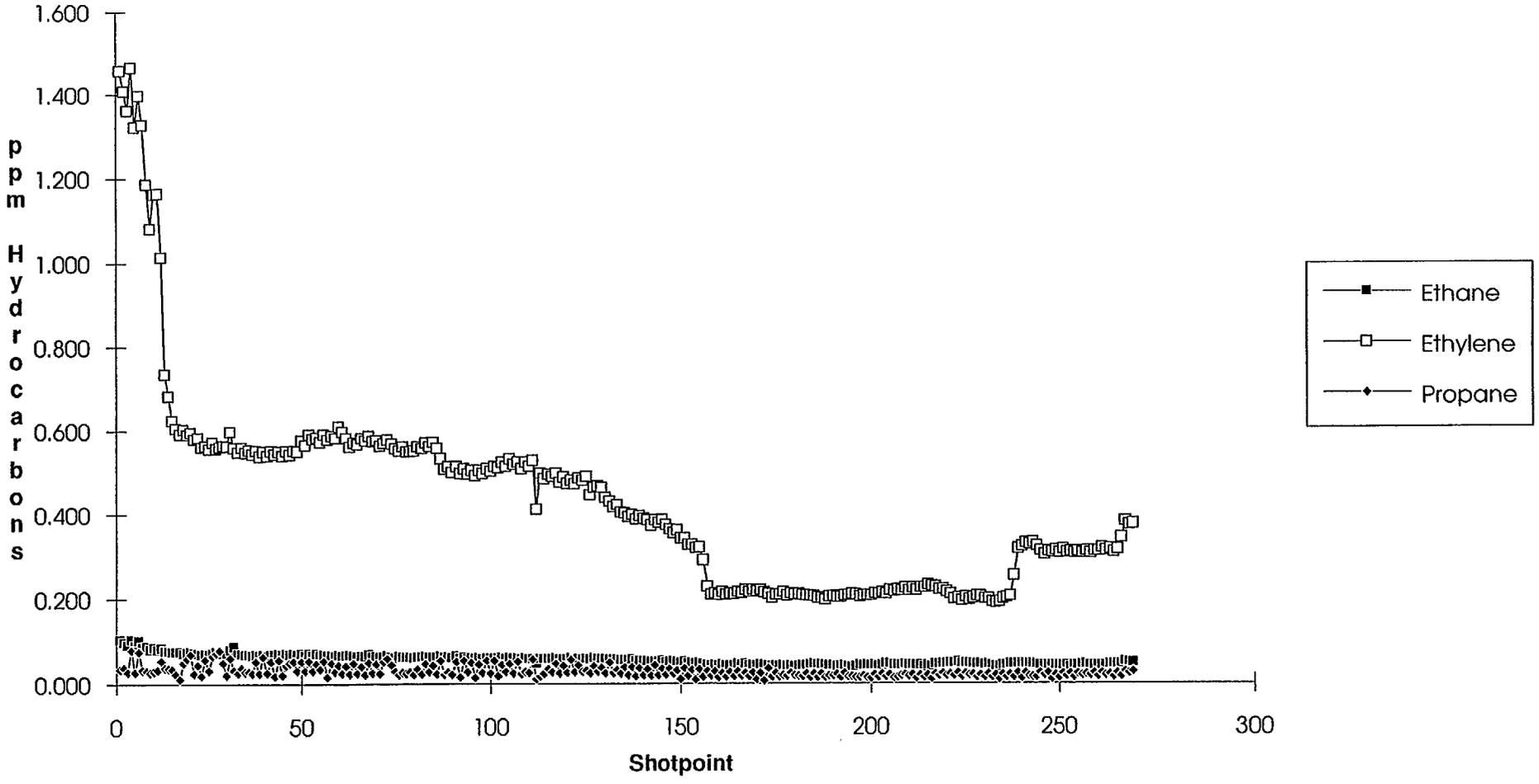
	Cond.	Temp.	F. Depth	W.Depth	Altitude	Calc. Alt.
Mean	57.956	25.125	78.071	243.160	0.060	164.675
Std. Dev.	1.613	1.140	50.074	265.465	0.007	225.555
Minimum	55.510	23.380	4.470	47.300	0.020	14.580
Maximum	62.000	27.730	148.820	1154.800	0.090	994.360

Notes Three weak THC and methane anomalies occur at SP 4, SP 35 and SP 45.

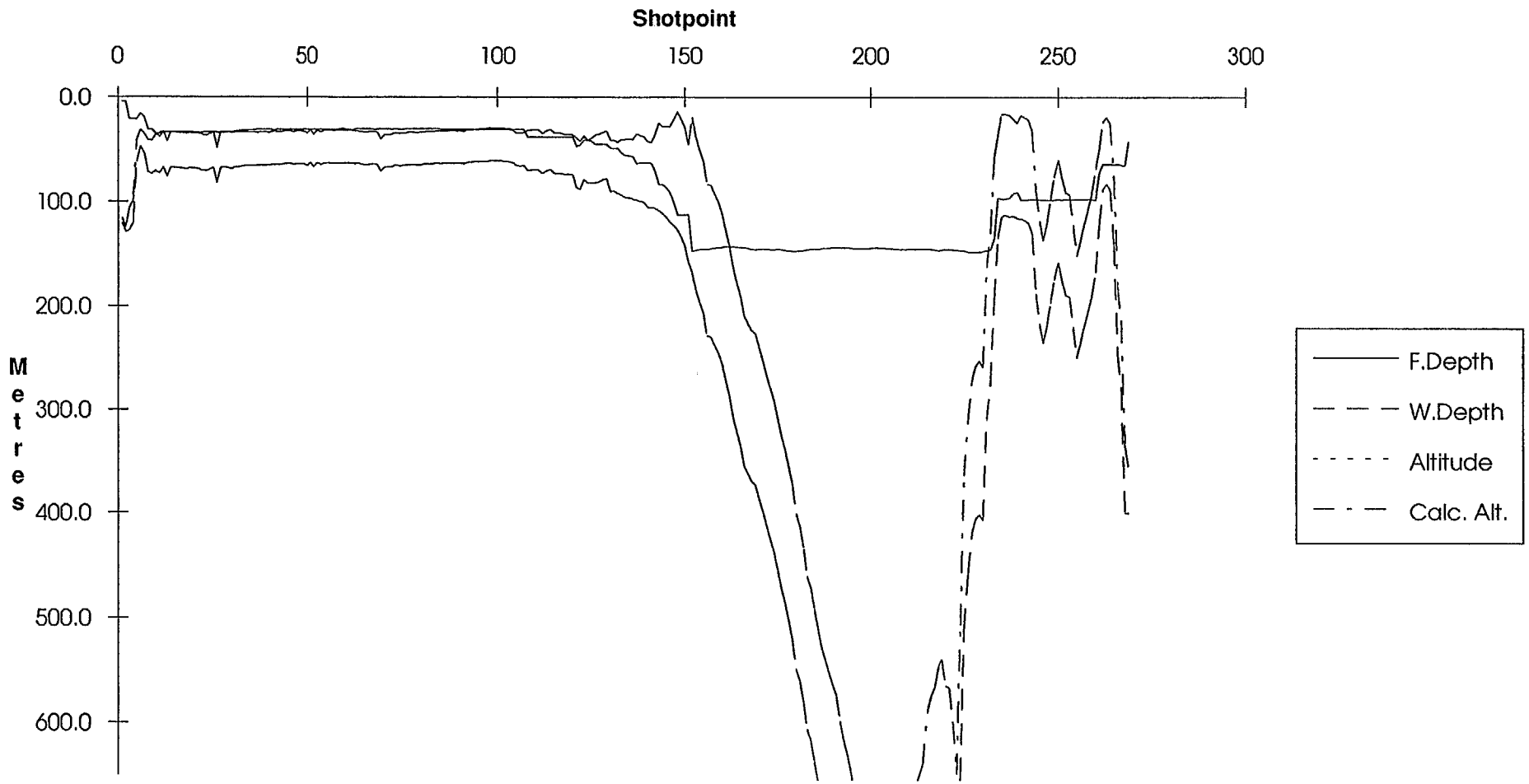
Line 109021 THC, Methane



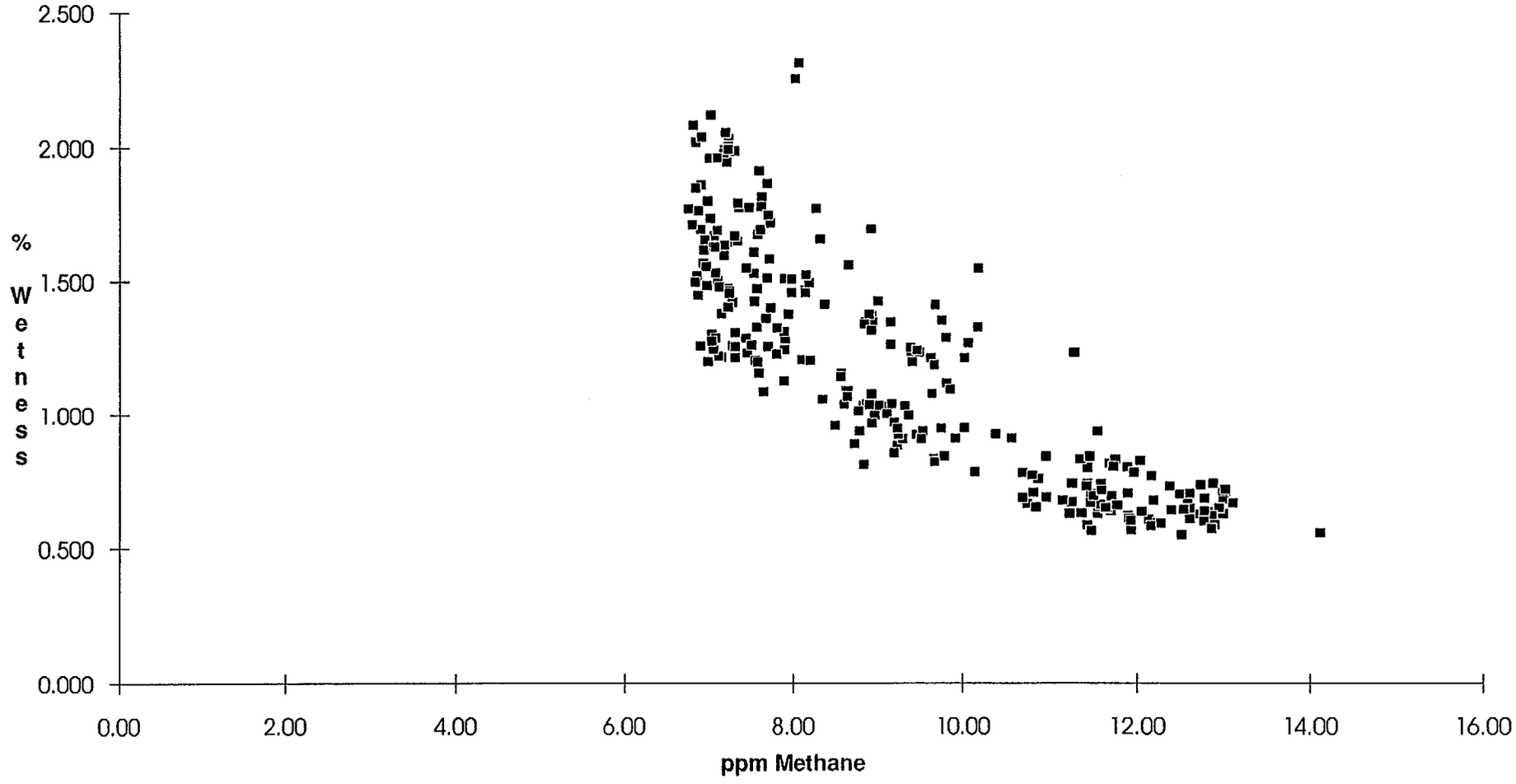
Line 109021 Ethane, Ethylene, Propane



Line 109021 Depths, Altitudes



Line 109021 Methane v. %Wetness



Line Summary

Line Number	109022
No. of Shotpoints	146

	Shotpoint	Date	Time	Latitude		Longitude	
Start	1	13-Apr-92	00:04:36	13	16.464	122	20.112
End	146	13-Apr-92	05:16:23	13	18.196	122	17.086

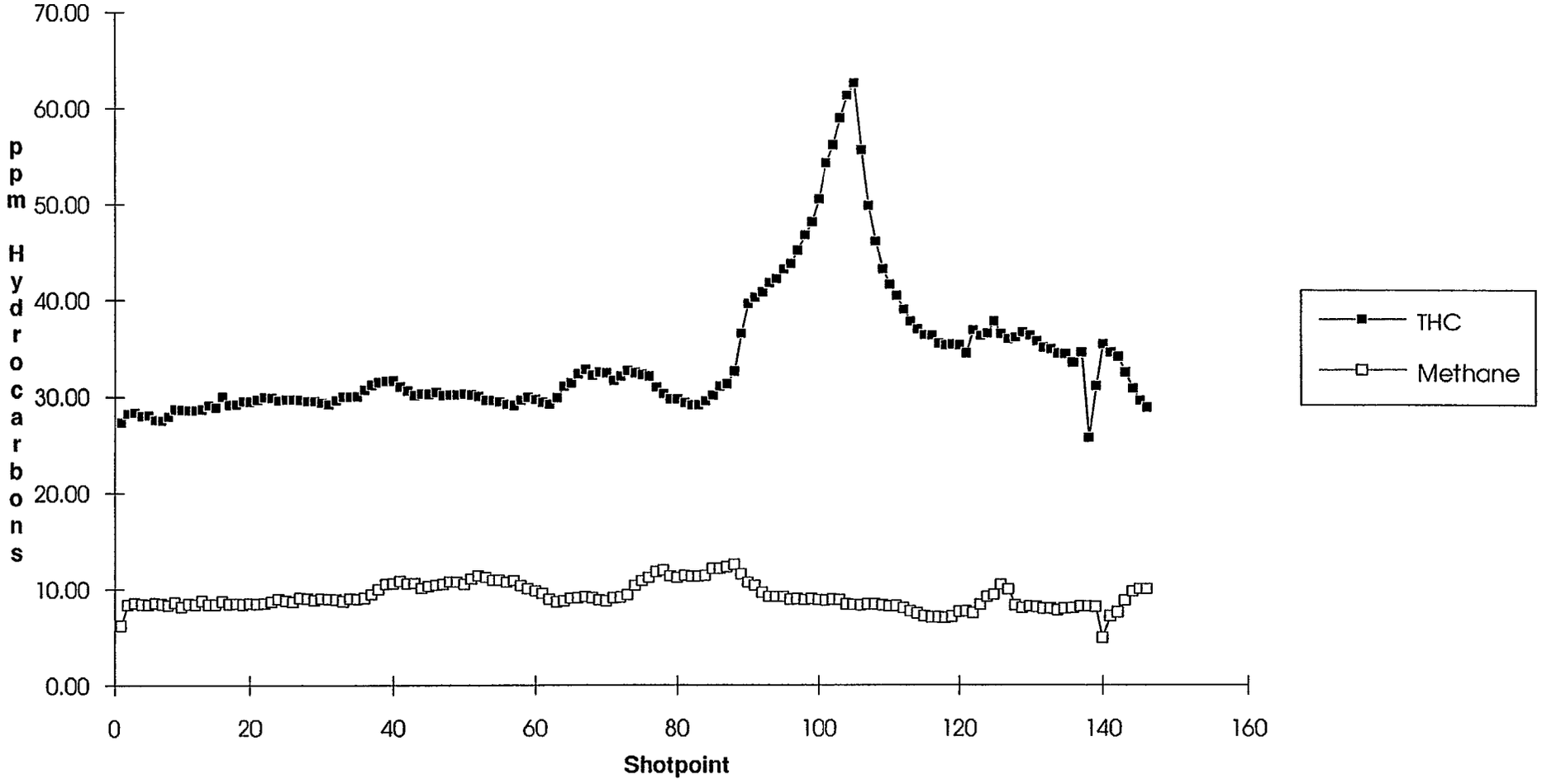
	THC	Methane	Ethane	Ethylene	Propane	Propylene	I-Butane	n-Butane	I-Pentane	n-Pentane	I-Hexane	n-Hexane	%Wetness
Mean	33.815	9.166	0.045	0.345	0.024	0.096	0.020	0.000	0.004	0.126	0.115	0.042	0.978
Std. Dev.	6.998	1.341	0.005	0.186	0.005	0.034	0.005	0.000	0.004	0.066	0.045	0.014	0.197
Minimum	25.688	4.965	0.020	0.068	0.006	0.030	0.010	0.000	0.000	0.000	0.000	0.000	0.576
Maximum	62.525	12.590	0.065	0.904	0.036	0.225	0.042	0.000	0.025	0.281	0.204	0.082	1.448

	Cond.	Temp.	F. Depth	W.Depth	Altitude	Calc. Alt.
Mean	59.855	26.367	76.124	778.012	26.778	701.888
Std. Dev.	1.543	1.073	31.416	452.847	8.336	463.701
Minimum	57.860	25.010	3.540	58.900	0.010	10.200
Maximum	63.780	29.110	115.760	1815.800	31.000	1774.390

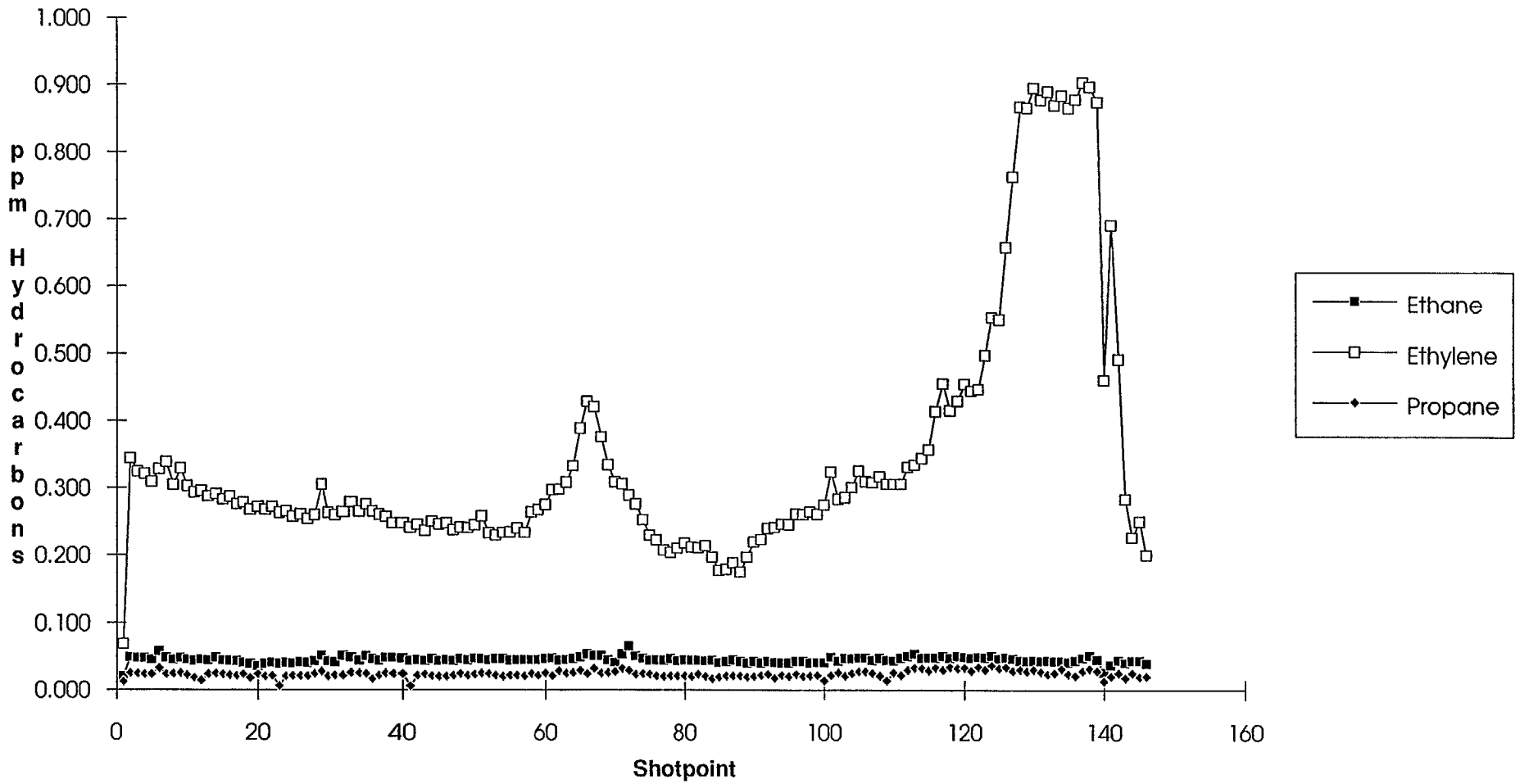
Notes A weak THC anomaly occurs between SP 90 and SP 105.

R9209205

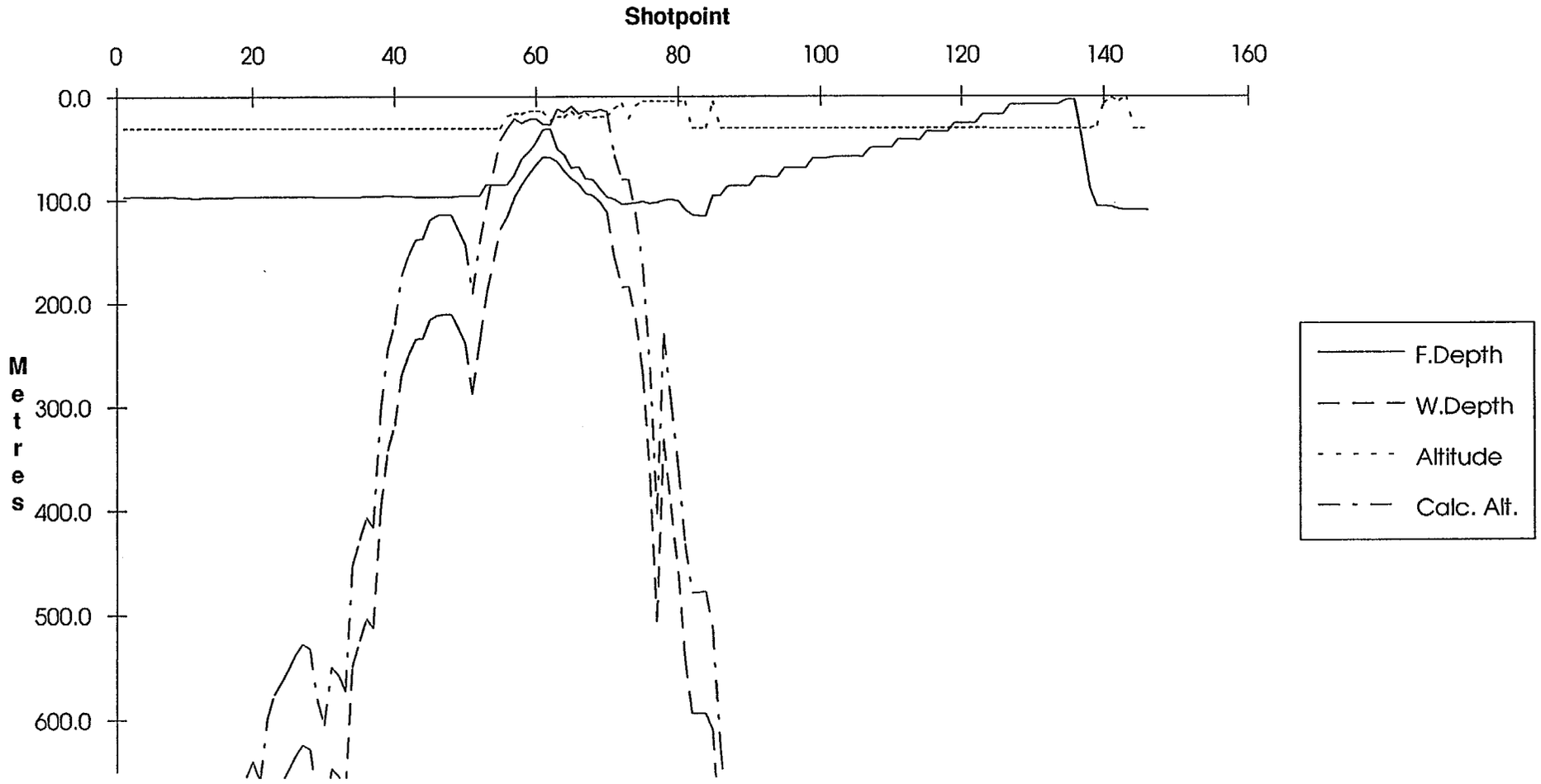
Line 109022 THC, Methane



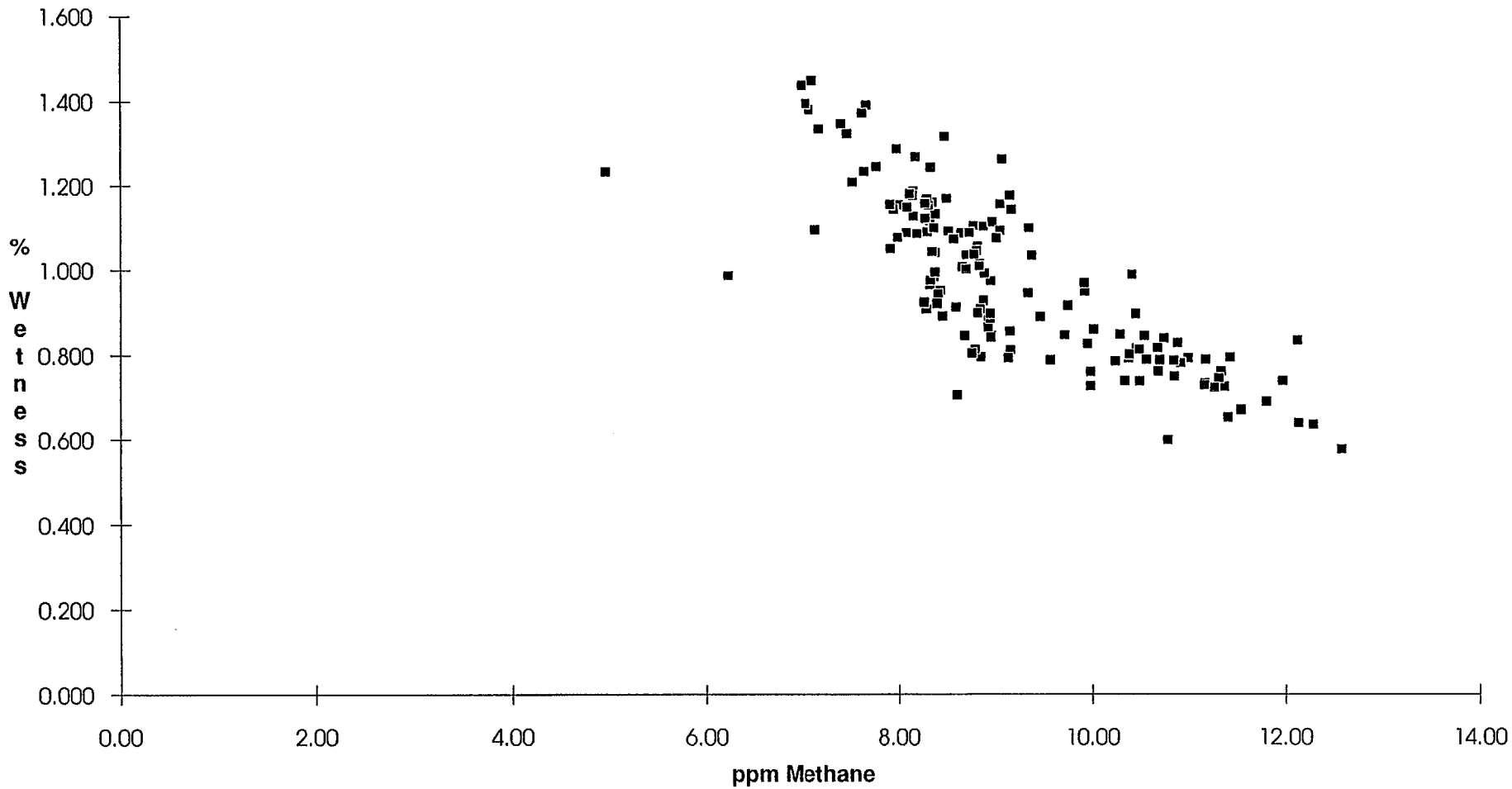
Line 109022 Ethane, Ethylene, Propane



Line 109022 Depths, Altitudes



Line 109022 Methane v. %Wetness



Line Summary

Line Number	109023
No. of Shotpoints	128

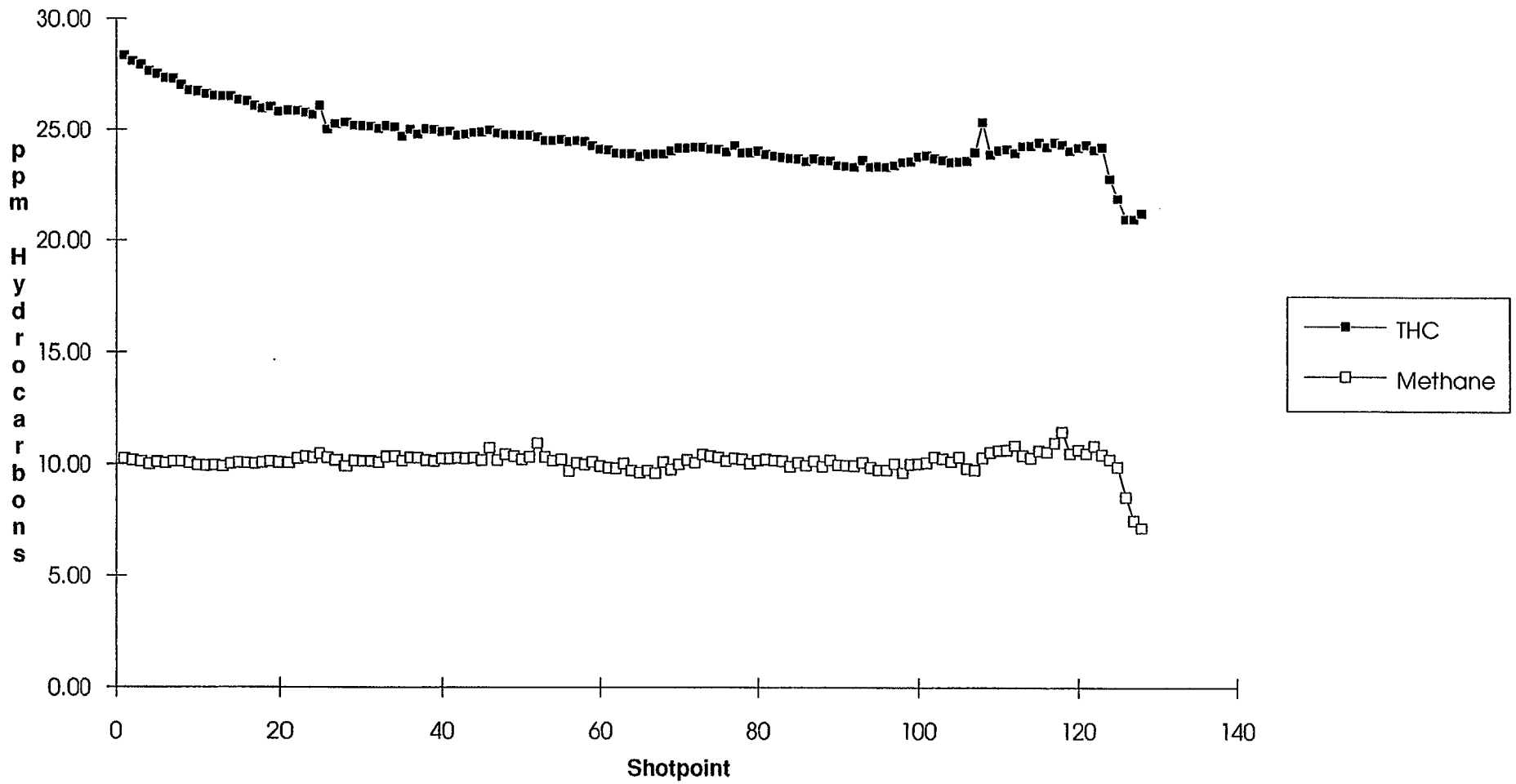
	Shotpoint	Date	Time	Latitude		Longitude	
Start	1	13-Apr-92	05:18:23	13	18.087	122	16.956
End	128	13-Apr-92	09:43:49	13	28.116	122	24.464

	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	24.601	10.110	0.039	0.202	0.019	0.065	0.011	0.000	0.002	0.085	0.054	0.042	0.680
Std. Dev.	1.294	0.473	0.002	0.022	0.005	0.008	0.006	0.000	0.003	0.016	0.013	0.011	0.108
Minimum	20.941	7.133	0.032	0.172	0.002	0.045	0.000	0.000	0.000	0.067	0.032	0.020	0.386
Maximum	28.322	11.442	0.046	0.359	0.027	0.086	0.026	0.000	0.018	0.201	0.096	0.078	1.232

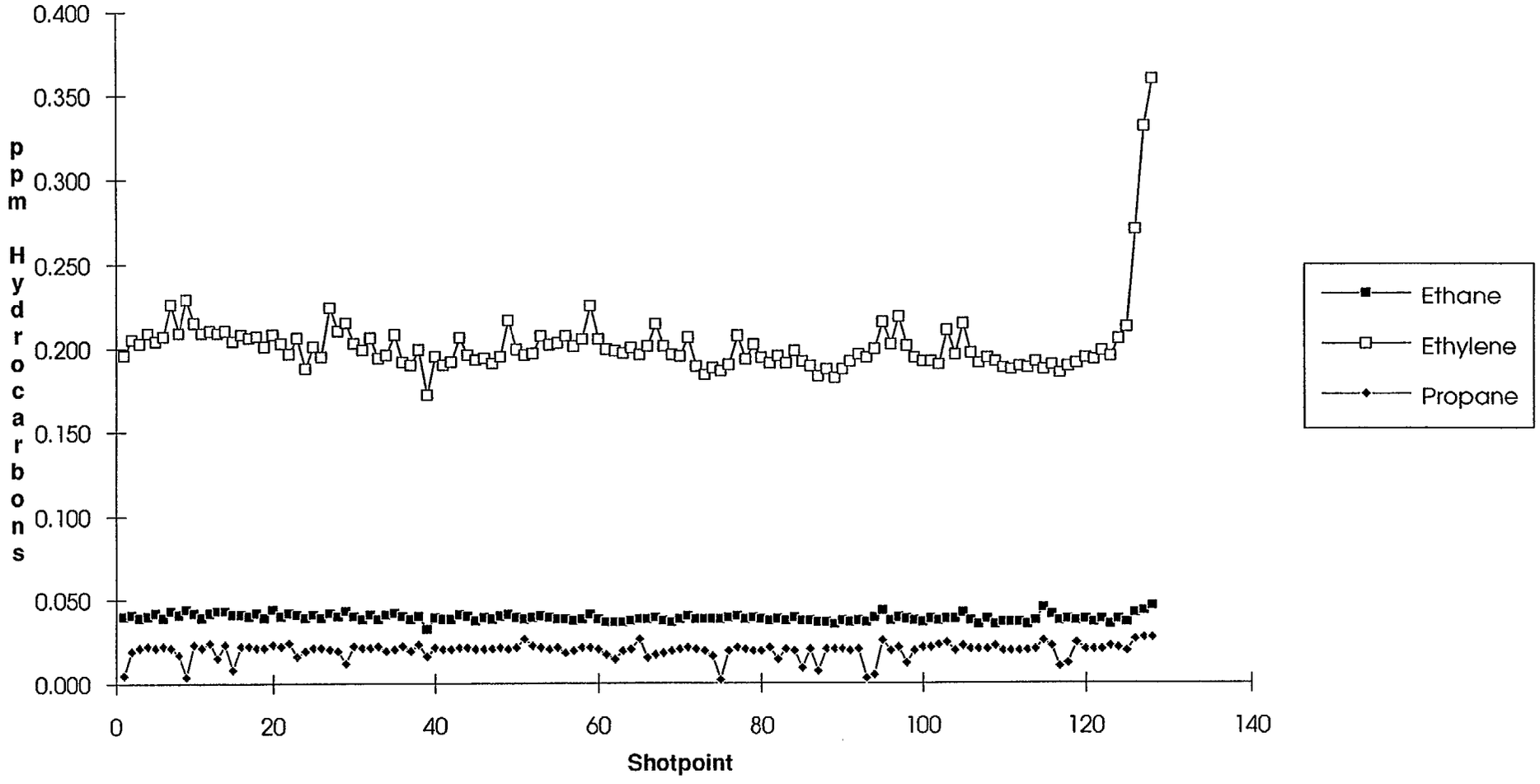
	Cond.	Temp.	F. Depth	W.Depth	Altitude	Calc. Alt.
Mean	58.342	25.354	108.738	938.580	3.587	829.842
Std. Dev.	0.333	0.237	16.690	362.856	9.760	353.697
Minimum	57.740	24.930	41.020	70.000	0.010	28.390
Maximum	59.660	26.350	115.780	1642.100	30.760	1527.840

Notes No anomalies are observed on this line.

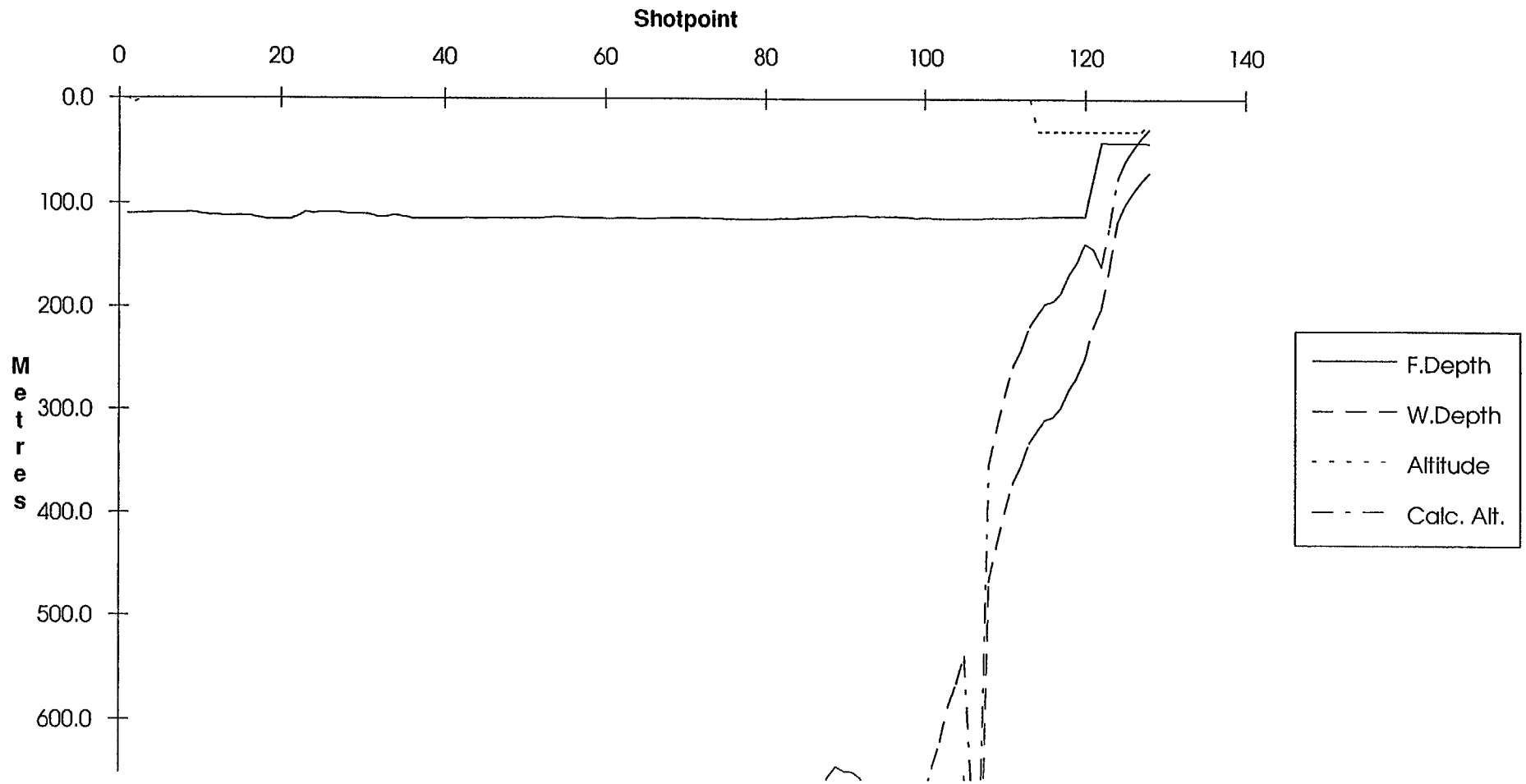
Line 109023 THC, Methane



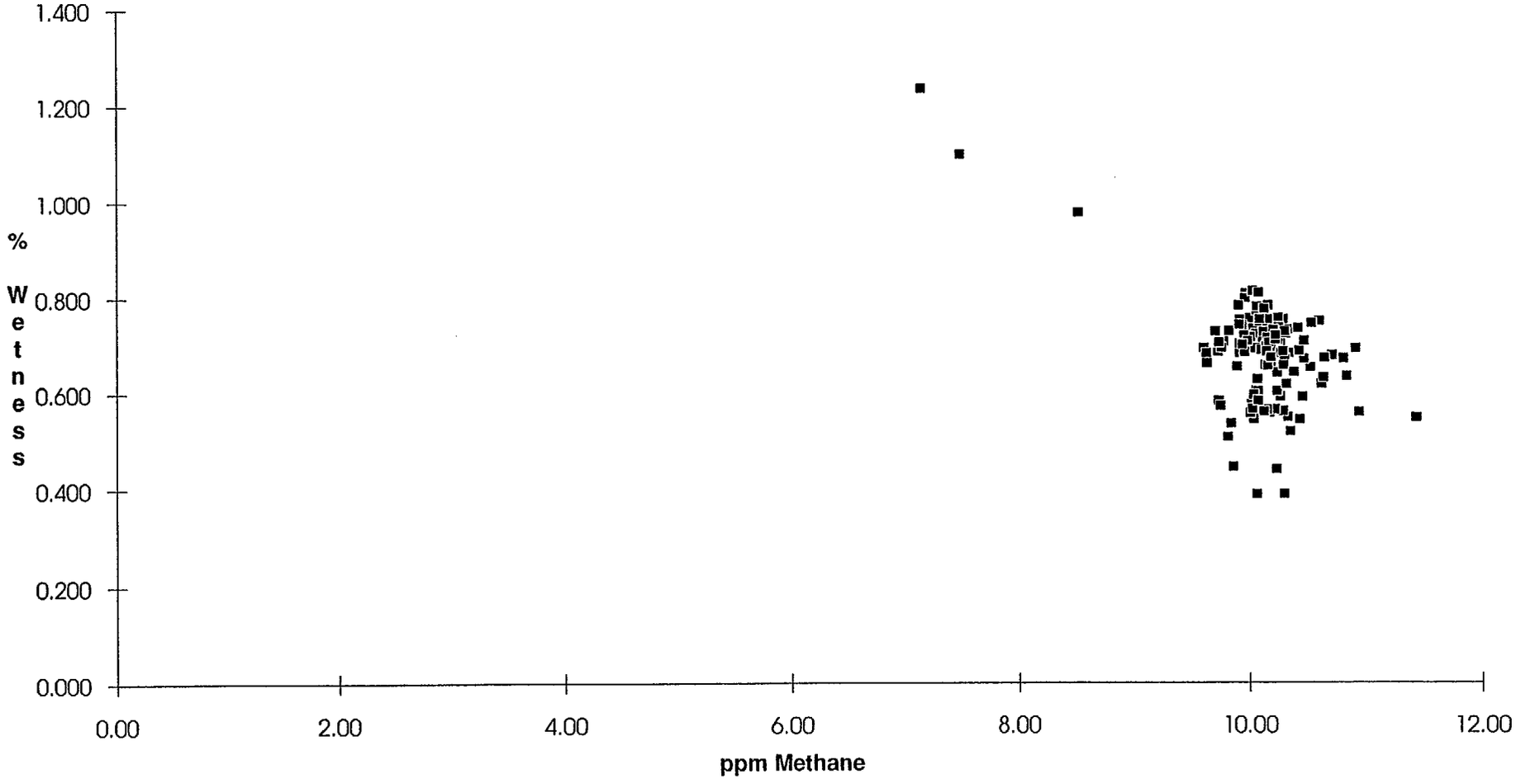
Line 109023 Ethane, Ethylene, Propane



Line 109023 Depths, Altitudes



Line 109023 Methane v. %Wetness



Line Summary

Line Number	109024
No. of Shotpoints	97

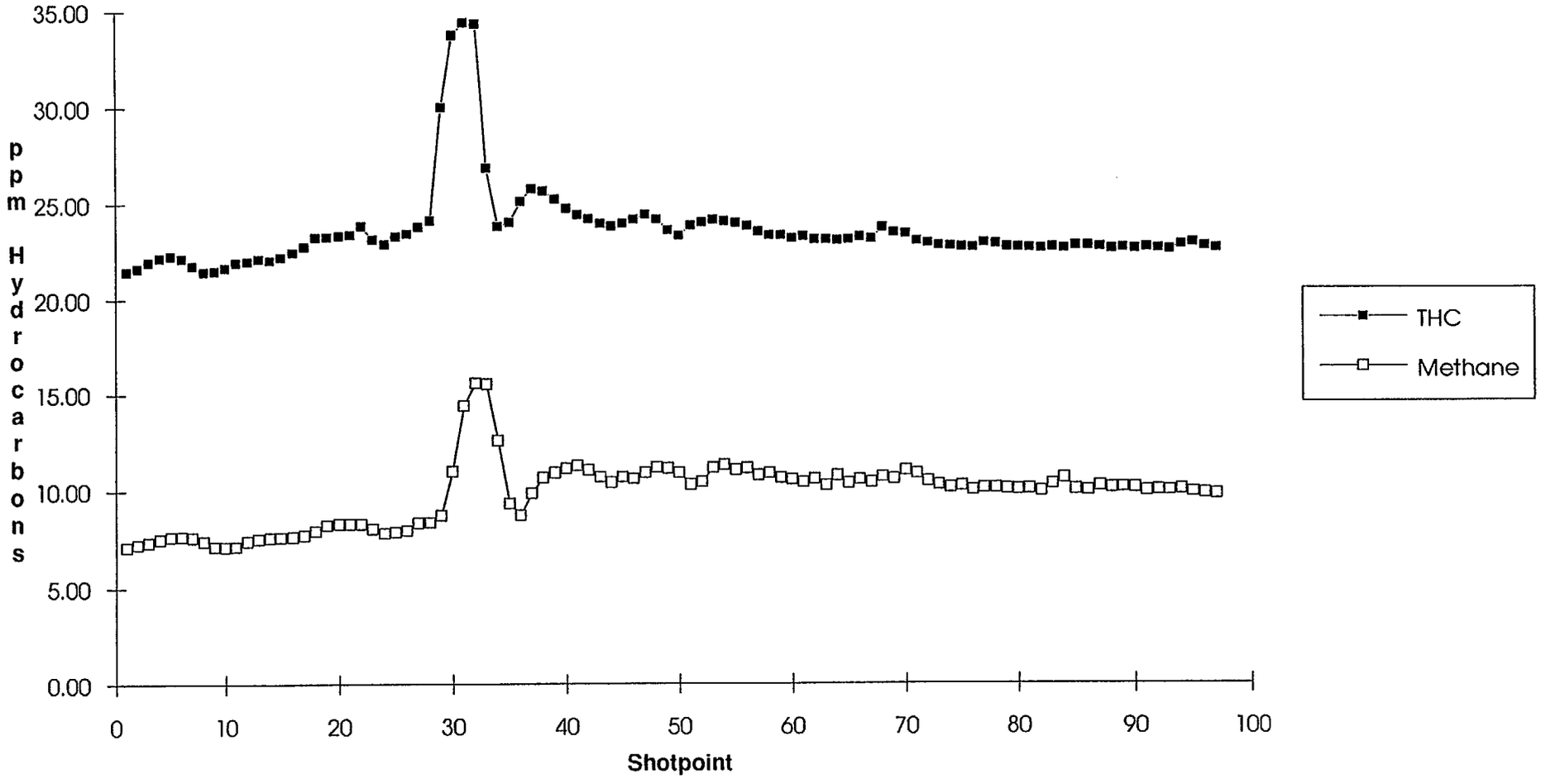
	Shotpoint	Date	Time	Latitude		Longitude	
Start	1	13-Apr-92	09:45:48	13	28.357	122	24.465
End	97	13-Apr-92	13:07:59	13	24.665	122	10.918

	THC	Methane	Ethane	Ethylene	Propane	Propylene	I-Butane	n-Butane	I-Pentane	n-Pentane	I-Hexane	n-Hexane	%Wetness
Mean	23.569	9.782	0.040	0.261	0.024	0.069	0.012	0.000	0.001	0.121	0.038	0.039	0.805
Std. Dev.	2.235	1.661	0.006	0.129	0.007	0.020	0.006	0.000	0.002	0.068	0.010	0.010	0.273
Minimum	21.431	7.074	0.032	0.157	0.010	0.043	0.000	0.000	0.000	0.056	0.014	0.012	0.477
Maximum	34.386	15.572	0.052	0.720	0.040	0.144	0.024	0.000	0.009	0.244	0.060	0.064	1.386

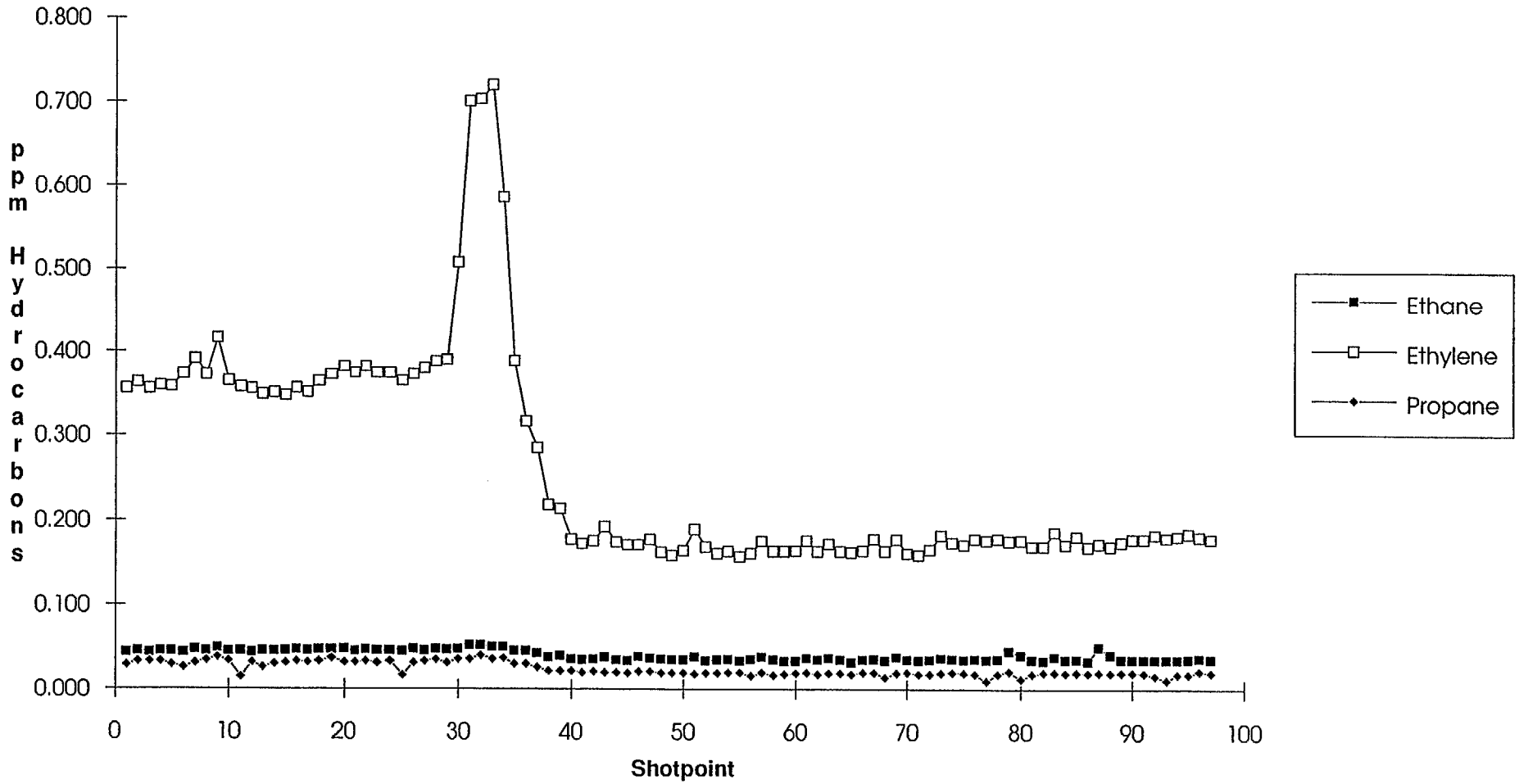
	Cond.	Temp.	F. Depth	W.Depth	Altitude	Calc. Alt.
Mean	57.940	25.106	90.067	169.130	13.816	79.343
Std. Dev.	1.476	1.029	42.445	105.028	9.806	74.722
Minimum	56.490	24.020	21.500	37.400	4.640	5.040
Maximum	61.020	27.140	125.630	392.800	30.750	270.750

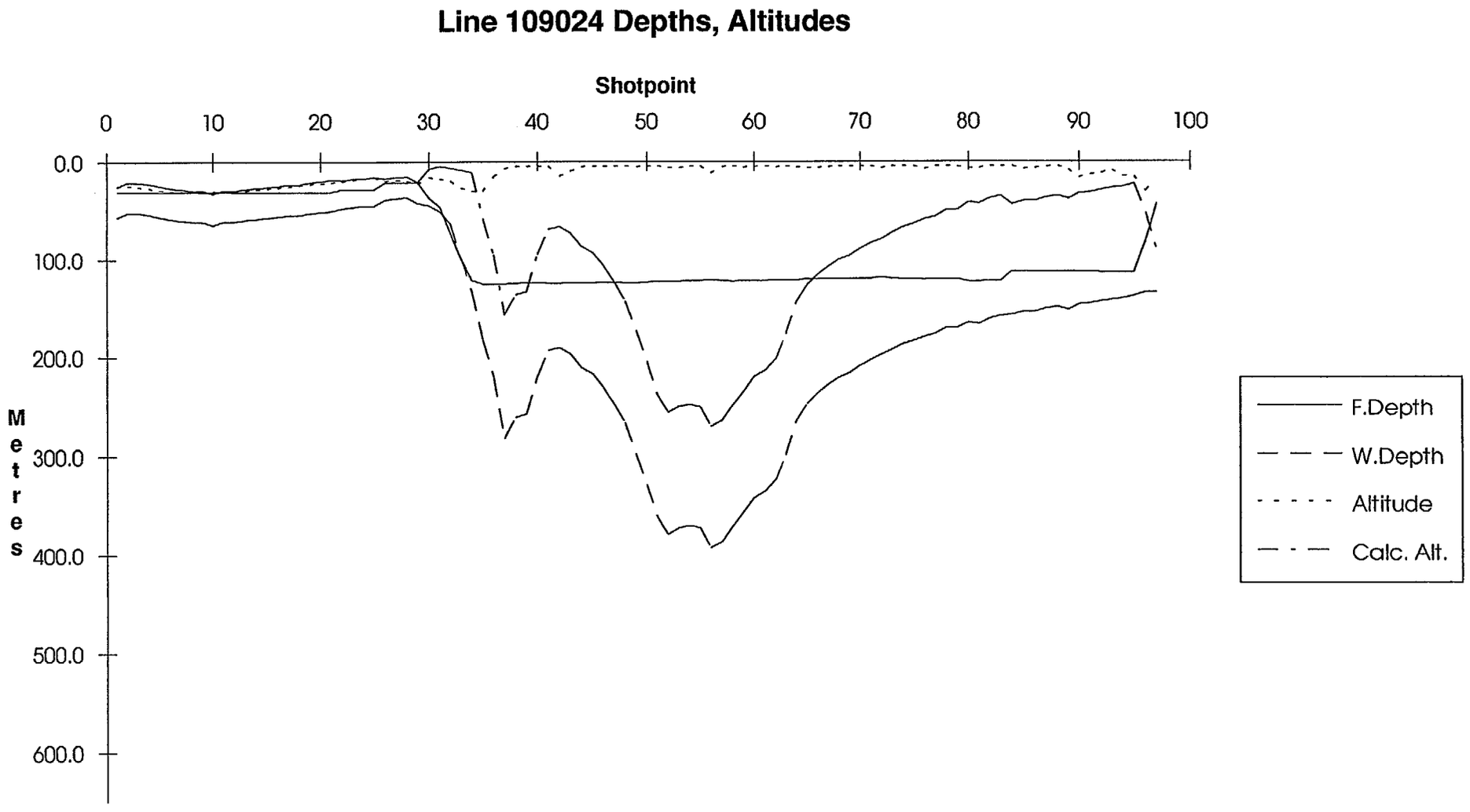
Notes A weak THC and methane anomaly occurs at SP 32.

Line 109024 THC, Methane

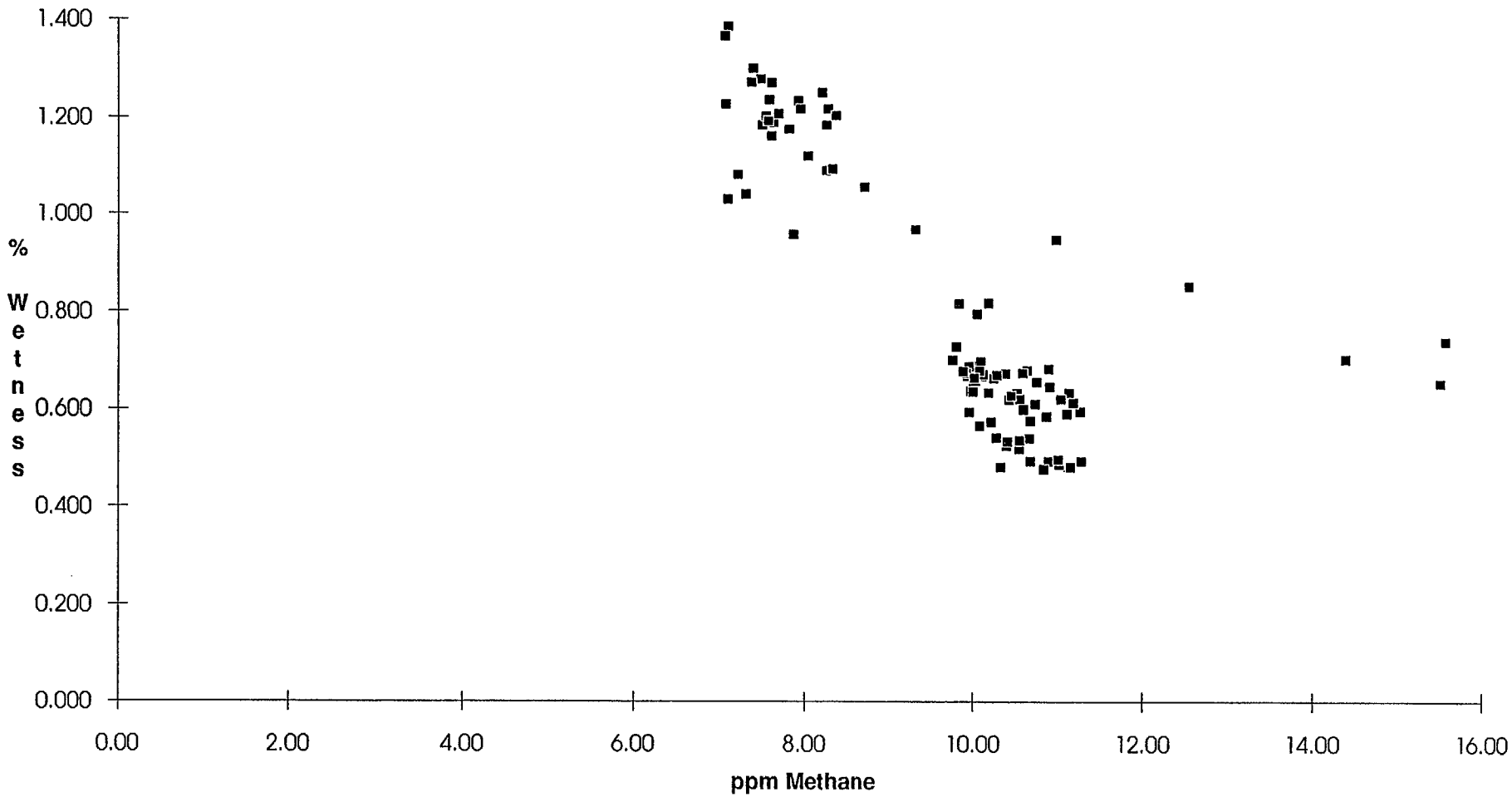


Line 109024 Ethane, Ethylene, Propane




Line 109024 Depths, Altitudes
Shotpoint
0
10
20
30
40
50
60
70
80
90
100
0.0
100.0
200.0
300.0
400.0
500.0
600.0
Metres
F.Depth
W.Depth
Altitude
Calc. Alt.

Line 109024 Methane v. %Wetness



Line Summary

Line Number	109025
No. of Shotpoints	176

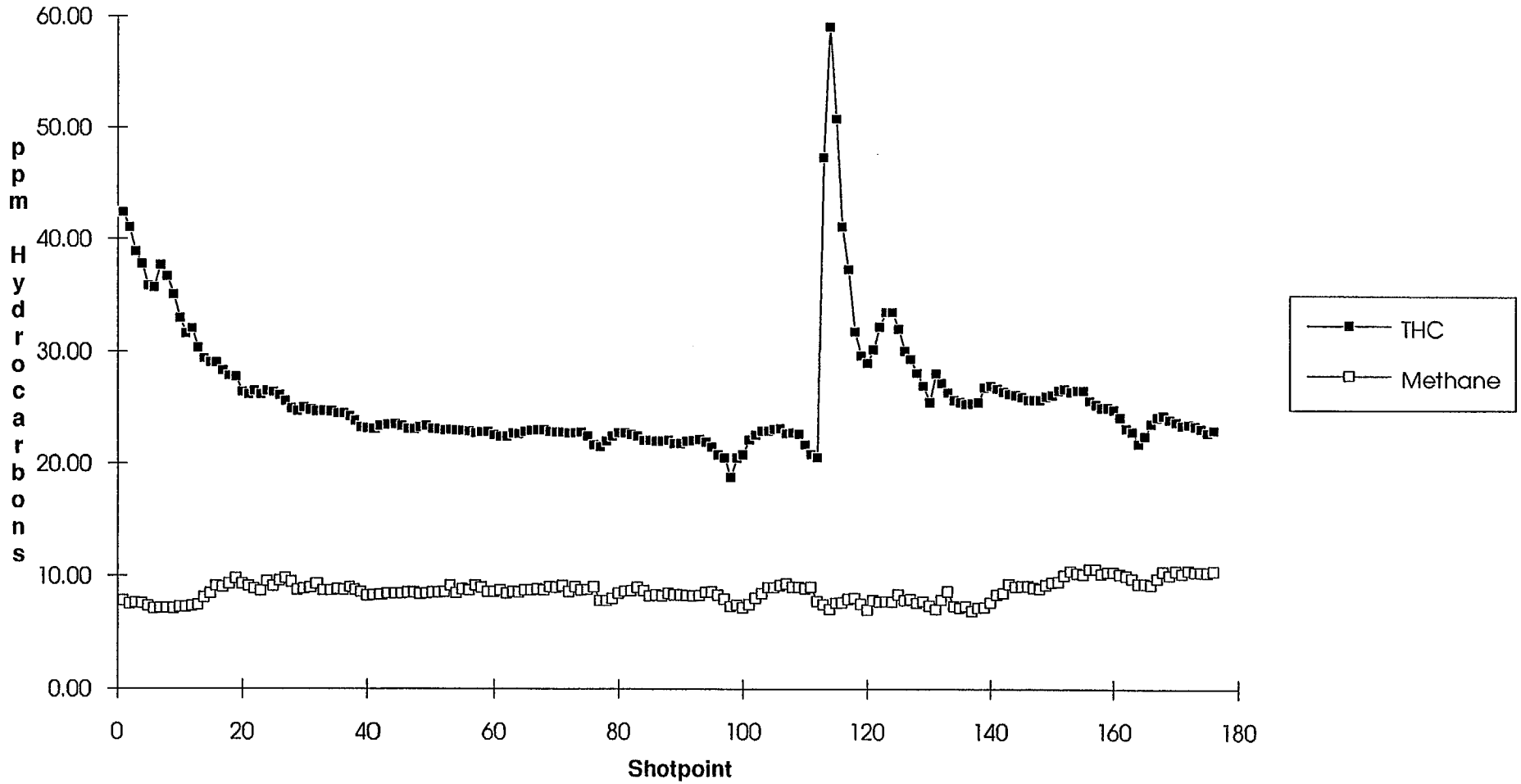
	Shotpoint	Date	Time	Latitude		Longitude	
Start	1	13-Apr-92	15:52:09	13	31.393	122	19.541
End	176	13-Apr-92	21:57:56	13	35.698	121	49.287

	THC	Methane	Ethane	Ethylene	Propane	Propylene	I-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	25.921	8.626	0.038	0.286	0.023	0.073	0.008	0.000	0.002	0.115	0.039	0.033	0.811
Std. Dev.	5.590	0.913	0.004	0.153	0.004	0.035	0.008	0.000	0.003	0.051	0.014	0.011	0.199
Minimum	18.784	6.881	0.021	0.088	0.007	0.028	0.000	0.000	0.000	0.023	0.019	0.000	0.358
Maximum	59.112	10.623	0.050	0.753	0.032	0.201	0.028	0.000	0.020	0.268	0.082	0.056	1.267

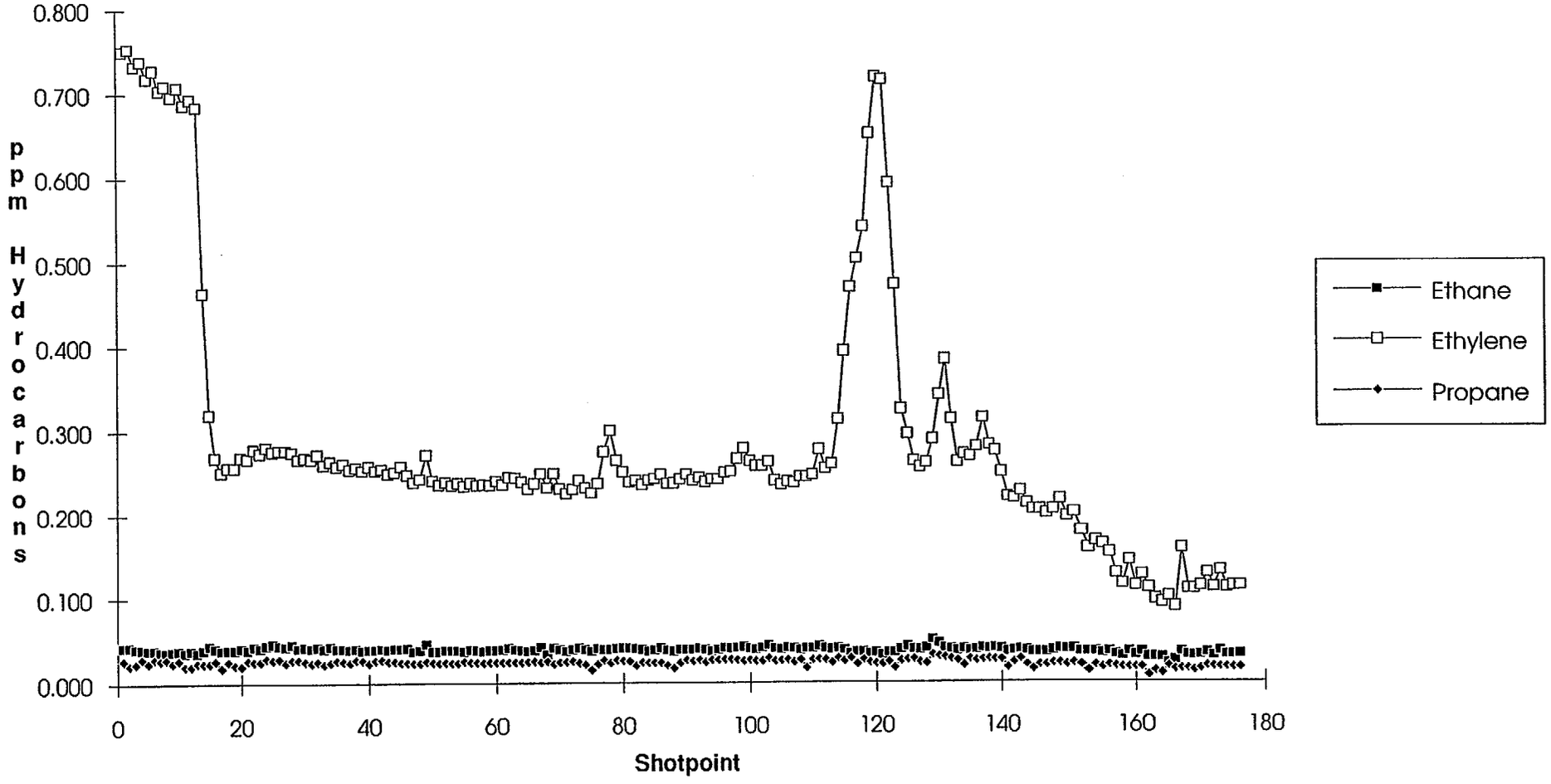
	Cond.	Temp.	F. Depth	W.Depth	Altitude	Calc. Alt.
Mean	58.133	25.267	68.895	94.530	13.259	25.566
Std. Dev.	1.445	0.967	33.117	48.173	6.697	37.819
Minimum	54.740	22.870	7.760	34.500	4.620	5.330
Maximum	61.510	27.430	154.460	265.200	30.770	257.440

Notes Two weak THC anomalies occur at SP 1 and SP 115.

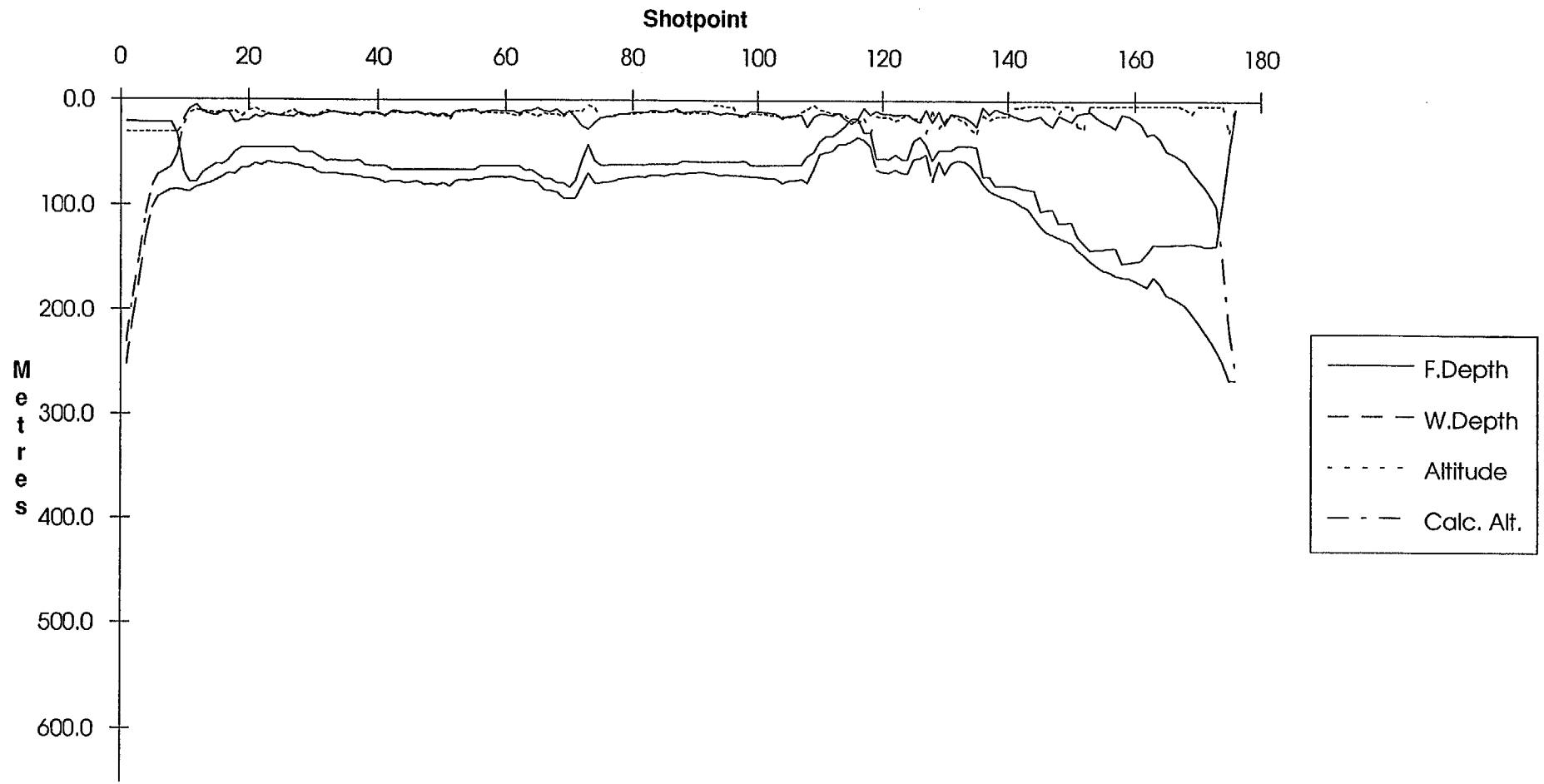
Line 109025 THC, Methane



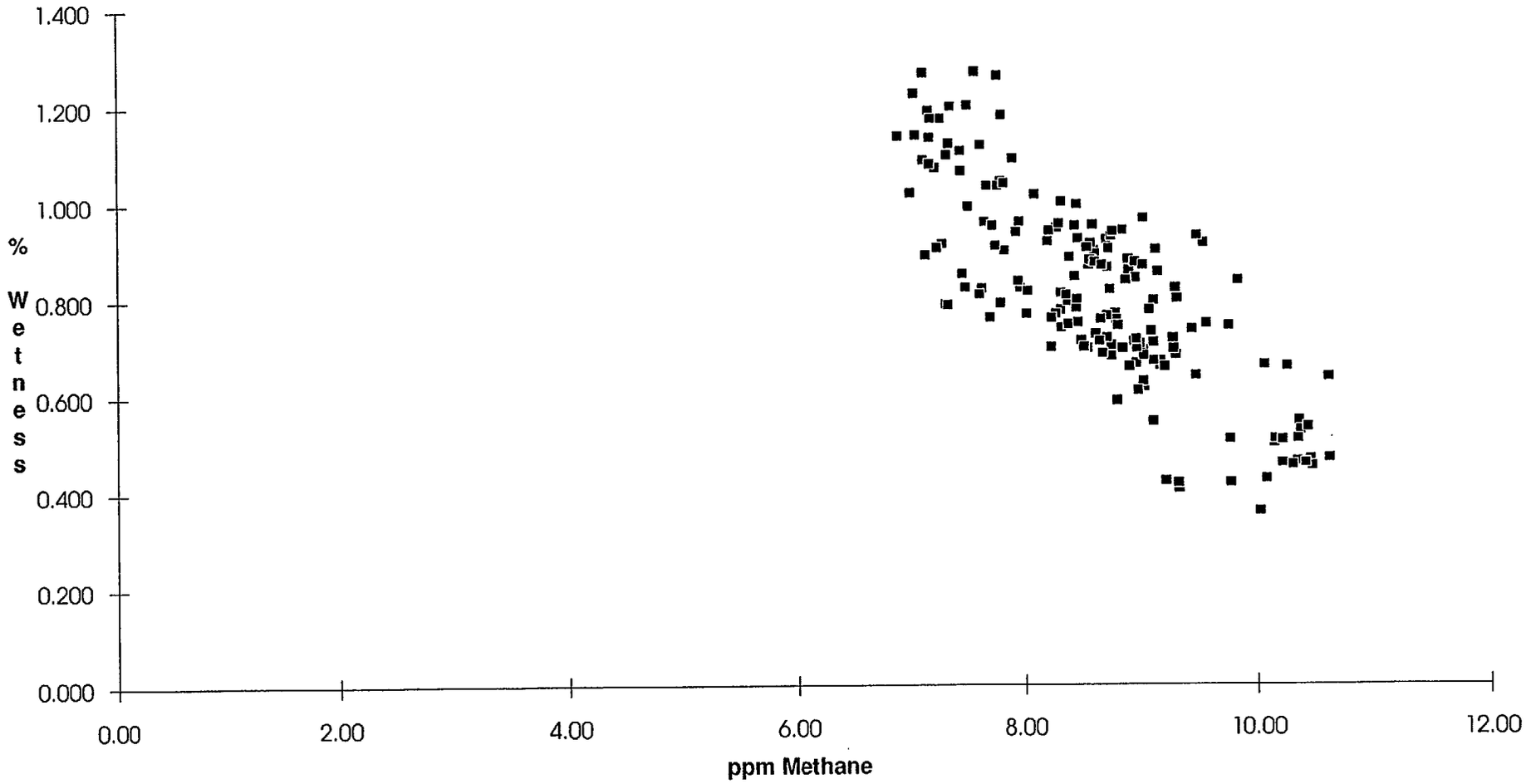
Line 109025 Ethane, Ethylene, Propane



Line 109025 Depths, Altitudes



Line 109025 Methane v. %Wetness



Line Summary

Line Number	109026
No. of Shotpoints	143

	Shotpoint	Date	Time	Latitude		Longitude	
Start	1	14-Apr-92	02:38:58	13	38.393	121	50.841
End	143	14-Apr-92	07:32:34	13	34.471	122	08.383

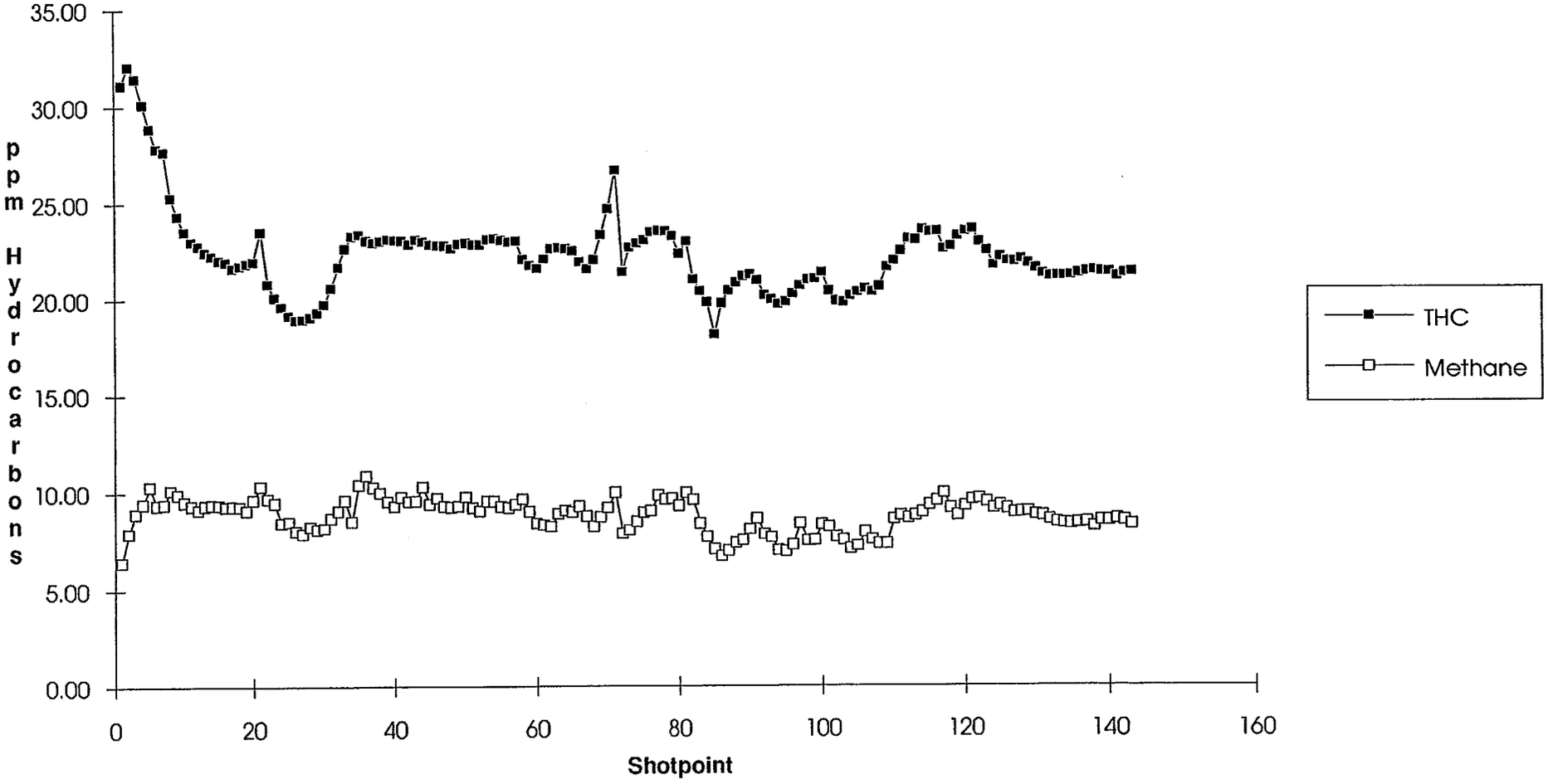
	THC	Methane	Ethane	Ethylene	Propane	Propylene	I-Butane	n-Butane	I-Pentane	n-Pentane	I-Hexane	n-Hexane	%Wetness
Mean	22.299	8.789	0.037	0.217	0.021	0.060	0.004	0.000	0.003	0.113	0.057	0.032	0.710
Std. Dev.	2.224	0.866	0.005	0.074	0.005	0.034	0.007	0.000	0.005	0.047	0.027	0.017	0.185
Minimum	18.108	6.387	0.021	0.064	0.005	0.016	0.000	0.000	0.000	0.000	0.000	0.000	0.362
Maximum	32.038	10.836	0.050	0.450	0.032	0.386	0.030	0.000	0.015	0.195	0.104	0.070	1.663

	Cond.	Temp.	F. Depth	W.Depth	Altitude	Calc. Alt.
Mean	59.799	26.405	71.701	97.004	16.311	25.299
Std. Dev.	1.592	1.117	33.613	58.659	6.505	34.563
Minimum	55.910	23.660	20.180	32.000	8.670	5.890
Maximum	62.770	28.660	154.950	262.600	30.900	178.490

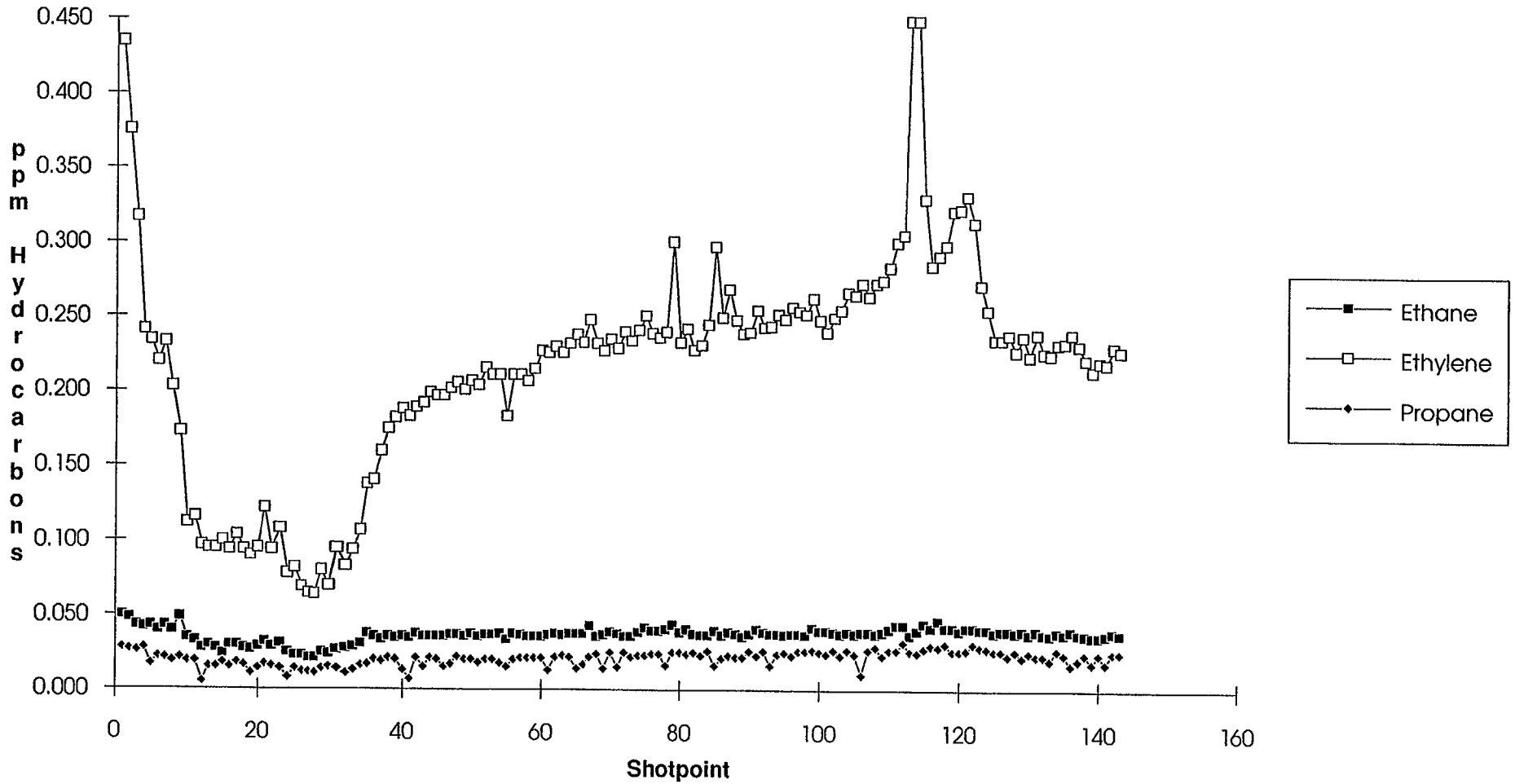
Notes

Two weak THC and Methane anomalies occur at SP 21 and SP 78.
A weak THC anomaly occurs at SP 2.

