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Chemical Analysis of Aerosol Samples from the Carbonaceous Species Methods Comparison Study of 1986

CALIFORNIA ENVIRONMENTAL PROTECTION AGENCY

AIR RESOURCES BOARD
Research Division

CHEMICAL ANALYSIS OF AEROSOL SAMPLES FROM THE CARBONACEOUS SPECIES METHODS COMPARISON STUDY OF 1986

FINAL REPORT
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ABSTRACT

This study was aimed at determining if modern or recently formed carbon particles, of biogenic origin, constitute an important component of the atmospheric particulate loading. The results of such studies are important for understanding photochemical processes in the atmosphere, for assigning responsibility in the decrease of atmospheric visibility and for planning remediation strategies by state and local agencies.

In this Final Report, we present analyses performed for this contract on the characteristics of organic and elemental carbon analyses, stable isotope ratios, characterization of hydrocarbons, fatty acids and plasticizers and radiocarbon measurements on over 40 filters collected from Glendora, Duarte and the Caldecott Tunnel (San Francisco Bay Area), California.

A total of 33 filters from air sampling at Glendora, California, during the Carbonaceous Species Methods Comparison Study in August, 1986, were prepared for detailed chemical analysis. Because it was considered that some of these may not have sufficient carbon for ^{14}C radioisotope analysis, several filters representing the same sampling time and location (Tables II-1 and II-2) were combined. This resulted in 22 filters for detailed study.

In addition, eight filters from Duarte, collected at approximately the same dates as those from Glendora were combined to five filter combinations, four filters (two day and two night filters). For comparison samples from Caldecott Tunnel were collected in August 1989 and also analyzed to establish a base for motor vehicle impacted sites. Several field blanks and blank filters were also analyzed. Thus a total of 55 filters were used for analysis. In addition, samples taken above a kitchen stove, vapor from heating beef fat and domestic fireplace ash were also analyzed, and mass spectrometric characterization of the plasticizer TXIB was performed.

Patterns have emerged which help to characterize the nature of the organic material in the extracts of the aerosols. The filters were extracted with methylene chloride and methanol and separated into hydrocarbon and polar fractions. The paraffinic fractions generally show petroleum hydrocarbon release by evaporative loss of fugitive petroleum products or non combusted automobile emissions. Some evidence for plant waxes was also observed. The aromatic fraction generally shows the long-chained polycyclic aromatic hydrocarbons (PAH) typical of petroleum hydrocarbons. Only non-quantifiable traces of retene, a three ring aromatic compound often associated with combustion of wood were detected in the extracts, indicating wood burning was not an important source for the PAH.

In the polar fraction of the extracts, long-chain fatty acids were identified, with a significant content of unsaturated fatty acids derived from natural plant oils and animal fats.

The ambient aerosols contained less elemental (residual or non-solvent extractable) carbon than was present in the Caldecott Tunnel samples, when compared with the organic carbon content of the sample.

The content of modern carbon measured on ambient aerosols, as well as Caldecott Tunnel samples, shows that the hydrocarbon fraction contains less modern carbon than the polar fraction or the residual (elemental carbon) fraction.

For Glendora and Duarte the average values for modern carbon in the hydrocarbon, polar fraction and non-extractable residual (elemental carbon) fractions were 12.6% 27.1% and 31.6% respectively for samples collected during day time. For the Caldecott Tunnel samples these same fractions yielded values of 0%, 9.5% and 8.9% modern carbon respectively.

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In 1989, funding was provided by the California Air Resources Board, primarily through the interest of Dr. Douglas Lawson, to conduct the present study. We appreciate his help and concern through the performance of this project.

The particle samples were collected by Richard Brewer; extraction, chemical characterization and isotopic analyses were performed by Ru-Po Lee, Kelly Dunnahoo, Dachun Zhang, Kris Kohrt, Shan-tan Lu, and Yakov Galperin all of Global Geochemistry Corp. Assistance in characterizing the plasticizer TXIB in the hydrocarbon fraction was provided by Professor Zeev Aizenshtat, Hebrew University, Jerusalem, Israel. Special appreciation is due to Dr. Hossein Alimi of GGC who provided valuable assistance in constructing the Tables and Figures in this report. His help was essential in ensuring the successful completion of the report.

All the ^{14}C measurements were made at the Accelerator Mass Spectrometer Facility at Lawrence Livermore National Laboratory (LCNL). About one third of the graphite targets were also prepared at LLNL. We especially appreciate the cooperation of Drs. Jay Davis, John Vogel and their associates in performing

these measurements carefully and in a timely manner. Two thirds of the graphite targets were prepared at U.C. Riverside under the direction of Dr. Erwin Taylor and his associates. His cooperation is also much appreciated.

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DISCLAIMER

The statements and conclusions in this report are those of the contractor and not necessarily those of the California Air Resources Board. The mention of commercial products, their source or their use in connection with material reported herein is not to be construed as either an actual or implied endorsement of such products.

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SUMMARY AND CONCLUSIONS

A study was undertaken by Global Geochemistry Corporation to measure the modern carbon content of particles in the size range of $PM_{2.5}$ ($<2.5\mu M$) by use of the radio-active ^{14}C method. This entailed the conversion of the filter sample content to carbon dioxide by catalytic combustion, conversion of the purified carbon dioxide to graphite "targets" and measurement of the ^{14}C content by irradiation in an accelerator mass spectrometer. Three fractions were systematically analyzed in each filter (i) a hydrocarbon extract (ii) a polar extract and (iii) a non organic solvent extractable fraction or residual fraction.

Samples were collected mainly in Glendora and Duarte, southern California, during the Carbonaceous Species Methods Comparison Study in August, 1986. Two additional samples were collected for comparison in the Caldecott Tunnel, near Berkeley, California, in August 1989.

Detailed analyses of the filters were performed to determine the total suspended material, organic and elemental carbon contents and the organic solvent extractable contents. The latter solution was then partitioned into a hydrocarbon-rich fraction and a polar fraction by use of liquid chromatography. The fractions were then characterized using a gas chromatograph-mass spectrometer.

The hydrocarbon fractions of the Glendora and Duarte filters contained petroleum hydrocarbons with an admixture of biogenic hydrocarbons. The Caldecott Tunnel samples only contained diesel-range hydrocarbons, probably from vehicular traffic. The hydrocarbon fractions from Glendora and Duarte, also contained relatively high contents of three plasticizers; 2,2,4-trimethyl,3-pentadiol di-isobutyrate, di-n-butylphthalate and bis(2-ethylhexyl) phthalate. These plasticizers were not found in the tunnel samples.

The polar fraction was found to contain saturated and unsaturated fatty acids in the C_{16}-C_{20} range. Unsaturated fatty acids are interpreted as arising

from biogenic sources, possibly released during cooking.

The ^{14}C modern carbon content of the Glendora, Duarte and Caldecott Tunnel samples was corrected for filter blank effects. A table listing the averages for the Fraction 1 (hydrocarbons), Fraction 2 (polar compounds) and the non-extractable residual (elemental carbon) is presented in Table ES-1. The data for the blank- corrected ^{14}C values are also shown in Figure ES-1. The residual values were not corrected for ^{14}C blanks because blank filters were shown to contain only trace quantities of this fraction. The data for Glendora (day and night) hydrocarbon fraction have a restricted range of modern carbon with an average of 15.5%. The carbon age determination of the tunnel hydrocarbon fraction illustrates that it is entirely fossil in composition after blank correction. The polar fraction for Glendora and Duarte day samples are almost identical with a mean of 27.3% modern carbon. The night sample from Glendora, by contrast, has an average modern carbon content of 46.9%. The residual (elemental) carbon in Glendora and Duarte also have a narrow modern carbon distribution with an average of 32.4%. The polar and residual fractions of the Caldecott Tunnel samples have an average of 9.5% and 8.9% modern carbon respectively.

The data clearly show that atmospheric particles in the Los Angeles air basin have entrained modern (non-fossil) carbon in all their constituents. The highest amount appears to be in the polar and organic solvent non-extractable (or elemental carbon) fractions.

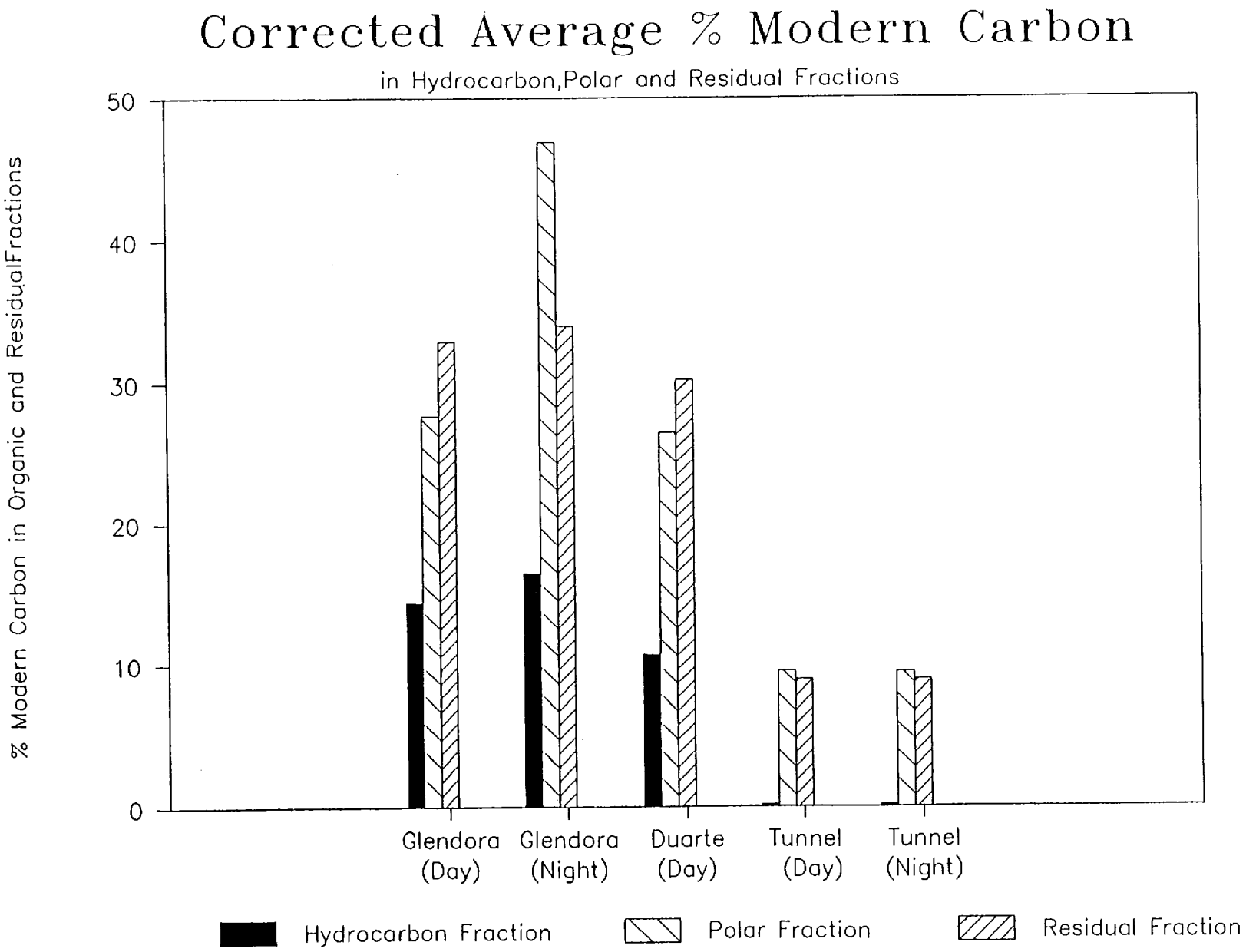
RECOMMENDATIONS: This study demonstrated that approximately one third of the organic carbon and an equal amount of residual carbon (which may largely represent elemental carbon) in aerosol particles, are from non-fossil fuel sources. An effort should therefore be undertaken by the California Air Resources Board to determine the sources of the non-fossil fuel carbon compounds which contribute to these aerosol particles.

Table SC-1. Average % modern carbon in hydrocarbon, polar and residual (elemental carbon) fractions measured on samples collected at city of Glendora, city of Duarte and Caldecott Tunnel adjusted for blank filter contamination.

Location	Average % modern carbon in hydrocarbon Fraction 1 (uncorrected)	N	Average % modern carbon in hydrocarbon Fraction 1 (corrected)	N	Average % modern carbon in polar Fraction 2 (uncorrected)	N	Average % modern carbon in polar Fraction 2 (corrected)	N	Average % modern carbon in elemental carbon from residual fraction (uncorrected)	N
Glendora (day)	16.3(±4.1)*	13	14.4(±4.4)	13	28.8(±6.2)	11	27.7(±7.0)	11	32.9(±2.9)	11
Glendora (night)	18.2(±5.8)	6	16.5(±6.3)	6	45.9(±4.1)	7	46.9(±4.6)	7	34.0(±6.2)	6
Duarte (day)	12.8(±1.9)	4	10.7(±2.1)	4	27.8(±7.5)	4	26.5(±8.4)	4	30.2(±3.5)	4
Tunnel (day)	3.4(-)	1	0		14.4(-)	1	9.5(-)	1	8.9(-)	1
Tunnel (night)	2.7(±2.1)	2	0		12.3(-)	1	9.4(-)	1	8.9(±5.3)	2

* Standard Deviation

Figure SC-1


Corrected Average % Modern Carbon
in Hydrocarbon,Polar and Residual Fractions
% Modern Carbon in Organic and ResidualFractions
50
40
30
20
10
0
Glendora (Day)
Glendora (Night)
Duarte (Day)
Tunnel (Day)
Tunnel (Night)
Hydrocarbon Fraction
Polar Fraction
Residual Fraction

I. INTRODUCTION

I. INTRODUCTION

Current strategies for controlling photochemical air pollution require control of the amount of hydrocarbons emitted by stationary and mobile sources. Although the global atmospheric loading of non-fossil particulate matter is thought to be substantial (Niki et al., 1984), the amount of non-fossil vapors present in urban atmospheres has generally been considered unimportant and has not usually been included in the evaluation of suppressed visibility by photochemical smog formation. Further, although volatile hydrocarbons from trees were proposed as haze precursors in rural areas as long ago as the 1960s by Went (1960), and Rasmussen and Went (1965), this possibility has largely been discounted in urban studies because non-fossil hydrocarbons are not usually found in high vapor concentrations in urban air (Dimitriades, 1981; Altshuller, 1983; Winer, 1982; Duce et al., 1983). However, the fraction of modern carbon in southern California urban aerosol has recently been shown by ^{14}C dating to be as high as 100% in a few cases, but most frequently in the range of 20-50% (Currie et al., 1983; Berger et al., 1986). These findings invited further investigation because of their potential implications for emission control measures.

Most of the previous measurements were made on PM-10 aerosols, which might include some pollen or plant fragments below the 10 μm nominal maximum diameter. In this study we report on a survey of ^{14}C content on extracted and residual (non-solvent extractable) carbon from fine particle aerosols (<2.5 μm), collected in southern California during summer 1986 as part of the Carbonaceous Species Methods Comparison Study sponsored by the California Air Resources Board.

The objectives here were to extend our understanding beyond those from

previous studies by Kaplan and Gordon (1989), who showed that $PM_{2.5}$ captured on prefired quartz filters from several southern California sites during the 1987 Air Quality Study (SCAQS) contained approximately 40% modern, or non-fossil fuel carbon.

To accomplish our objectives for the research program, a plan was applied to extract the total fine particles on the filter ($PM_{2.5}$) with organic solvents and to separate the extracts into hydrocarbon and polar fractions. All these fractions including the residual non-extractable fraction was then characterized by performing elemental analyses for hydrogen, carbon and nitrogen. In addition to ^{14}C radioactive carbon isotope measurements on the fractions, the following stable isotope ratios were also measured; D/H, $^{13}C/^{12}C$ and $^{15}N/^{14}N$.

The organic extracts were characterized for their hydrocarbon content (paraffinic and aromatic fractions), fatty acids and plasticizers, by use of gas chromatography and GC-mass spectroscopy in order to evaluate their sources. This approach enabled us to determine whether biogenic sources of carbon were present in the aerosol particles.

The results presented in this report constitutes a large addition to the database on carbon compounds in the Los Angeles Air Basin. A complete statistical evaluation among the identified species was not possible in the context of this program. Hence, at this stage only a partial interpretation has been attempted. The results, however, clearly show that modern non-fossil carbon constituents are present in the aerosol particles in significantly large quantities.

II. SAMPLING AND METHODS

II. SAMPLING AND METHODS

II.1 SAMPLING AND SITES

Samples were collected at three California collection sites, city of Glendora, city of Duarte and Caldecott Tunnel.

For the measurements needed to be made in this study, relatively large amounts of total suspended aerosol particles had to be collected. This was done by using high-vol samplers with size fractionation by means of cascade impactors to collect particles in the desired size range of <2.5 μm and 2.5-8 μm. Each sampling episode consisted of three consecutive periods: 4 hours (0800-1200 for morning), 8 hours (1200-2000 for afternoon and evening) and 12 hours (2000-0800 for night time). Prewashed and fired (at 700°C) fused quartz fiber filters were used to collect the aerosol. Automatic timers were used to start and stop the collectors at sites simultaneously. Only the samples on the filters which collected particles <2.5 μm (to be called $PM_{2.5}$) were used.

A total of 47 samples were collected during August 10 and August 20, 1986. The meteorological conditions during the sampling period was relatively constant and have been described by Zeldin and Wylie, (1990). This allowed some of the filters with small sample mass for adjacent days to be composited for analysis. All filters were tared in the laboratory and returned there after exposure in the field.

A field blank wrapped in aluminum foil was taken out to a collecting site each day, not exposed, but held in the field for the time of sampling and then returned to the laboratory. Another cassette blank was mounted in the Hi-Vol sampler in a manner corresponding to the mounting of collection filters in the samplers, air was pulled through for about 15 seconds and the filters were rewrapped in aluminum foil and returned to the laboratory, where all samples were stored in sealed cans filled with dry nitrogen.

II.2 LABORATORY METHODOLOGY

Extraction of Filters

The returned filters were equilibrated at constant temperature and humidity for at least 16 hours before weighing in each case. Equilibration and subsequent cutting of the filter was done in a clean room, at controlled temperature and humidity, on a laminar flow clean bench.

Each filter was extracted and aliquots used for GC/MS and derivatization, the remainder was used for ^{13}C and ^{14}C analysis. Small punches for TOC (Total Organic Carbon) and EC (Elemental Carbon) content determinations were first removed from each filter.

Composites of half filters were cut into small pieces for sonicator extraction in a flask. Three successive extractions were made in a mixture of 1:1 (v/v) dichloromethane/methanol solvent. This mixture has been the most generally used solvent for filter extraction; it combines a good hydrophobic solvent, dichloromethane, with a polar solvent having excellent desorption capability, methanol. The combined extract was filtered to remove suspended matter and concentrated at low temperature under vacuum followed by nitrogen blowdown to a known small volume. A small aliquot from each filter extract was evaporated to dryness and weighed to determine the extract yields.

Due to the small quantity, the extracts isolated from the following samples were combined for further analytical measurements:

Filters from city of Glendora

Filter No.	Day	Sampling Periods
8007 + 8008	8/13/86	0800-1200
8013 + 8014	8/13/86	2000-0800
8017 + 8027	8/14+15/86	0800-1200
8026 + 8029	8/15/86	1200-2000
8034 + 8040	8/16+17/86	0800-1200
8033 + 8036	8/16/86	1205-2000
8043 + 8044	8/17/86	1200-2000
8047 + 8051	8/18+19/86	0800-1200
8048 + 8049	8/18/86	1200-2000
8054 + 8055	8/19/86	1200-2015
8057 + 8058	8/20/86	0800-1200
8060 + 8061	8/20/86	1200-2000

Filters from city of Duarte

Filter No.	Day	Sampling Periods
8006 + 8016	8/13+14/86	0810-1252
8010 + 8025	8/13+15/86	1200-2030
8053 + 8059	8/19+20/86	1200-2000

Liquid Chromatography

The extracts were subjected to two-stage liquid chromatography (LC) using a column of silica with controlled water content and equilibrated with solvent, in order to control the adsorption activity of the silica and to prevent changes due to eluent moisture differences, so as to ensure repeatable elution behavior for the various compound classes. A hexane/dichloromethane (3:2 v/v) solvent mixture was used to elute saturated and aromatic hydrocarbons and this was identified as the first fraction. Solvent elution was continued with acetonitrile/methanol (10:1 v/v) for the polar fraction containing carboxylic (fatty) acids. Small aliquots of each LC fraction were gently evaporated to dryness and weighed to estimate the yields. The very polar constituents which

contain phenols, nitro-compounds and very soluble salts e.g. ammonium nitrate, were not eluted.