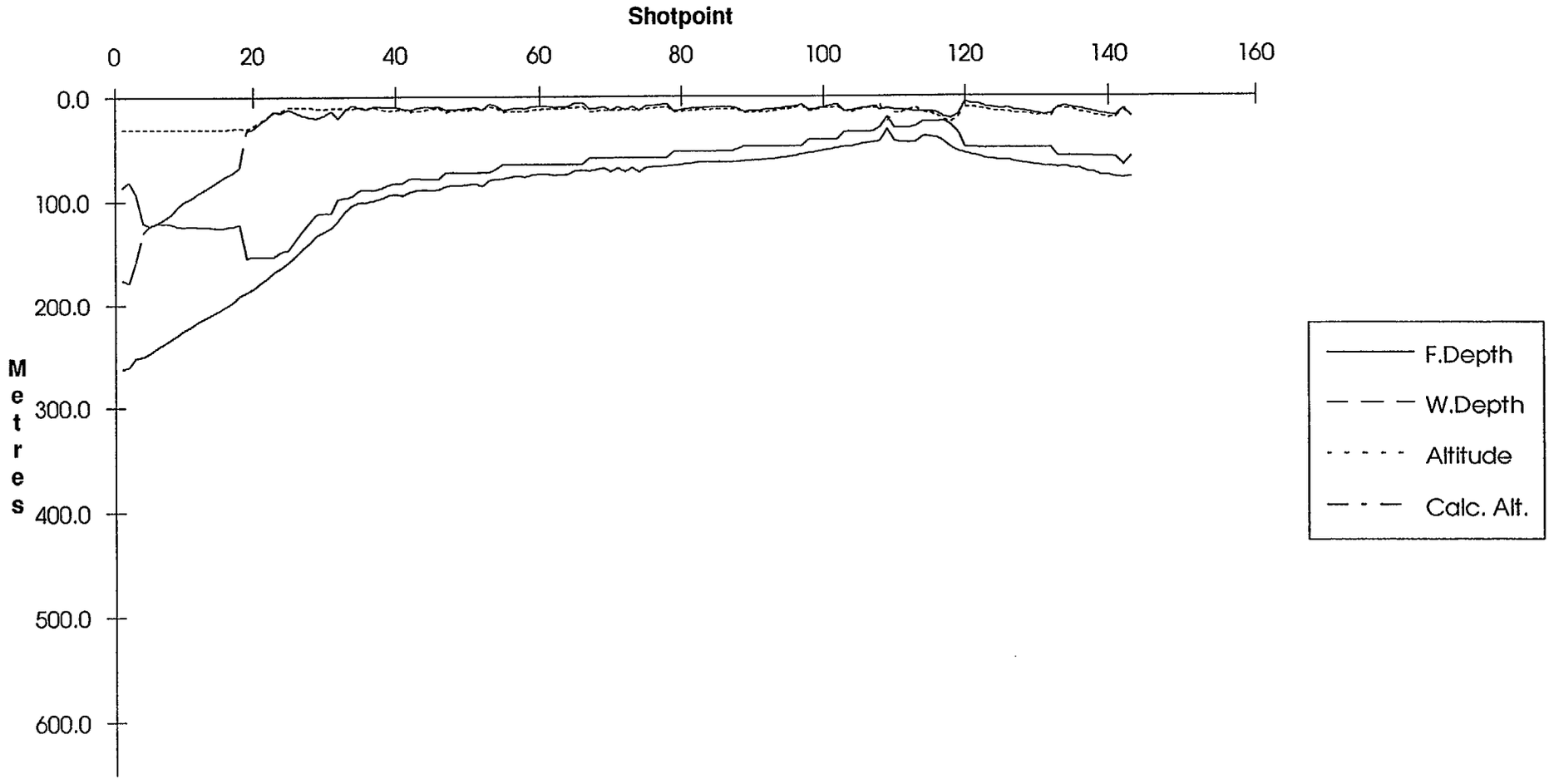
Line 109026 THC, Methane



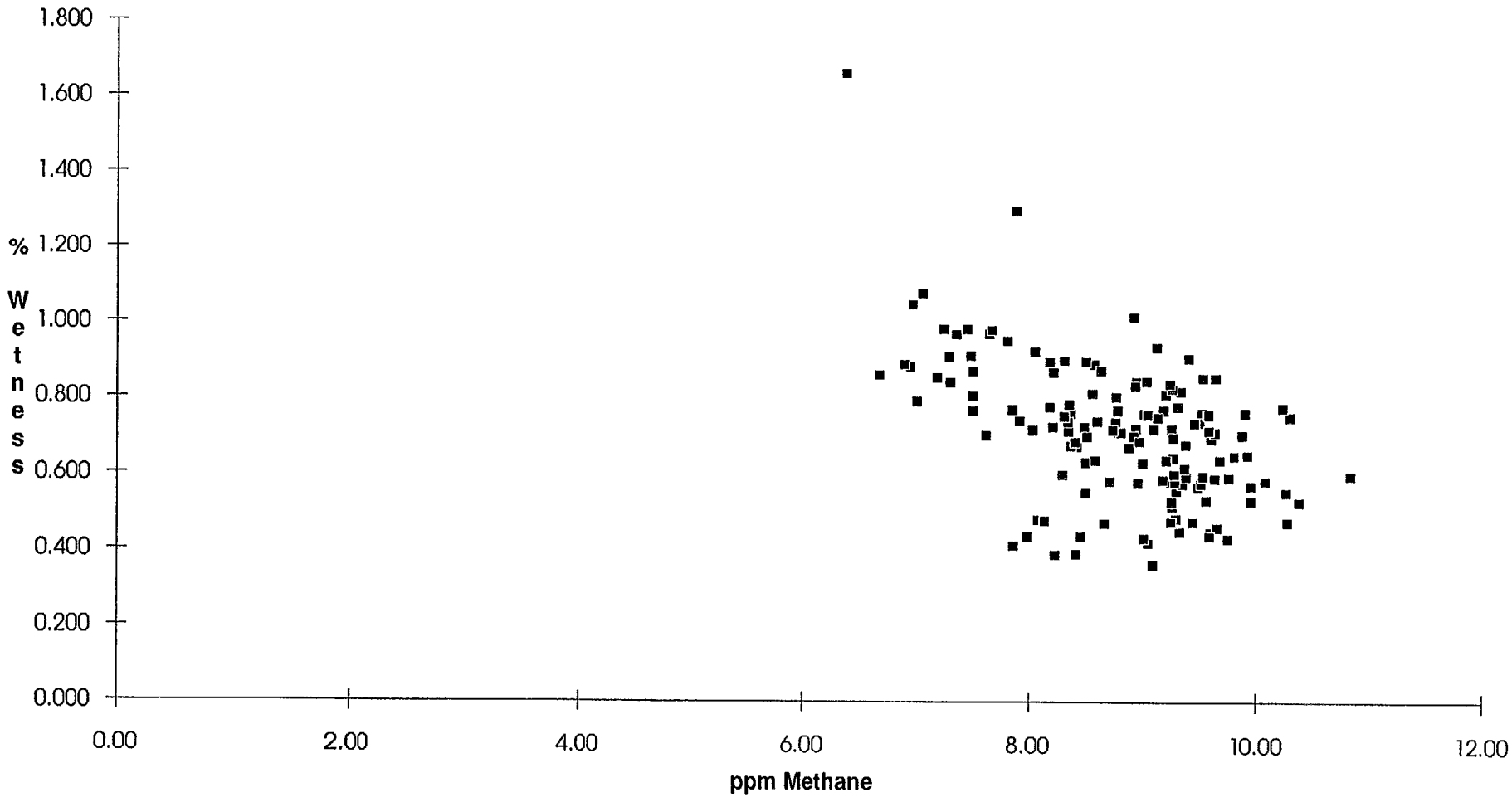
Line 109026 Ethane, Ethylene, Propane



Line 109026 Depths, Altitudes



Line 109026 Methane v. %Wetness



Line Summary

Line Number	109027
No. of Shotpoints	94

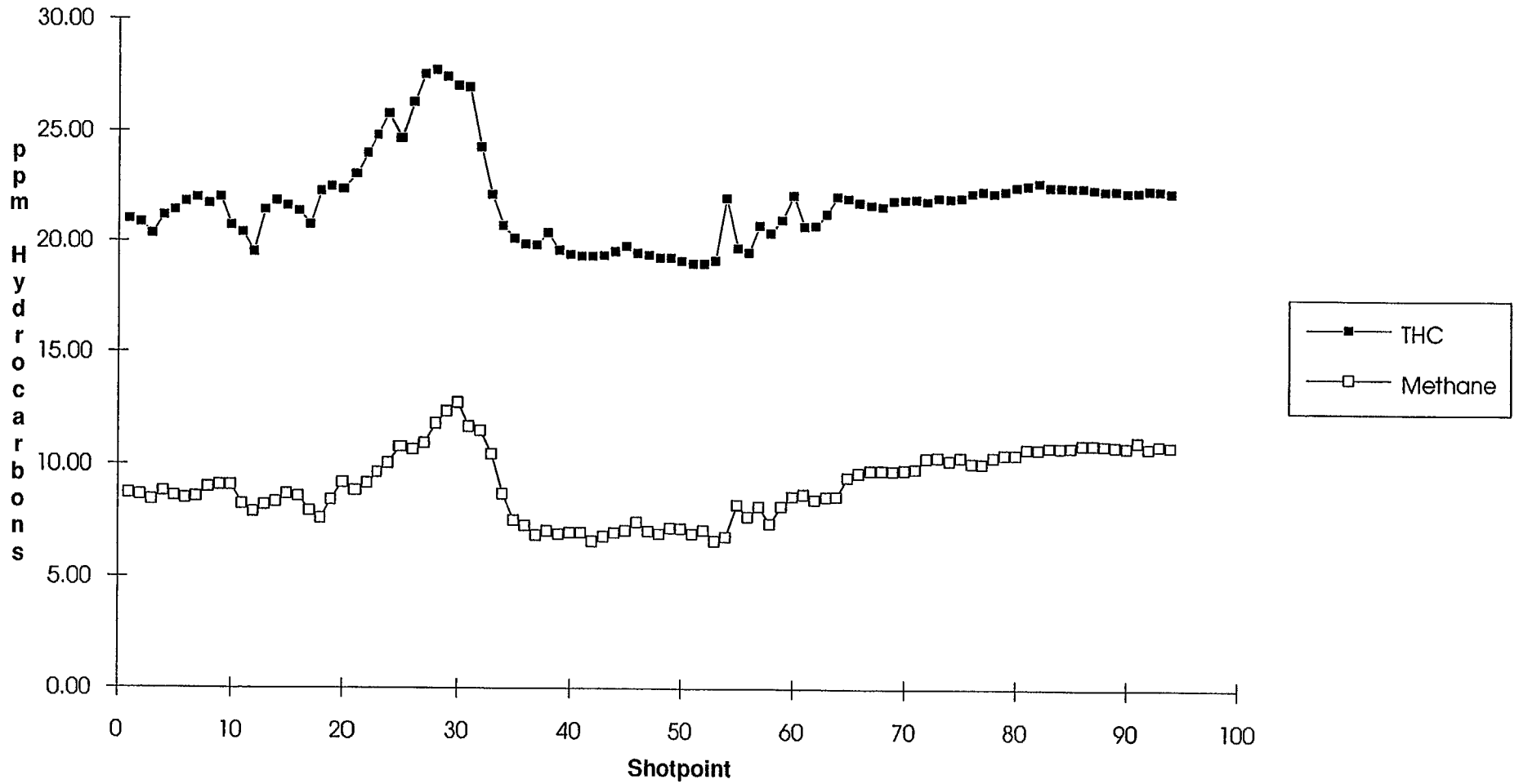
	Shotpoint	Date	Time	Latitude		Longitude	
Start	1	14-Apr-92	07:34:46	13	34.603	122	08.297
End	117	14-Apr-92	11:43:11	13	40.090	121	52.075

	THC	Methane	Ethane	Ethylene	Propane	Propylene	I-Butane	n-Butane	I-Pentane	n-Pentane	I-Hexane	n-Hexane	%Wetness
Mean	21.793	9.094	0.037	0.252	0.022	0.061	0.003	0.000	0.001	0.124	0.031	0.032	0.706
Std. Dev.	1.979	1.553	0.002	0.117	0.005	0.020	0.005	0.000	0.002	0.069	0.012	0.013	0.188
Minimum	19.030	6.584	0.029	0.112	0.009	0.029	0.000	0.000	0.000	0.000	0.000	0.000	0.399
Maximum	27.733	12.751	0.041	0.617	0.032	0.119	0.014	0.000	0.008	0.231	0.050	0.060	1.164

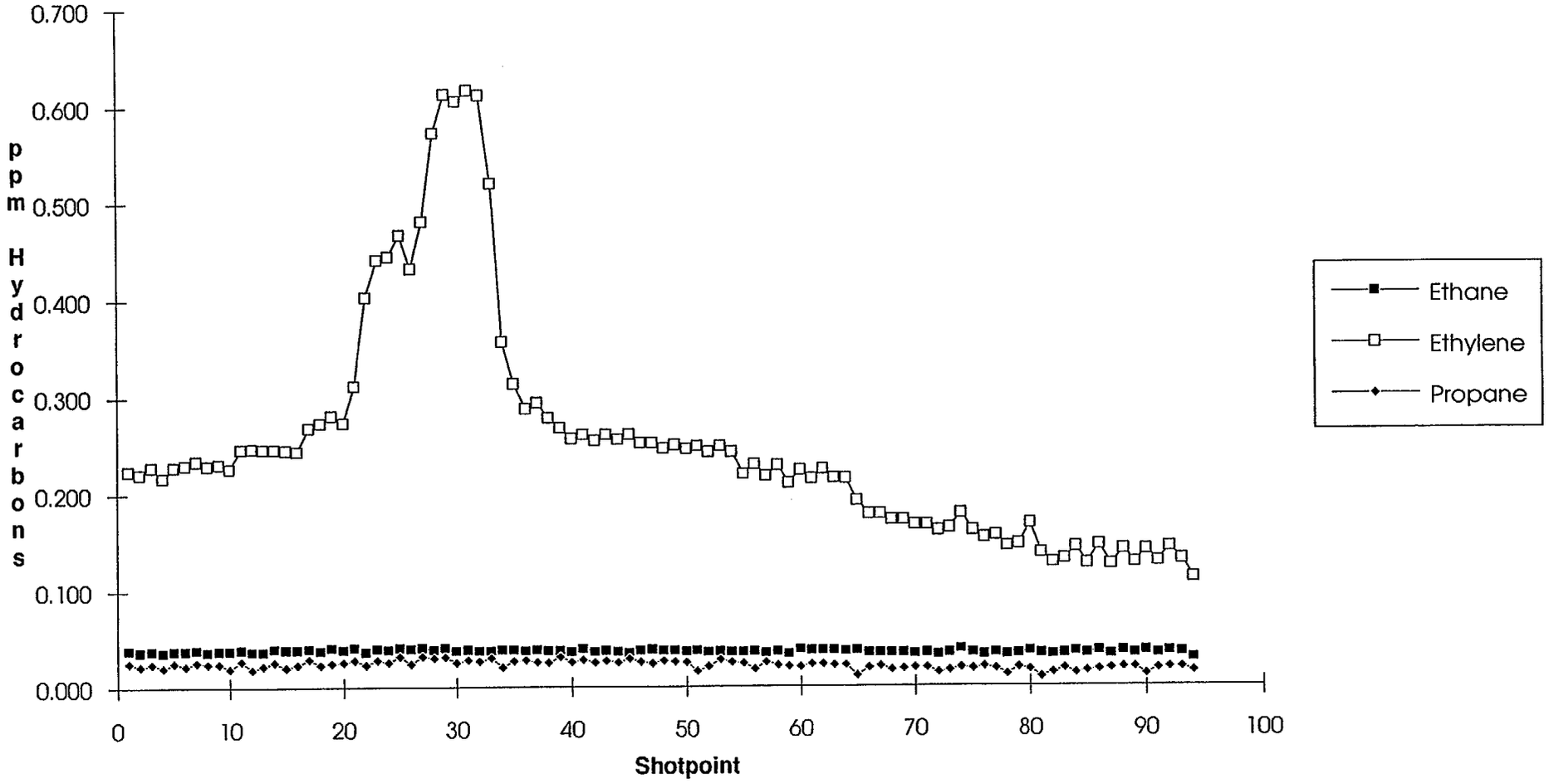
	Cond.	Temp.	F. Depth	W.Depth	Altitude	Calc. Alt.
Mean	58.984	25.846	69.587	87.585	16.671	18.123
Std. Dev.	1.605	1.075	38.762	50.522	6.749	18.845
Minimum	56.460	24.130	20.000	37.300	8.320	0.410
Maximum	61.800	27.670	132.800	219.300	30.840	93.000

Notes A weak THC and methane anomaly occurs between SP 22 and SP 33.

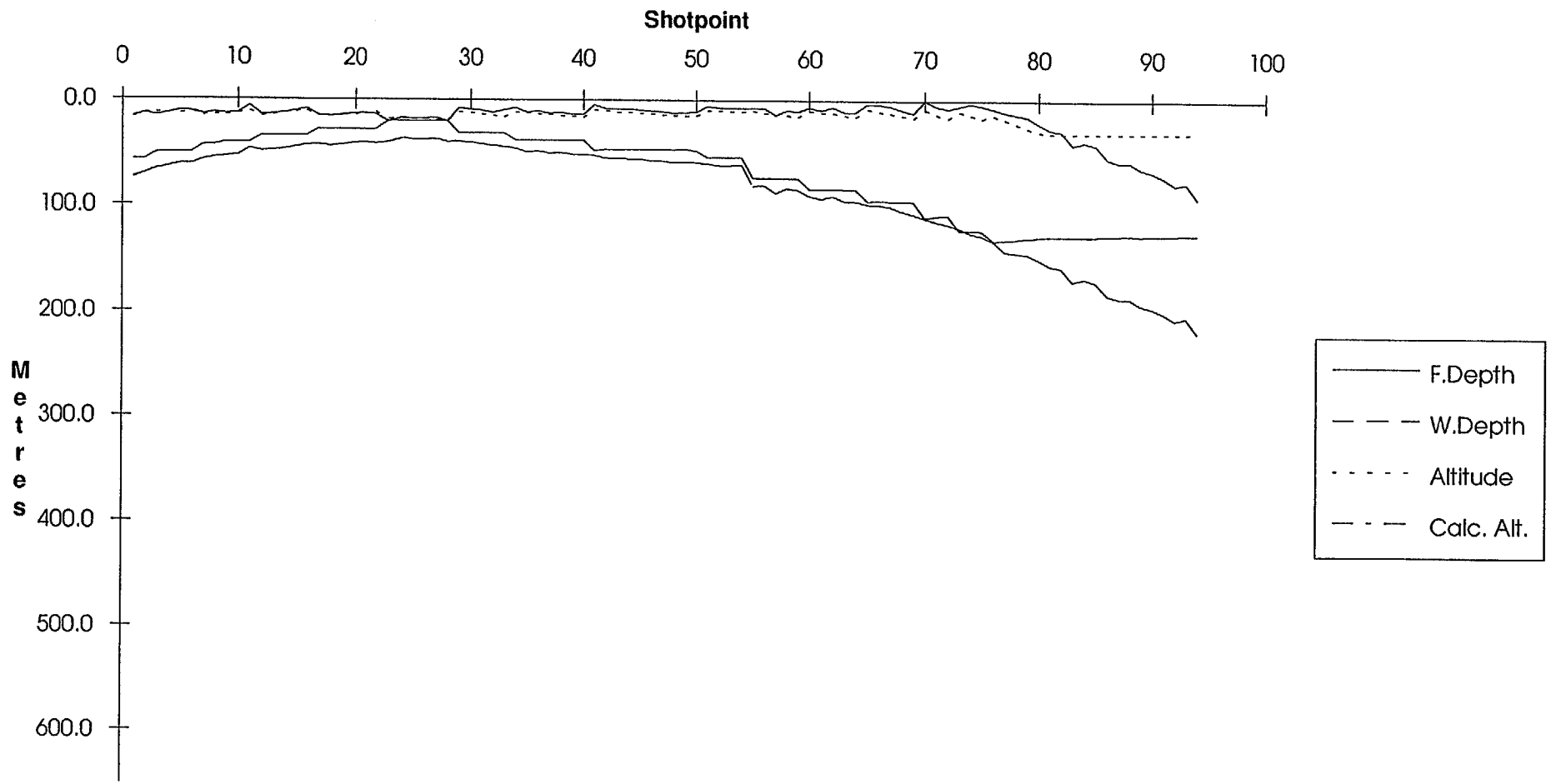
Line 109027 THC, Methane



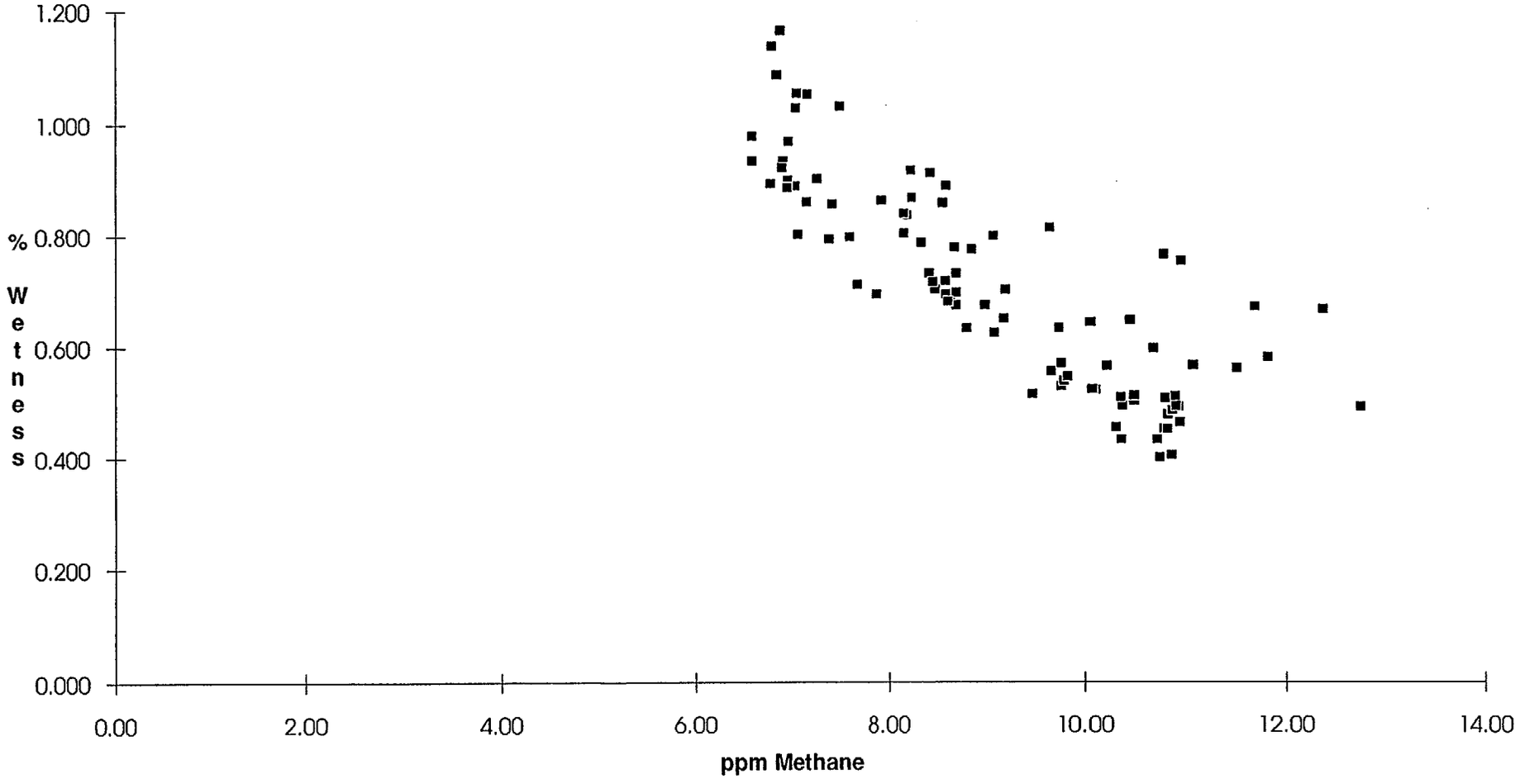
Line 109027 Ethane, Ethylene, Propane



Line 109027 Depths, Altitudes



Line 109027 Methane v. %Wetness



Line Summary

Line Number	109028
No. of Shotpoints	221

	Shotpoint	Date	Time	Latitude		Longitude	
Start	1	14-Apr-92	11:45:10	13	40.095	121	51.893
End	221	14-Apr-92	19:19:04	13	41.607	121	55.316

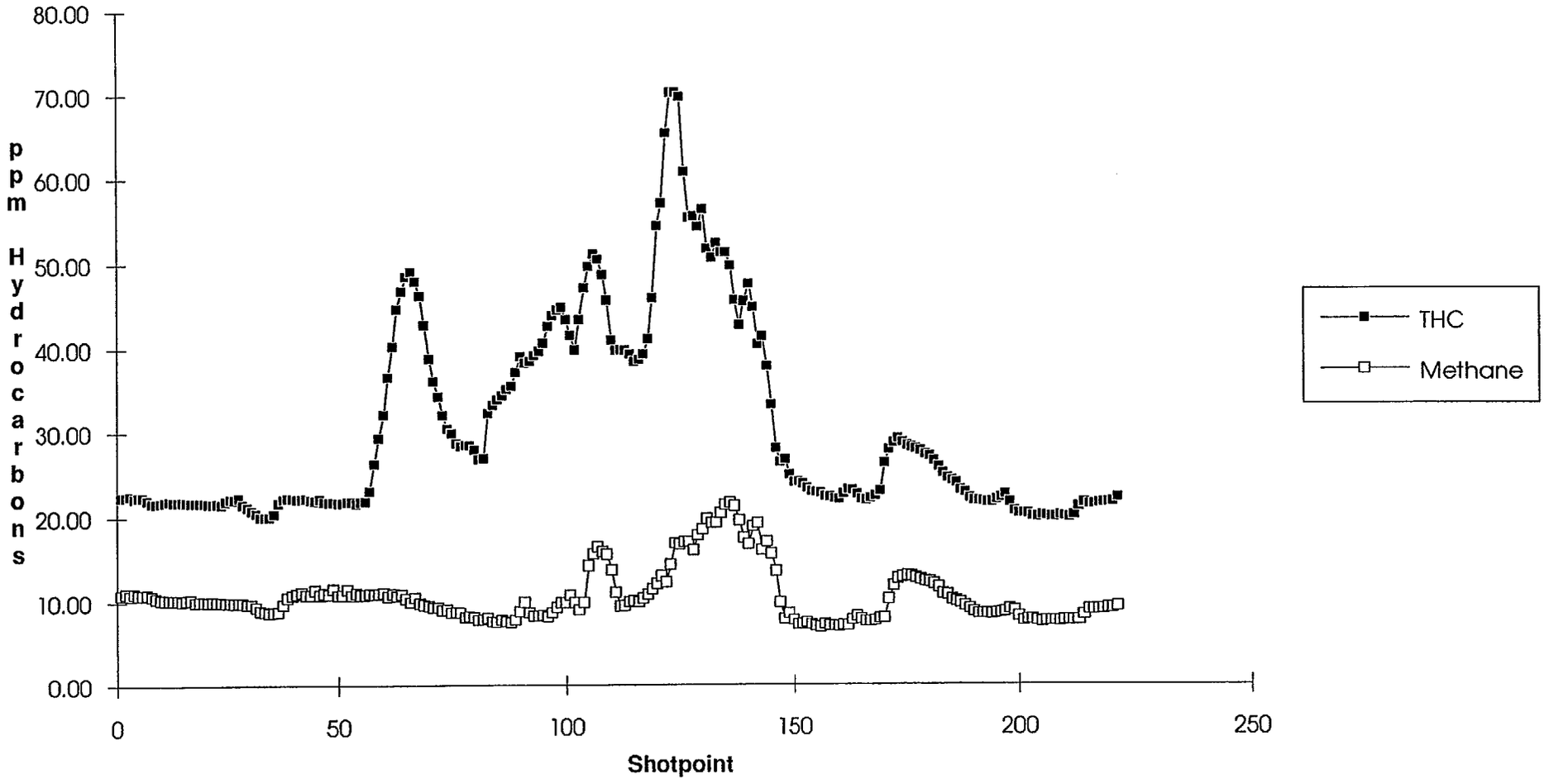
	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	30.576	10.576	0.038	0.244	0.023	0.060	0.003	0.000	0.000	0.118	0.022	0.030	0.626
Std. Dev.	11.801	3.157	0.005	0.120	0.007	0.022	0.006	0.000	0.001	0.063	0.005	0.011	0.147
Minimum	19.880	6.854	0.027	0.106	0.012	0.023	0.000	0.000	0.000	0.044	0.009	0.000	0.366
Maximum	70.274	21.638	0.053	0.647	0.043	0.162	0.033	0.000	0.006	0.262	0.037	0.054	1.085

	Cond.	Temp.	F. Depth	W.Depth	Altitude	Calc. Alt.
Mean	58.182	25.316	69.229	102.398	16.989	33.154
Std. Dev.	1.283	0.874	32.017	67.714	7.698	47.884
Minimum	55.770	23.630	21.000	29.500	9.470	3.130
Maximum	61.230	27.320	134.930	269.200	30.860	174.180

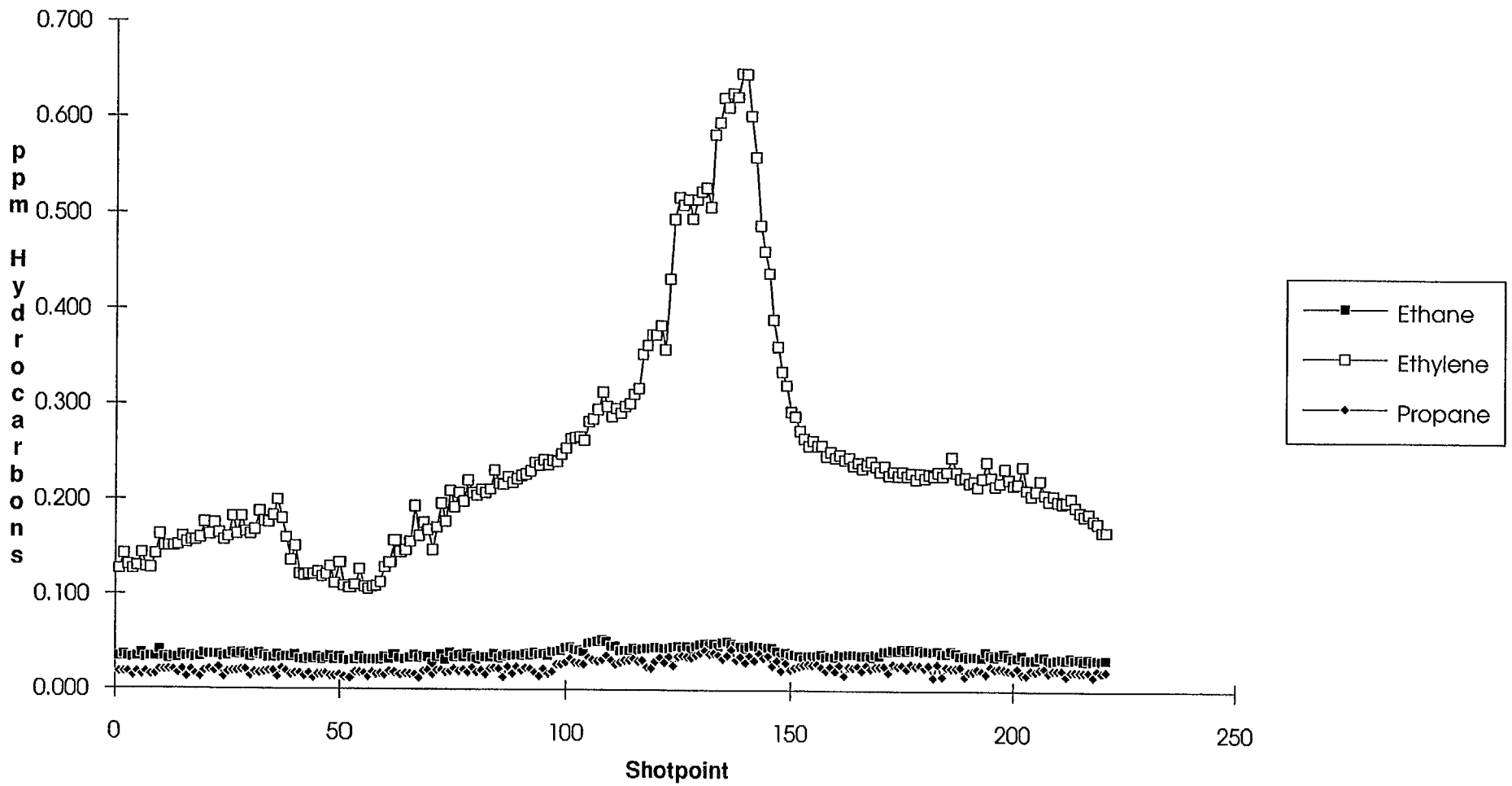
Notes

A weak THC and two weak THC and methane anomalies occur at SP 60, SP 110 and SP 125 respectivley.
A weak THC and methane anomaly occurs at SP 180.

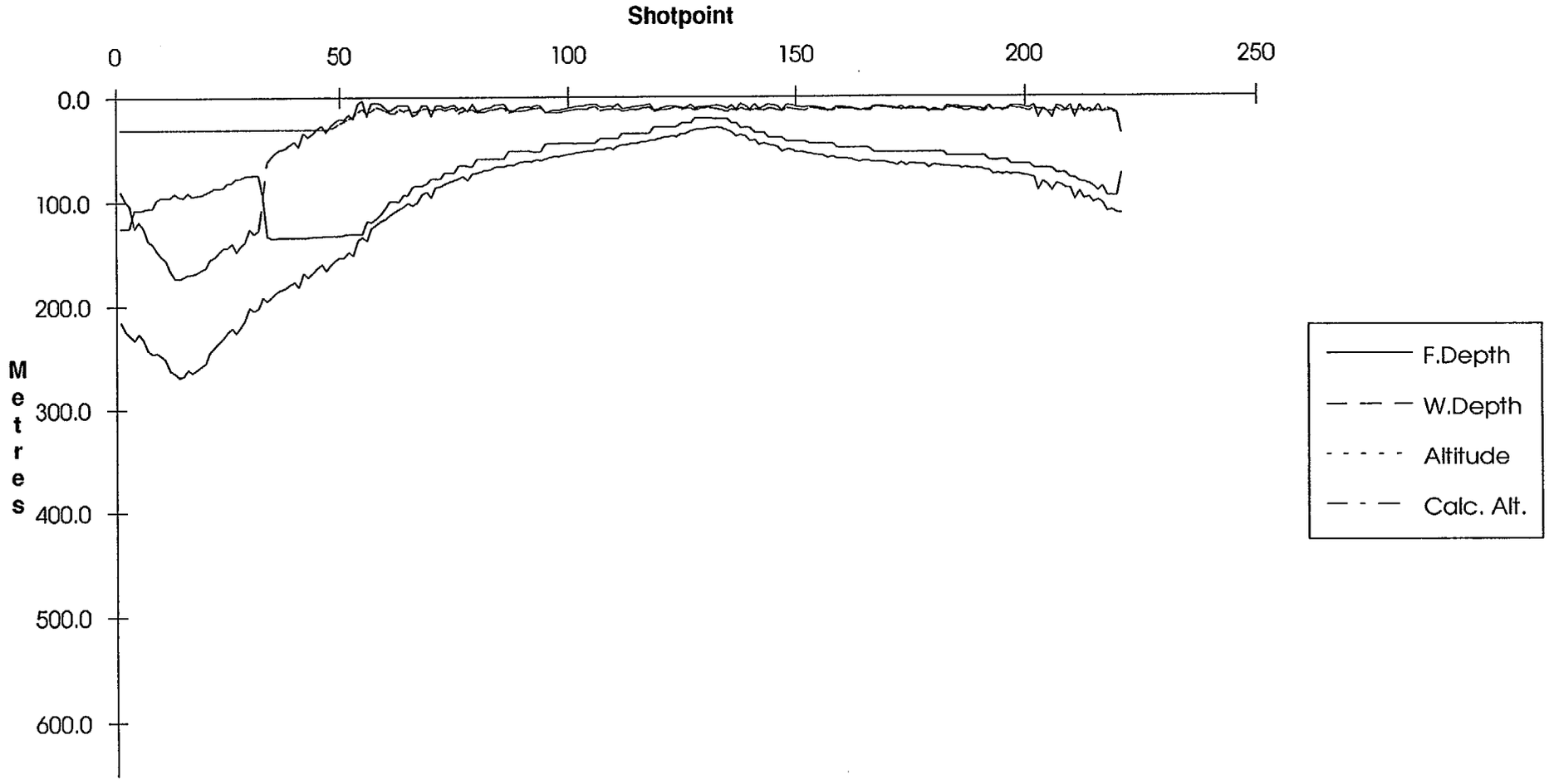
Line 109028 THC, Methane



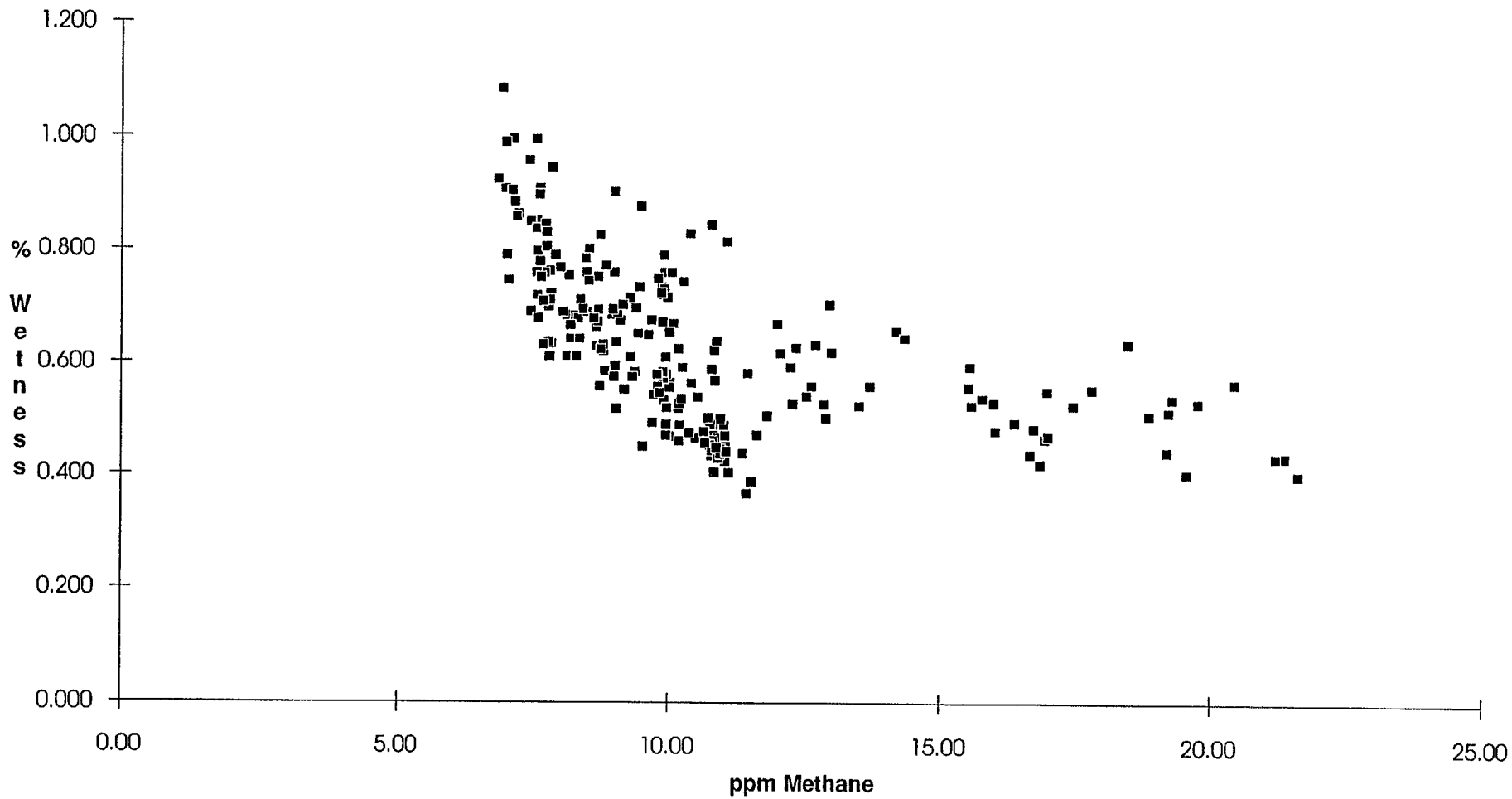
Line 109028 Ethane, Ethylene, Propane



Line 109028 Depths, Altitudes



Line 109028 Methane v. %Wetness



Line Summary

Line Number	109029
No. of Shotpoints	91

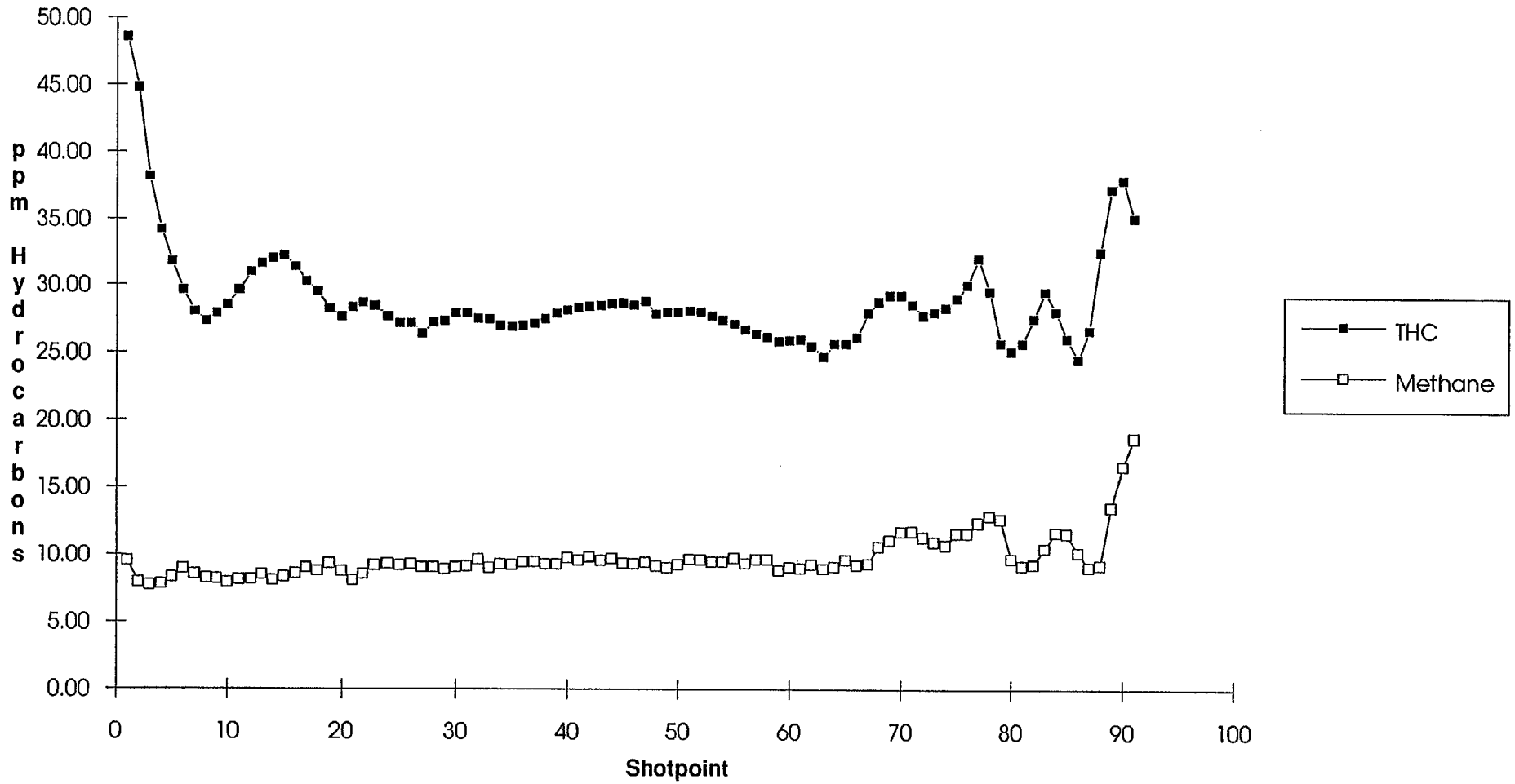
	Shotpoint	Date	Time	Latitude		Longitude	
Start	1	14-Apr-92	21:44:24	13	34.219	121	53.233
End	91	15-Apr-92	00:49:37	13	43.805	122	04.629

	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	28.904	9.729	0.038	0.216	0.022	0.056	0.005	0.000	0.001	0.100	0.039	0.027	0.674
Std. Dev.	3.741	1.678	0.005	0.045	0.005	0.012	0.013	0.000	0.002	0.035	0.010	0.006	0.206
Minimum	24.538	7.727	0.028	0.160	0.009	0.021	0.000	0.000	0.000	0.059	0.017	0.017	0.466
Maximum	48.578	18.696	0.059	0.378	0.040	0.092	0.104	0.000	0.008	0.222	0.064	0.053	1.859

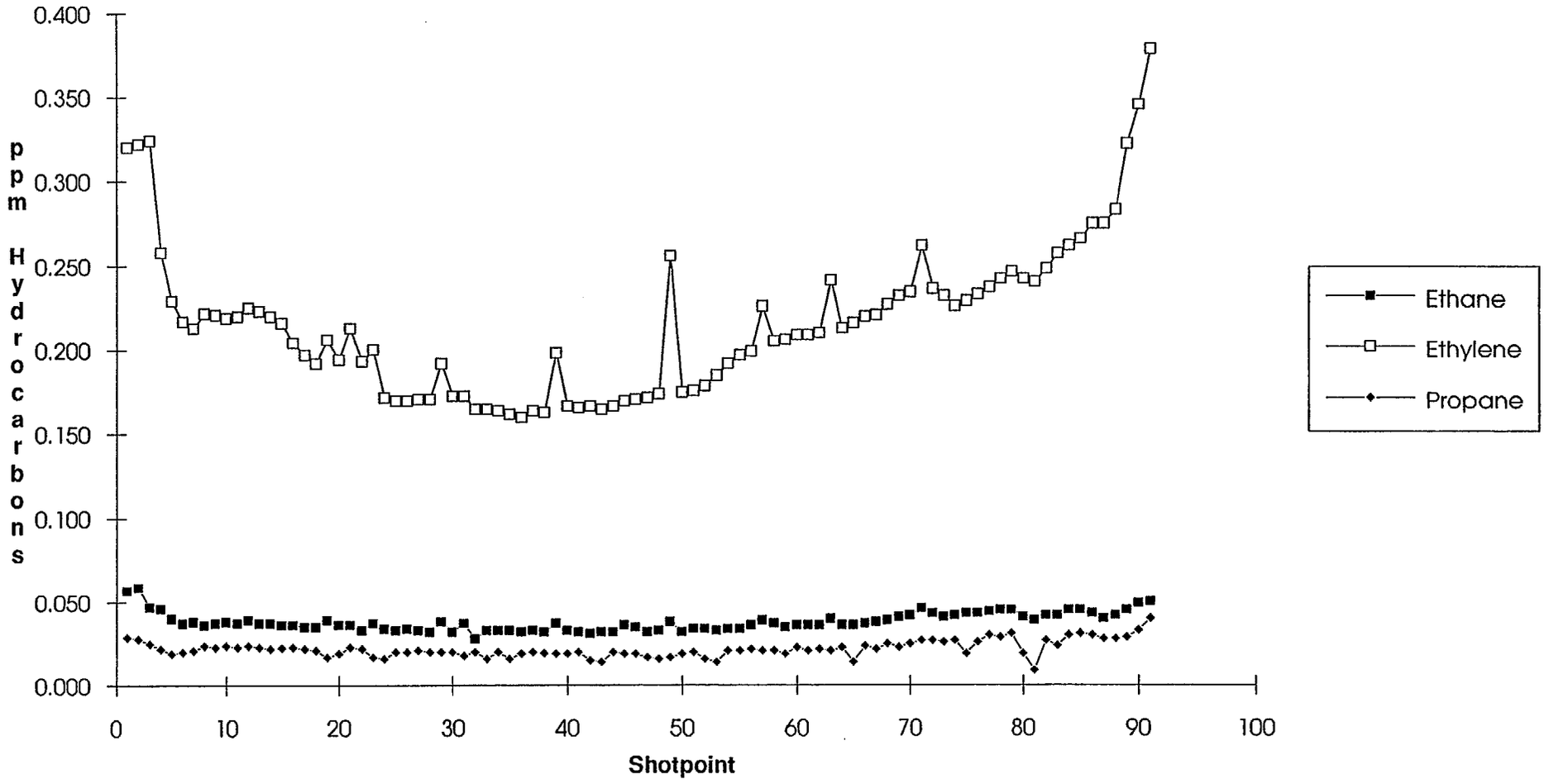
	Cond.	Temp.	F. Depth	W.Depth	Altitude	Calc. Alt.
Mean	58.286	25.362	57.886	71.105	13.235	13.232
Std. Dev.	0.702	0.468	18.383	18.207	2.467	3.365
Minimum	57.470	24.820	19.450	31.000	10.180	5.190
Maximum	60.600	26.890	84.640	98.500	23.710	25.920

Notes Five weak THC and methane anomalies occur at SP 1, SP 70, SP 77, SP 84, and SP 89.

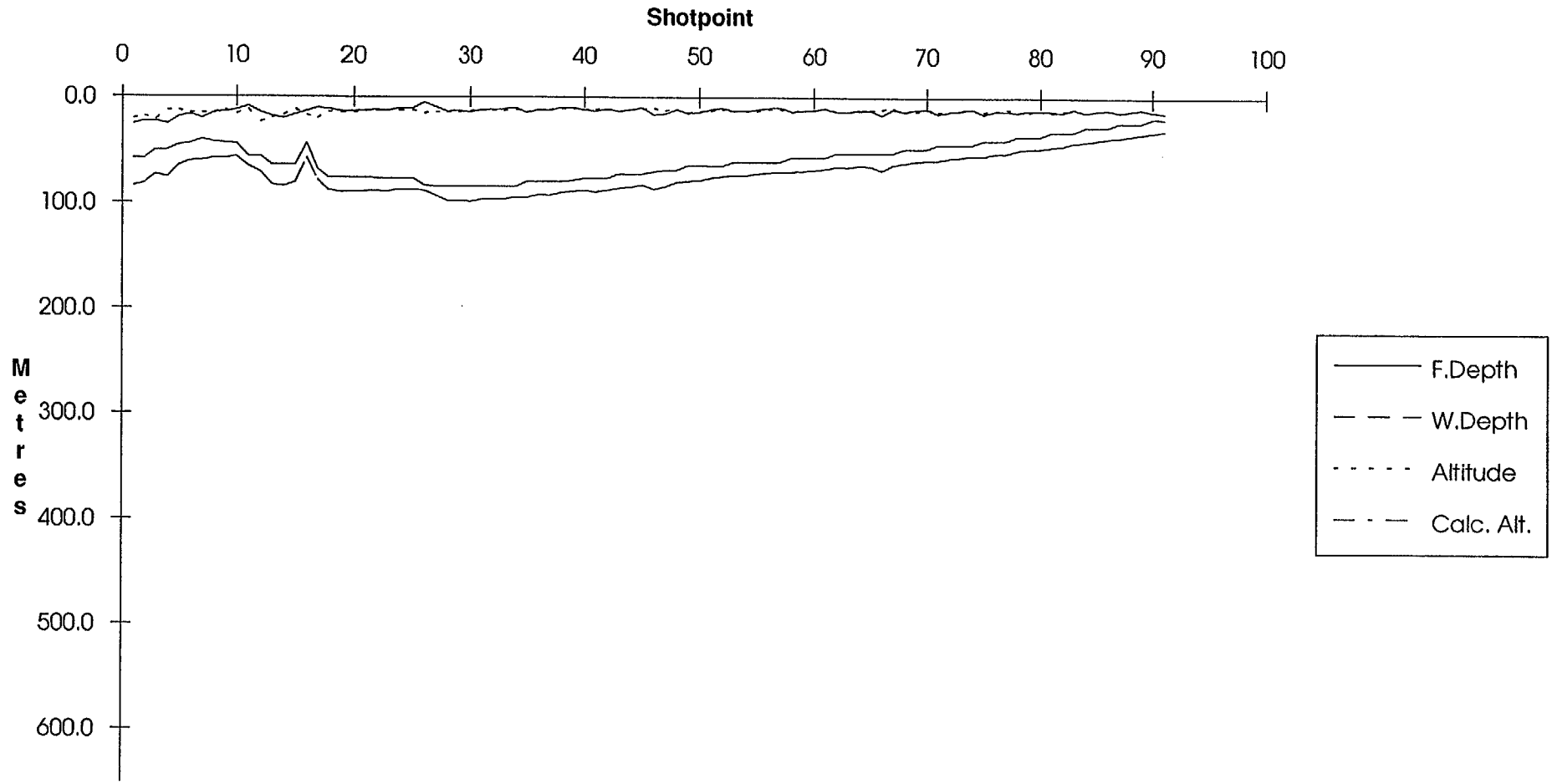
Line 109029 THC, Methane



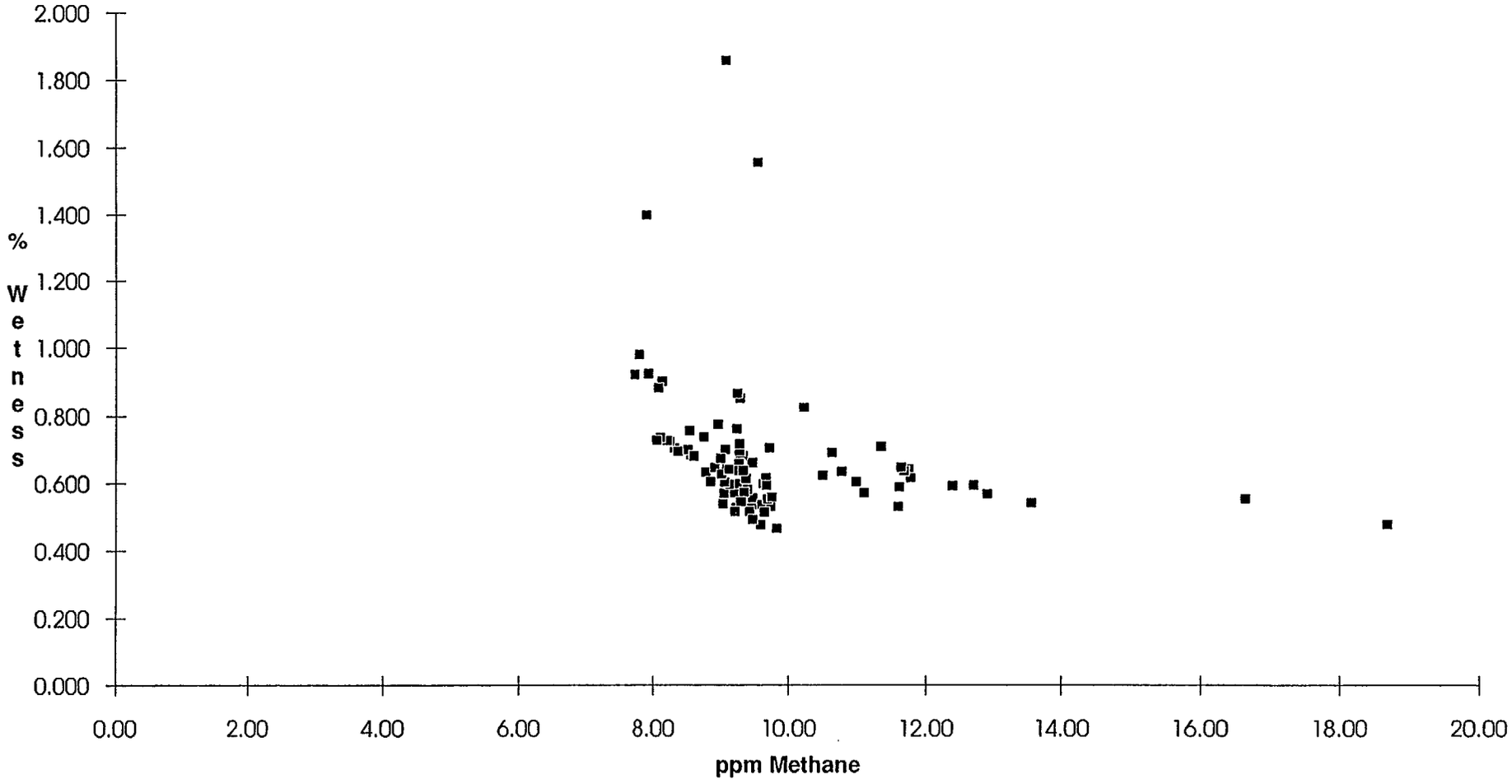
Line 109029 Ethane, Ethylene, Propane



Line 109029 Depths, Altitudes



Line 109029 Methane v. %Wetness



Line Summary

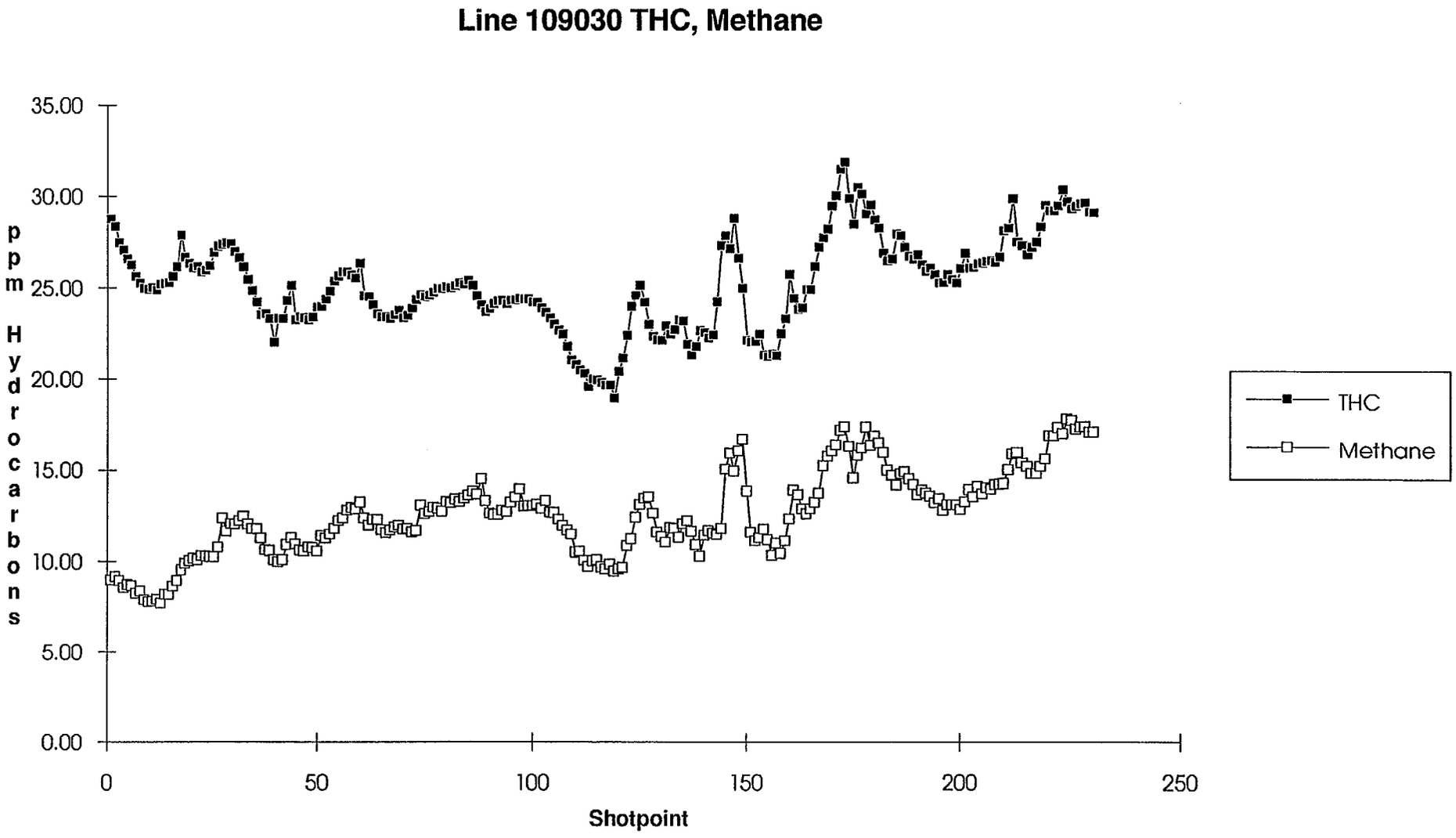
Line Number	109030
No. of Shotpoints	230

	Shotpoint	Date	Time	Latitude		Longitude	
Start	1	17-Apr-92	02:00:09	13	31.438	122	12.974
End	231	17-Apr-92	09:51:55	13	04.310	122	38.991

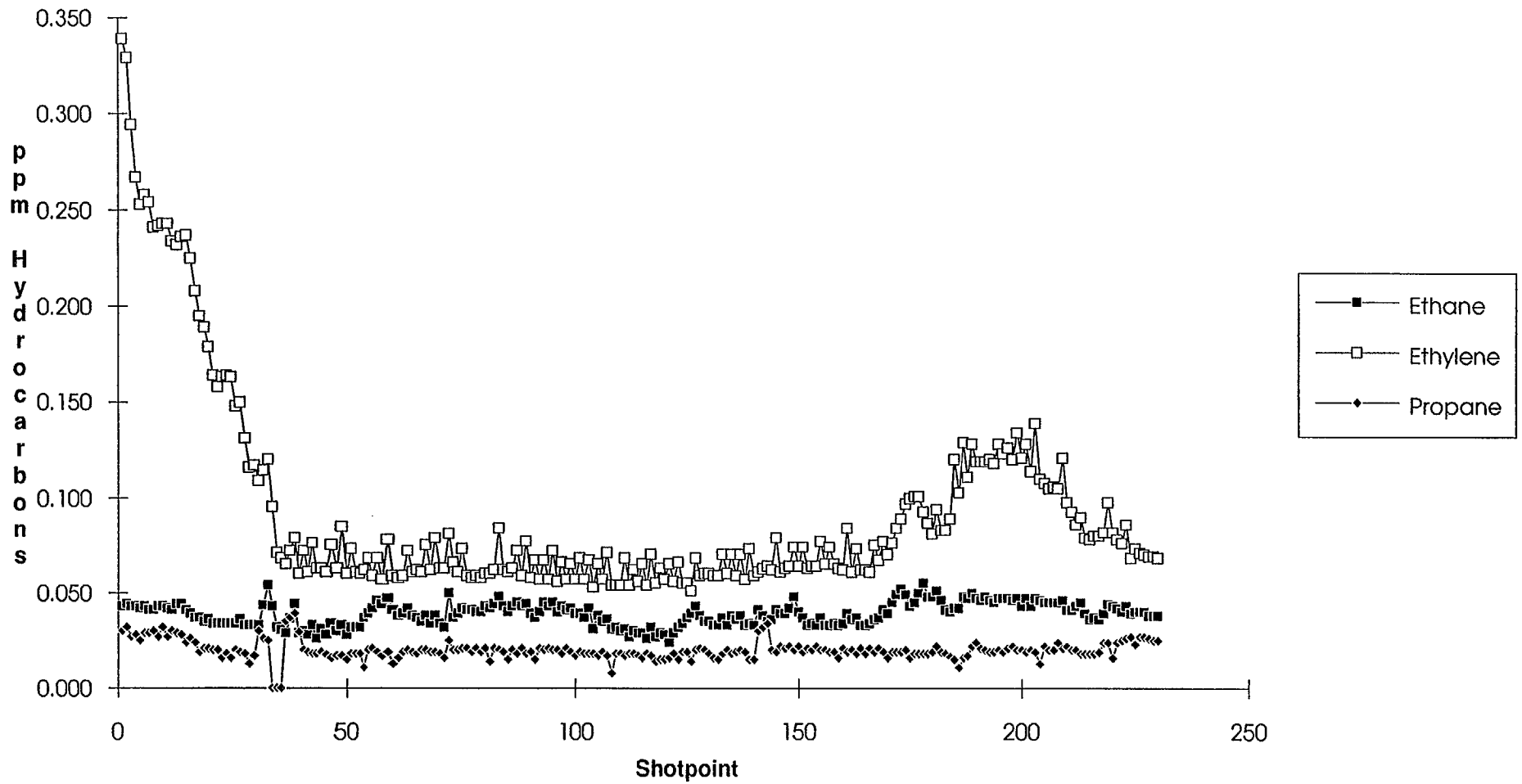
	THC	Methane	Ethane	Ethylene	Propane	Propylene	I-Butane	n-Butane	I-Pentane	n-Pentane	I-Hexane	n-Hexane	%Wetness
Mean	25.153	12.585	0.039	0.093	0.020	0.034	0.000	0.000	0.007	0.081	0.070	0.031	0.486
Std. Dev.	2.518	2.321	0.006	0.054	0.005	0.015	0.003	0.002	0.006	0.022	0.034	0.014	0.128
Minimum	18.950	7.689	0.024	0.051	0.000	0.000	0.000	0.000	0.000	0.055	0.022	0.000	0.259
Maximum	31.844	17.844	0.055	0.339	0.039	0.072	0.031	0.024	0.026	0.214	0.167	0.074	1.080

	Cond.	Temp.	F. Depth	W.Depth	Altitude	Calc. Alt.
Mean	57.171	24.551	137.266	606.400	30.025	469.201
Std. Dev.	1.200	0.842	21.105	358.808	2.834	349.606
Minimum	55.610	23.490	47.940	93.600	14.710	2.610
Maximum	61.070	27.240	149.190	2007.700	30.890	1862.310

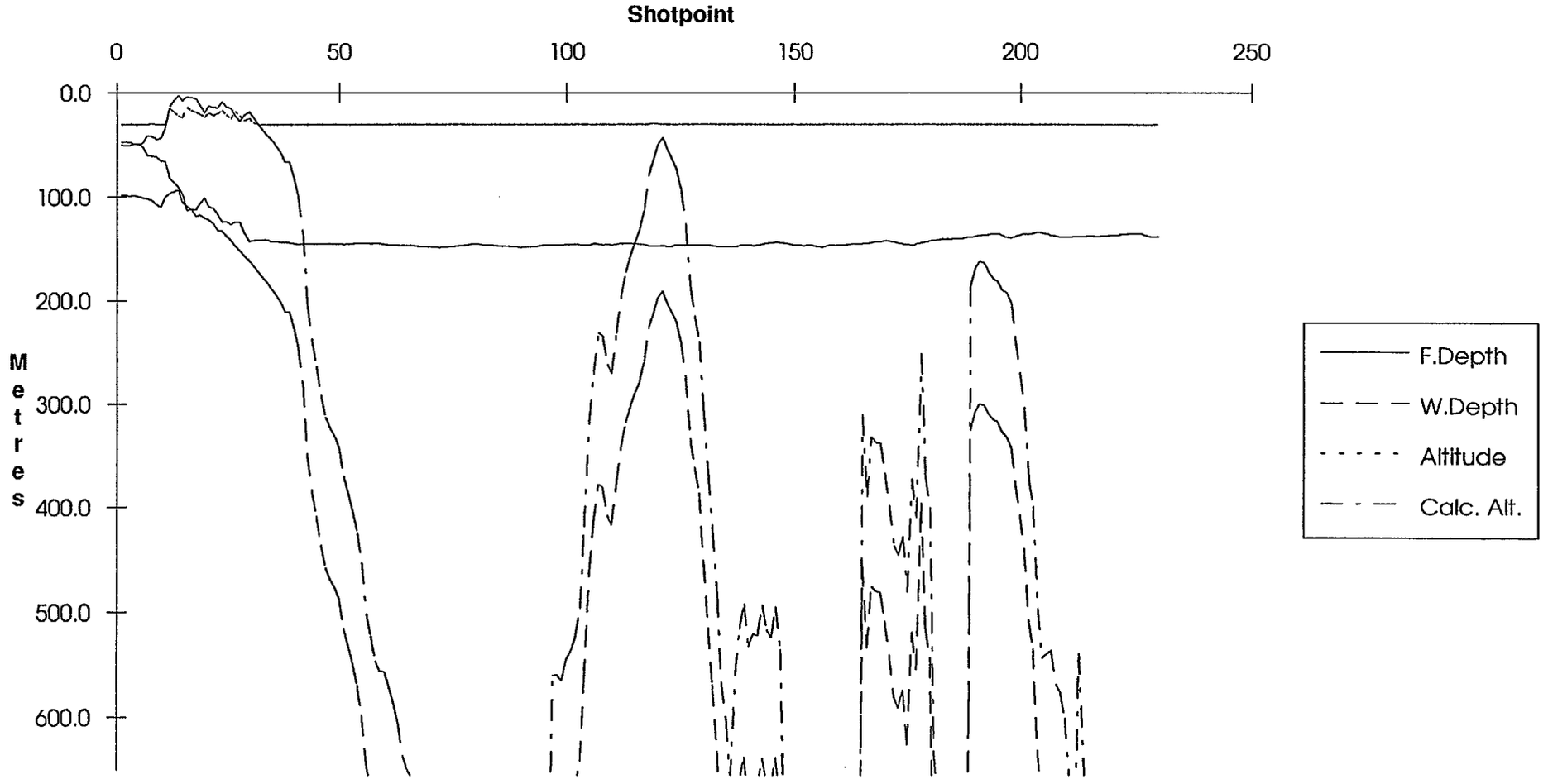
Notes Three weak THC, methane and ethane anomalies occur at SP 125, SP 146 and SP 170.


Line 109030 THC, Methane
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00
ppm Hydrocarbons
0
50
100
150
200
250
Shotpoint
THC
Methane

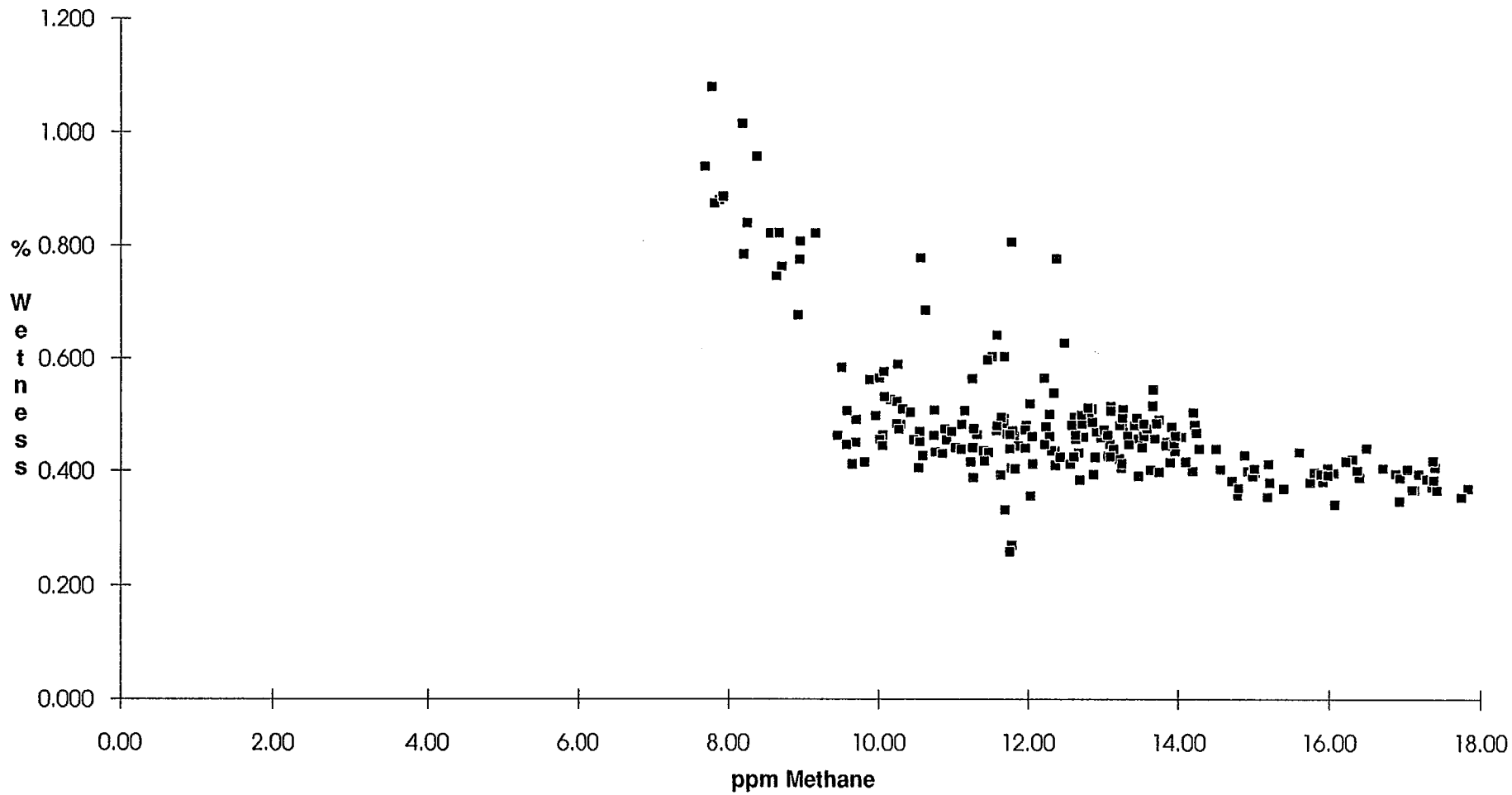
Line 109030 Ethane, Ethylene, Propane



Line 109030 Depths, Altitudes



Line 109030 Methane v. %Wetness



Line Summary

Line Number	109063
No. of Shotpoints	144

	Shotpoint	Date	Time	Latitude		Longitude	
Start	4	29-Apr-92	21:38:30	13	05.820	122	26.680
End	147	30-Apr-92	02:30:34	13	19.864	122	26.700

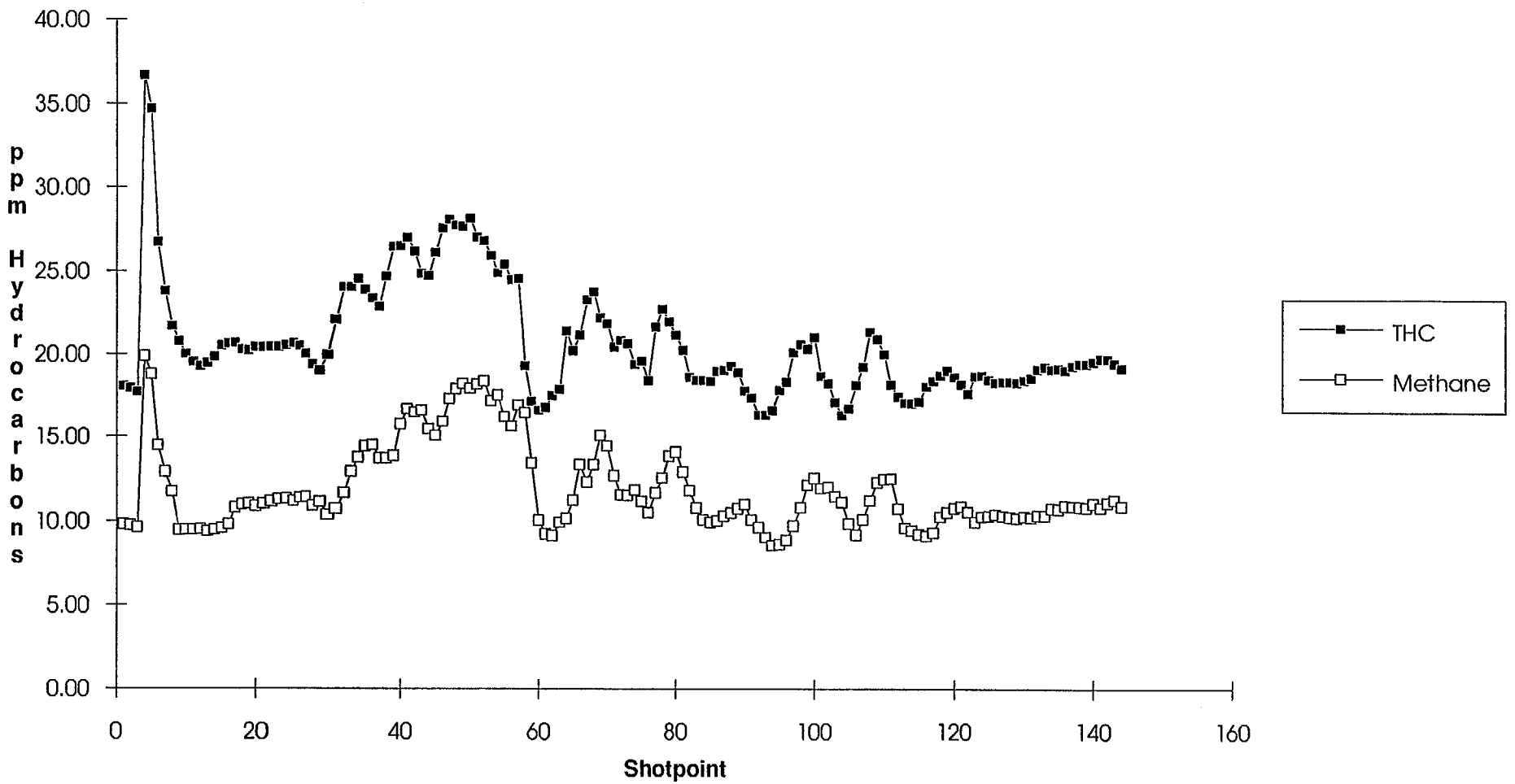
	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	20.766	11.920	0.035	0.095	0.019	0.028	0.002	0.000	0.000	0.061	20.766	0.021	0.471
Std. Dev.	3.437	2.559	0.006	0.041	0.005	0.012	0.004	0.002	0.000	0.016	3.437	0.012	0.079
Minimum	16.331	8.574	0.024	0.027	0.010	0.000	0.000	0.000	0.000	0.033	16.331	0.000	0.228
Maximum	36.677	19.876	0.049	0.176	0.045	0.082	0.020	0.013	0.000	0.111	36.677	0.065	0.789

	Cond.	Temp.	F. Depth	W.Depth	Altitude	Calc. Alt.
Mean	57.436	24.680	119.832	610.114	24.945	491.137
Std. Dev.	1.400	0.960	23.319	544.005	8.196	543.458
Minimum	55.070	23.100	62.750	80.900	7.870	2.450
Maximum	59.540	26.110	195.670	1491.200	30.900	1393.100

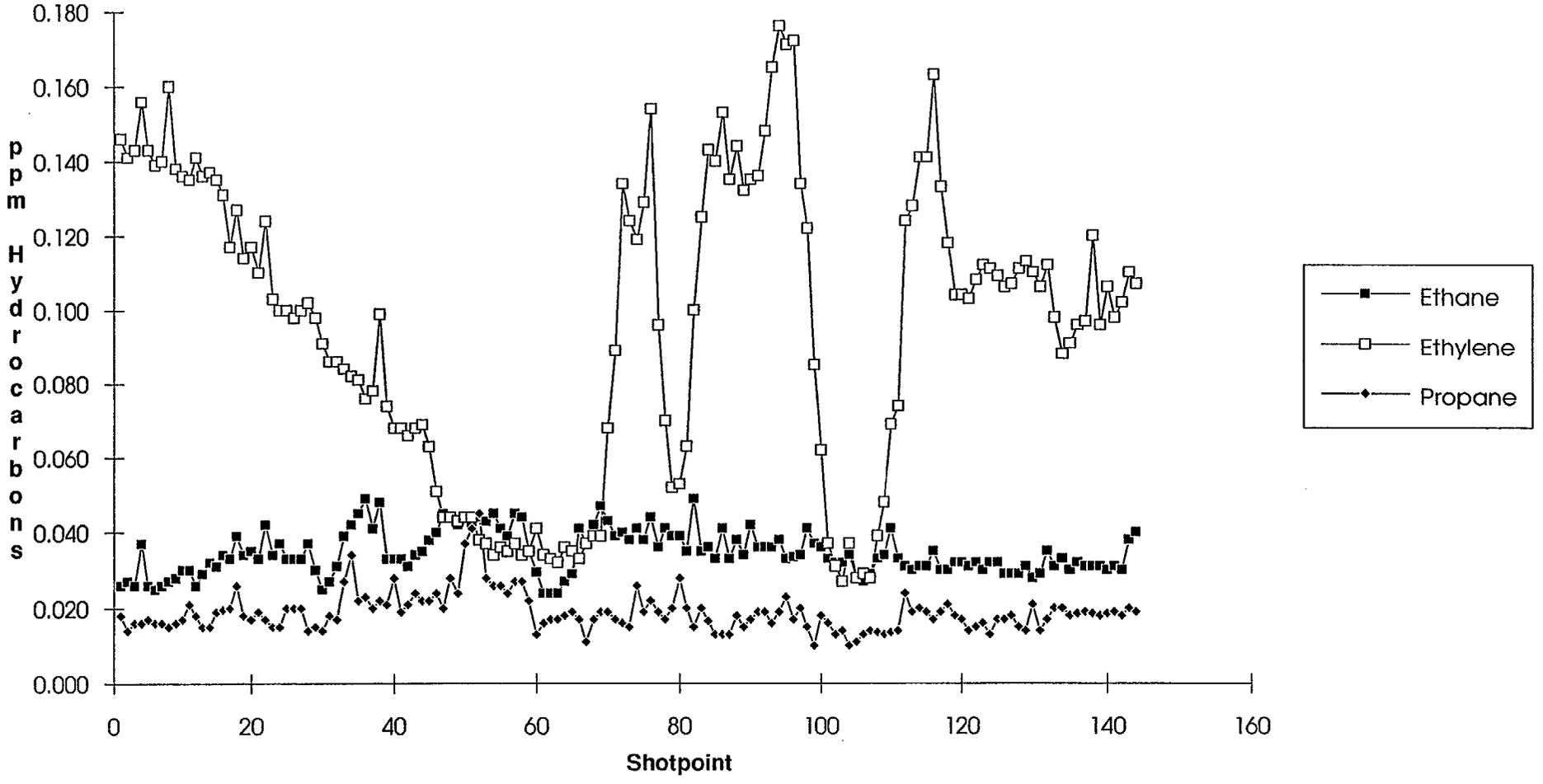
Notes

Four weak THC, methane, ethane and propane anomalies occur at SP 69, SP 80, SP 100 and SP 110.
A weak THC, methane and ethane anomaly occurs at SP 5.
A weak THC, methane, ethane, and propane anomaly occurs beween SP 35 and SP 57.

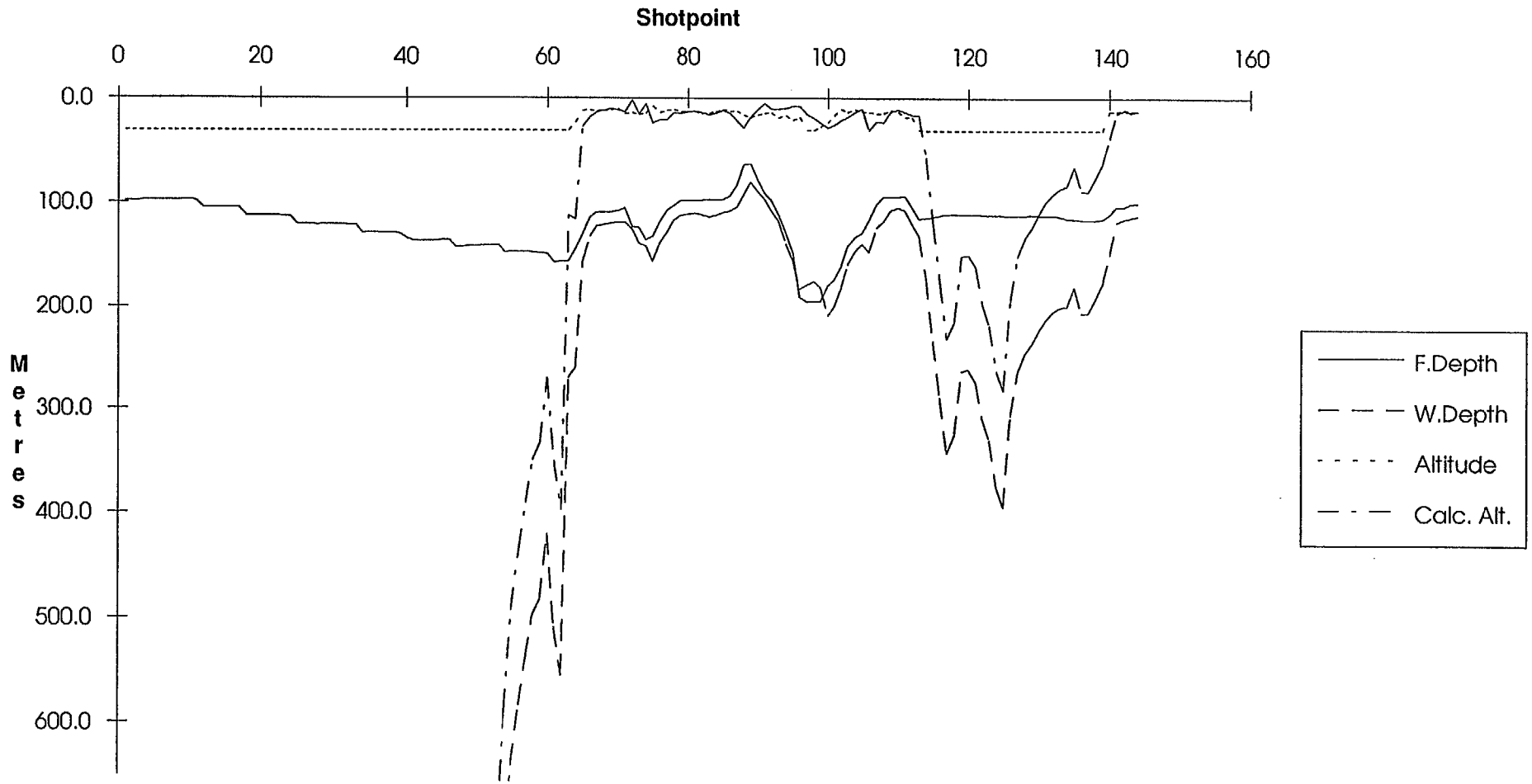
Line 109063 THC, Methane



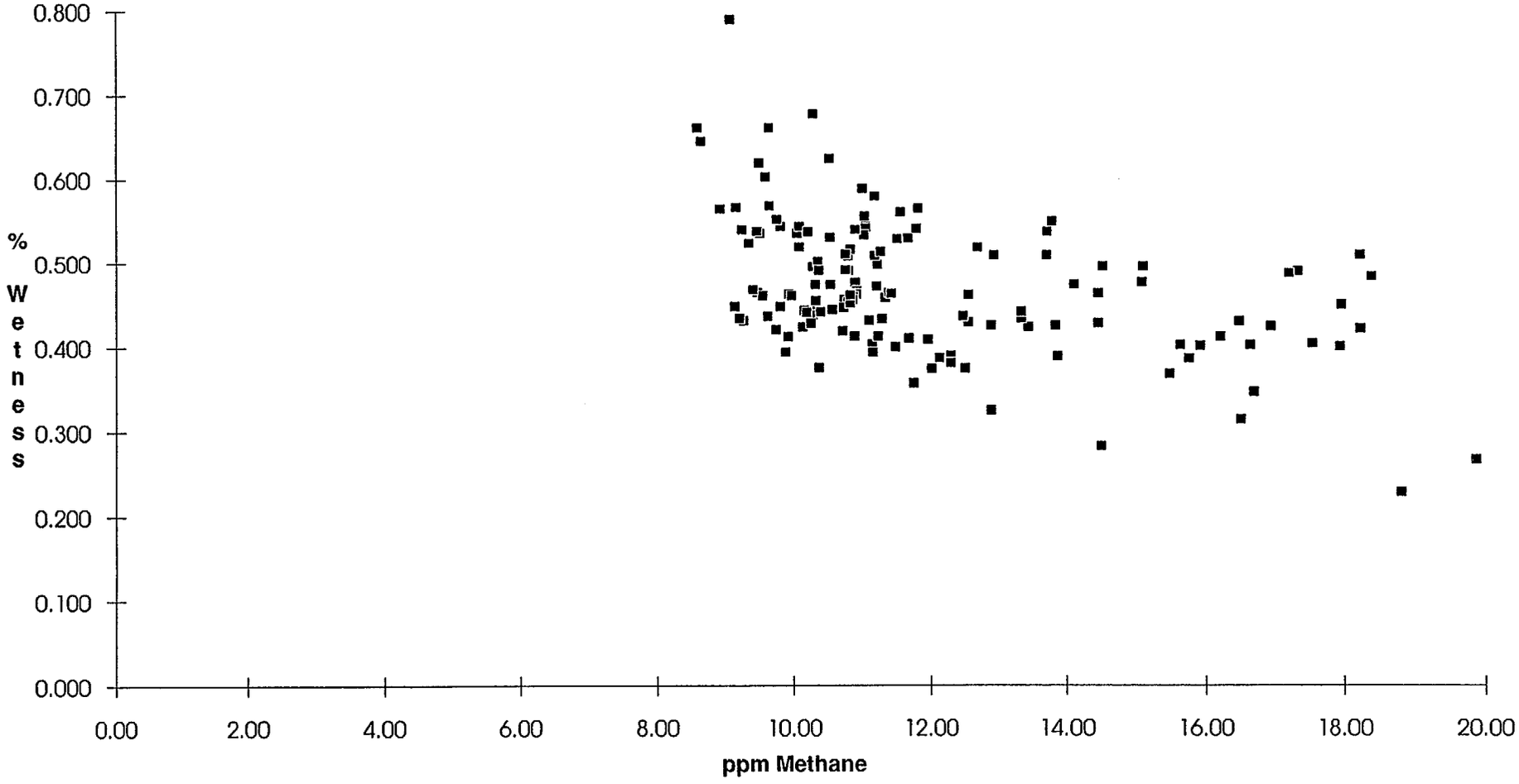
Line 109063 Ethane, Ethylene, Propane



Line 109063 Depths, Altitudes



Line 109063 Methane v. %Wetness



Line Summary

Line Number	109064
No. of Shotpoints	127

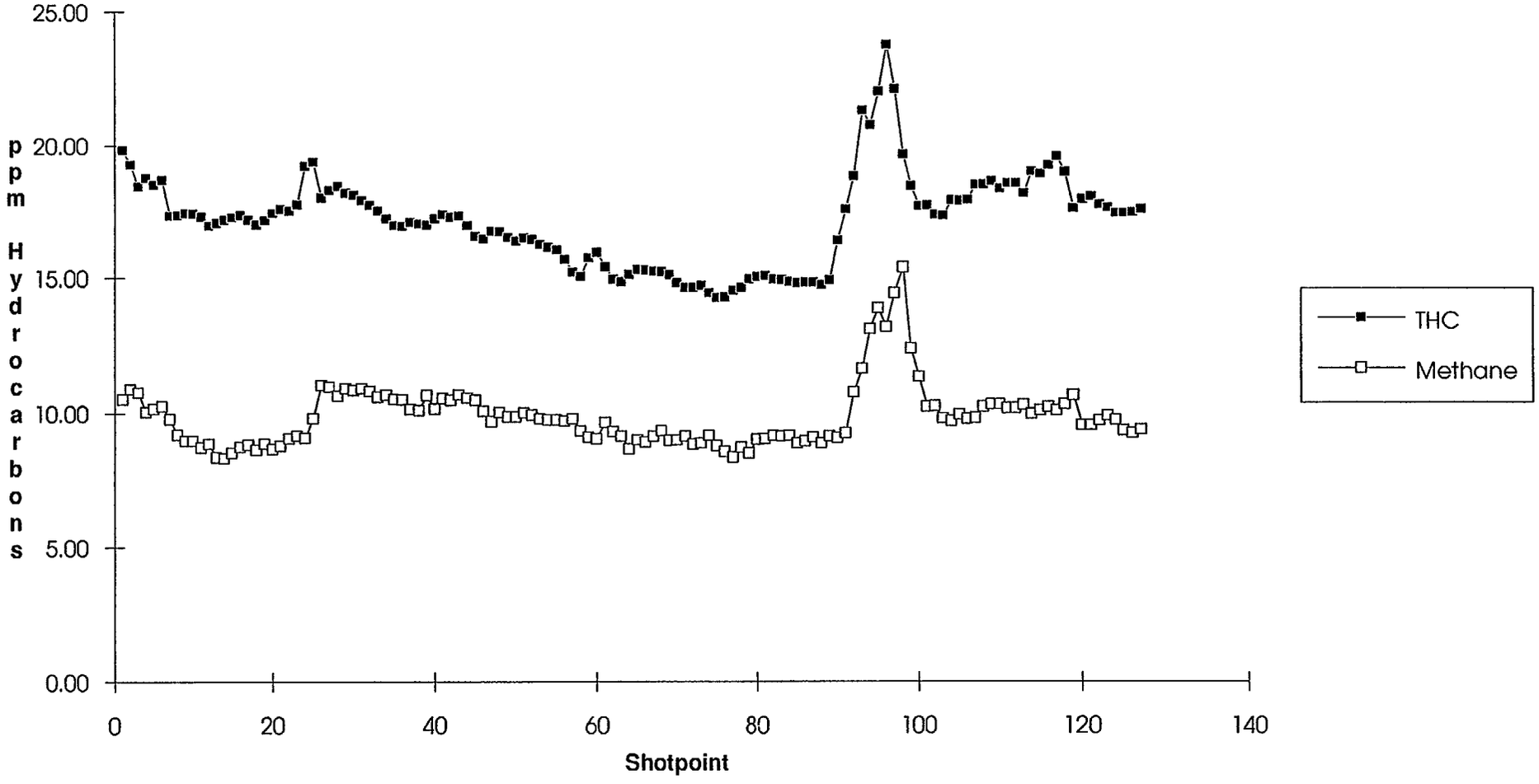
	Shotpoint	Date	Time	Latitude		Longitude	
Start	1	30-Apr-92	02:32:33	13	19.799	122	26.872
End	4	30-Apr-92	06:53:59	13	31.464	122	15.250

	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	17.141	9.864	0.032	0.096	0.017	0.023	0.002	0.004	0.000	0.071	0.003	0.035	0.552
Std. Dev.	1.738	1.153	0.005	0.083	0.006	0.015	0.006	0.011	0.000	0.027	0.006	0.010	0.190
Minimum	14.267	8.320	0.024	0.021	0.008	0.000	0.000	0.000	0.000	0.029	0.000	0.007	0.318
Maximum	23.757	15.383	0.057	0.318	0.036	0.081	0.033	0.060	0.000	0.158	0.028	0.067	1.381

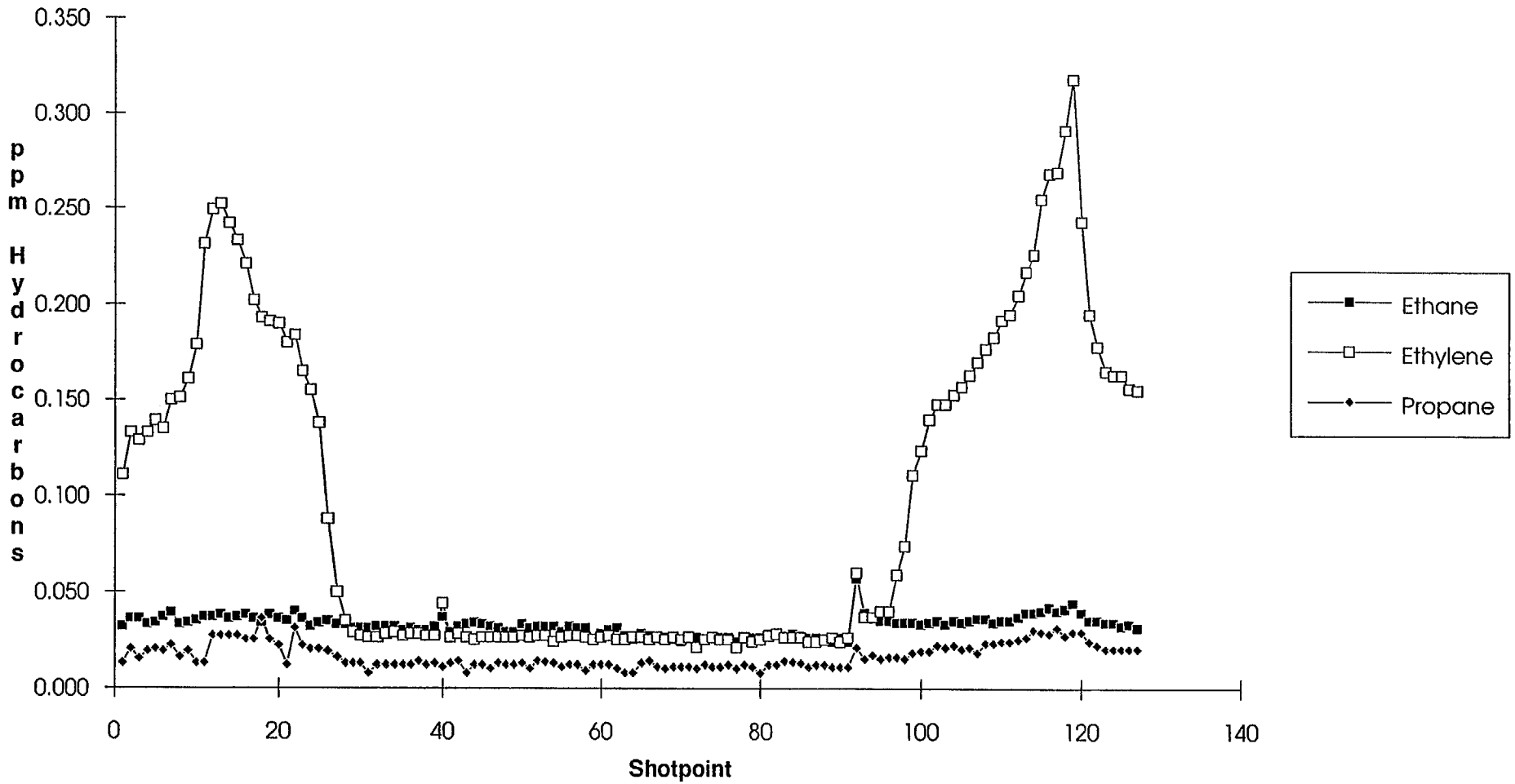
	Cond.	Temp.	F. Depth	W.Depth	Altitude	Calc. Alt.
Mean	57.667	24.886	136.993	223.863	23.111	87.293
Std. Dev.	2.409	1.674	63.881	158.380	8.417	112.561
Minimum	55.340	23.260	35.650	46.400	9.180	6.780
Maximum	61.280	27.400	199.200	829.700	30.840	634.530

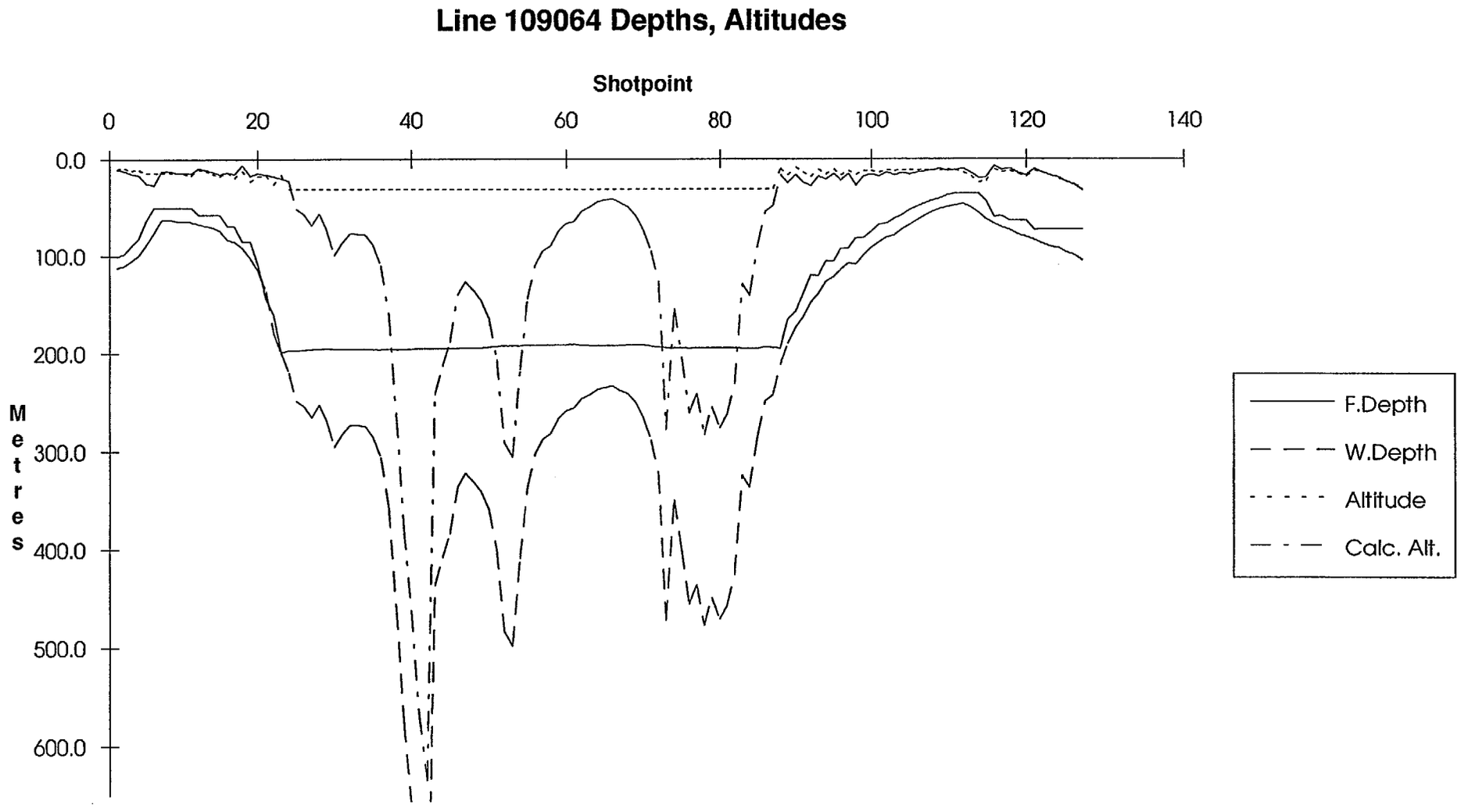
Notes A weak THC, methane, ethane and propane anomaly occurs at SP 95.