Gas Chromatography-Mass Spectrometry (GC-MS)

The first hydrocarbon-containing fraction of the filter extracts, which contains saturated and polynuclear aromatics and probably hydrophobic esters, was analyzed by a computerized quadrupole GC-MS to estimate contributions from vegetation sources, fuel combustion and petroleum volatilization sources, using molecular structure such as long chain hydrocarbons (n-alkanes) and biomarkers. Although the straight chain hydrocarbons (n-alkanes) were not quantified, their relative amounts were calculated. From these, the carbon preference index (CPI) was calculated. Identification of the aromatic hydrocarbons was performed to identify wood burning products such as retene, pyrenes, fluoranthene, etc. in the extract. A Varian 3400 gas chromatograph coupled to an INCOS 50 mass spectrometer interfaced with an INCOS data system was used in this study, in addition to a Finnigan 4000 GC/mass spectrometer. Sample injections were made in a splitless mode into a 30 m DB-5 capillary column with helium as carrier gas. Oven temperature was programmed as follows: Isothermal at 50°C for 4 min, then increased from 50°C to 300°C at 4°C/min, again isothermal at 310°C for 4 min.

To determine the fatty acids, the second (polar) fraction was derivatized (methylated) by BF_3-CH_3OH in the following manner. To a 250 μl volume of polar fraction, 2 ml BF_3-CH_3OH was added and the vial was sealed. The mixture was heated on a steam bath for 3 minutes and then cooled to room temperature. A small amount of water (usually 1 ml) was added to stop further reaction. The mixture was washed with saturated sodium bicarbonate solution in water and the organic layer (now containing methylated esters) was separated and dried with

sodium sulfate to remove moisture. The resulting solution was analyzed by GC on a 30m capillary Nukol column, and an FID detector.

Organic and Elemental Carbon

Small punches (~2.5 cm diameter) of filters were burnt in a two-stage furnace for determination of total organic and elemental carbon. In this procedure the sample is first combusted at 400-425°C for organic carbon and then at 700°C for elemental carbon. The detection of carbon dioxide was performed by a combined non-dispersive infrared detector and a coulometric detector in series.

Isotopic Measurements

In preparation for the isotopic measurements, the combined aliphatic and aromatic fraction, and the polar and residual fractions were divided into equal halves, which were then combusted in quartz tubes at 850°C with copper oxide by the method of Minagawa et al. (1984). The evolved carbon dioxide from the combustions of each fraction was purified on a vacuum line, isolated, and sealed into Pyrex tubes for ^{13}C and ^{14}C determinations.

Most CO_2 samples for ^{14}C measurements were first converted to graphite targets in the laboratory of Dr. E. Taylor at U.C. Riverside and the Delta ^{14}C was determined by the Accelerator Mass Spectrometer at Lawrence Livermore National Laboratory (LLNL). Some prepared CO_2 samples were submitted directly to LLNL for conversion to graphite targets. The percent modern carbon was determined against an Australian National University oxalic acid standard. All $\delta^{13}C$ results were measured on a 3-inch Nuclide dual collecting mass spectrometer and are given relative to the PDB standard which has an arbitrary value of 0.00 $^{o}/oo$. In addition to measuring the $^{13}C/^{12}C$ ratios, the $^{15}N/^{14}N$ ratios and the deuterium/hydrogen isotope ratios (D/H) were also measured on the combusted fractions as described in Minagawa et al. (1984).

II.3 NOTES FOR SAMPLE IDENTIFICATION IN GRAPHICAL DISPLAYS

In all the graphs (except for $D^{14}C$, n-alkanes and fatty acid distributions), the samples are identified as sampling day (day and night). The keys for sample identification are presented in Tables II-1 and II-2 for Glendora and Duarte respectively. The values plotted in the figures and identified as Total Contents for a particular day or night, are the sum of the values obtained for filters collected during these times. The only exceptions are the following filters.

Filter No.	Sampling Date	Sampling Time
8017	8/14/86	0800-1200
8027	8/15/86	0800-1200
8034	8/16/86	0800-1200
8040	8/17/86	0800-1200
8047	8/18/86	0800-1200
8051	8/19/86	0800-1200

Each pair of these filters was combined for extraction and further analyses. However, half of the total value for each individual pair of measurements was assigned a value and added to other filters collected during the same day (or night).

Graphic displays for the Duarte samples, are the same as shown above for Glendora, with a difference that each graphical point represents a composite of sample collected on a different day sampling but the same sampling times.

Example: Point C is a composite of the following filters:

8010	1230-2030	(8/13/86)
8025	1200-2000	(8/15/86)

Table II-1. Key for sample identification shown in graphical displays (except for ^{14}C dating displays) for Glendora samples.

Sample ID	Filter No.	Sampling Date	Sampling Time
A	8007	8/13/86	0800-1200
	8008	8/13/86	0800-1200
	8009	8/13/86	1200-2000
B	8013	8/13/86	2000-0800
	8014	8/13/86	2000-0800
C	8017	8/14/86	0800-1200
	8019	8/14/86	1210-2000
	8020	8/14/86	1210-2000
D	8024	8/14/86	2000-0800
E	8027	8/15/86	0800-1200
	8026	8/15/86	1200-2000
	8029	8/15/86	1205-2000
F	8031	8/15/86	2005-0800
G	8034	8/16/86	0800-1200
	8033	8/16/86	1205-2000
	8036	8/16/86	1205-2000
H	8037	8/16/86	2000-0720
I	8040	8/17/86	0800-1200
	8043	8/17/86	1200-2000
	8044	8/17/86	1205-2000
J	8045	8/17/86	2005-0800
K	8047	8/18/86	0800-1200
	8048	8/18/86	1200-2000
	8049	8/18/86	1200-2000
L	8050	8/18/86	2000-0800
M	8051	8/19/86	0800-1200
	8054	8/19/86	1200-2000
	8055	8/19/86	1200-2015
N	8056	8/19/86	2020-0800
O	8057	8/20/86	0800-1200
	8058	8/20/86	0800-1200
	8060	8/20/86	1200-2000
	8061	8/20/86	1200-2000

Table II-2. Key for sample identification shown in graphical displays (except for ^{14}C dating displays) for Duarte samples.

Sample ID	Filter No.	Sampling Date	Sampling Time
A	8006	8/13/86	0810-1230
	8018	8/14/86	0830-1252
B	8015	8/13/86	2030-0830
C	8010	8/13/86	1230-2030
	8025	8/15/86	1200-2000
D	8041	8/17/86	1200-2000
E	8053	8/19/86	1200-2000
	8059	8/20/86	1200-2000

Table II-3. Key for sample identification in graphical displays (except for 14C displays) for Caldecott Tunnel samples.

Sample ID	Filter No.	Sampling Date	Sampling Time
TLD	3809	8/10/89	0950-1405
TLN	3813	8/10/89	1850-0556
TLN2	3814	8/10/89	1850-0556

TLD = Tunnel, day sampling
TLN = Tunnel, night sampling
TLN2 = Tunnel, second night sampling

III. $PM_{2.5}$, TOTAL CARBON, ORGANIC CARBON AND ELEMENTAL CARBON ON HI-VOL FILTERS

III. $PM_{2.5}$, TOTAL CARBON, ORGANIC CARBON AND ELEMENTAL CARBON ON HI-VOL FILTERS

The data shown in Tables III-1 to III-9 and Figures III-1 to III-6 clearly demonstrate that there is a distinct difference in the amount of $PM_{2.5}$ collected during day and night sampling for both Glendora and Duarte as well as for the Caldecott Tunnel samples in Berkeley/Oakland. It is probable that the larger quantities of $PM_{2.5}$ collected during day sampling are due to greater vehicular traffic and to industrial activity, such as land clearance and road and building construction.

Closely correlated with the suspended particles are the total carbon and the organic carbon contents, particularly the day samples and to a lesser extent the night samples. The total carbon content constitutes about 25-35% of the $PM_{2.5}$. The total organic material could amount to 35-45% of the $PM_{2.5}$ fraction, when oxygen, nitrogen and hydrogen are factored into the organic carbon content.

For the ambient air samples at Glendora or Duarte, the ratio of organic carbon/elemental carbon (OC/EC) falls in a range of ~1.3 to 2.5, being more variable in the samples collected at Glendora than at Duarte. However, for the Caldecott Tunnel samples, the OC/EC has a ratio of ~0.3. Hence these samples are highly enriched in elemental carbon, probably representing incomplete fuel combustion.

If we assume that this ratio is characteristic of vehicular emission, then the ambient air samples have additional organic carbon which may not be directly attributed to primary automobile emissions. The difference in the compositions can quickly be recognized by comparing the total extracts in Tables III-3, III-6 and III-9. For the tunnel samples the extract constitutes about 18% of $PM_{2.5}$, for Glendale and Duarte it is 54%-62%. This reflects the higher residual (elemental) carbon content in the tunnel sample.

The total extractable material was further fractionated into two fractions by column chromatography and eluted off as described in Section II. For Glendora and Duarte, the fractions eluted amount to 40-60% of the total extract, whereas for the tunnel samples it is 20-50%. Sample 3814 was run at a later time than samples 3809 and 3813 and may reflect a difference in the extraction efficiency. It is apparent from these results that a significant fraction (~50%) of the total extract remained on the column and was not eluted by the solvent mixture used. This represents the very polar portion of the extract.

In order to estimate the contribution of biogenic material produced during cooking, fatty acids were determined in the polar (2nd) column chromatographic fraction. The content of fatty acids (Tables III-3 and III-6) constitute ~1-6% of the total extract. These values will be used later to evaluate the ^{14}C radiocarbon determination of modern carbon (Section IX).

Table III-1. Summary of Hi-Vol data collected by GGC during the Carbonaceous Species Methods Comparison Study at the City of Glendora.