Line 109064 THC, Methane

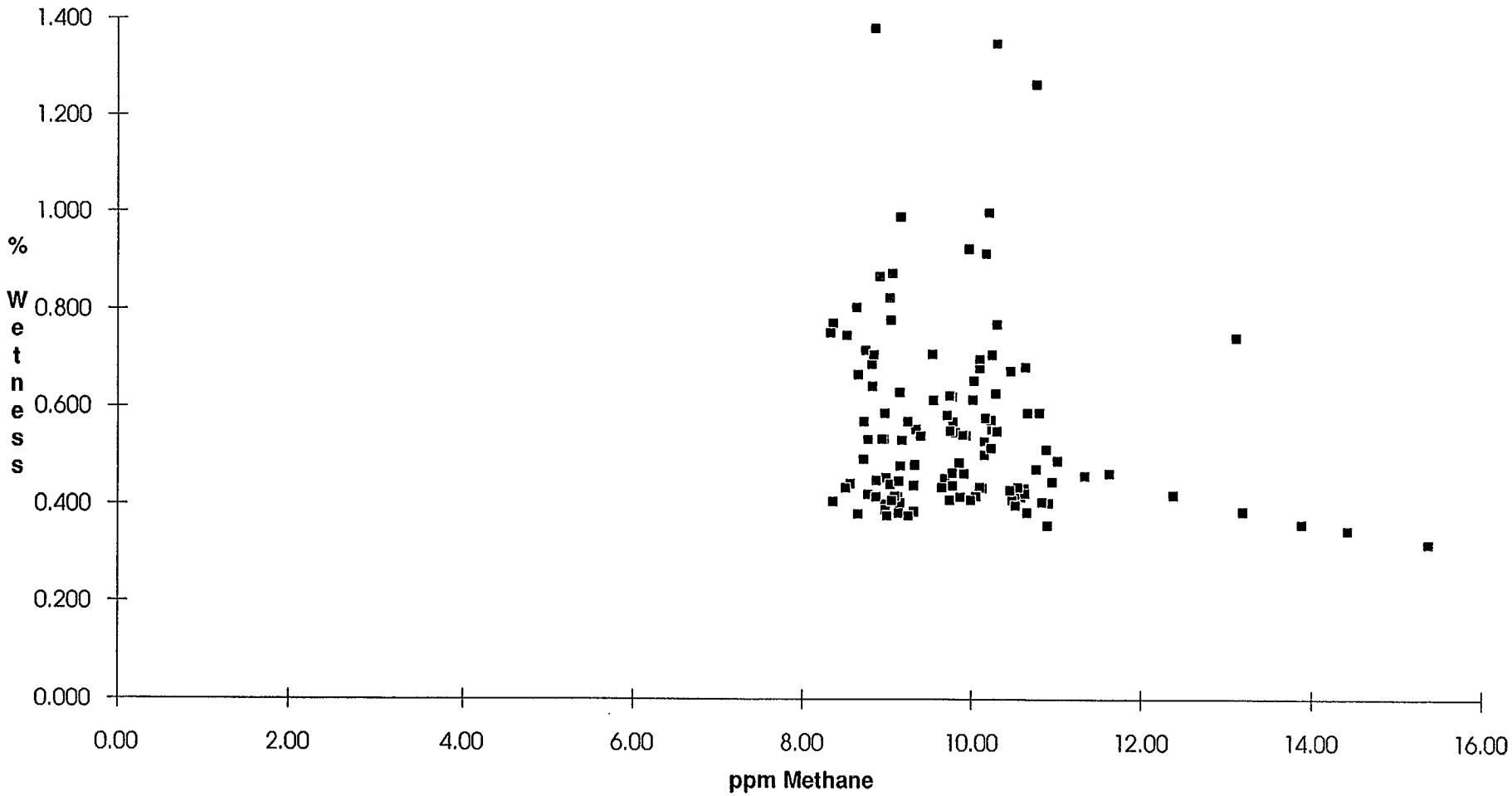


Line 109064 Ethane, Ethylene, Propane




Line 109064 Depths, Altitudes
Shotpoint
0
20
40
60
80
100
120
140
0.0
100.0
200.0
300.0
400.0
500.0
600.0
Metres
F.Depth
W.Depth
Altitude
Calc. Alt.

Line 109064 Methane v. %Wetness



Line Summary

Line Number	109065
No. of Shotpoints	89

	Shotpoint	Date	Time	Latitude		Longitude	
Start	5	30-Apr-92	06:55:59	13	31.367	122	15.419
End	93	30-Apr-92	09:53:25	13	27.281	122	09.576

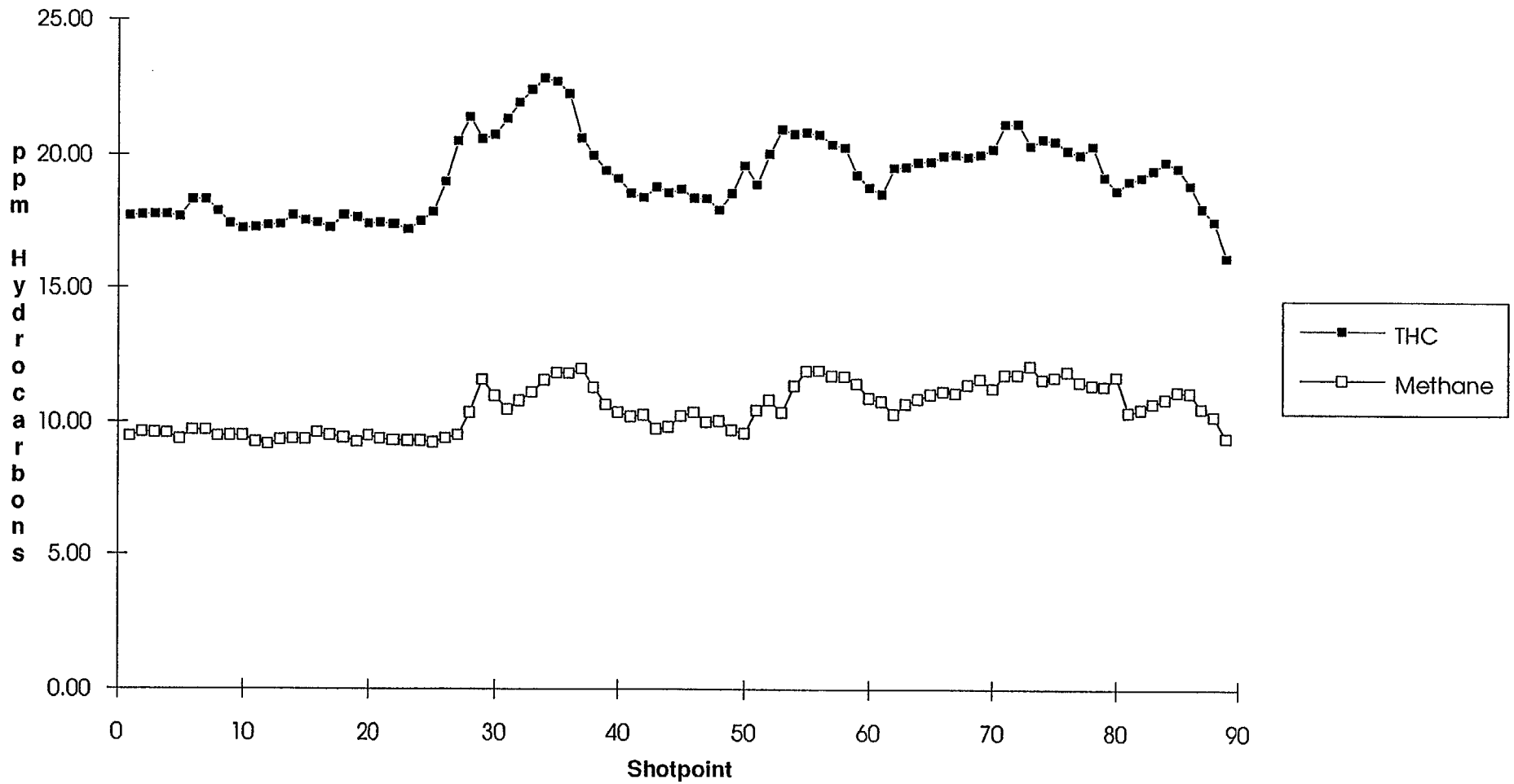
	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	19.219	10.495	0.034	0.218	0.021	0.042	0.000	0.001	0.000	0.098	0.004	0.034	0.534
Std. Dev.	1.473	0.907	0.004	0.225	0.004	0.023	0.001	0.005	0.000	0.049	0.007	0.015	0.107
Minimum	16.190	9.182	0.029	0.098	0.009	0.016	0.000	0.000	0.000	0.053	0.000	0.000	0.360
Maximum	22.855	12.108	0.043	1.014	0.032	0.186	0.008	0.032	0.000	0.261	0.031	0.078	0.996

	Cond.	Temp.	F. Depth	W.Depth	Altitude	Calc. Alt.
Mean	59.392	26.097	77.301	97.277	17.257	19.985
Std. Dev.	1.226	0.826	25.561	25.586	7.403	13.602
Minimum	57.740	24.990	11.810	33.600	9.380	5.050
Maximum	62.300	28.020	108.400	125.200	30.920	76.090

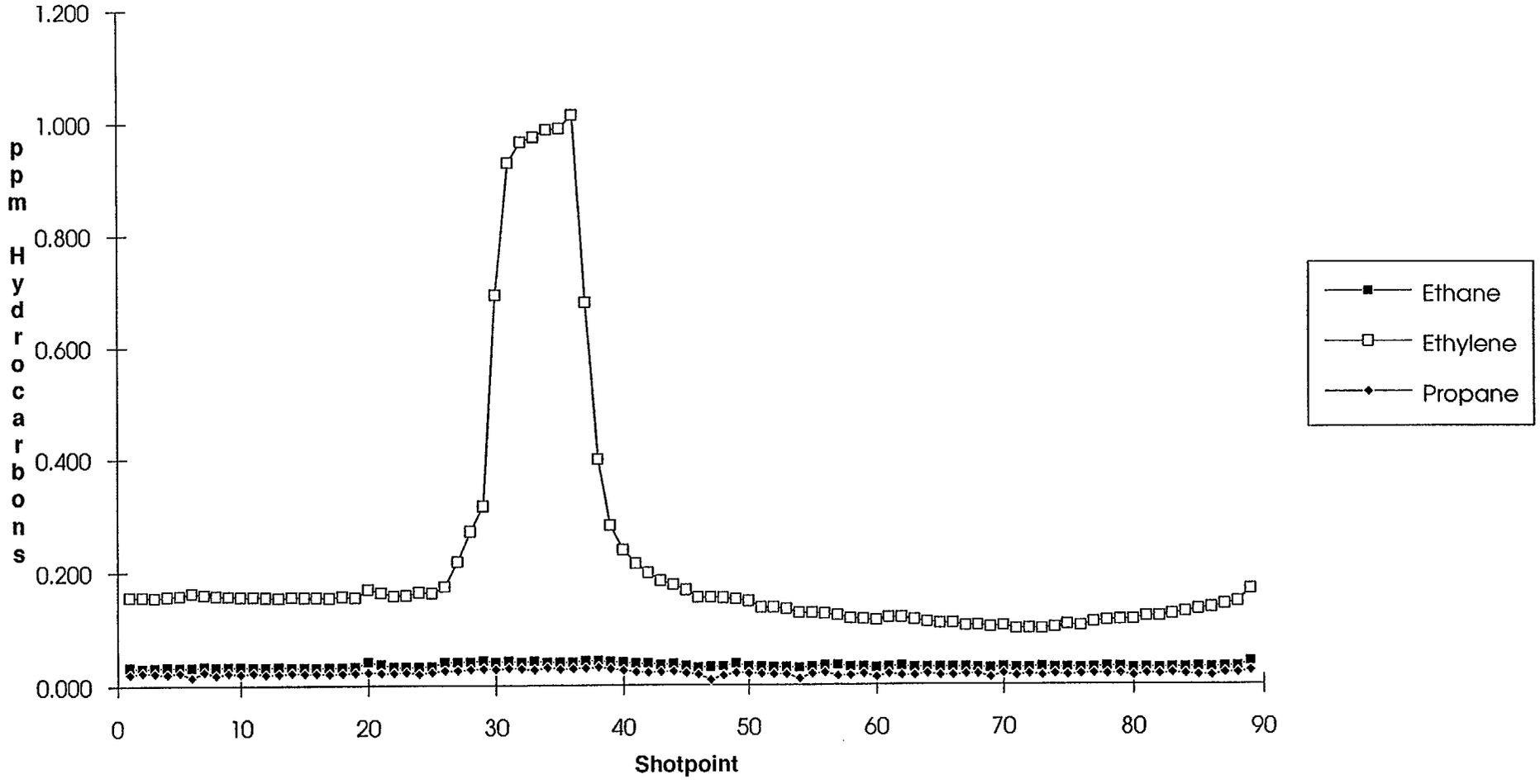
Notes

Two weak THC and methane anomalies occur at SP 56 and SP 71.
A weak THC and methane anomaly occurs at SP 35.

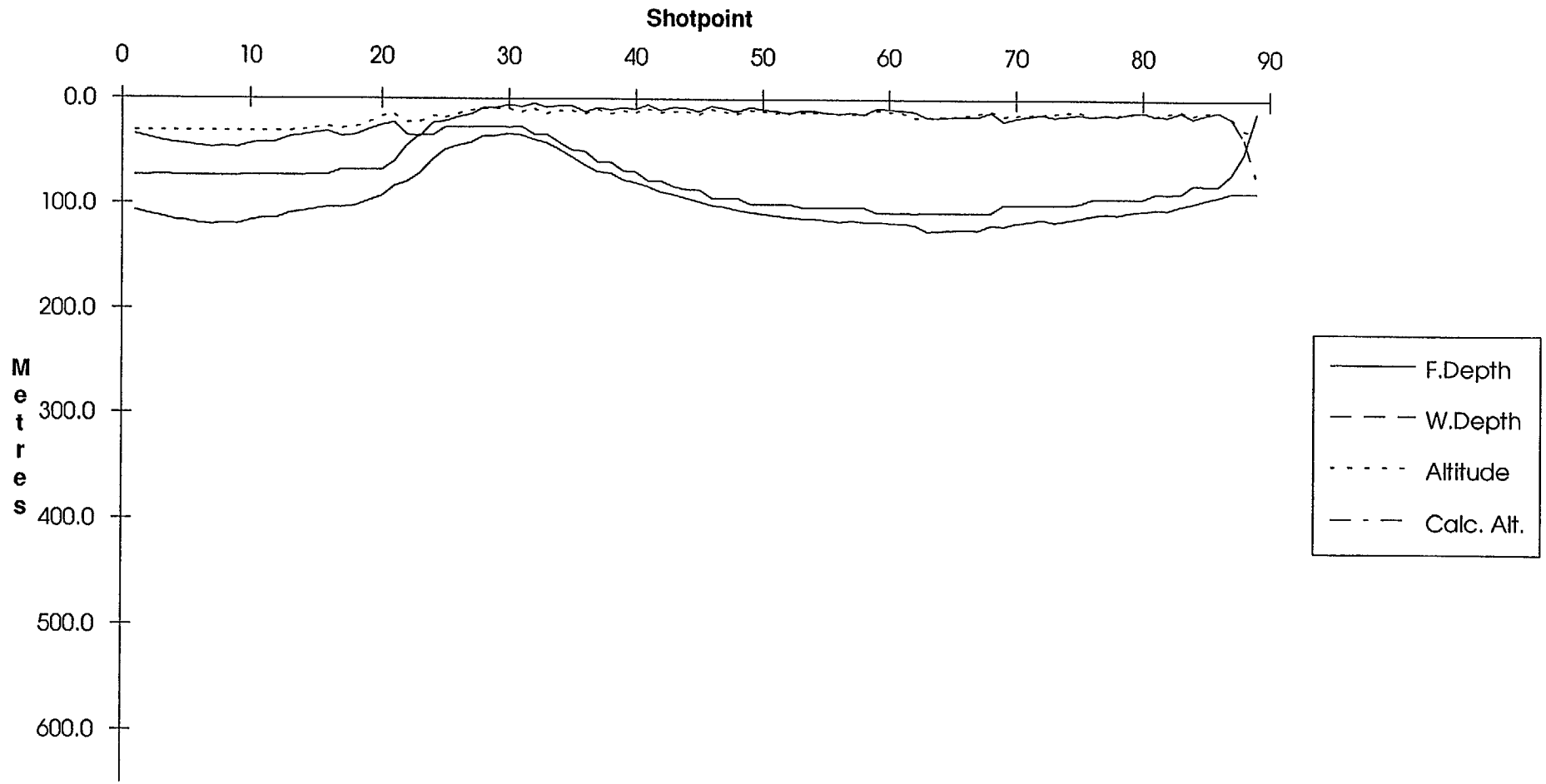
Line 109065 THC, Methane



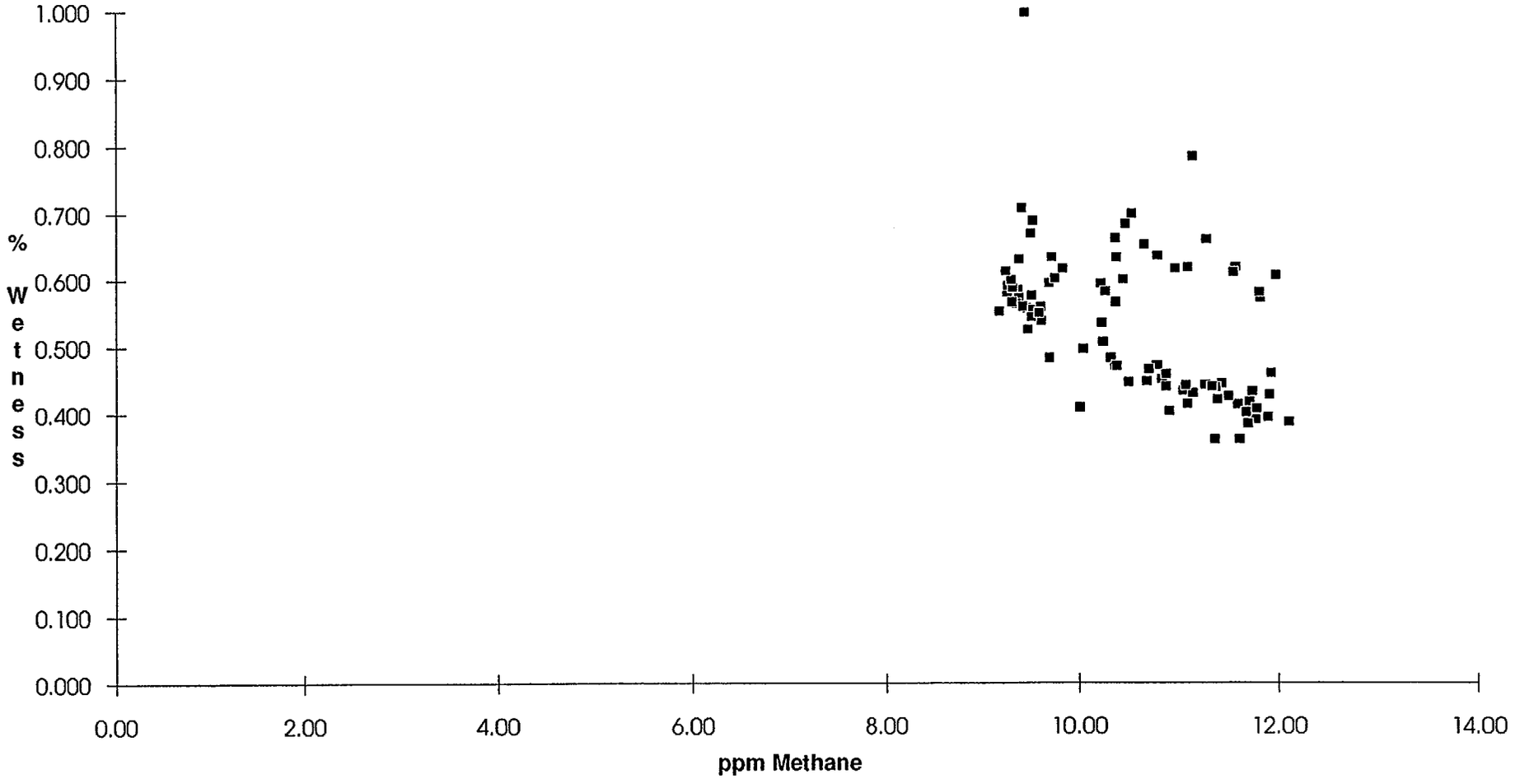
Line 109065 Ethane, Ethylene, Propane



Line 109065 Depths, Altitudes



Line 109065 Methane v. %Wetness



Line Summary

Line Number	109066
No. of Shotpoints	69

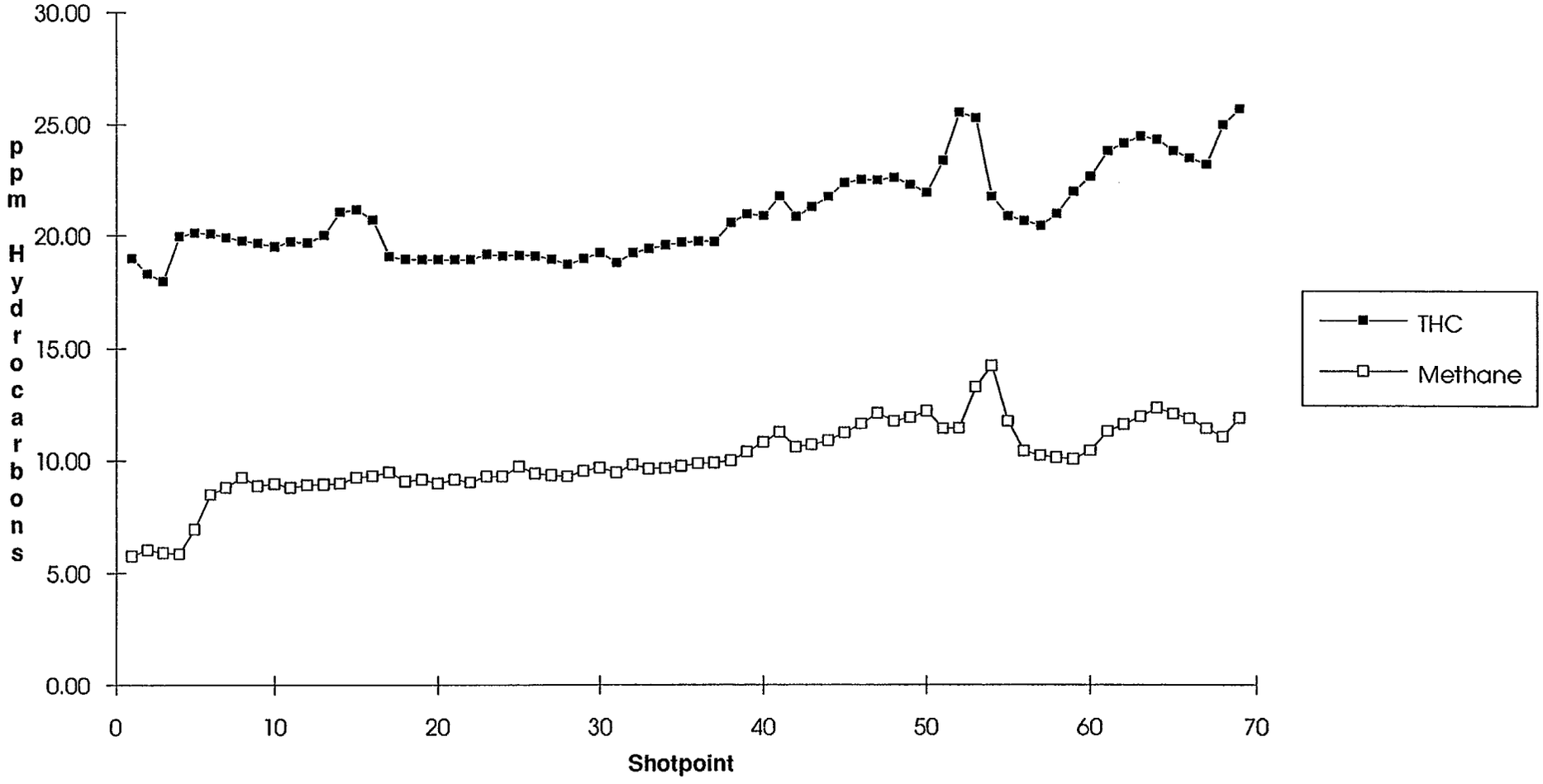
	Shotpoint	Date	Time	Latitude		Longitude	
Start	1	30-Apr-92	22:27:36	13	34.571	121	57.749
End	70	30-Apr-92	00:57:12	13	40.289	122	07.301

	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	20.896	10.030	0.045	0.353	0.027	0.066	0.003	0.000	0.004	0.132	0.020	0.021	0.779
Std. Dev.	1.970	1.656	0.007	0.257	0.006	0.065	0.005	0.001	0.004	0.073	0.007	0.014	0.262
Minimum	17.974	5.760	0.032	0.155	0.015	0.024	0.000	0.000	0.000	0.060	0.007	0.000	0.499
Maximum	25.661	14.213	0.059	1.146	0.045	0.348	0.020	0.010	0.011	0.285	0.040	0.050	1.941

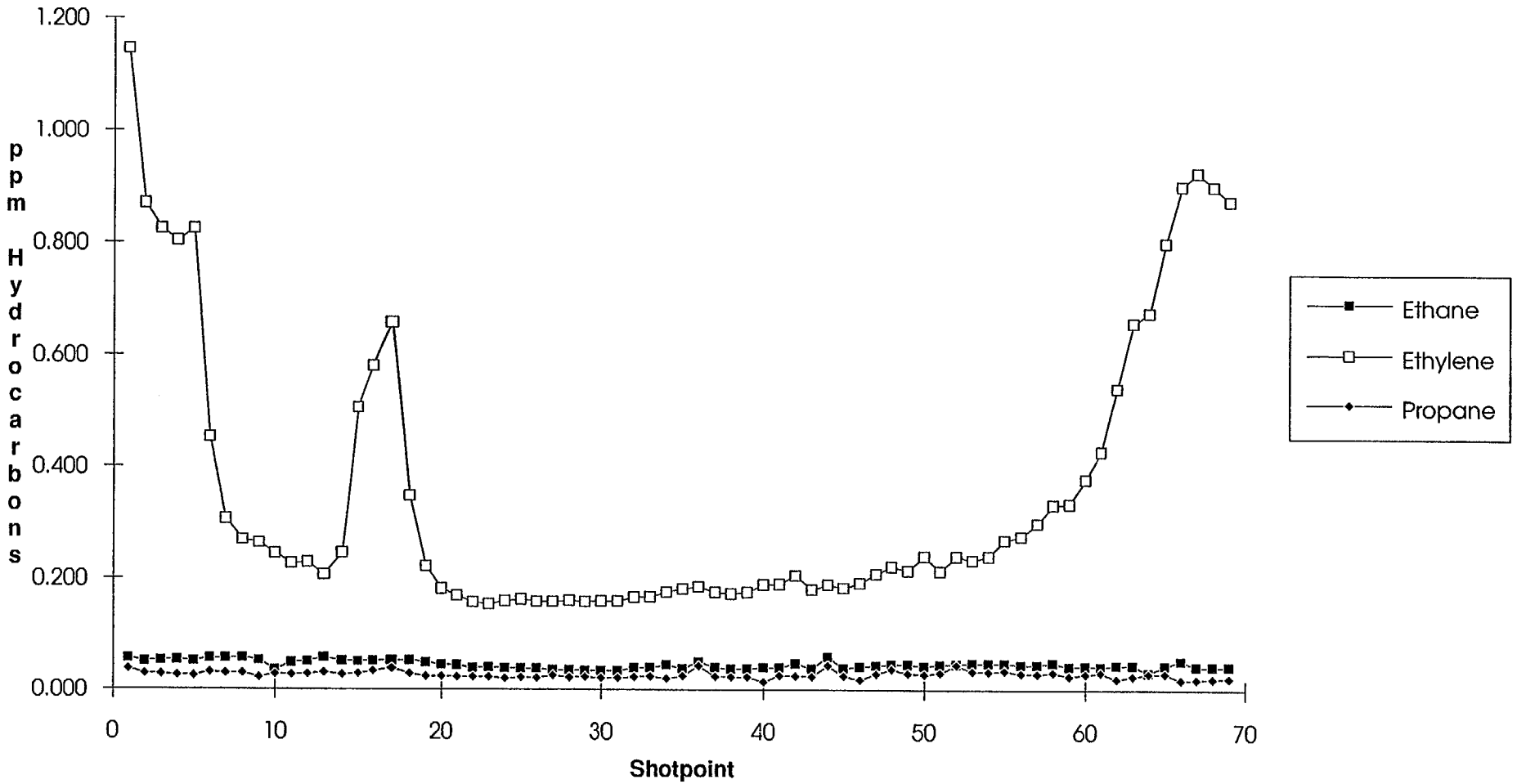
	Cond.	Temp.	F. Depth	W.Depth	Altitude	Calc. Alt.
Mean	59.729	26.353	49.129	62.835	13.497	13.930
Std. Dev.	1.072	0.696	14.716	15.214	2.949	4.682
Minimum	58.560	25.560	26.160	37.600	10.430	9.480
Maximum	62.240	27.990	74.350	86.400	24.790	32.110

Notes Two THC and methane anomalies occur at SP 17 and SP 54.

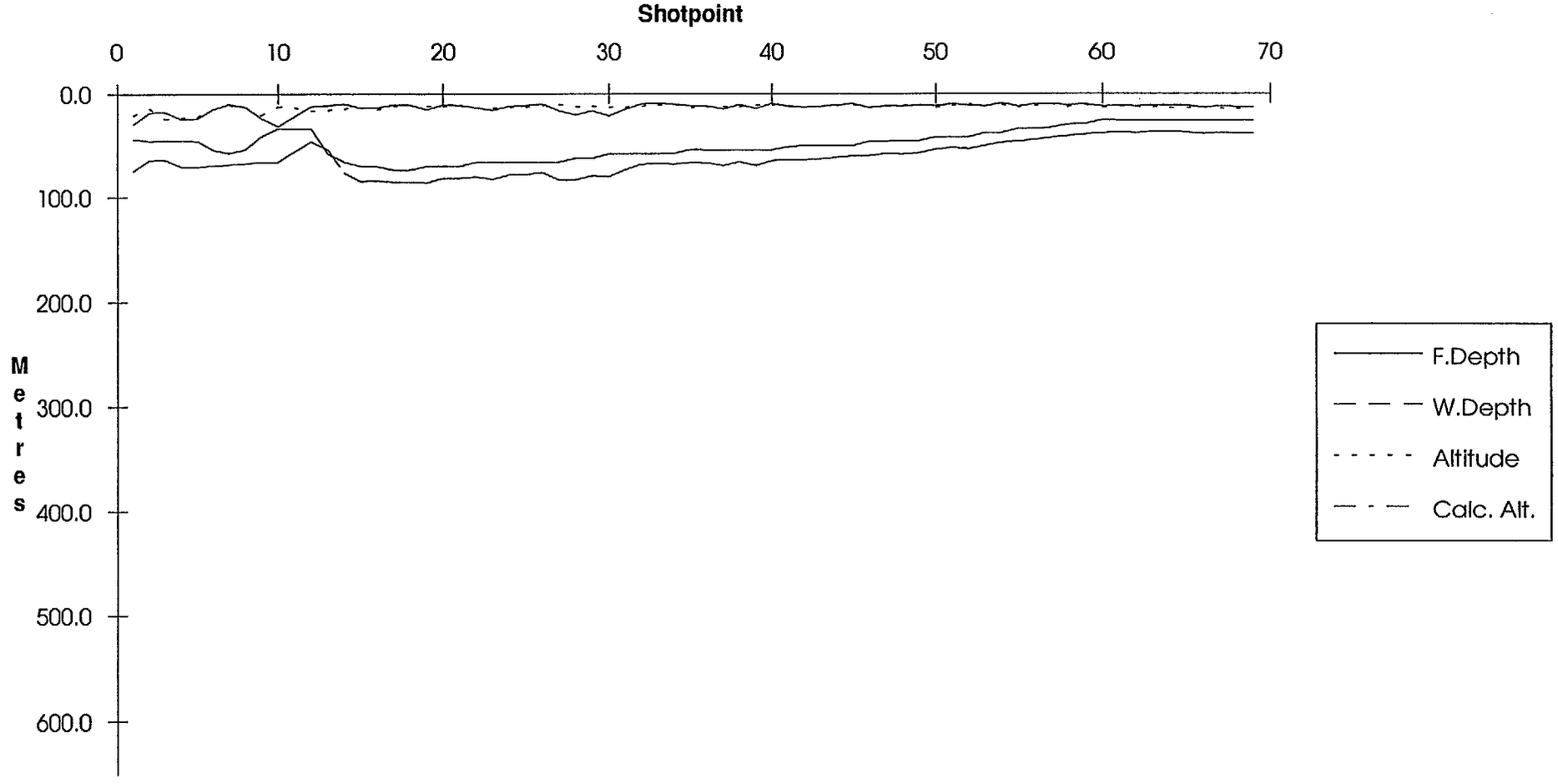
Line 109066 THC, Methane



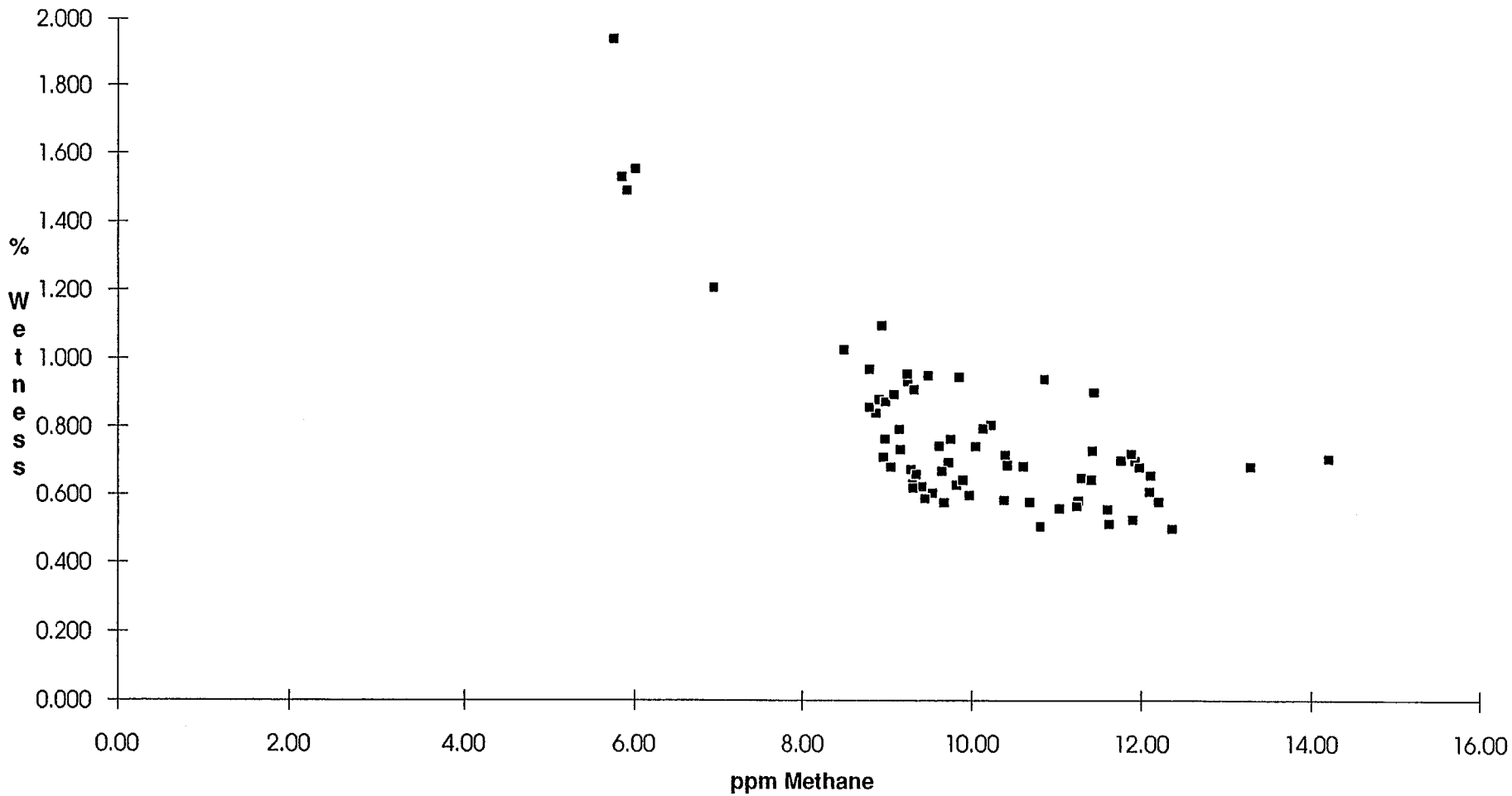
Line 109066 Ethane, Ethylene, Propane



Line 109066 Depths, Altitudes



Line 109066 Methane v. %Wetness



Line Summary

Line Number	109067
No. of Shotpoints	148

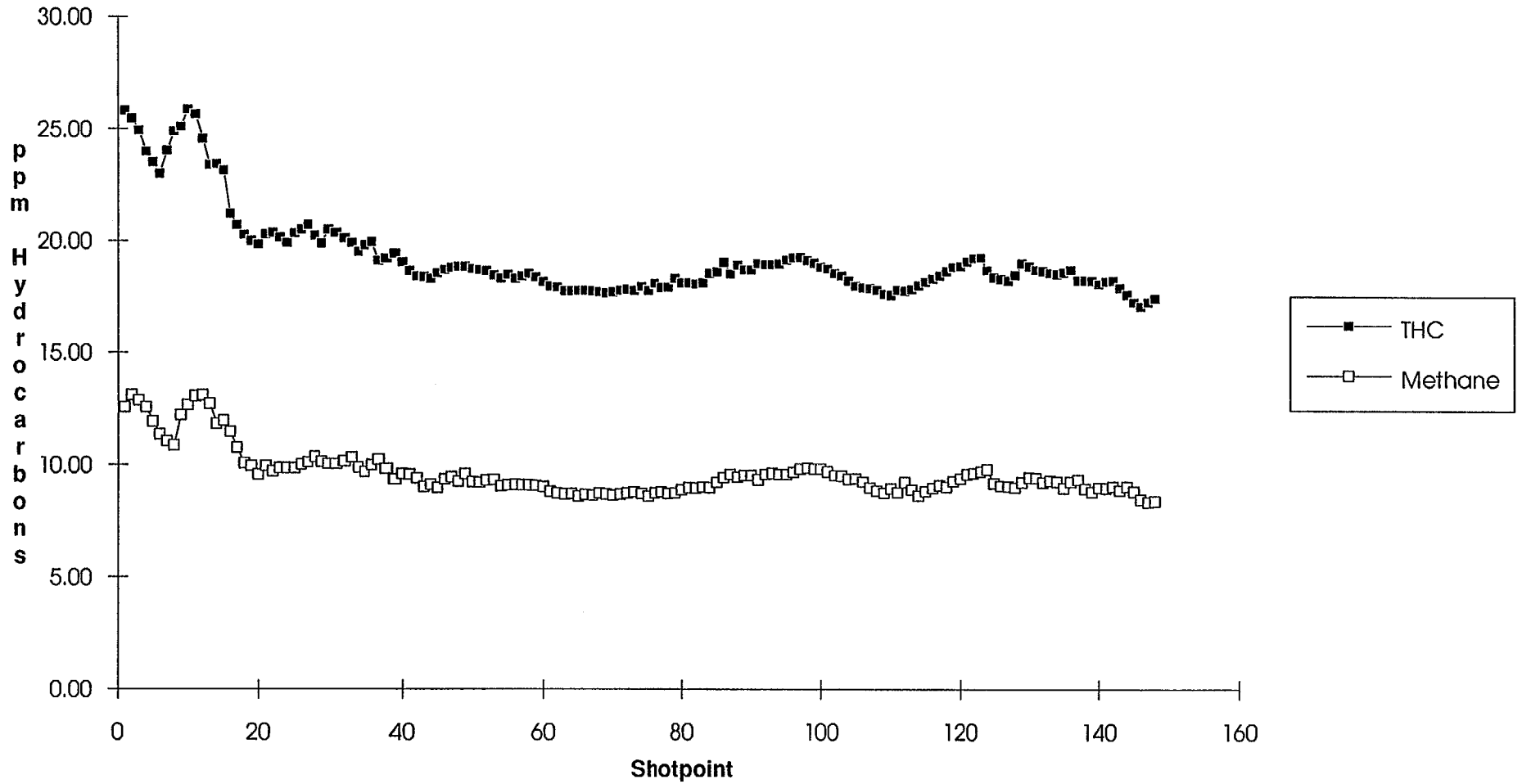
	Shotpoint	Date	Time	Latitude		Longitude	
Start	1	30-Apr-92	00:59:11	13	40.140	122	07.428
End	2	30-Apr-92	06:01:20	13	29.140	122	09.574

	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	19.237	9.599	0.038	0.258	0.026	0.040	0.003	0.002	0.000	0.120	0.012	0.038	0.707
Std. Dev.	1.954	1.041	0.006	0.188	0.005	0.017	0.006	0.006	0.002	0.051	0.008	0.016	0.120
Minimum	17.072	8.346	0.020	0.160	0.015	0.007	0.000	0.000	0.000	0.072	0.000	0.000	0.445
Maximum	25.868	13.084	0.069	0.965	0.041	0.117	0.037	0.035	0.017	0.279	0.033	0.097	1.149

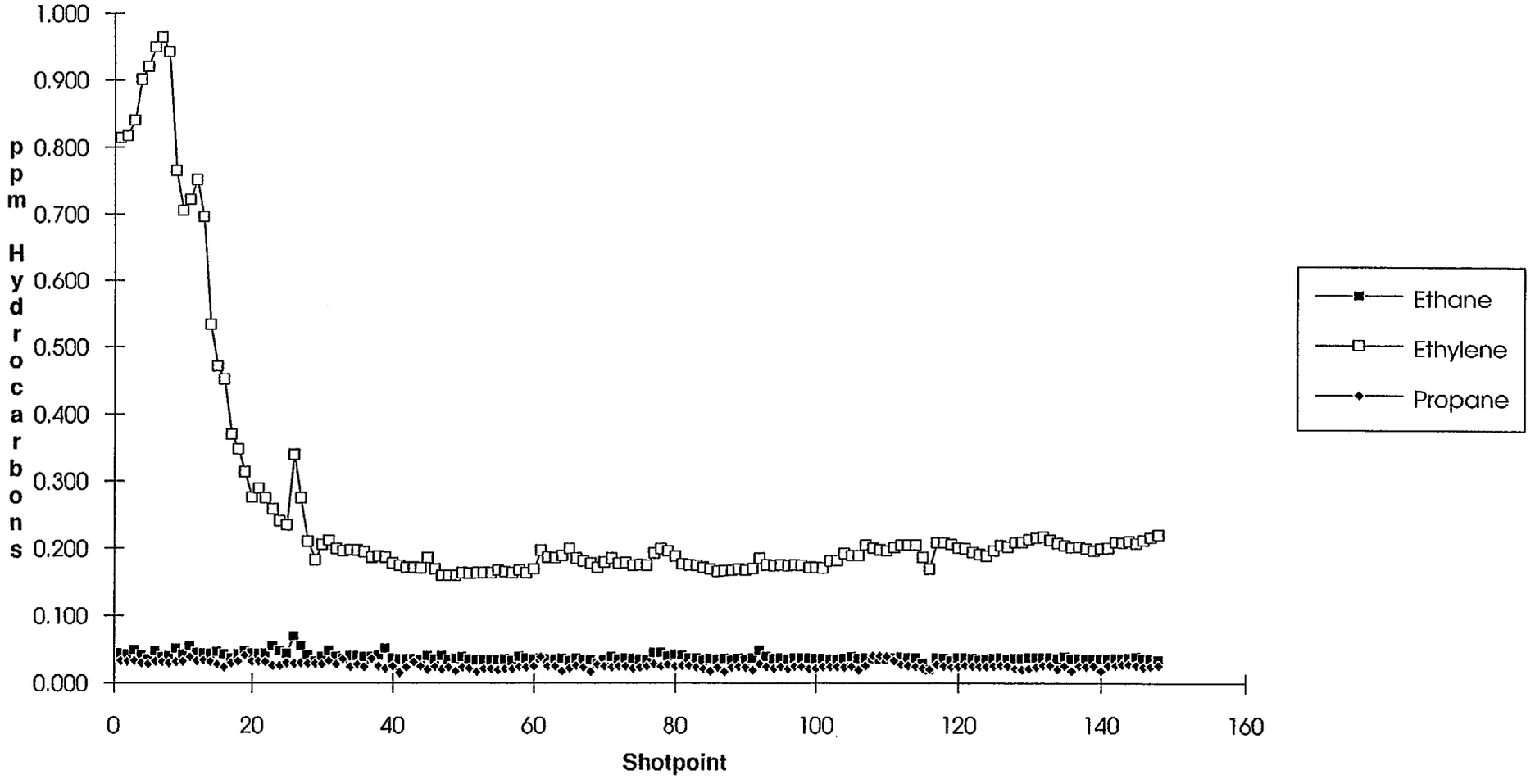
	Cond.	Temp.	F. Depth	W.Depth	Altitude	Calc. Alt.
Mean	60.777	27.108	55.980	76.797	18.179	20.818
Std. Dev.	0.536	0.344	10.463	17.155	7.313	14.515
Minimum	60.200	26.700	26.150	39.700	10.410	8.590
Maximum	62.630	28.260	75.660	117.000	30.930	63.050

Notes No anomalies occur along this line, the higher levels of THC and methane at the begining of the line are related to the fish being lowered through the surface waters.

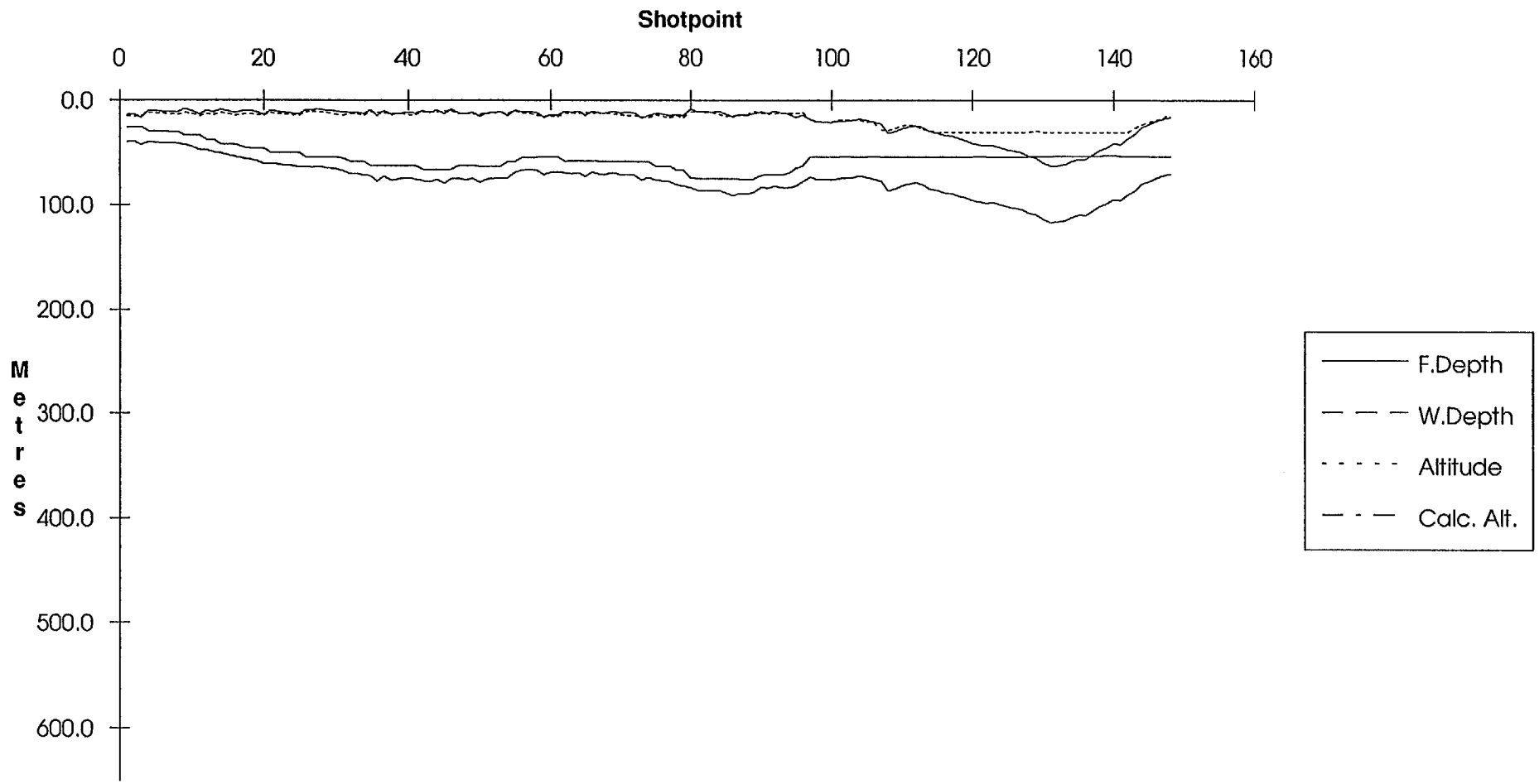
Line 109067 THC, Methane



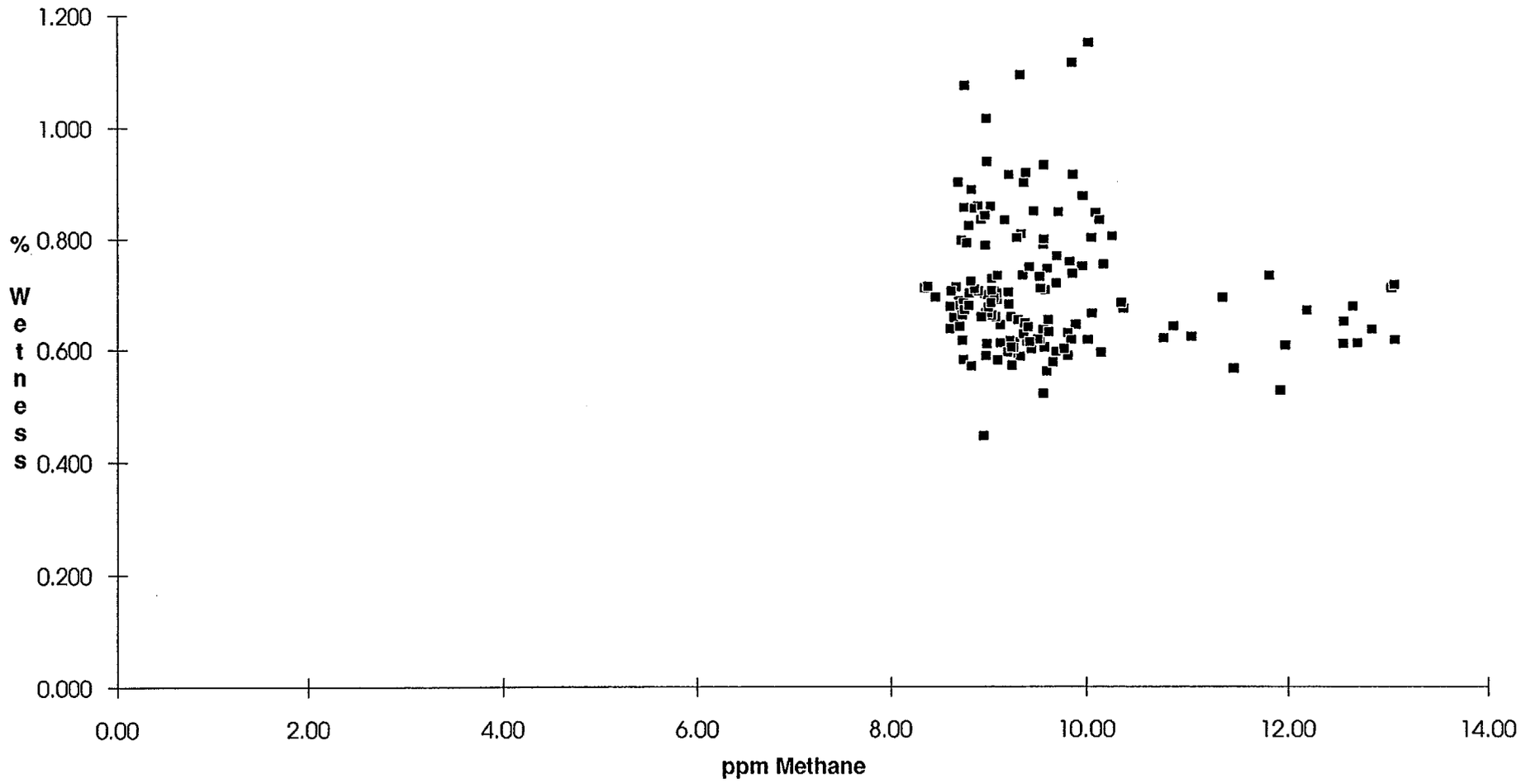
Line 109067 Ethane, Ethylene, Propane



Line 109067 Depths, Altitudes



Line 109067 Methane v. %Wetness



Line Summary

Line Number	109068
No. of Shotpoints	92

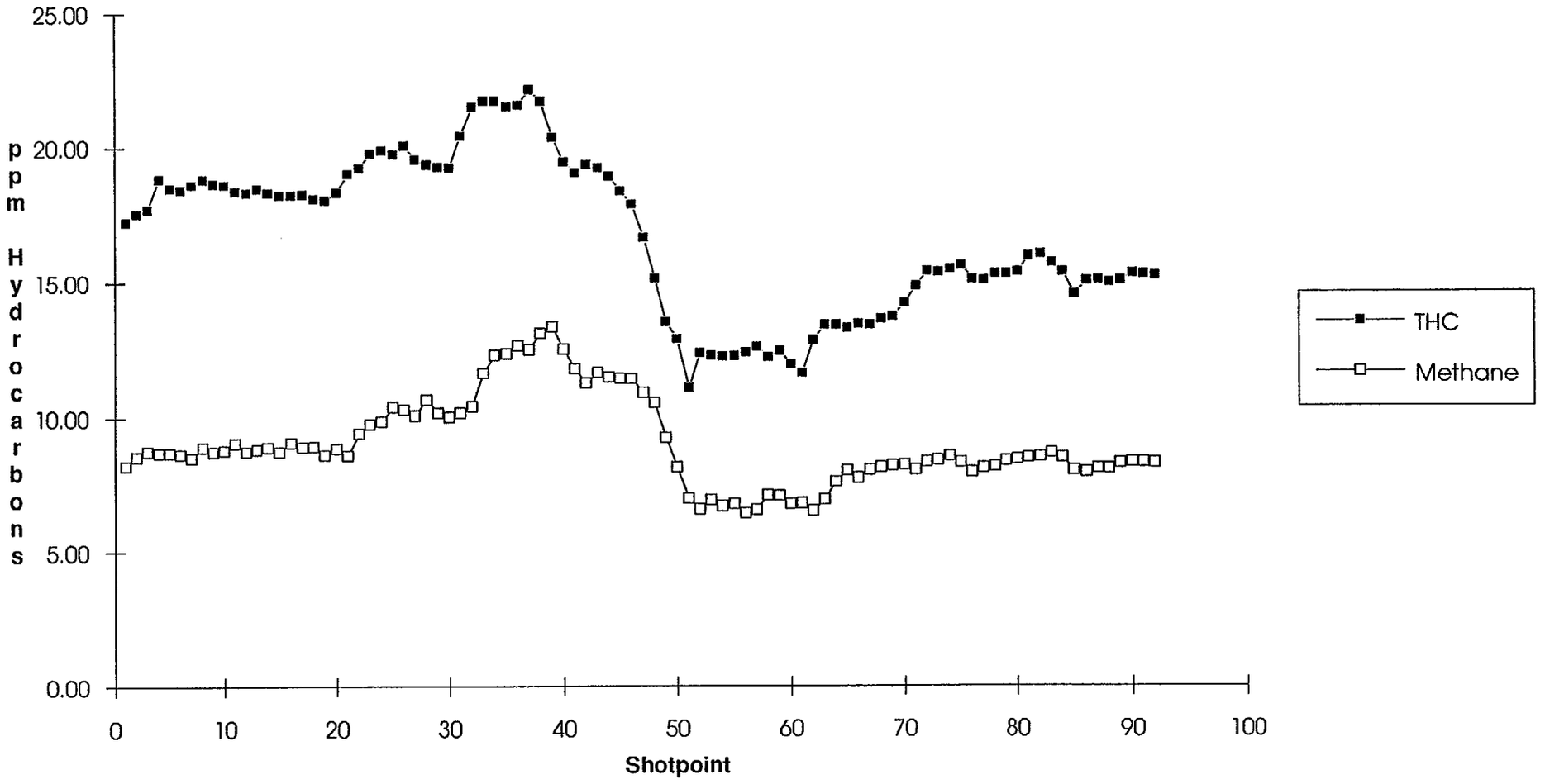
	Shotpoint	Date	Time	Latitude		Longitude	
Start	3	30-Apr-92	06:03:20	13	29.108	122	09.374
End	94	30-Apr-92	09:05:53	13	18.882	122	18.660

	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	16.685	9.004	0.029	0.086	0.016	0.024	0.000	0.000	0.000	0.079	0.007	0.043	0.498
Std. Dev.	2.906	1.656	0.007	0.078	0.007	0.015	0.002	0.001	0.000	0.034	0.012	0.016	0.126
Minimum	11.072	6.437	0.014	0.003	0.005	0.002	0.000	0.000	0.000	0.036	0.000	0.000	0.297
Maximum	22.148	13.350	0.046	0.242	0.037	0.065	0.016	0.009	0.000	0.181	0.066	0.079	0.820

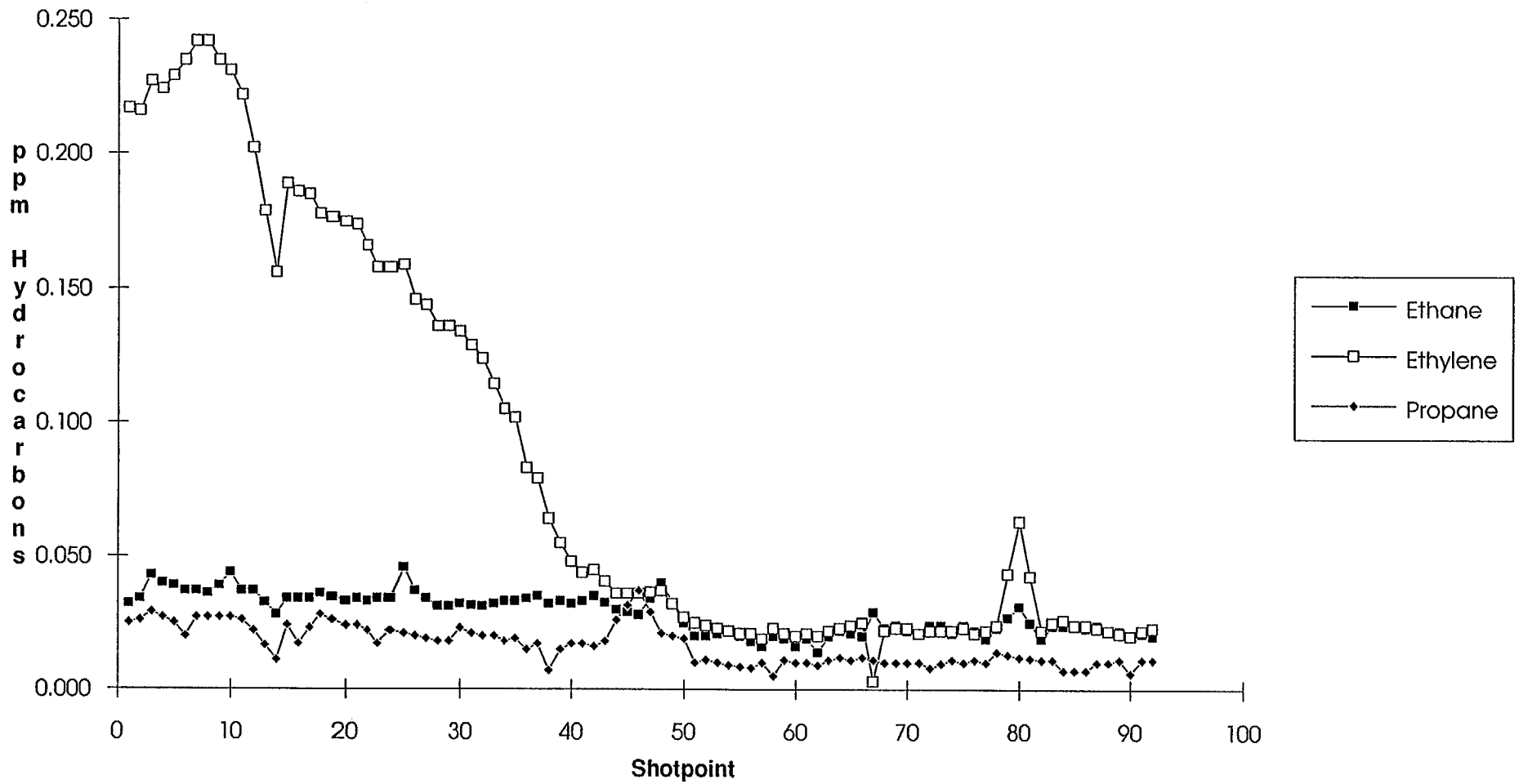
	Cond.	Temp.	F. Depth	W.Depth	Altitude	Calc. Alt.
Mean	56.796	24.318	153.951	478.736	22.008	324.785
Std. Dev.	2.561	1.781	58.949	423.016	8.791	379.195
Minimum	54.230	22.420	43.580	56.200	9.490	3.540
Maximum	60.640	27.000	207.260	1122.500	30.850	917.940

Notes A weak THC and methane anomaly occurs SP 35.

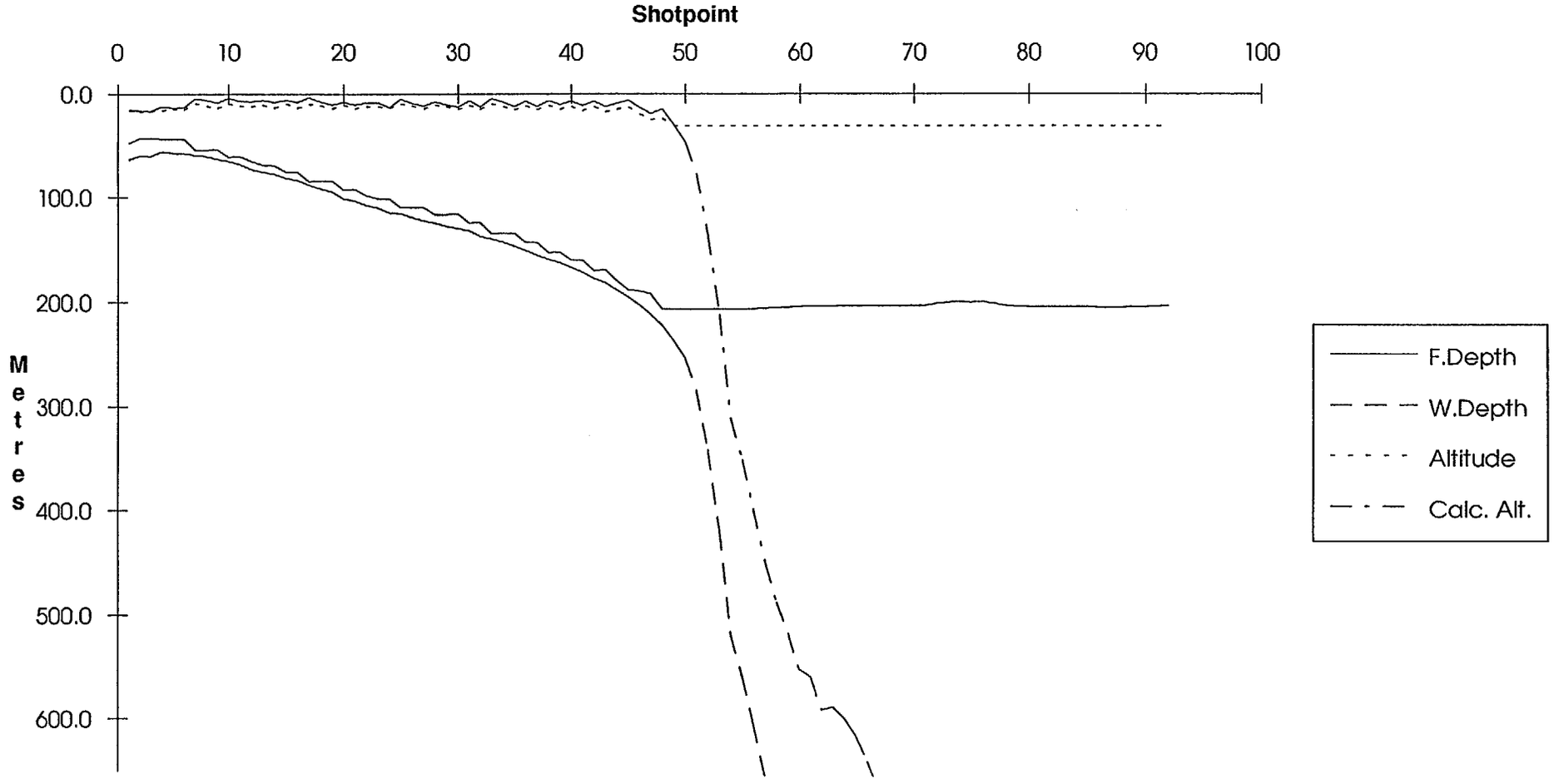
Line 109068 THC, Methane



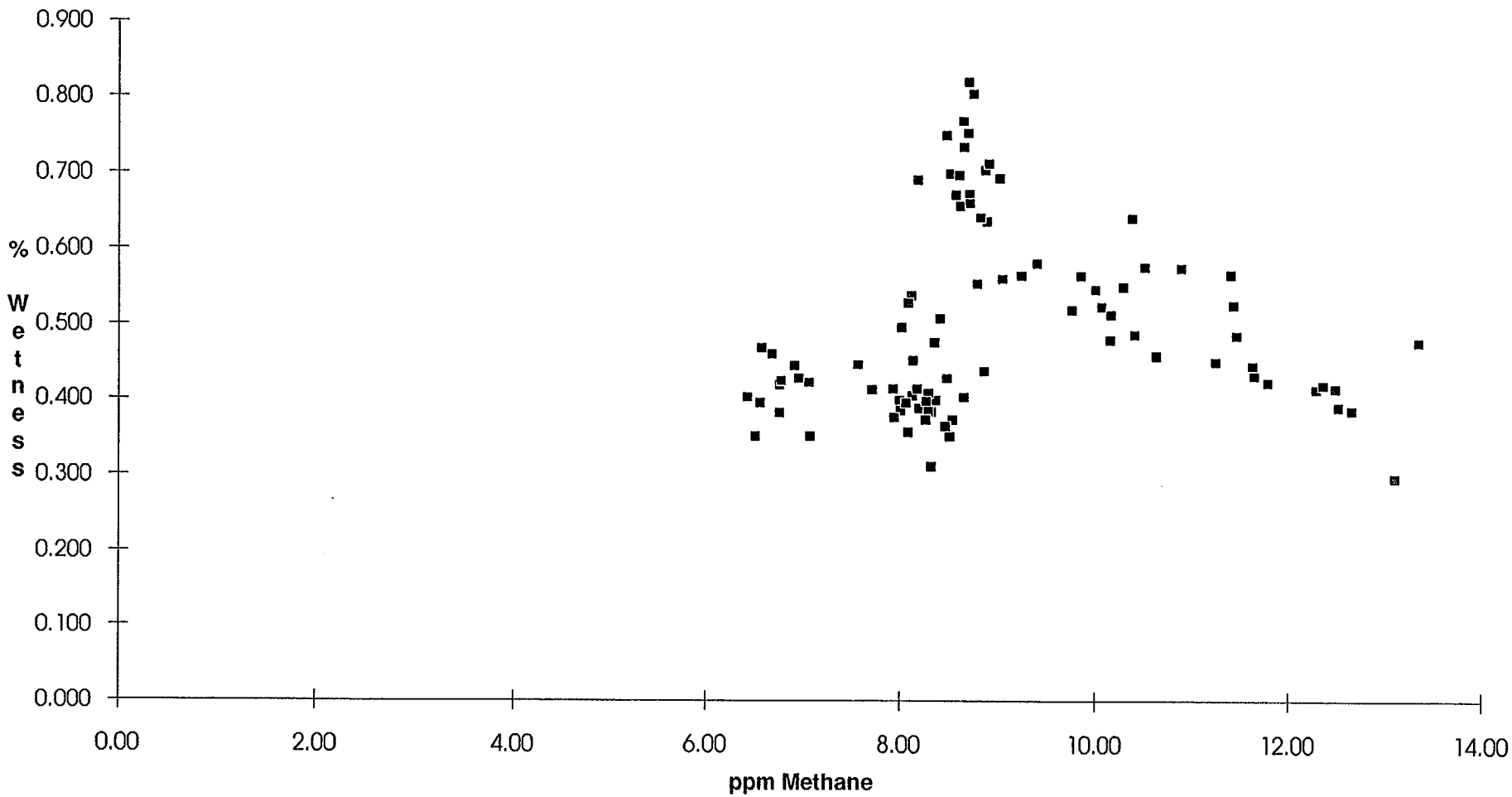
Line 109068 Ethane, Ethylene, Propane



Line 109068 Depths, Altitudes



Line 109068 Methane v. %Wetness



AUSTRALIA

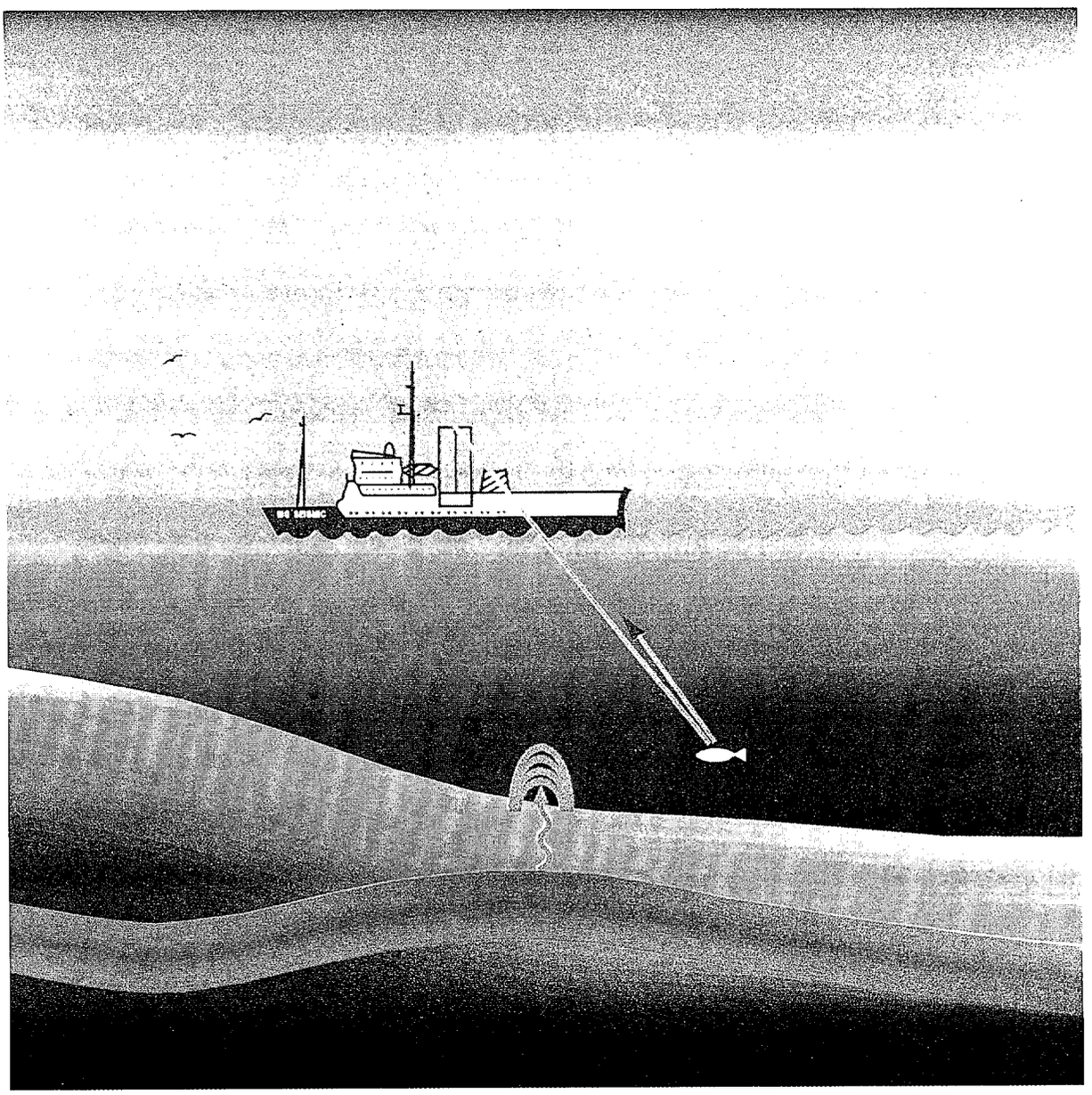
AGSO RECORD 1992/92

LIGHT HYDROCARBON GEOCHEMISTRY IN BOTTOM-WATERS OF THE PHILIPPINES CONTINENTAL SHELF Part B: NORTH EAST PALAWAN SHELF AND CUYO PLATFORM *RIG SEISMIC* SURVEY 109

AGSO
AUSTRALIAN GEOLOGICAL SURVEY ORGANISATION

AUSTRALIAN INTERNATIONAL DEVELOPMENT ASSISTANCE BUREAU

teg



PROJECT 123.03

D.Evans, D.T. Heggie, J.H. Bishop, E.N. Reyes and C-S. Lee

MARINE GEOSCIENCE AND PETROLEUM GEOLOGY PROGRAM

LIGHT HYDROCARBON GEOCHEMISTRY IN BOTTOM-WATERS OF THE PHILIPPINES CONTINENTAL SHELF

PART B:
NE PALAWAN SHELF AND CUYO PLATFORM

AGSO RECORD 1992/92

Project 123.03
AGSO (SURVEY 109)

D.Evans, D.T. Heggie, J.H. Bishop, E.N. Reyes, C-S. Lee.

This project was conducted by the Australian Geological Survey Organisation, for the Philippines Office of Energy Affairs with funding from the Australian International Development Assistance Bureau.

DEPARTMENT OF PRIMARY INDUSTRIES AND ENERGY
Minister: The Hon. Simon Crean
Secretary: G.L. Miller

AUSTRALIAN GEOLOGICAL SURVEY ORGANISATION
Executive Director: R.W.R. Rutland AO

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ISSN No. 1039-0073
ISBN No. 0 642 18586 7

EXECUTIVE SUMMARY iv

GEOLOGY AND BRIEF HISTORY OF EXPLORATION: NE PALAWAN SHELF AND CUYO PLATFORM 1

SURFACE GEOCHEMICAL OBJECTIVES: NE PALAWAN AND CUYO PLATFORM 4

DHD RESULTS 5

NE Palawan Shelf (Lines 109/001 through 109/012) 5

Overview 5

Hydrocarbon 'Source' 21

Cuyo Platform (Lines 109/013 through 109/020) 24

Overview 24

Hydrocarbon 'Source' 38

SUMMARY: NE PALAWAN SHELF AND CUYO PLATFORM RESULTS 41

REFERENCES 42

ACKNOWLEDGMENTS 43

List of AGSO Survey Personnel 43

LIST OF FIGURES (PART B) 44

LIST OF APPENDICES (PART B) 46

APPENDIX 1. NE PALAWAN SHELF DHD LINE SUMMARY SHEETS AND INDIVIDUAL LINE PLOTS 47

APPENDIX II. CUYO PLATFORM DHD LINE SUMMARY SHEETS AND INDIVIDUAL LINE PLOTS 108

APPENDIX III. DHD METHODOLOGY. 148

APPENDIX IV. INTERPRETATIVE METHODOLOGY. 152

Light Hydrocarbons In Seawater 152

Data interpretation: the mixing model 154

Classification of anomalies. 156

References 156

APPENDIX V. SYSTEMS OPERATIONS REPORTS. 159

DHD operations 159

Tow-fish/cable/winch subsystem 159

Gas extractor subsystem 161

Gas Analysis subsystem 161

Control and data acquisition 162
Non-Seismic Data Acquisition (H.Miller) 164
Navigation 164
Bathymetry 165
Gravity 165
Magnetics 165

EXECUTIVE SUMMARY (PART B)

Between March and May 1992 the Australian Geological Survey Organisation (AGSO), formerly the Bureau of Mineral Resources, and the Philippines Office of Energy Affairs (OEA) conducted a combined deep crustal seismic and Direct Hydrocarbon Detection (DHD) survey (AGSO Survey 109) in four areas of the Philippines continental shelf. This survey included the Ragay Gulf, Tayabas Bay, North East (hereinafter NE) Palawan Shelf and the Cuyo Platform (Figures 1a-b). The project was funded by the Australian International Development Assistance Bureau (AIDAB), using the government's geoscience research vessel *Rig Seismic*.

This record comprises two sections. Part A presents the DHD data from the geologically similar Ragay Gulf and Tayabas Bay. This section, Part B, presents the DHD data from the geologically similar NE Palawan Shelf and Cuyo Platform.

A total of 5160 line-km of DHD data were collected from these four areas during Survey 109. Of these, 580 line-km were collected from the NE Palawan Shelf and 730 line-km collected from the Cuyo Platform.

There were no significant (as compared to Ragay Gulf) hydrocarbon anomalies detected on the NE Palawan Shelf. However, some weak light hydrocarbon anomalies were detected. Anomalous, but weak and non-extensive (less than 2 km distance), levels of THC, methane, ethane and trace amounts of propane were found near the three plugged and abandoned oil exploration wells (Roxas-1 on lines 109/002 and 109/012, Paly-1 on line 109/002, and Dumaran-1 on line 109/001). These anomalies were associated with other, broad (approximately 60-80 km distance), elevated (two-fold above background) increases in methane and ethane concentrations.

A weak but areally extensive (approximately 30 km distance) anomaly was found in NE Palawan near to where lines 109/012 and 109/011 intersect. This anomaly is not associated with any exploration well.

Anomalous, but weak (less than five-fold background) levels of ethane and propane (but no anomalous methane) were found on line 109/005, resulting in an increase in the percent hydrocarbon wetness. The petroleum significance of this is unknown.

No significant anomalies were found on the Cuyo Platform.

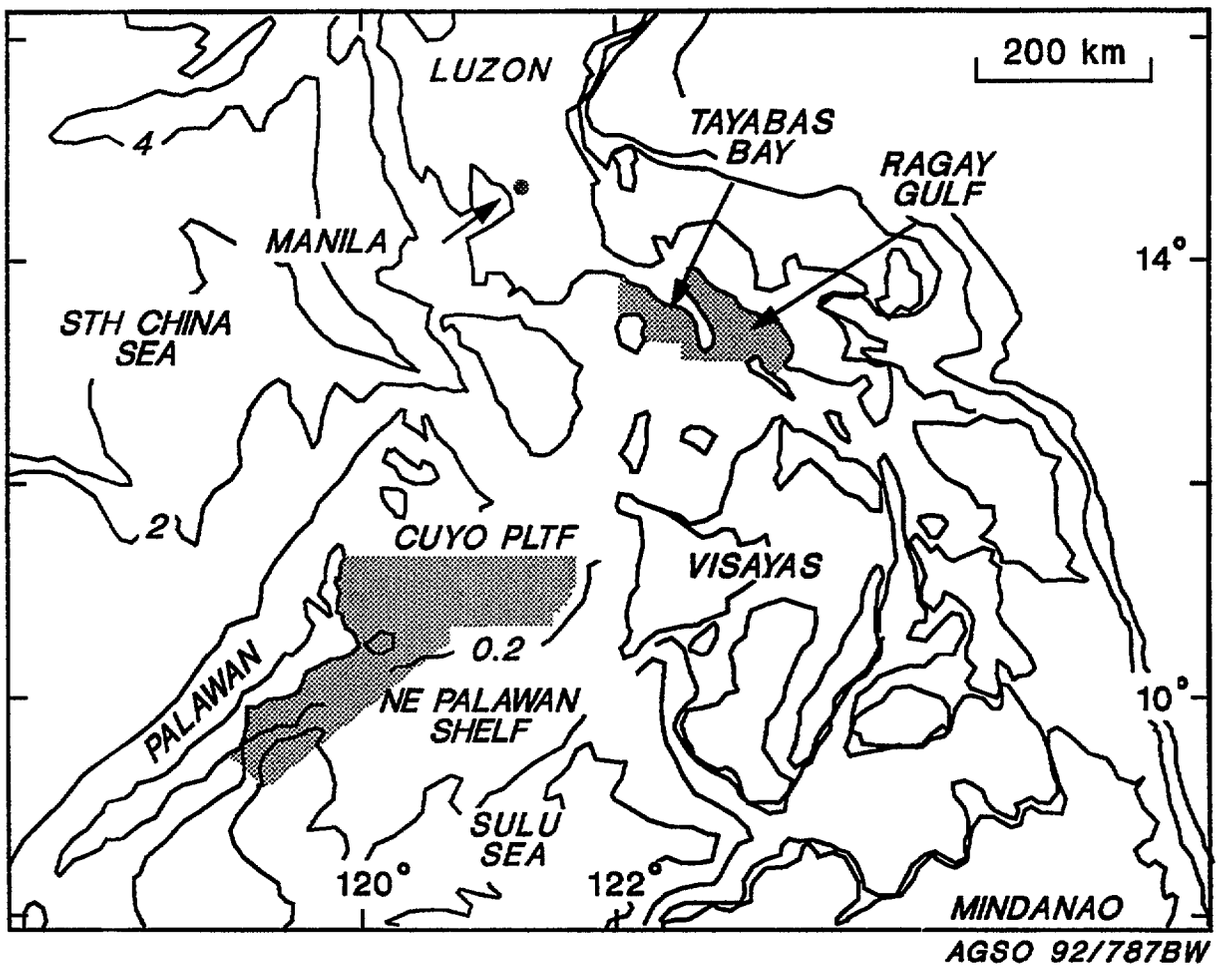


Figure 1a Location map of the Philippines showing the four basins surveyed during AGSO Survey 109.

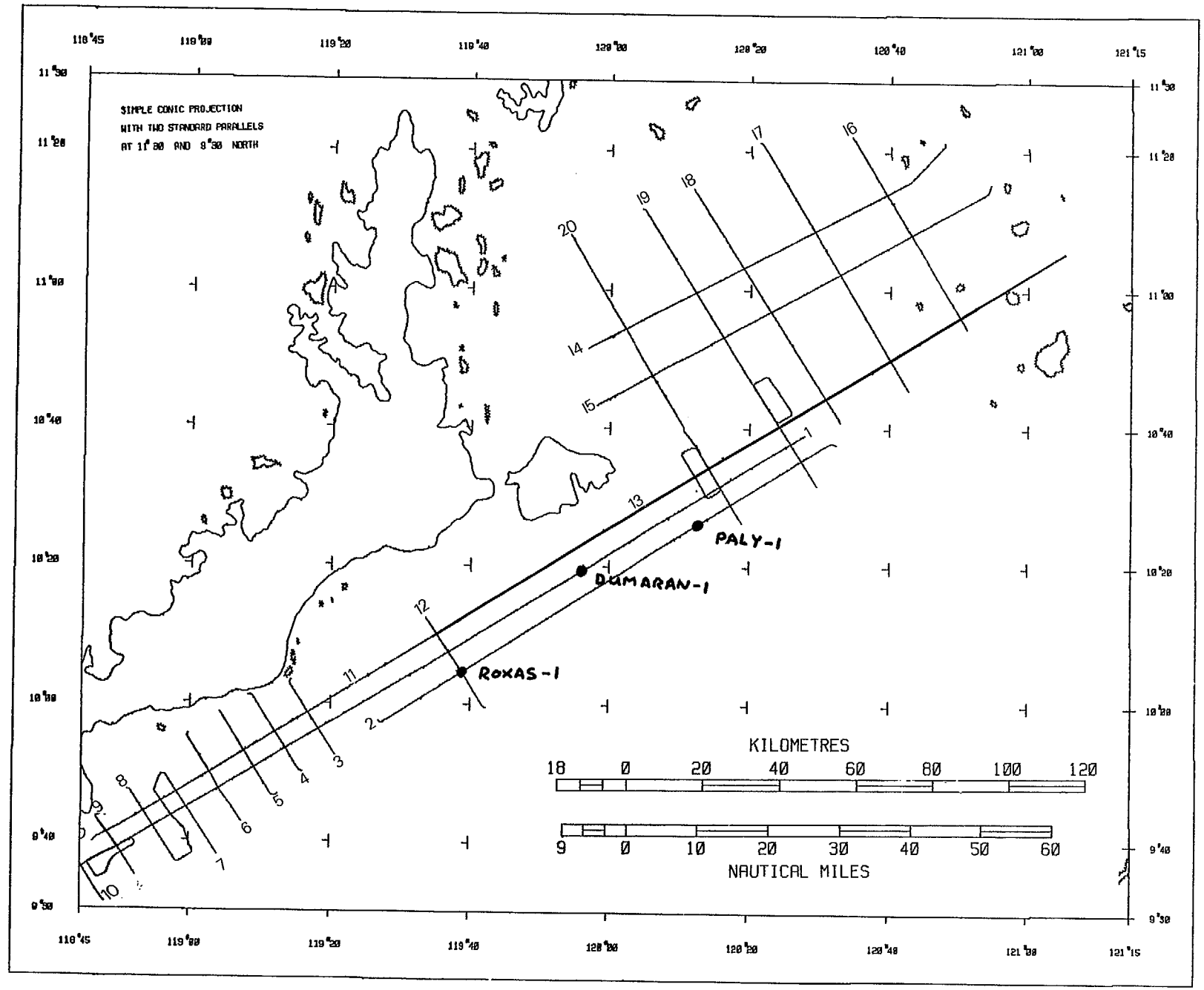


Figure 1b. Map of the NE Palawan Shelf and Cuyo Platform showing the DHD survey lines and selected well locations for AGSO Survey 109.

GEOLOGY AND BRIEF HISTORY OF EXPLORATION: NE PALAWAN SHELF AND CUYO PLATFORM

Tectonics

The NE Palawan Shelf and Cuyo Platform are located in the offshore area northeast of the island of Palawan. They are part of the Kalayaan-Calamian Microplate which rifted from the South China continental margin during Late Oligocene through Middle Miocene times (Hamilton, 1979). The area is considered to be a continental rift basin. The Late Mesozoic and Tertiary marine clastic/carbonate section has a thickness of over 10 km, of which the Tertiary fill probably accounts for as much as 4 to 5 km. Substantial amounts of quartz are present in the clastic intervals. Deformation is characterised by extensional block faulting and tilting, except in the eastern and southern margins where compressional features dominate.

Stratigraphy

Sediments range in age from Late Palaeozoic to Holocene with significant gaps in the late Cretaceous, Paleocene, Oligocene and Middle Miocene.

Outcrops of Permian formations (Bacuit Fm. and Miniloc Ls.) occur in northern Palawan. These consist of cherts, limestones, conglomerates, sandstones and shales. Outcrops of Permian shallow marine limestones and clastics are also found on Carabao Island, south of Tablas Island (Fontaine, 1983). In the Cuyo Platform proper, the oldest outcrops are cherts occurring in the northernmost islands of the Cuyo Group (Alcala, 1987). These are very similar to cherts found in northern Palawan, which were dated by Hashimoto and Sato (1973) as Middle Triassic, based on conodont fossils. Wolfart et al. (1984) confirmed the Middle Triassic age, based on radiolarian fossils in chert collected from Busuanga Island.

The Jurassic outcrops on Mindoro consist of non marine to shallow marine quartzose sandstones, shales and conglomerates (Maasalay Fm.). The Cretaceous sediments, as exposed in North Palawan and Mindoro, are composed of turbidites, cherts and limestones with minor shale, quartzose sandstones, tuffs and conglomerates deposited in non marine to bathyal environments.

The Palaeogene section consists of sandstones, shales, limestones, with minor coal and quartzite. These were deposited in transitional to neritic environments.

Lower Miocene to Pliocene sediments consist of reefal limestones, and non marine to neritic conglomerates, quartzose and argillaceous sandstones with interbeds of siltstone, shale and microcrystalline limestone.

The Quaternary sediments encountered in wells are composed predominantly of coralline to biomicritic limestone with minor sandstone, siltstone and claystone.

Numerous small islands in the central part of the Cuyo Platform are covered with volcanic rocks such as basalts, andesites and pyroclastics, which are believed to be Quaternary in age (Alcala, 1987).

Geophysics

The first seismic survey of the Cuyo Platform was conducted by Brascan in 1974. Subsequently, data were acquired by Cities Service Multi-Natural, POGEI, and Seafront between 1976 to 1982. The most recent survey comprising several grids was conducted by Petro-Canada International Assistance Corporation in 1986.

A reconnaissance aeromagnetic survey (metastable helium magnetometer type) was flown across part of the Cuyo Platform/Palawan area in 1969. The results show high amplitude, steep-gradient anomalies elongated to the northeast, and the presence of two sets of lineaments trending northeast and northwest (Bosum et al., 1971).

Drilling

The only wells in the area are three drilled in the NE Palawan shelf by Cities Service from 1979 to 1981. The depths of these wells, namely Roxas-1, Paly-1 and Dumaran-1, range from 2031 to 2187 m. Only Dumaran-1 bottomed in pre-Cretaceous ultramafic basement rocks.

The Roxas-1 well was intended to test a reefal buildup but found clastics underlying a major erosional unconformity. No structural closure is apparent at this location; however, porous Middle Miocene sands were encountered from 823 to 1220m.

The Dumaran-1 well targeted another possible carbonate buildup, but the seismic anomaly turned out to be a sandy conglomerate, from 1524 to 1829 m, having traces of dead oil.

The Paly-1 well was drilled to test an unconformity trap formed by truncated southeast-dipping, presumed Upper Cretaceous sediments. The well however encountered poor reservoir rocks of undifferentiated Oligocene to Early Miocene age at T.D.

SURFACE GEOCHEMICAL OBJECTIVES: NE PALAWAN AND CUYO PLATFORM

1. To seek evidence of thermogenic hydrocarbon seepage from the NE Palawan Shelf and Cuyo Platform and, hence, assist in new exploration and reduce exploration risk in these areas.

2. To test for new exploration leads and prospects.

3. To test for hydrocarbon seepage above possible carbonate reservoirs in both the Cuyo Platform and the NE Palawan Shelf.

4. To examine the relationship between hydrocarbon generation and migration by relating the surface and sub-seafloor expressions of hydrocarbon anomalies to the sub-seafloor geology and locations and type(s) of source rocks.

5. To relate the chemical compositions of any light hydrocarbon anomalies to 'source' characteristics, i.e. gas, condensate, liquids, and to predictions from geohistory and maturation modelling of different source rock types.

The geochemical analysis system (Direct Hydrocarbon Detection or DHD) that has been installed aboard the *Rig Seismic* is shown schematically in Figure III-I of Appendix III. The laboratory system analyses a variety of gases extracted from seawater, including C_1-C_8 hydrocarbons, and has 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 III and IV respectively.

This section (Part B) of the Record presents the surface geochemical (bottom-water DHD) data obtained during AGSO Survey 109 from the NE Palawan Shelf, and Cuyo Platform.

DHD RESULTS

NE Palawan Shelf (Lines 109/001 through 109/012)

Overview

A total of 580 line-km of seismic and DHD data were acquired along 12 lines (109/001 through 109/012) on the NE Palawan Shelf. The DHD data are presented graphically in Figures 2 a-m. These plots include THC, sum C_1-C_4, and the individual hydrocarbons methane, ethane, propane, ethylene, propylene and butane along the different survey lines. Also shown are the variations in the percent hydrocarbons wetness, the ratio C_1/C_2 and ratio C_2/C_3 and the Bernard parameter along the survey lines. The DHD data (for each individual line) are shown in Appendix I, as hydrocarbon concentrations plotted against DHD shot-point, along each survey line.

Several weak bottom-water light hydrocarbon anomalies (less than five-fold typical background concentrations) were detected.

The most distinctive anomalies in total hydrocarbons (THC) and sum C_1-C_4 hydrocarbons were found near the intersections of survey lines 109/011 and 109/012. The anomalies had THC, sum C_1-C_4, methane and ethane concentrations two-to-three-fold above background (Figure 2 a-d). The anomaly over the area is also evident in the ratio C_1/C_2 (Figure 2k) and an increase in the Bernard parameter (Figure 2m), and a small increase in percent hydrocarbon wetness from background values less than 0.75% to values approaching 1.25% (Figure 2j).

A further three weak, areally restricted 'spike' anomalies in THC, the sum C_1- C_4 hydrocarbons, methane and ethane were evident over the positions of the Dumaran-1 well on line 109/001 and the Paly-1 and Roxas-1 wells on line 109/002 (Figures 2a-d). These isolated anomalies are associated with broad, regional elevated values of THC, sum C_1 - C_4, methane and ethane along lines 109/001 and 109/002.

The weak hydrocarbon anomalies at the end of line 109/002 evident in THC, the sum C_1-C_4 and methane concentrations, and the C_1/C_2 ratio, and Bernard parameter (Figures 2 a-c, k & m), are related to the DHD tow-fish being raised into surface waters. The increase in the unsaturated hydrocarbons ethylene and propylene (Figures 2 e & g), with decreases in tow-fish and water depth (refer to single line plots for NE Palawan, Appendix I) are the indicators used to identify the passage of the DHD tow-fish into

surface waters, and the possibility that very weak anomalies may be produced by some biological activity in the surface waters.