Filter ID	Begin Date	D/N	Begin Time	End Time	Duration (hours)	Sampling Volume (m3)	Organic Carbon (µg/m3)	Organic** Carbon (µg/m3) (12 hr period)	Elemental Carbon (µg/m3)	Total Carbon (µg/m3)	Total** Carbon (µg/m3) (12 hr period)	PM 2.5 Total (µg/m3)	PM 2.5** (µg/m3) (12 hr period)
8007	860813	D	800	1200	4.0	230.9	13.2	12.6	9.9	23.5	21.0	102.2	80.2
8008	860813	D	800	1200	4.0	230.9	12.3		10.0	22.3		89.2	
8009	860813	D	1200	2000	8.0	461.9	12.6		7.6	20.1		72.5	
8017	860814	D	800	1200	4.0	230.9	12.6	15.4	7.8	20.4	23.3	93.1	90.7
8019	860814	D	1210	2000	7.8	422.8	16.2		7.4	23.5		82.8	
8020	860814	D	1210	2000	7.8	422.8	16.9		8.0	25.0		91.5	
8026	860815	D	1200	2000	8.0	461.9	15.0	12.5	6.8	21.7	18.8	76.6	72.6
8027	860815	D	800	1200	4.0	230.9	9.8		6.4	16.2		80.1	
8029	860815	D	1205	2000	8.0	457.0	12.8		5.6	18.5		61.0	
8033	860816	D	1205	2000	7.9	457.0	13.5	13.0	5.3	18.8	19.2	64.5	69.1
8034	860816	D	800	1200	4.0	230.9	11.6		6.9	18.5		74.0	
8036	860816	D	1205	2000	7.9	457.0	13.7		6.1	19.8		67.2	
8040	860817	D	800	1200	4.0	230.9	14.5	13.8	7.9	22.5	19.9	81.4	63.9
8043	860817	D	1200	2000	8.0	461.9	13.2		4.9	18.0		51.5	
8044	860817	D	1205	2000	7.9	457.0	13.4		5.5	18.9		58.0	
8047	860818	D	800	1200	4.0	230.9	12.8	12.0	7.5	20.2	18.1	74.5	58.8
8048	860818	D	1200	2000	8.0	461.9	11.3		5.5	16.8		49.4	
8049	860818	D	1200	2000	8.0	461.9	11.9		5.4	17.3		52.6	

Table III-1. Summary of Hi-Vol data collected by GGC during the Carbonaceous Species Methods Comparison Study at the City of Glendora. (con'd)

Filter ID	Begin Date	D/N	Begin Time	End Time	Duration (hours)	Sampling Volume (m3)	Organic Carbon (µg/m3)	Organic** Carbon (µg/m3) (12 hr period)	Elemental Carbon (µg/m3)	Total Carbon (µg/m3)	Total** Carbon (µg/m3) (12 hr period)	PM 2.5 Total (µg/m3)	PM 2.5** (µg/m3) (12 hr period)
8051	860819	D	800	1200	4.0	230.9	11.8	10.2	7.0	18.8	15.9	70.2	56.2
8054	860819	D	1200	2000	8.0	461.9	10.0		5.4	15.5		51.5	
8055	860819	D	1200	2015	8.2	476.3	9.2		4.5	13.7		48.3	
8057	860820	D	800	1200	4.0	230.9	16.9	14.9	10.8	27.7	22.5	79.7	71.9
8058	860820	D	800	1200	4.0	230.9	18.1		10.6	28.7		82.7	
8060	860820	D	1200	2000	8.0	461.9	14.9		6.8	21.7		80.8	
8061	860820	D	1200	2000	8.0	461.9	12.4		5.3	17.7		53.7	
8013	860813	N	2000	800	12.0	692.8	6.8	6.7	4.3	11.1	11.2	54.6	54.8
8014	860813	N	2000	800	12.0	692.8	6.6		4.8	11.4		55.0	
8024	860814	N	2005	800	11.9	688.0	5.0	5.0	3.4	8.4	8.5	39.0	39.3
8031	860815	N	2005	800	11.9	688.0	5.4	5.4	3.2	8.6	8.7	29.8	30.1
8037	860816	N	2000	720	11.3	654.3	7.4	7.9	3.7	11.1	11.8	38.5	40.9
8045	860817	N	2005	800	11.9	688.0	6.4	6.5	3.4	9.8	9.9	28.8	29.0
8050	860818	N	2000	800	12.0	692.8	7.2	7.2	3.6	10.8	10.8	35.2	35.2
8056	860819	N	2020	800	11.7	673.5	8.8	9.0	4.5	13.3	13.6	37.0	37.9

* D = day; N = night ** Values plotted in Figures III-1 through III-4.

Table III-2. Calculated mass of PM 2.5, Total C and Organic C for filters collected at city of Glendora.

Collection Date (AUG 1986)	Filter No.	D/N*	PM 2.5 (mg)	Total Carbon (mg)	Organic Carbon (mg)	Elemental Carbon (mg)	Organic Carbon / Elemental Carbon
13	8007	D	21.9	5.0	2.8	2.2	1.3
13	8008	D	19.2	4.8	2.6	2.2	1.2
13	8009	D	31.2	8.6	5.4	3.2	1.7
14	8017	D	19.6	4.3	2.6	1.7	1.5
14	8019	D	32.5	9.2	6.4	2.8	2.3
14	8020	D	36.0	9.8	6.7	3.1	2.2
15	8026	D	32.2	9.1	6.3	2.8	2.3
15	8027	D	16.8	3.4	2.1	1.3	1.6
15	8029	D	25.4	7.7	5.4	2.3	2.3
16	8033	D	26.8	7.8	5.6	2.2	2.5
16	8034	D	15.9	4.0	2.5	1.5	1.7
16	8036	D	27.9	8.2	5.7	2.5	2.3
17	8040	D	17.5	4.8	3.2	1.6	2.0
17	8043	D	21.6	7.6	5.5	2.1	2.6
17	8044	D	23.2	7.8	5.6	2.2	2.5
18	8047	D	16.0	4.3	2.8	1.5	1.9
18	8048	D	21.2	7.2	4.9	2.3	2.1
18	8049	D	22.1	7.3	5.0	2.3	2.2
19	8051	D	15.1	4.0	2.5	1.5	1.7
19	8054	D	39.8	6.5	4.2	2.3	1.8
19	8055	D	20.9	5.9	4.0	1.9	2.1
20	8057	D	17.1	6.0	3.6	2.4	1.5
20	8058	D	17.8	6.2	3.9	2.3	1.7
20	8060	D	33.9	9.1	6.2	2.9	2.1
20	8061	D	22.6	7.4	5.4	2.0	2.7
13	8013	N	35.2	7.2	4.4	2.8	1.6
13	8014	N	33.6	7.4	4.3	3.1	1.4
14	8024	N	24.9	5.4	3.2	2.2	1.5
15	8031	N	19.1	5.5	3.5	2.0	1.8
16	8037	N	22.9	6.8	4.5	2.3	1.9
17	8045	N	18.4	6.3	4.1	2.2	1.9
18	8050	N	22.7	7.0	4.6	2.4	1.9
19	8056	N	23.6	8.3	5.1	3.2	1.6

* D = day; N = night

Table III-3. Total extract weight of each filter and fraction weights for samples collected at city of Glendora.

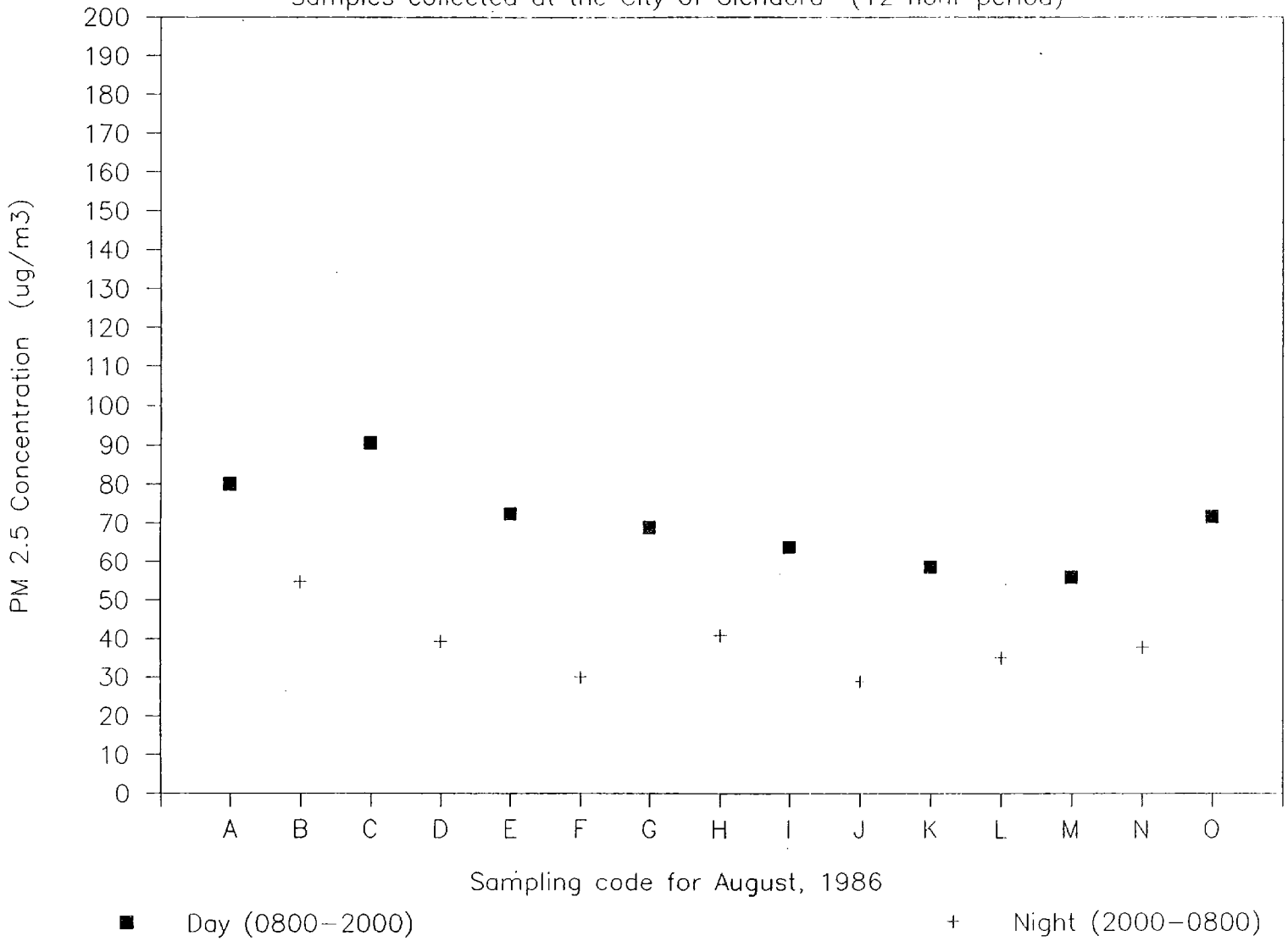
Collection Date (AUG 1986)	Filter No.	D/N*	Total Extract Wt (mg)	Fraction 1 (Aliphatic & Aromatic) Wt (mg)	Fraction 1 % Total Extract	Fraction 2 (Polar) Wt (mg)	Fraction 2 % Total Extract	% Extract Remaining in Column	Fatty Acids % Total Extract	Fatty Acids µg/m3	Extract / Total C
13	8007,8008	D	21.4	3.7	17.3	3.2	15.0	67.7	1.7	0.8	2.2
13	8009	D	17.0	2.3	13.5	4.3	24.9	61.6	6.0	2.2	2.0
14/15	8017,8027	D	11.3	2.4	21.3	1.9	17.3	61.4	2.0	0.5	1.5
14	8019	D	19.1	3.6	18.6	2.9	15.5	65.9	2.1	0.9	2.1
14	8020	D	16.4	1.6	9.8	4.6	27.8	62.4	2.2	0.9	1.7
15	8026,8029	D	18.8	3.5	18.6	3.9	20.5	60.9	1.5	0.2	1.1
16/17	8034,8040	D	17.9	3.1	17.3	4.4	24.3	58.4	0.7	0.3	2.0
16	8033,8036	D	16.2	3.1	18.9	4.1	25.1	56.0	4.2	0.7	1.0
17	8043,8044	D	16.6	3.7	22.0	3.2	19.3	58.7	0.9	0.2	1.1
18/19	8047,8051	D	11.7	2.9	25.2	2.7	22.6	52.2	1.1	0.3	1.4
18	8048,8049	D	11.5	2.5	21.8	2.4	20.9	57.3	1.3	0.2	0.8
19	8054,8055	D	12.3	2.9	23.2	2.1	17.1	59.7	0.8	0.1	1.0
20	8057,8058	D	13.6	3.2	23.2	3.1	22.5	54.3	1.1	0.3	1.1
20	8060,8061	D	15.4	3.1	19.8	3.2	20.7	59.5	1.2	0.2	0.9
13	8013,8014	N	25.0	3.3	13.2	3.2	12.8	74.0	2.0	0.4	1.7
14	8024	N	11.2	2.1	18.4	2.3	20.6	61.0	1.4	0.2	2.1
15	8031	N	7.2	2.5	35.0	2.1	28.7	36.3	1.9	0.2	1.3
16	8037	N	12.1	2.1	17.0	2.9	24.0	59.0	2.2	0.4	1.8
17	8045	N	11.6	2.0	17.3	3.4	29.0	53.7	3.4	0.6	1.8
18	8050	N	12.2	1.6	12.7	3.0	24.6	62.7	1.8	0.3	1.7
19	8056	N	14.2	2.6	18.0	3.0	21.2	60.8	1.2	0.3	1.7