Anomalous ethane and propane values were found at the beginning of line 109/005, and show about a three-fold increase of these hydrocarbons above background (Figures 2 d & f). There is no anomalous methane associated with the ethane and propane anomaly (Figure. 2c). This anomaly is also indicated by a decrease in both the ratio C_1/C_2 (Figure. k) and the Bernard parameter (Figure 2m), and is associated with a distinctive increase in percent hydrocarbon wetness, from background values of about 0.5 % up to 2.5% (Figure. 2j). However, the anomaly is also associated with anomalous ethylene and propylene values (Figures 2 e & g), indicating the DHD tow-fish was in the surface waters. The significance of these anomalies remains unknown.

A brief description of the individual survey lines is presented below.

Line 109/001:

A very weak THC, methane, ethane and propane anomaly with occasional traces of butane was detected near the Dumaran-1 exploration well. Concentrations of sum C_1-C_4 hydrocarbons increase from 4 ppm to 12 ppm (Figure 2b).

Line 109/002:

A very weak THC, ethane, and propane anomaly at the north-east end of the line marks the position of the Paly-1 exploration well. THC increases by 5 ppm above background. Concentrations of sum C_1-C_4 increase from 4 ppm to 5 ppm (Figures 2 a-f).
A very weak THC, methane, ethane, and propane anomaly occurs at SP 361, marking the position of the Roxas-1 exploration well; a 2 ppm increase above background is noted in sum C_1-C_4 (Figure 2b). The three weak (but more extensive than those noted over the wells), THC and methane anomalies occurring beyond Roxas-1 are coupled with increases in ethylene and propylene (Figures 2 e & g), a shallowing of water depth and DHD tow-fish depth.

Line 109/003:

A very weak THC and methane anomaly was detected in the middle of the line, concentrations of sum C_1-C_4 hydrocarbons increase from 4 ppm to 6 ppm (Figure 2 b).

Line 109/004:

No anomalies were detected on this line.

Line 109/005:

A weak ethane and propane anomaly (Figures 2 d & f) was detected at the beginning of the line, showing an approximate three-fold increase above background. The anomaly is associated with an increase in propylene and ethylene values (Figures 2 e & g) and the raising of the tow-fish in the water column. No anomalous methane was found. Percent hydrocarbon wetness rises almost four-fold above background (Figure 2j).

Line 109/006:

No anomalies were detected on this line.

Line 109/007:

Very weak increases in THC were detected in the middle of the line.

Line 109/008:

No anomalies were detected on this line.

Line 109/009:

No anomalies were detected on this line.

Line 109/010:

No anomalies were detected on this line.

Line 109/011:

A weak THC, methane, and ethane anomaly occurs over 50 shotpoints at the end of the line. Concentrations of sum C_1-C_4 increase from 5 ppm to almost 14 ppm (Figure 2b).

Line 109/012:

Two weak THC, sum C_1-C_4, methane, and ethane (Figures 2 a-d), anomalies make up most of the line. The anomalies are divided by a 5 ppm decrease in THC and methane values. The anomalies are near the position of the Roxas-1 exploration well. Concentrations of the sum C_1-C_4 hydrocarbons increase from 5 ppm to about 12 ppm. This anomaly was also detected on line 109/011.

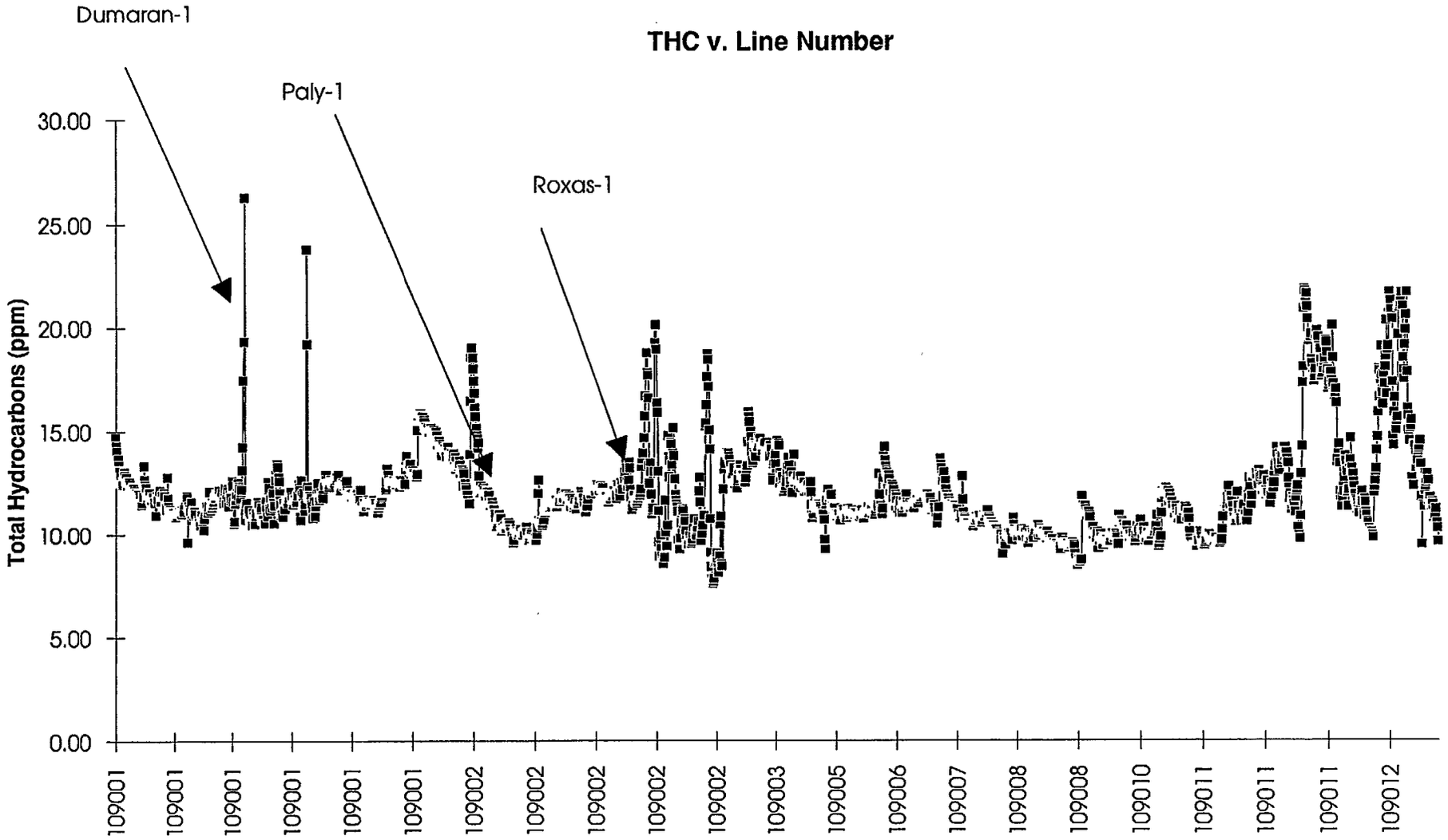


Figure 2a Total Hydrocarbons (THC) versus survey line number, NE Palawan Shelf (Lines 109/001 through 109/012).

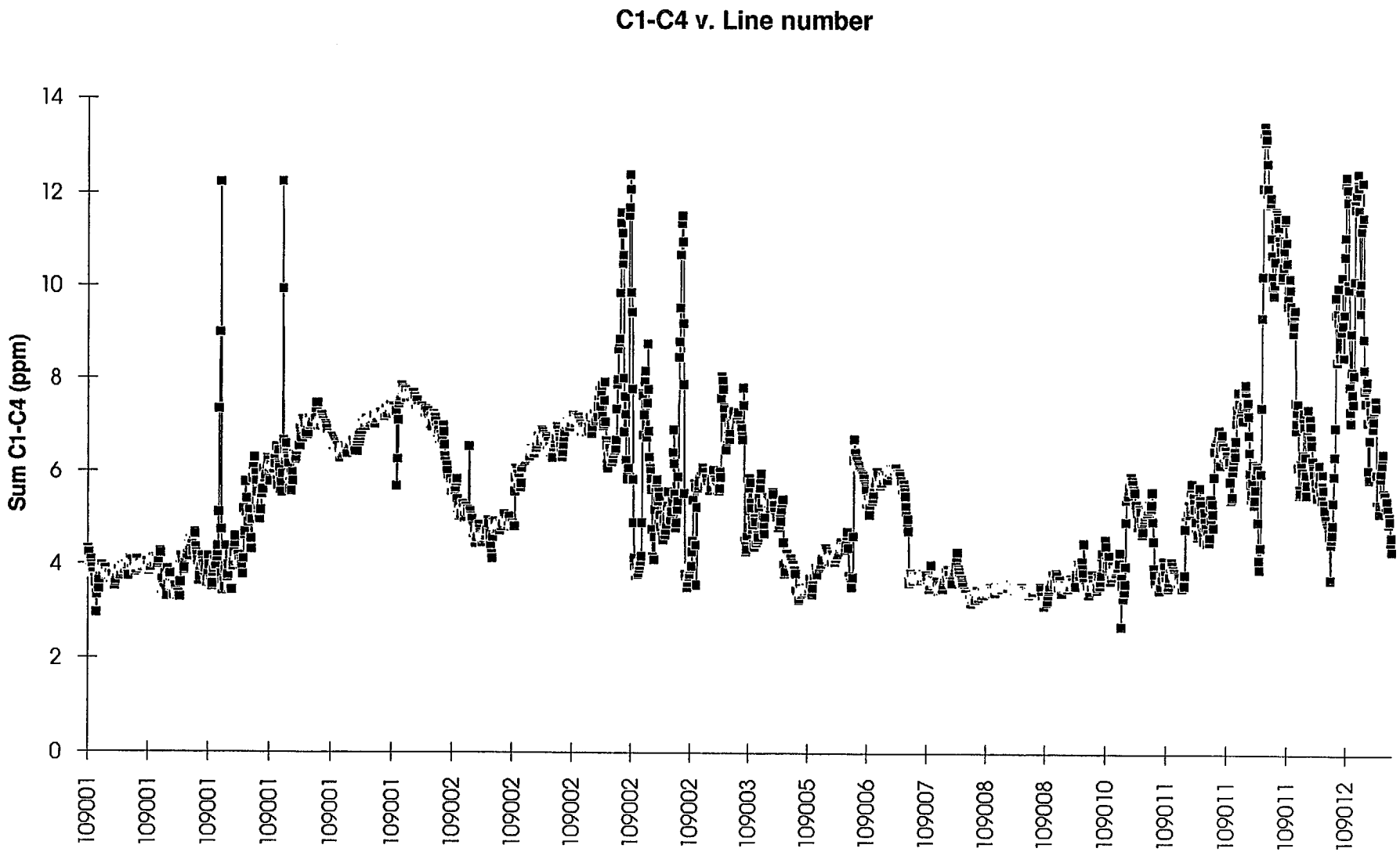


Figure 2b Sum C_1-C_4 versus survey line number, NE Palawan Shelf (Lines 109/001 through 109/012).

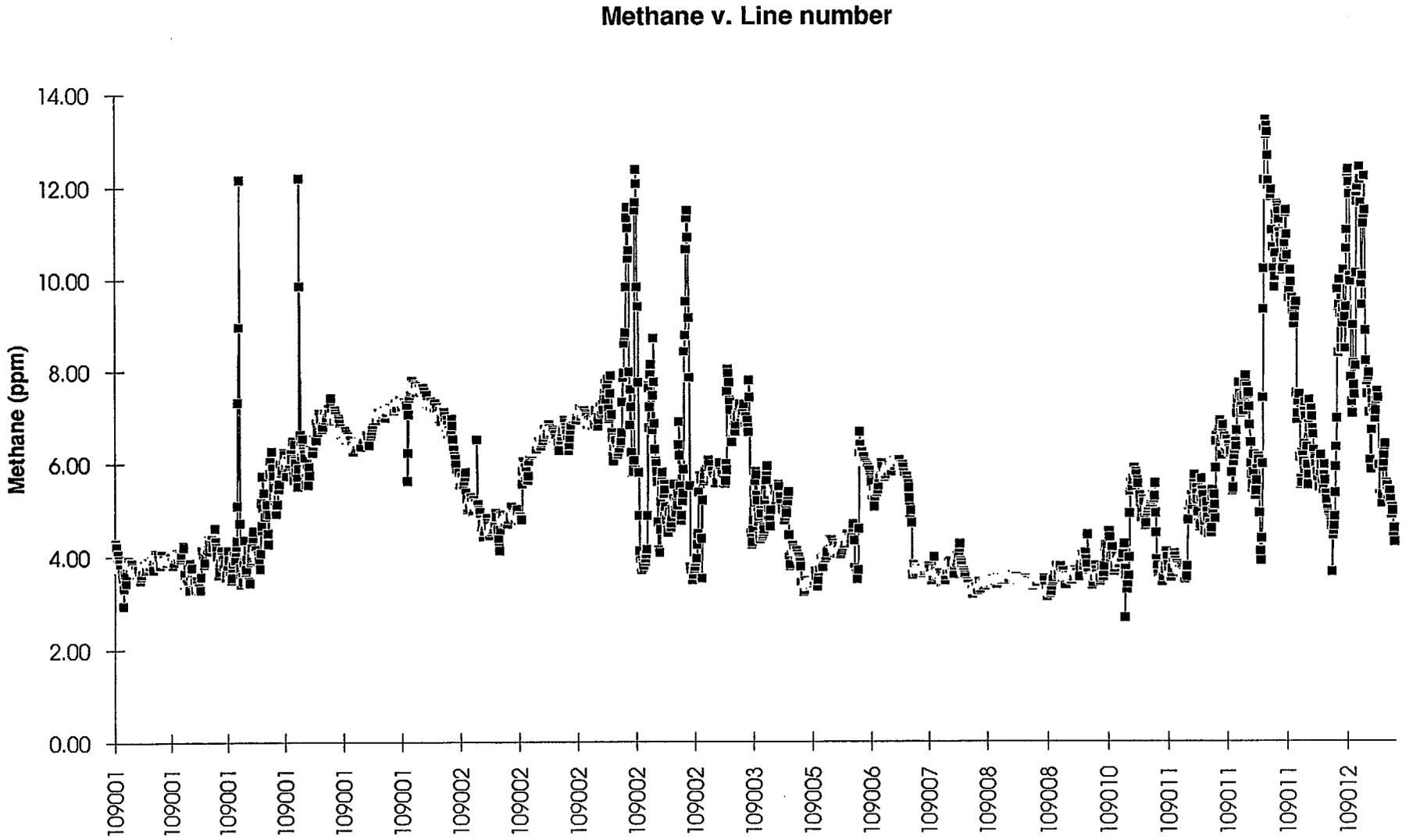


Figure 2c Methane versus survey line number, NE Palawan Shelf (Lines 109/001 through 109/012).

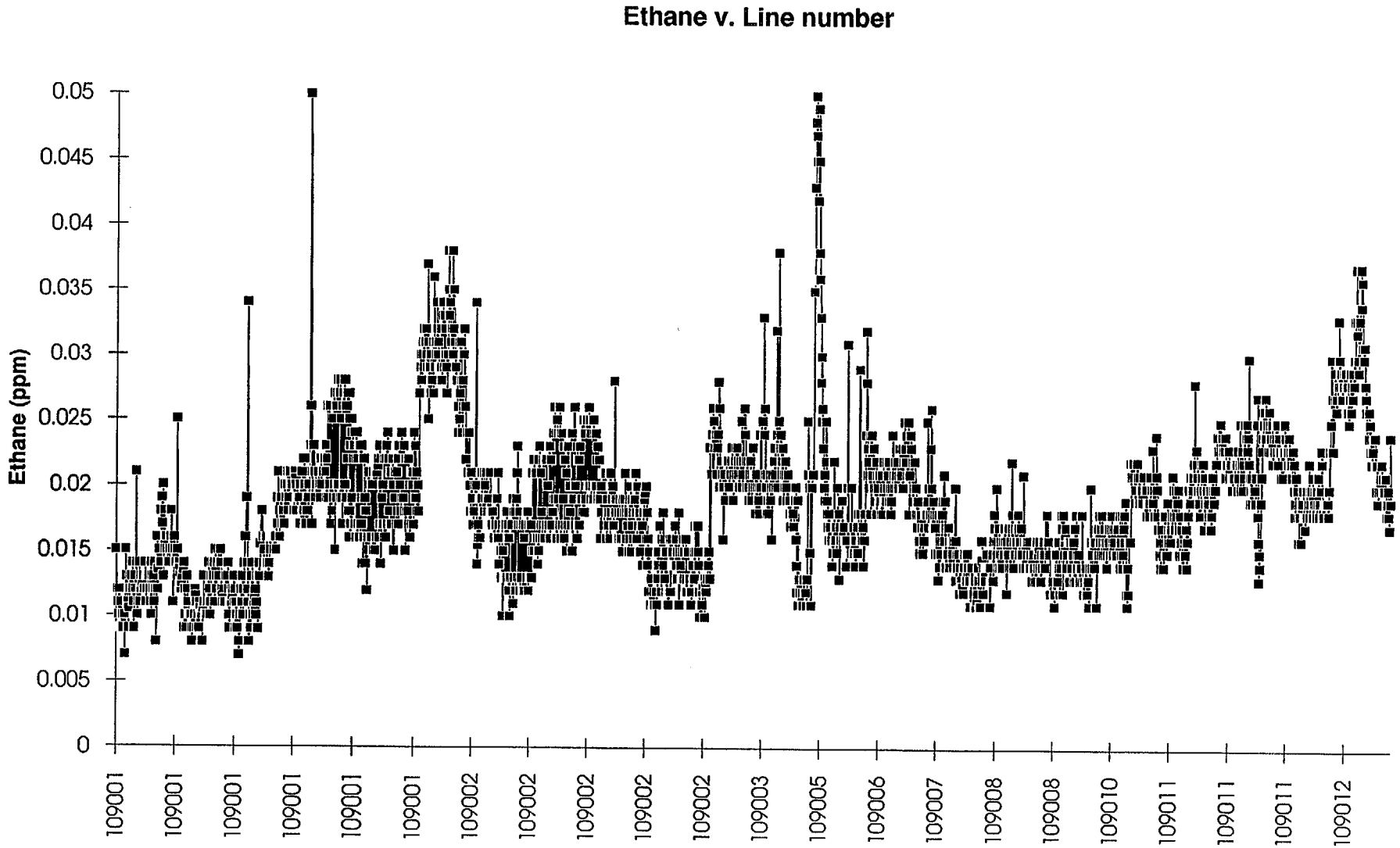


Figure 2d Ethane versus survey line number, NE Palawan Shelf (Lines 109/001 through 109/012).

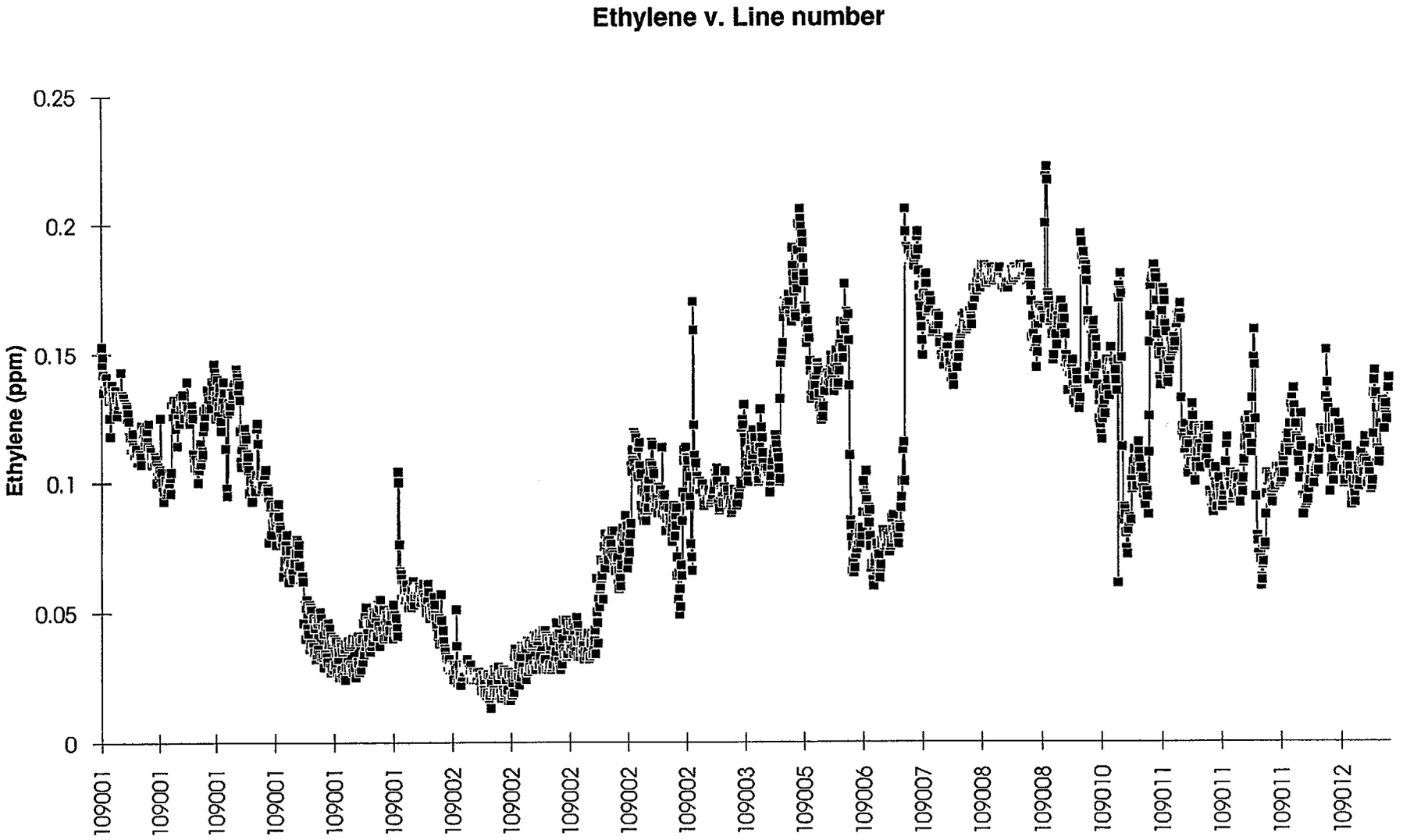


Figure 2e Ethylene versus survey line number, NE Palawan Shelf (Lines 109/001 through 109/012).

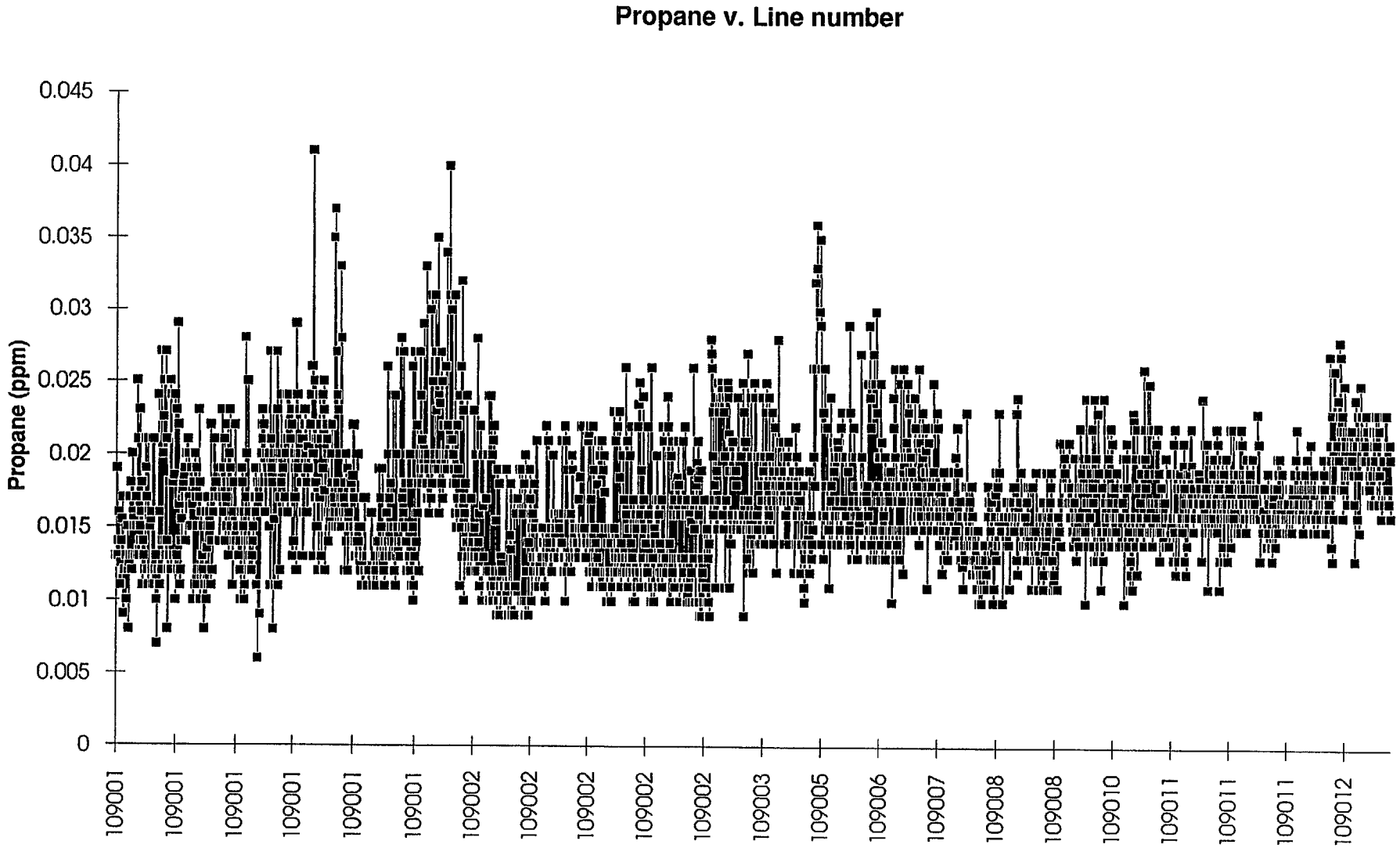


Figure 2f Propane versus survey line number, NE Palawan Shelf (Lines 109/001 through 109/012).

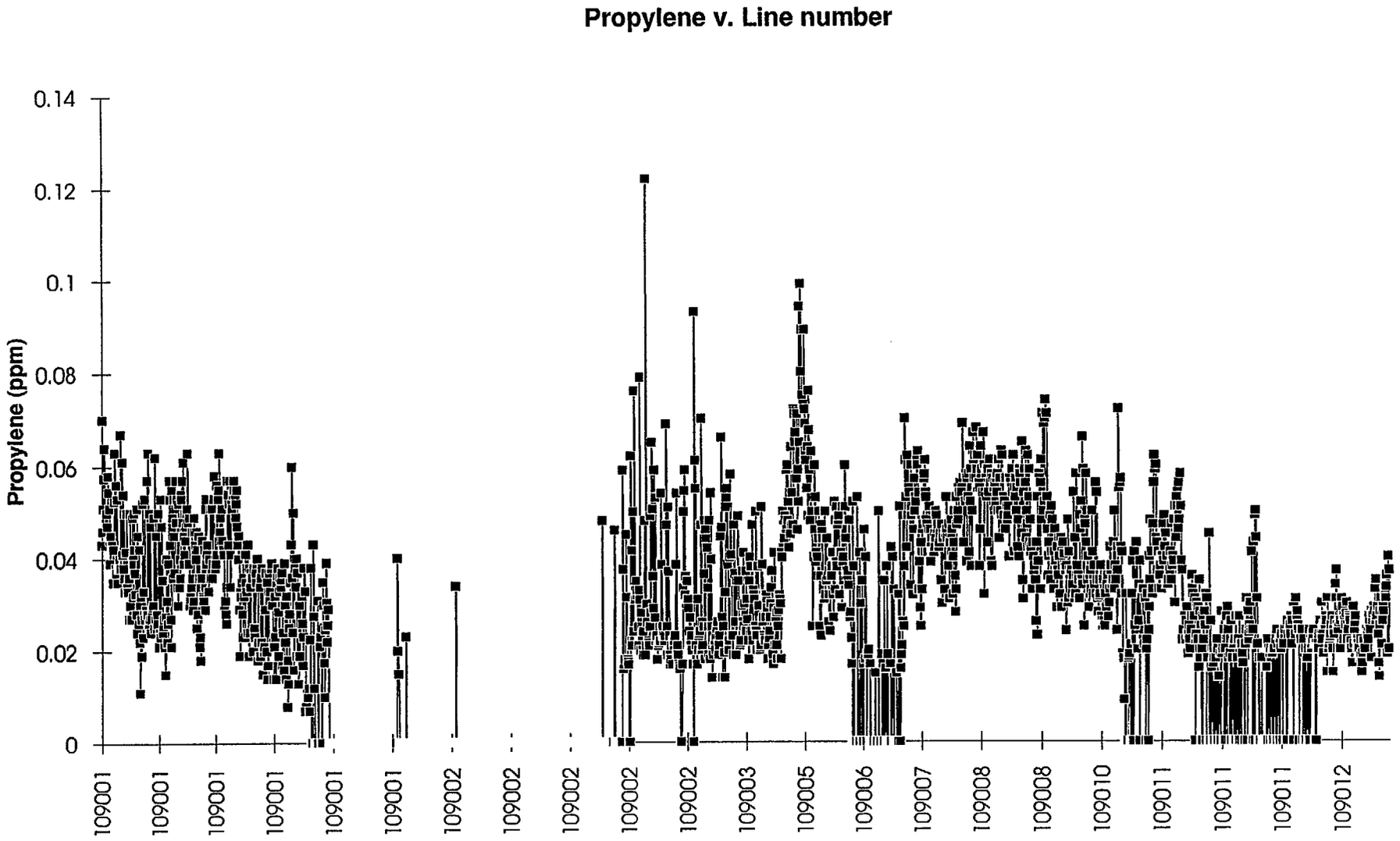


Figure 2g Propylene versus survey line number, NE Palawan Shelf (Lines 109/001 through 109/012).

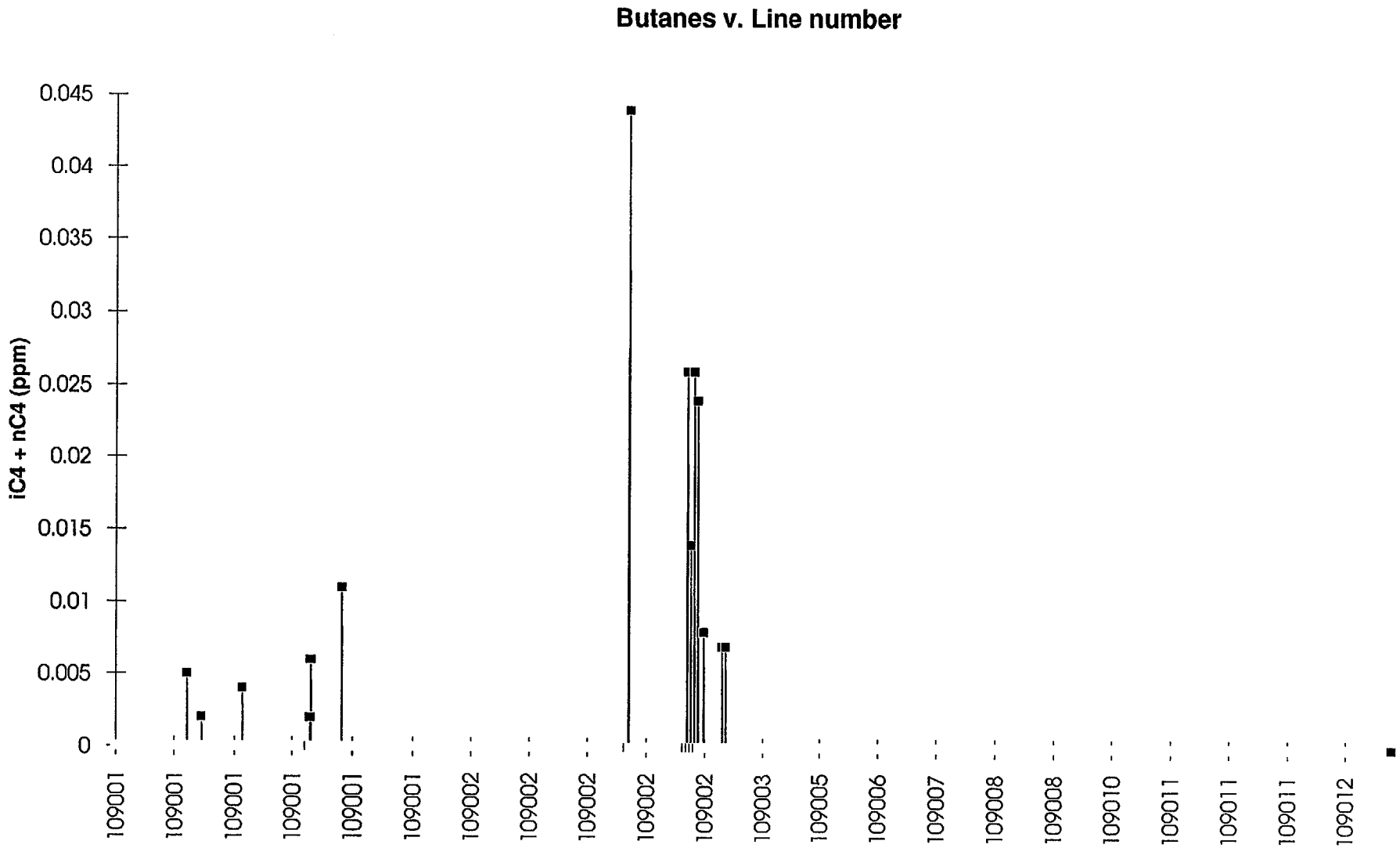


Figure 2h Total Butanes versus survey line number, NE Palawan Shelf (Lines 109/001 through 109/012).

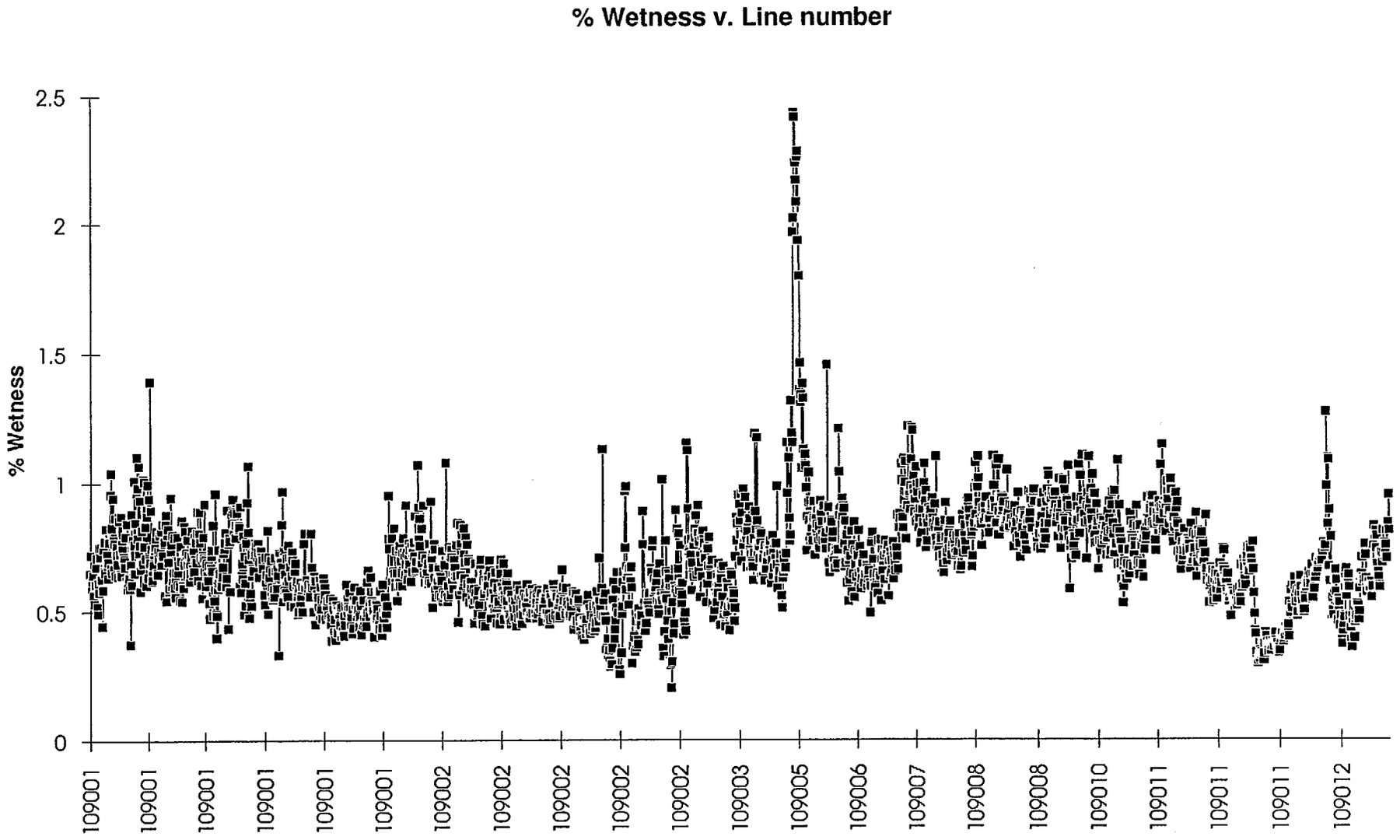


Figure 2j Percent hydrocarbon wetness versus survey line number, NE Palawan Shelf (Lines 109/001 through 109/012).

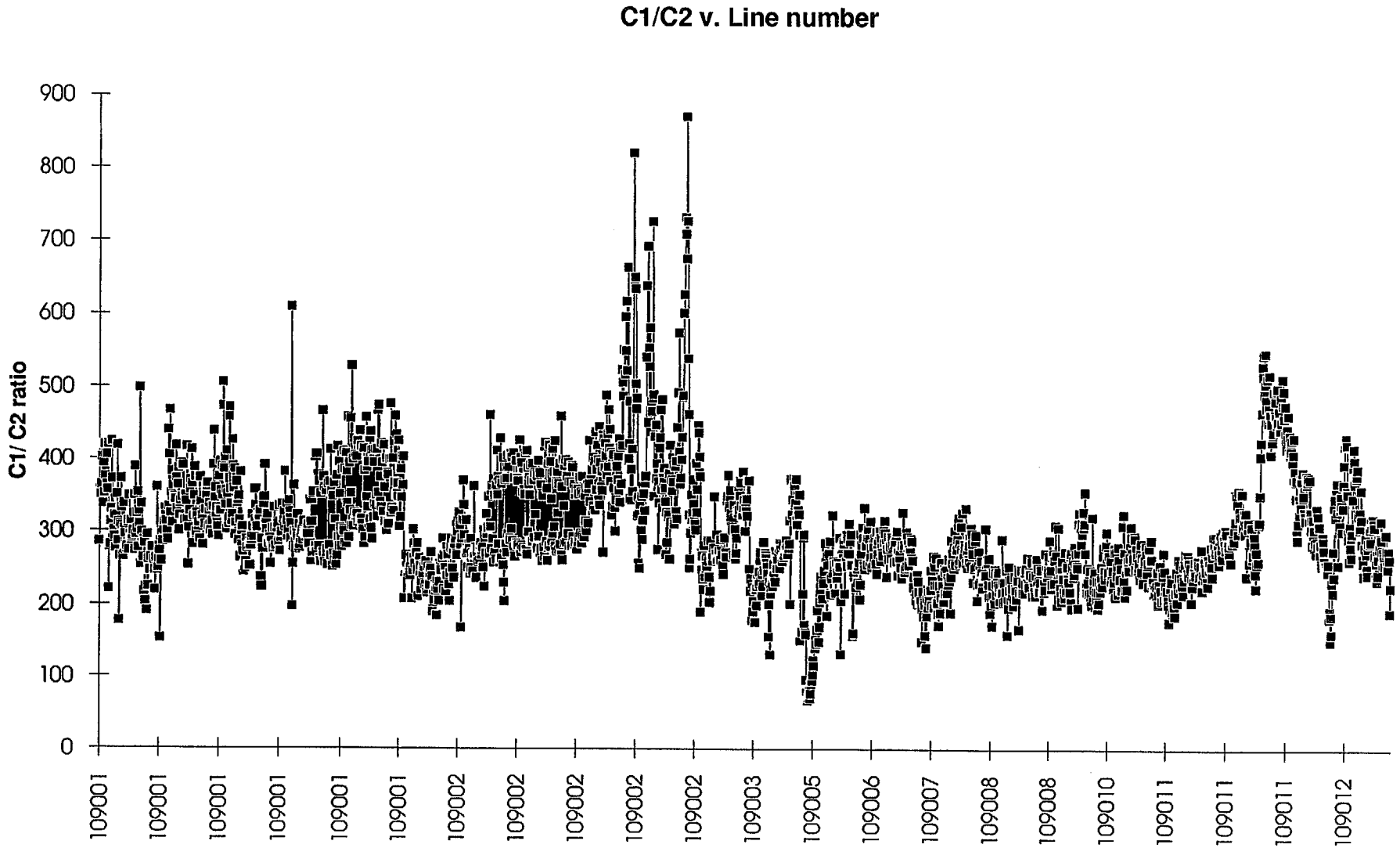


Figure 2k C_1/C_2 ratio versus survey line number, NE Palawan Shelf (Lines 109/001 through 109/012).

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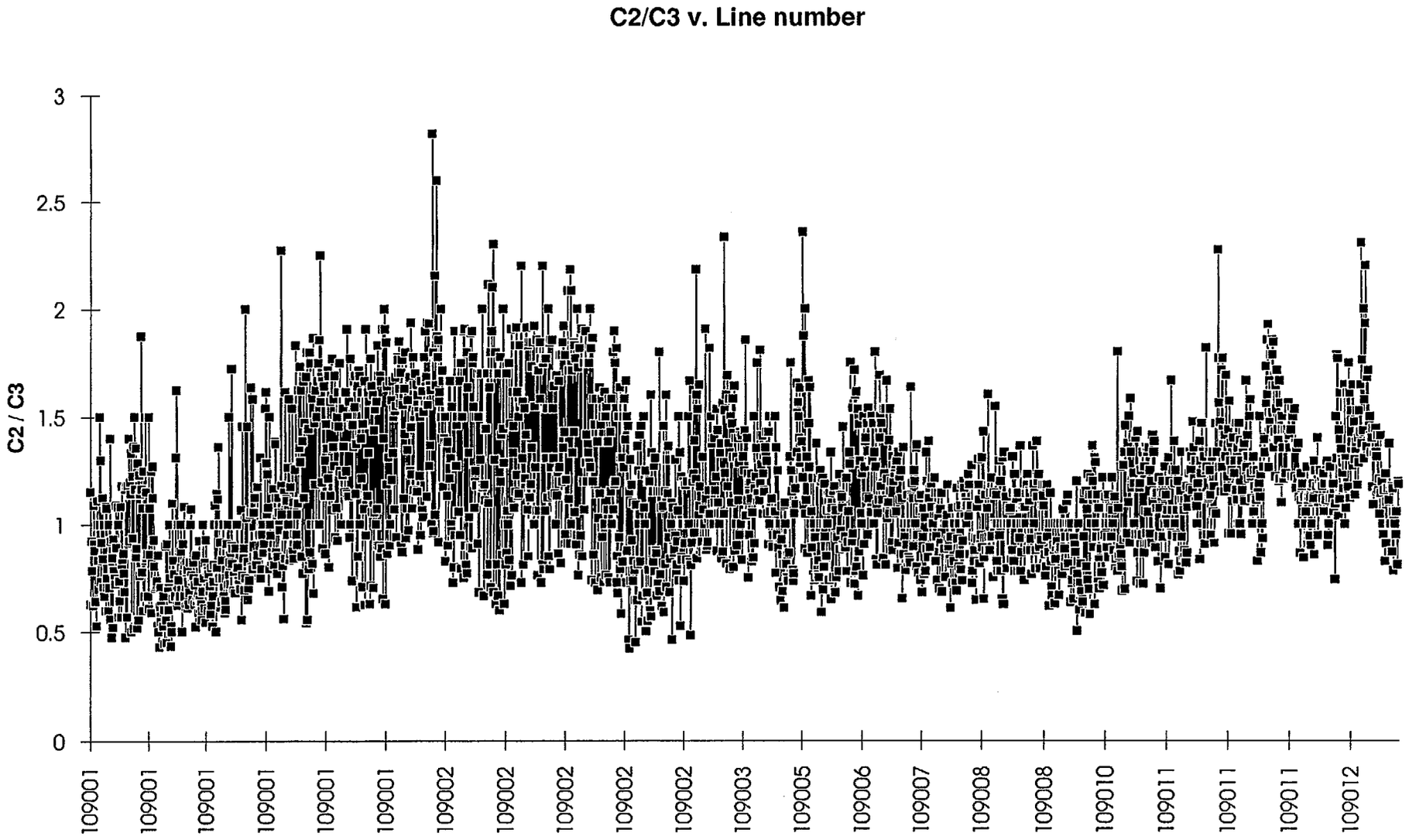


Figure 21 C_2/C_3 ratio versus survey line number, NE Palawan Shelf (Lines 109/001 through 109/012).

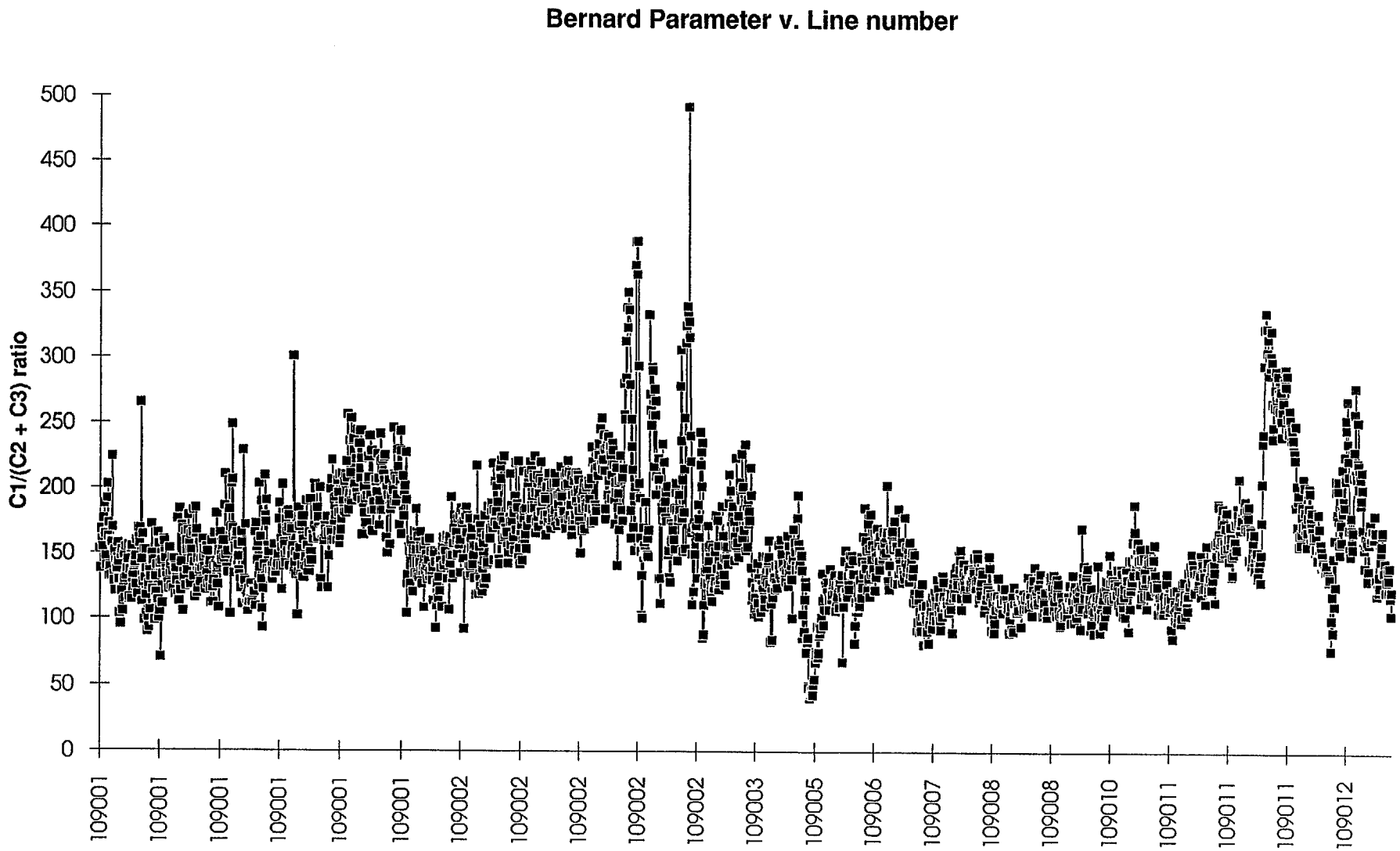


Figure 2m Bernard Parameter (C_1/C_2+C_3) versus survey line number, NE Palawan Shelf (Lines 109/001 through 109/012).

Hydrocarbon 'Source'

To investigate possible light hydrocarbon 'source' (dry gas, condensate or liquids prone) of anomalies, cross-plots of methane concentration versus percent hydrocarbon wetness and other selected hydrocarbons were constructed (Figures 3a-b). The rationale for these plots is discussed in Appendix IV, and Figure IV-I (Appendix IV).

Figure 3a is a crossplot of methane versus percent hydrocarbon wetness of NE Palawan lines 109/001 to 109/012. Two clear trends can be seen .

One trend shows a decrease in hydrocarbon wetness from background values of less than 1% (about 0.7%) to values of about 0.3 % for a three-fold increase in methane concentrations from background values of about 3-4 ppm to values approaching 14 ppm. The crossplot model suggests that this trend is derived from a 'dry' gas (thermogenic or biogenic) source. This trend-line characterises the Type A anomalies discussed earlier in (Part A).

The second trend evident in Figure 3a shows a four-fold increase in percent hydrocarbon wetness, from background values of 0.7 %, to 2.5% hydrocarbon wetness, with little increase in methane concentrations. This trend reflects the weak ethane and propane anomaly found on line 109/005, and suggests (according to the cross-plot model) a strong oil-sourced anomaly.

Figure 3b (methane vs ethane) shows two trends, confirming two different types of anomalies.

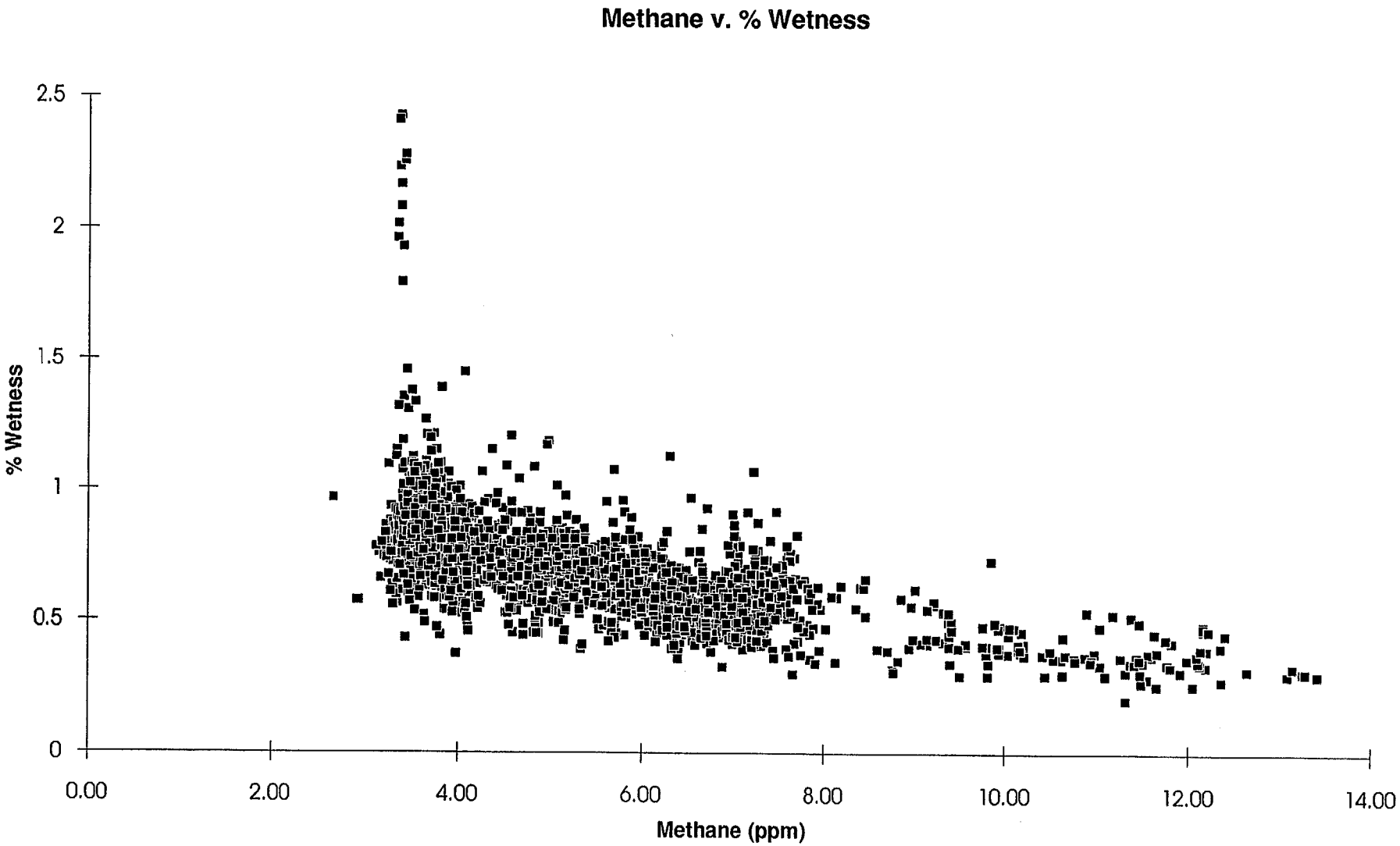


Figure 3a Methane versus percent hydrocarbon wetness , NE Palawan Shelf (Lines 109/001 through 109/012)..

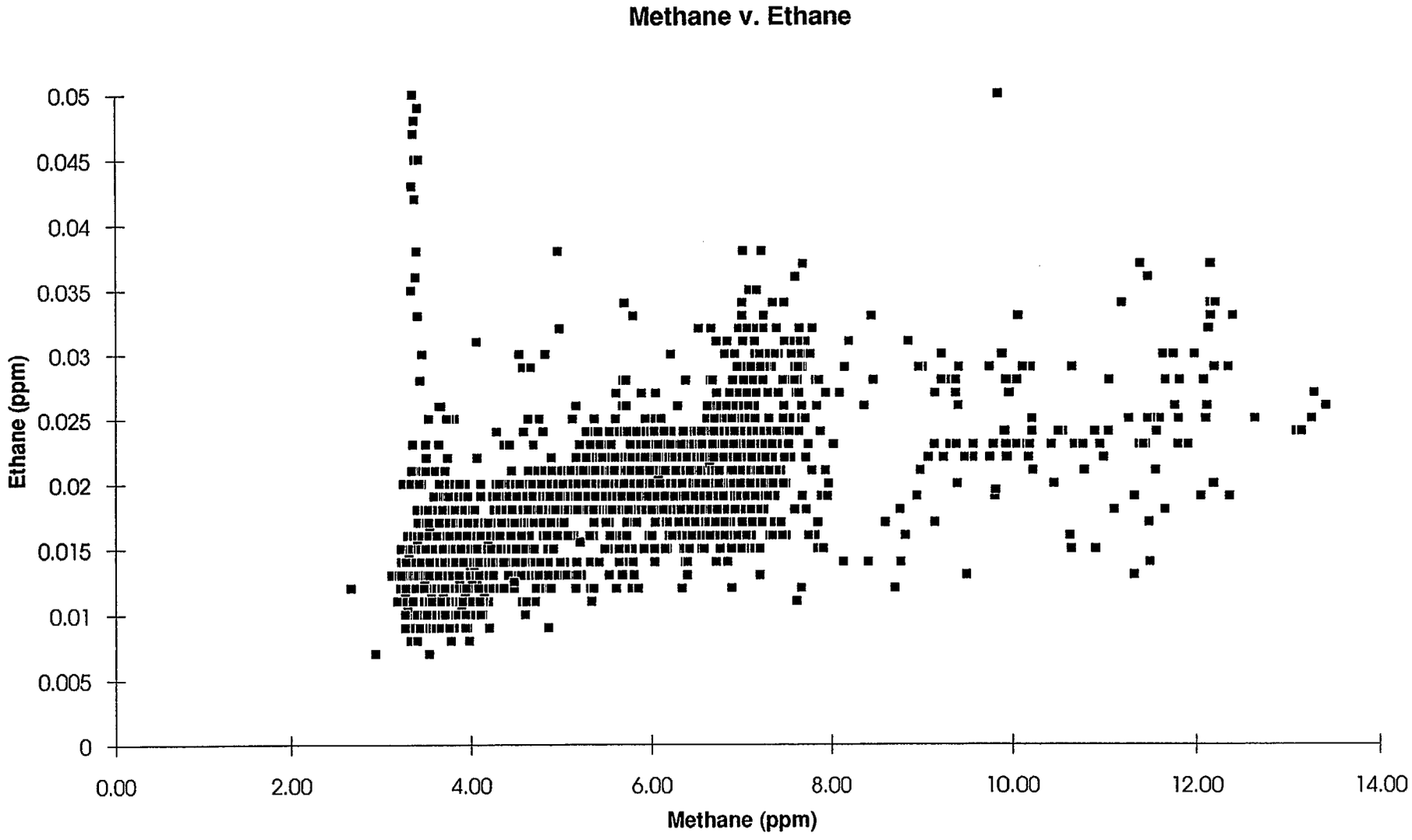


Figure 3b Methane versus ethane, NE Palawan Shelf (Lines 109/001 through 109/012).

Cuyo Platform (Lines 109/013 through 109/020)

Overview

A total of 730 line-km of seismic and DHD data were aquired along 8 lines (109/013 to 109/020), on the Cuyo Platform (Figures 4 a-k).These plots include THC, sum C_1-C_4, and the individual hydrocarbons methane, ethane, propane, ethylene, propylene and butane along the different survey lines. Also shown are the variations in the percent hydrocarbon wetness, the ratio C_1/C_2 and ratio C_2/C_3 and the Bernard parameter along the survey lines. The DHD data (for each individual line) are shown in the Appendix II, as hydrocarbon concentrations plotted against DHD shot-point, along each survey line.

No significant hydrocarbon anomalies were found in this area. However, some other anomalous features were noted. Some of these are probably related to the DHD tow-fish striking the seafloor (survey lines 109/017 through 109/020), resulting in artifacts in hydrocarbon concentrations. The apparent anomalies in ethane detected on survey lines 109/017 are probably related to a combination of factors, including temporarily poor integrator performance noted on the operational log-sheets and the fact that the DHD tow-fish hit the seafloor on this line. The apparent propane anomaly on survey line 109/0015 (Figure 4f) is also probably related to a temporarily poor GC integrator performance and adjustment noted on the operational log-sheets. Variations in the unsaturated hydrocarbons ethylene and propylene (the biogenic hydrocarbons) reflect variations in tow-fish altitude above the seafloor (Figures 4 e & g).

Two other observations are worth noting from this survey area. First, methane concentrations are generally elevated about two-to-three-fold above what we believe to be typical 'background' concentrations of 2 - 4 ppm (Figure 4c). Secondly, there is an increase (albeit weak) in the wetness parameter on line 109/013. This increasing wetness is not related to an increase in either the ethane or propane concentrations, but rather a decrease in the methane concentration. The net effect is an increase in wetness (Figure 4h). The petroleum significance of this is unknown.

A brief description of survey lines is presented on the following pages.

Line 109/013:

Several trace (1- 3 ppm) increases in methane and ethane were found along the line. All are related to increases in the unsaturated hydrocarbons ethylene and propylene in surface waters and varying tow-fish depths (Figures 4c-f).

Line 109/014:

No significant anomalies were found on this line. Trace increases in THC and methane, (1 ppm to 3 ppm above background) were found at six locations along the line and are related to shallowing water depths and increases in ethylene and propylene concentrations (Figures 4 a,c,e & g).

Line 109/015:

No significant anomalies were found on this line. Trace increases in THC and methane along this line are related to the tow-fish being lowered and raised through the water column over the irregular seafloor topography. The erratic propane values along the line are due to poor integration of the chromatographs (Figures 4 a,c & f).

Line 109/016:

A trace increase in THC (less than 5 ppm above background) was found towards the middle of the line (Figure 4a).

Line 109/017:

The weak THC, methane and ethane anomaly at the beginning of the line marks the position of the tow-fish hitting the seafloor. THC values increase from 15 ppm to 19 ppm. Erratic ethane values are due to the poor integration of the chromatographs (Figures 4 a,c & d).

Line 109/018:

The very weak THC and methane anomaly occurring towards the SE end of the line marks the position of the tow-fish hitting bottom. THC is seen to increase by 3 ppm above background values (Figures 4 a & c).

Line 109/019:

The anomaly at the NE end of the line marks the position of the tow-fish hitting bottom, resulting in about a doubling of the methane and THC concentrations (Figure 4a).

Line 109/020:

The weak THC, methane propane and ethane anomaly occurring at shotpoint 32 marks the position of the tow-fish hitting bottom (Figures 4 a,c,d & f).

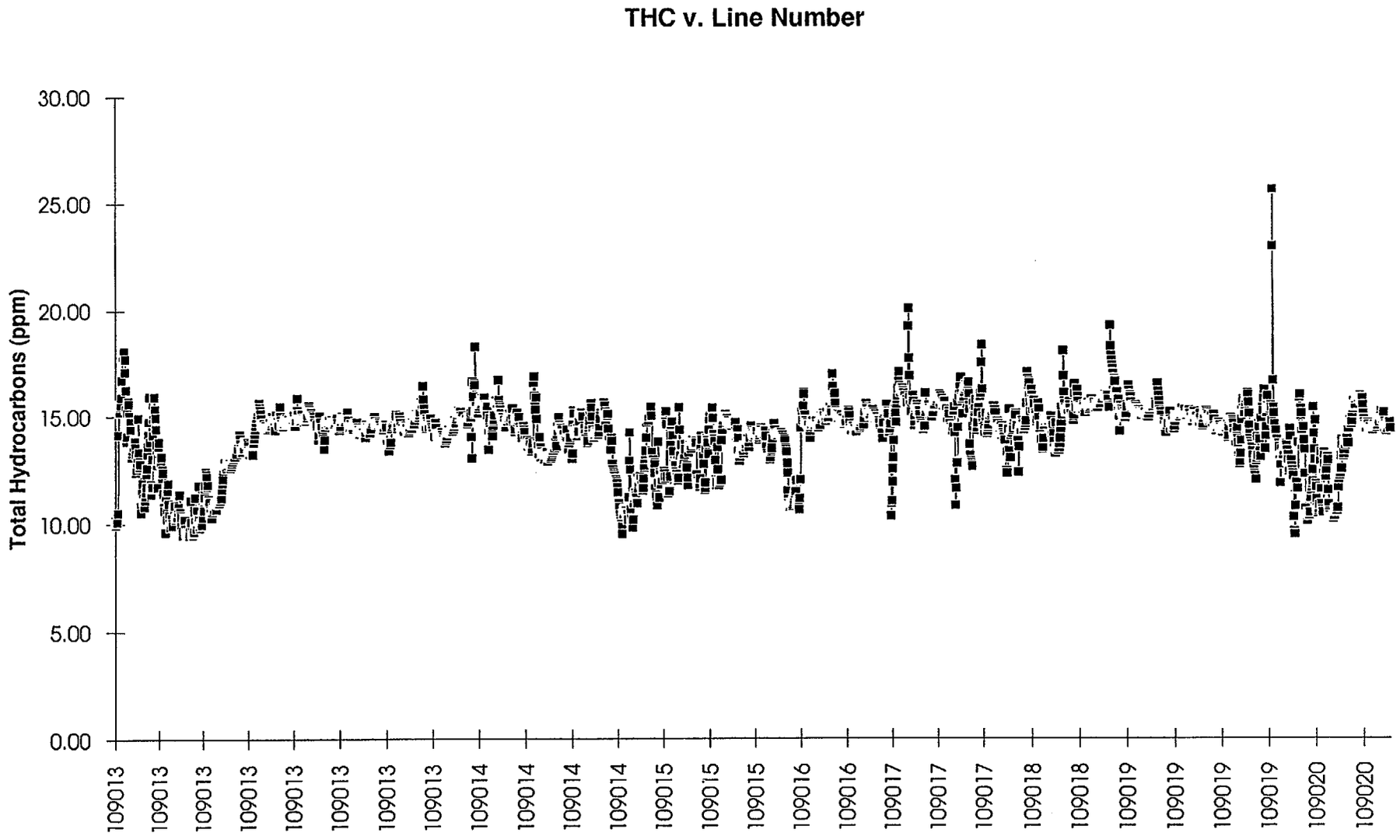


Figure 4a Total Hydrocarbons (THC) versus survey line number, Cuyo Platform (Lines 109/013 through 109/020).

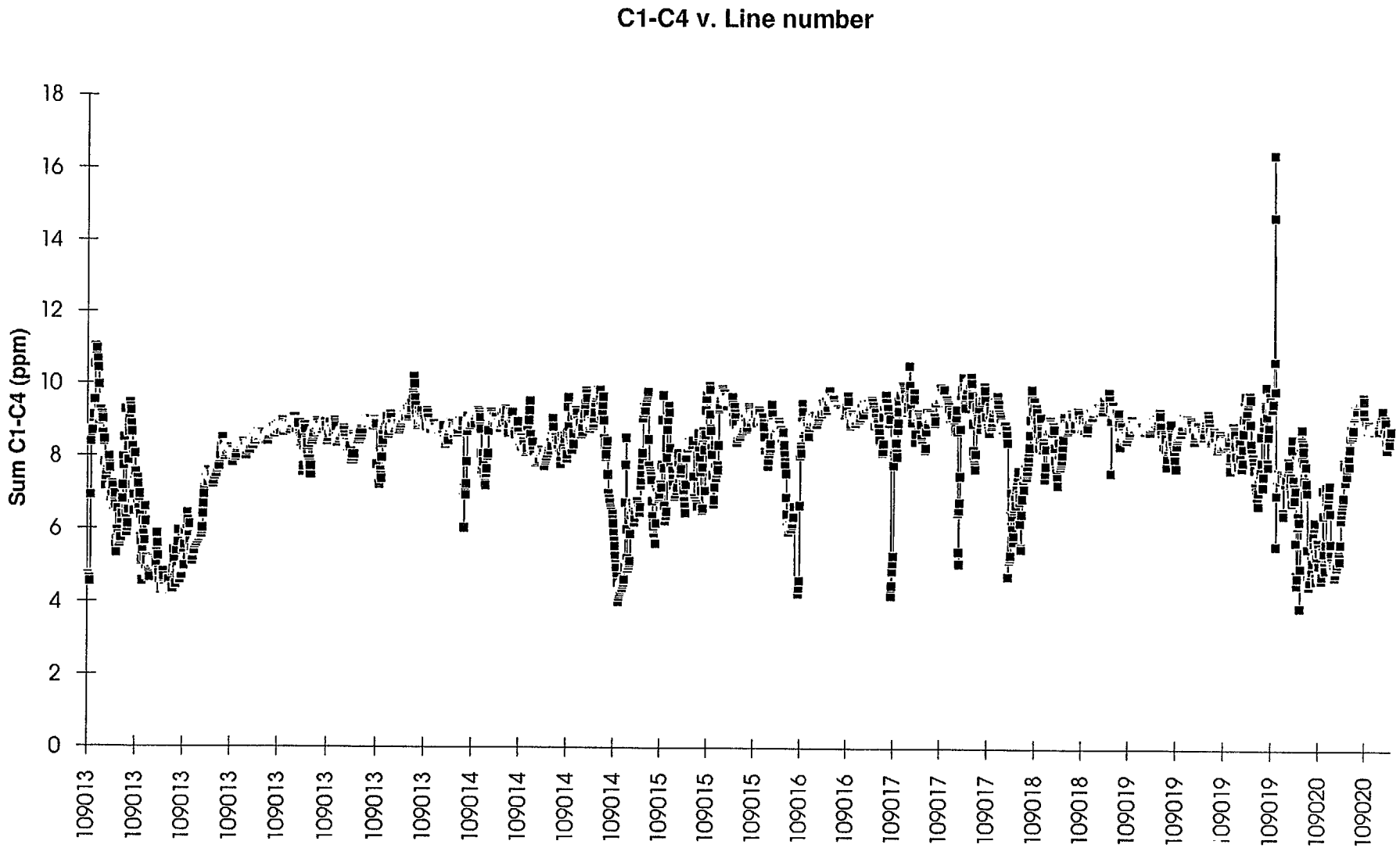


Figure 4b Sum C_1-C_4 versus survey line number, Cuyo Platform (Lines 109/013 through 109/020).

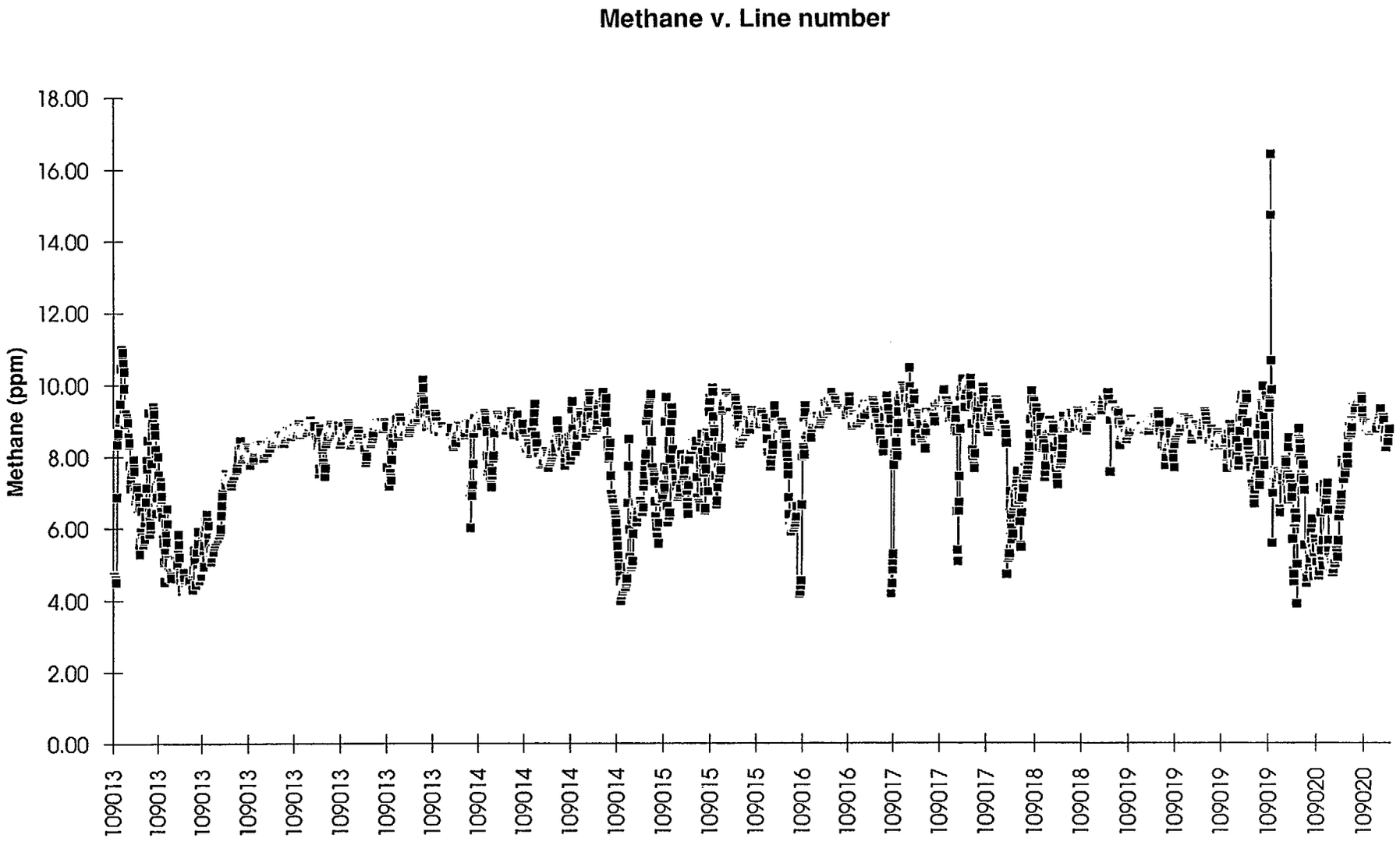


Figure 4c Methane versus survey line number, Cuyo Platform (Lines 109/013 through 109/020).

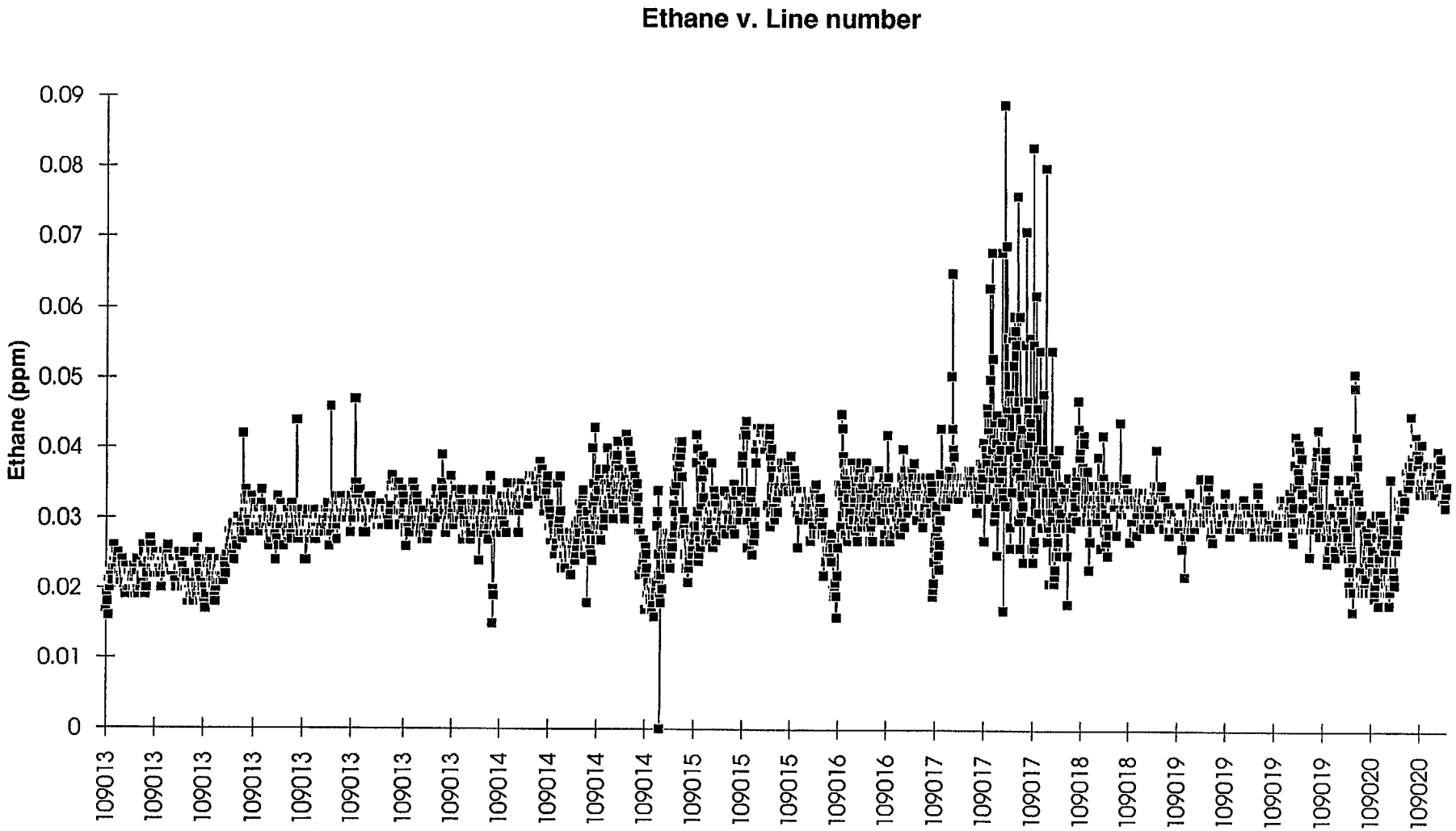


Figure 4d Ethane versus survey line number, Cuyo Platform (Lines 109/013 through 109/020).

CUYO_C2.XLC 13/11/92

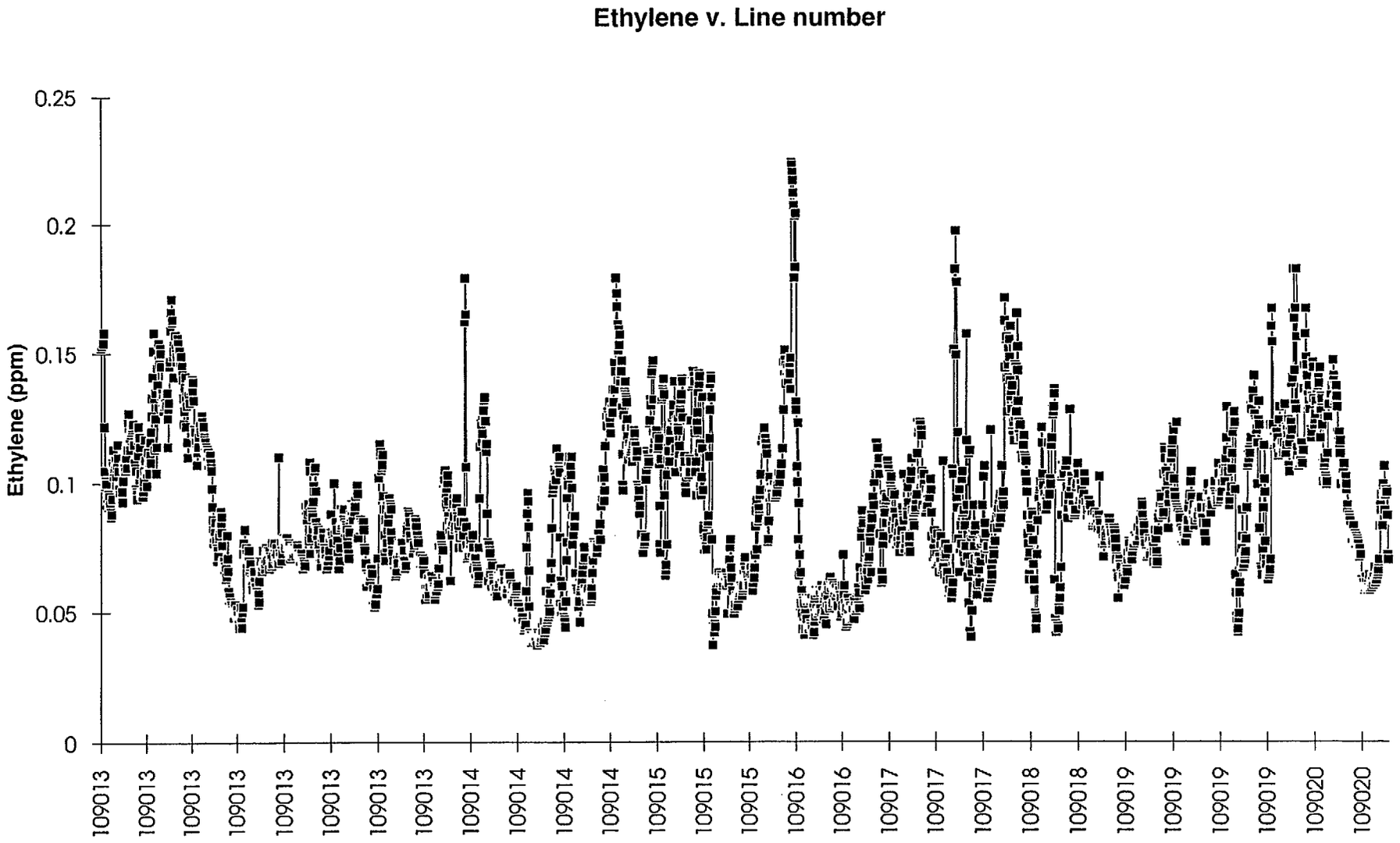


Figure 4e Ethylene versus survey line number, Cuyo Platform (Lines 109/013 through 109/020).

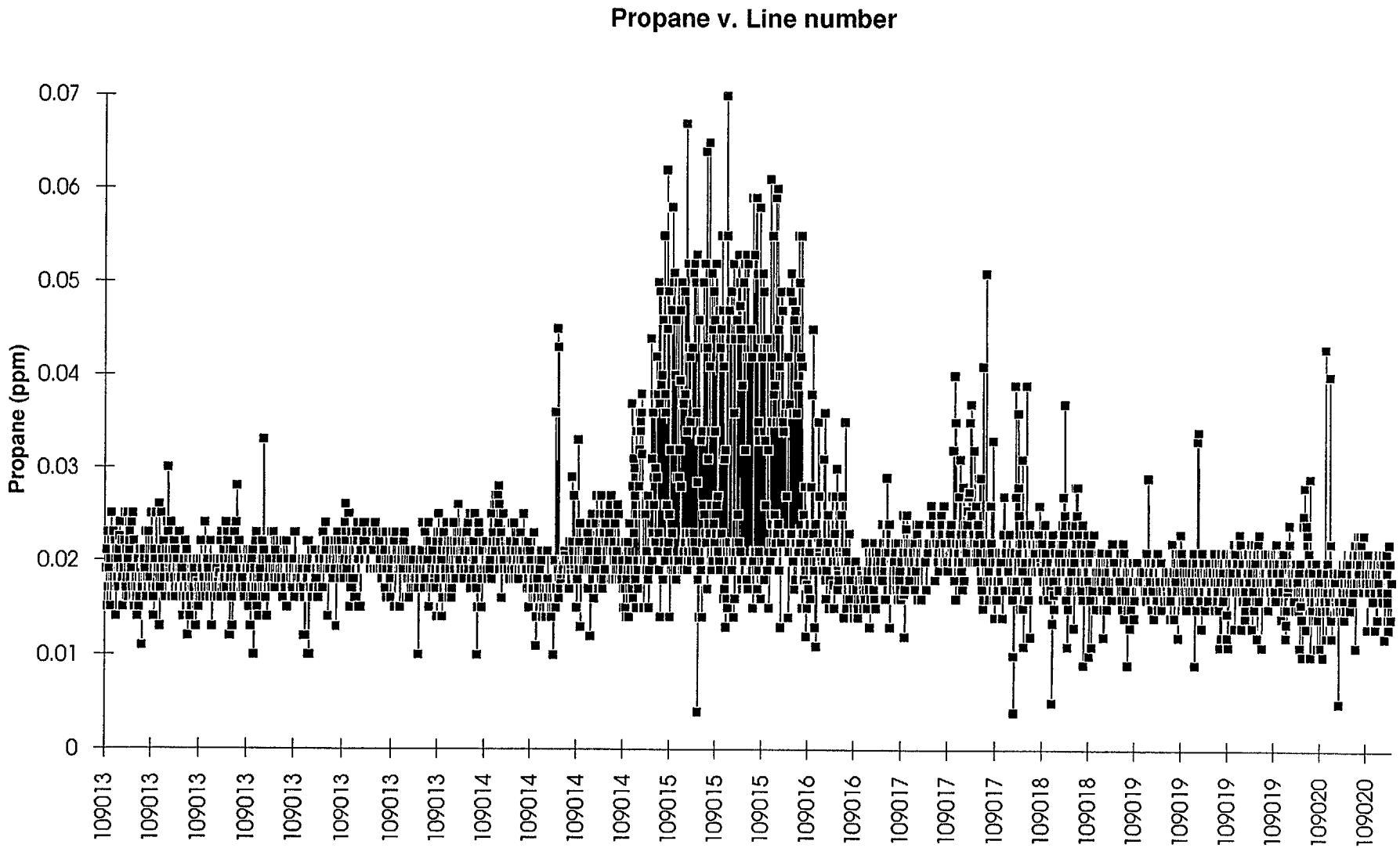


Figure 4f Propane versus survey line number, Cuyo Platform (Lines 109/013 through 109/020).

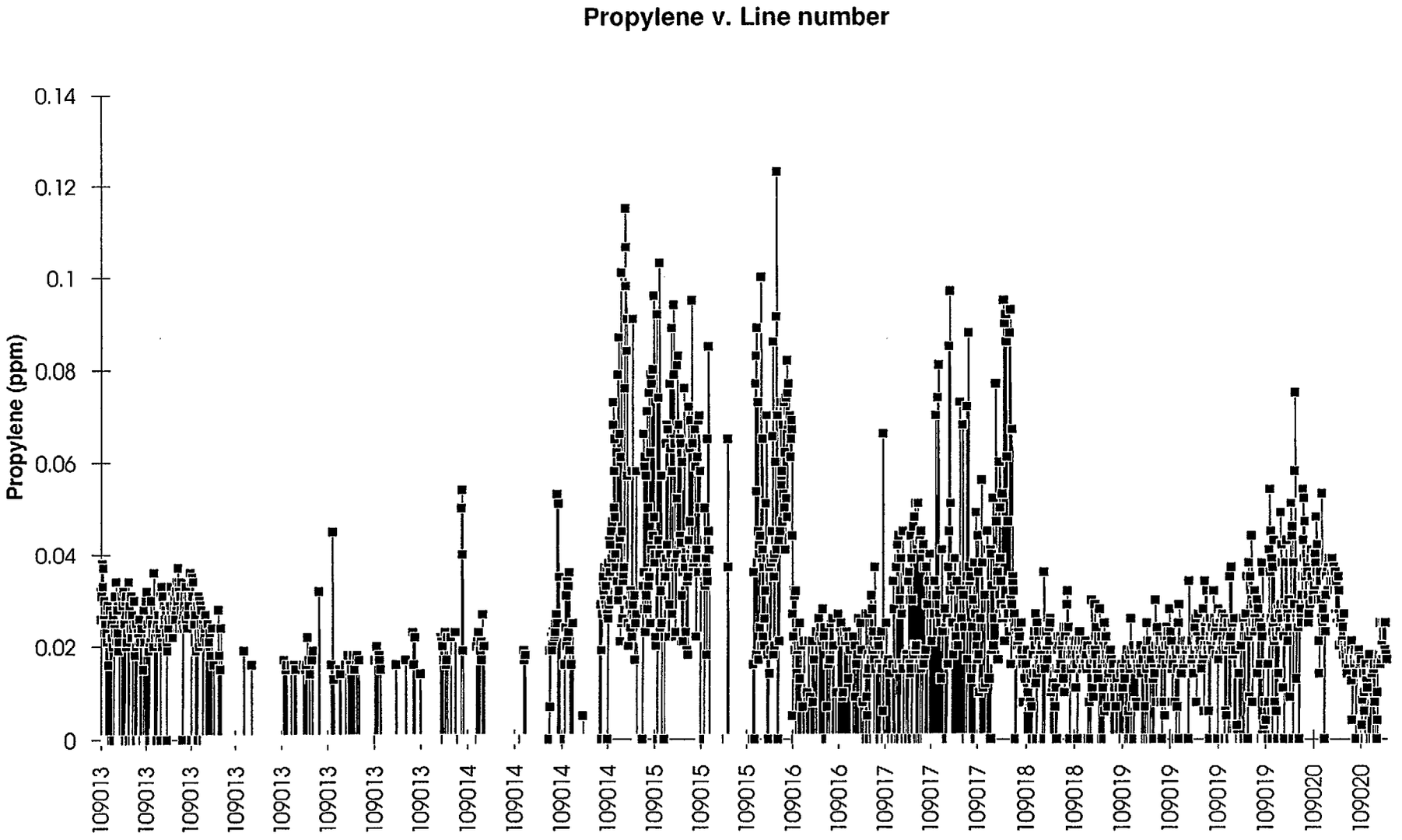


Figure 4g Propylene versus survey line number, Cuyo Platform (Lines 109/013 through 109/020).

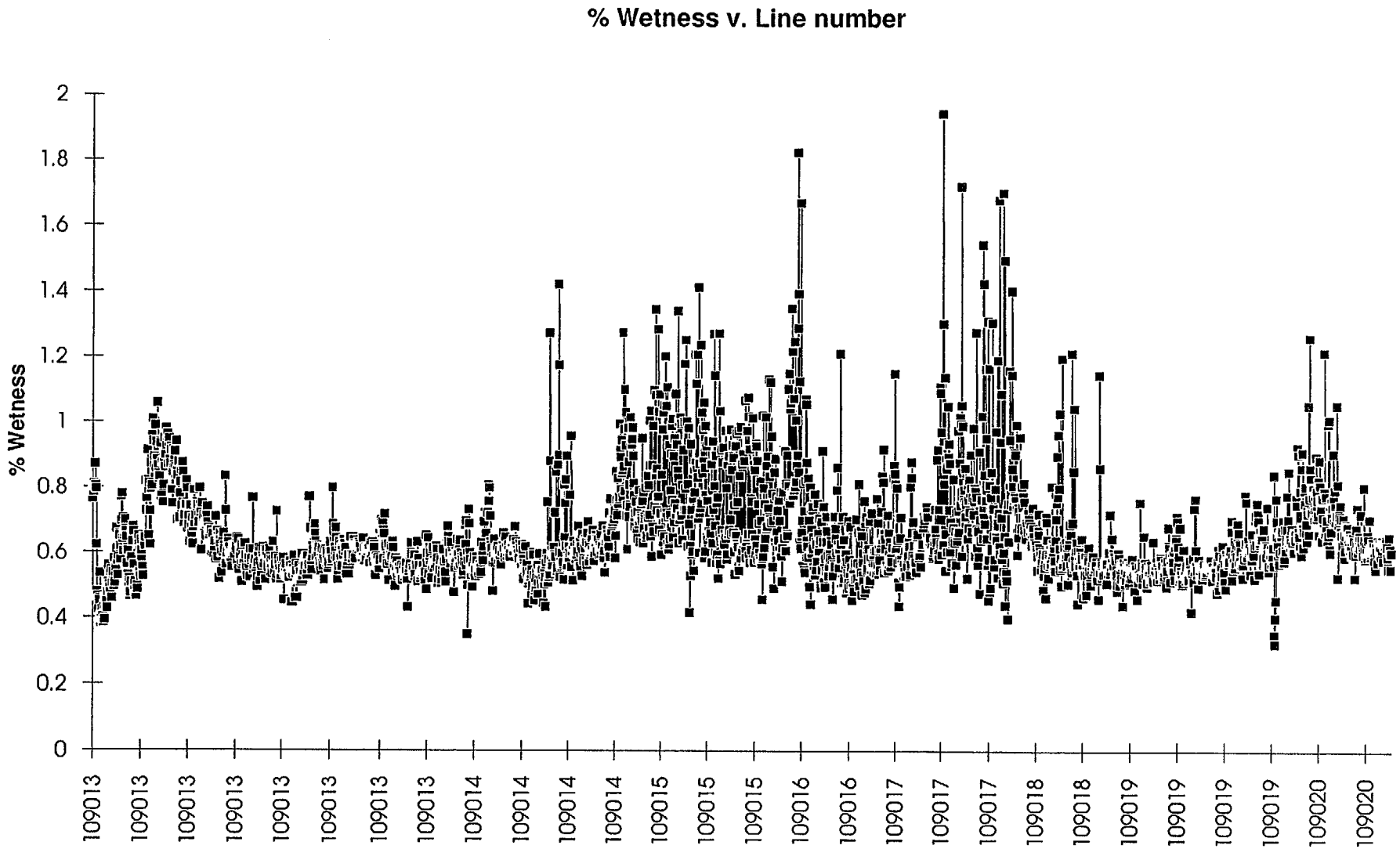


Figure 4h Percent hydrocarbon wetness versus survey line number, Cuyo Platform (Lines 109/013 through 109/020).

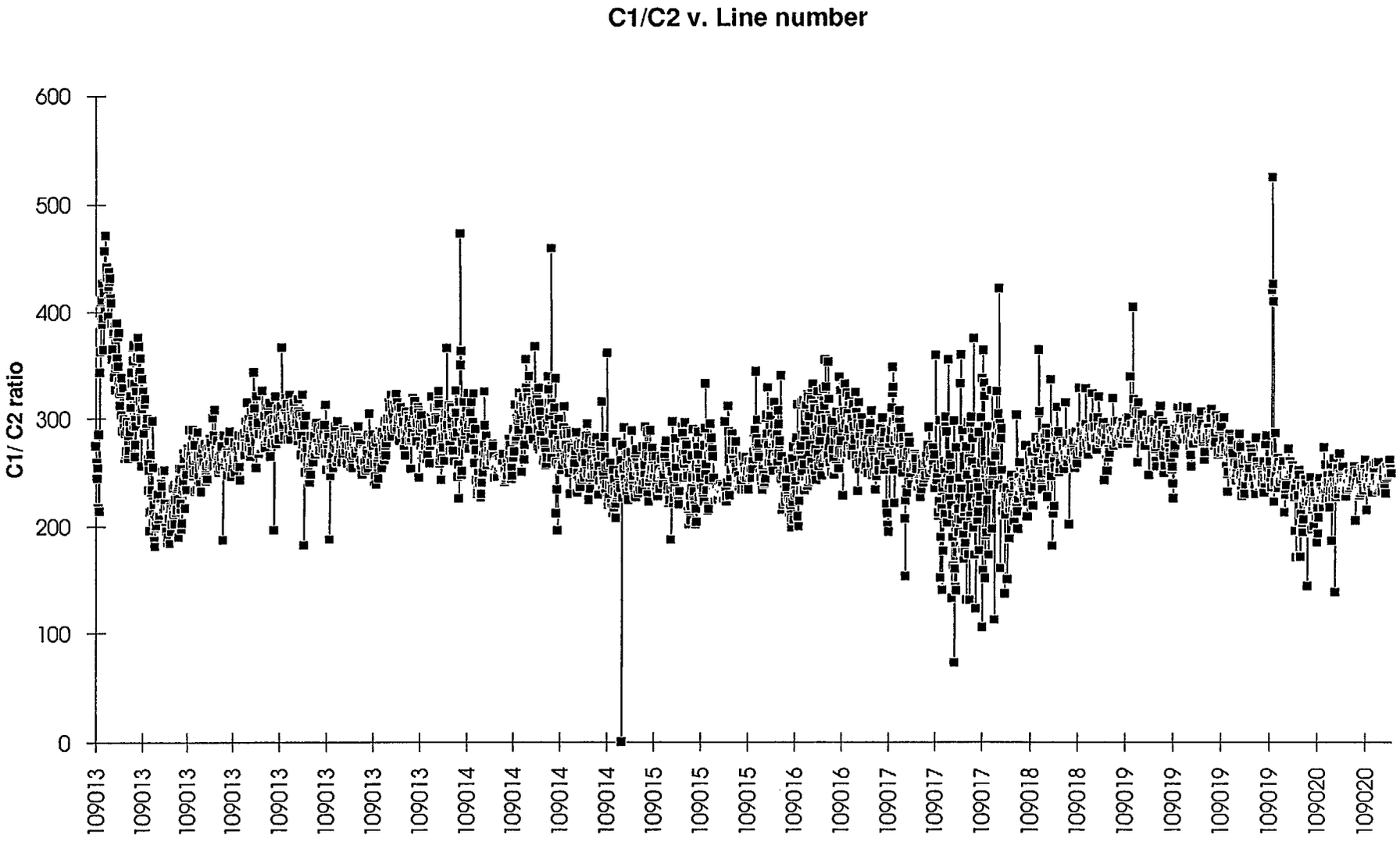


Figure 4i C_1/C_2 ratio versus survey line number, Cuyo Platform (Lines 109/013 through 109/020).

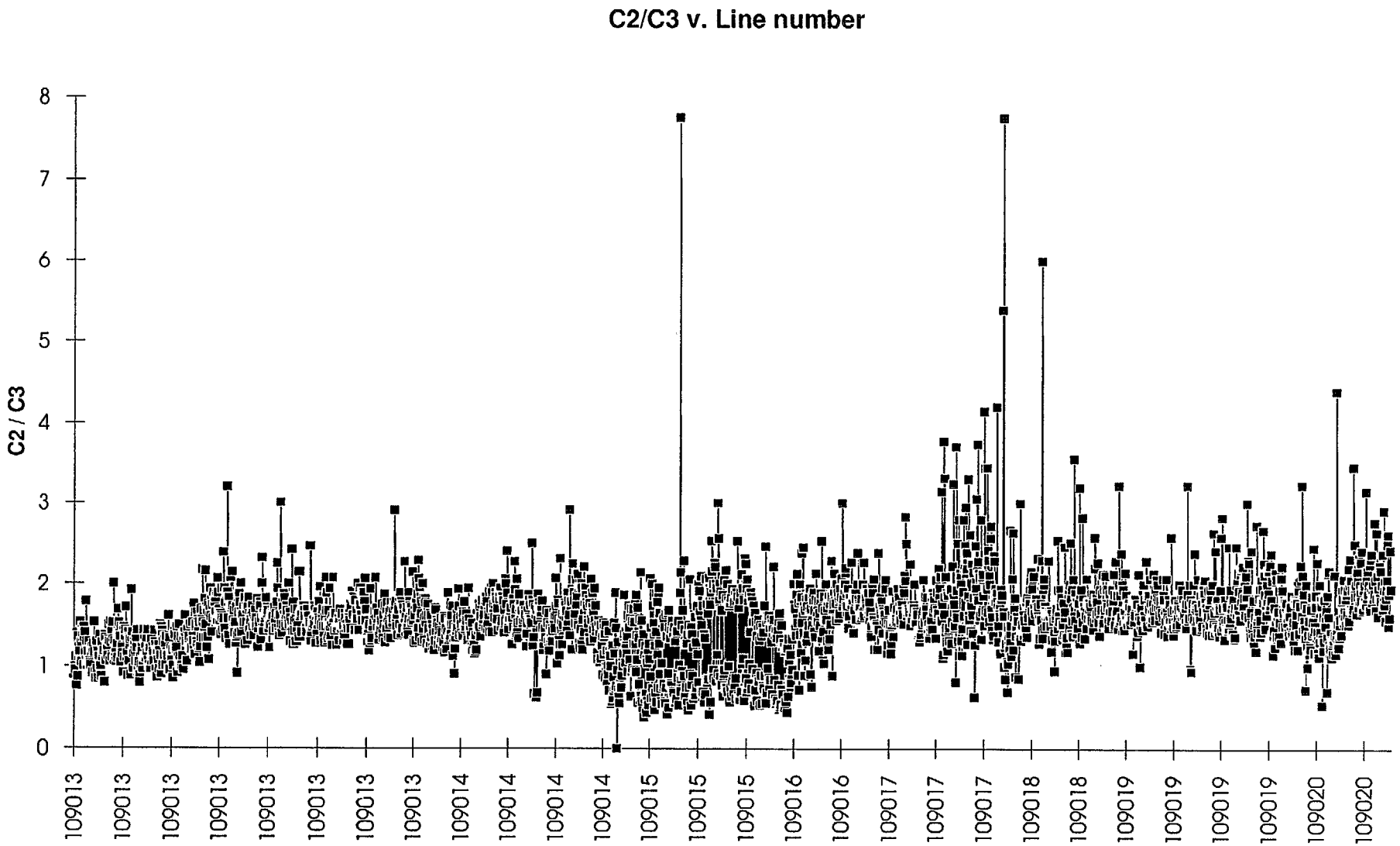


Figure 4j C_2/C_3 ratio versus survey line number, Cuyo Platform (Lines 109/013 through 109/020).

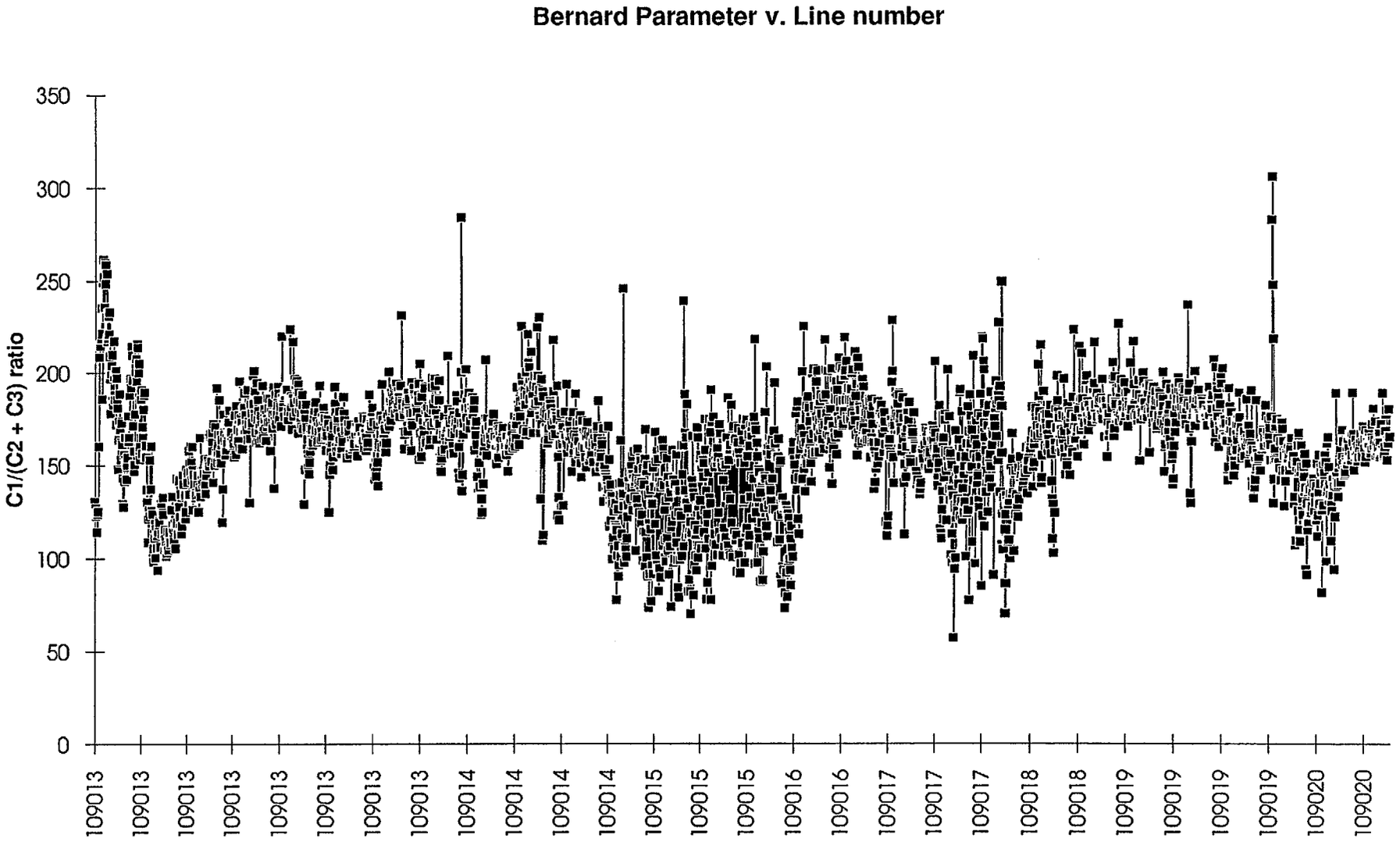


Figure 4k Bernard Parameter (C_1/C_2+C_3) versus survey line number, Cuyo Platform (Lines 109/013 through 109/020).

Hydrocarbon 'Source'

To investigate possible light hydrocarbon 'source' (dry gas, condensate or liquids prone) of anomalies, cross-plots of methane concentration versus percent hydrocarbon wetness and other selected hydrocarbons were constructed (Figures 5 a & b). The rationale for these plots is discussed in Appendix IV, and Figure IV-I (Appendix IV).

Figure 5a is a crossplot of methane versus percent hydrocarbon wetness for Cuyo Platform, lines 109/013 through 109/020.

One trend shows a decrease in percent hydrocarbon wetness from background values of less than 1% (about 0.7 %) to values of 0.4 % hydrocarbon wetness, with a two-fold increase in methane. This trend is a result of the tow-fish hitting the seafloor, giving an anomalous (but artifact) light hydrocarbon anomaly on line 109/019.

No other clear trends are evident. The scatter in the data, and the wetness values greater than 1% hydrocarbon wetness result from the elevated ethane and propane values on lines 109/015, 109/016 and 109/017, which are artifacts resulting from erratic propane, ethane and butane values noted earlier.

Methane and ethane are cross correlated in Figure 5b.

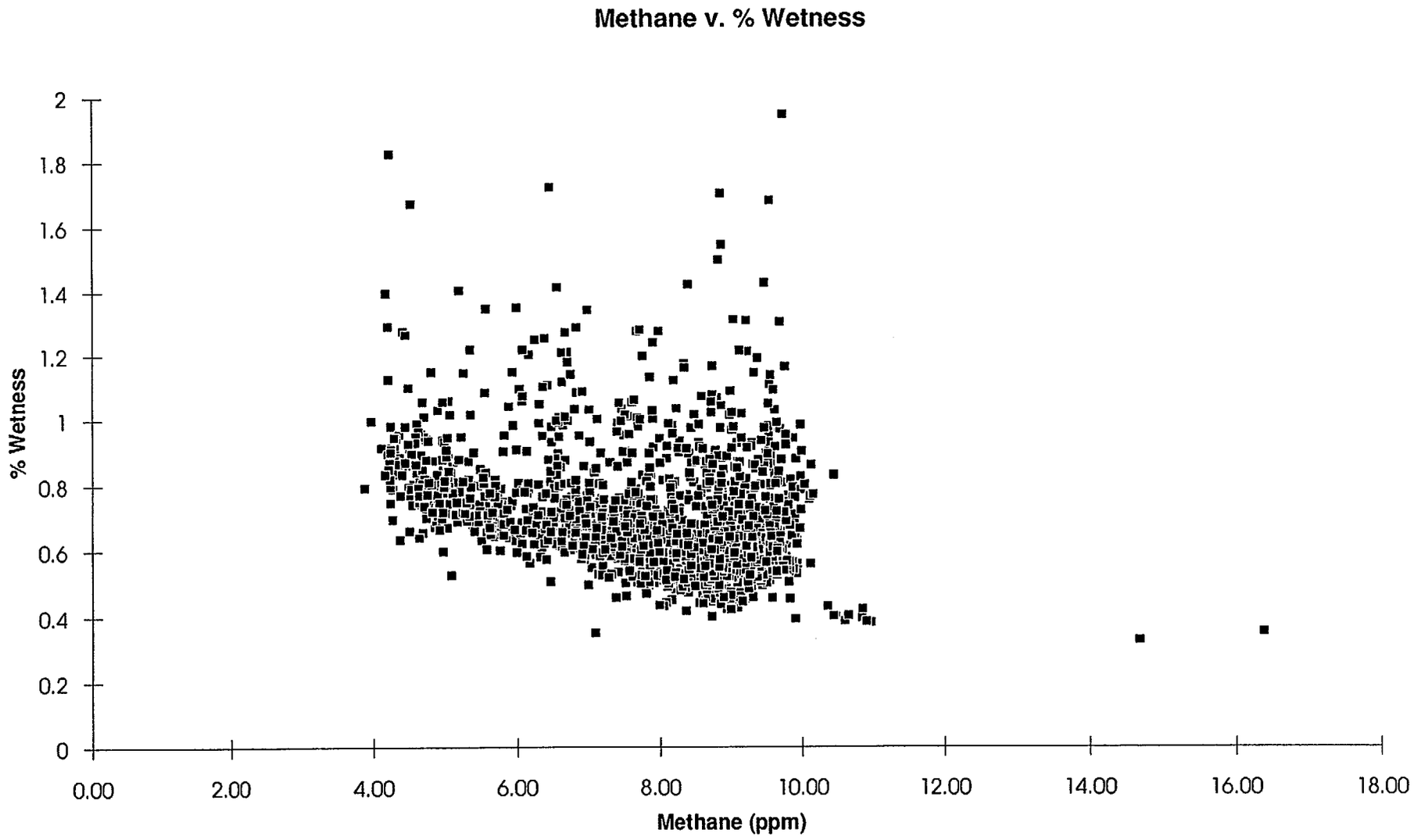


Figure 5a Methane versus percent hydrocarbon wetness , Cuyo Platform (Lines 109/013 through 109/020)..

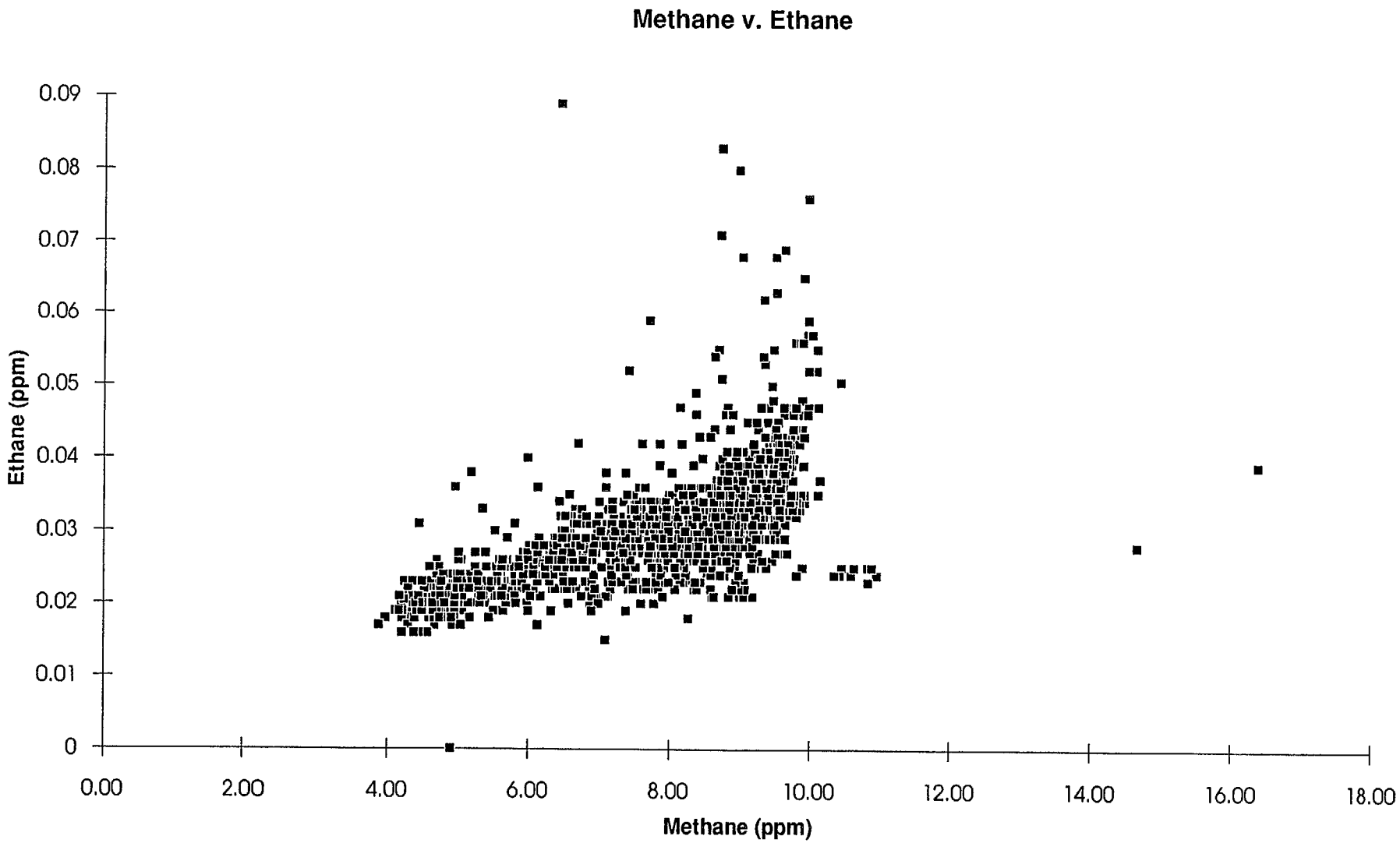


Figure 5b Methane versus ethane, Cuyo Platform (Lines 109/013 through 109/020).

SUMMARY: NE PALAWAN SHELF AND CUYO PLATFORM RESULTS

A total of 5160 line-km of DHD data were collected from four areas of the Philippines continental shelf. Of these 580 line-km were collected concurrently with seismic data from the NE Palawan Shelf and 730 line-km were collected from the Cuyo Platform.

There were no significant hydrocarbon anomalies found on the NE Palawan Shelf. However, some weak light hydrocarbon anomalies were detected. Anomalous but weak levels of THC, methane, ethane and trace propane were found near the three plugged and abandoned oil wells on the NE Palawan Shelf (Roxas-1 on lines 109/002, and 109/012, Paly-1 on line 109/002, and Dumaran-1 on line 109/001). These anomalies were associated with other broad, elevated, and weak increases in methane and ethane concentrations.

A weak but aerially extensive (approximately 30 km) anomaly was found in NE Palawan near to where lines 109/012 and 109/011 intersect.

Anomalous but weak levels of ethane and propane were found on line 109/005 resulting in an increase in the percent hydrocarbon wetness. The petroleum significance of this is unknown.

No significant anomalies were found on the Cuyo Platform.

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ACKNOWLEDGMENTS

We wish to thank the Master, A. Codrington, and crew of the R.V. *Rig Seismic* and all AGSO/Filipino/AIDAB scientific and technical staff listed below for their skill and contributions to the success of this study. Dr David Lowe and his staff from (NIWAR) New Zealand for carbon isotope analysis of the gas samples.

List of AGSO Survey Personnel

Cruise Leaders:	C.S. Lee, D.C. Ramsay.
Scientific Staff:	J.H. Bishop, H. Miller, L.Kalinisan.
Technical Staff:	C.Tindall, T.McNamara, L.Hatch, B.Dickinson,J.Bedford, F. Stradwick, A.Hunter, D.Holdway, C.Saroch, M.James, A.Radley, C.Dyke, J.Vickery
Filipino Scientists	R.Apostol, E.Guazon, N.Trinidad, D.Panganiban, D.Carlos
AIDAB Rep	I.Hawkshaw

LIST OF FIGURES (PART B)

Figure 1a Location map of the Philippines showing the four basins surveyed during AGSO Survey 109.

Figure 1b. Map of the NE Palawan Shelf and Cuyo Platform showing the DHD survey lines and selected well locations for AGSO Survey 109.

Figure 2a Total Hydrocarbons (THC) versus survey line number, NE Palawan Shelf (Lines 109/001 through 109/012).

Figure 2b Sum C_1-C_4 versus survey line number, NE Palawan Shelf (Lines 109/001 through 109/012).

Figure 2c Methane versus survey line number, NE Palawan Shelf (Lines 109/001 through 109/012).

Figure 2d Ethane versus survey line number, NE Palawan Shelf (Lines 109/001 through 109/012).

Figure 2e Ethylene versus survey line number, NE Palawan Shelf (Lines 109/001 through 109/012).

Figure 2f Propane versus survey line number, NE Palawan Shelf (Lines 109/001 through 109/012).

Figure 2g Propylene versus survey line number, NE Palawan Shelf (Lines 109/001 through 109/012).

Figure 2h Total Butanes versus survey line number, NE Palawan Shelf (Lines 109/001 through 109/012).

Figure 2j Percent hydrocarbon wetness versus survey line number, NE Palawan Shelf (Lines 109/001 through 109/012).

Figure 2k C_1/C_2 ratio versus survey line number, NE Palawan Shelf (Lines 109/001 through 109/012).

Figure 2l C_2/C_3 ratio versus survey line number, NE Palawan Shelf (Lines 109/001 through 109/012).

Figure 2m Bernard Parameter (C_1/C_2+C_3) versus survey line number, NE Palawan Shelf (Lines 109/001 through 109/012).

Figure 3a Methane versus percent hydrocarbon wetness , NE Palawan Shelf (Lines 109/001 through 109/012).

Figure 3b Methane versus ethane, NE Palawan Shelf (Lines 109/001 through 109/012).

Figure 4a Total Hydrocarbons (THC) versus survey line number, Cuyo Platform (Lines 109/013 through 109/020).

Figure 4b Sum C_1-C_4 versus survey line number, Cuyo Platform (Lines 109/013 through 109/020).

Figure 4c Methane versus survey line number, Cuyo Platform (Lines 109/013 through 109/020).

Figure 4d Ethane versus survey line number, Cuyo Platform (Lines 109/013 through 109/020).

Figure 4e Ethylene versus survey line number, Cuyo Platform (Lines 109/013 through 109/020).

Figure 4f Propane versus survey line number, Cuyo Platform (Lines 109/013 through 109/020).

Figure 4g Propylene versus survey line number, Cuyo Platform (Lines 109/013 through 109/020).

Figure 4h Percent hydrocarbon wetness versus survey line number, Cuyo Platform (Lines 109/013 through 109/020).

Figure 4i C_1/C_2 ratio versus survey line number, Cuyo Platform (Lines 109/013 through 109/020).

Figure 4j C_2/C_3 ratio versus survey line number, Cuyo Platform (Lines 109/013 through 109/020).

Figure 4k Bernard Parameter (C_1/C_2+C_3) versus survey line number, Cuyo Platform (Lines 109/013 through 109/020).

Figure 5a Methane versus percent hydrocarbon wetness , Cuyo Platform (Lines 109/013 through 109/020).

Figure 5b Methane versus ethane, Cuyo Platform (Lines 109/013 through 109/020).

LIST OF APPENDICES (PART B)

Appendix 1. Appendix I. NE Palawan Shelf DHD line summary sheets and individual line plots (Lines 109/001 through 109/012).

Appendix II. Cuyo Platform DHD line summary sheets and individual line plots (Lines 109/013 through 109/020).

Appendix III. DHD Methodology

Appendix IV. Interpretative Methodology

Appendix V. Systems Operation Reports

APPENDIX 1. NE PALAWAN SHELF DHD LINE SUMMARY SHEETS AND INDIVIDUAL LINE PLOTS

Line Summary

Line Number	109001
No. of Shotpoints	509

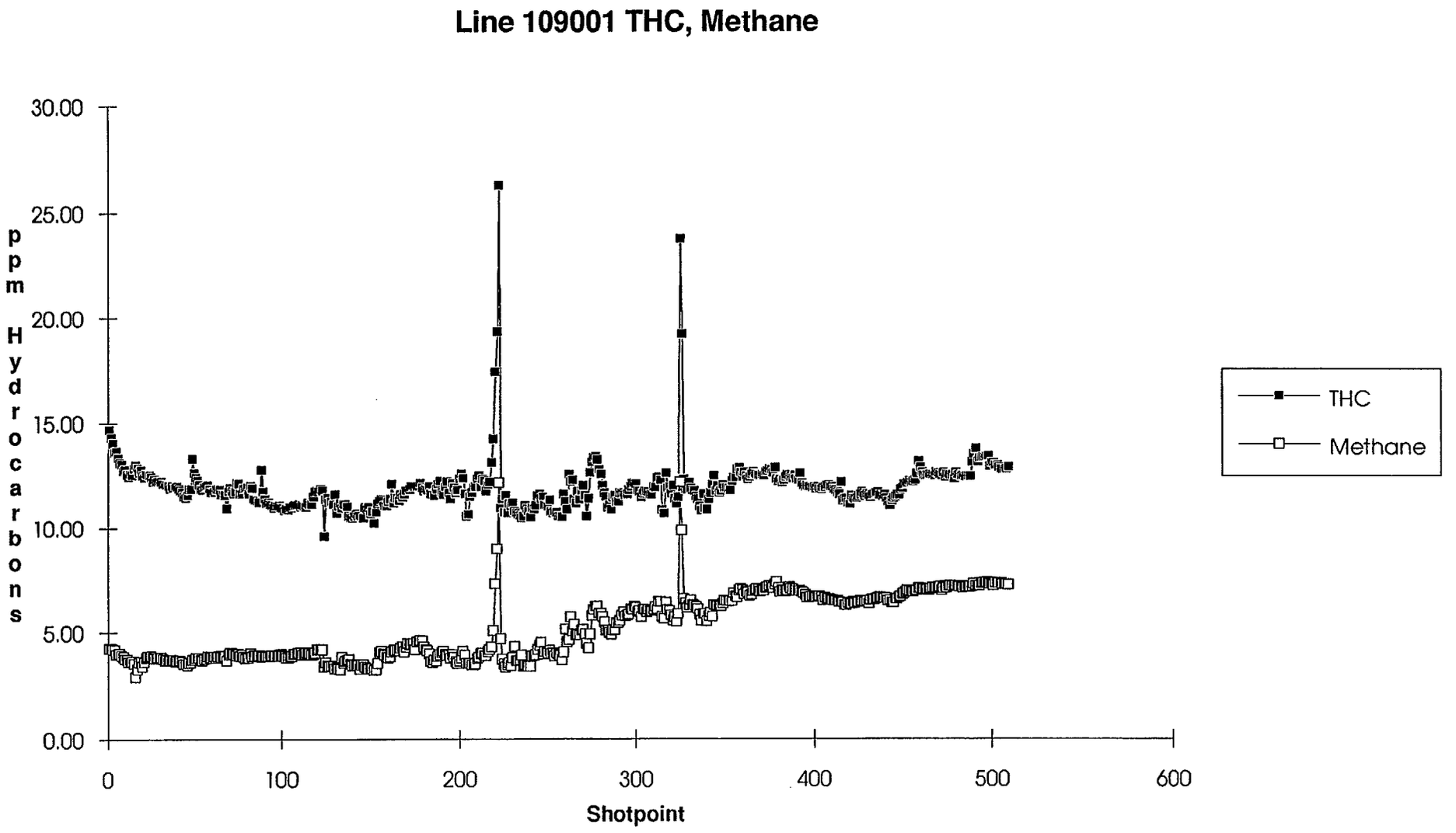
	Shotpoint	Date	Time	Latitude		Longitude	
Start	1	30-Mar-92	17:47:19	9	34.517	118	42.908
End	510	31-Mar-92	21:48:01	10	38.812	120	27.356

	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	11.942	5.199	0.016	0.090	0.017	0.027	0.000	0.000	0.039	0.139	0.058	0.040	0.651
Std. Dev.	1.214	1.499	0.005	0.038	0.005	0.019	0.000	0.000	0.017	0.056	0.036	0.028	0.139
Minimum	9.589	2.937	0.007	0.024	0.006	0.000	0.000	0.000	0.005	0.031	0.006	0.000	0.331
Maximum	26.270	12.191	0.050	0.153	0.041	0.070	0.006	0.011	0.117	0.280	0.202	0.124	1.393

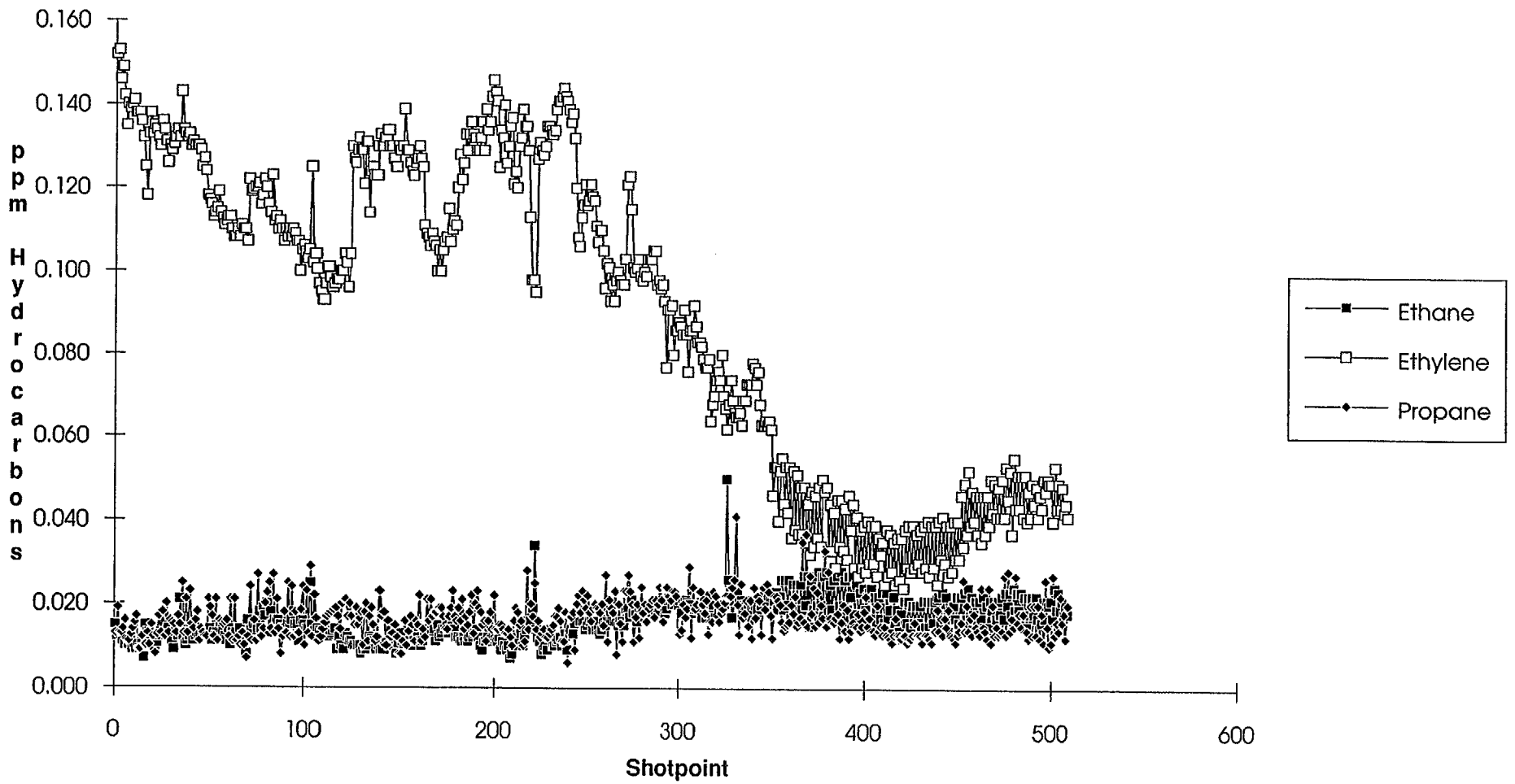
	Cond.	Temp.	F. Depth	W.Depth	Altitude	Calc. Alt.
Mean	58.524	25.466	62.527	443.846	20.849	381.283
Std. Dev.	2.650	1.836	23.596	544.164	8.046	553.729
Minimum	54.590	21.790	0.000	43.200	9.560	2.820
Maximum	62.510	28.420	106.360	1979.300	30.750	1930.710

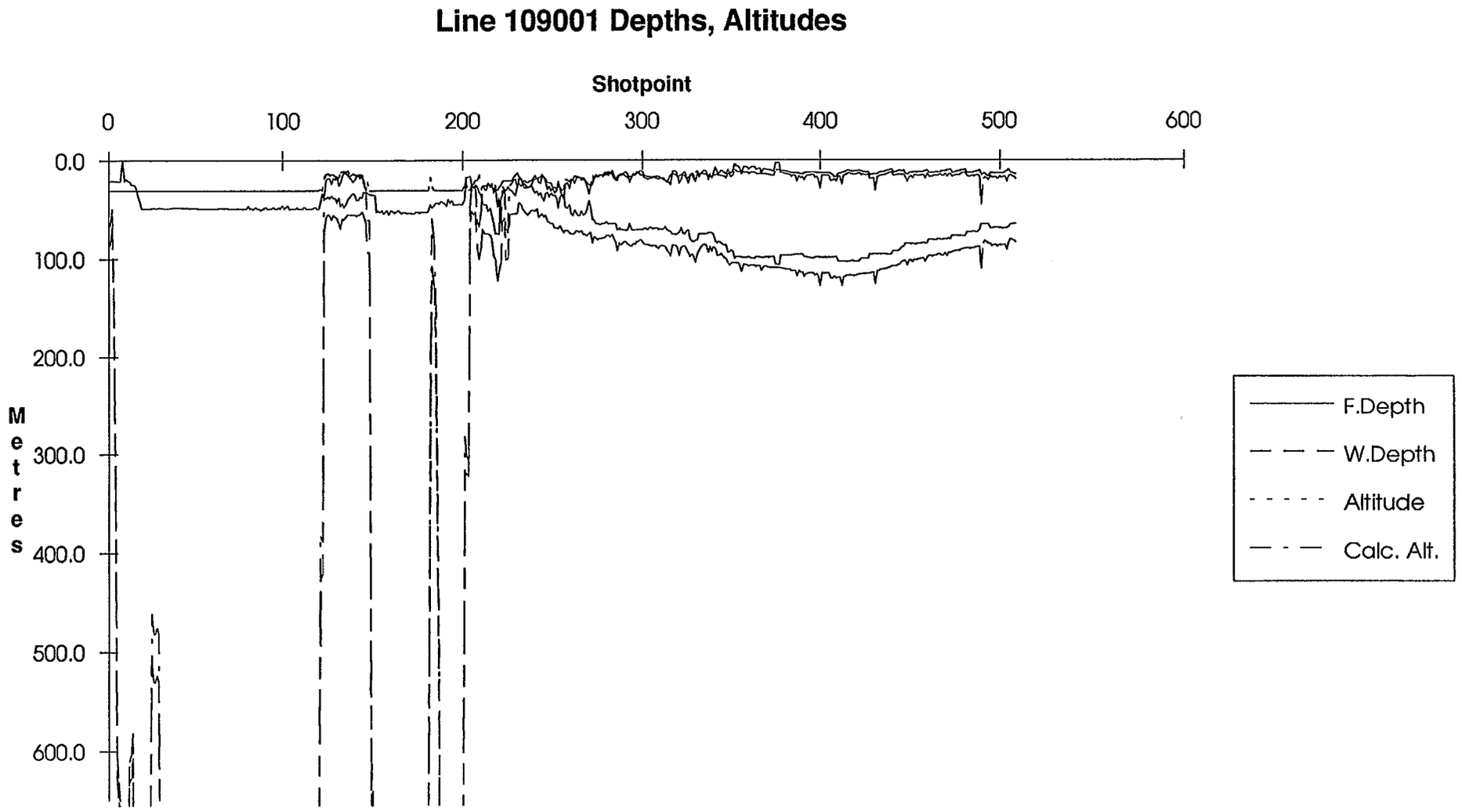
Notes

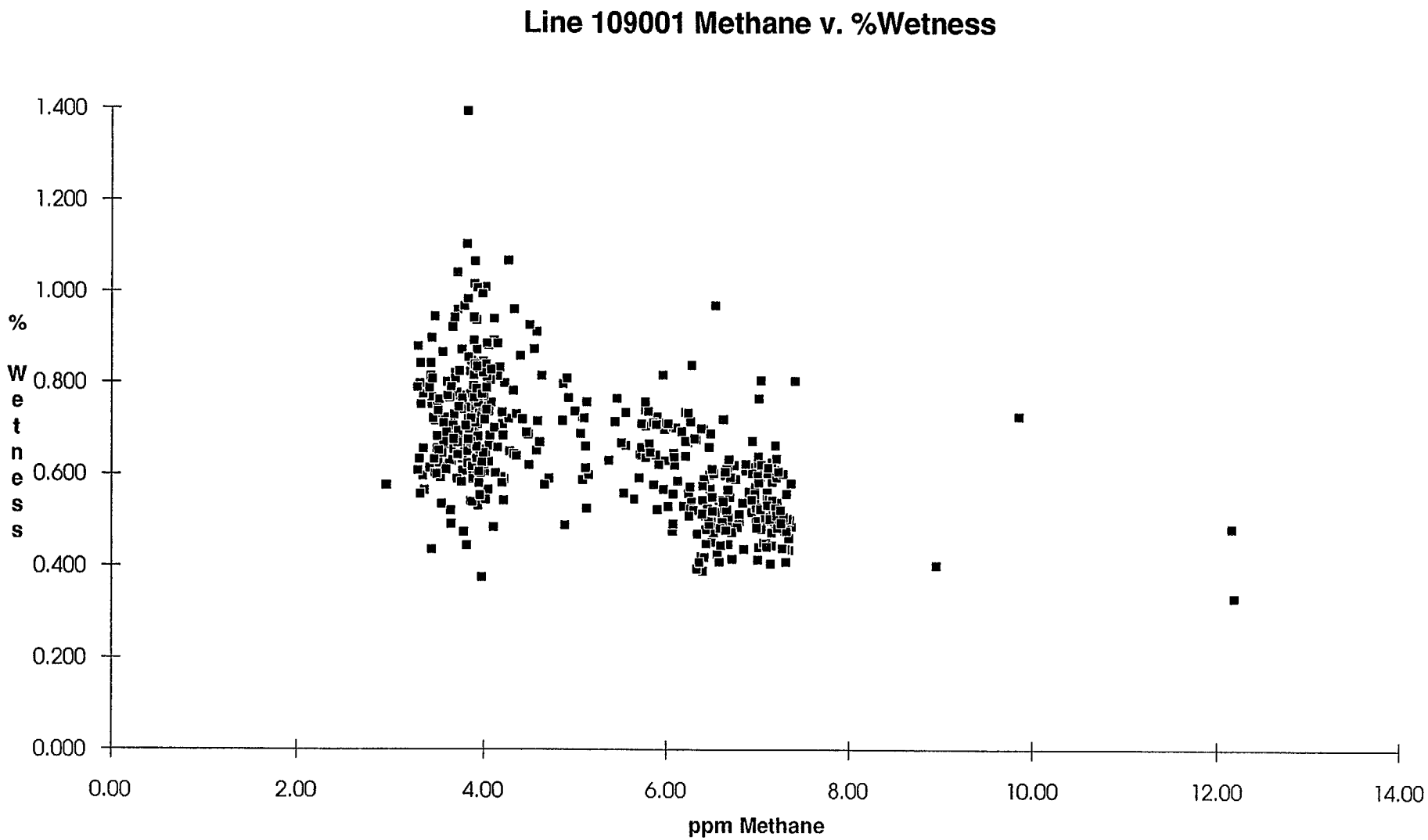
A weak THC, methane, ethane and propane anomaly is noted at SP 222 to SP 224.
The anomaly at SP 326 is over the area of the plugged and abandoned Dumaran wellsite.


Line 109001 THC, Methane
30.00
25.00
20.00
15.00
10.00
5.00
0.00
ppm Hydrocarbons
0
100
200
300
400
500
600
Shotpoint
THC
Methane

Line 109001 Ethane, Ethylene, Propane




Line 109001 Depths, Altitudes
Shotpoint
0
100
200
300
400
500
600
0.0
100.0
200.0
300.0
400.0
500.0
600.0
Metres
F.Depth
W.Depth
Altitude
Calc. Alt.


Line 109001 Methane v. %Wetness
1.400
1.200
1.000
0.800
0.600
0.400
0.200
0.000
% Wetness
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
ppm Methane

Line Summary

Line Number	109002
No. of Shotpoints	502

	Shotpoint	Date	Time	Latitude		Longitude	
Start	1	1-Apr-92	06:03:14	10	37.130	120	30.202
End	502	1-Apr-92	22:48:11	9	57.081	119	19.517

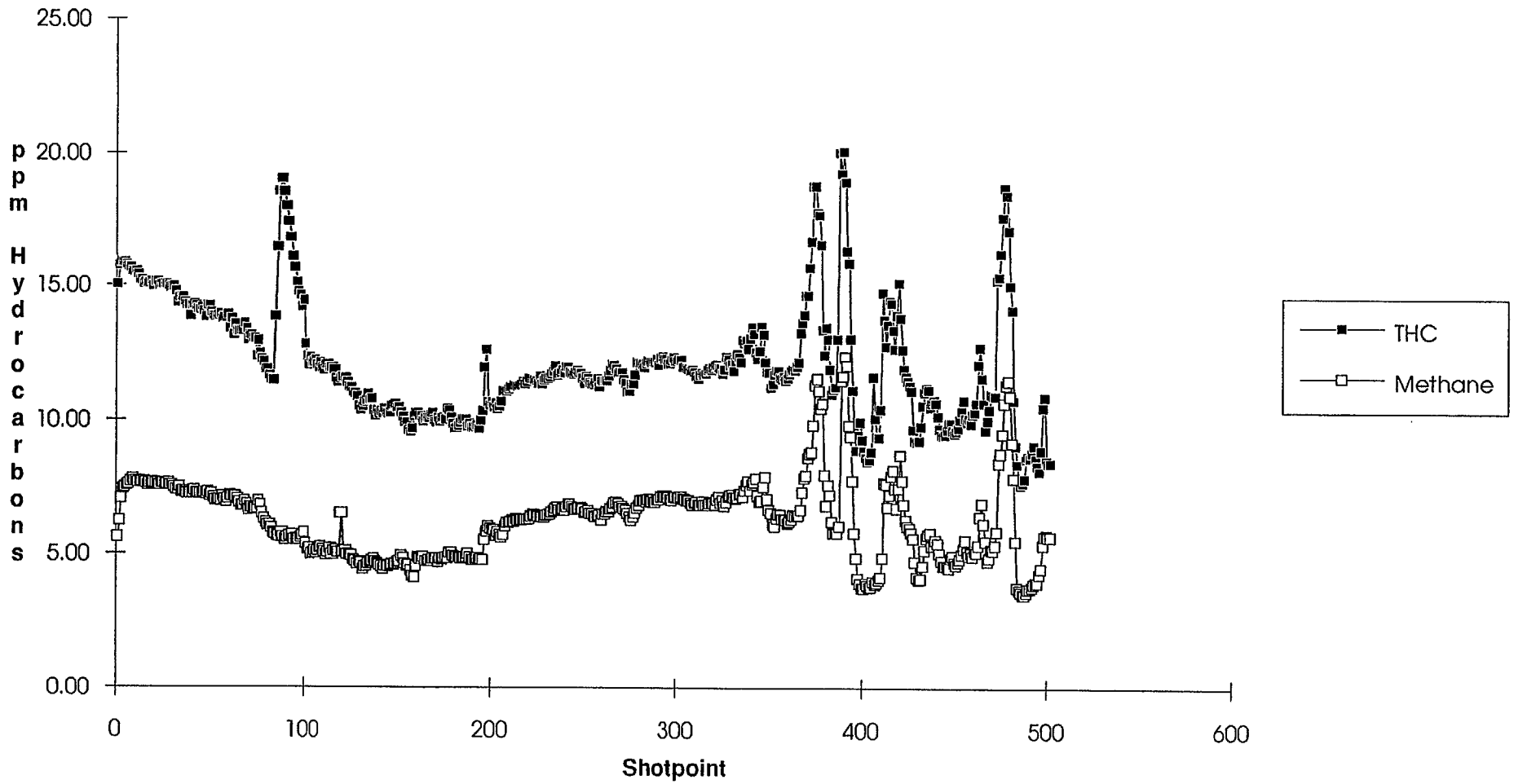
	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	12.084	6.254	0.019	0.052	0.016	#REF!	0.000	0.000	0.025	0.096	0.025	0.008	0.572
Std. Dev.	2.175	1.453	0.006	0.027	0.005	#REF!	0.001	0.003	0.012	0.037	0.018	0.021	0.131
Minimum	7.588	3.485	0.009	0.013	0.009	#REF!	0.000	0.000	0.005	0.041	0.000	0.000	0.203
Maximum	20.103	12.366	0.038	0.119	0.040	#REF!	0.024	0.044	0.090	0.255	0.102	0.183	1.128

	Cond.	Temp.	F. Depth	W.Depth	Altitude	Calc. Alt.
Mean	56.214	23.965	87.698	189.183	22.313	101.856
Std. Dev.	2.110	1.507	31.352	158.196	7.228	152.564
Minimum	53.110	21.760	21.880	45.300	4.980	9.090
Maximum	60.290	26.890	138.220	825.100	30.710	750.200

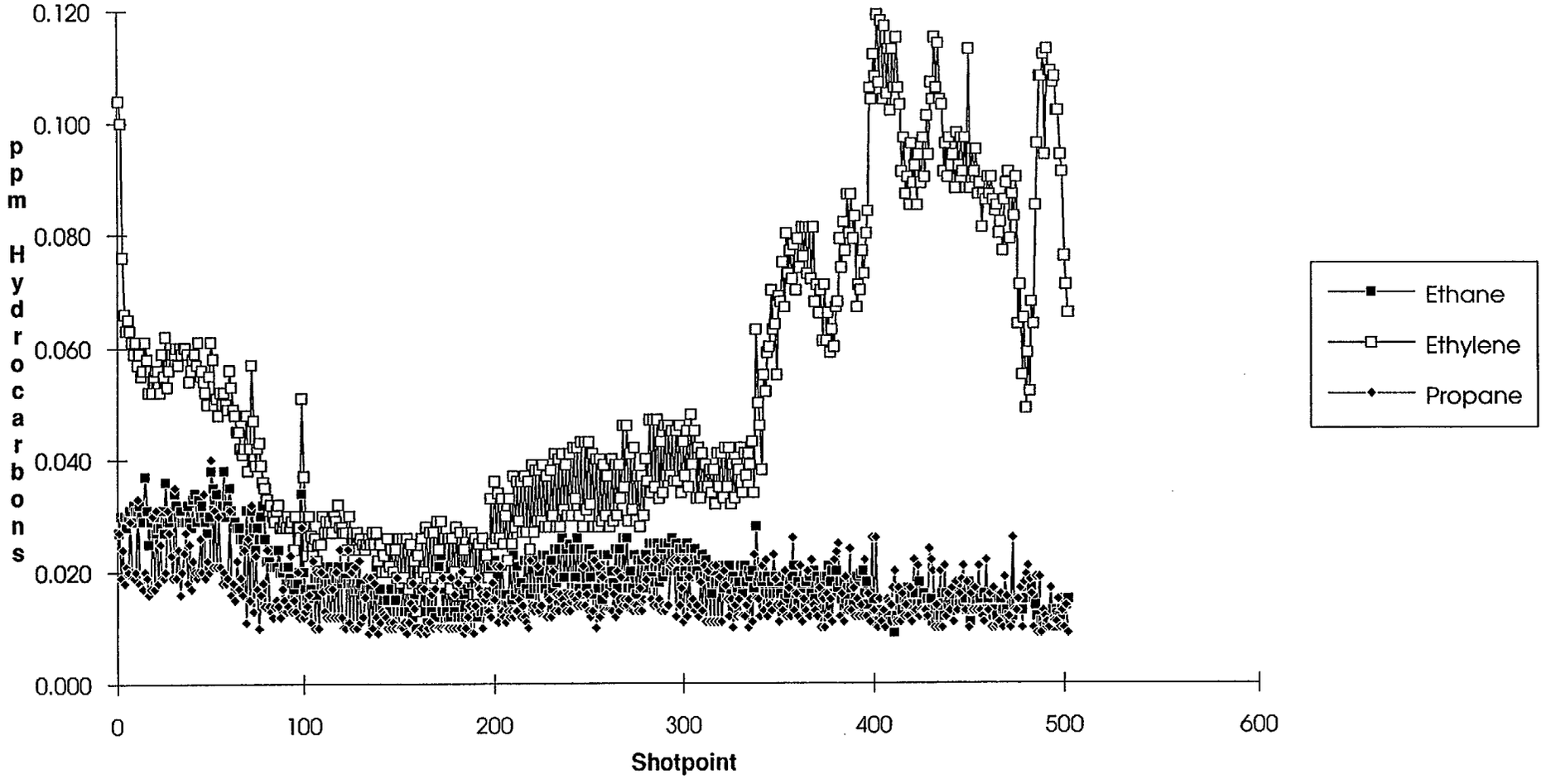
Notes

Two weak THC, methane, ethane, and propane anomalies occur at SP 95 marking the position of Well Paly - 1, and at SP 361 marking Well Roxas - 1.
Three weak THC and methane anomalies occur at SP 391, SP 411, and SP 480.

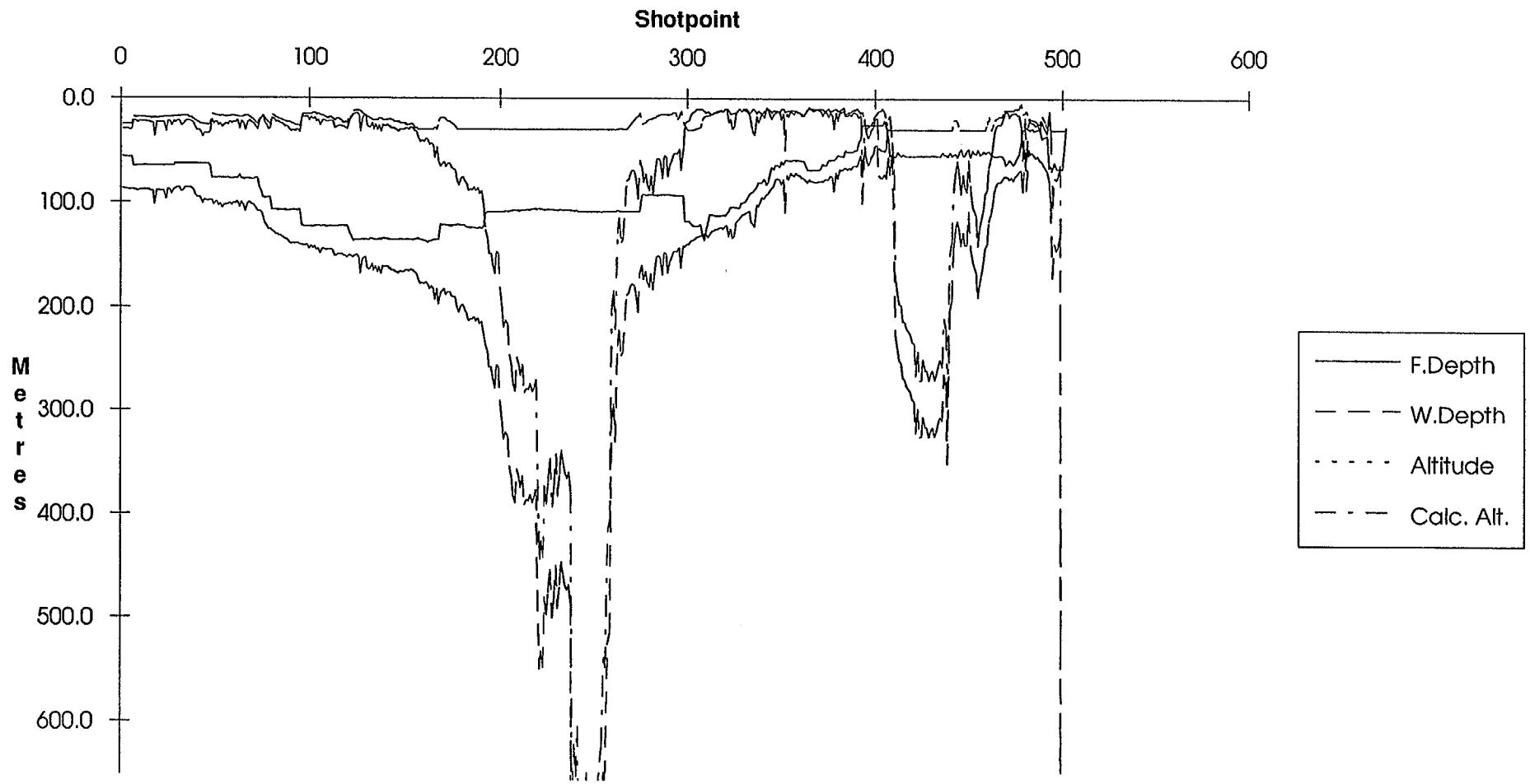
Line 109002 THC, Methane

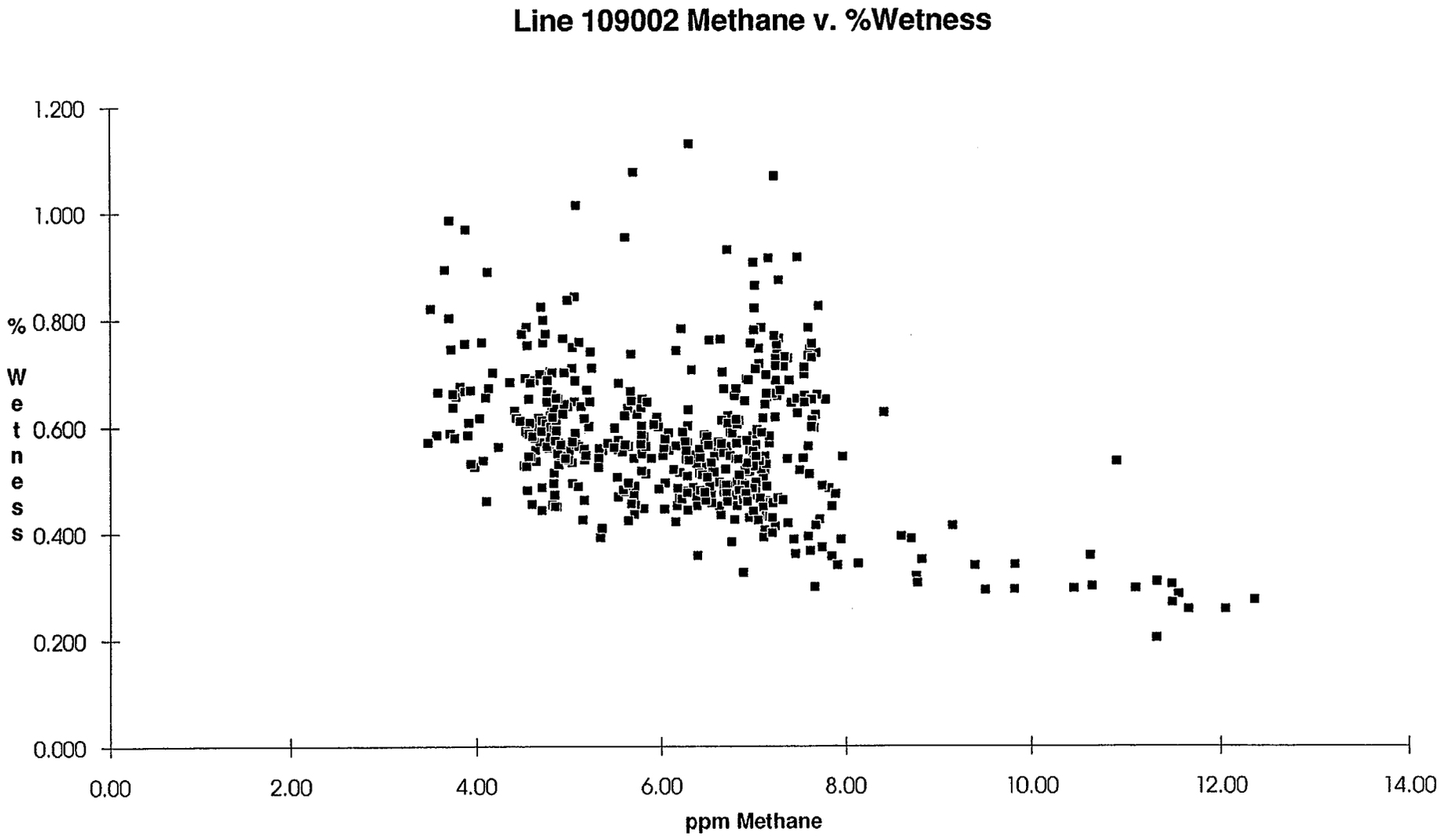


Line 109002 Ethane, Ethylene, Propane



Line 109002 Depths, Altitudes




Line 109002 Methane v. %Wetness
1.200
1.000
0.800
0.600
0.400
0.200
0.000
% Wetness
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
ppm Methane

Line Summary

Line Number	109003
No. of Shotpoints	95

	Shotpoint	Date	Time	Latitude		Longitude	
Start	1	2-Apr-92	01:17:08	9	53.812	119	19.822
End	12	2-Apr-92	07:27:37	9	52.050	119	14.414

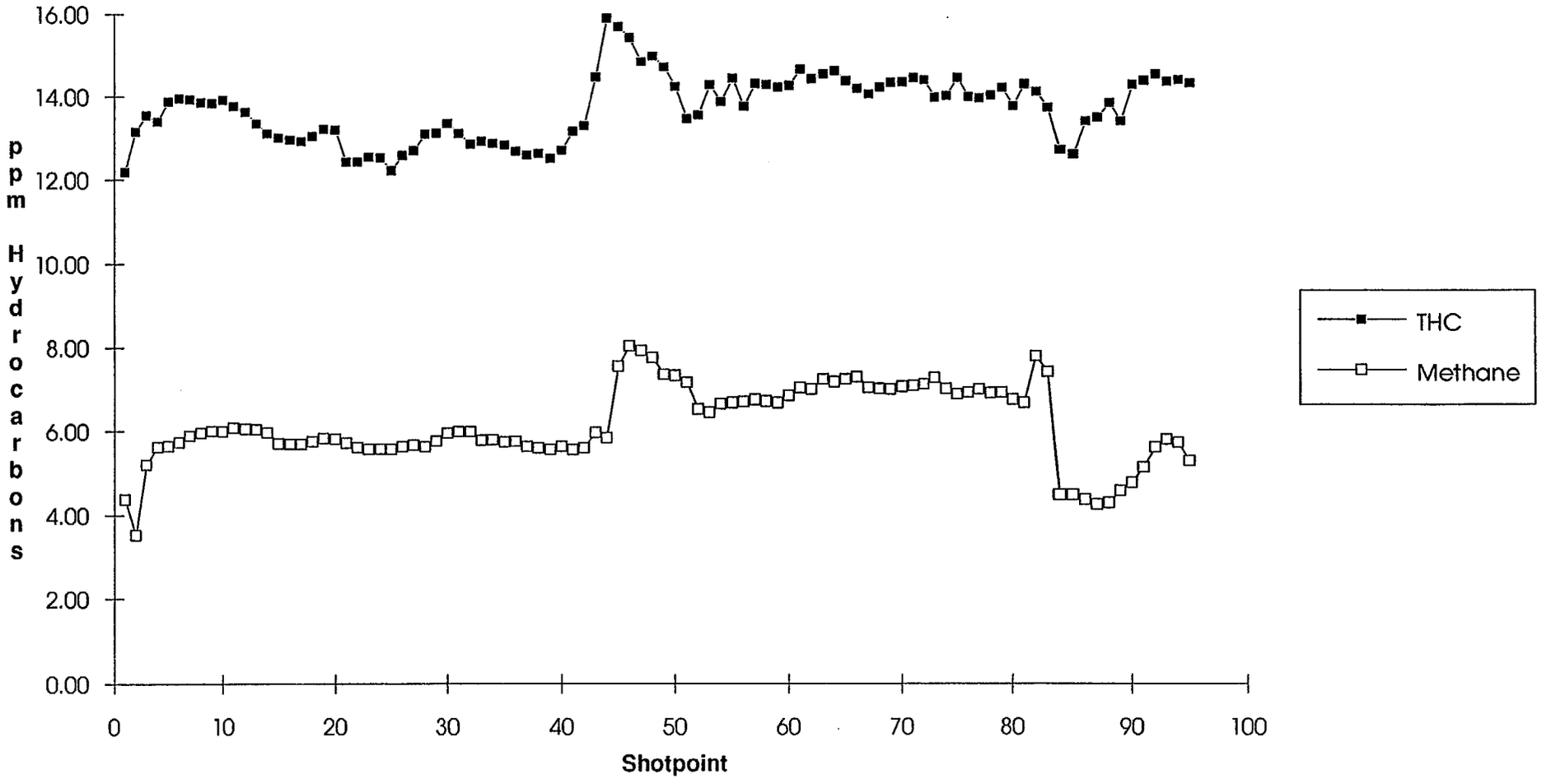
	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	13.701	6.149	0.022	0.100	0.019	0.031	0.000	0.000	0.038	0.157	0.059	0.040	0.677
Std. Dev.	0.784	0.917	0.003	0.013	0.004	0.014	0.001	0.000	0.008	0.023	0.018	0.015	0.146
Minimum	12.181	3.519	0.013	0.088	0.009	0.014	0.000	0.000	0.014	0.124	0.020	0.008	0.425
Maximum	15.885	8.025	0.033	0.170	0.028	0.093	0.007	0.000	0.060	0.292	0.104	0.077	1.153

	Cond.	Temp.	F. Depth	W.Depth	Altitude	Calc. Alt.
Mean	59.554	26.346	48.655	854.787	30.662	806.206
Std. Dev.	0.545	0.387	6.804	526.213	0.343	524.924
Minimum	58.890	25.860	18.680	84.400	28.020	40.290
Maximum	61.150	27.510	67.000	1530.900	30.740	1481.660

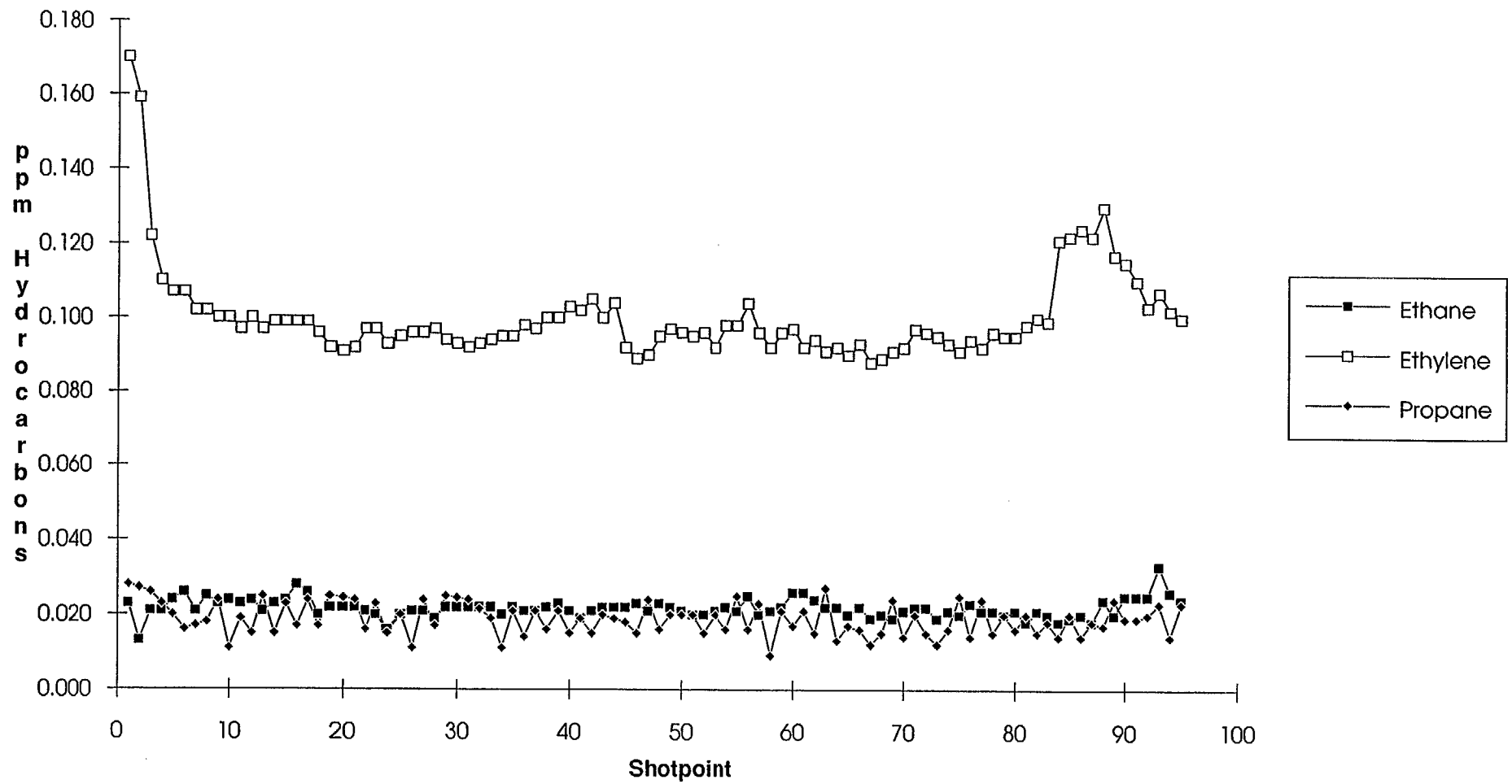
Notes

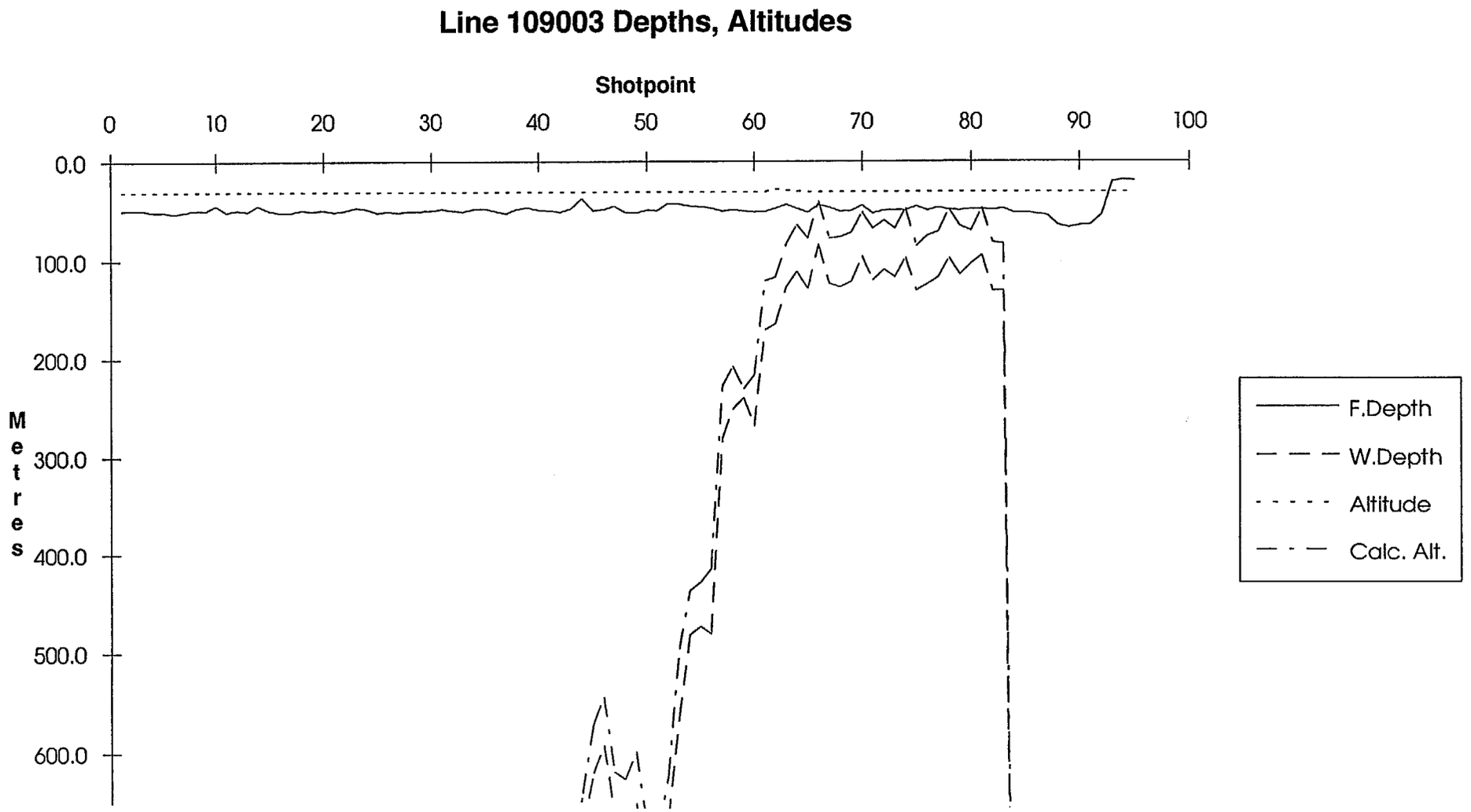
A very weak THC and methane anomaly is noted at SP 47.

Line 109003 THC, Methane

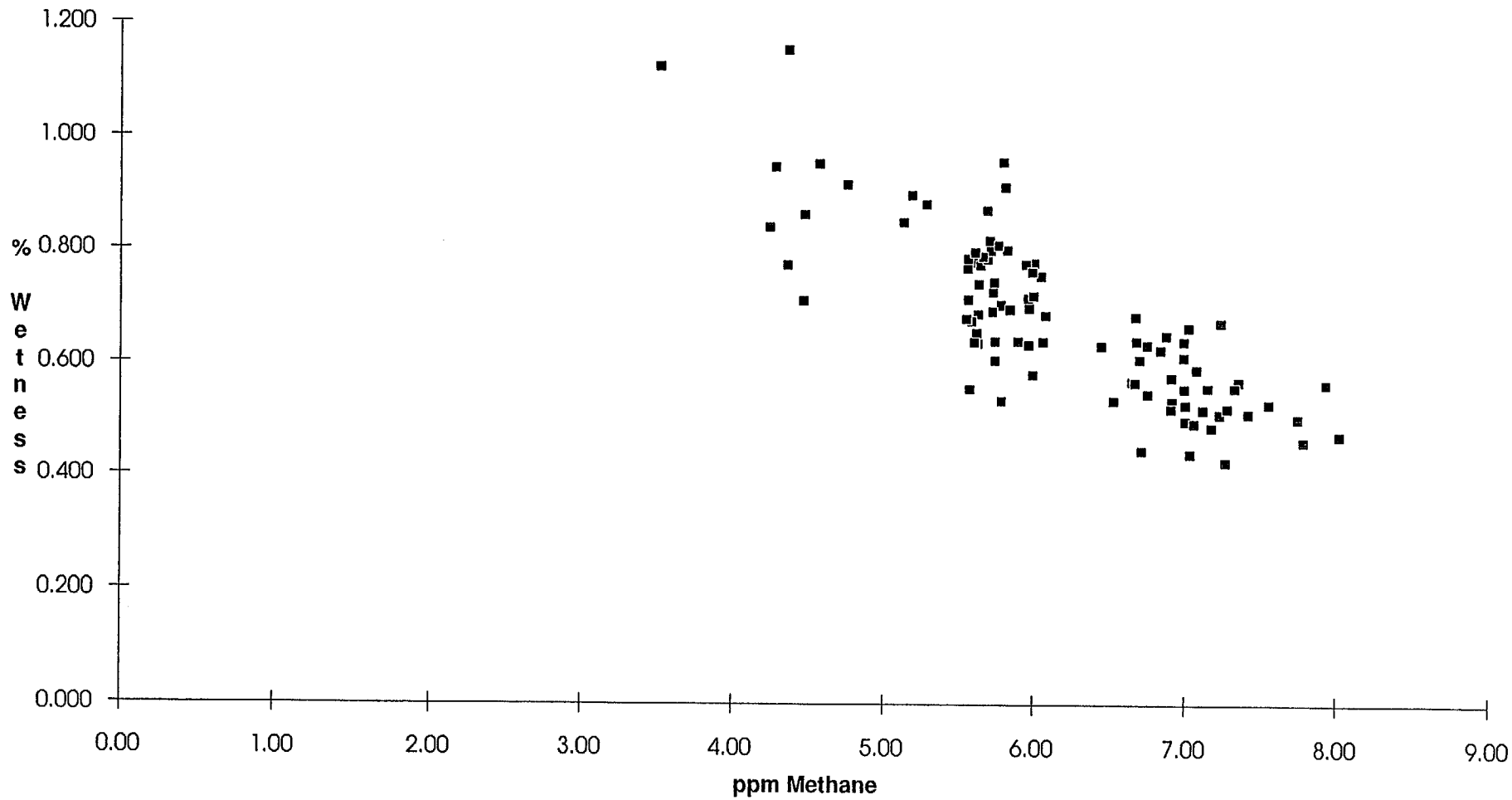


Line 109003 Ethane, Ethylene, Propane




Line 109003 Depths, Altitudes
Shotpoint
0
10
20
30
40
50
60
70
80
90
100
0.0
100.0
200.0
300.0
400.0
500.0
600.0
Metres
F.Depth
W.Depth
Altitude
Calc. Alt.

Line 109003 Methane v. %Wetness



Line Summary

Line Number	10900 4
No. of Shotpoints	80

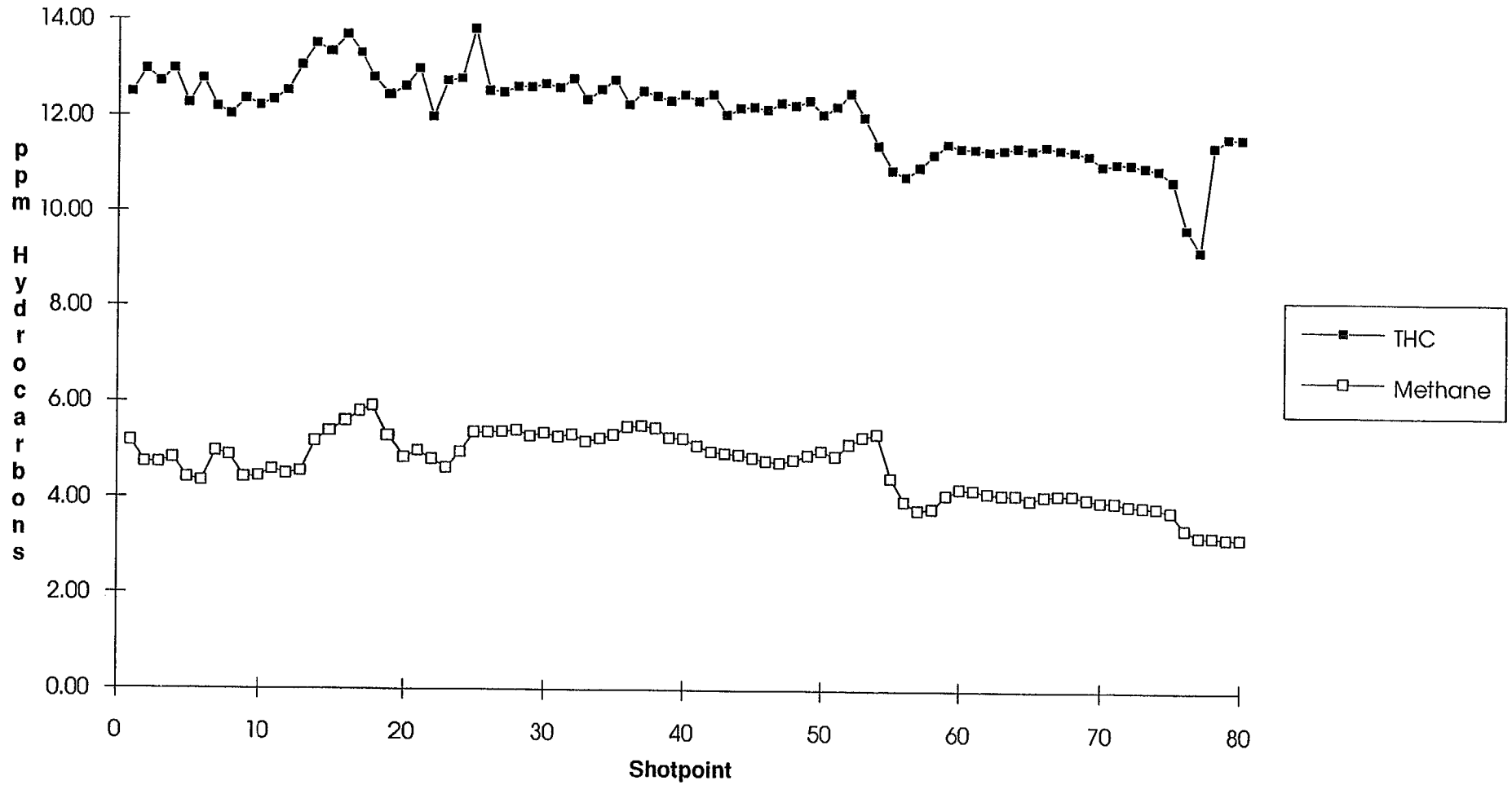
	Shotpoint	Date	Time	Latitude		Longitude	
Start	14	2-Apr-92	07:34:12	9	52.581	119	14.079
End	6	2-Apr-92	13:39:50	10	48.069	119	10.751

	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	12.075	4.683	0.019	0.127	0.017	0.036	0.000	0.000	0.031	0.153	0.063	0.049	0.760
Std. Dev.	0.837	0.660	0.005	0.029	0.003	0.015	0.000	0.000	0.010	0.046	0.026	0.022	0.135
Minimum	9.225	3.222	0.011	0.096	0.010	0.017	0.000	0.000	0.000	0.000	0.000	0.000	0.509
Maximum	13.832	5.919	0.038	0.191	0.028	0.072	0.000	0.000	0.047	0.244	0.112	0.098	1.189

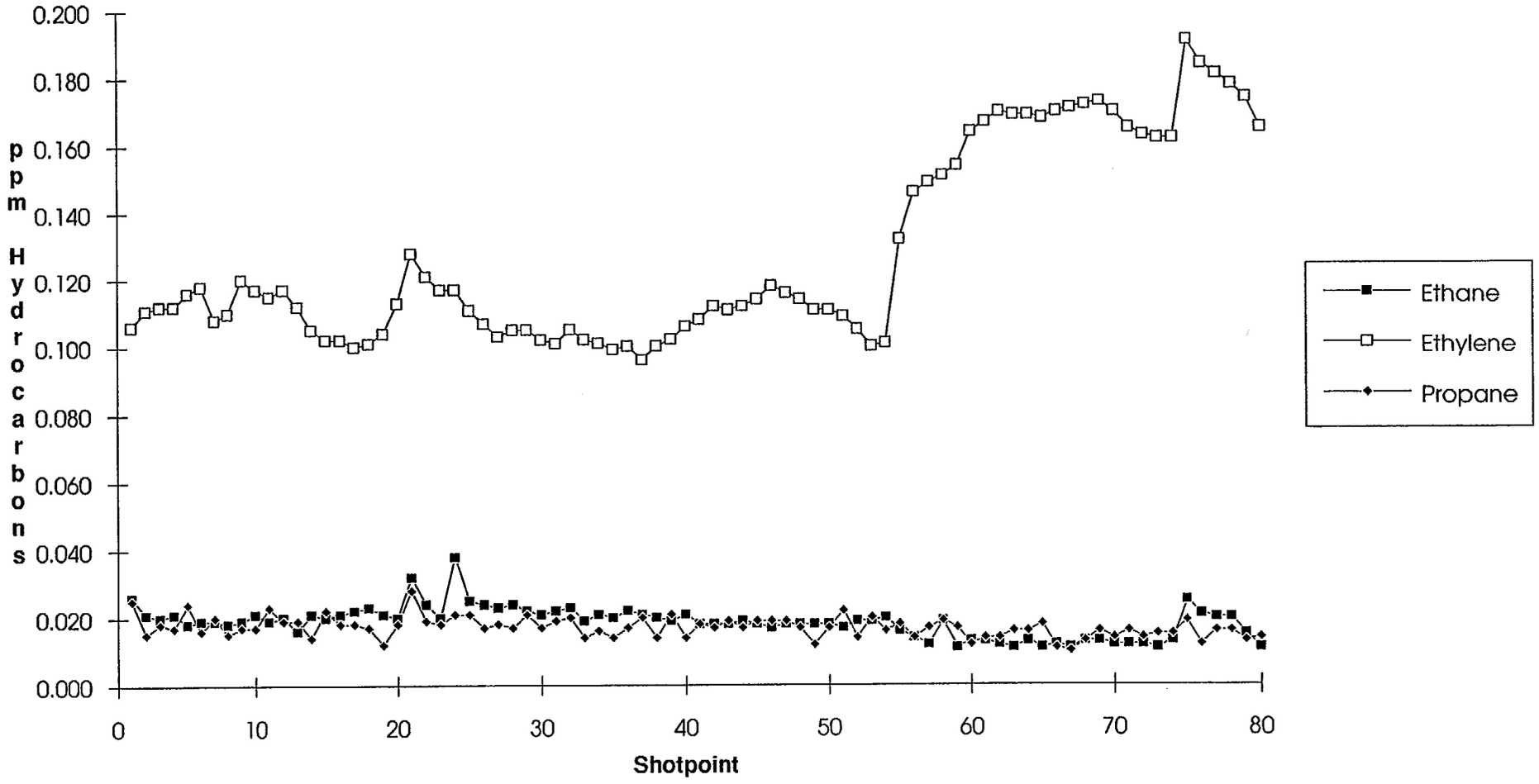
	Cond.	Temp.	F. Depth	W.Depth	Altitude	Calc. Alt.
Mean	60.439	26.937	29.370	805.703	30.731	772.797
Std. Dev.	0.713	0.460	17.287	481.652	0.010	475.245
Minimum	59.320	26.160	2.620	106.700	30.720	99.420
Maximum	61.810	27.830	61.390	1846.200	30.750	1816.510

Notes No anomalies occured on this line.

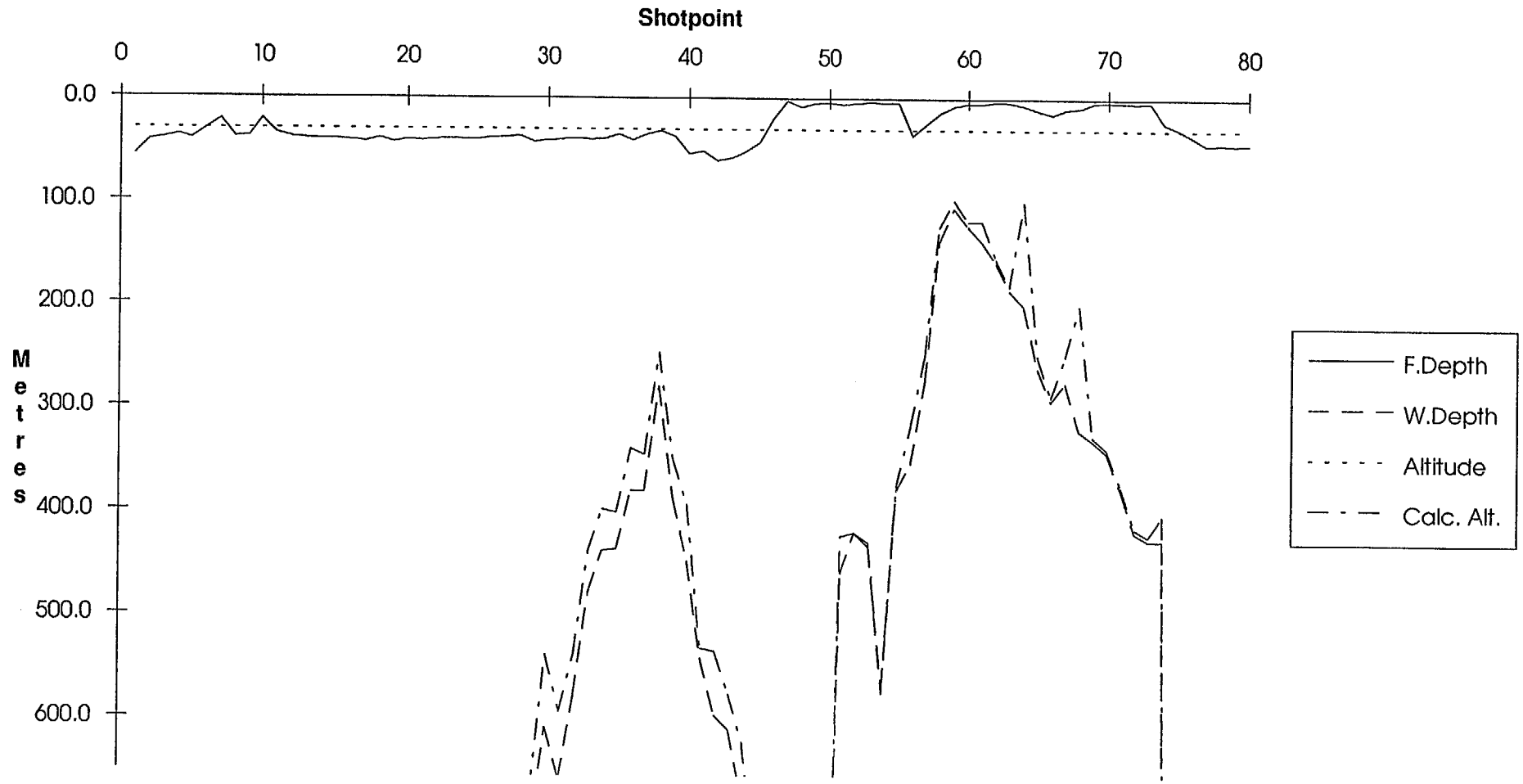
Line 109004 THC, Methane

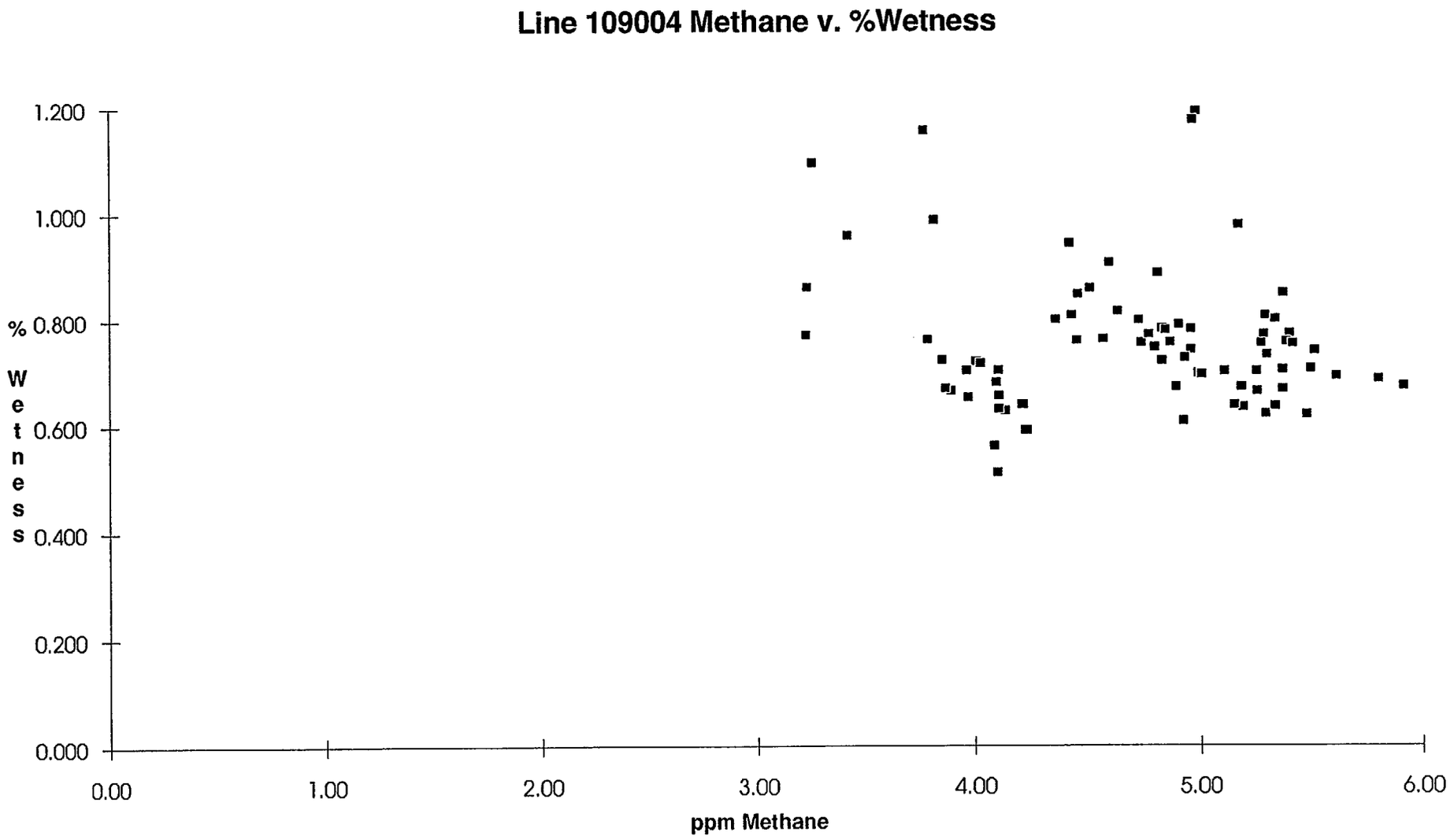


Line 109004 Ethane, Ethylene, Propane



Line 109004 Depths, Altitudes




Line 109004 Methane v. %Wetness
1.200
1.000
% 0.800
W
e
t
n
e
s
s 0.600
0.400
0.200
0.000
0.00
1.00
2.00
3.00
4.00
5.00
6.00
ppm Methane

Line Summary

Line Number	109005
No. of Shotpoints	84

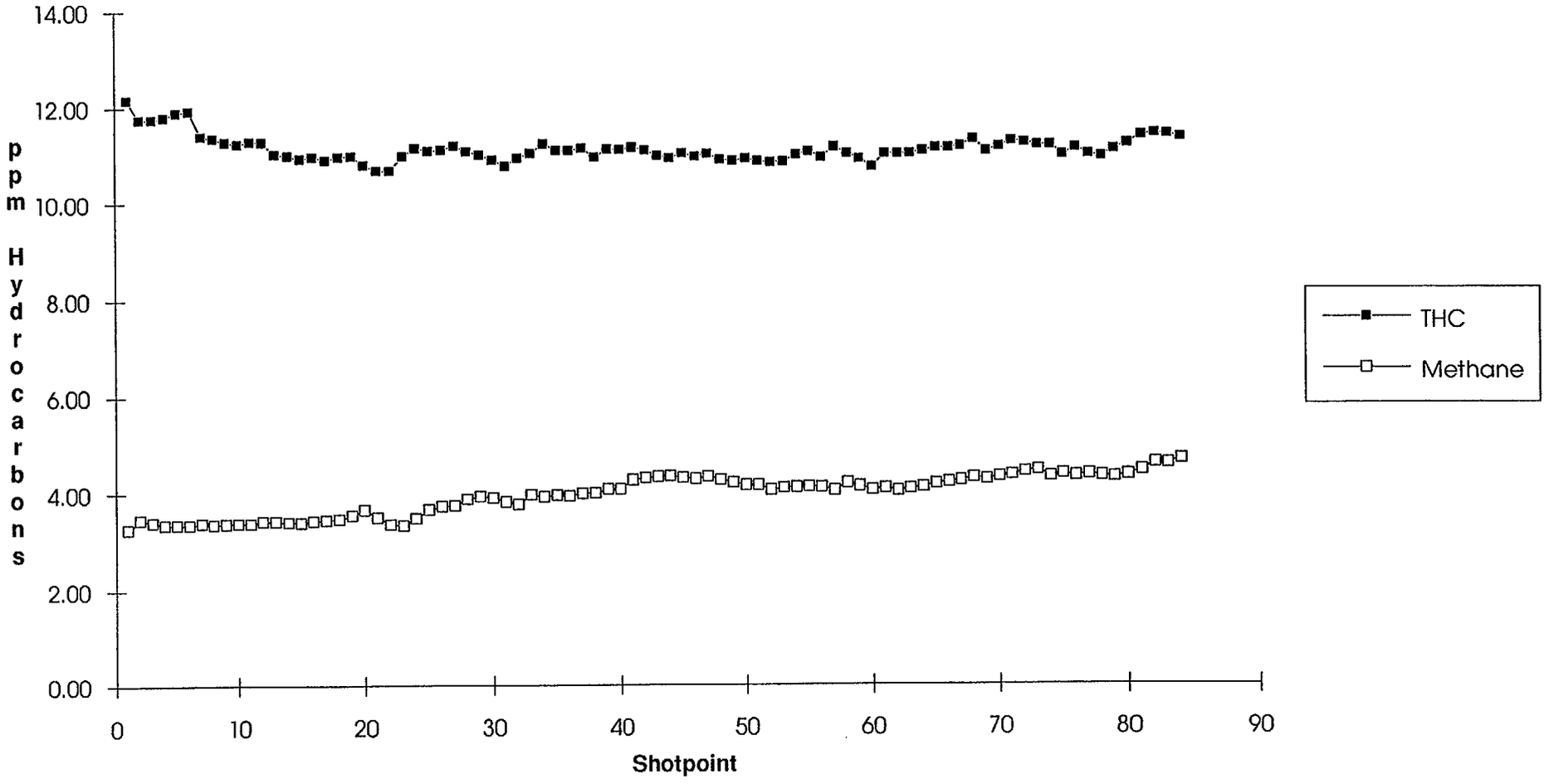
	Shotpoint	Date	Time	Latitude		Longitude	
Start	7	2-Apr-92	13:41:49	9	48.227	119	10.644
End	90	2-Apr-92	16:28:06	9	59.725	119	04.478

	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	11.106	3.947	0.022	0.152	0.020	0.049	0.000	0.000	0.033	0.178	0.063	0.052	1.067
Std. Dev.	0.269	0.390	0.010	0.021	0.006	0.017	0.000	0.000	0.008	0.016	0.017	0.018	0.468
Minimum	10.669	3.255	0.011	0.124	0.011	0.023	0.000	0.000	0.010	0.142	0.037	0.017	0.648
Maximum	12.149	4.666	0.050	0.206	0.036	0.099	0.000	0.000	0.060	0.232	0.127	0.112	2.431

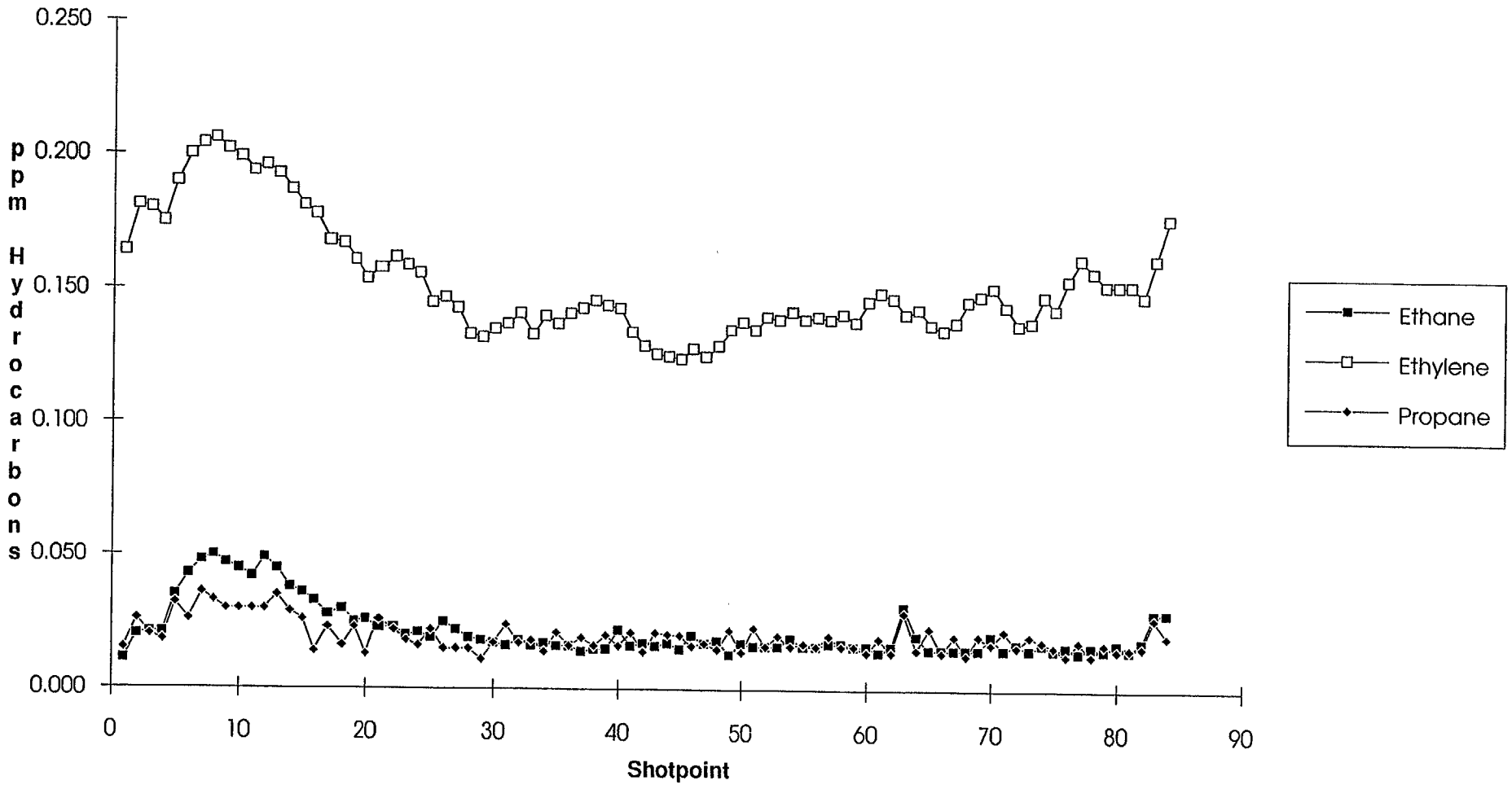
	Cond.	Temp.	F. Depth	W.Depth	Altitude	Calc. Alt.
Mean	60.330	26.837	43.422	1053.640	30.660	1009.487
Std. Dev.	0.245	0.172	4.157	509.017	0.653	506.893
Minimum	59.780	26.460	26.390	103.300	24.750	66.790
Maximum	60.710	27.110	52.950	1785.800	30.750	1743.680

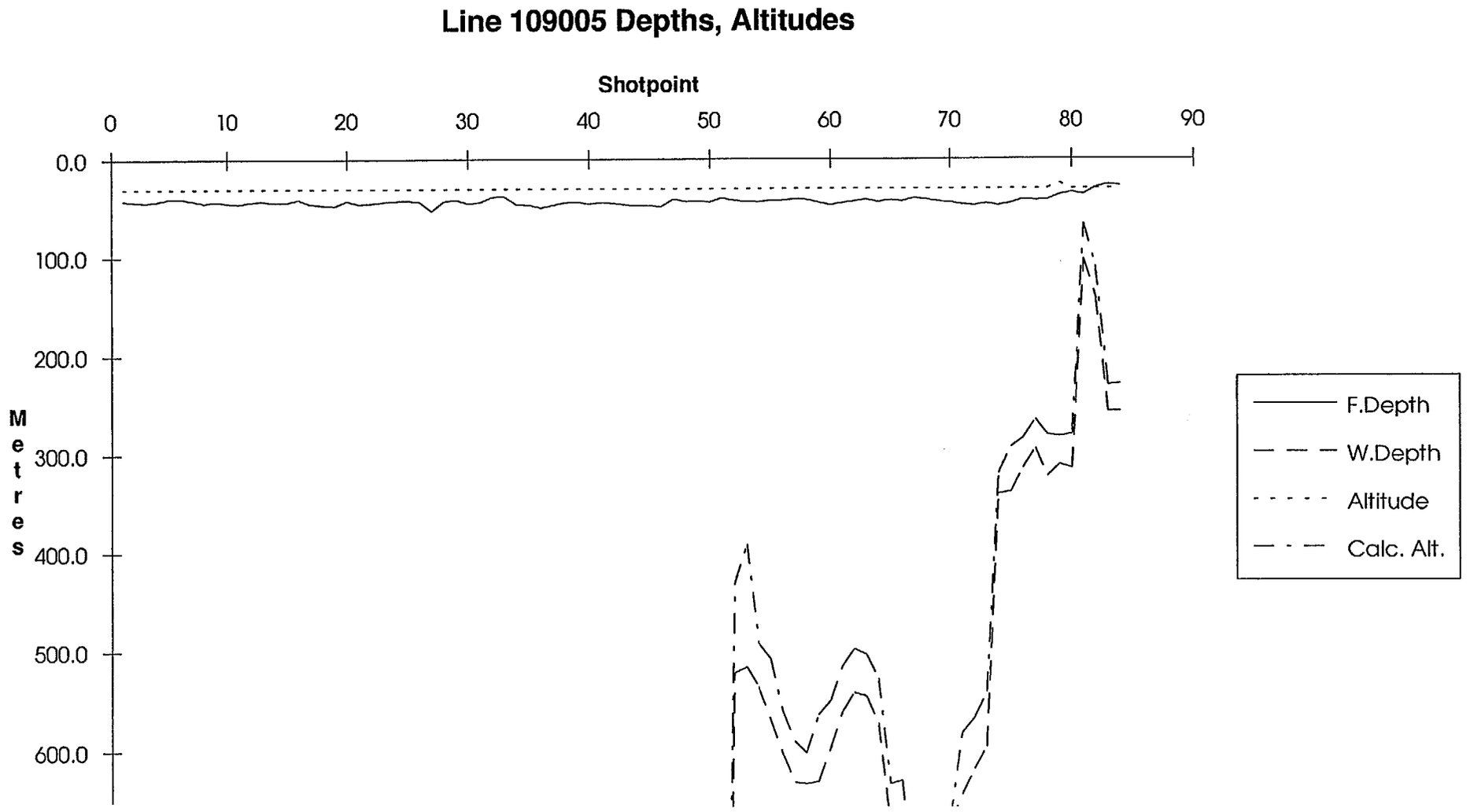
Notes A weak THC, ethane and propane anomaly occurs between SP 4 and SP 15.