* D = day; N = night

Figure III-1

PM 2.5 Concentration (ug/m3)

Samples collected at the City of Glendora (12 hour period)



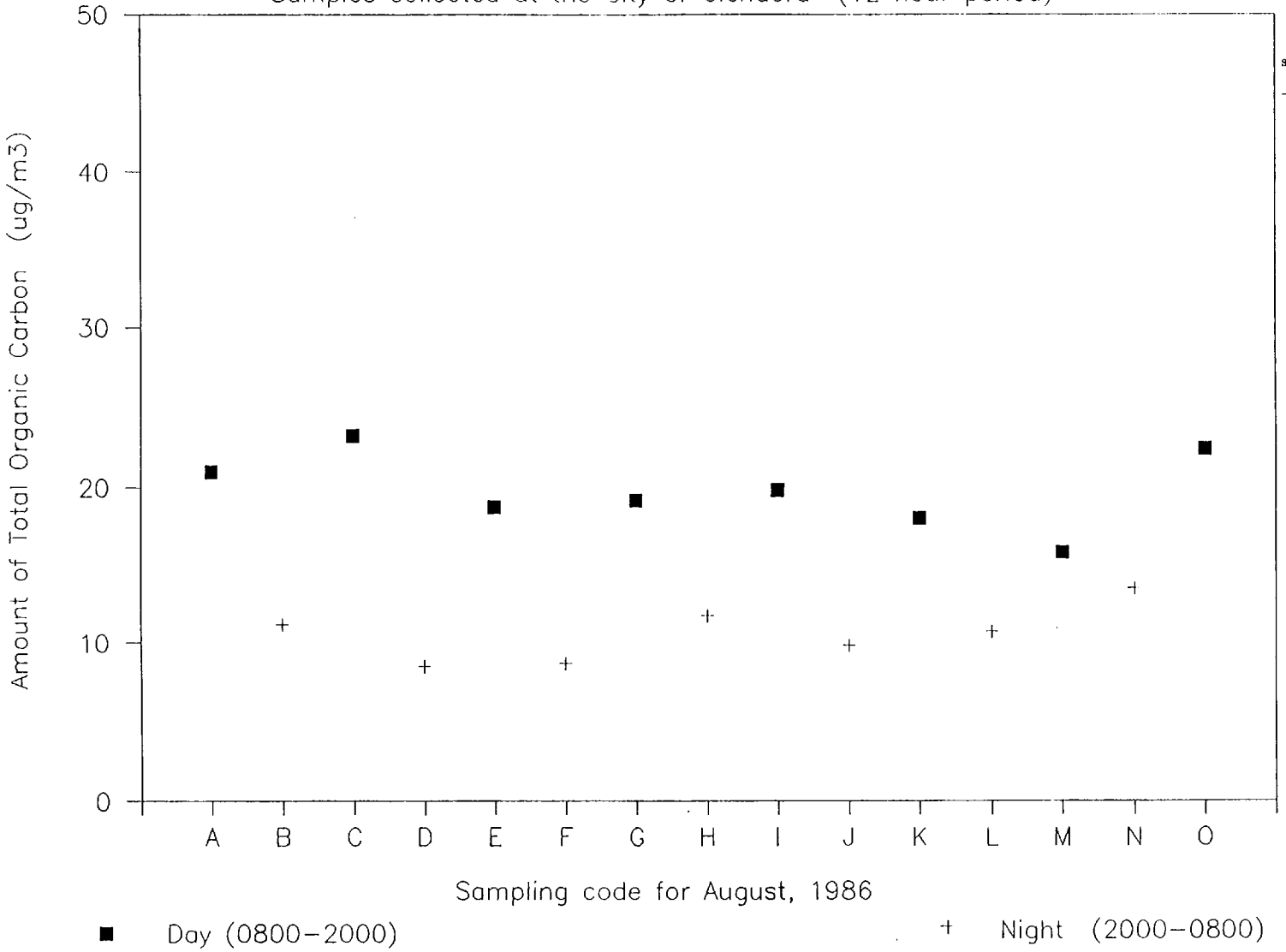
KEY

Sample ID	Sampling	Sample Time: D (day) or N (night)	Sample Time: Time
A	8/13/86	D	0800-2000
B	8/13/86	N	2000-0800
C	8/14/86	D	0800-2000
D	8/14/86	N	2000-0800
E	8/15/86	D	0800-2000
F	8/15/86	N	2000-0800
G	8/16/86	D	0800-2000
H	8/16/86	N	2000-0720
I	8/17/86	D	0800-2000
J	8/17/86	N	2005-0800
K	8/18/86	D	0800-2000
L	8/18/86	N	2000-0800
M	8/19/86	D	0800-2015
N	8/19/86	N	2020-0800
O	8/20/86	D	0800-2000

Figure III-2

Total Carbon Concentration (ug/m3)

Samples collected at the City of Glendora (12 hour period)