Line 109005 THC, Methane

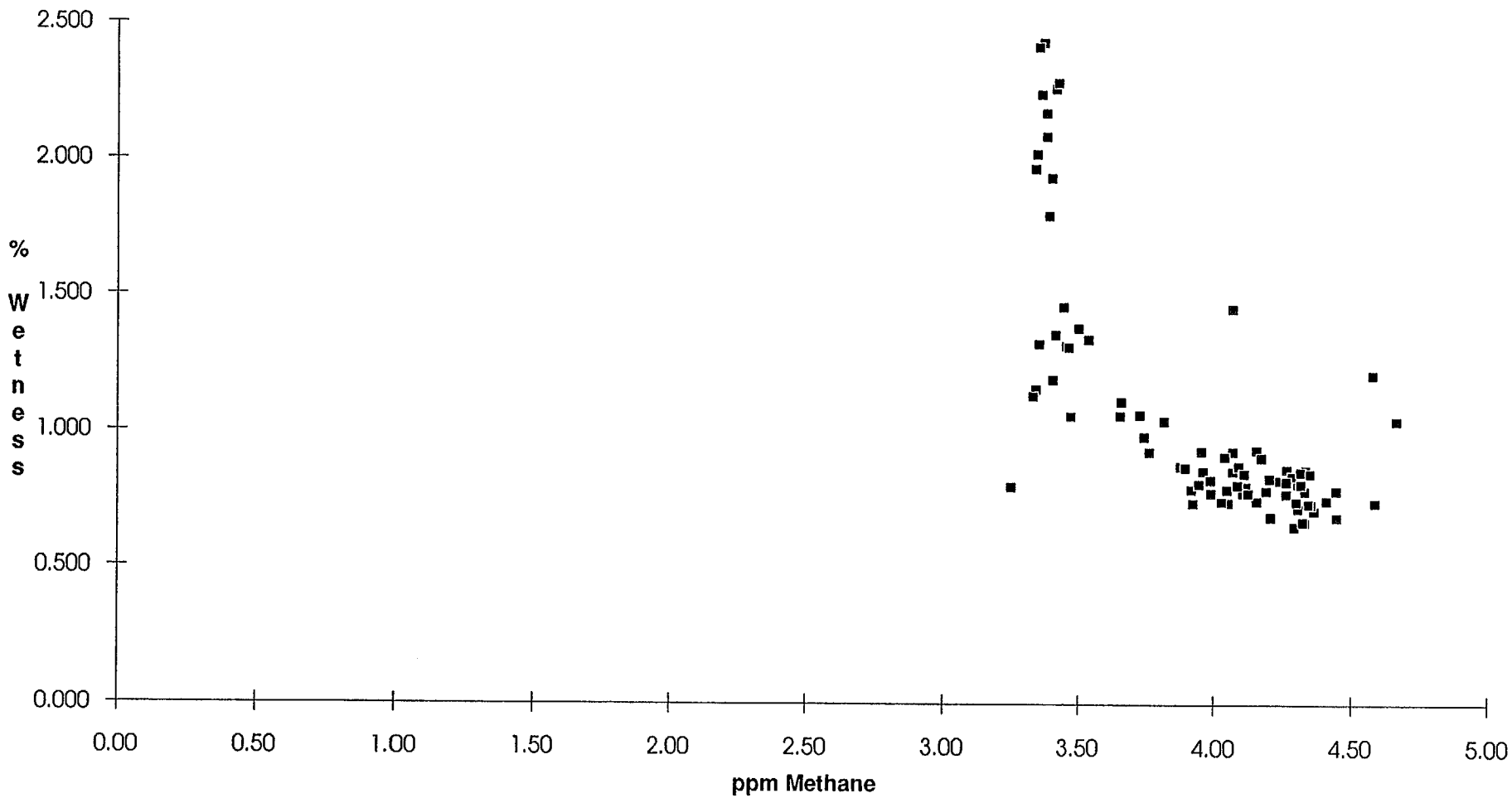


Line 109005 Ethane, Ethylene, Propane




Line 109005 Depths, Altitudes
Shotpoint
0
10
20
30
40
50
60
70
80
90
0.0
100.0
200.0
300.0
400.0
500.0
600.0
Metres
F.Depth
W.Depth
Altitude
Calc. Alt.

Line 109005 Methane v. %Wetness



Line Summary

Line Number	109006
No. of Shotpoints	101

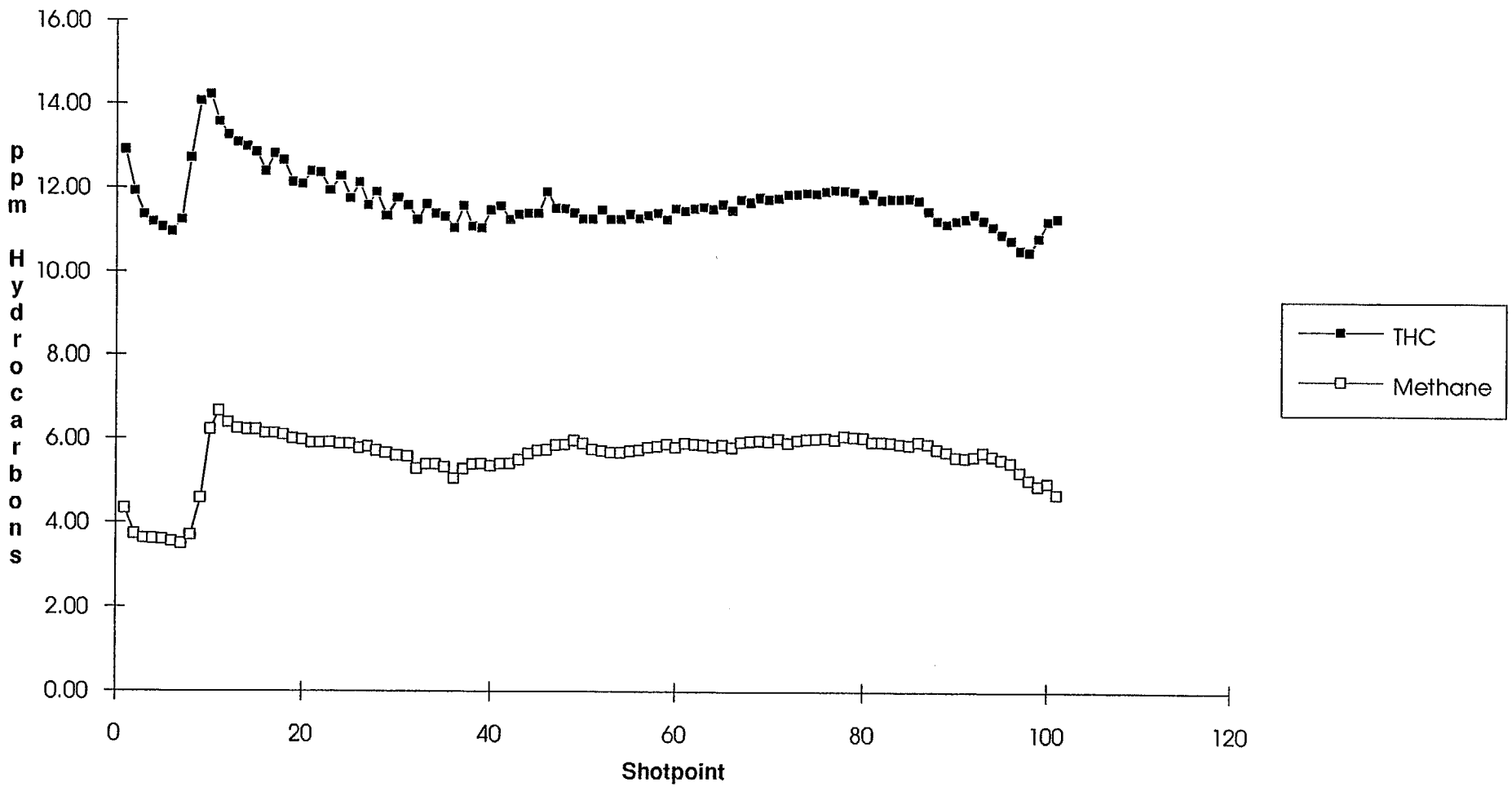
	Shotpoint	Date	Time	Latitude		Longitude	
Start	1	2-Apr-92	20:38:13	9	42.949	119	07.258
End	101	2-Apr-92	23:58:27	9	55.393	119	01.780

	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	11.706	5.588	0.021	0.086	0.018	0.014	0.000	0.000	0.027	0.108	0.043	0.032	0.698
Std. Dev.	0.656	0.652	0.003	0.024	0.004	0.017	0.000	0.000	0.007	0.030	0.013	0.012	0.094
Minimum	10.498	3.497	0.014	0.060	0.010	0.000	0.000	0.000	0.008	0.067	0.020	0.004	0.491
Maximum	14.210	6.666	0.032	0.166	0.030	0.053	0.000	0.000	0.045	0.217	0.108	0.067	0.936

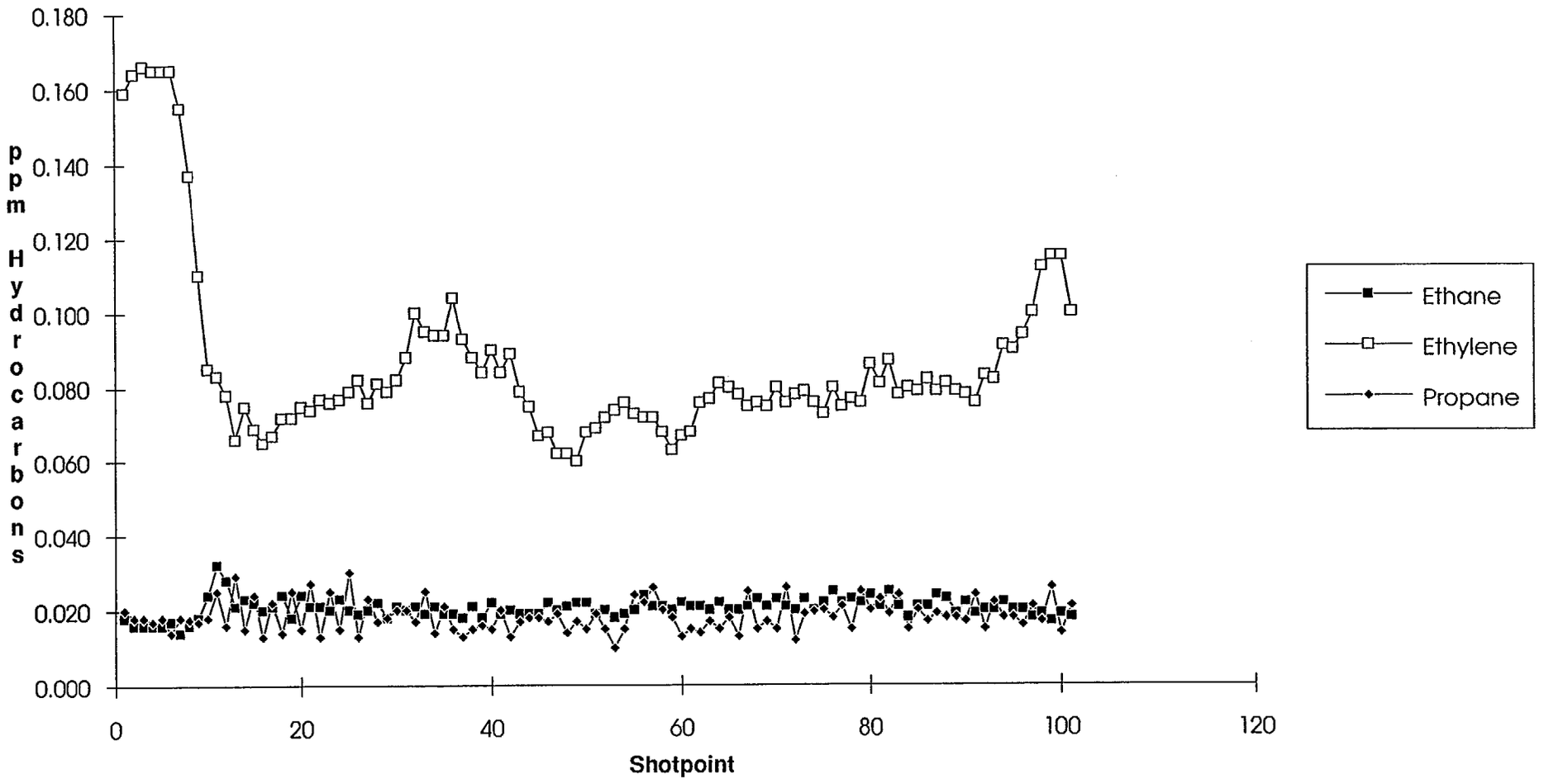
	Cond.	Temp.	F. Depth	W.Depth	Altitude	Calc. Alt.
Mean	57.259	24.714	69.437	458.247	27.205	387.455
Std. Dev.	0.824	0.578	7.985	508.427	6.888	509.045
Minimum	56.310	24.070	40.000	73.500	10.500	9.650
Maximum	59.820	26.510	77.750	1824.300	30.730	1776.530

Notes No anomalies occured on this line.

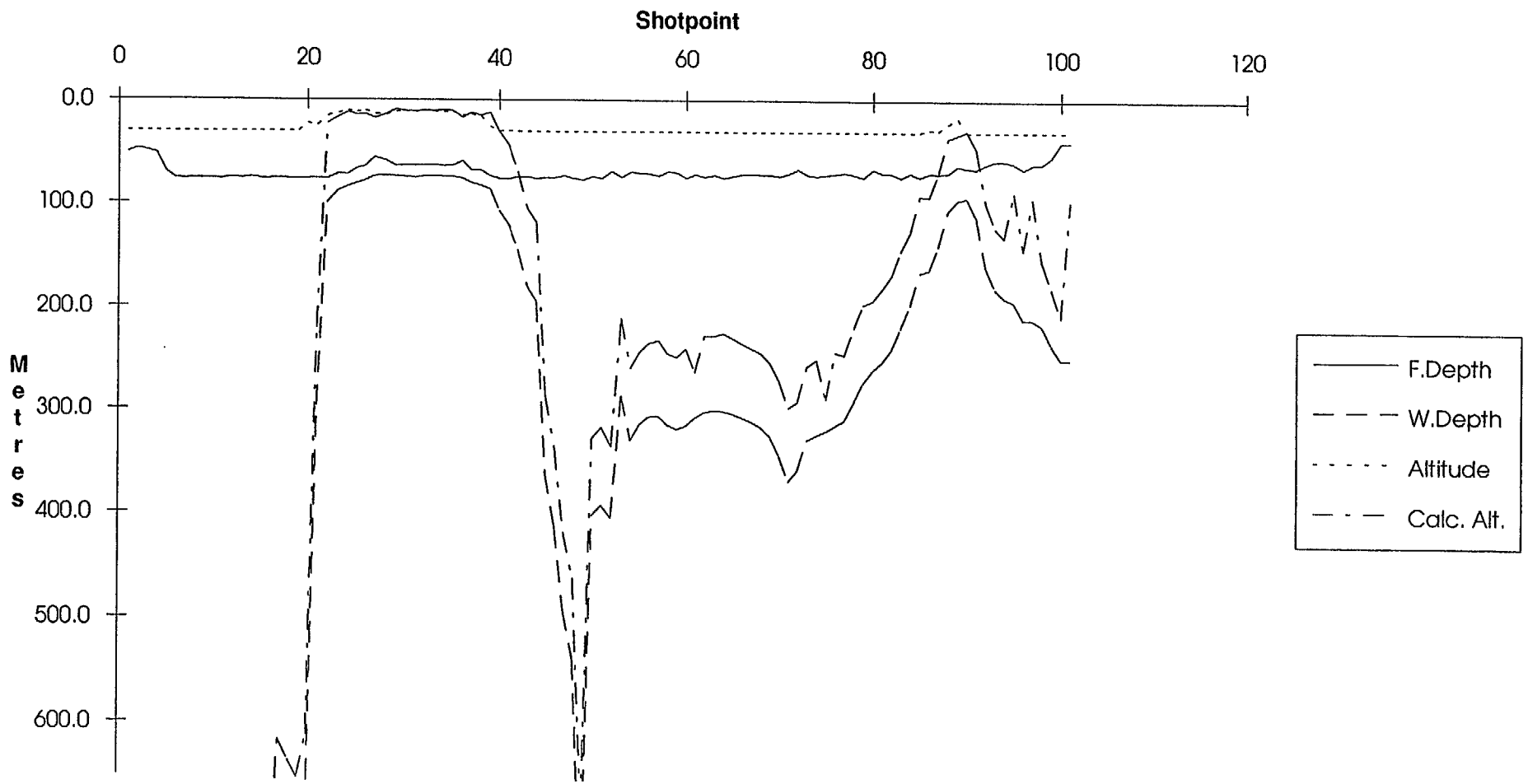
Line 109006 THC, Methane

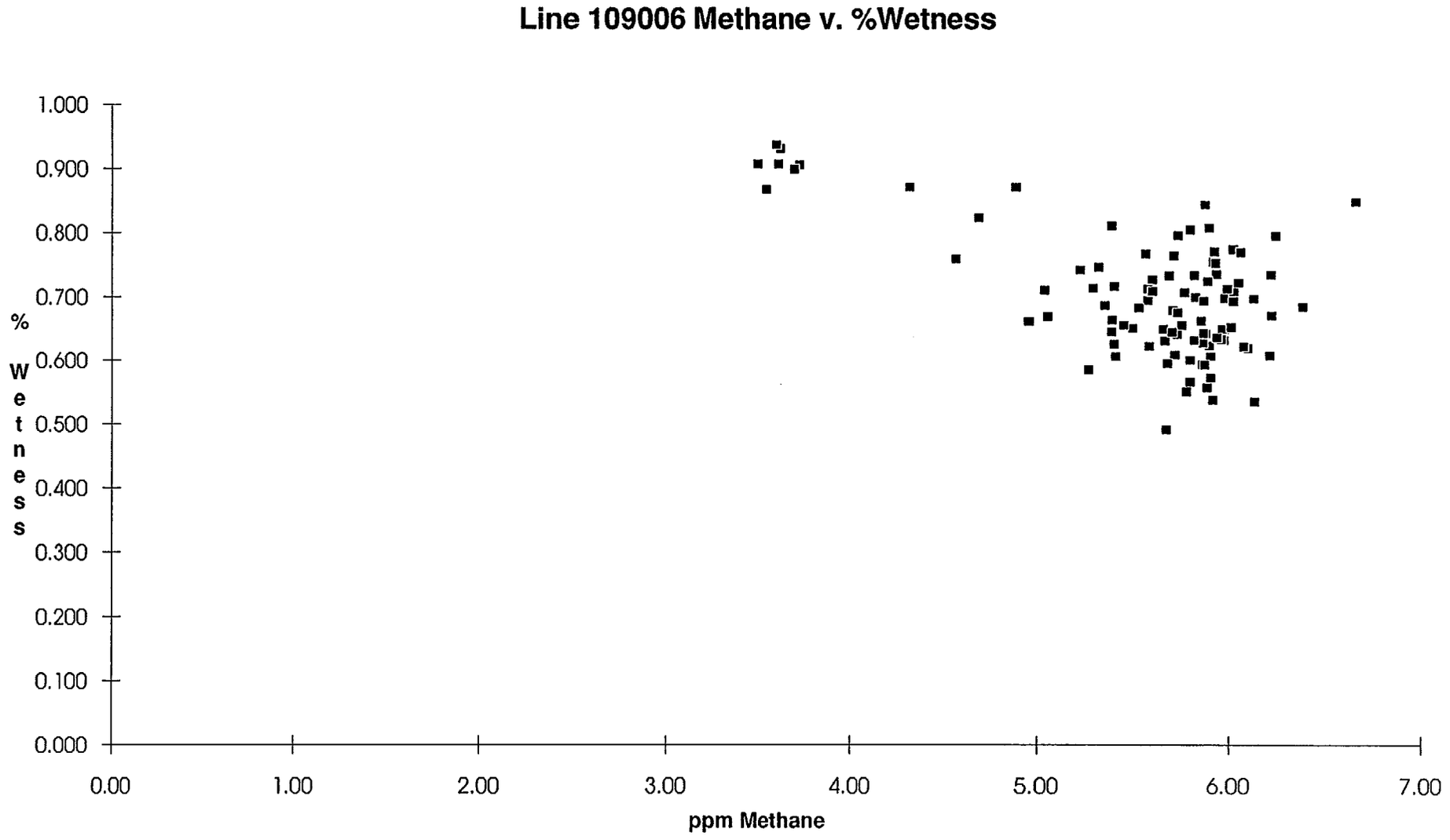


Line 109006 Ethane, Ethylene, Propane



Line 109006 Depths, Altitudes




Line 109006 Methane v. %Wetness
1.000
0.900
0.800
0.700
0.600
0.500
0.400
0.300
0.200
0.100
0.000
% Wetness
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
ppm Methane

Line Summary

Line Number	109007
No. of Shotpoints	86

	Shotpoint	Date	Time	Latitude		Longitude	
Start	1	3-Apr-92	04:39:26	9	38.657	119	03.513
End	2	3-Apr-92	07:29:40	9	48.629	118	55.611

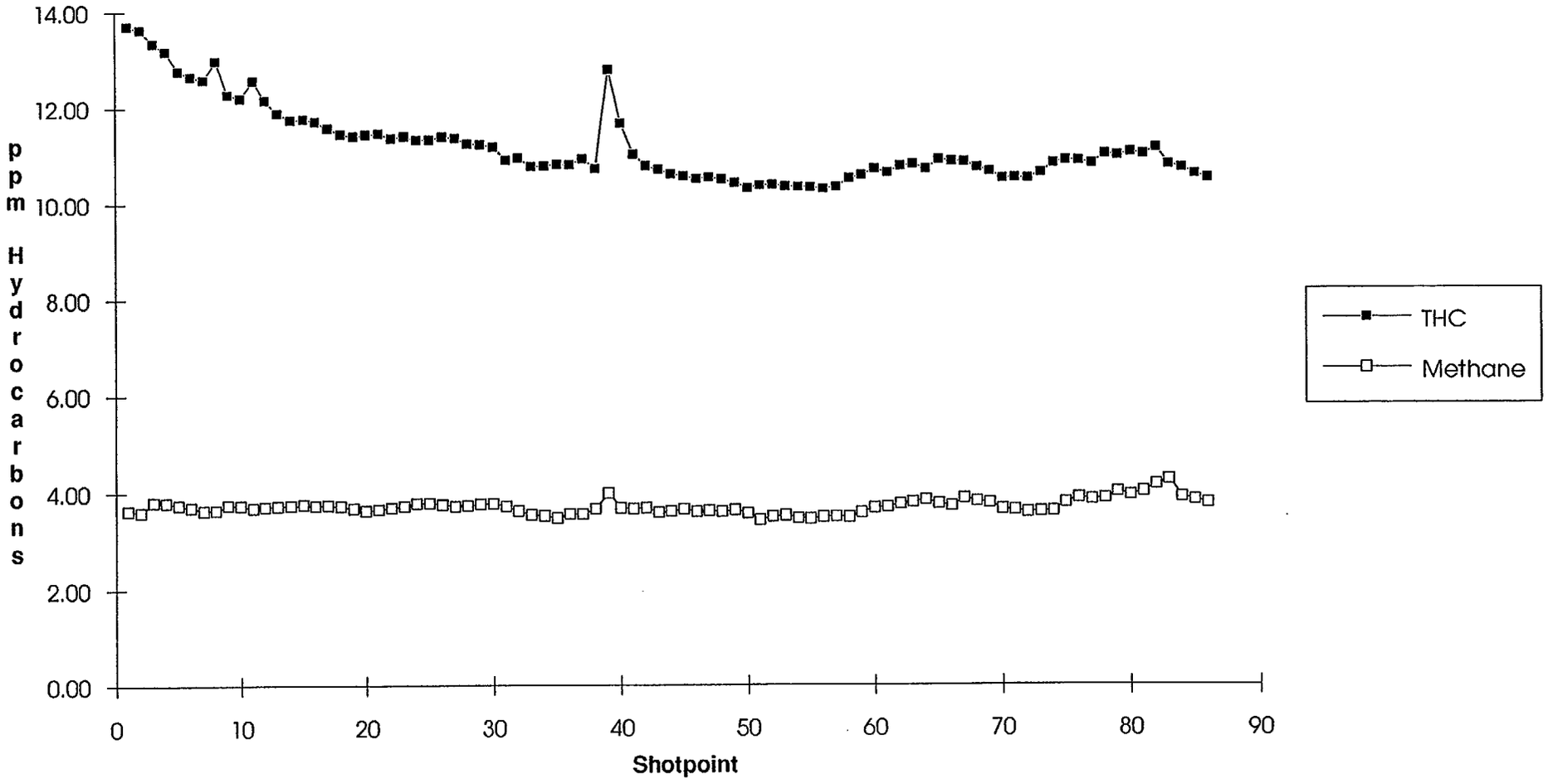
	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	11.187	3.692	0.016	0.167	0.017	0.046	0.000	0.000	0.028	0.195	0.057	0.006	0.887
Std. Dev.	0.811	0.149	0.003	0.017	0.003	0.009	0.000	0.000	0.007	0.020	0.017	0.019	0.125
Minimum	10.298	3.419	0.012	0.137	0.011	0.025	0.000	0.000	0.009	0.159	0.022	0.000	0.647
Maximum	13.694	4.251	0.026	0.206	0.025	0.070	0.000	0.000	0.062	0.299	0.096	0.095	1.215

	Cond.	Temp.	F. Depth	W.Depth	Altitude	Calc. Alt.
Mean	62.491	28.365	1.583	327.430	21.756	325.803
Std. Dev.	0.317	0.224	0.015	545.816	6.154	545.830
Minimum	61.970	28.020	1.560	49.000	14.060	45.100
Maximum	63.560	29.160	1.640	2129.300	30.760	2127.700

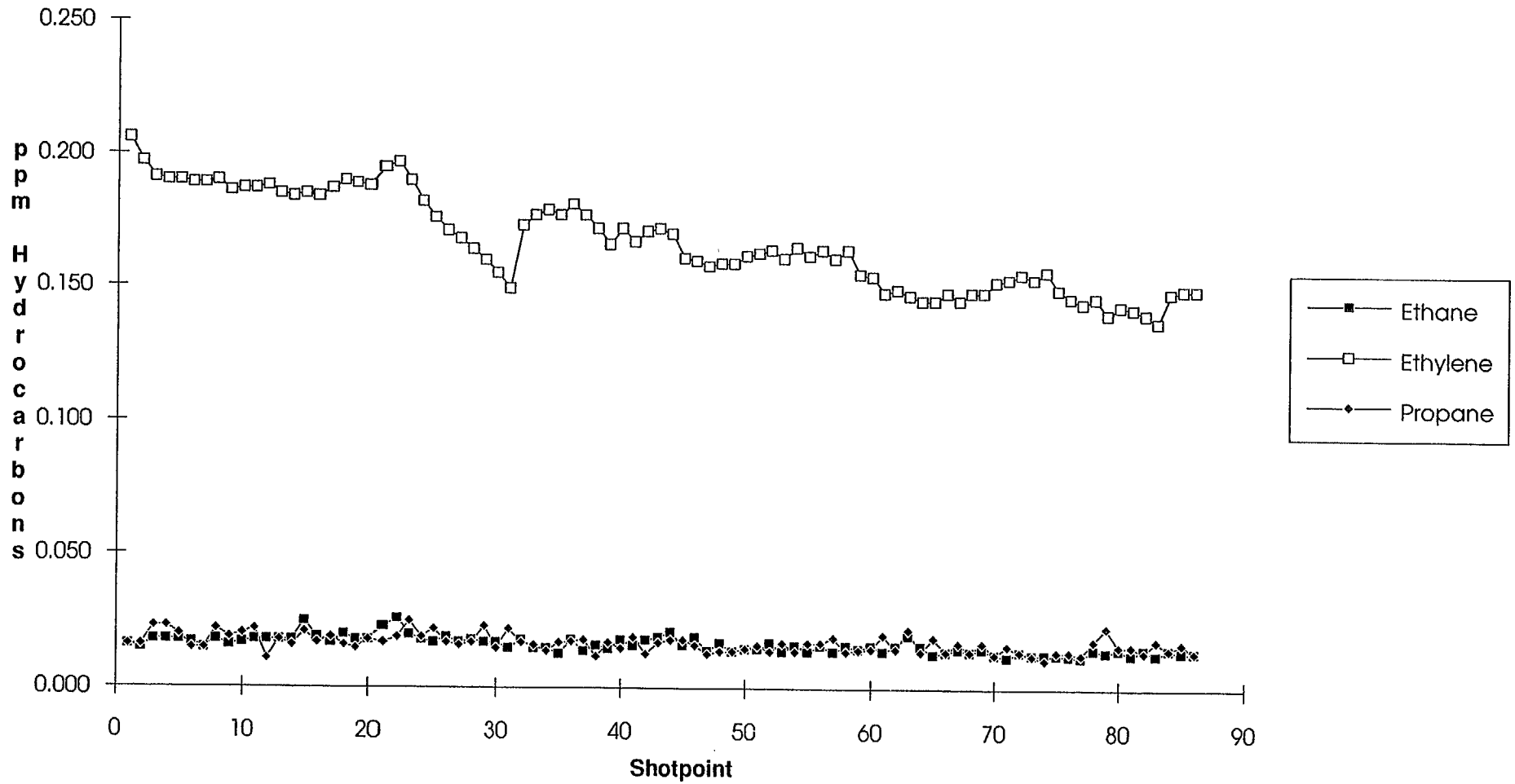
Notes

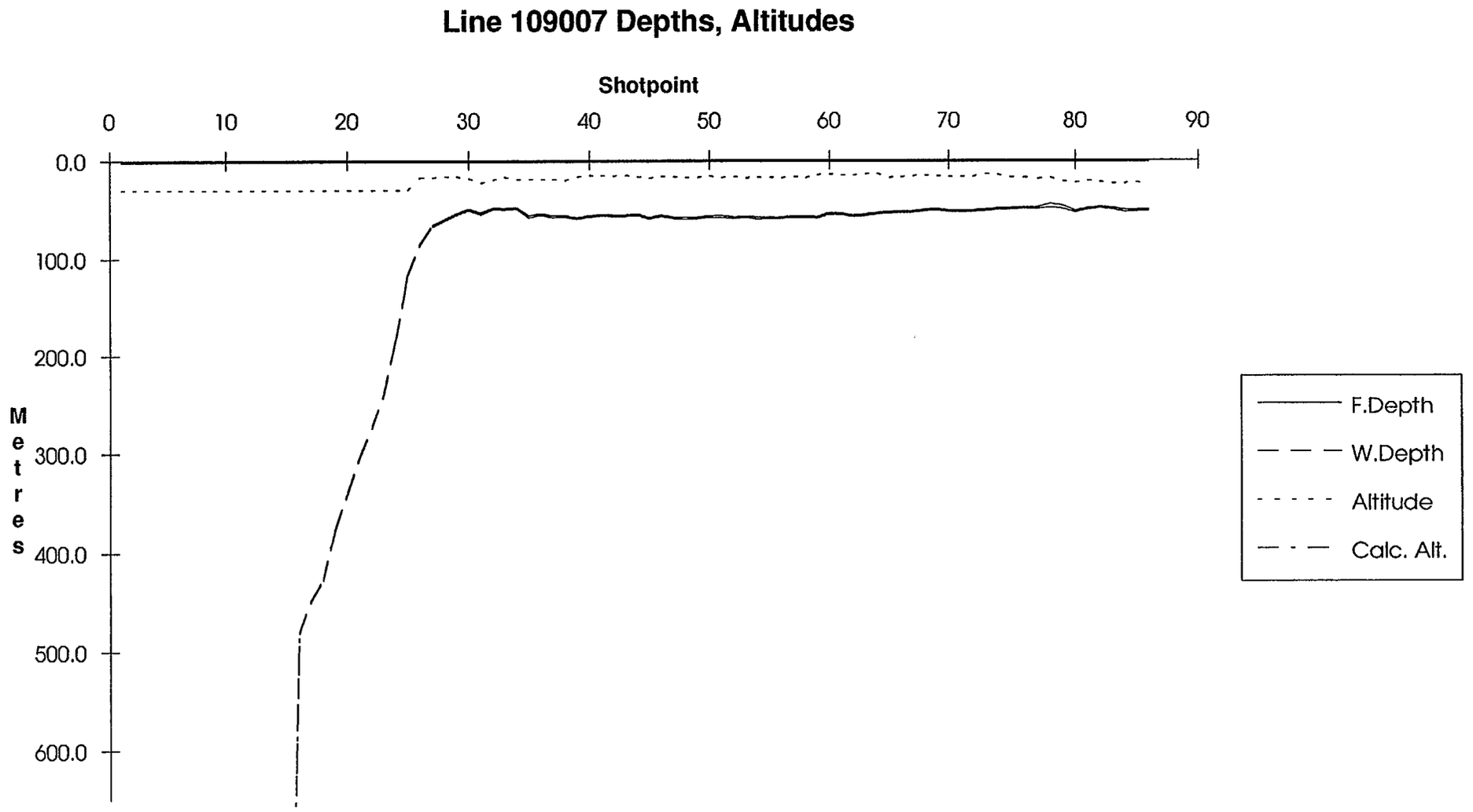
A very weak THC and methane anomaly occurs at SP 39.
No fish depth data is available

Line 109007 THC, Methane

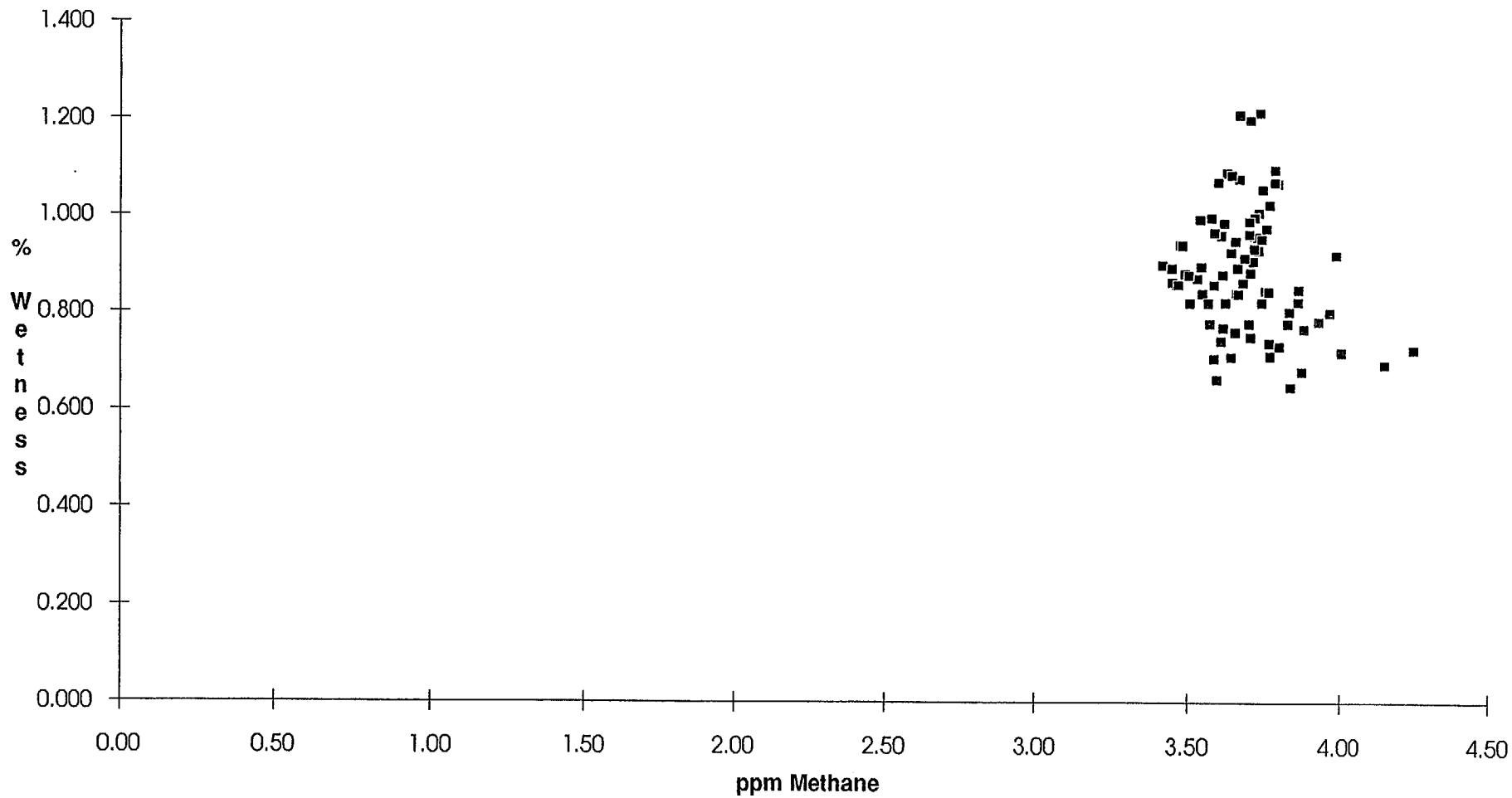


Line 109007 Ethane, Ethylene, Propane




Line 109007 Depths, Altitudes
Shotpoint
0
10
20
30
40
50
60
70
80
90
0.0
100.0
200.0
300.0
400.0
500.0
600.0
Metres
F.Depth
W.Depth
Altitude
Calc. Alt.

Line 109007 Methane v. %Wetness



Line Summary

Line Number	109008
No. of Shotpoints	149

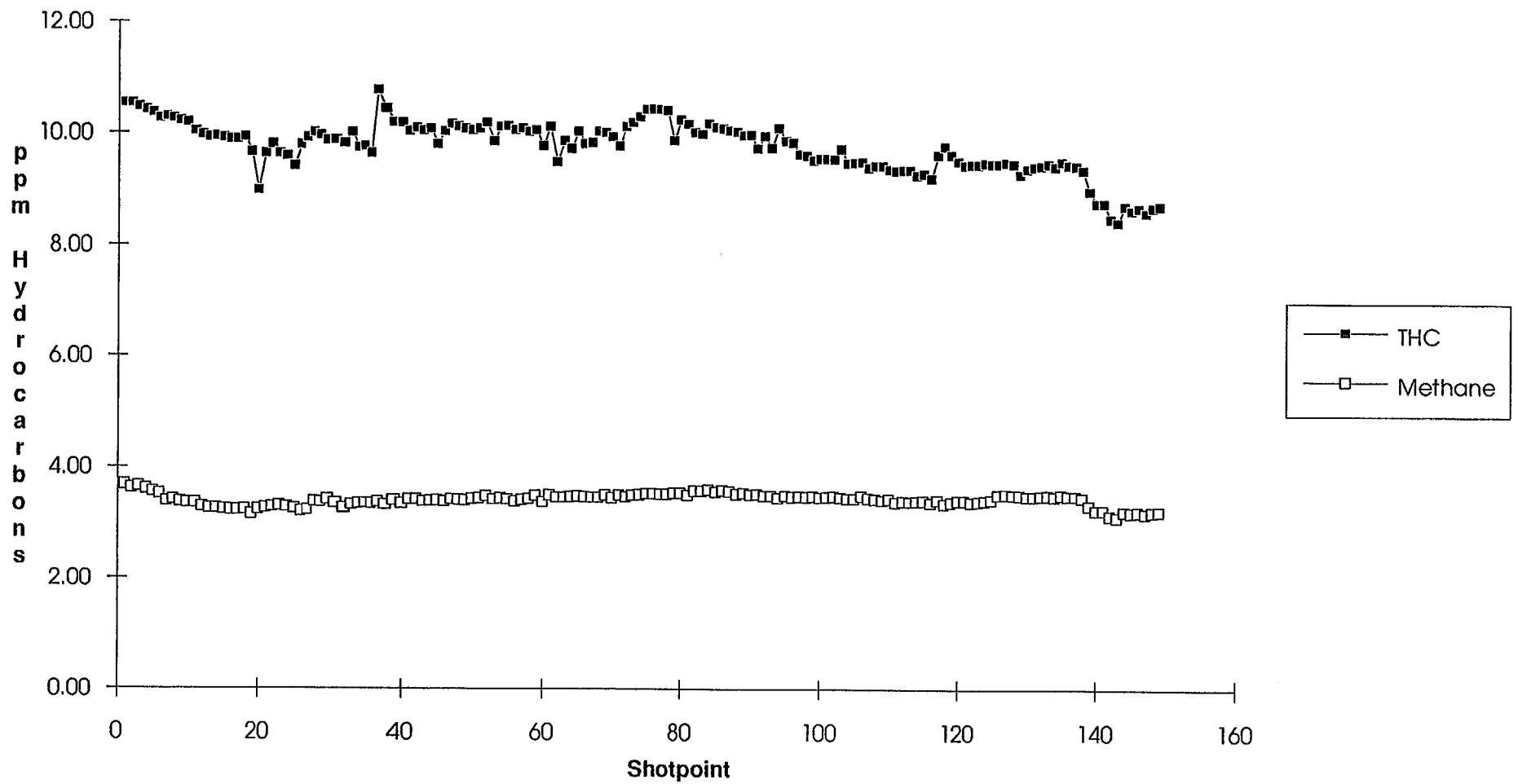
	Shotpoint	Date	Time	Latitude		Longitude	
Start	3	3-Apr-92	07:31:41	9	48.443	118	55.543
End	153	3-Apr-92	12:49:50	9	47.022	118	51.631

	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	9.766	3.426	0.015	0.173	0.015	0.052	0.000	0.000	0.028	0.181	0.042	0.000	0.849
Std. Dev.	0.451	0.109	0.002	0.011	0.003	0.009	0.000	0.000	0.009	0.019	0.016	0.000	0.088
Minimum	8.425	3.121	0.011	0.144	0.010	0.023	0.000	0.000	0.008	0.139	0.009	0.000	0.658
Maximum	10.779	3.688	0.022	0.184	0.024	0.071	0.000	0.000	0.053	0.233	0.092	0.000	1.100

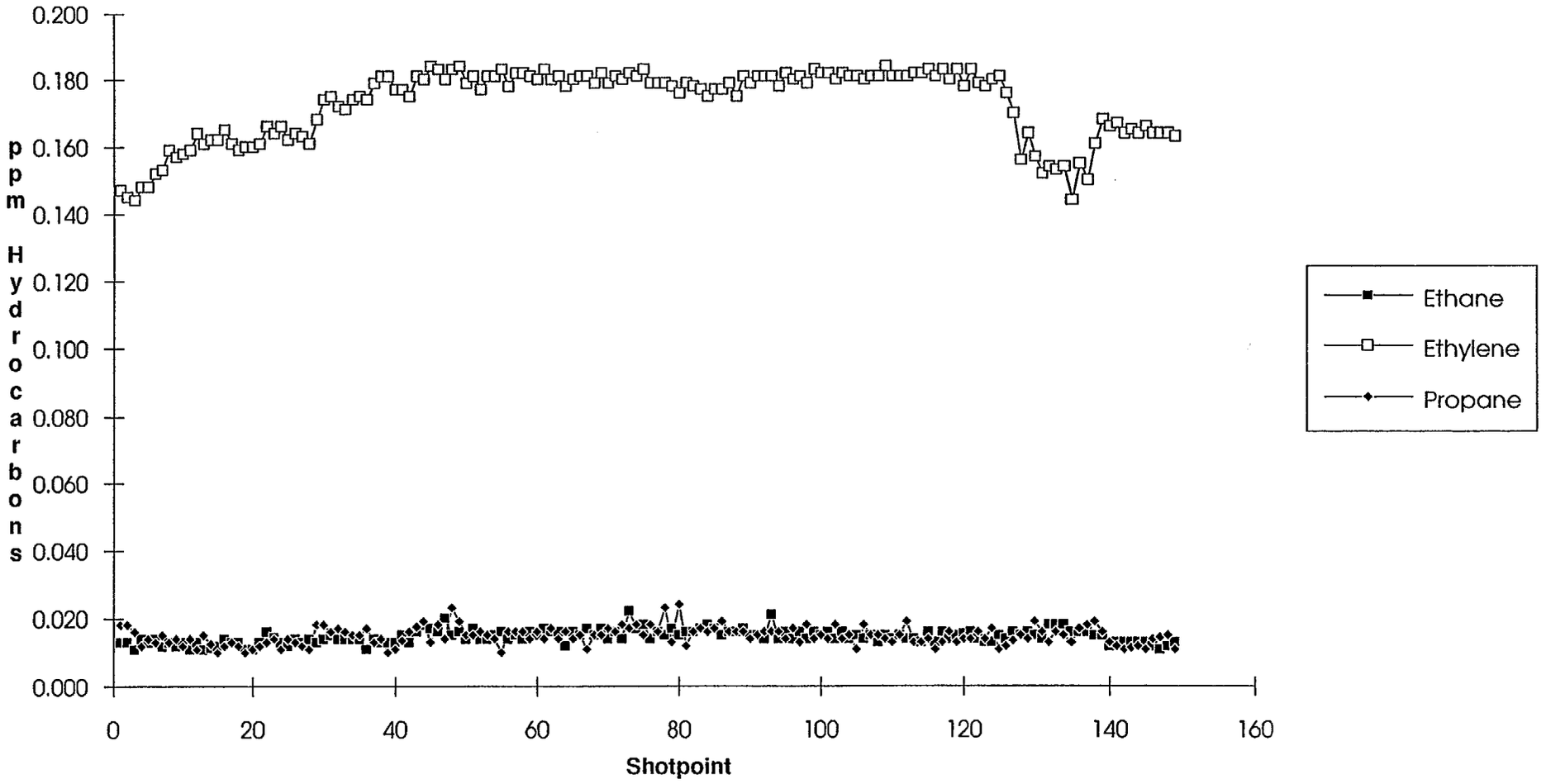
	Cond.	Temp.	F. Depth	W.Depth	Altitude	Calc. Alt.
Mean	61.224	27.482	1.583	825.283	27.513	823.679
Std. Dev.	0.652	0.450	0.013	800.587	4.733	800.592
Minimum	59.960	26.840	1.540	40.600	15.890	39.010
Maximum	62.550	28.420	1.610	2517.500	30.790	2515.930

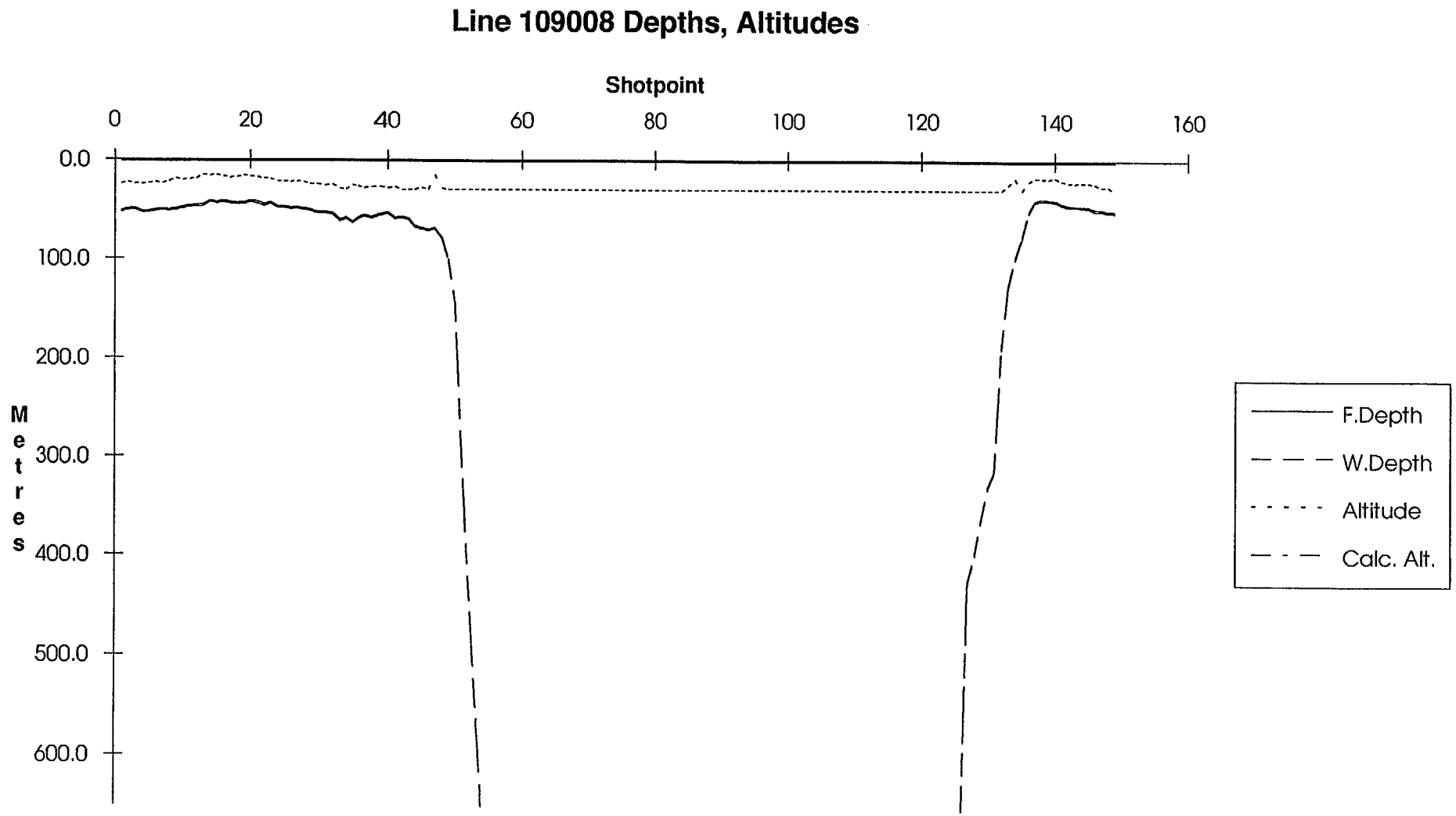
Notes No anomalies occured on this line.

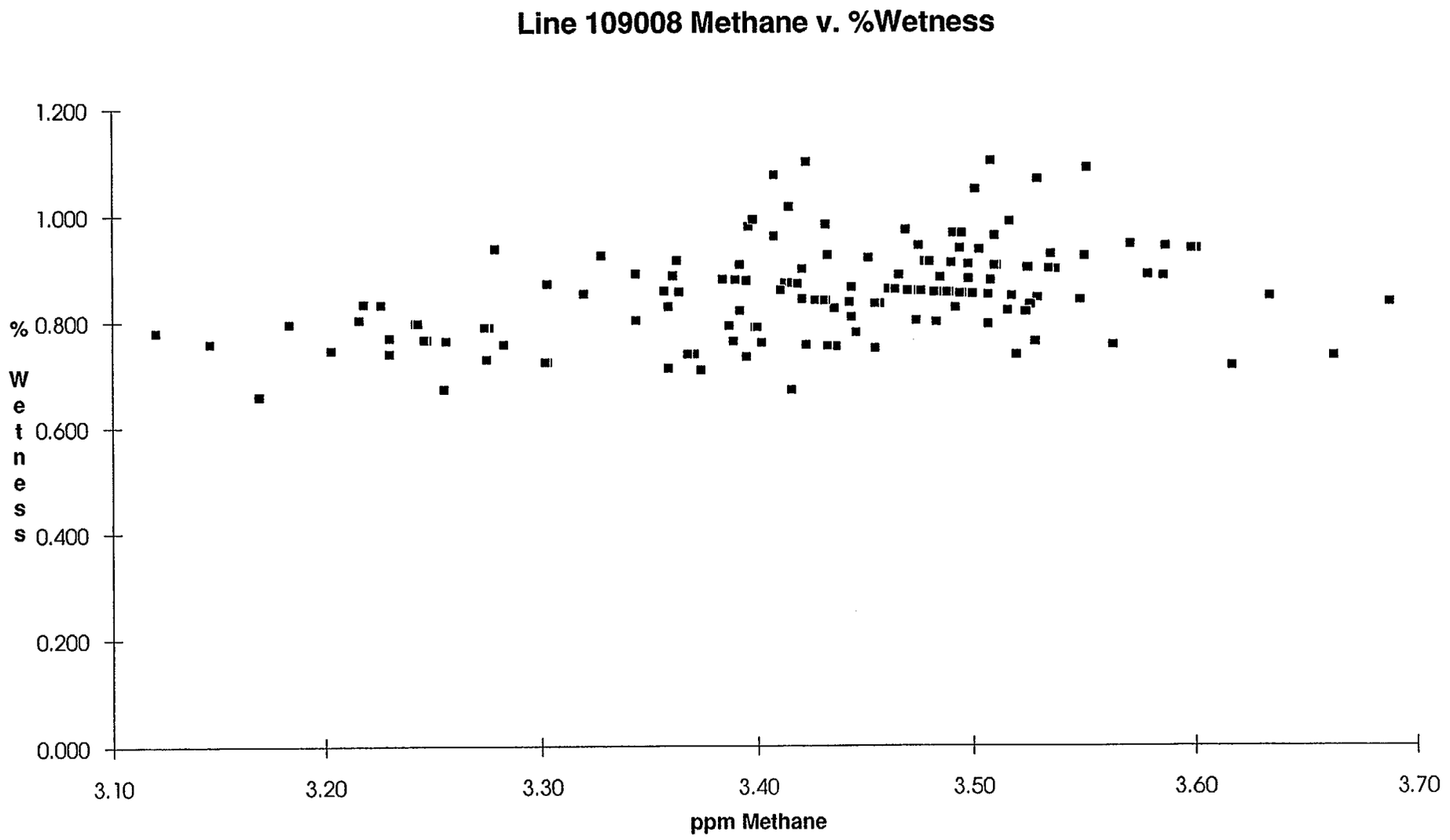
Line 109008 THC, Methane



Line 109008 Ethane, Ethylene, Propane




Line 109008 Depths, Altitudes
Shotpoint
0
20
40
60
80
100
120
140
160
0.0
100.0
200.0
300.0
400.0
500.0
600.0
Metres
F.Depth
W.Depth
Altitude
Calc. Alt.


Line 109008 Methane v. %Wetness
1.200
1.000
0.800
0.600
0.400
0.200
0.000
% Wetness
3.10
3.20
3.30
3.40
3.50
3.60
3.70
ppm Methane

Line Summary

Line Number	109009
No. of Shotpoints	59

	Shotpoint	Date	Time	Latitude		Longitude	
Start	1	3-Apr-92	16:18:59	9	36.352	118	51.460
End	59	3-Apr-92	18:15:33	9	43.520	118	48.893

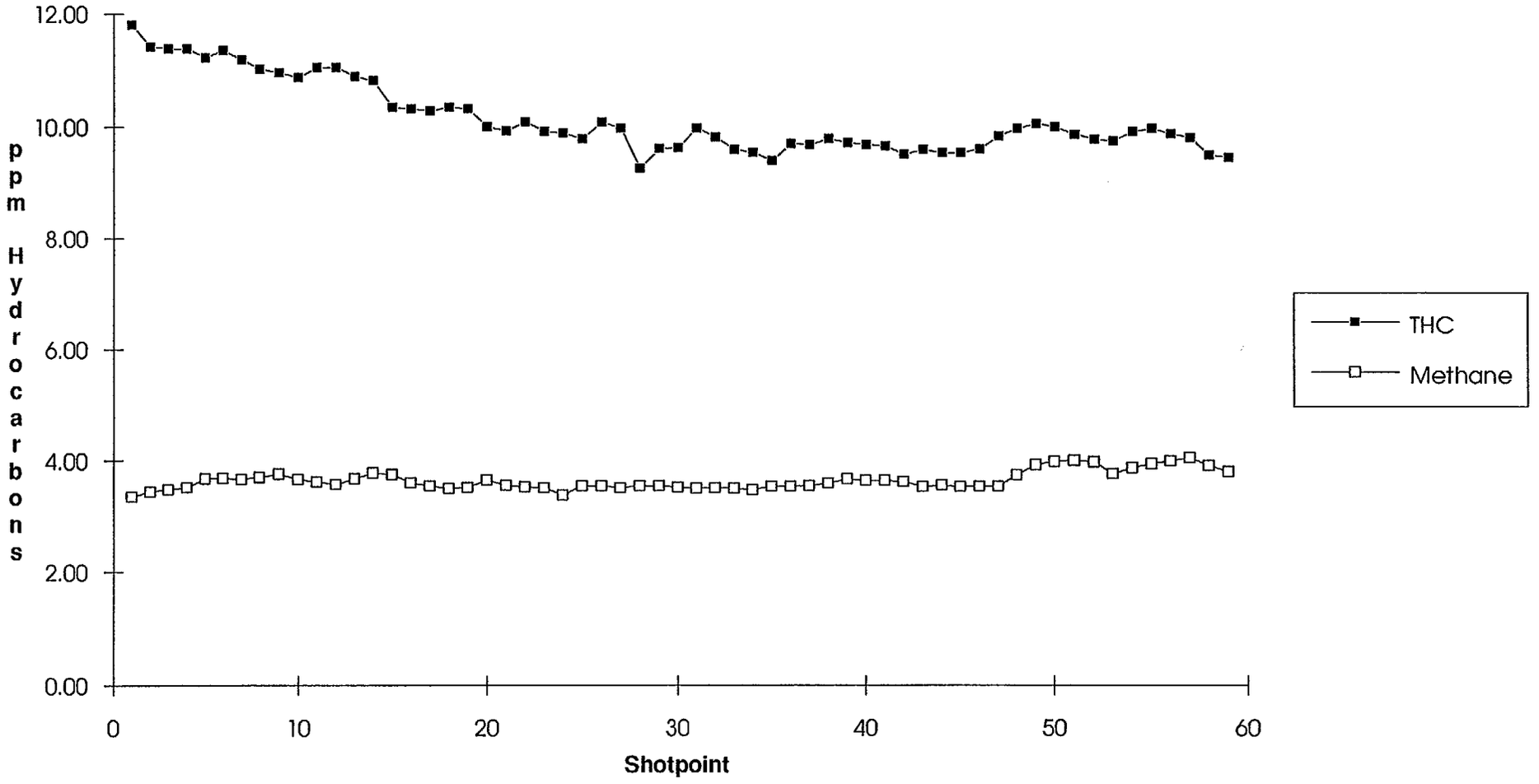
	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	10.138	3.642	0.015	0.156	0.017	0.041	0.000	0.000	0.028	0.183	0.000	0.000	0.865
Std. Dev.	0.640	0.168	0.002	0.021	0.003	0.010	0.000	0.000	0.007	0.021	0.000	0.000	0.094
Minimum	9.259	3.349	0.011	0.128	0.010	0.024	0.000	0.000	0.010	0.133	0.000	0.000	0.583
Maximum	11.798	4.054	0.018	0.222	0.024	0.074	0.000	0.000	0.042	0.255	0.000	0.000	1.061

	Cond.	Temp.	F. Depth	W.Depth	Altitude	Calc. Alt.
Mean	0.000	0.000	240.000	1129.068	31.092	1118.898
Std. Dev.	0.000	0.000	0.000	572.817	2.218	573.006
Minimum	0.000	0.000	240.000	250.000	26.000	240.000
Maximum	0.000	0.000	240.000	1750.000	39.000	1740.000

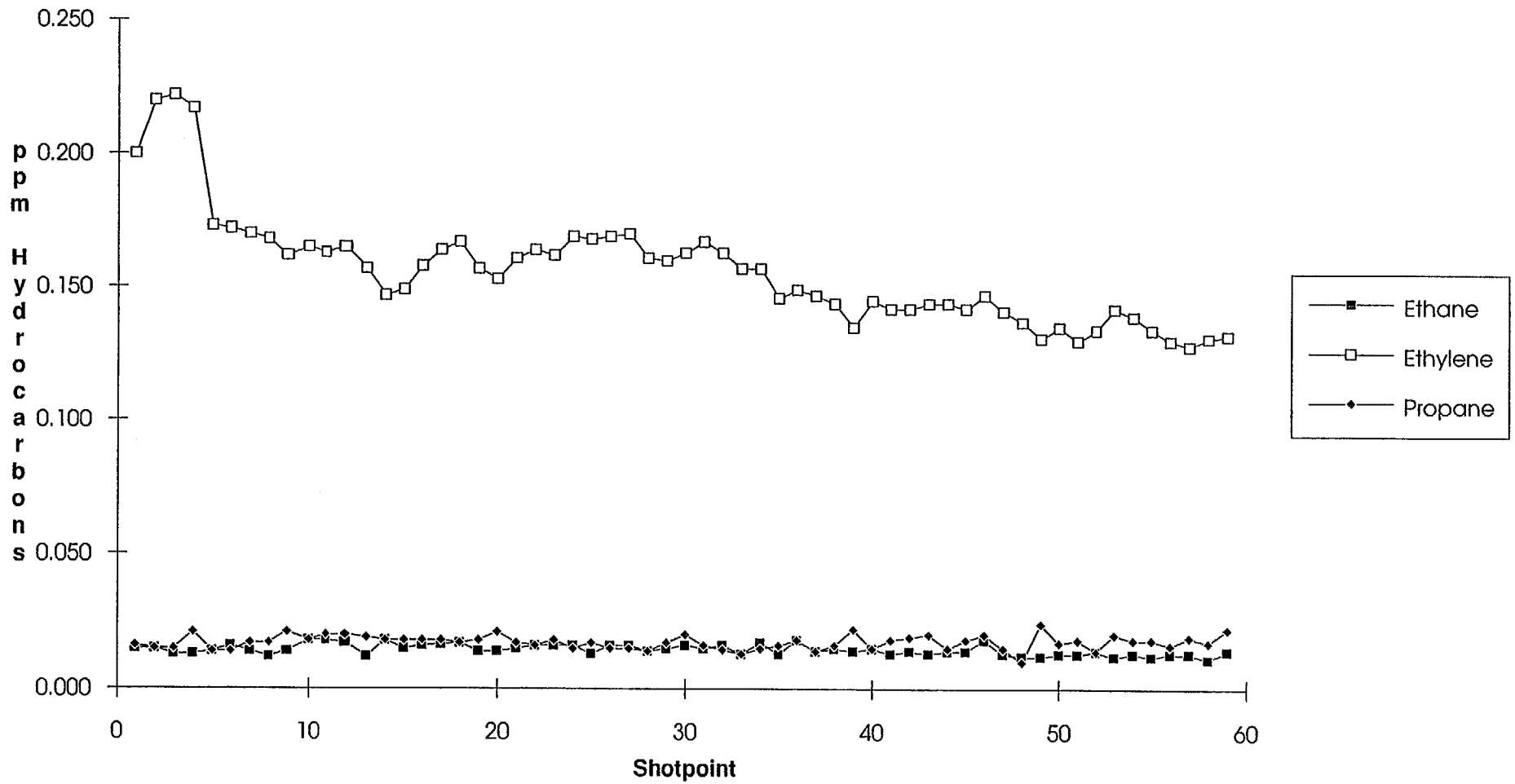
Notes

No anomalies occured on this line.
No conductivity or depth data was recorded.

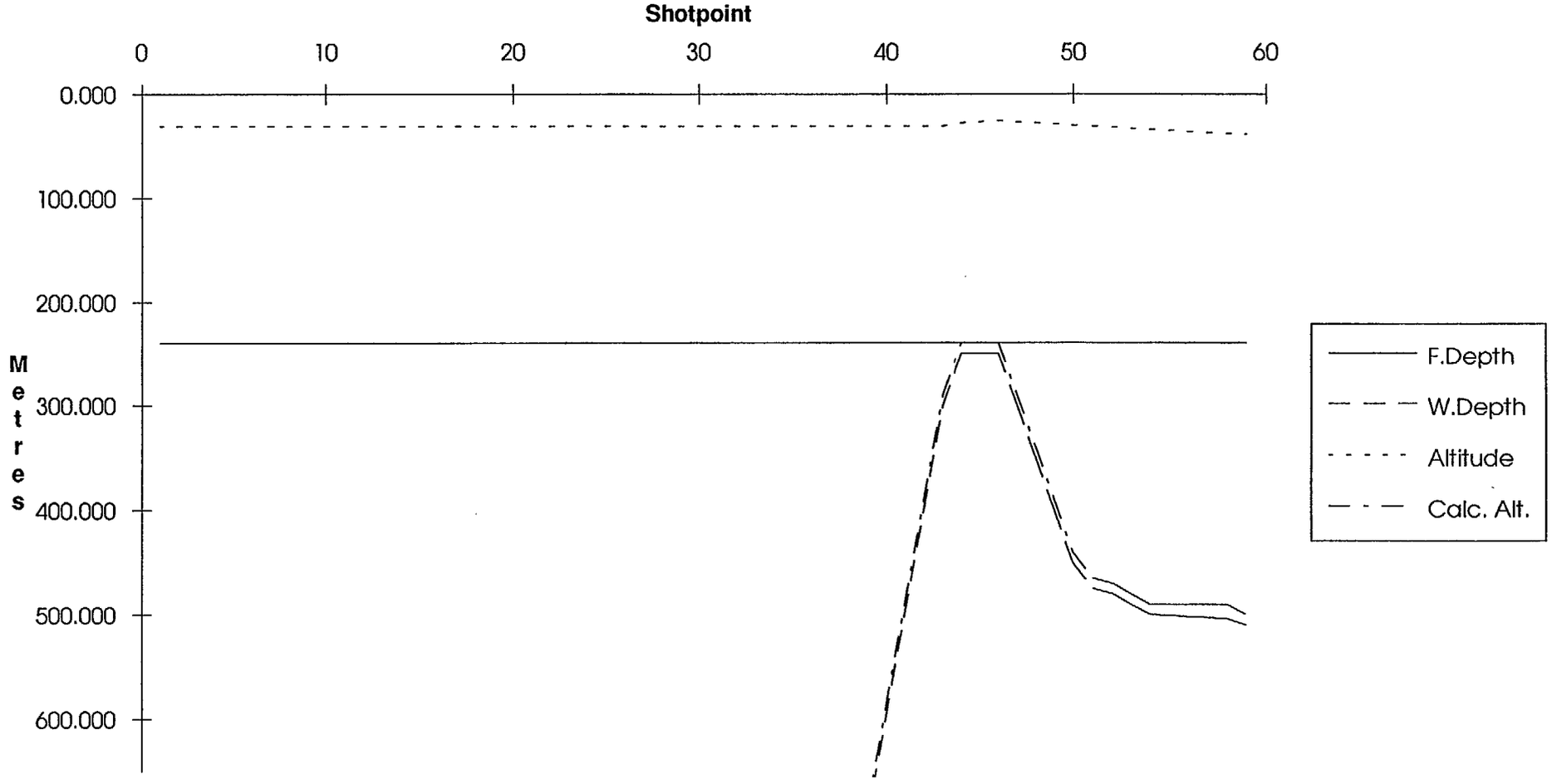
Line 109009 THC, Methane



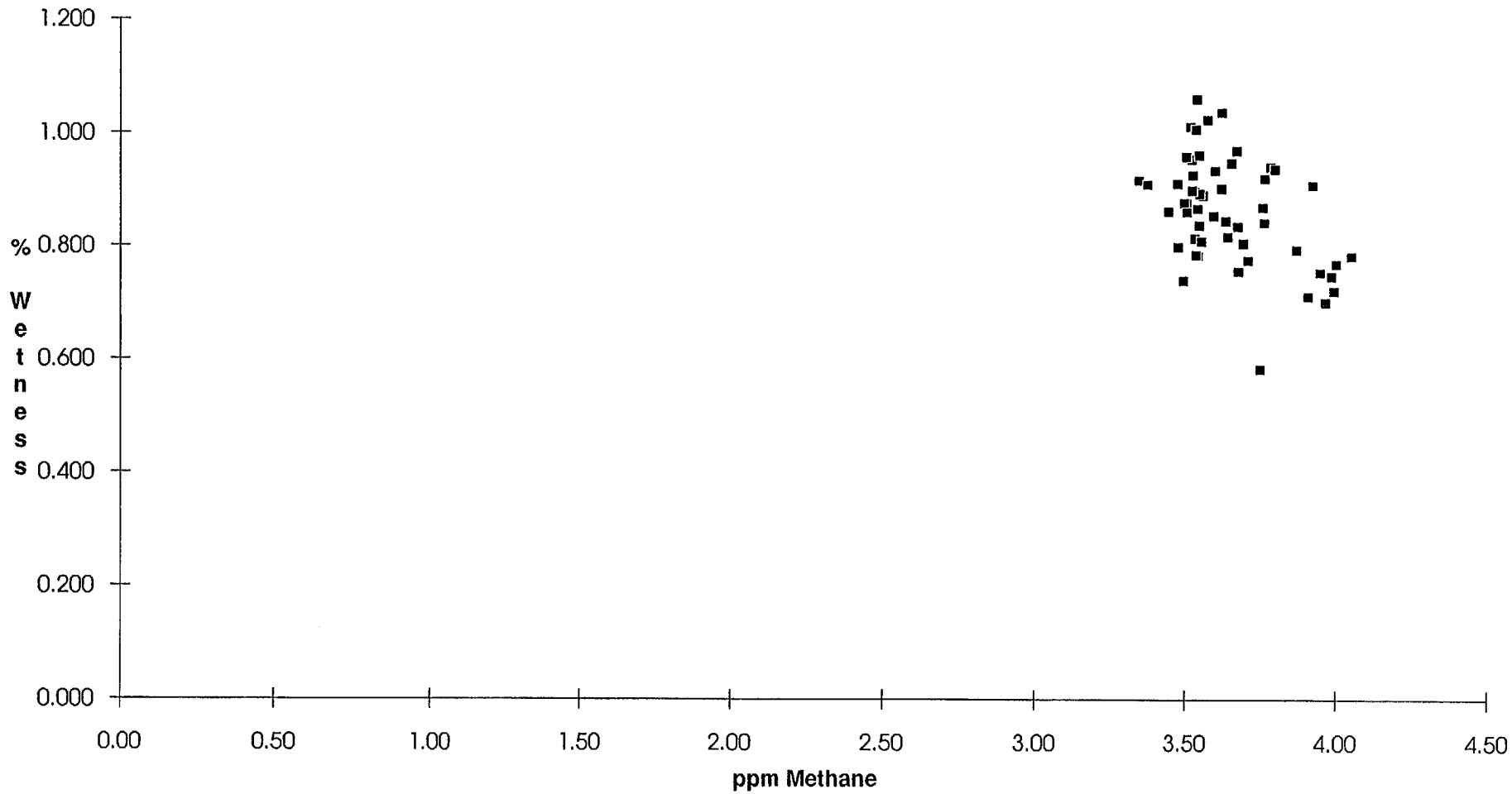
Line 109009 Ethane, Ethylene, Propane



Line 109009 Depths, Altitudes



Line 109009 Methane v. %Wetness



Line Summary

Line Number	109010
No. of Shotpoints	62

	Shotpoint	Date	Time	Latitude		Longitude	
Start	2	3-Apr-92	21:39:22	9	30.093	118	49.029
End	64	3-Apr-92	23:44:22	9	38.542	118	45.497

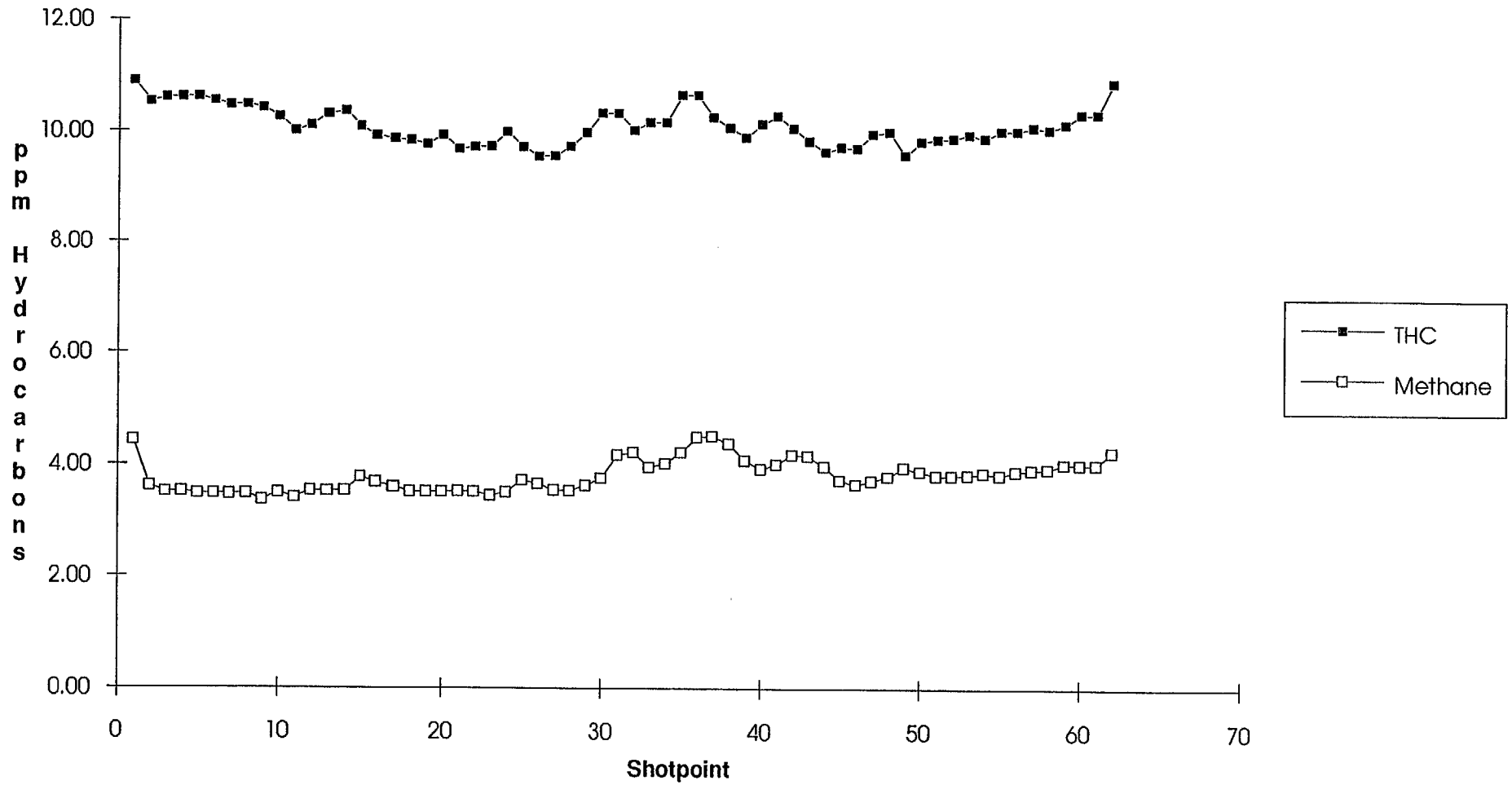
	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	10.109	3.805	0.016	0.150	0.017	0.037	0.000	0.000	0.024	0.173	0.049	0.036	0.854
Std. Dev.	0.328	0.297	0.001	0.020	0.003	0.009	0.000	0.000	0.007	0.017	0.011	0.016	0.094
Minimum	9.564	3.364	0.011	0.116	0.010	0.024	0.000	0.000	0.007	0.138	0.025	0.007	0.662
Maximum	10.912	4.520	0.020	0.196	0.024	0.066	0.000	0.000	0.038	0.214	0.071	0.073	1.102

	Cond.	Temp.	F. Depth	W.Depth	Altitude	Calc. Alt.
Mean	0.000	26.571	221.984	1382.780	30.730	1382.780
Std. Dev.	0.000	0.289	41.837	570.537	0.007	570.537
Minimum	0.000	25.810	112.000	122.300	30.720	122.300
Maximum	0.000	27.000	240.000	1916.800	30.750	1916.800

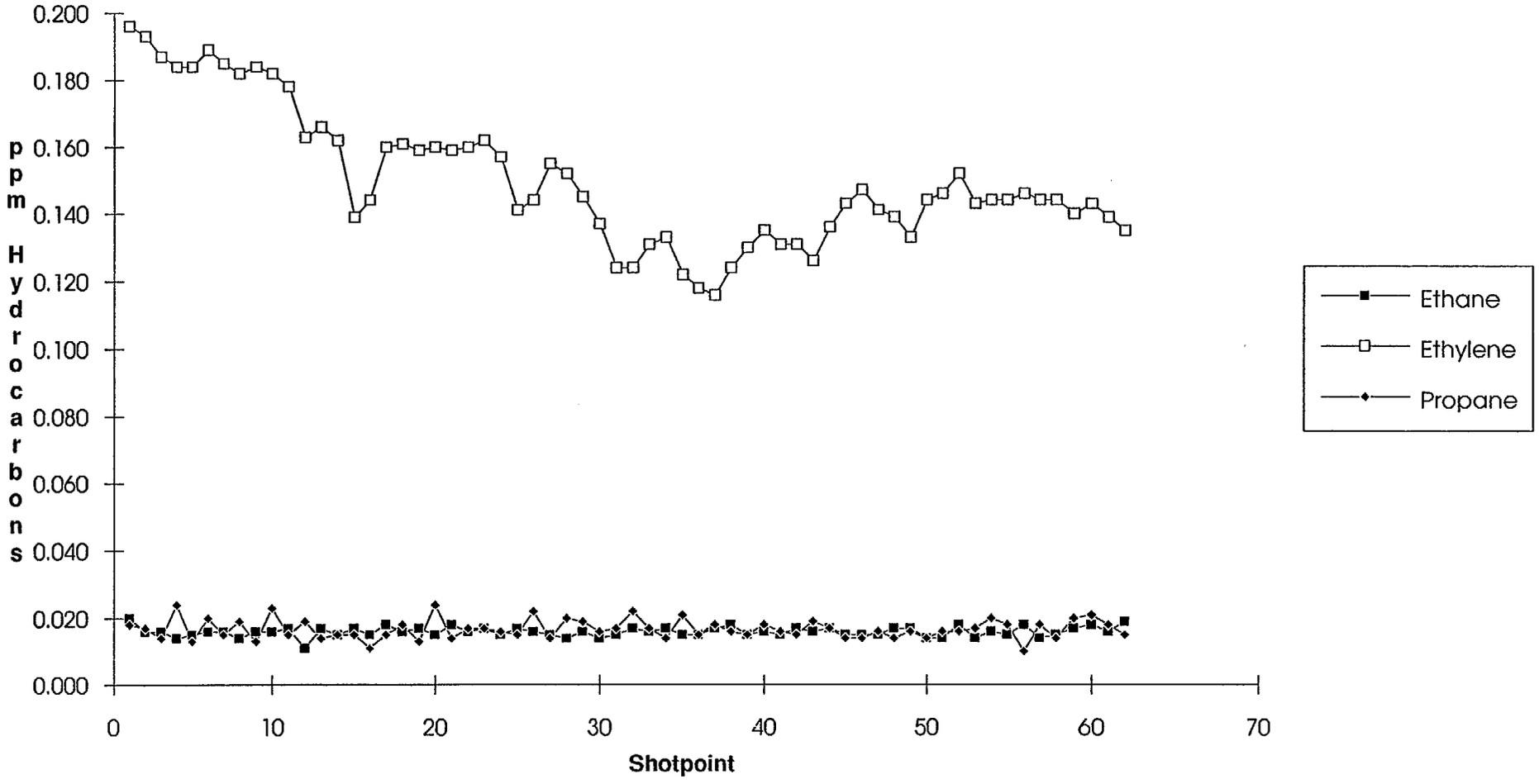
Notes

No anomalies occured on this line.
No conductivity or depth data was recorded.