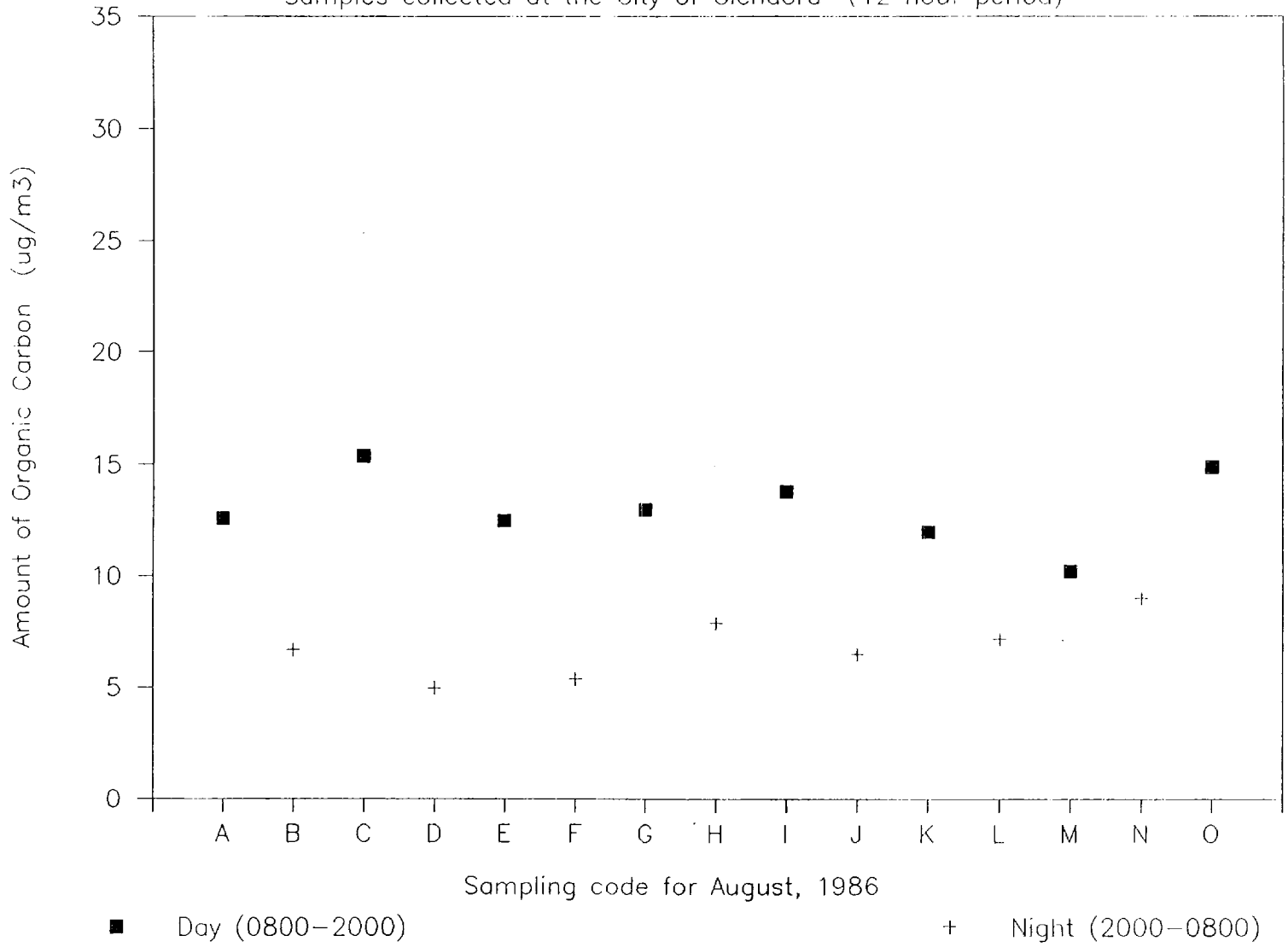
KEY

Sample ID	Sampling	Sample Time: D (day) or N (night)	Sample Time: Time
A	8/13/86	D	0800 - 2000
B	8/13/86	N	2000 - 0800
C	8/14/86	D	0800 - 2000
D	8/14/86	N	2000 - 0800
E	8/15/86	D	0800 - 2000
F	8/15/86	B	2000 - 0800
G	8/16/86	D	0800 - 2000
H	8/16/86	N	2000 - 0720
I	8/17/86	D	0800 - 2000
J	8/17/86	N	2005 - 0800
K	8/18/86	D	0800 - 2000
L	8/18/86	N	2000 - 0800
M	8/19/86	D	0800 2015
N	8/19/86	N	2020 0800
O	8/20/86	D	0800 - 2000

Figure III-3

Organic Carbon Concentration (ug/m3)

Samples collected at the City of Glendora (12 hour period)



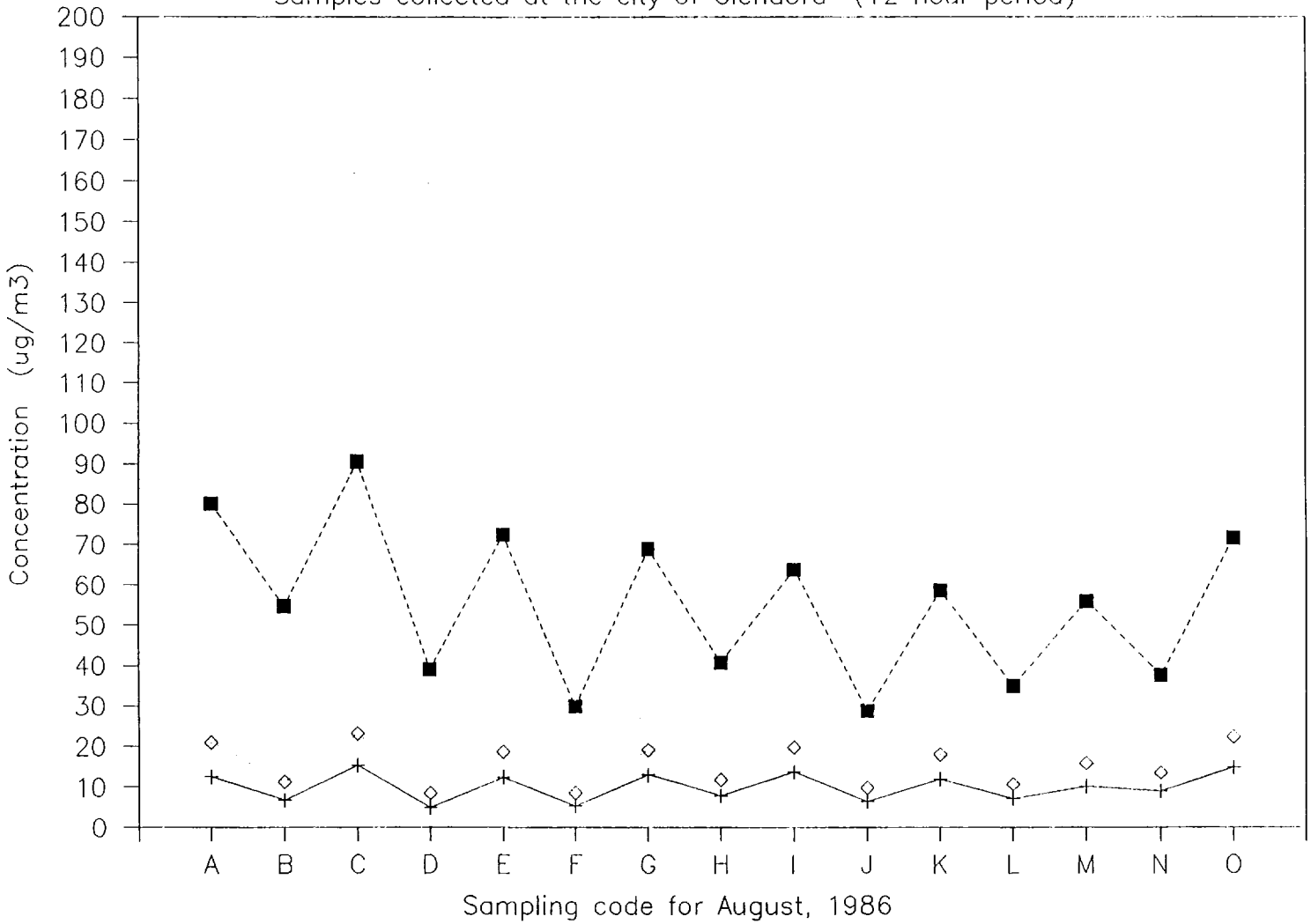
KEY

Sample ID	Sampling	Sample Time: D (day) or N (night)	Sample Time: Time
A	8/13/86	D	0800 - 2000
B	8/13/86	N	2000 - 0800
C	8/14/86	D	0800 - 2000
D	8/14/86	N	2000 - 0800
E	8/15/86	D	0800 - 2000
F	8/15/86	N	2000 - 0800
G	8/16/86	D	0800 - 2000
H	8/16/86	N	2000 - 0720
I	8/17/86	D	0800 - 2000
J	8/17/86	N	2005 - 0800
K	8/18/86	D	0800 - 2000
L	8/18/86	N	2000 - 0800
M	8/19/86	D	0800 - 2015
N	8/19/86	N	2020 - 0800
O	8/20/86	D	0800 - 2000

Figure III-4

PM 2.5, Total Carbon and Organic Carbon Concentrations

Samples collected at the city of Glendora (12 hour period)



KEY

Sample ID	Sampling	Sample Time D (day) or N (night)	Time
A	8/13/86	D	0800 2000
B	8/13/86	N	2000 0800
C	8/14/86	D	0800 2000
D	8/14/86	N	2000 0800
E	8/15/86	D	0800-2000
F	8/15/86	B	2000-0800
G	8/16/86	D	0800-2000
H	8/16/86	N	2000-0720
I	8/17/86	D	0800-2000
J	8/17/86	N	2005-0800
K	8/18/86	D	0800-2000
L	8/18/86	N	2000-0800
M	8/19/86	D	0800 2015
N	8/19/86	N	2020-0800
O	8/20/86	D	0800-2000

■ PM 2.5 + Organic Carbon ◇ Total Carbon

Table III-4. Summary of Hi-Vol data collected by GGC during the Carbonaceous Species Methods Comparison Study at city of Duarte.

Filter No.	Begin Date	D/N*	Begin Time	End Time	Duration (hours)	Sampling Volume (m3)	Organic Carbon (µg/m3)	Elemental Carbon (µg/m3)	Total Carbon (µg/m3)	PM 2.5 (µg/m3)
8006	860813	D	810	1230	4.3	250.2	11.5	7.5	19.0	77.5
8018	860814	D	830	1252	4.4	252.1	14.0	8.4	22.4	94.4
8010	860813	D	1230	2030	8.0	461.9	11.7	7.0	18.6	62.8
8025	860815	D	1200	2000	8.0	461.9	11.7	5.5	17.2	68.6
8041	860817	D	1200	2000	8.0	461.9	11.5	5.5	17.0	53.0
8053	860819	D	1200	2000	8.0	461.9	8.9	4.3	13.2	49.4
8059	860820	D	1200	2000	8.0	461.9	12.6	4.7	17.3	54.8
8015	860813	N	2030	830	12.0	692.8	6.1	4.4	10.5	52.1

* D = day; N = night

Table III-5. Calculated mass of PM 2.5, Total C and Organic C for filters collected at city of Duarte.

Collection Date (AUG 1986)	Filter No.	D/N*	PM 2.5 (mg)	Total Carbon (mg)	Organic Carbon (mg)	Elemental Carbon (mg)	Organic Carbon / Elemental Carbon
13	8006	D	18.1	4.4	2.7	1.7	1.6
13	8010	D	26.4	7.8	4.9	2.9	1.7
14	8018	D	21.6	5.1	3.2	1.9	1.7
15	8025	D	29.5	7.4	5.0	2.4	2.1
17	8041	D	22.3	7.1	4.8	2.3	2.1
19	8053	D	20.7	5.5	3.7	1.8	2.1
20	8059	D	23.0	7.3	5.3	2.0	2.7
13	8015	N	33.6	6.8	3.9	2.9	1.3

* D = day; N = night

Table III-6. Total extract weight of each filter and fraction weights for samples collected at city of Duarte.