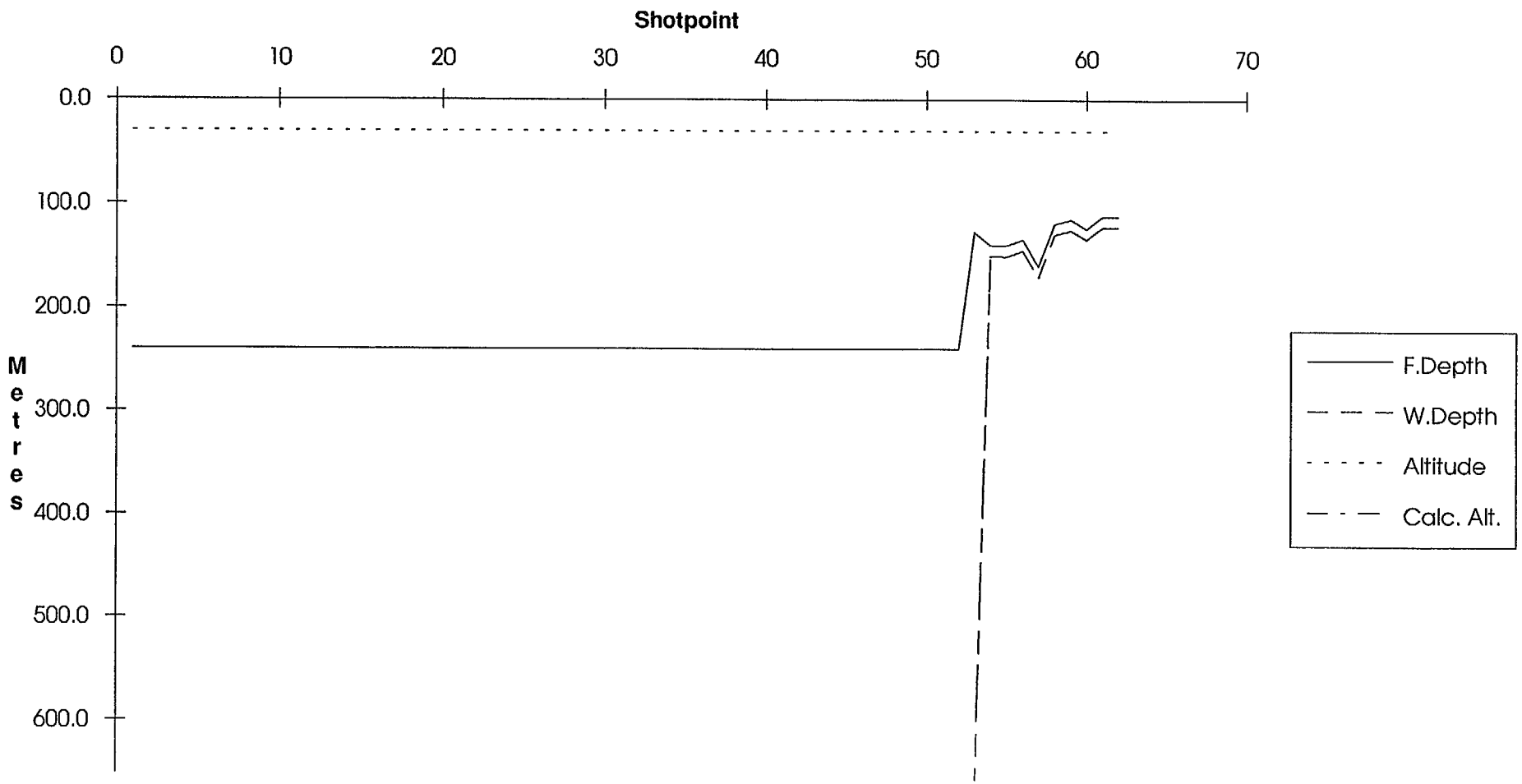
Line 109010 THC, Methane



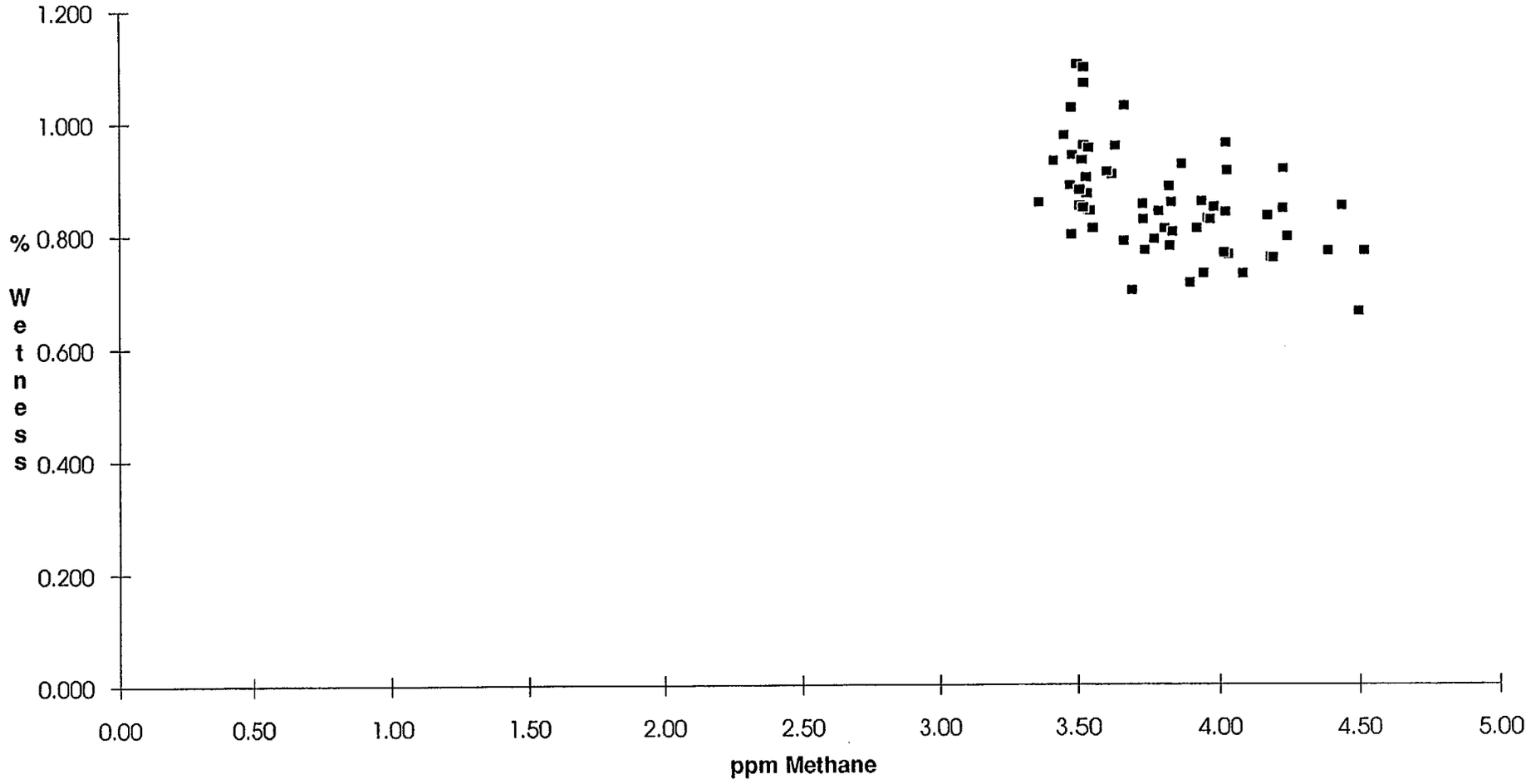
Line 109010 Ethane, Ethylene, Propane



Line 109010 Depths, Altitudes



Line 109010 Methane v. %Wetness



Line Summary

Line Number	109011
No. of Shotpoints	337

	Shotpoint	Date	Time	Latitude		Longitude	
Start	1	4-Apr-92	00:18:34	9	40.508	118	47.916
End	2	4-Apr-92	11:33:41	10	10.886	119	36.380

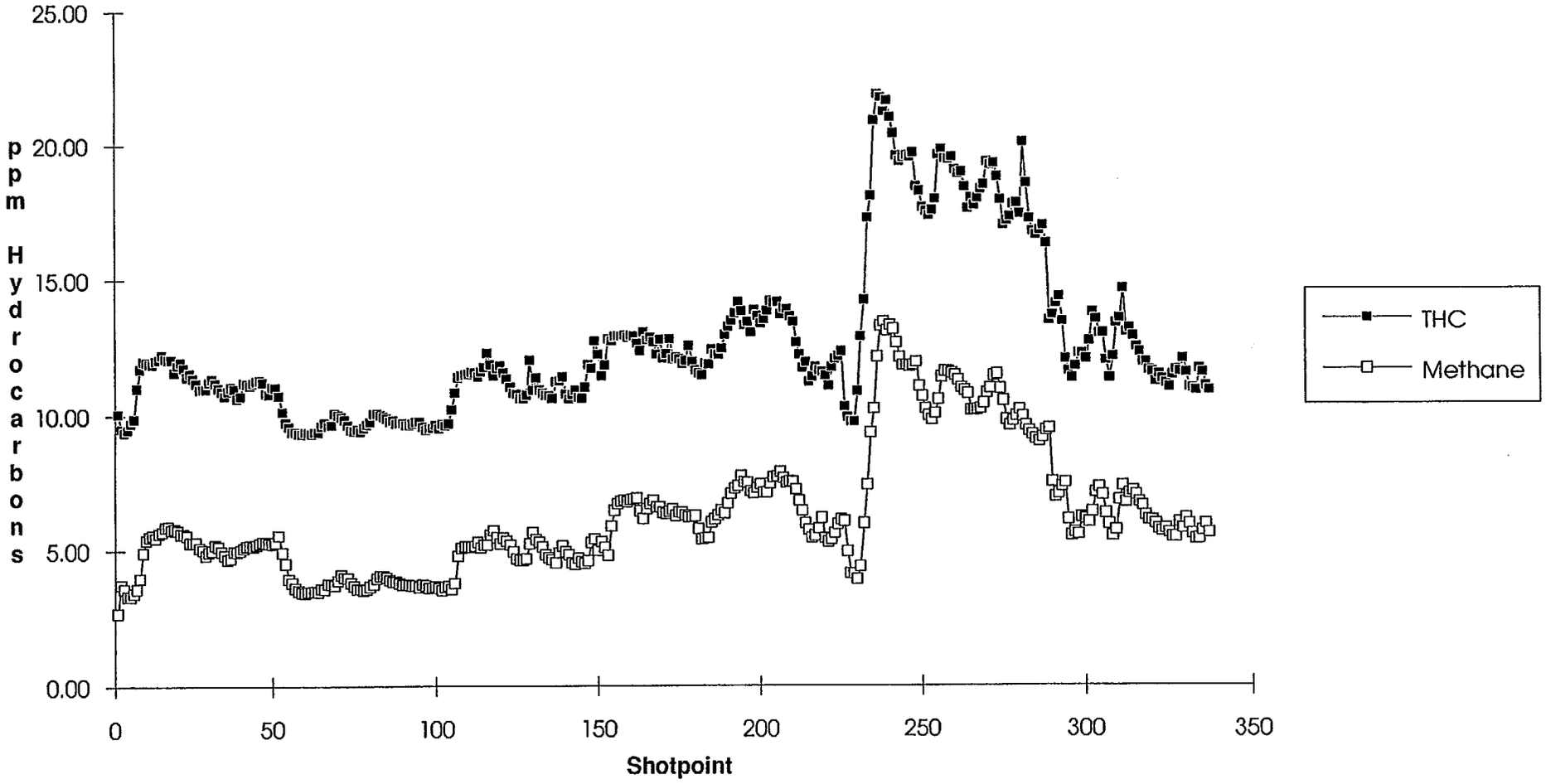
	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	12.658	6.273	0.020	0.114	0.017	0.022	0.000	0.000	0.010	0.140	0.034	0.050	0.649
Std. Dev.	2.987	2.358	0.003	0.026	0.003	0.016	0.000	0.000	0.012	0.028	0.015	0.019	0.171
Minimum	9.278	2.665	0.011	0.060	0.011	0.000	0.000	0.000	0.000	0.068	0.006	0.000	0.297
Maximum	21.853	13.424	0.030	0.184	0.026	0.072	0.000	0.000	0.051	0.215	0.099	0.126	1.145

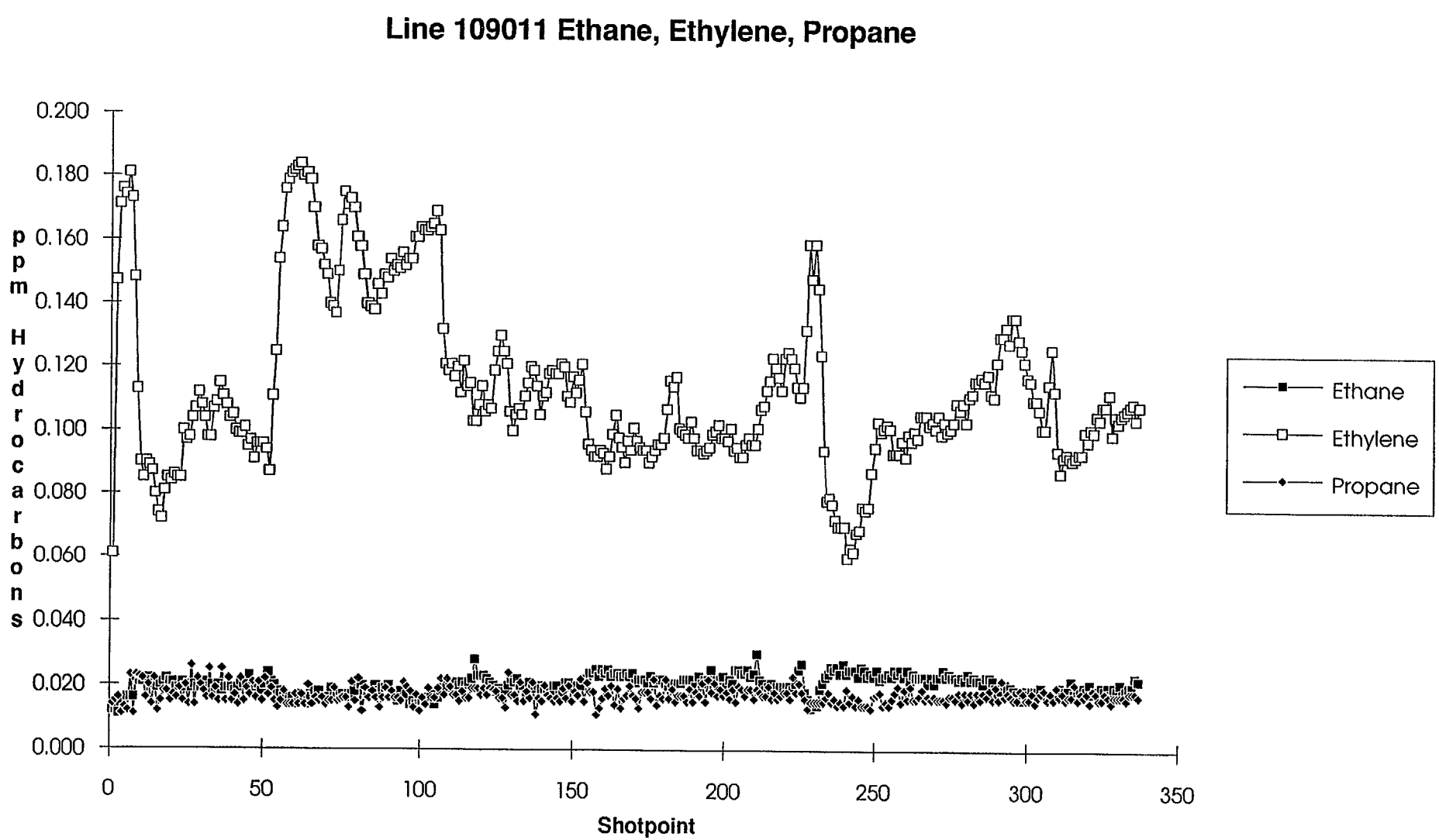
	Cond.	Temp.	F. Depth	W.Depth	Altitude	Calc. Alt.
Mean	60.116	26.730	50.171	535.707	23.081	486.514
Std. Dev.	1.162	0.805	12.137	581.071	7.963	575.854
Minimum	57.580	24.930	18.070	37.000	9.760	8.650
Maximum	62.760	28.530	76.000	2364.300	30.850	2289.300

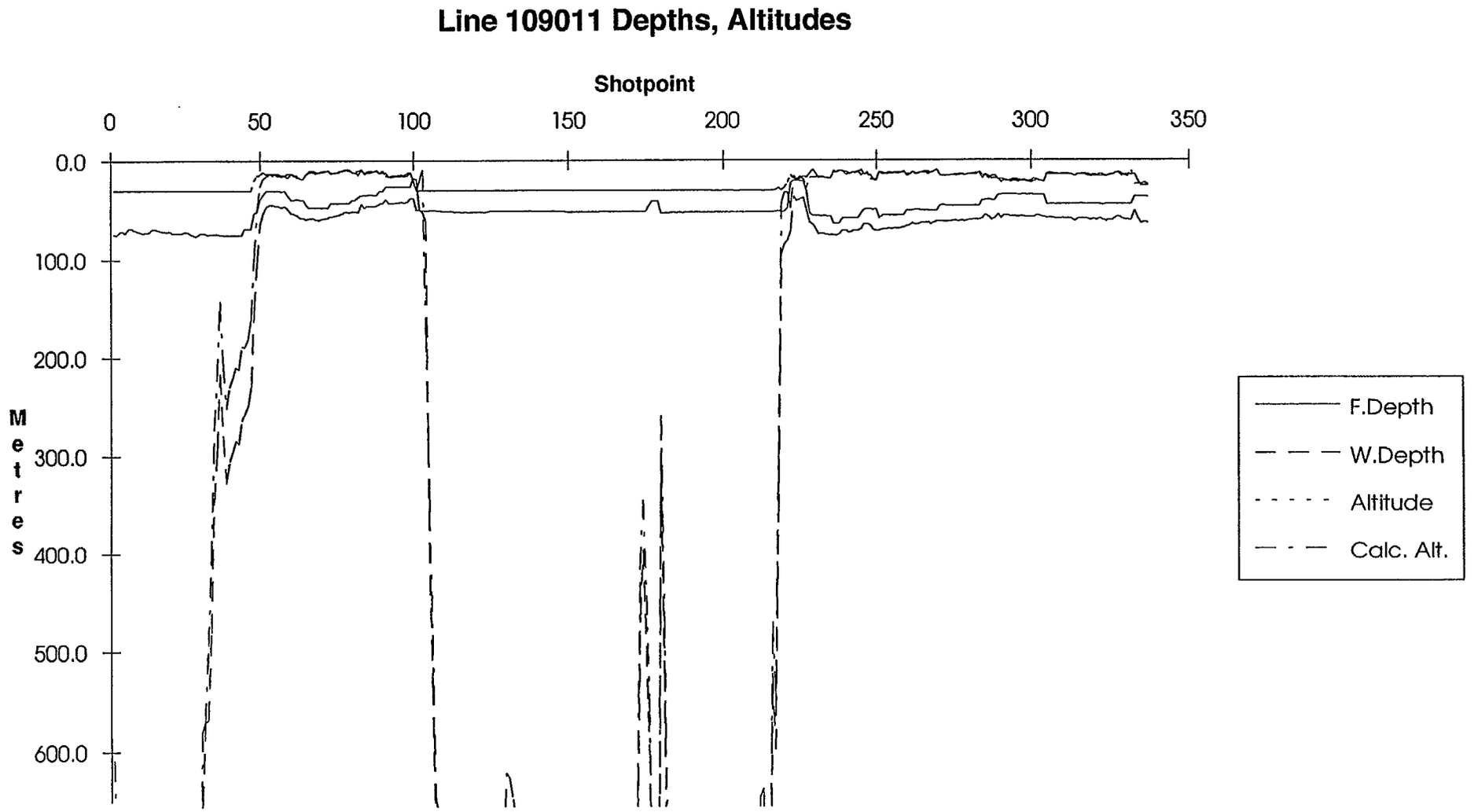
Notes

A weak THC, methane and ethane anomaly occurs between SP 240 and SP 280.
Poor depth data before SP 50.

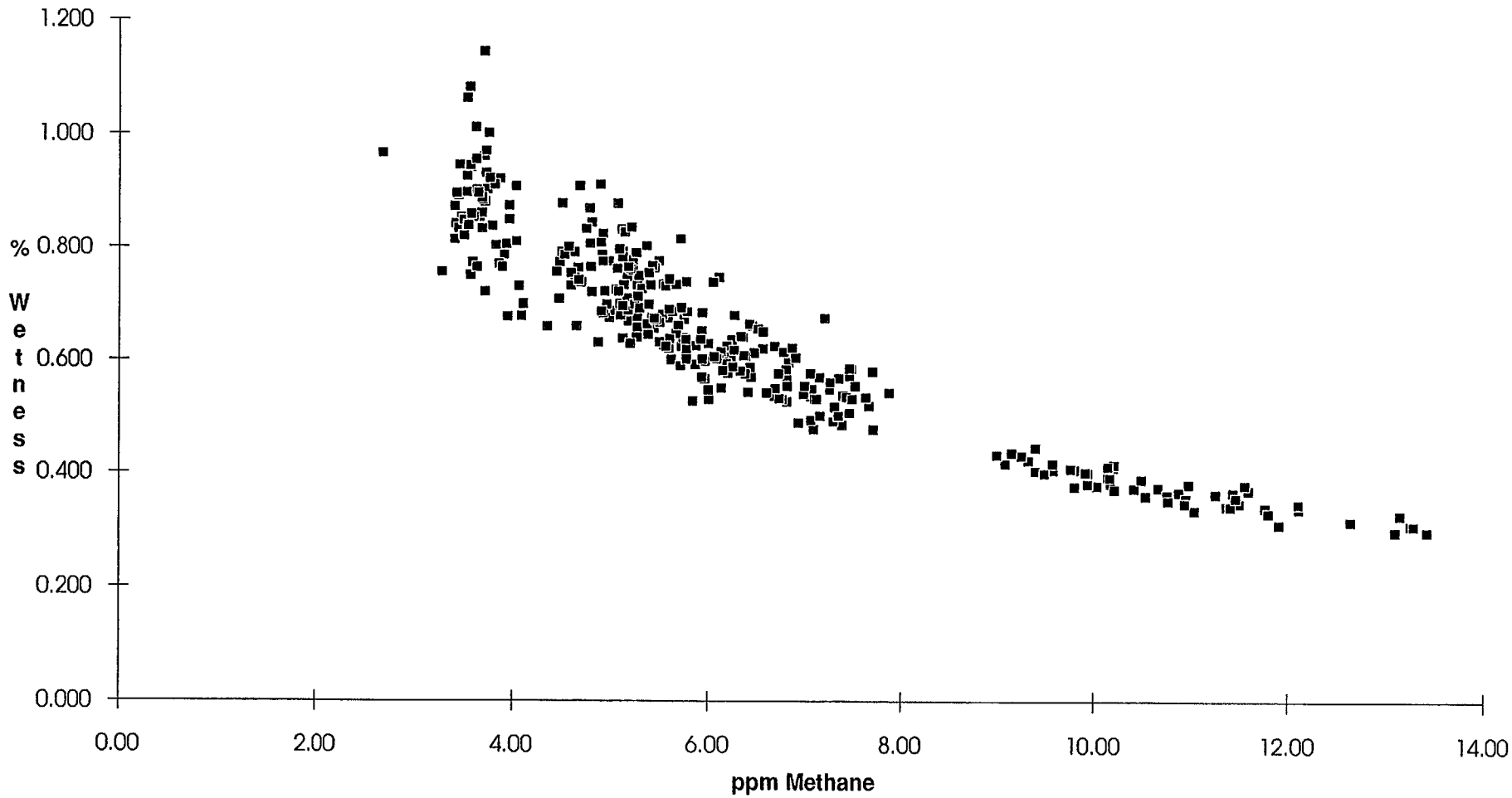
Line 109011 THC, Methane




Line 109011 Ethane, Ethylene, Propane
ppm Hydrocarbons
0.200
0.180
0.160
0.140
0.120
0.100
0.080
0.060
0.040
0.020
0.000
0
50
100
150
200
250
300
350
Shotpoint
Ethane
Ethylene
Propane


Line 109011 Depths, Altitudes
Shotpoint
0
50
100
150
200
250
300
350
0.0
100.0
200.0
300.0
400.0
500.0
600.0
Metres
F.Depth
W.Depth
Altitude
Calc. Alt.

Line 109011 Methane v. %Wetness



Line Summary

Line Number	109012
No. of Shotpoints	116

	Shotpoint	Date	Time	Latitude		Longitude	
Start	3	4-Apr-92	11:35:40	10	10.982	119	36.542
End	120	4-Apr-92	18:18:43	10	12.023	119	35.980

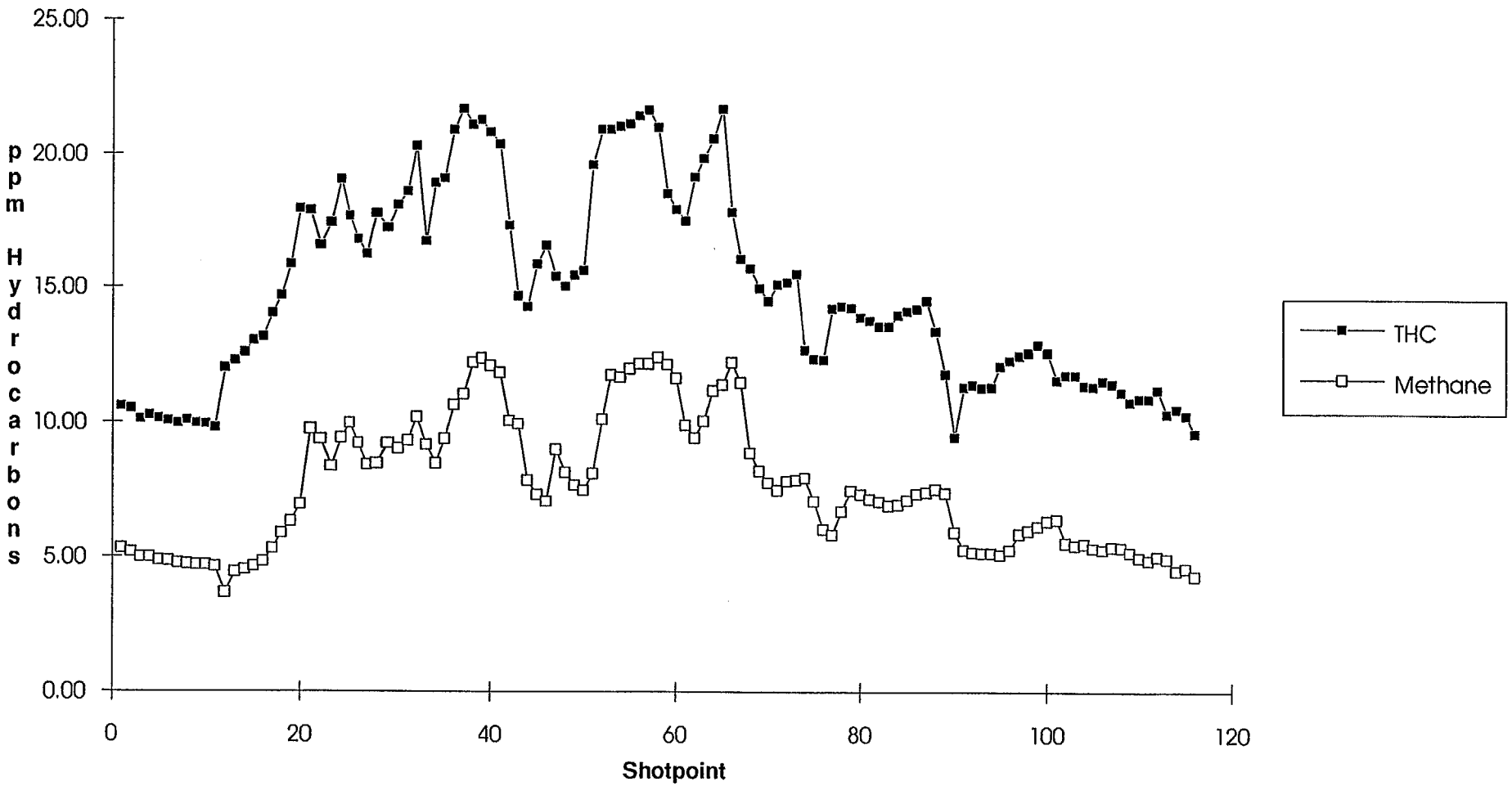
	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	14.849	7.568	0.025	0.113	0.020	0.025	0.000	0.000	0.017	0.154	0.038	0.045	0.634
Std. Dev.	3.659	2.464	0.005	0.013	0.003	0.005	0.000	0.000	0.012	0.037	0.013	0.018	0.156
Minimum	9.454	3.652	0.017	0.091	0.013	0.014	0.000	0.000	0.000	0.090	0.017	0.011	0.357
Maximum	21.694	12.408	0.037	0.151	0.028	0.040	0.000	0.000	0.044	0.269	0.085	0.091	1.271

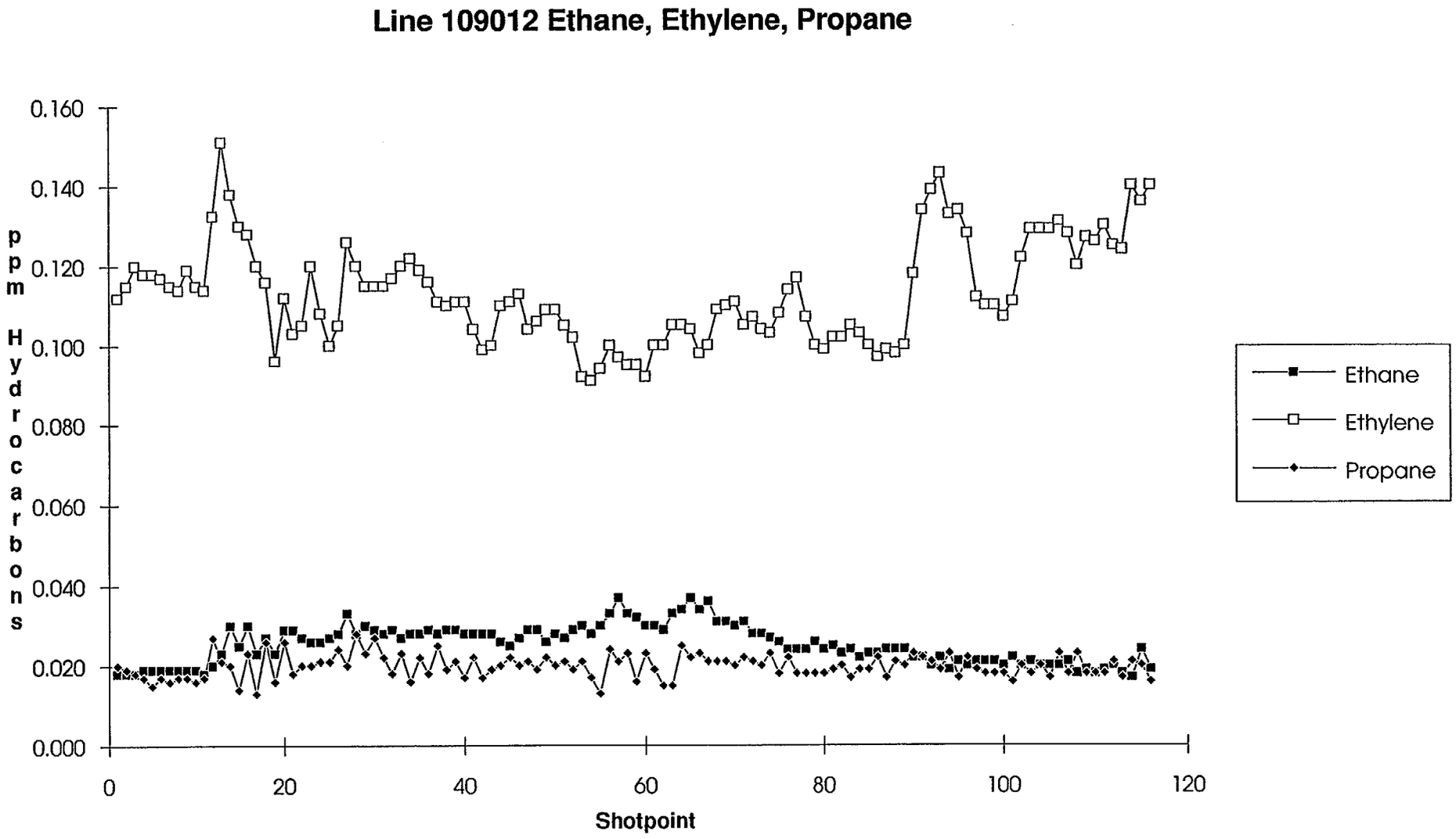
	Cond.	Temp.	F. Depth	W.Depth	Altitude	Calc. Alt.
Mean	58.504	25.595	46.890	122.987	19.416	76.041
Std. Dev.	0.634	0.442	9.595	117.402	7.744	114.453
Minimum	57.340	24.770	31.130	40.200	7.750	6.590
Maximum	59.500	26.270	60.360	420.900	30.750	367.810

Notes

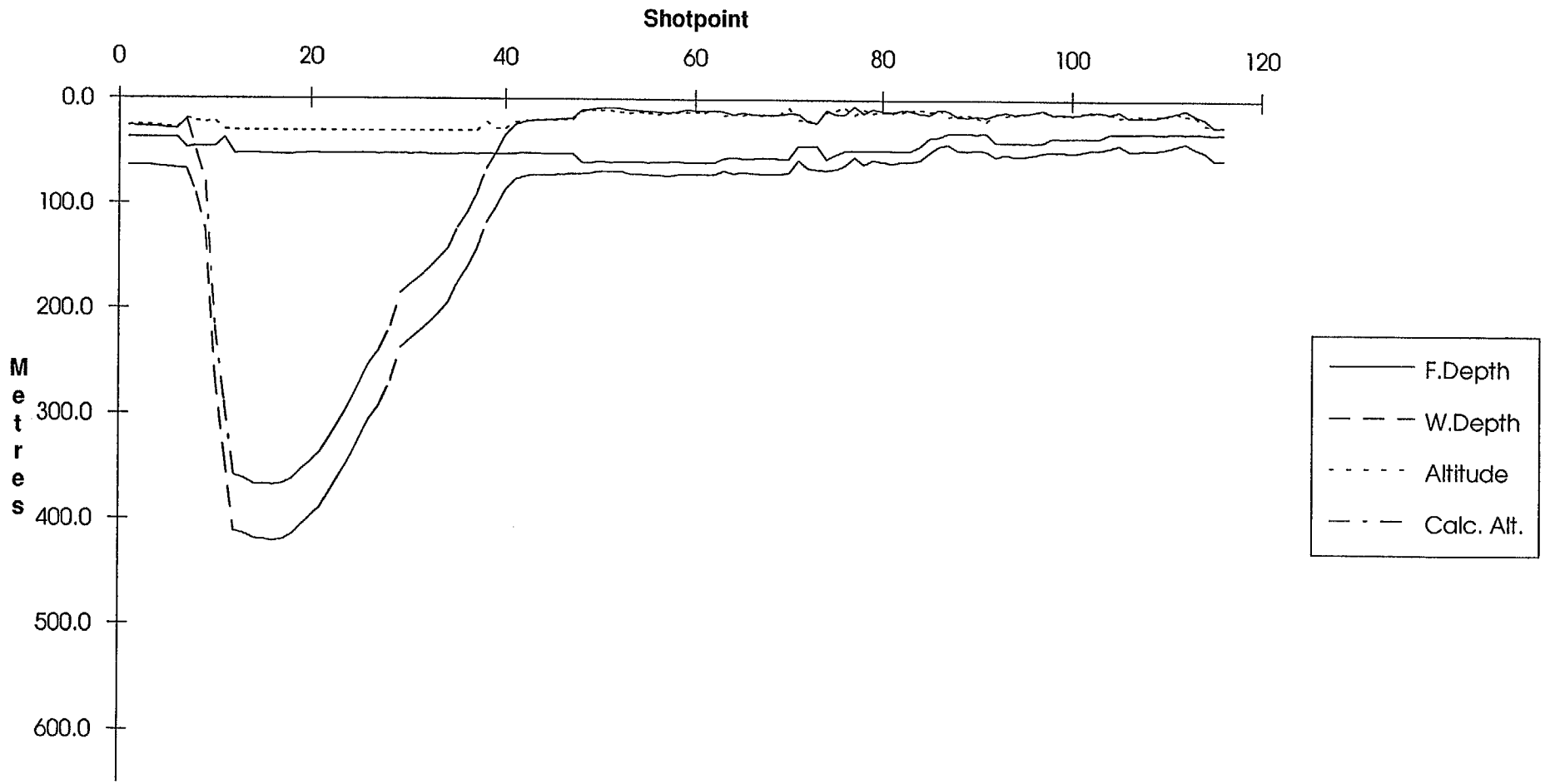
A weak THC, methane, ethane and propane anomaly occurs at SP 38, and SP 55.
Well Roxas - 1 occurs in the region of SP 38.

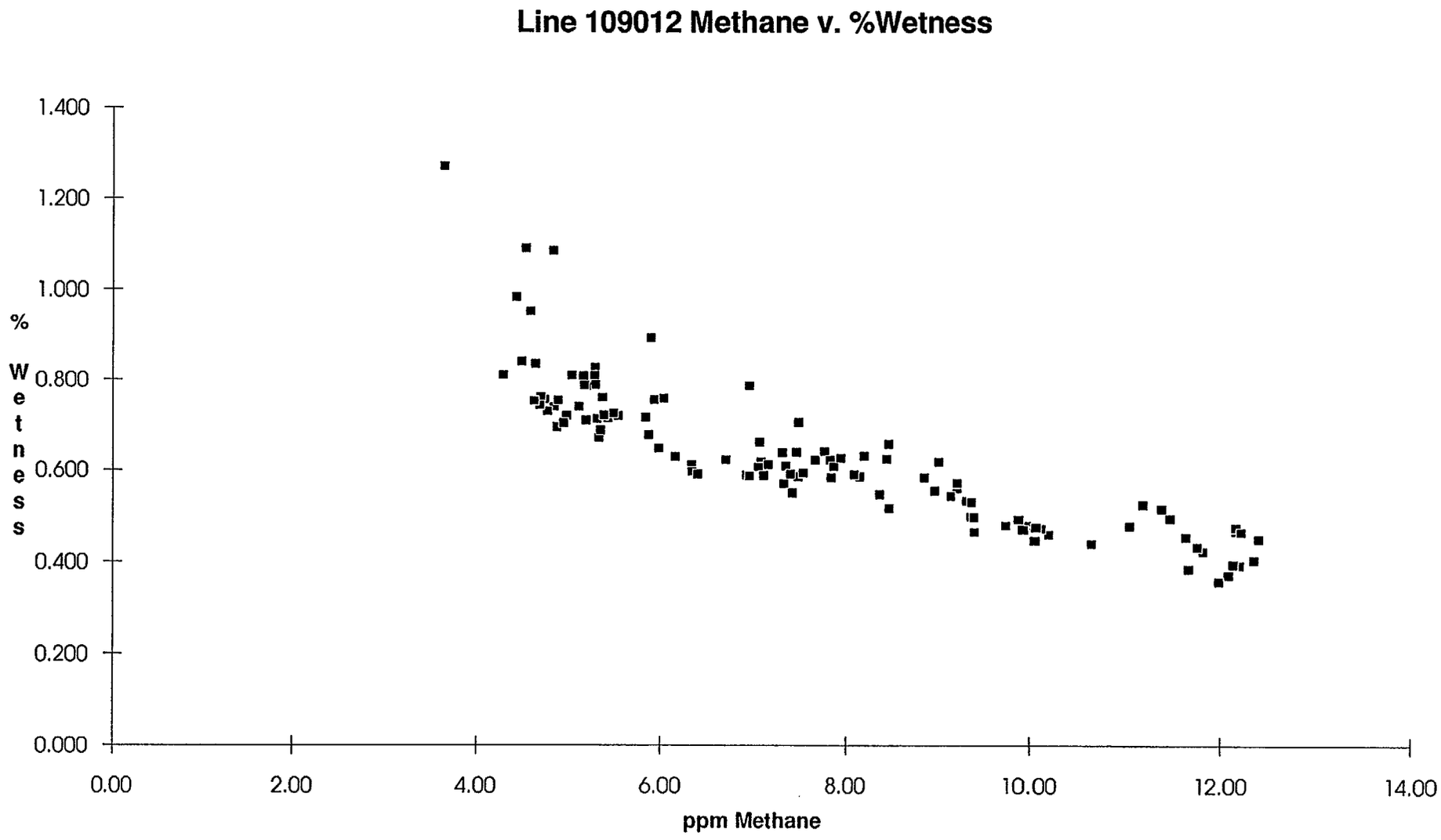
Line 109012 THC, Methane




Line 109012 Ethane, Ethylene, Propane
ppm Hydrocarbons
0.160
0.140
0.120
0.100
0.080
0.060
0.040
0.020
0.000
0
20
40
60
80
100
120
Shotpoint
Ethane
Ethylene
Propane

Line 109012 Depths, Altitudes




Line 109012 Methane v. %Wetness
1.400
1.200
1.000
0.800
0.600
0.400
0.200
0.000
% Wetness
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
ppm Methane

APPENDIX II. CUYO PLATFORM DHD LINE SUMMARY SHEETS AND INDIVIDUAL LINE PLOTS

Line Summary

Line Number	109013
No. of Shotpoints	743

	Shotpoint	Date	Time	Latitude		Longitude	
Start	1	4-Apr-92	19:09:48	10	07.766	119	35.288
End	744	5-Apr-92	20:06:12	11	16.716	120	56.595

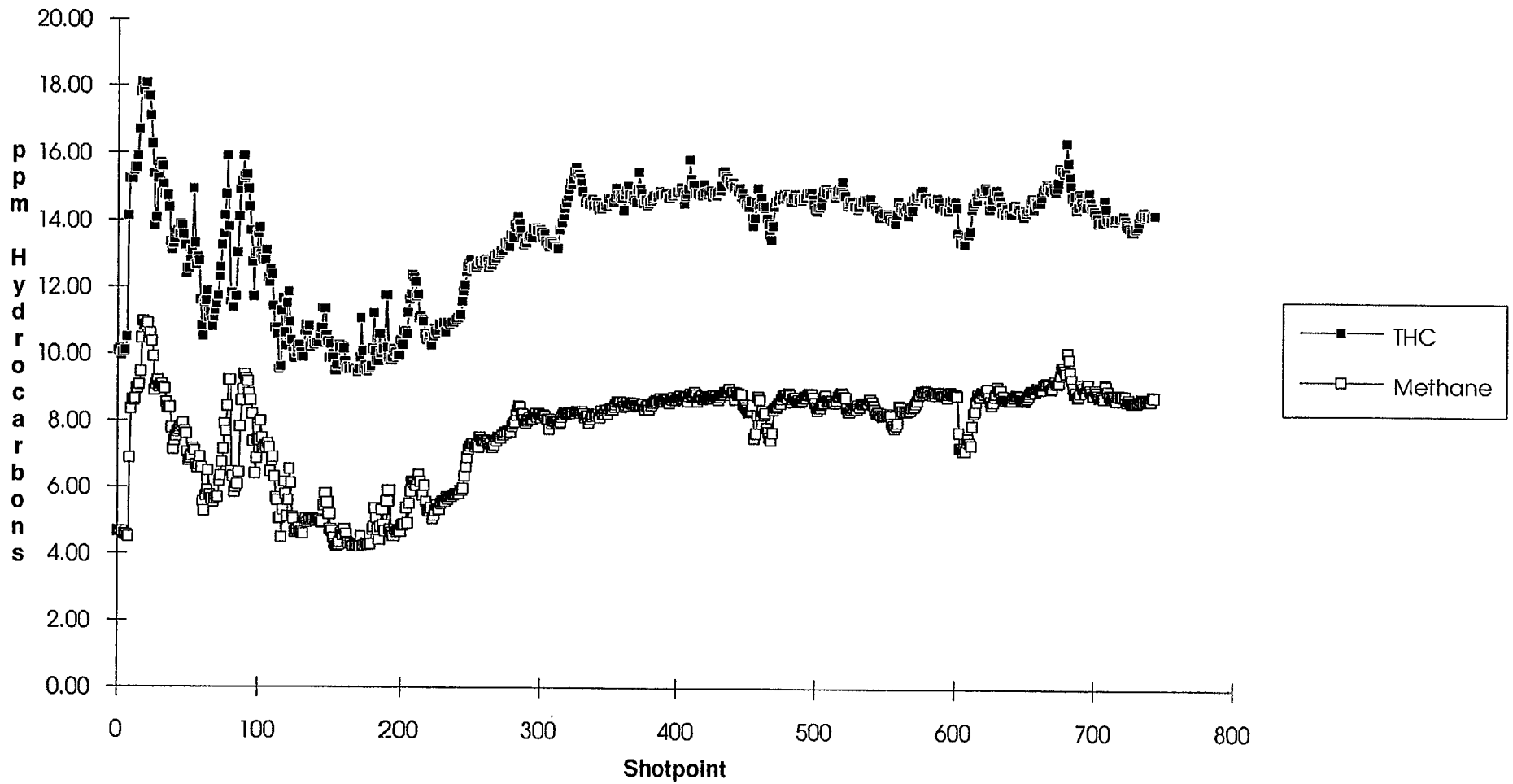
	THC	Methane	Ethane	Ethylene	Propane	Propylene	I-Butane	n-Butane	I-Pentane	n-Pentane	I-Hexane	n-Hexane	%Wetness
Mean	13.580	7.747	0.028	0.090	0.019	0.008	0.000	0.000	0.005	0.128	0.029	0.065	0.617
Std. Dev.	1.779	1.497	0.005	0.027	0.003	0.012	0.000	0.000	0.011	0.036	0.017	0.030	0.109
Minimum	9.469	4.222	0.016	0.044	0.010	0.000	0.000	0.000	0.000	0.053	0.000	0.000	0.382
Maximum	18.098	10.966	0.047	0.171	0.033	0.045	0.000	0.000	0.053	0.239	0.092	0.143	1.059

	Cond.	Temp.	F. Depth	W.Depth	Altitude	Calc. Alt.
Mean	57.354	24.793	58.719	73.168	14.472	14.386
Std. Dev.	1.509	1.048	13.809	13.029	4.159	5.161
Minimum	54.900	23.070	31.050	50.200	8.770	5.900
Maximum	60.700	27.110	100.620	111.000	30.870	42.460

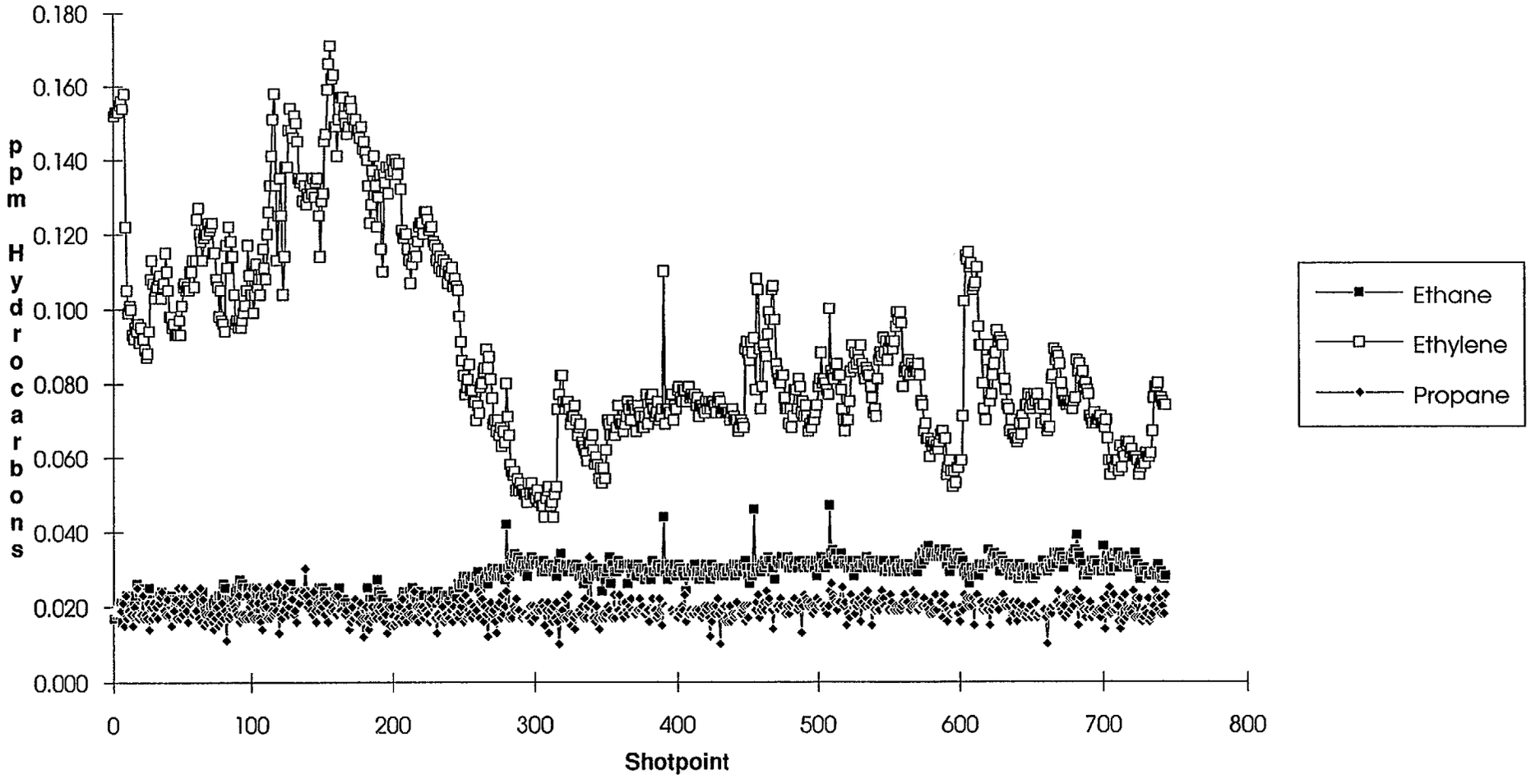
Notes

A weak THC, methane and ethane anomaly occurs at SP 692.
Weak THC and methane values prior to SP 210 may be related to biogenic influences in surface waters.

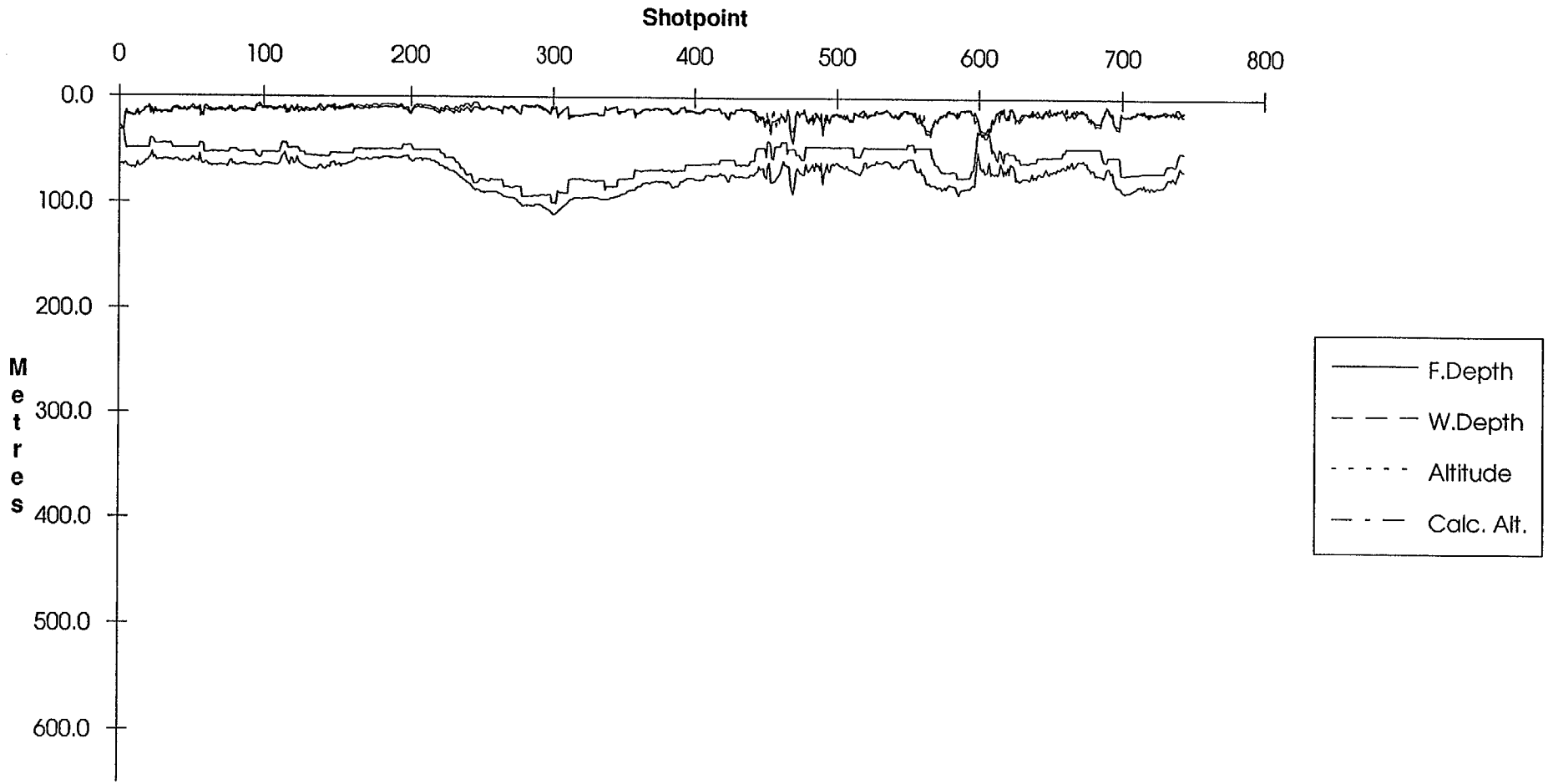
Line 109013 THC, Methane

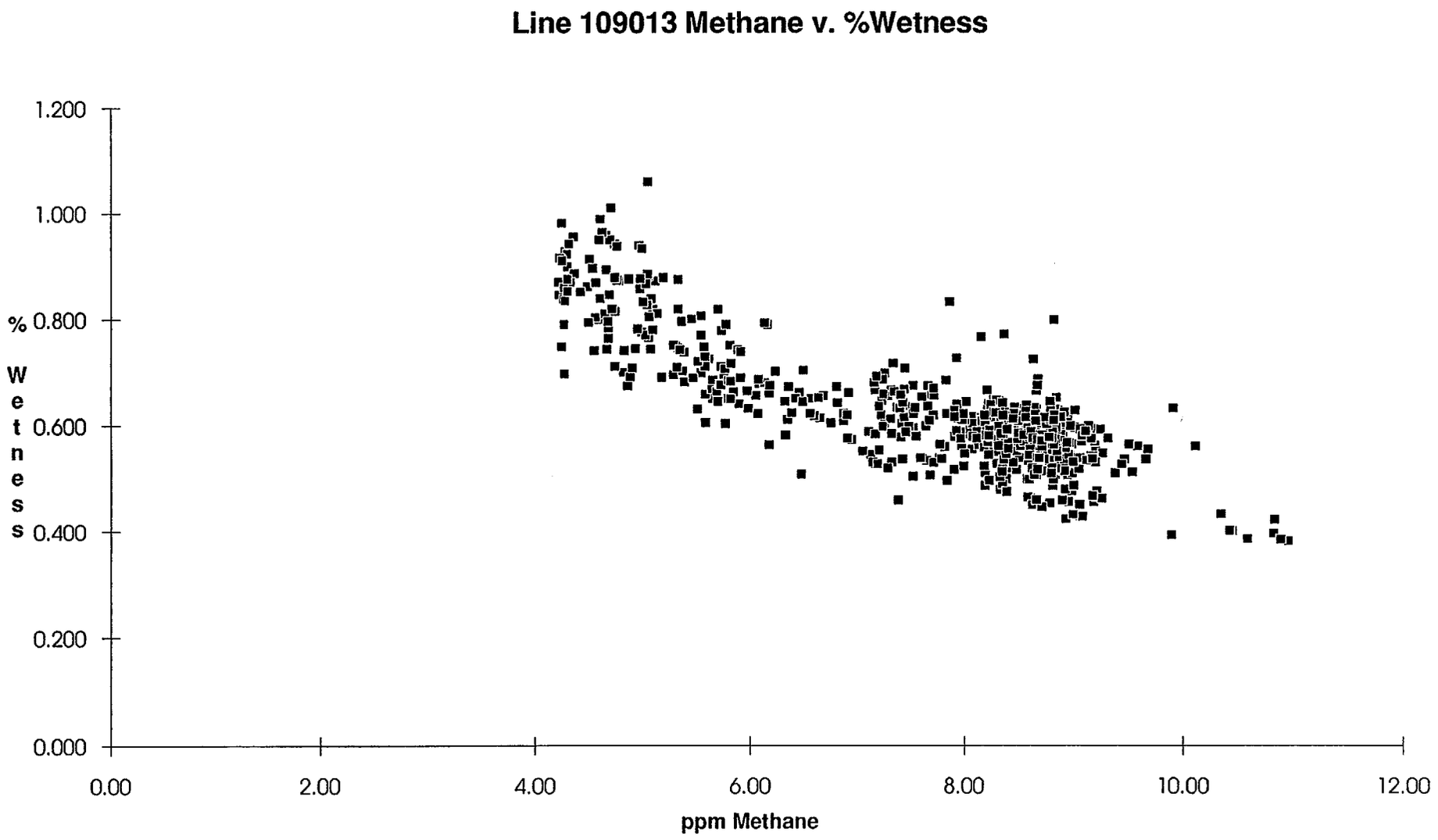


Line 109013 Ethane, Ethylene, Propane



Line 109013 Depths, Altitudes




Line 109013 Methane v. %Wetness
1.200
1.000
% 0.800
W
e
t 0.600
n
e
s
s 0.400
0.200
0.000
0.00
2.00
4.00
6.00
8.00
10.00
12.00
ppm Methane

Line Summary

Line Number	109014
No. of Shotpoints	368

	Shotpoint	Date	Time	Latitude		Longitude	
Start	1	5-Apr-92	20:31:52	11	15.892	120	54.694
End	371	6-Apr-92	09:32:07	10	43.084	119	57.675

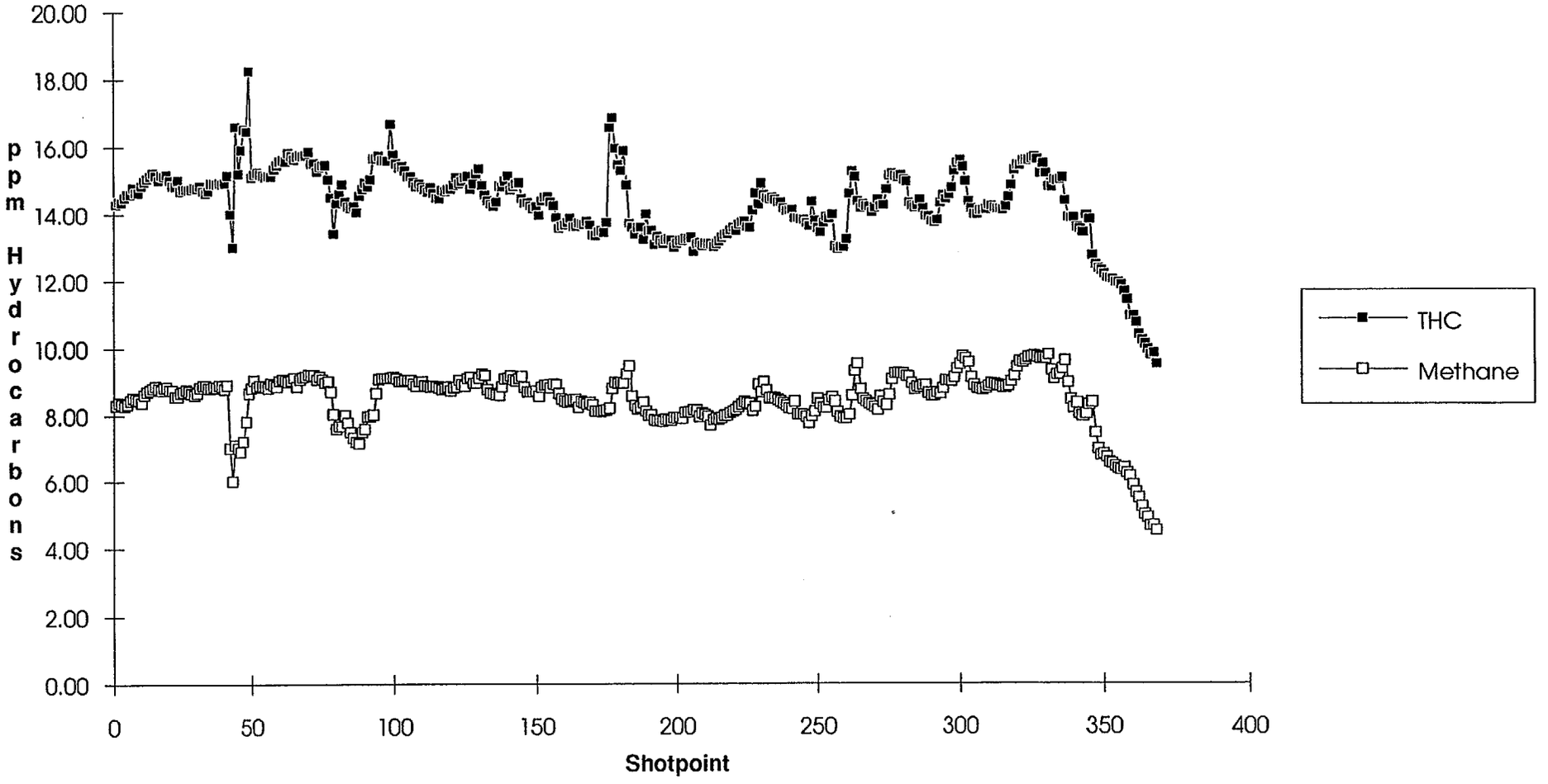
	THC	Methane	Ethane	Ethylene	Propane	Propylene	i-Butane	n-Butane	i-Pentane	n-Pentane	i-Hexane	n-Hexane	%Wetness
Mean	14.301	8.443	0.031	0.075	0.020	0.006	0.001	0.000	0.001	0.104	0.016	0.056	0.613
Std. Dev.	1.151	0.845	0.004	0.027	0.004	0.012	0.005	0.002	0.005	0.030	0.017	0.032	0.098
Minimum	9.495	4.510	0.015	0.037	0.010	0.000	0.000	0.000	0.000	0.044	0.000	0.000	0.351
Maximum	18.236	9.774	0.043	0.179	0.045	0.054	0.072	0.027	0.039	0.206	0.069	0.127	1.422

	Cond.	Temp.	F. Depth	W.Depth	Altitude	Calc. Alt.
Mean	56.955	24.486	74.457	91.678	14.727	17.221
Std. Dev.	1.086	0.767	20.473	21.417	4.209	7.416
Minimum	54.310	23.150	16.800	55.600	5.280	6.770
Maximum	59.860	26.540	118.720	155.000	30.940	67.690

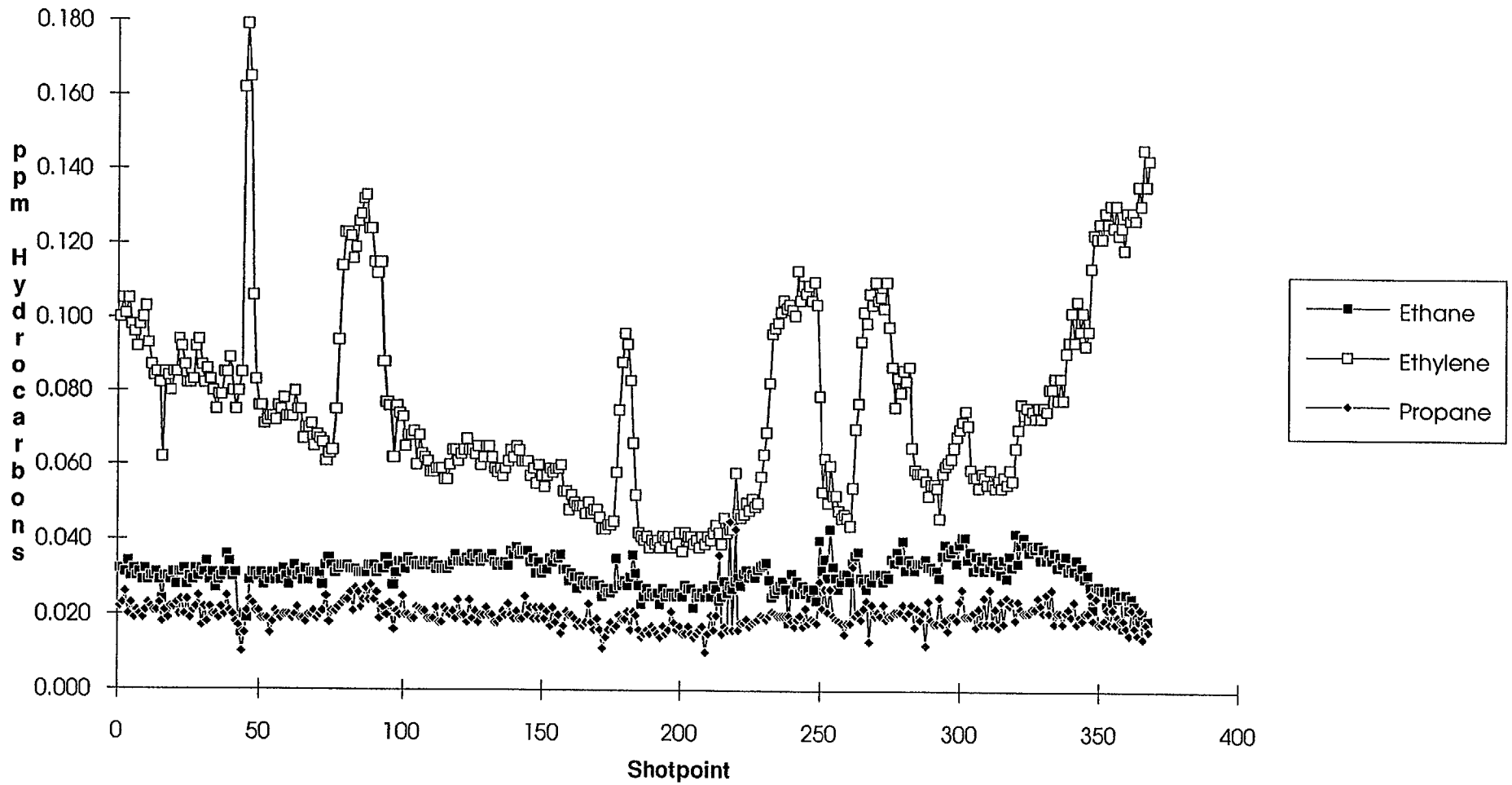
Notes

Six weak THC and methane anomalies occur at SP 45, SP 95, SP 170, SP 265, SP 305, SP 330.

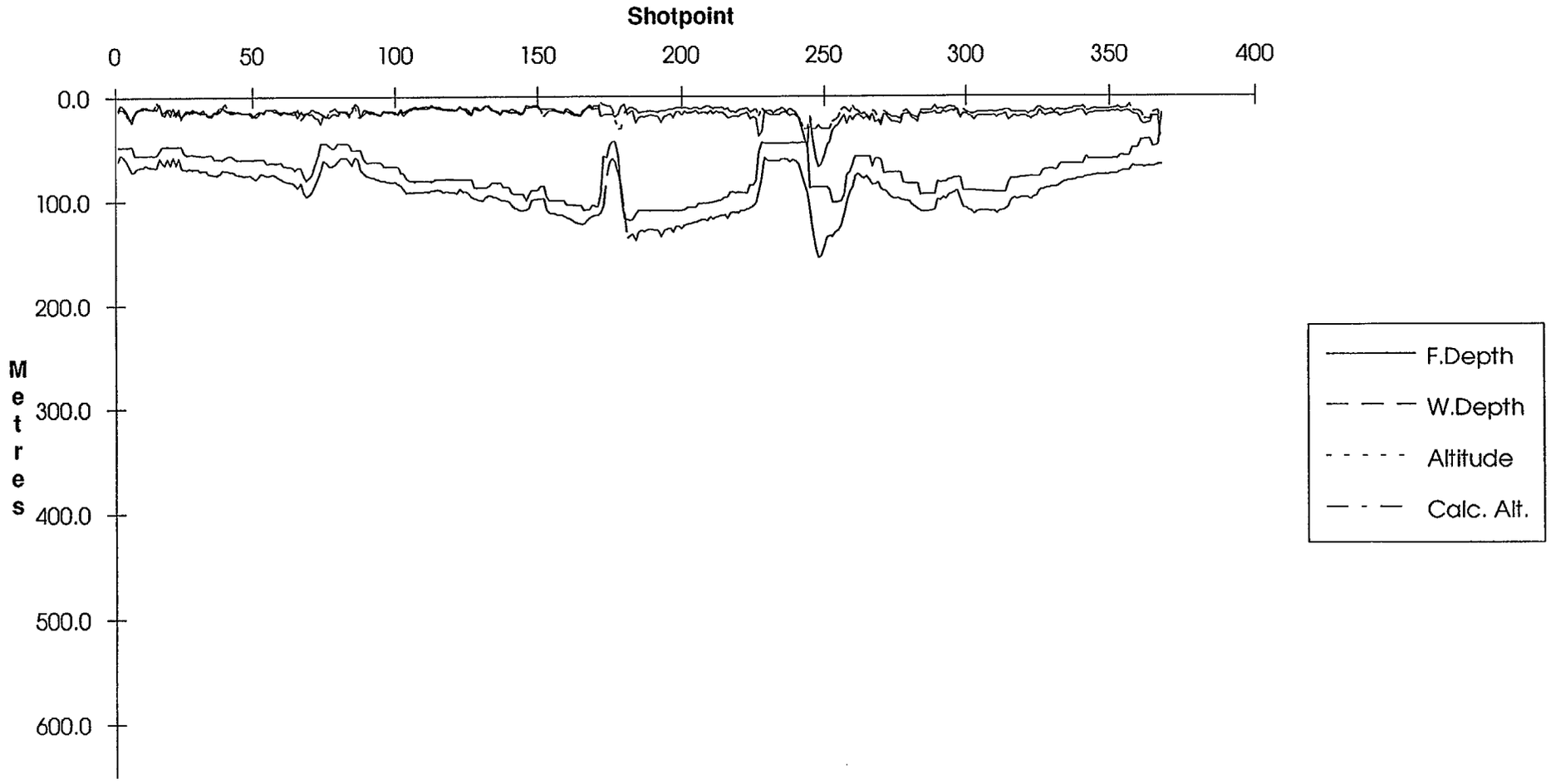
Line 109014 THC, Methane



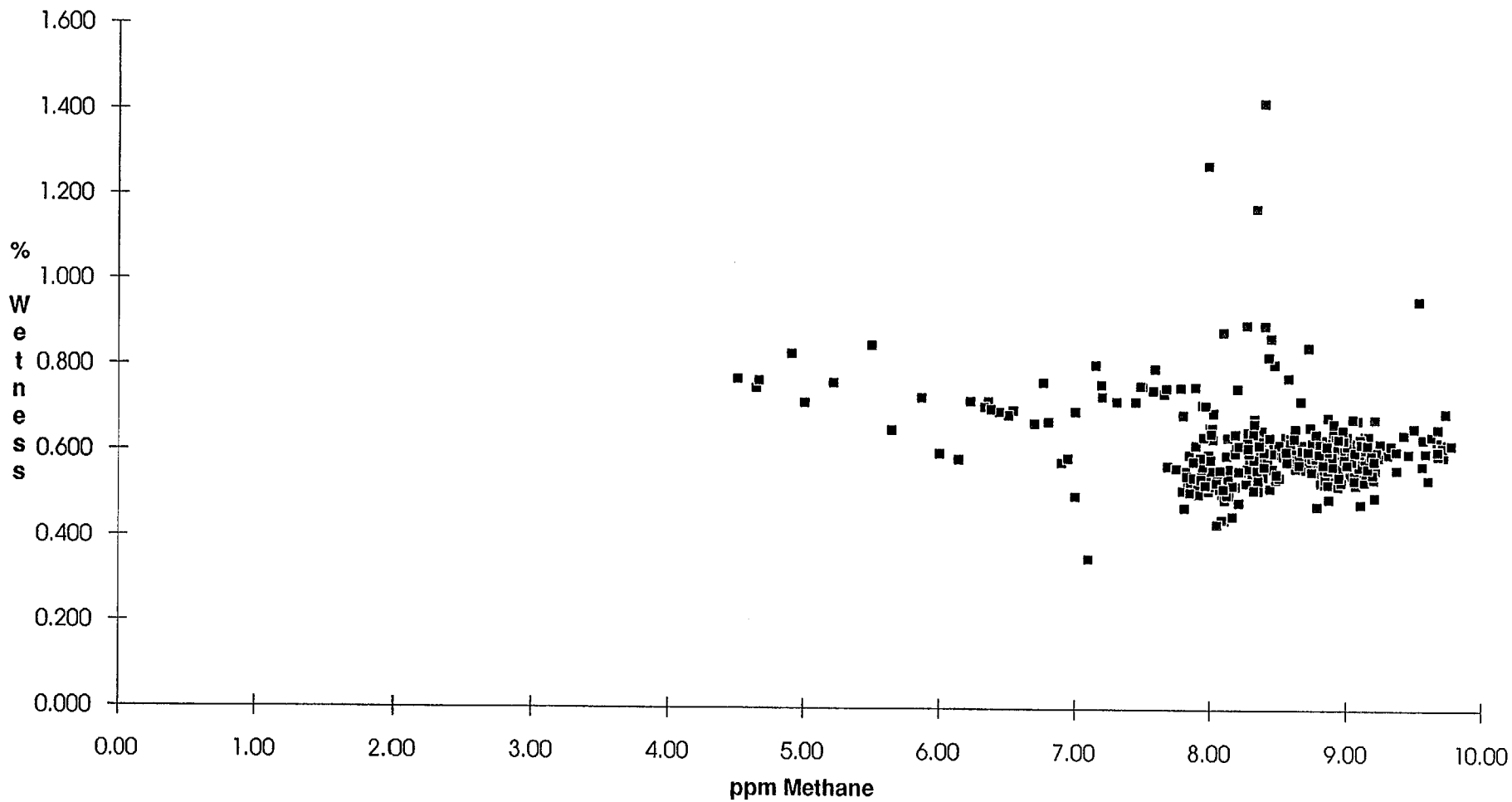
Line 109014 Ethane, Ethylene, Propane



Line 109014 Depths, Altitudes



Line 109014 Methane v. %Wetness



R9209207

Line Summary

Line Number	109015
No. of Shotpoints	379

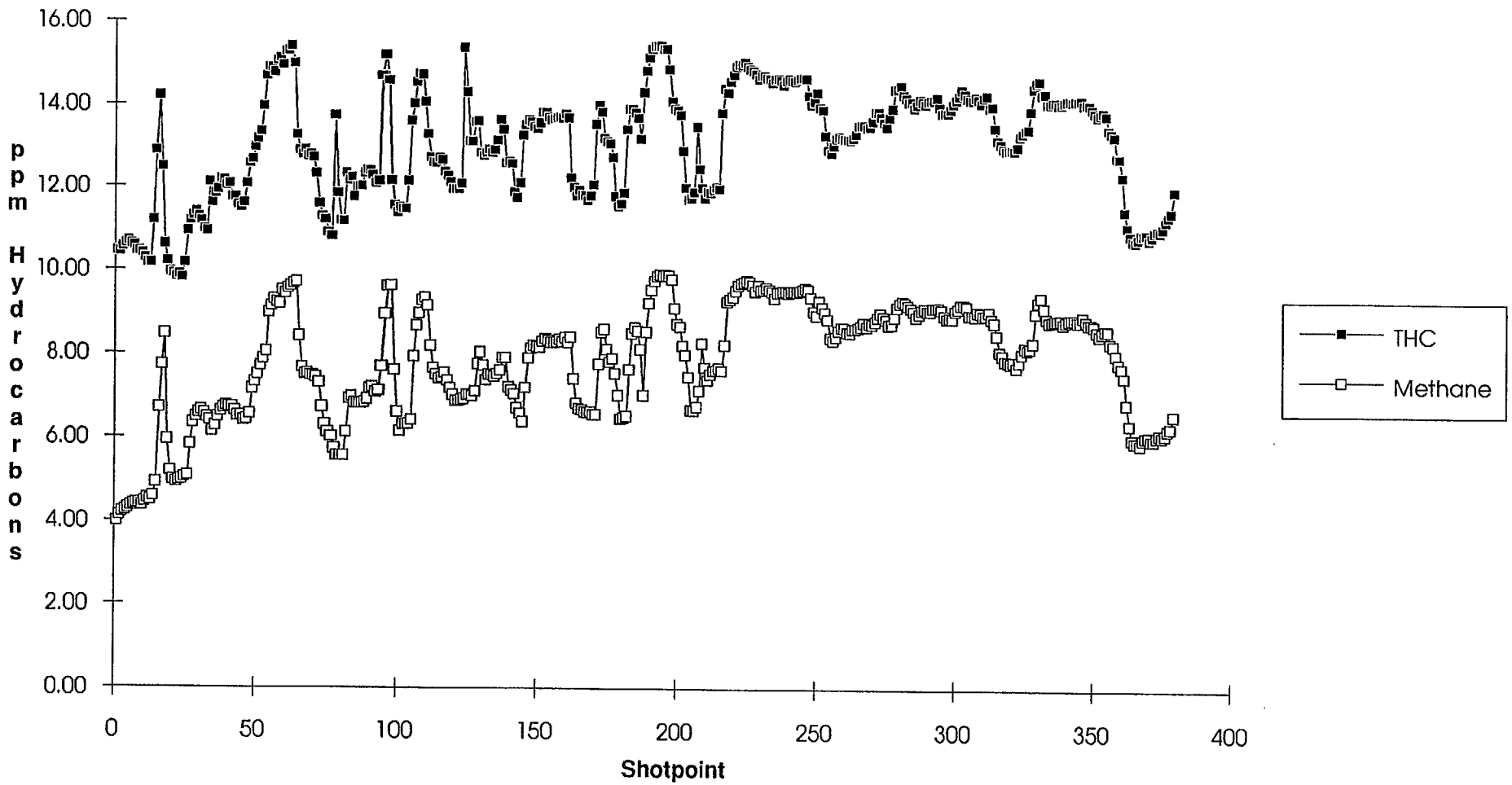
	Shotpoint	Date	Time	Latitude		Longitude	
Start	1	6-Apr-92	11:21:33	10	51.082	119	55.919
End	379	6-Apr-92	23:59:50	11	22.707	120	45.768

	THC	Methane	Ethane	Ethylene	Propane	Propylene	I-Butane	n-Butane	I-Pentane	n-Pentane	I-Hexane	n-Hexane	%Wetness
Mean	13.071	7.838	0.031	0.100	0.031	0.032	0.000	0.000	0.004	0.102	0.011	0.022	0.798
Std. Dev.	1.359	1.377	0.006	0.030	0.013	0.029	0.000	0.000	0.008	0.042	0.008	0.014	0.180
Minimum	9.804	3.980	0.000	0.037	0.004	0.000	0.000	0.000	0.000	0.048	0.000	0.000	0.417
Maximum	15.439	9.906	0.044	0.179	0.070	0.123	0.000	0.000	0.042	0.265	0.044	0.055	1.413

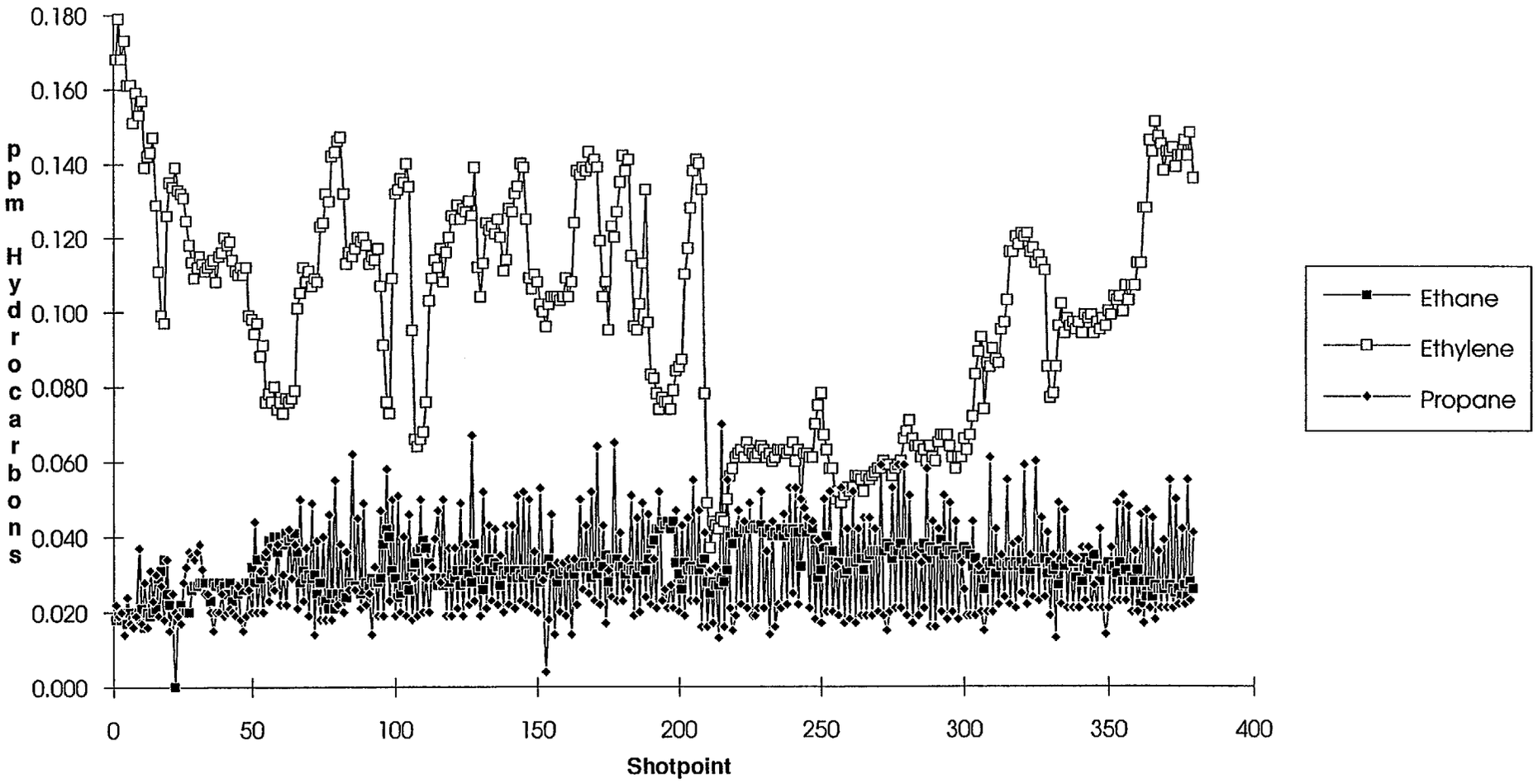
	Cond.	Temp.	F. Depth	W.Depth	Altitude	Calc. Alt.
Mean	56.772	24.371	56.656	76.462	16.193	20.038
Std. Dev.	1.309	0.929	17.734	19.172	5.960	8.804
Minimum	54.520	22.730	19.500	47.600	8.120	6.160
Maximum	60.210	26.760	115.310	178.800	30.920	63.490

Notes Numerous weak THC and methane anomalies occur prior to SP 220.

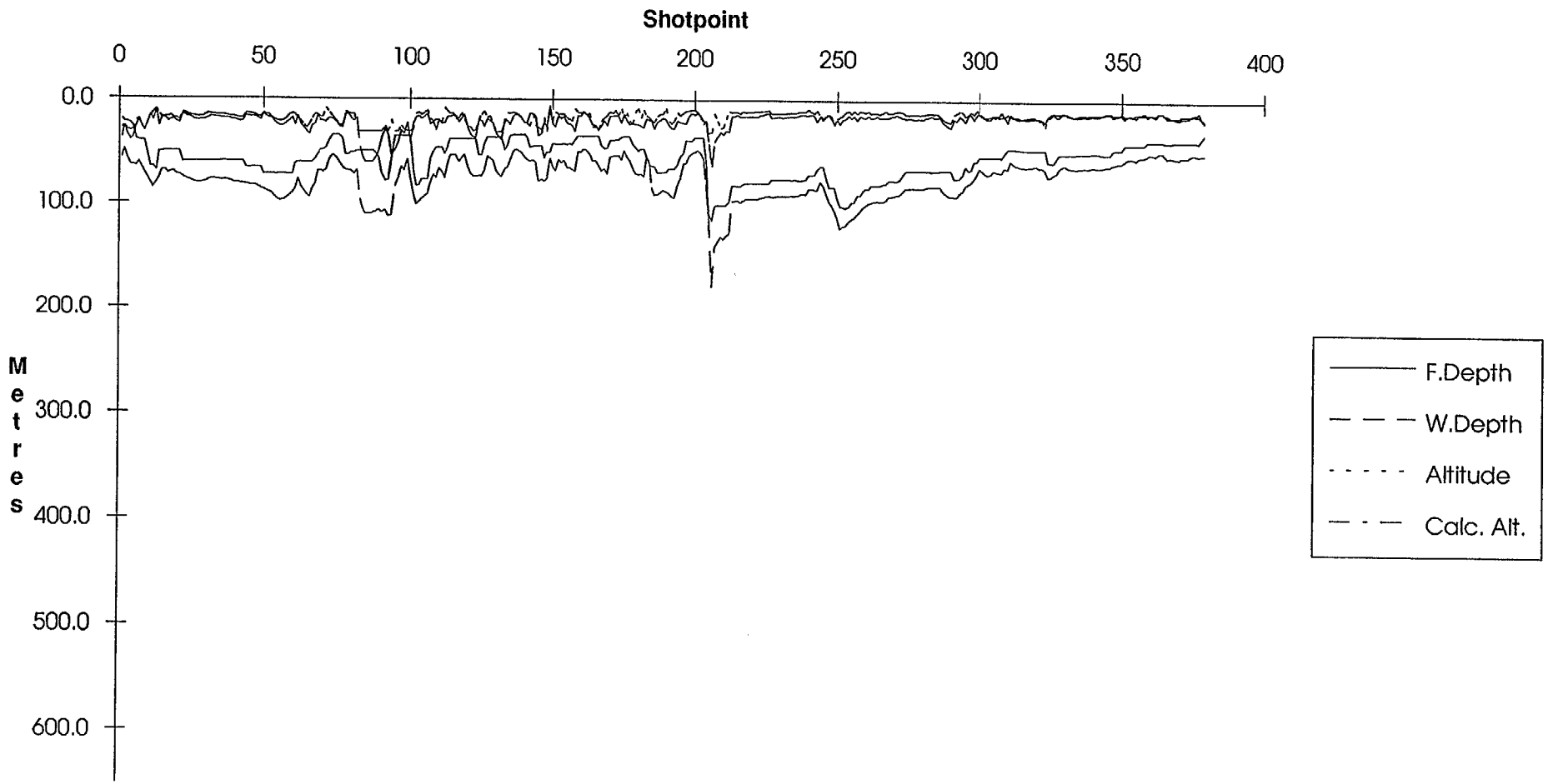
Line 109015 THC, Methane



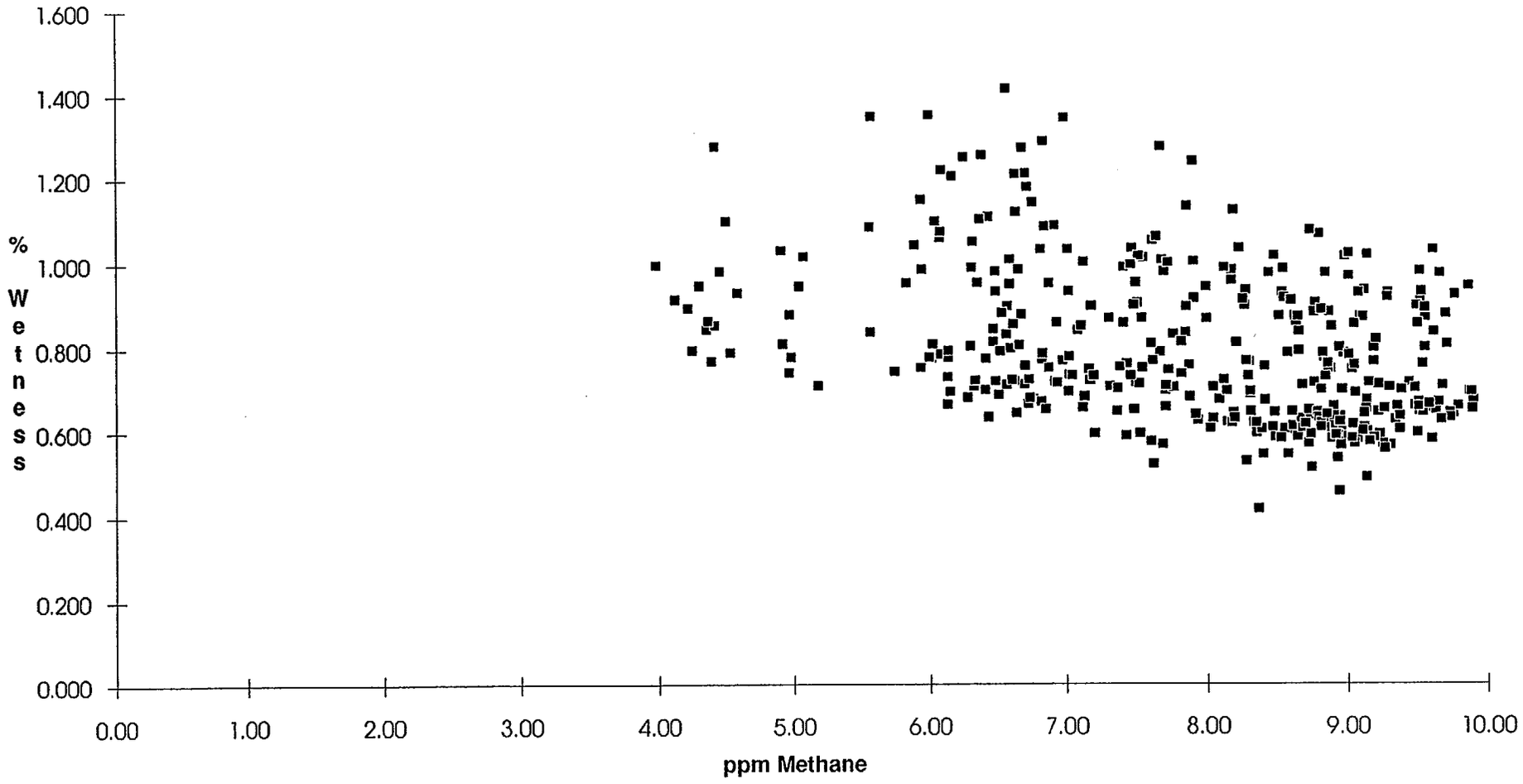
Line 109015 Ethane, Ethylene, Propane



Line 109015 Depths, Altitudes



Line 109015 Methane v. %Wetness



Line Summary

Line Number	109016
No. of Shotpoints	206

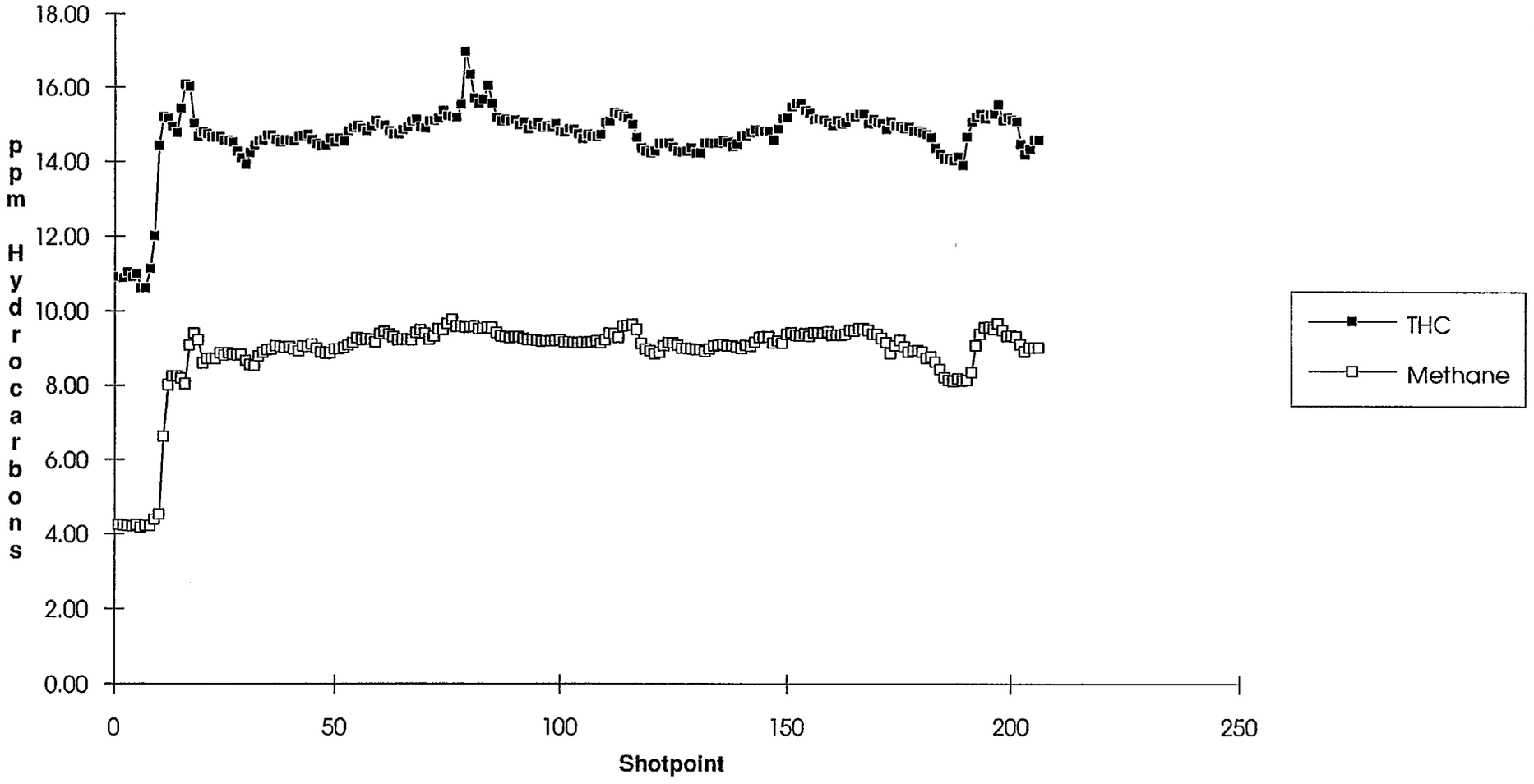
	Shotpoint	Date	Time	Latitude		Longitude	
Start	1	7-Apr-92	03:28:40	11	24.771	120	35.771
End	206	7-Apr-92	10:29:29	10	55.236	120	50.808

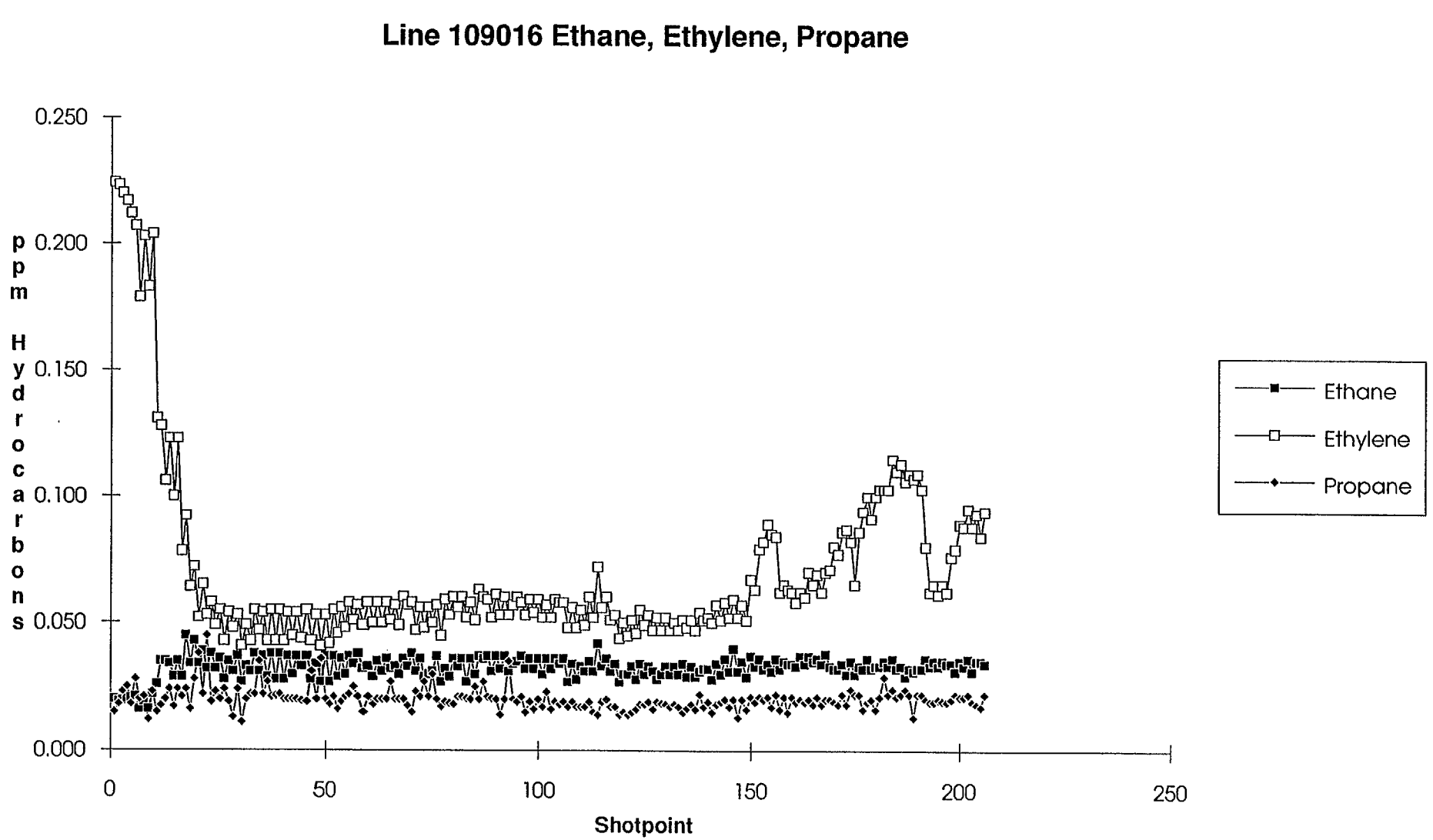
	THC	Methane	Ethane	Ethylene	Propane	Propylene	I-Butane	n-Butane	i-Pentane	n-Pentane	I-Hexane	n-Hexane	%Wetness
Mean	14.680	8.860	0.033	0.071	0.020	0.012	0.002	0.001	0.003	0.088	0.015	0.035	0.641
Std. Dev.	0.899	1.109	0.004	0.036	0.004	0.016	0.005	0.004	0.008	0.033	0.005	0.009	0.177
Minimum	10.605	4.173	0.016	0.041	0.011	0.000	0.000	0.000	0.000	0.055	0.007	0.011	0.442
Maximum	16.953	9.767	0.045	0.224	0.045	0.077	0.026	0.032	0.040	0.256	0.036	0.063	1.826

	Cond.	Temp.	F. Depth	W.Depth	Altitude	Calc. Alt.
Mean	56.671	24.281	70.943	91.596	16.165	20.604
Std. Dev.	1.418	1.000	20.657	18.153	5.850	20.377
Minimum	55.690	23.660	4.960	46.400	6.970	5.690
Maximum	62.490	28.310	110.910	130.400	31.000	116.830

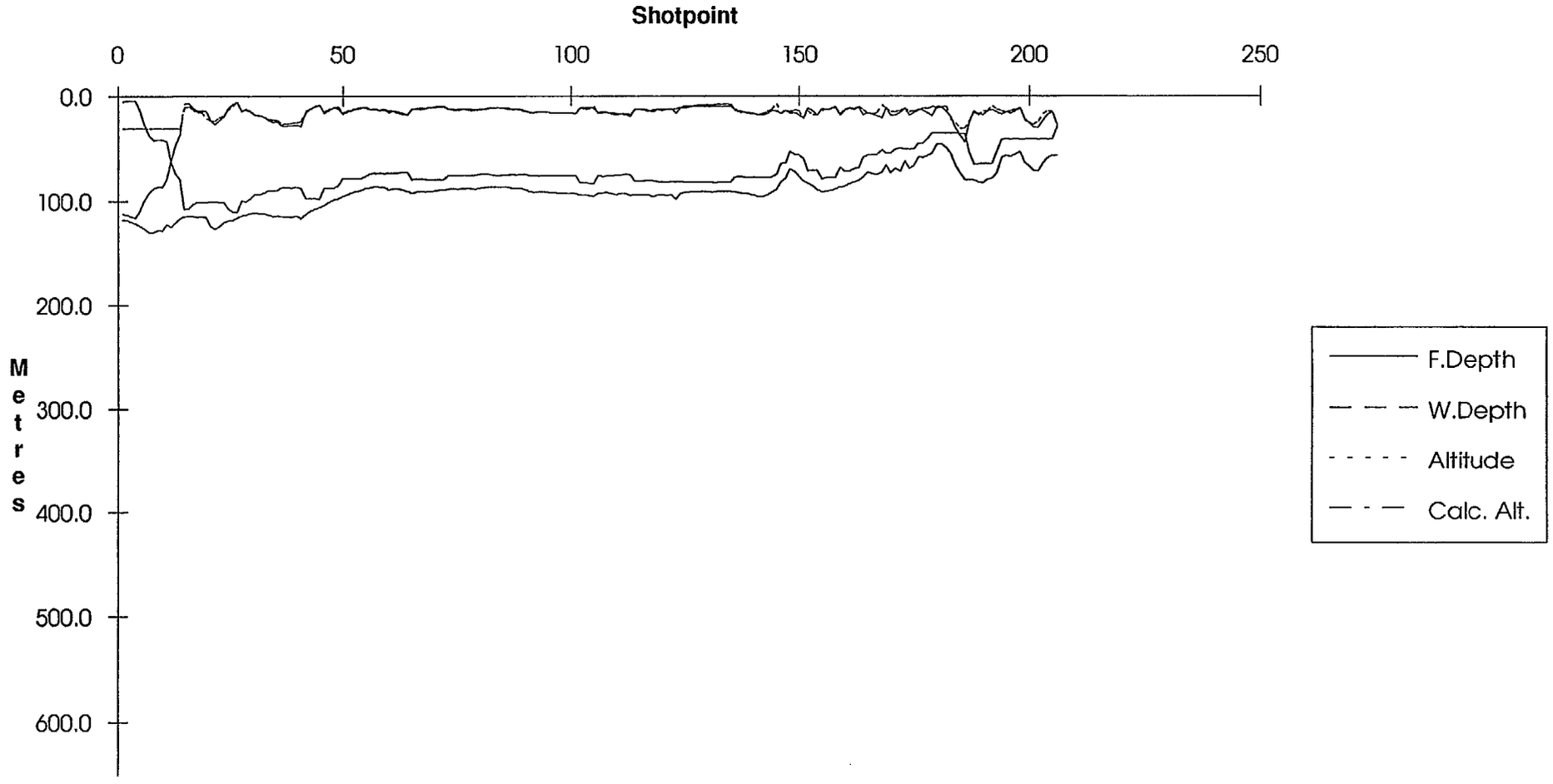
Notes A weak THC, methane, ethane, and propane anomaly occurs at SP 80.