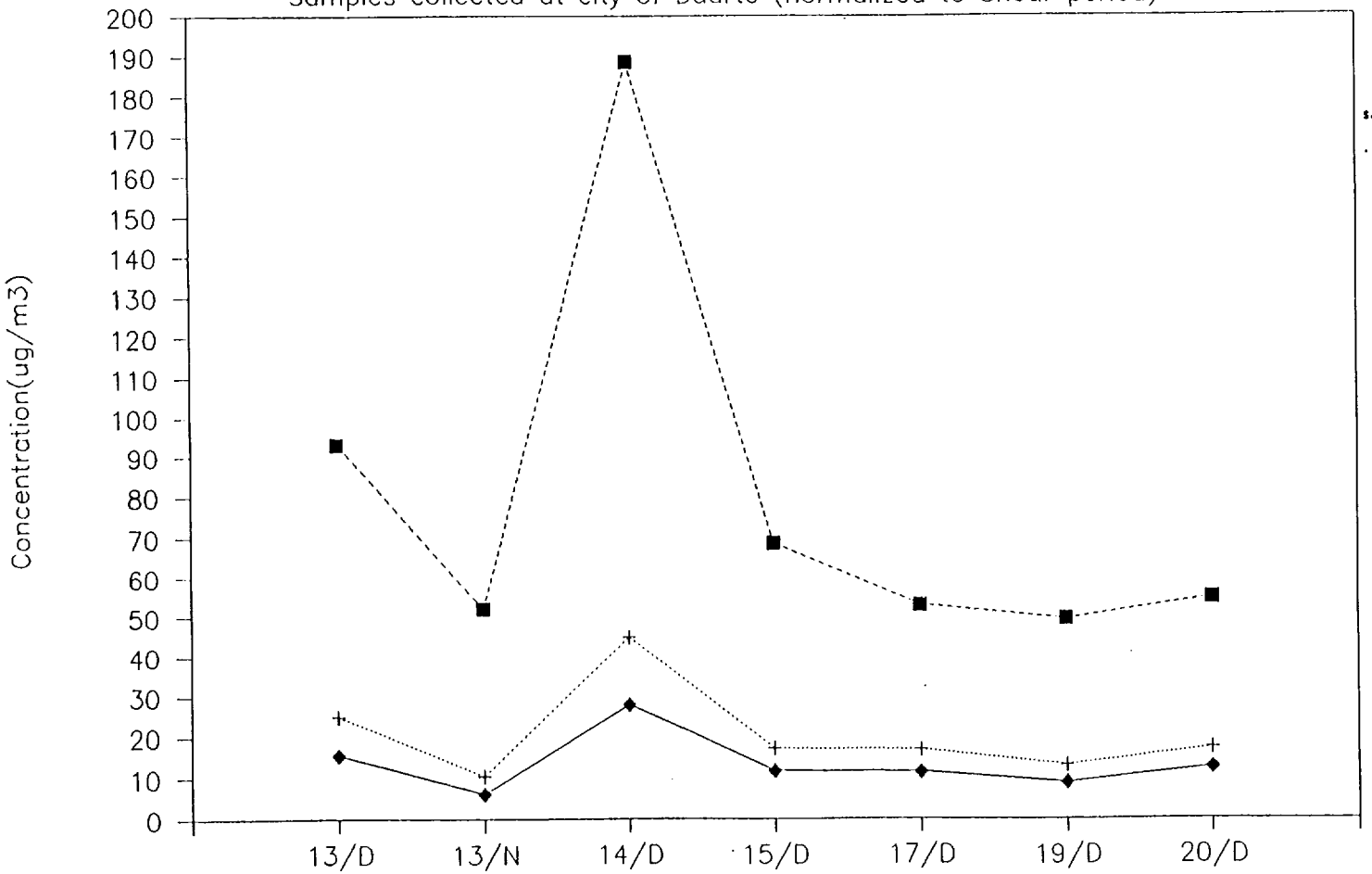
Collection Date (AUG 1986)	Filter No.	D/N*	Total Extract Wt (mg)	Fraction 1 (Aliphatic & Aromatic) Wt (mg)	Fraction 1 % Total Extract	Fraction 2 (Polar) Wt (mg)	Fraction 2 % Total Extract	% Extract Remaining in Column	Fatty Acids % Total Extract	Fatty Acids µg/m3	Extract / Total C
13/14	8006,8018	D	16.5	3.0	17.9	2.0	12.0	70.0	1.0	0.4	1.7
13/15	8010,8025	D	20.9	2.8	13.2	4.1	19.0	67.4		0.2	1.3
17	8041	D	8.7	1.2	13.2	2.2	25.0	61.5	2.0	0.5	1.2
19/20	8053,8059	D	7.2	1.2	16.0	2.5	34.0	49.9	1.0	0.1	0.6
13	8015	N	12.7	2.3	17.8	1.8	14.0	68.0	1.0	0.2	1.9

* D = day; N = night

Figure III-5

PM2.5,Total Carbon and Organic Carbon Concentration

Samples collected at city of Duarte (normalized to 8hour period)



■ PM2.5 + Total Carbon ◆ Organic Carbon

Key

Sample ID	Sampling Date	Sampling Time: Day or Night	Sampling Time: Time
A	8/13/86	D	0810-1230
A	8/14/86	D	0830-1252
B	8/13/86	N	2030-0830
C	8/13/86	D	1230-2030
C	8/15/86	D	1200-2000
D	8/17/86	D	1200-2000
E	8/19/86	D	1200-2000
E	8/20/89	D	1200-2000

} combined samples

Table III-7. Summary of Hi-Vol data collected at Caldecott Tunnel.

Filter No.	Begin Date	D/N*	Begin Time	End Time	Duration (hours)	Sampling Volume (m3)	Organic Carbon (µg/m3)	Elemental Carbon (µg/m3)	Total Carbon (µg/m3)	PM 2.5 (µg/m3)
3809	890810	D	950	1405	4.3	259.0	50.0	150.0	200.0	287.6
3810	890810	D	950	1405	4.3	266.3	47.3	142.0	189.3	291.0
3813	890810	N	1850	556	11.1	777.8	17.8	53.0	71.0	102.1
3814	890810	N	1850	556	11.1	790.5	16.8	50.0	67.3	104.4

* D = day; N = night

Table III-8. Calculated mass of PM2.5, Total C and Organic C for filters collected at Caldecott Tunnel.

Collection Date (AUG 1989)	Filter No.	D/N*	PM2.5 (mg)	Total Carbon (mg)	Organic Carbon (mg)	Elemental Carbon (mg)	Organic Carbon / Elemental Carbon
10	3809	D	74.5	51.8	13.0	38.8	0.3
10	3810	D	77.5	50.4	12.6	37.8	0.3
10	3813	N	79.4	55.2	13.8	41.4	0.3
10	3814	N	82.5	53.2	13.3	39.9	0.3

* D = day; N = night

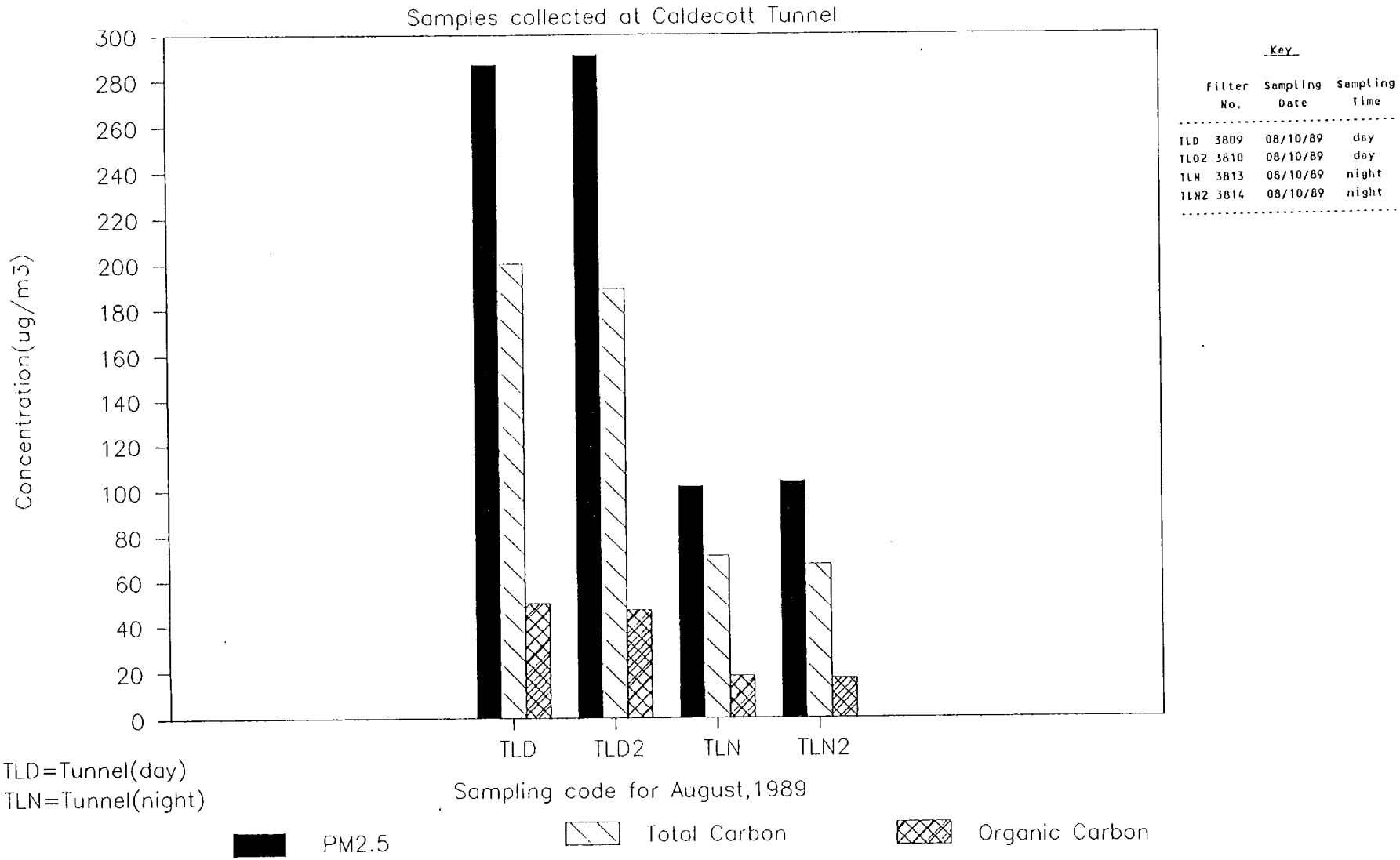
Table III-9. Total extract weight of each filter and fraction weights for samples collected at Caldecott Tunnel.

Collection Date (AUG 1989)	Filter No.	D/N*	Total Extract Wt (mg)	Fraction 1 (Aliphatic & Aromatic) Wt (mg)	Fraction 1 % Total Extract	Fraction 2 (Polar) Wt (mg)	Fraction 2 % Total Extract	% Extract Remaining in Column	Fatty Acids % Total Extract	Fatty Acids µg/m3	Extract / Total C
10	3809	D	12.6	1.3	10.0	1.6	13.4	76.6	3.3	1.6	0.2
	3809(D)	D		1.4		1.8					
10	3813	N	13.9	1.1	8.6	1.8	13.5	77.9	4.1	1.7	0.3
	3813(D)	N		1.3		2.0					
10	3814	N	18.0	3.4	18.9	5.0	27.8	53.3			0.3

* D = day; N = night

Figure III-6

PM2.5,Total Carbon and Organic Carbon Concentrations



IV. SATURATED HYDROCARBONS AND ALKANE DISTRIBUTION PATTERNS

IV. SATURATED HYDROCARBONS AND ALKANE DISTRIBUTION PATTERNS

The major objective for performing alkane analysis on the aerosols was to determine if a biological component could be recognized. This component would be present in the long-chain ($>C_{25}$) alkanes. It would be especially apparent in the odd carbon/even carbon ratio (O/E) and the carbon preference ratio (CPI). Mature crude oils have a CPI or O/E ratio ~ 1.00. Biological samples originating from trees have a CPI $>>2.0$ and can frequently reach ratios >5.00, because leaf waxes contain esters which hydrolyze to produce odd carbon-numbered hydrocarbons in the C_{27}-C_{33} range.