Line 109016 THC, Methane

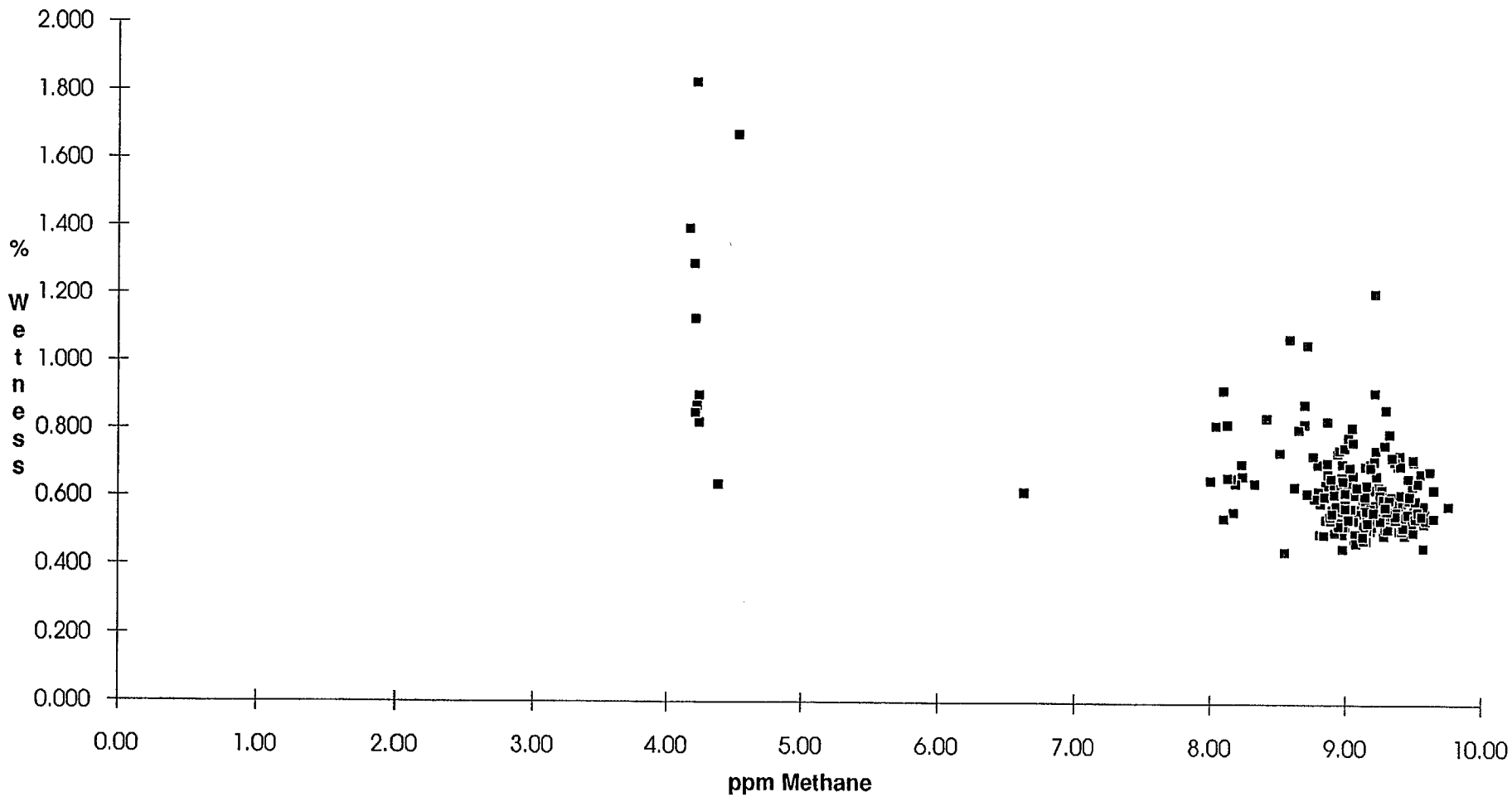



Line 109016 Ethane, Ethylene, Propane
0.250
0.200
0.150
0.100
0.050
0.000
ppm Hydrocarbons
0
50
100
150
200
250
Shotpoint
Ethane
Ethylene
Propane

Line 109016 Depths, Altitudes



Line 109016 Methane v. %Wetness



Line Summary

Line Number	109017
No. of Shotpoints	249

	Shotpoint	Date	Time	Latitude		Longitude	
Start	1	7-Apr-92	12:12:47	10	47.407	120	46.270
End	245	7-Apr-92	21:33:39	11	21.361	120	21.207

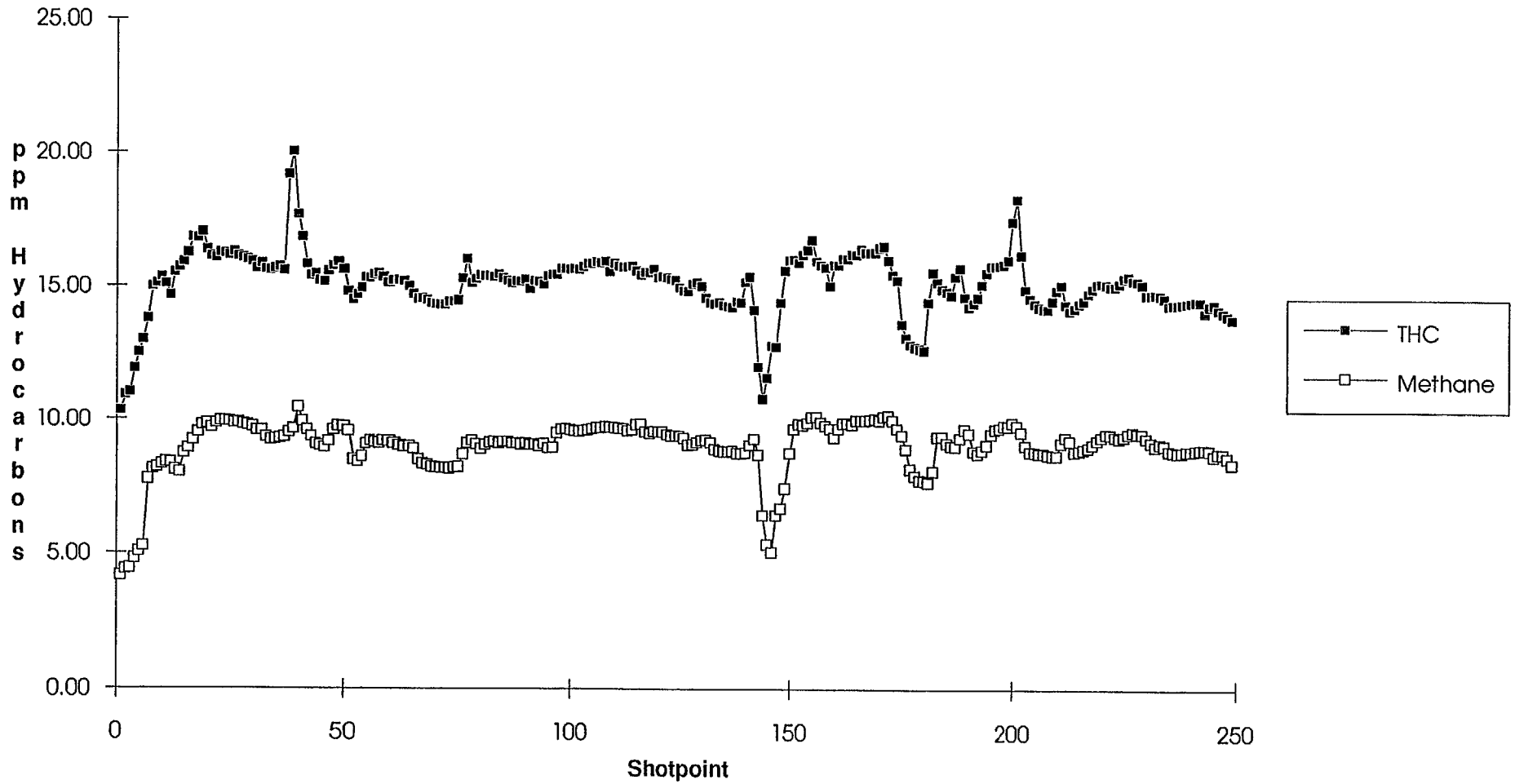
	THC	Methane	Ethane	Ethylene	Propane	Propylene	I-Butane	n-Butane	I-Pentane	n-Pentane	I-Hexane	n-Hexane	%Wetness
Mean	15.117	9.001	0.038	0.085	0.021	0.019	0.003	0.004	0.001	0.078	0.010	0.032	0.735
Std. Dev.	1.160	0.981	0.011	0.022	0.005	0.021	0.011	0.015	0.004	0.031	0.012	0.024	0.232
Minimum	10.311	4.170	0.017	0.040	0.004	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.399
Maximum	20.042	10.443	0.089	0.197	0.051	0.097	0.106	0.104	0.040	0.213	0.090	0.139	1.946

	Cond.	Temp.	F. Depth	W.Depth	Altitude	Calc. Alt.
Mean	56.078	23.874	67.610	84.767	14.939	17.201
Std. Dev.	0.784	0.568	18.232	16.786	3.636	5.393
Minimum	54.840	22.930	28.460	42.900	8.860	7.980
Maximum	60.350	26.810	111.680	131.200	30.750	47.980

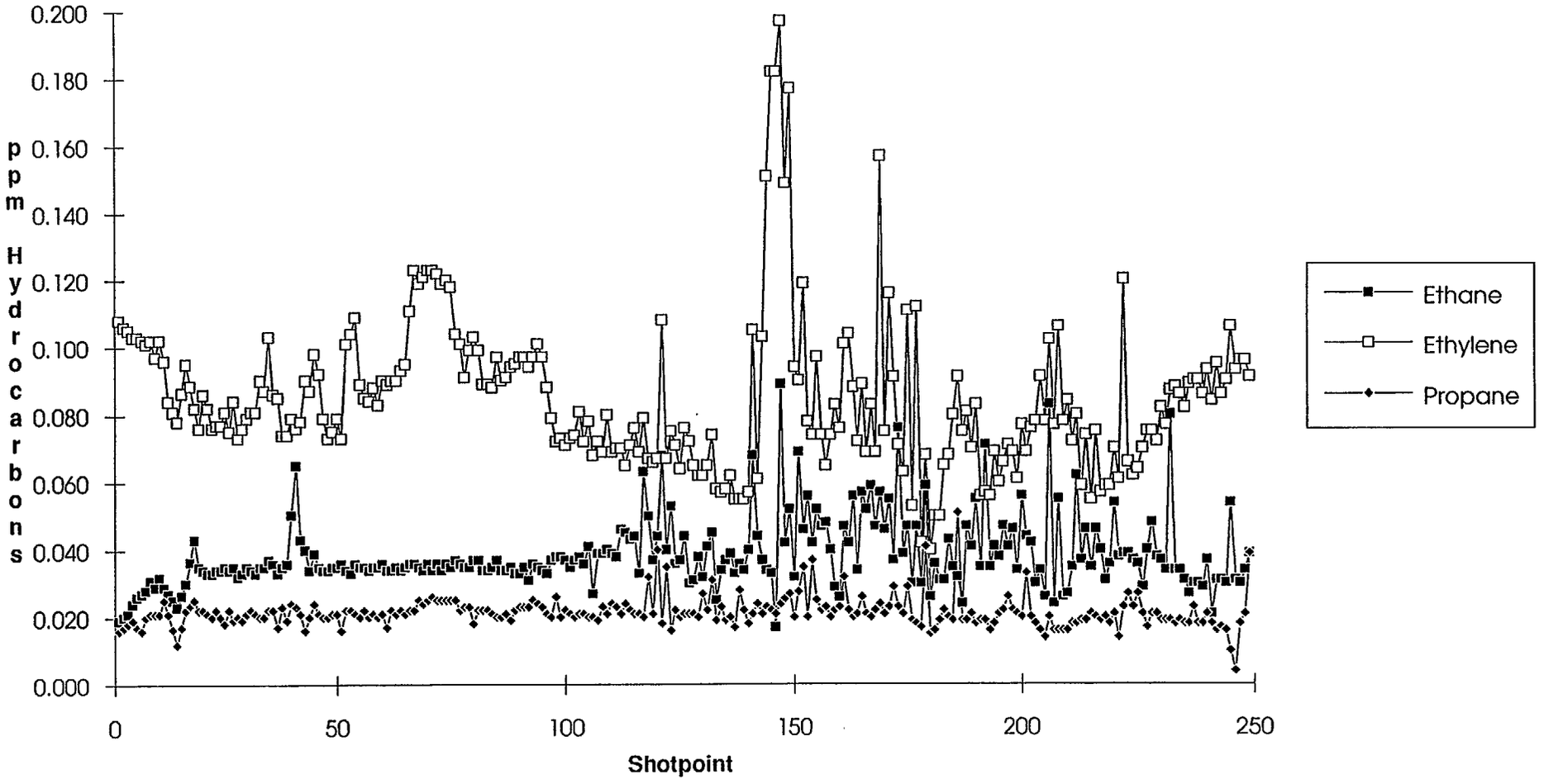
Notes

A weak THC, methane, ethane, and propane anomaly occurs at SP 195.
The weak THC and methane anomaly at SP 34 and SP 35 is due to the fish hitting bottom.

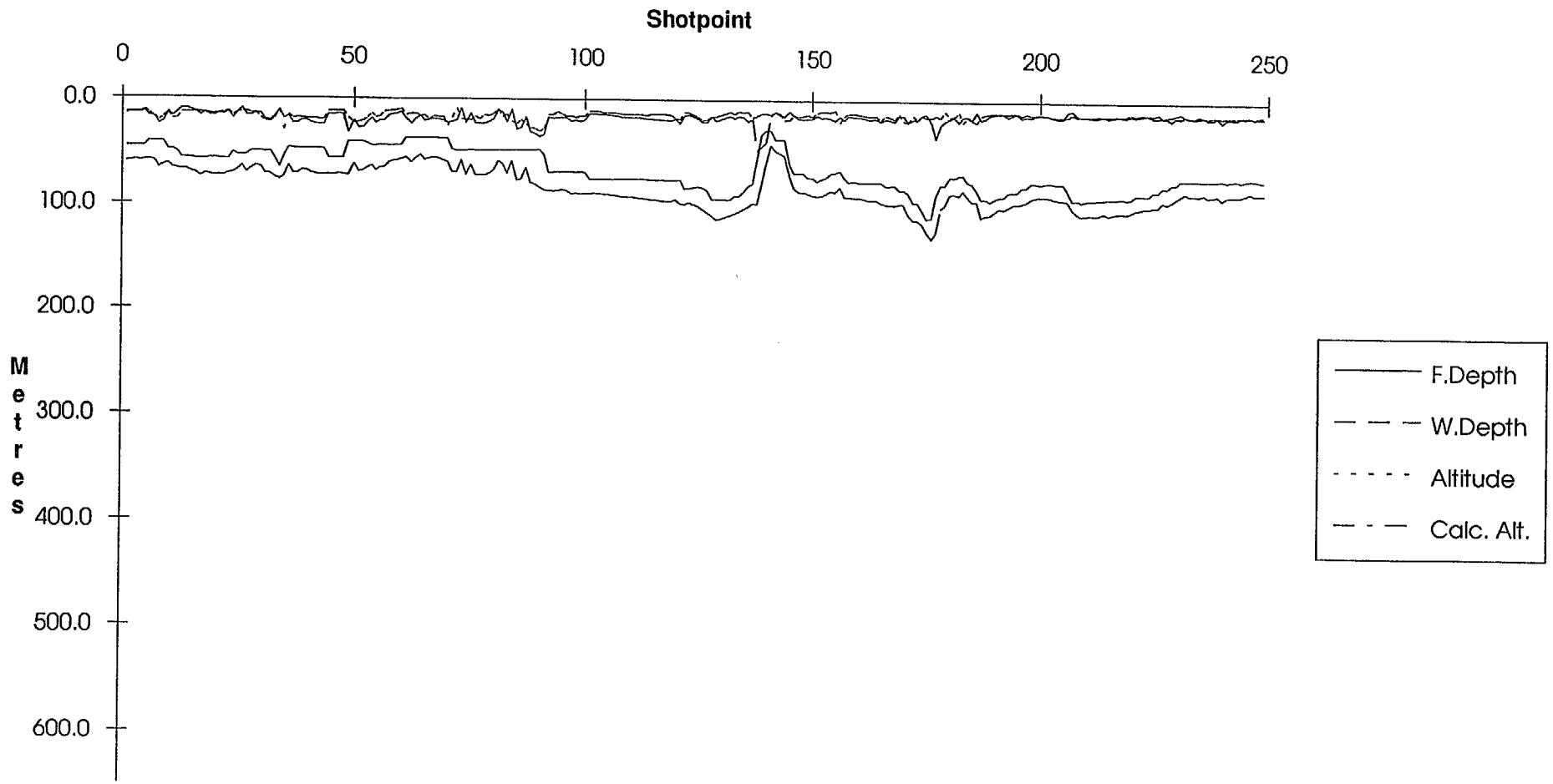
Line 109017 THC, Methane

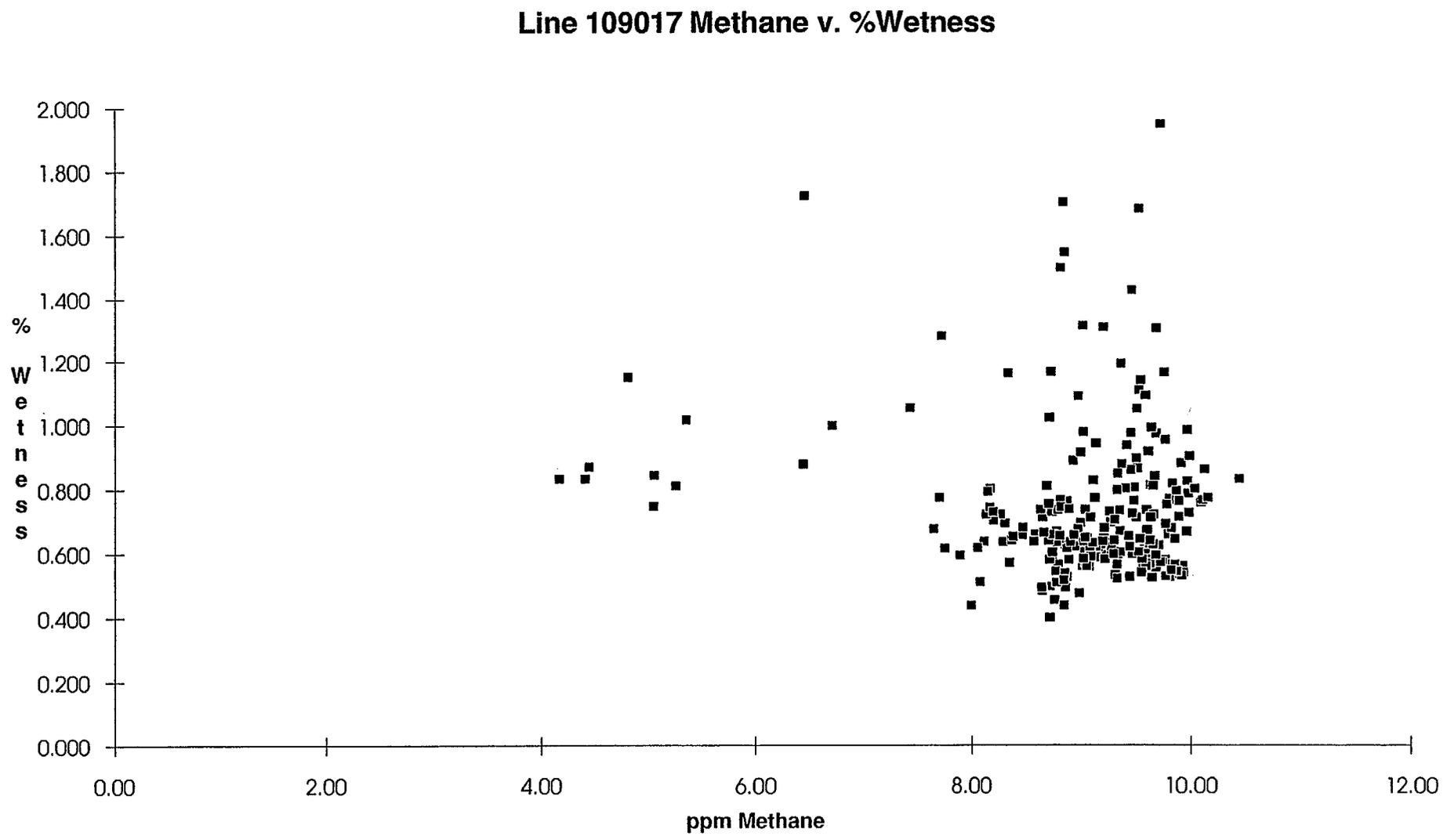


Line 109017 Ethane, Ethylene, Propane



Line 109017 Depths, Altitudes




Line 109017 Methane v. %Wetness
% Wetness
2.000
1.800
1.600
1.400
1.200
1.000
0.800
0.600
0.400
0.200
0.000
0.00
2.00
4.00
6.00
8.00
10.00
12.00
ppm Methane

Line Summary

Line Number	109018
No. of Shotpoints	218

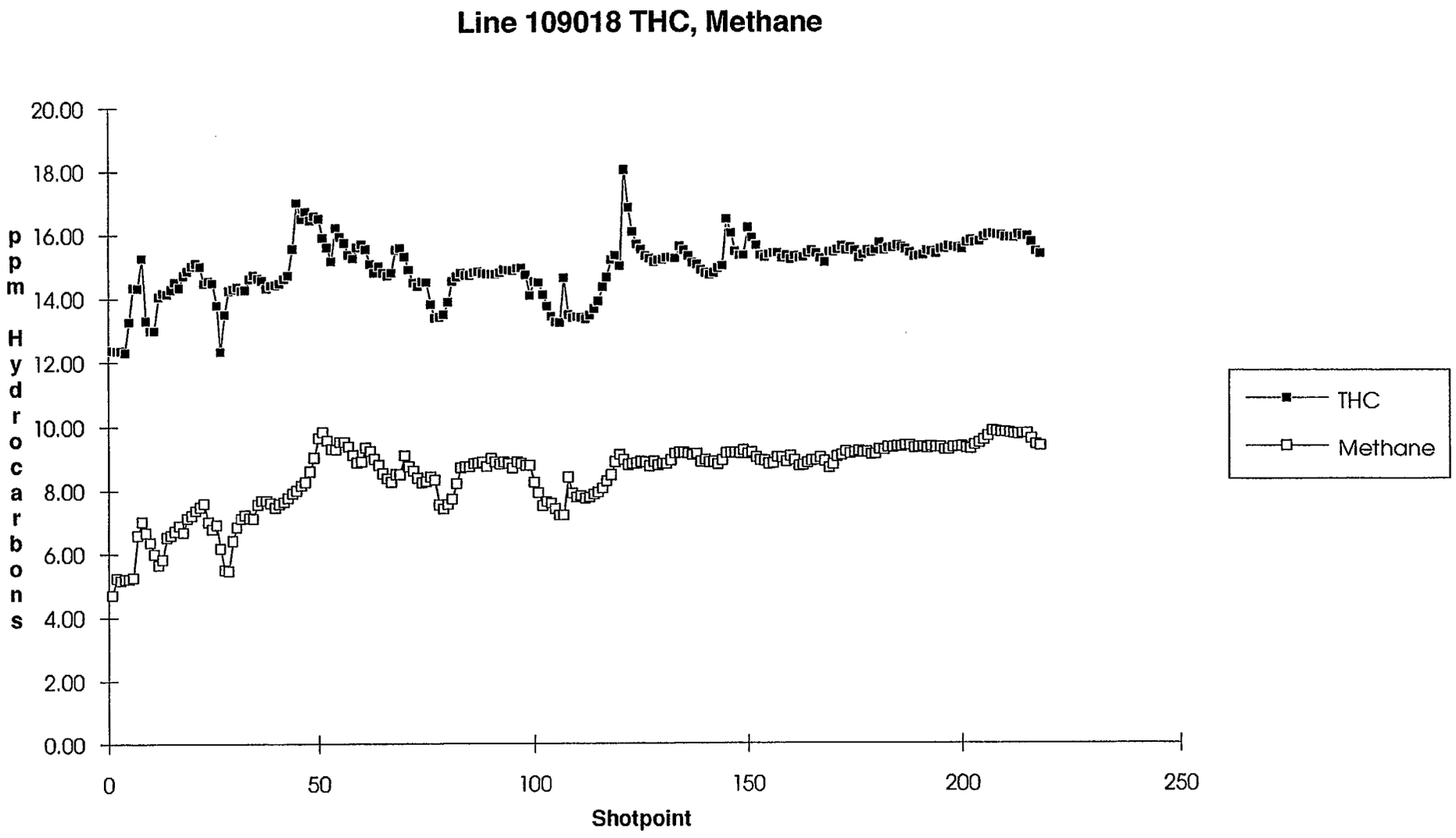
	Shotpoint	Date	Time	Latitude		Longitude	
Start	1	8-Apr-92	01:30:09	11	13.015	120	12.838
End	219	8-Apr-92	08:52:52	10	41.610	120	32.600

	THC	Methane	Ethane	Ethylene	Propane	Propylene	I-Butane	n-Butane	I-Pentane	n-Pentane	I-Hexane	n-Hexane	%Wetness
Mean	14.966	8.418	0.032	0.098	0.020	0.020	0.001	0.001	0.002	0.089	0.015	0.027	0.645
Std. Dev.	0.894	1.091	0.004	0.026	0.004	0.017	0.005	0.005	0.007	0.034	0.006	0.011	0.140
Minimum	12.300	4.691	0.018	0.042	0.005	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.446
Maximum	18.020	9.822	0.047	0.171	0.039	0.095	0.052	0.060	0.033	0.222	0.036	0.054	1.404

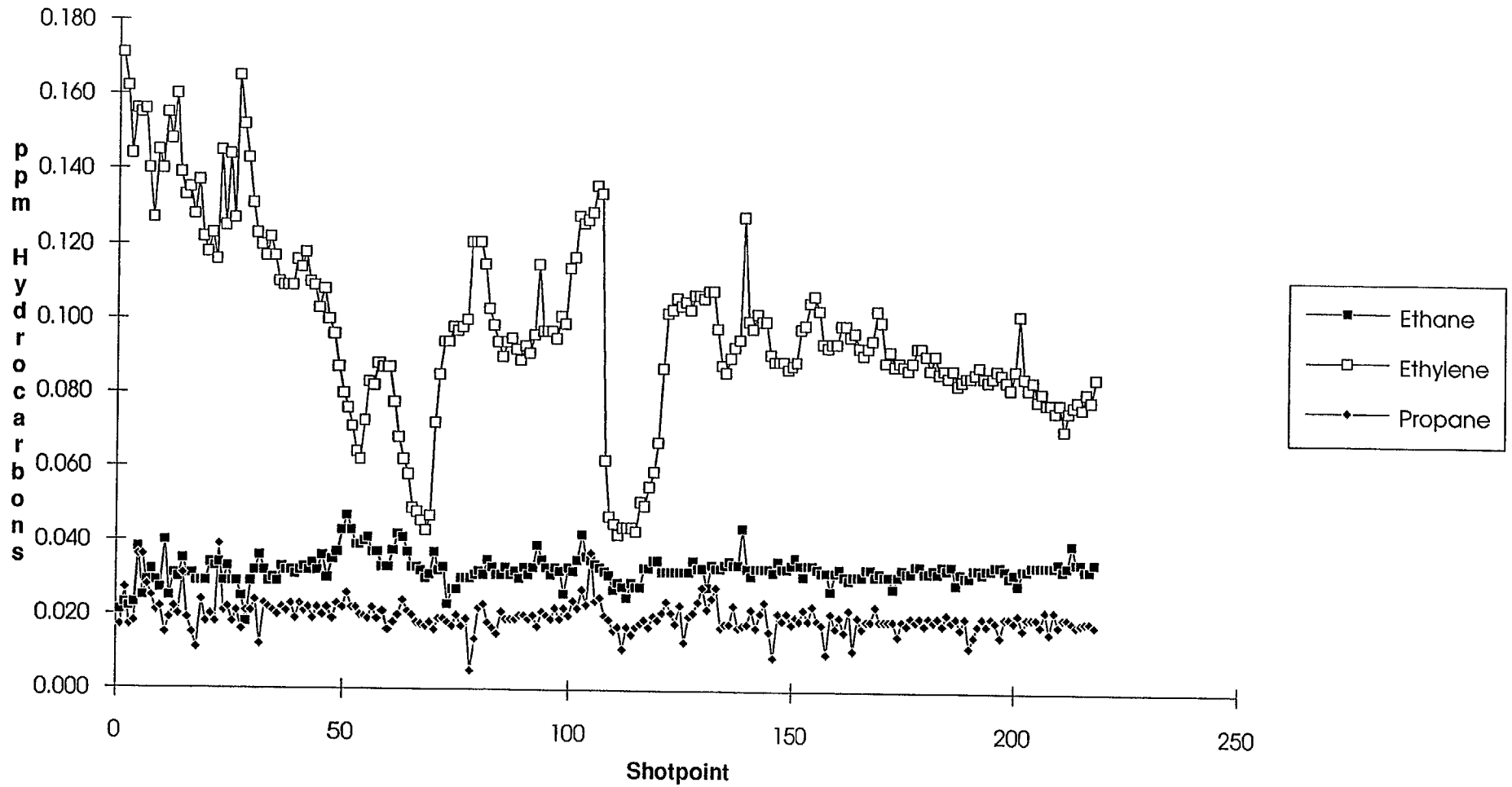
	Cond.	Temp.	F. Depth	W.Depth	Altitude	Calc. Alt.
Mean	57.607	24.948	60.978	80.449	17.353	19.500
Std. Dev.	0.944	0.663	16.952	17.347	5.595	10.400
Minimum	55.770	23.600	32.590	46.500	6.420	9.200
Maximum	60.050	26.620	118.460	137.400	30.910	74.430

Notes

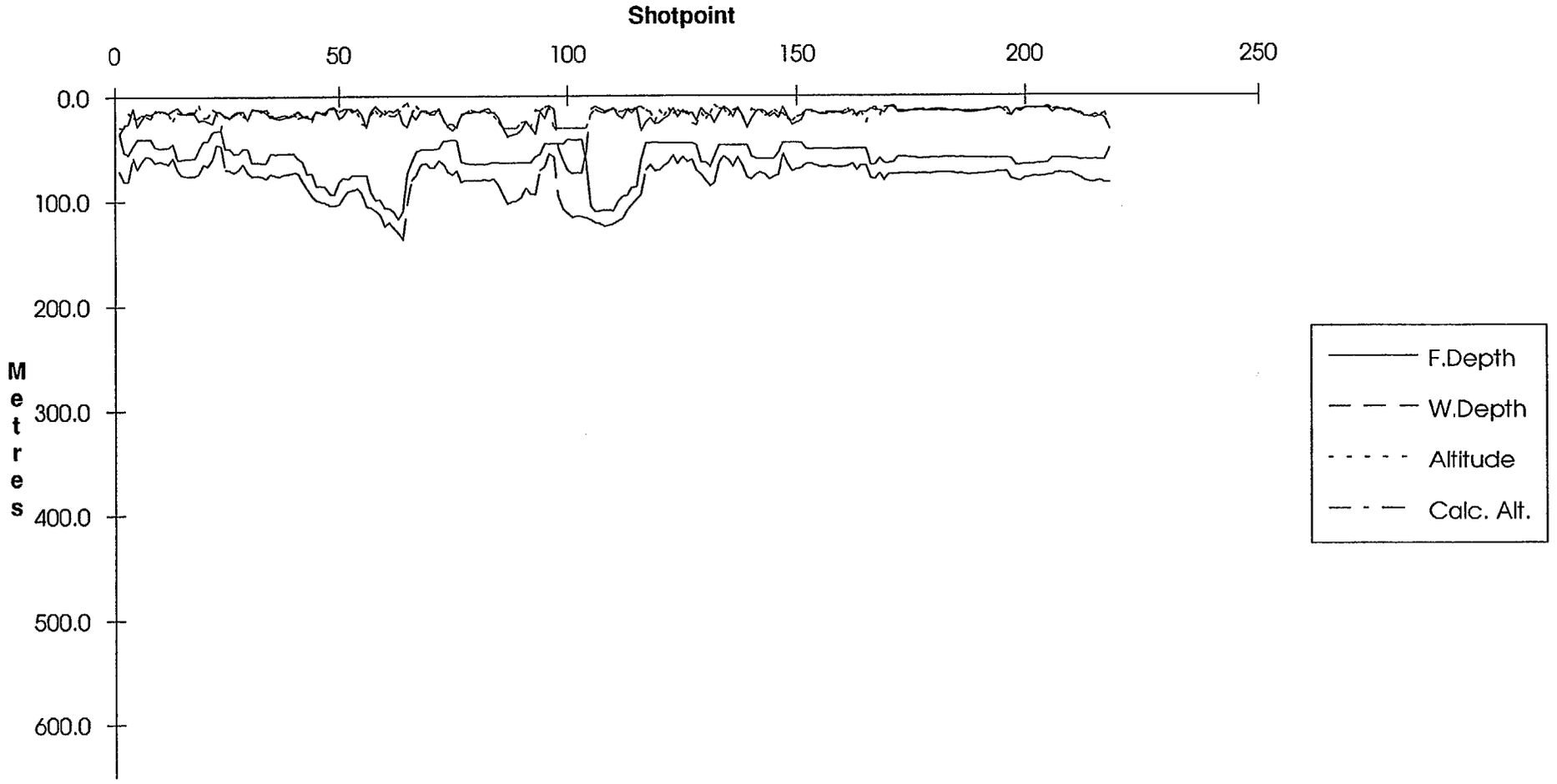
Four very weak THC, methane, ethane and propane anomalies occur at SP 10, SP 50, SP 70, and SP 120.
The weak THC and methane anomaly at SP 150 is a result of the fish hitting the bottom.


Line 109018 THC, Methane
ppm Hydrocarbons
20.00
18.00
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
0
50
100
150
200
250
Shotpoint
THC
Methane

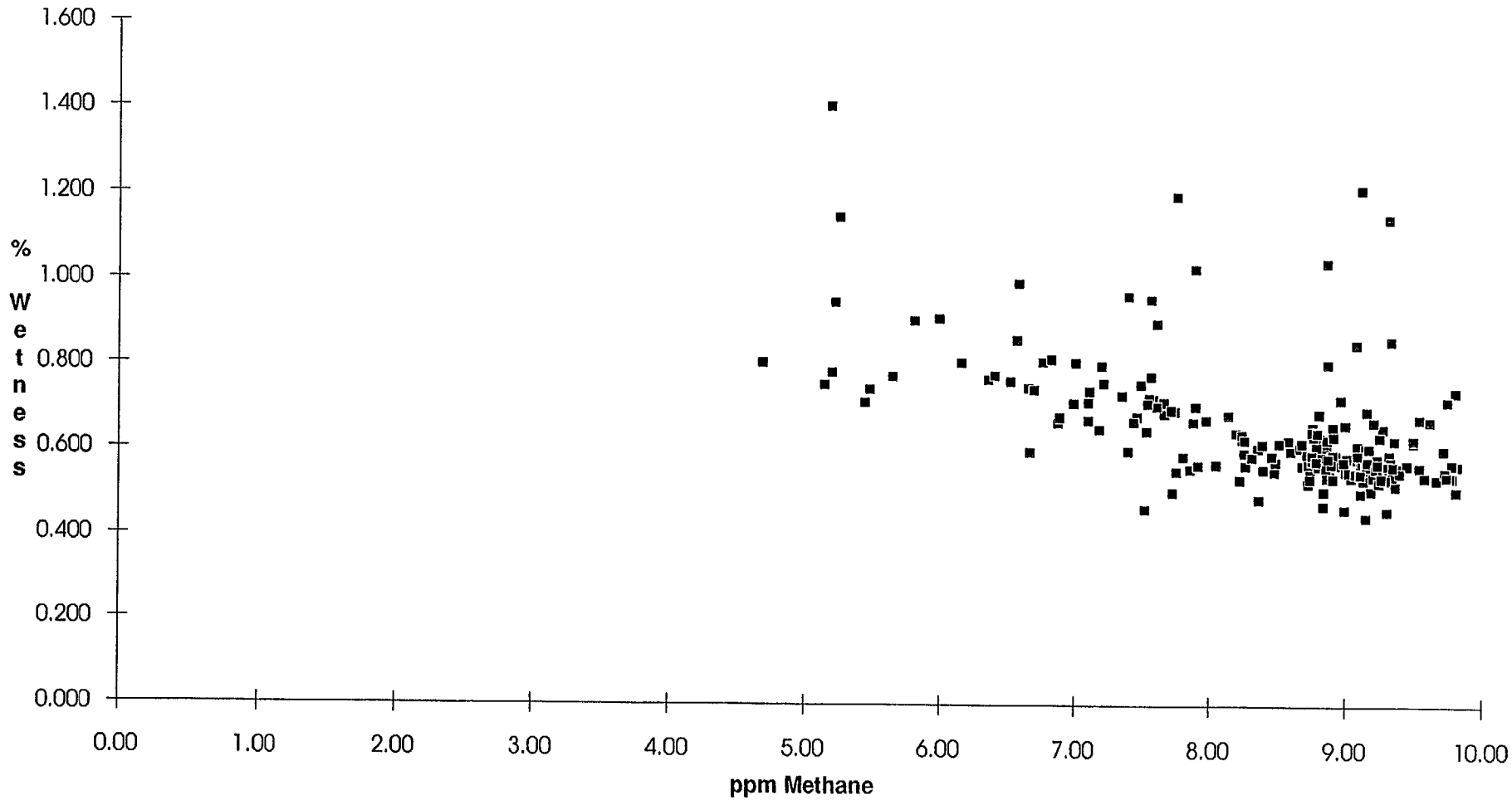
Line 109018 Ethane, Ethylene, Propane



Line 109018 Depths, Altitudes



Line 109018 Methane v. %Wetness



Line Summary

Line Number	109019
No. of Shotpoints	399

	Shotpoint	Date	Time	Latitude		Longitude	
Start	1	8-Apr-92	11:04:47	10	31.233	120	31.354
End	400	8-Apr-92	00:29:33	11	11.689	120	04.241

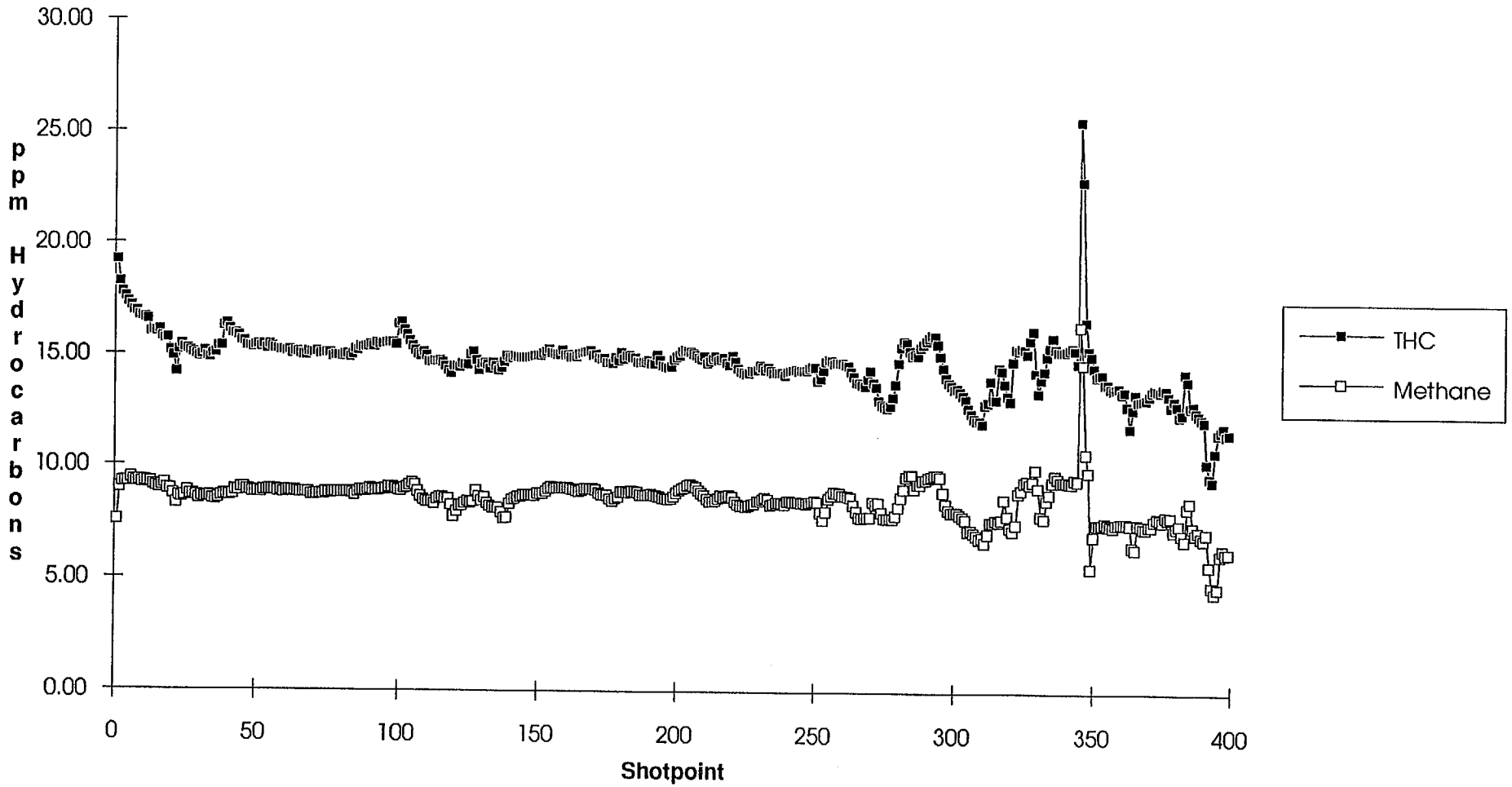
	THC	Methane	Ethane	Ethylene	Propane	Propylene	I-Butane	n-Butane	I-Pentane	n-Pentane	I-Hexane	n-Hexane	%Wetness
Mean	14.692	8.483	0.031	0.092	0.018	0.017	0.000	0.000	0.000	0.081	0.009	0.019	0.585
Std. Dev.	1.327	0.931	0.003	0.022	0.003	0.011	0.002	0.001	0.002	0.020	0.006	0.014	0.069
Minimum	9.442	4.495	0.020	0.042	0.009	0.000	0.000	0.000	0.000	0.033	0.000	0.000	0.326
Maximum	25.579	16.389	0.043	0.182	0.034	0.054	0.018	0.020	0.025	0.182	0.034	0.049	0.926

	Cond.	Temp.	F. Depth	W.Depth	Altitude	Calc. Alt.
Mean	56.566	24.221	66.829	81.882	15.143	15.237
Std. Dev.	0.777	0.548	15.797	14.597	3.944	5.643
Minimum	54.970	23.010	4.680	41.800	7.210	2.640
Maximum	59.220	26.050	121.830	141.500	30.880	57.920

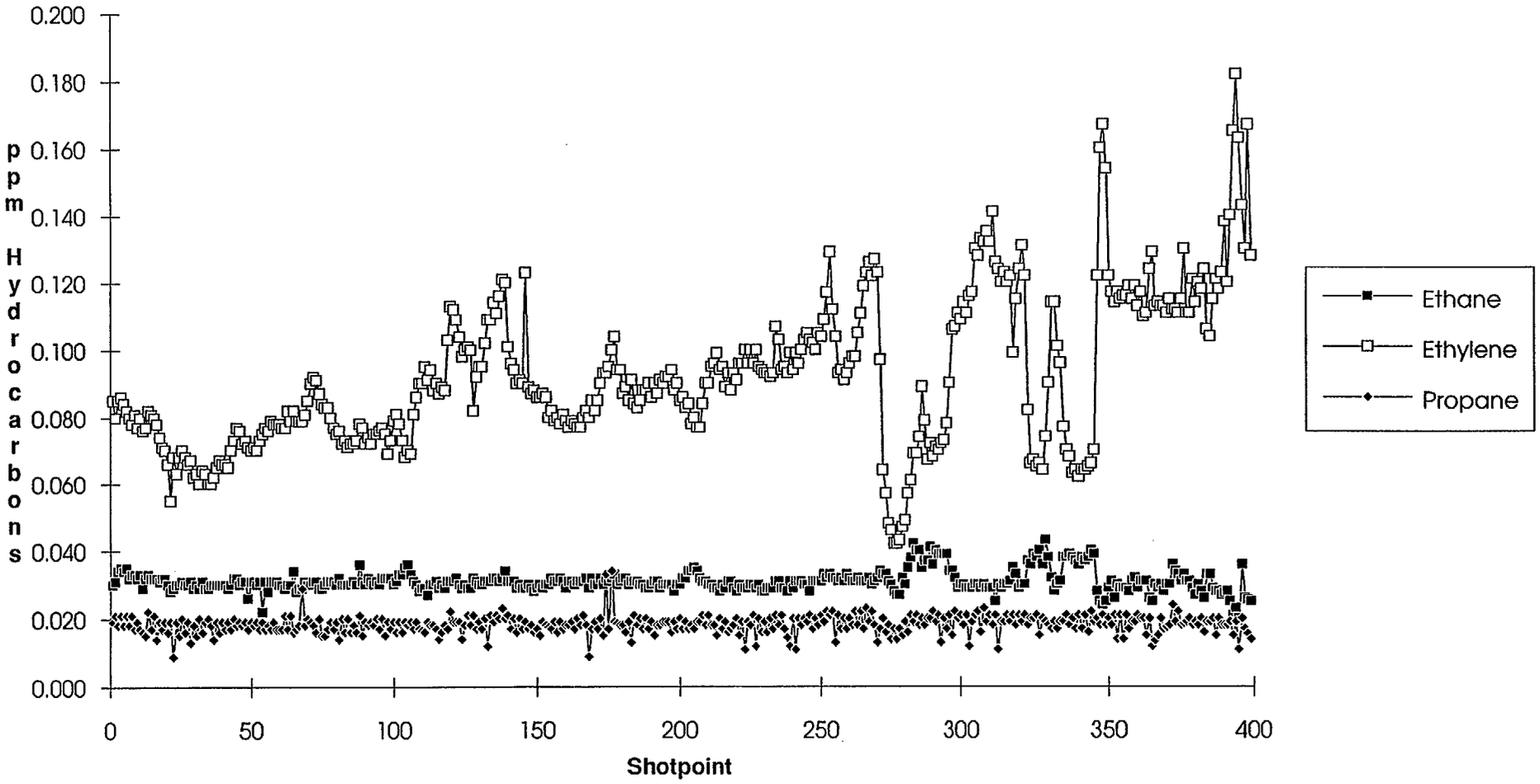
Notes

Two weak THC, methane, and ethane anomalies occur at SP 105 and SP 285.
The weak THC and methane anomaly at SP 345 is a result of the fish hitting the bottom.

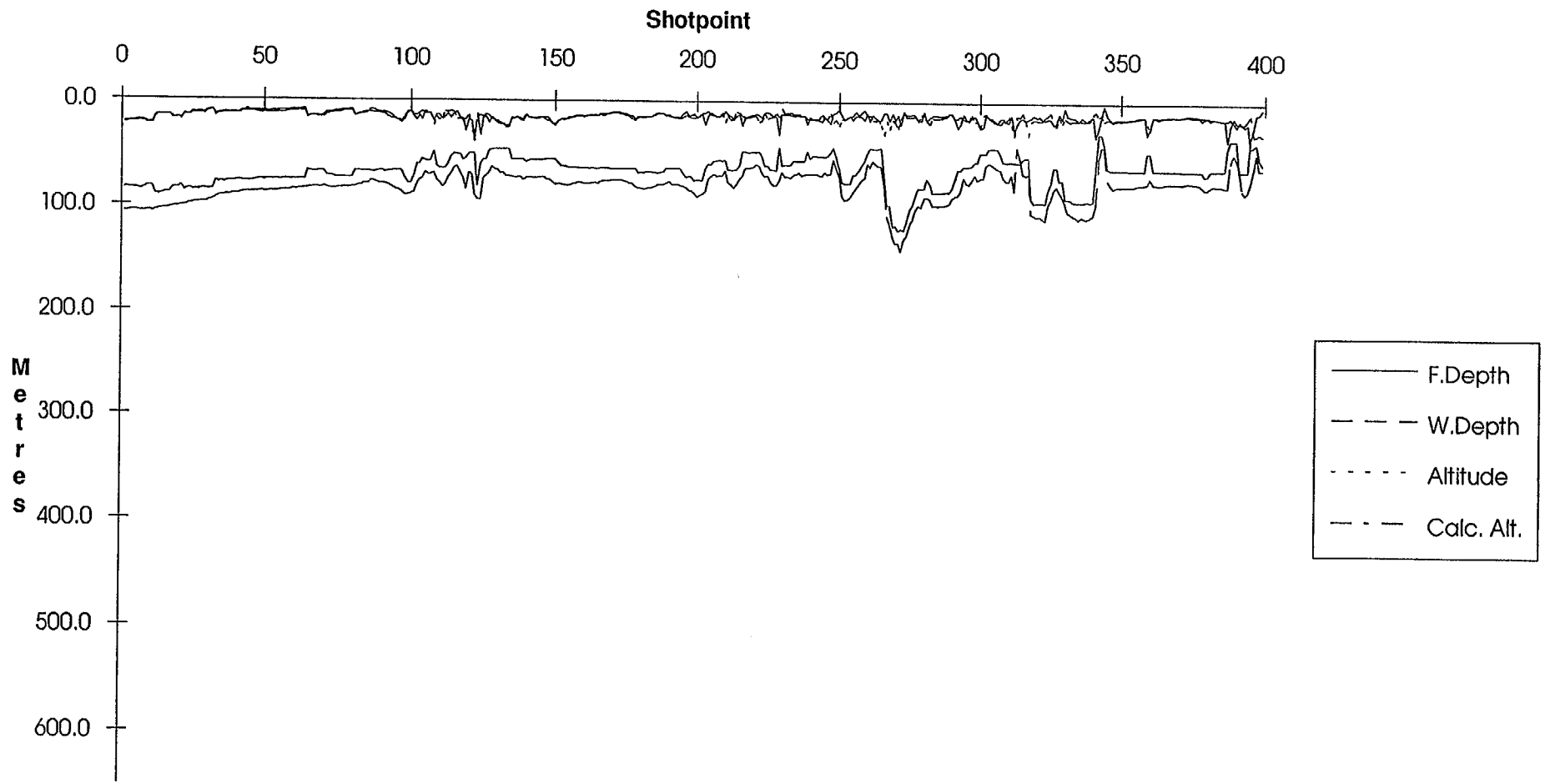
Line 109019 THC, Methane

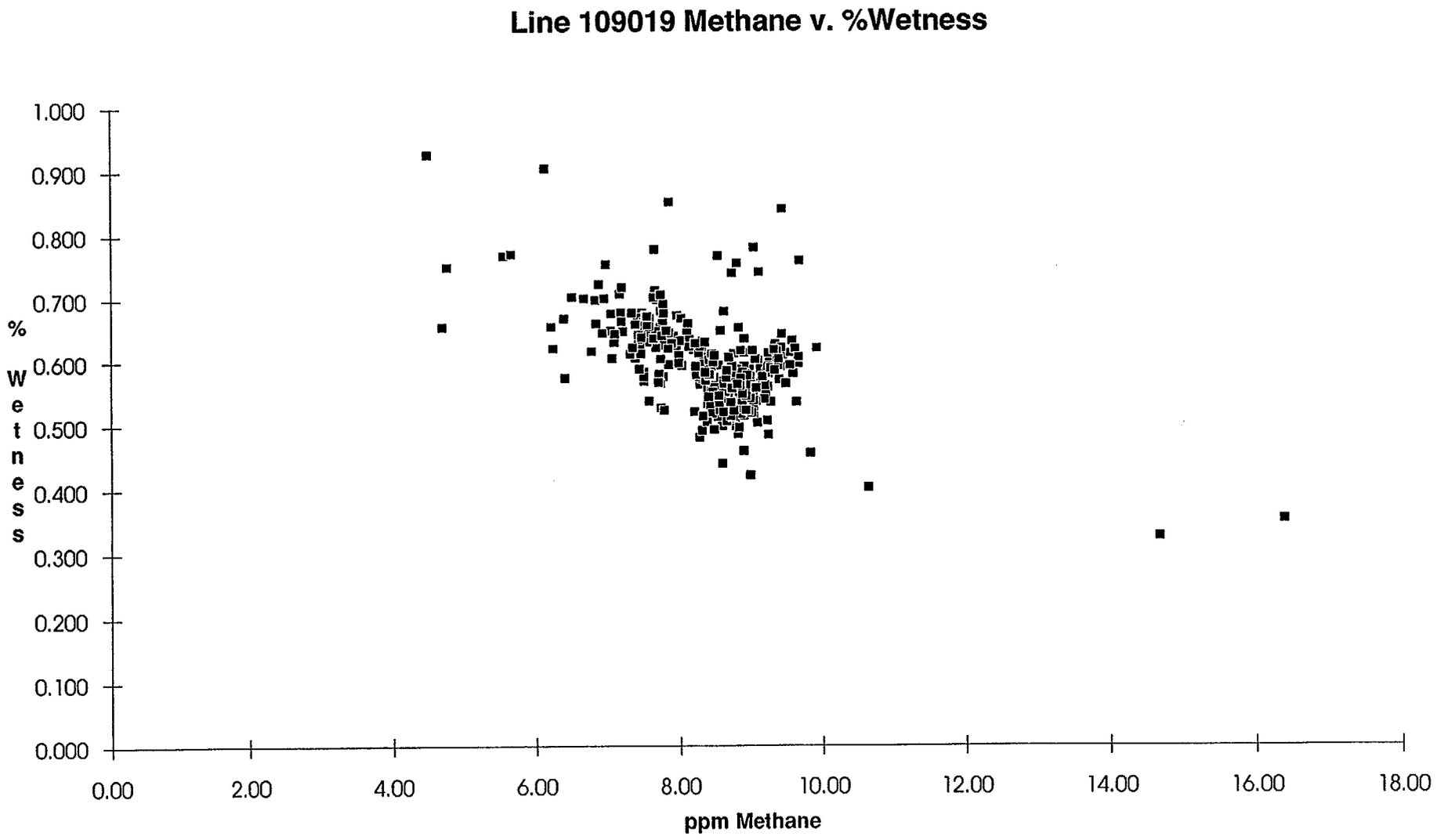


Line 109019 Ethane, Ethylene, Propane



Line 109019 Depths, Altitudes




Line 109019 Methane v. %Wetness
1.000
0.900
0.800
0.700
0.600
0.500
0.400
0.300
0.200
0.100
0.000
% Wetness
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
16.00
18.00
ppm Methane

Line Summary

Line Number	109020
No. of Shotpoints	195

	Shotpoint	Date	Time	Latitude		Longitude	
Start	1	9-Apr-92	02:58:13	11	07.911	119	54.034
End	196	9-Apr-92	09:33:36	10	39.216	120	10.996

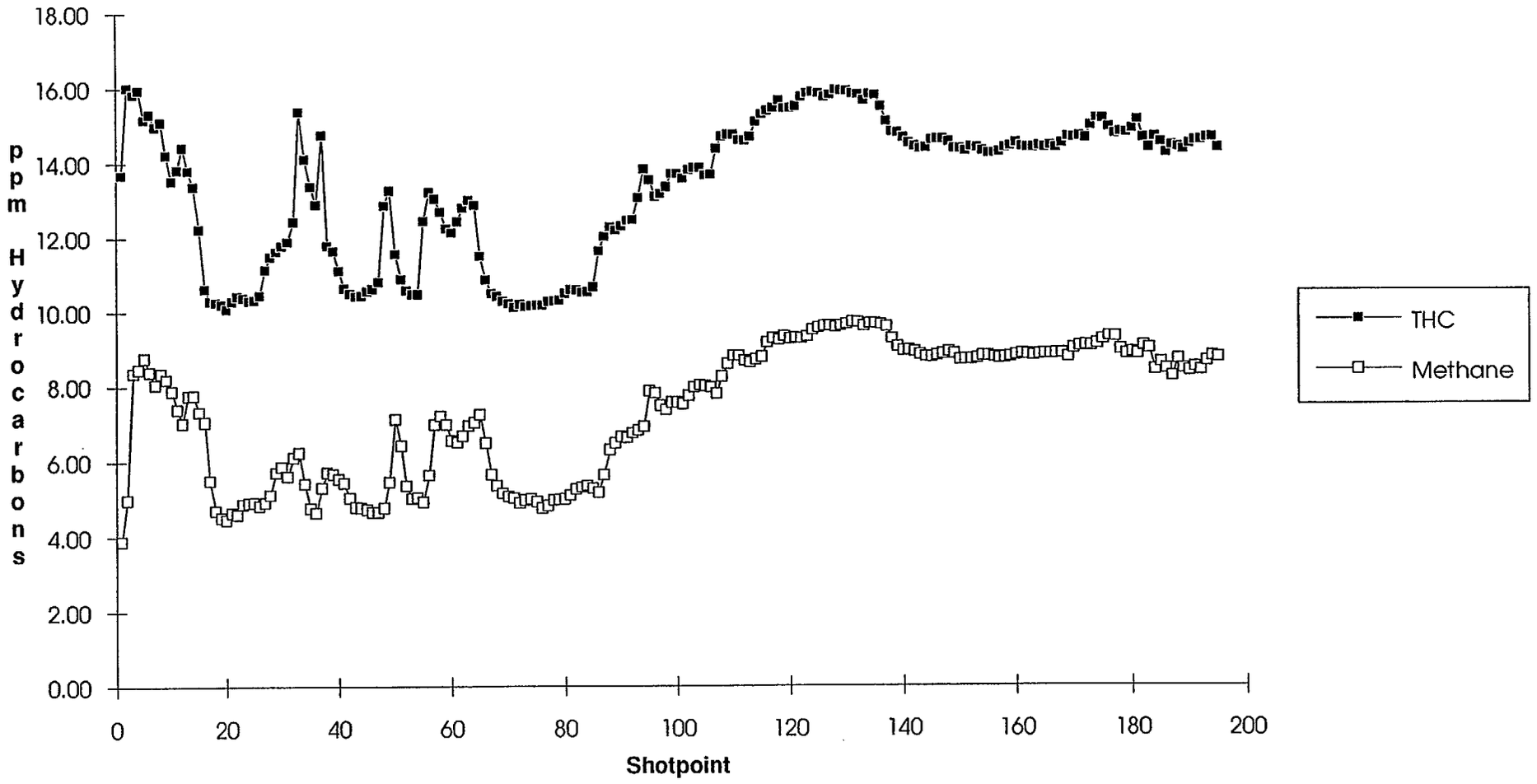
	THC	Methane	Ethane	Ethylene	Propane	Propylene	I-Butane	n-Butane	I-Pentane	n-Pentane	I-Hexane	n-Hexane	%Wetness
Mean	13.339	7.380	0.031	0.101	0.018	0.023	0.000	0.000	0.013	0.112	0.016	0.025	0.686
Std. Dev.	1.876	1.725	0.007	0.029	0.004	0.013	0.002	0.001	0.011	0.036	0.006	0.009	0.107
Minimum	10.069	3.883	0.017	0.058	0.005	0.000	0.000	0.000	0.000	0.056	0.000	0.000	0.526
Maximum	16.016	9.698	0.051	0.182	0.043	0.075	0.016	0.019	0.032	0.209	0.036	0.052	1.264

	Cond.	Temp.	F. Depth	W.Depth	Altitude	Calc. Alt.
Mean	33.988	25.605	29.933	89.129	17.636	59.196
Std. Dev.	29.646	0.997	27.758	14.045	5.127	38.284
Minimum	0.000	24.100	0.000	46.900	10.330	10.780
Maximum	60.530	26.950	69.930	121.800	30.850	121.800

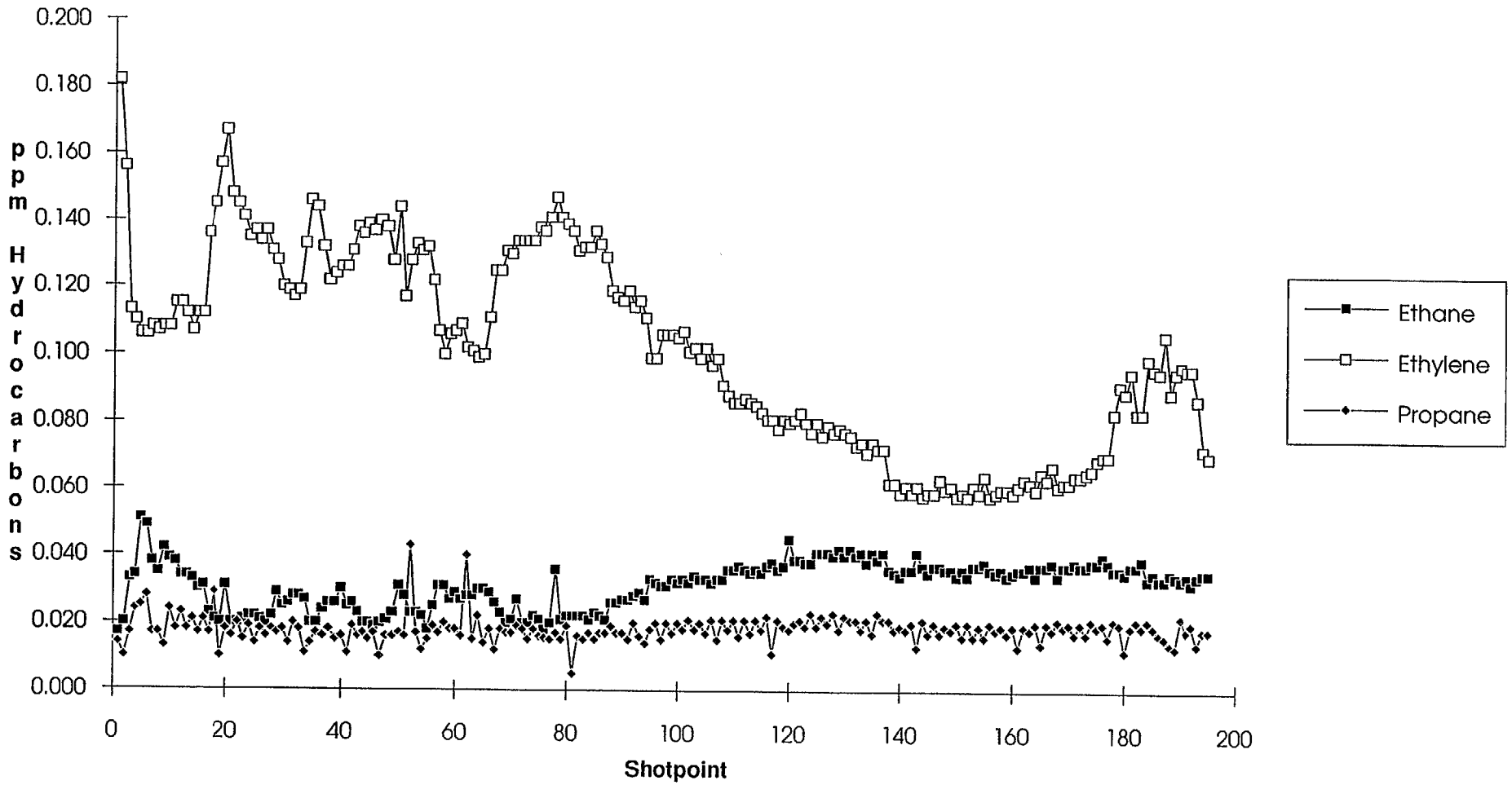
Notes

Three weak THC, methane, ethane, and propane anomalies occur at SP 5, SP 50, and SP 59
The weak THC, methane, ethane, and propane anomaly at SP 32 is a result of the fish hitting the bottom.
No fish depth or conductivity data after SP 113.

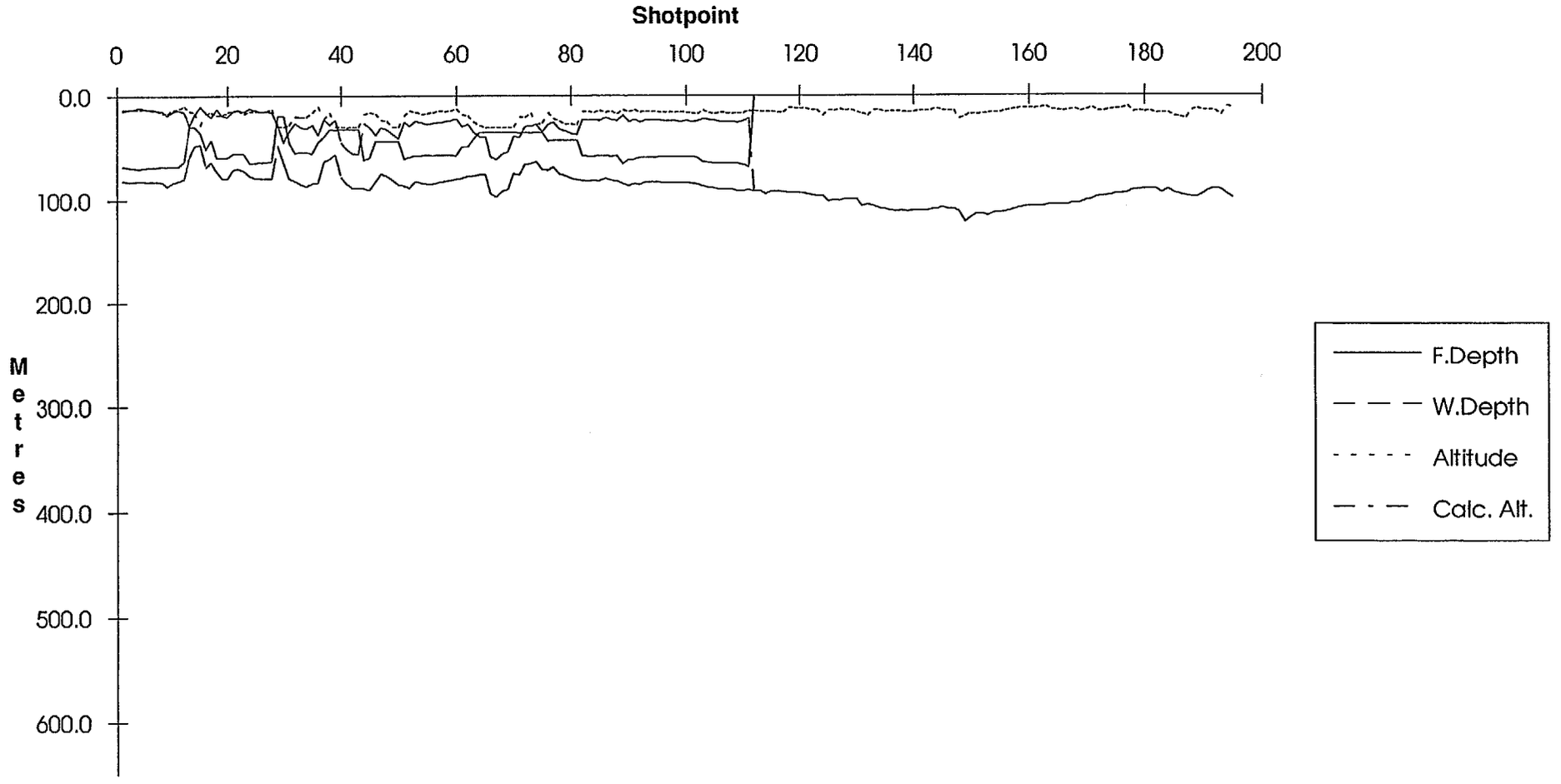
Line 109020 THC, Methane



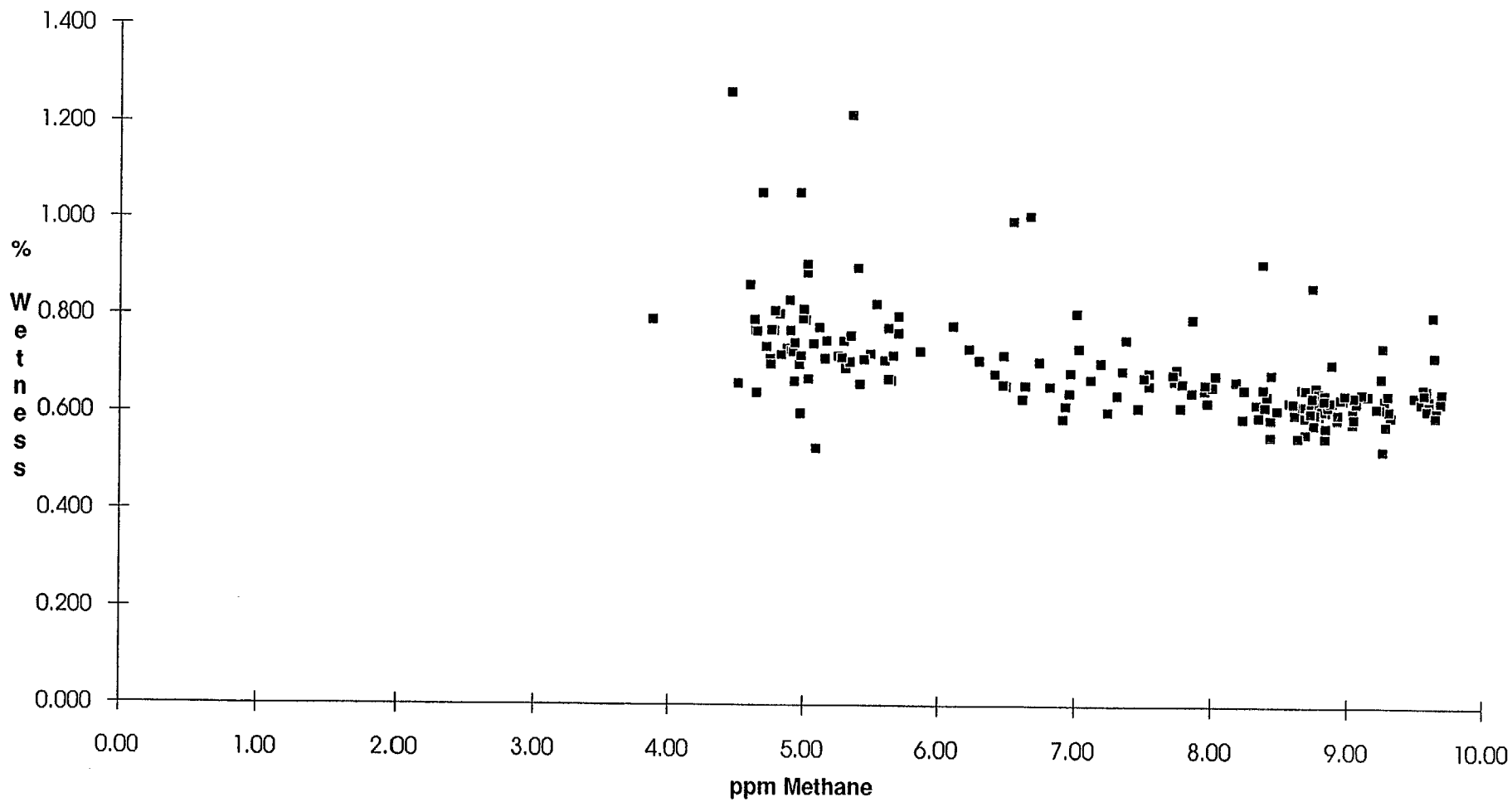
Line 109020 Ethane, Ethylene, Propane



Line 109020 Depths, Altitudes



Line 109020 Methane v. %Wetness



APPENDIX III. DHD METHODOLOGY.

Direct hydrocarbon detection in bottom-water (DHD) is accomplished with the equipment schematically shown in Figure III-I 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-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 C_{2+} compounds.

The following parameters are measured:

Parameter	Units	Equipment Used
Total Hydrocarbon (THC)	ppm	Shimadzu GC with FID Detector using 6" glass bead column
Methane	ppm	Shimadzu GC with FID Detector using 42" activated alumina column
Ethane	ppm	"
Ethylene	ppm	"
Propane	ppm	"
Propylene	ppm	"
i-Butane	ppm	"
n-Butane	ppm	"
i-Pentane	ppm	Shimadzu GC with FID Detector using 30m DB-1 Megabore column
n-Pentane	ppm	"
i-Hexane	ppm	"
n-Hexane	ppm	"
Water Depth	Metres	On-board 3.5 Khz and 12 Kh echo sounders
Tow-tow-fish Altitude	Metres	Mesotech 807 altitude sonar.
Conductivity	mmhos/cm	Sea-Bird conductivity meter
Water Temperature	degrees Celsius	YSI temperature thermistor
Tow-tow-fish Depth	Metres	Druck pressure transducer

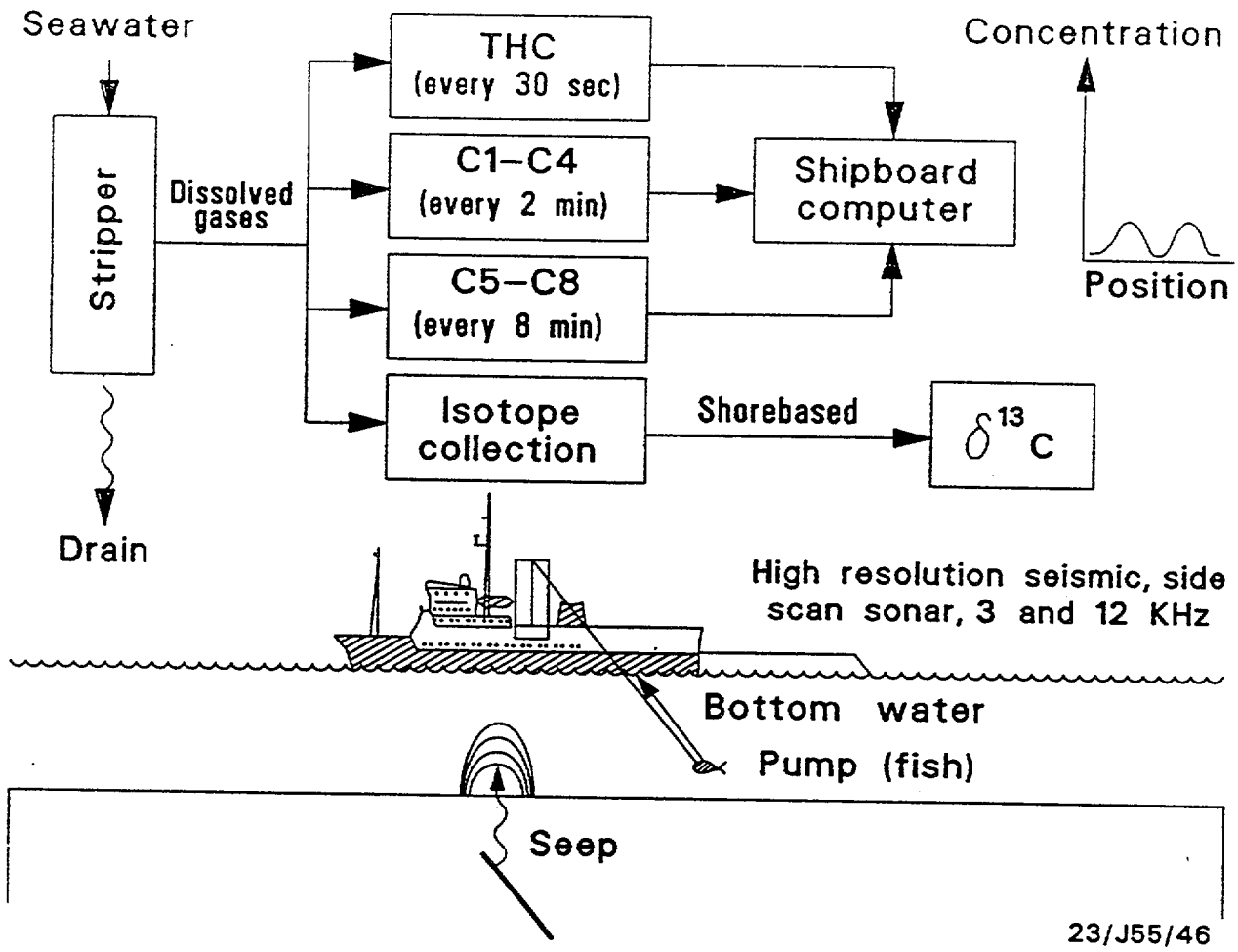


Figure III-I Schematic of the geochemical equipment aboard *Rig Seismic* for the continuous profiling of hydrocarbons in seawater: the bottom-water DHD technique.

APPENDIX IV. INTERPRETATIVE METHODOLOGY.

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

Light Hydrocarbons In Seawater

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

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

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

(Primrose & Dilworth 1976; Claypool & Kvenvolden 1983), provides one criteria to distinguish between biogenic and thermogenic hydrocarbons.

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

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

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

The bottom-water DHD technique is dependent upon hydrocarbons migrating from hydrocarbon reservoirs or petroleum source rocks to the seafloor. Although the exact mechanism(s) of migration may be variable or even unknown, some form of vertical migration, as evidenced by the many observations of seepage (e.g., Brooks et al. 1974; Bernard et al. 1976; Reed & Kaplan 1977; Cline & Holmes 1977; Nelson et al. 1978; Reitsma et al. 1978; Brooks et al. 1979; Kvenvolden et al. 1979; Kvenvolden & Field 1981; Hovland & Judd 1988) does occur (via porous sediments, fault planes and micro fissures 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 & Claypool 1980; Hunt 1984; Sweeney 1988; Hovland & Judd 1988).

Data interpretation: the mixing model

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

Our initial approach is to review the data on a line-by-line basis and compare measured concentrations with the regional background. Then, a variety of hydrocarbon cross-plots are constructed, particularly that where methane is plotted versus percent hydrocarbon wetness (percent wetness = [SUM(C_2-C_4)/SUM(C_1-C_4)] x100) 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 & Welte 1984; Claypool & Kvenvolden 1983). In this model background hydrocarbons plot in a narrow range towards the left origin (low concentrations), while end-member 'source' hydrocarbons 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.

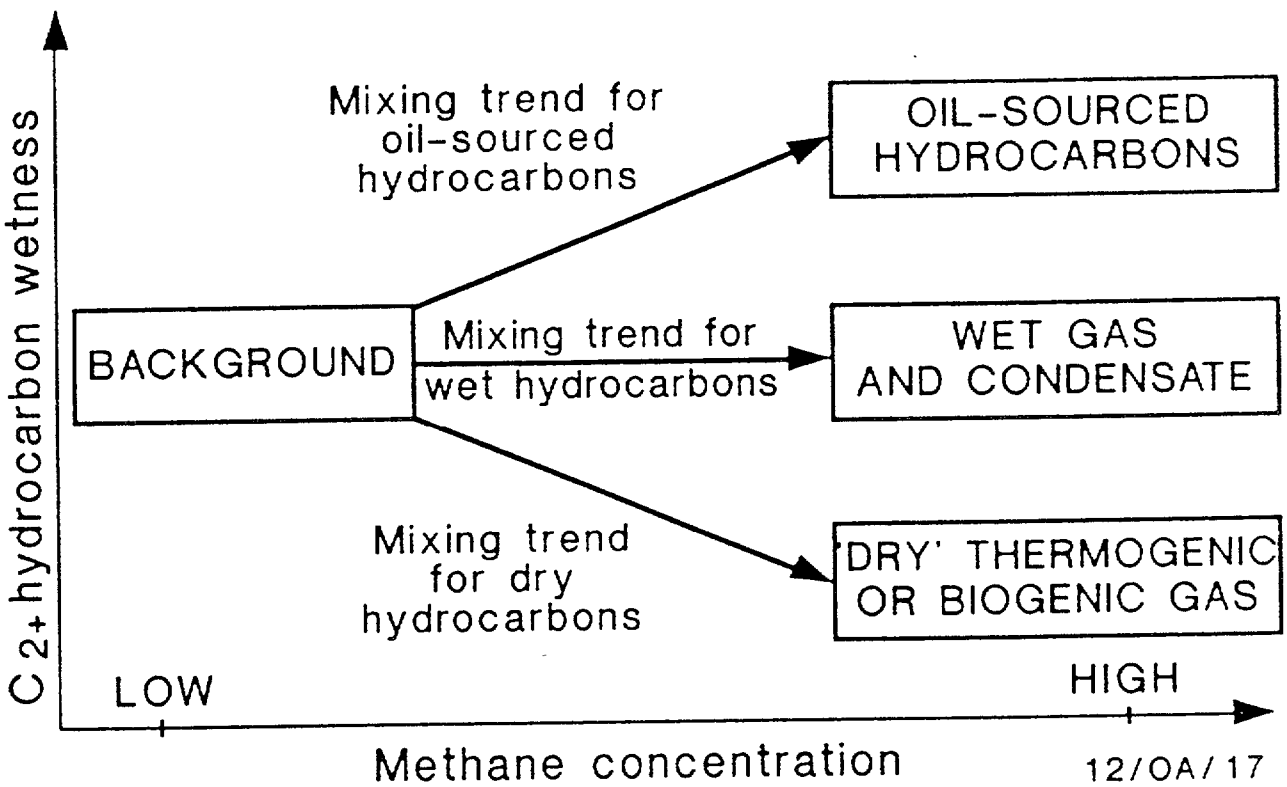


Figure IV-I. Cross-plot of methane versus hydrocarbon wetness, showing the general decrease in wetness with increasing methane for gas-prone or biogenic sources. Conversely, oil-prone sources are indicated by increasing wetness with increasing wetness with increasing methane. Gas-condensate sources fall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

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-tow-fish above the seafloor, a shoaling of the water depth, penetration of the tow-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-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.

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APPENDIX V. SYSTEMS OPERATIONS REPORTS.

The following system reports were compiled upon completion of the survey.

DHD operations

The DHD system comprises 4 principal sub systems: tow-fish/cable/winch, gas extractor, gas analysis, and control and data acquisition. The operational problems are described under these 4 categories.

Tow-fish/cable/winch subsystem

The tow-fish cable suffered a collection of on going operational problems. The cable was reterminated twice, once at the end of the NE Palawan/Cuyo Platform section of the survey, after the tow-fish hit the bottom near the start of line 109/020, and the electrical systems failed towards the end of that line.

The tow-fish hit the bottom numerous times, including when the ship ran aground on an uncharted reef in Tayabas Bay. Collisions were generally caused by either a) a rapid decrease in water depth with little or no warning, ie reefs and similar structures, or b) soft muddy bottoms that were not detected by the echo sounder (see below). Most of these collisions resulted in little damage, with the exception of the collision on line 109/020, other than denting the tow-fishes nose and failure of two of the Druck depth transducers. On one occasion the tow-fish had to be retrieved in order to clean the tow-fish of soft mud.

Problems continued with the fairings, although a high level of ongoing maintenance prevented many potential problems. the drag of the cable and fairings as it passes through the water causes the fairings to be pushed down the cable, compressing the fairings at the lower end. This makes it difficult for them to rotate around the cable, thus increasing the drag, and often results in damage to the fairings as they attempt to pass through the A-frame sheave and winch spooling gear. In particular significant problems were experienced with the fairings whilst the vertical profiles were carried out at the end of the program, due to twisting of the tow-fish and cable relative to the vessel, and compressed state of the fairings. Design, testing and implementation of a robust and easily installable system of "fairing stoppers" should be given priority. The new pneumatic stapler was very useful and productive, significantly reducing the time and repetitive strain experienced

when using a manual stapler. The quality of the picture from the A-frame camera continues to dereriorate due to it pointing skyward being "burnt" by the sun. The quality is particularly poor at night.

Three of the Druck depth transducers failed during the survey. One suffered a gradual failure, becoming noisier during lines 109/004 to 109/006 before failing completely prior to line 109/007, following which no depth data was recorded for lines 109/008 to 109/010. In addition, no conductivity data was obtained for lines 109/009 and 109/010, due to removal of the depth transducer and electronics pod for replacement. The other two depth transducers failed when the tow-fish collided with reefs.

The Mesotech altimeters generally worked well, although two failed and were replaced and repaired as required. In parts of Ragay Gulf the soft muddy bottom often could not be detected by the altimeter, and as a result, the tow-fish hit bottom on several occasions in this area. No damage occurred as a result of any of these collisions, but on one occasion the tow-fish had to be retrieved in order to wash out the mud that had become trapped inside the tow-fish.

On a brighter note, after redeployment following the second Mabini Port call, the tow-fish was in the water for about 12 days continuously, and the system was fully operational for most of that time. The continuity was only broken when a piece of tow-fishing net became wrapped around the cable and we had to retrieve the tow-fish in order to cut it free.

Gas extractor subsystem

Gas Extractor:
No significant problems were experienced with the gas extractor system during the survey, although problems with starting the tow-fish exhaust pump motor resulting in one or more of the circuit breakers tripping were an annoyance throughout the survey. The rewiring of the ships power supply prevented any of these circuit breaker trips from affecting the instrument room power supply. An improved method of starting the tow-fish pump should be investigated and implemented, as per Martin Calloways suggestion(Cruise 108/Sea Trials DHD report).

The new 240v vacuum pumps (installed during the sea trials) were very successful, holding their vacuum well, and required virtually no ongoing maintenance during the course of the survey. There were minor problems with exhaust motor and exhaust pump "sticking" early in the survey, although this resolved itself as the survey progressed.

We were unable to obtain any YSI temperature thermistors prior to the start of the survey. As a result, a new type was tried which we were initially unable to get to work. Consequently, no temperature data was recorded during the first 10 miles of line 109/001.

The new cable-out counter installed during the sea trials worked well, much easier than the old system of manually keeping count of the number of wraps of cable deployed from the winch.

Gas Analysis subsystem

Gas Chromatographs:
The gas chromatographs throughout the survey operated with generally few problems, although LHC2 suffered a stuck valve or valve actuator early on line 109/001 and was not operational for most of this line, resulting in light hydrocarbon data being acquired every 4 minutes instead of every 2. The problem seemed to fix itself, and LHC2 operated throughout the rest of the survey, although it continued to suffer from occasional, intermittent problems.

THC and to a lesser extent, LHC2, were prone to intermittent "hanging", a known problem that has been observed on previous surveys. It now seems very likely that the

cause is related to electrical earthing problems. This needs further investigation and fixing as soon as possible.

Chromatograph calibration was generally good. Calibrations were checked every 24-48 hours, as line changes permitted, and individual systems were recalibrated if the values differed by more than 3% from the standard gas. Some problems were experienced with drifting retention times, this affected the butanes on LHC1 and LHC2, and most of the HHC hydrocarbons. It was noticed that THC has integration problems at high THC levels, possibly due to chromatographic separation of hydrocarbons in the THC column.

A number of the integrators had print-head problems and failures; we need more spare print heads for future surveys.

Control and data acquisition

Only one significant problem: line 109/009 was not recorded on either floppy or hard disk. The reason for this is unknown. Fortunately the line was short (10.9 km, equal to 36 DHD shotpoints (analysis)), and most of the data can be entered by hand from the printer hard-copy.

Minor improvements were made to the acquisition software early in the survey, including obtaining the type of navigation used (dGPS, non-dGPS, T-Set or DR) from the TEGW program running on the DAS computer.

Other

HADES 'died' after the instrument room was powered off when the ship ran aground on the uncharted reef in Tayabas Bay, and the EPC was set up to slave off the primary EPC in the instrument room. Whilst this did the job, the greater resolution and smaller scales offered by HADES would have been preferred.

We noticed that the 12Khz echo sounder suffered from the same problem as the Mesotech echo sounder in Ragay Gulf, namely that it failed to pick up the soft mud layer. Whilst this layer was visible on the EPC records, the digitiser often failed to pick up this layer, and instead picked up the stronger signal from the deeper layer. This resulted in

erroneous water depth readings, which in turn affect the "calculated altitude" of the tow-fish (water depth minus tow-fish depth).

Erroneous water depths, and consequently erroneous calculated tow-fish altitudes were common in many deep water areas, in areas of rapidly changing bathymetry, and in very shallow areas, due to either failure of the automatic gate to follow the bottom correctly, or the gate being set on manual and the bottom changing significantly before being reset by the DAS operators. As a result, we will need to obtain the post-processed bathymetric data from the non-seismic processing group and integrate this with our data.

Non-Seismic Data Acquisition (H.Miller)

The non-seismic data acquisition system (DAS) ran for the duration of the cruise with only four breaks in data collection. Two were intentional reboots of the system by the system personnel during transit; one occurred when all the equipment was powered down after the ship ran aground on an uncharted reef. Lastly, sixteen hours of data were lost because of an unobserved termination of tape recording; seismic data collected during this period was reshot.

Navigation

Positioning of the ship is derived from three systems: Navstar Global Positioning System with and without differential data (dGPS and GPS), and dead reckoning with updates from the U.S. Navy Navigation Satellite System (Transit satnavs). The 2 GPS systems use the same satellites but all onboard equipment is completely independent.

All ship positions are calculated in the WGS84 coordinate system.

Navstar Global Positioning System

The dGPS system consists of a Trimble 4000 series GPS receiver, a Racal satellite data demodulator and Racal supplied software running on a Compaq 386 PC. The Trimble receiver provides basic GPS data. Pseudo-range corrections are transmitted from a reference station operated by Racal via a geostationary satellite. The supplied software incorporates the data and corrections to provide dGPS positioning and provides the operator with a monitoring and control interface. The positioning data are in turn read by the DAS navigation computer. During this survey, two identical systems (RACAL 1 and RACAL 2) were run using separate Trimble receivers and PCs. RACAL 1 and RACAL 2 were set to receive differential corrections from Manila, Philippines and Miri, Malaysia, respectively. During instances when Manila was down, RACAL 1 was set to Singapore. In addition, software was available to download Almanacs from the receivers and predict GPS satellite availability and quality in advance.

GPS positions without corrections are also obtained from the onboard Magnavox T-Set receiver.

Both systems use the GPS coarse/acquisition code. This provides the T-Set system with positioning within 35 metres rms under optimum conditions. Racal estimate the error in dGPS to be 7.5m at a distance of 900km from the reference station with a horizontal dilution of precision of 1.5. Operating distances from the Manila reference station ranged

up to 300km; in general dGPS positioning were within 5 metres. A section of one line was reshot due to a faulty satellite causing unacceptable navigation.

Dead reckoning Systems:
Dead Reckoning is provided by incorporating a gyro compass, dual axis sonar-doppler and Transit satnav receiver for periods when the other navigation systems prove inadequate.

The primary dead reckoning system of Sperry gyro-compass, Magnavox MX610d sonar-doppler and MX1107RS dual channel satnav receiver provides one of the best available positioning systems of this type. A lower grade system of Sperry gyro, Raython DSN450 sonar-doppler and MX1142 single channel satnav receiver is used as a backup. A SG-Brown gyro-compass is also available.

The dead reckoning system, was, however, available for only a few weeks before the ship ran aground on an uncharted reef. Transducers for the doppler sonars were either lost or damaged beyond repair in the accident. Fortunately dGPS provided 24-hour navigation coverage except for a few days when data were unavailable or unacceptable for up to 90 minutes each day.

Bathymetry
Bathymetric data were obtained from a Raytheon echo-sounder operating at 12 kHz with a maximum output of 2 kW. The recorded data require a shift of 6 metres to relate to sea surface.

Gravity
Gravity data were obtained throughout the survey using a Bodenseewerk KSS31 Marine Gravity meter with no problem. Gravity ties were carried out in Puerto Princesa, Palawan, at the start and end of the survey. The meter was, however, turned off following the grounding of the ship.

Magnetics
Magnetic data were collected whenever possible during seismic acquisition using a Geometrics G801/3 marine proton precession magnetometer. With the exception of some brief periods, noise levels were typically of the order of 2-3 nT, and some distinct anomalies were noted.