The data demonstrate that for Glendora and Duarte, the CPI ratio varies from 1.1 (petroleum origin) to 2.0 (mixture of petroleum and biological hydrocarbons). The distribution patterns are clearly displayed in Figures IV-1 to IV-28, and Figures IV-32 and IV-33.

Whereas for the ambient air samples the range of alkanes extended to C_{32}, the range abruptly terminates at C_{25} for the Caldecott Tunnel sample. This is undoubtedly due to the source of these hydrocarbons principally originating from uncombusted diesel fuel, with no detectable input of heavy oil emissions. By contrast, in the ambient air, heavier oil components are recognizable, in addition to the biological inputs. The heavier components could either originate from crude oil, motor oil, refining processes or other industrial release.

The distribution pattern seems to be bimodal with maxima at C_{21} and C_{25}. Day samples frequently have maxima at C_{21}, whereas night samples have maxima at C_{25}. The Tunnel samples show strong maxima at C_{21}.

Table IV-1: Saturated hydrocarbon concentrations (ng/m3) in samples collected at the city of Glendora.

	Day														Night						
Collection Date, 1986	8/13	8/13	8/14-15	8/14	8/14	8/15	8/16	8/16-17	8/17	8/18-19	8/18	8/19	8/20	8/20	8/13	8/14	8/15	8/16	8/17	8/18	8/19
Filter Number	8007	8009	8017	8019	8020	8026	8033	8034	8043	8047	8048	8054	8057	8060	8013	8024	8031	8037	8045	8050	8056
	8008		8027			8029	8036	8040	8044	8051	8049	8055	8058	8061	8014						
Carbon No.																					
C19	10.7	2.5	6.7	2.2	2.1	1.6	4.8	5.1	1.5	4.9	3.7	4.4	5.2	2.3	1.9	2.1	0.6	0.7	1.0	1.4	2.1
C20	10.9	11.9	6.9	12.8	5.4	5.0	7.2	12.4	7.1	10.9	5.3	9.1	12.8	5.8	4.4	5.6	2.2	3.1	2.2	1.6	5.9
C21	18.3	15.4	12.9	20.0	11.5	16.1	31.7	57.4	27.5	34.9	19.1	11.7	13.8	8.2	5.0	10.9	11.2	10.8	7.5	2.4	7.4
C22	18.2	5.3	9.4	6.8	3.9	5.2	9.4	16.7	8.1	11.1	6.9	4.4	7.1	2.7	16.0	7.7	3.0	2.9	3.4	1.2	2.2
C23	25.3	7.7	15.6	8.1	5.1	8.0	20.1	35.8	15.0	24.6	12.3	5.6	10.5	3.3	48.4	15.2	7.3	5.5	7.0	2.1	3.2
C24	31.2	9.7	19.3	8.0	6.1	15.3	40.0	66.4	25.4	40.3	23.9	6.7	17.5	4.0	68.7	24.1	15.1	9.5	12.6	2.6	4.1
C25	25.6	13.9	16.0	6.8	7.0	20.7	55.1	83.8	36.8	52.9	31.2	10.5	22.8	7.3	62.9	25.4	21.3	11.5	17.1	3.2	5.3
C26	15.1	7.0	10.5	3.1	4.2	15.2	40.6	60.2	28.0	35.8	22.2	6.4	12.5	4.7	45.8	20.0	16.6	8.5	11.7	1.6	3.0
C27	10.4	5.4	6.3	1.9	2.2	9.8	22.2	31.9	17.6	23.9	12.1	4.9	12.6	4.7	28.9	13.5	10.6	5.3	7.2	2.1	3.0
C28	7.4	3.6	4.2	0.7	1.4	4.6	10.1	11.9	6.5	8.0	4.5	2.3	5.8	2.1	15.7	9.0	4.3	2.4	2.9	0.8	1.4
C29	4.4	4.3	3.3	1.2	1.4	2.8	5.0	8.6	4.6	5.8	4.4	4.9	13.5	5.8	13.1	8.2	3.9	1.5	2.6	2.2	3.8
C30	3.0	1.3	2.1		0.6	1.4	1.5	2.7	1.4	1.7	1.1	0.9	3.6	1.1	7.5	7.0	1.8	0.8	0.7	0.6	0.8
C31	4.8	2.8	2.1		0.6	1.7	2.7	2.7	2.6	3.7	1.7	2.9	5.8	3.8	8.5	7.5	2.3	1.2	2.1	1.9	2.7
C32		0.8	1.6		0.5		0.6	1.3			0.4	1.1	1.3	1.5	3.1	6.6	0.8	0.6	4.2	0.5	0.6
CPI*	1.3	1.6	1.1	1.7	1.3	1.4	1.2	1.3	1.4	1.4	1.4	1.8	1.9	1.9	1.2	1.1	1.3	1.2	1.2	2.1	2.0
O/E**	0.9	1.4	0.9	1.7	1.0	0.8	0.7	0.8	0.9	1.0	1.1	2.4	2.1	3.0	0.9	1.0	1.0	0.8	1.3	2.9	3.0

* CPI is calculated from the following ratio

$$\frac{1}{2}\left(\frac{C25 + C27 + \ldots + C33}{C24 + C26 + \ldots + C32} + \frac{C25 + C27 + \ldots + C33}{C26 + C28 + \ldots + C34}\right)$$

** Odd/Even Ratio = $\frac{C29 + C31}{C28 + C30}$

Table IV-2: Relative amounts of saturated hydrocarbons in samples collected at the city of Glendora.

	Relative Percent to Total Saturated Hydrocarbons																			
	Day														Night					
Collection Date, 1986	8/13	8/13	8/14-15	8/14	8/14	8/15	8/16	8/16-17	8/17	8/18-19	8/18	8/19	8/20	8/20	8/13	8/14	8/15	8/16	8/17	8/18	8/19
Filter No.	8007 8008	8009	8017 8027	8019	8020	8026 8029	8033 8036	8034 8040	8043 8044	8047 8051	8048 8049	8054 8055	8057 8058	8060 8061	8013 8014	8024	8031	8037	8045	8050	8056
Carbon No.																					
19	5.8	2.7	5.7	3.1	4.1	1.4	1.9	1.3	0.8	1.9	2.5	5.8	3.6	3.9	0.6	1.3	0.6	1.1	1.4	5.8	4.6
20	5.9	13.0	5.9	17.8	10.3	4.7	2.9	3.1	3.9	4.2	3.6	12.1	8.8	10.0	1.3	3.5	2.2	4.8	2.8	6.7	13.0
21	9.9	16.8	11.1	27.8	22.1	15.0	12.6	14.5	15.1	13.5	12.9	15.5	9.6	14.2	1.5	6.7	11.1	16.9	9.7	10.2	16.3
22	9.8	5.7	8.0	9.6	7.5	4.9	3.7	4.2	4.4	4.3	4.6	5.9	4.9	4.7	4.8	4.8	3.0	4.5	4.3	4.8	4.9
23	13.6	8.5	13.4	11.4	9.9	7.4	8.0	9.0	8.2	9.5	8.2	7.4	7.2	5.7	14.7	9.3	7.2	8.4	8.9	8.8	7.1
24	16.8	10.6	16.5	11.1	11.8	14.2	15.9	16.7	13.9	15.6	16.1	8.9	12.1	7.0	20.8	14.8	14.9	14.8	16.1	10.5	8.8
25	13.8	15.2	13.7	9.5	13.4	19.3	22.0	21.1	20.2	20.4	20.9	14.0	15.8	12.9	19.1	15.6	21.1	17.9	21.7	13.4	11.6
26	8.1	7.7	9.0	4.4	8.1	14.1	16.2	15.2	15.4	13.8	15.0	8.4	8.7	8.3	13.9	12.3	16.5	13.3	15.0	6.8	6.7
27	5.6	5.9	5.4	2.7	4.2	9.1	8.8	8.1	9.7	9.2	8.2	6.4	8.8	8.2	8.8	8.2	10.5	8.3	9.1	8.4	6.6
28	4.0	3.9	3.6	1.0	2.6	4.3	4.0	3.0	3.6	3.1	3.0	2.9	4.0	3.7	4.8	5.5	4.3	3.8	3.6	3.2	3.1
29	2.4	4.7	2.8	1.6	2.8	2.6	2.0	2.2	2.5	2.3	2.9	6.4	9.3	10.1	4.0	5.0	3.8	2.3	3.2	9.3	8.5
30	1.6	1.4	1.8		1.2	1.4	0.6	0.7	0.7	0.7	0.7	1.1	2.5	2.0	2.3	4.3	1.7	1.3	0.9	2.4	1.8
31	2.6	3.0	1.8		1.2	1.6	1.1	0.7	1.4	1.4	1.2	3.8	4.0	6.7	2.6	4.6	2.3	1.9	2.7	7.6	5.8
32		0.9	1.3		0.8		0.3	0.3			0.3	1.4	0.9	2.6	0.9	4.0	0.8	0.9	5.3	2.1	1.2
CPI*	1.3	1.6	1.1	1.7	1.3	1.3	1.3	1.3	1.4	1.4	1.4	1.8	1.9	1.9	1.2	1.1	1.3	1.2	1.4	2.1	2.0
O/E**	0.9	1.4	0.9		1.0	0.7	0.7	0.8	0.9	1.0	1.1	2.5	2.1	2.9	0.9	1.0	1.0	0.8	1.3	3.0	2.9

* CPI is calculated from the following ratio

$$\frac{1}{2}\left(\frac{C25 + C27 + \ldots + C33}{C24 + C26 + \ldots + C32} + \frac{C25 + C27 + \ldots + C33}{C26 + C28 + \ldots + C34}\right)$$

** Odd/Even Ratio = $\frac{C29 + C31}{C28 + C30}$

Figure IV-1

Alkane Distribution Pattern for Day Sample

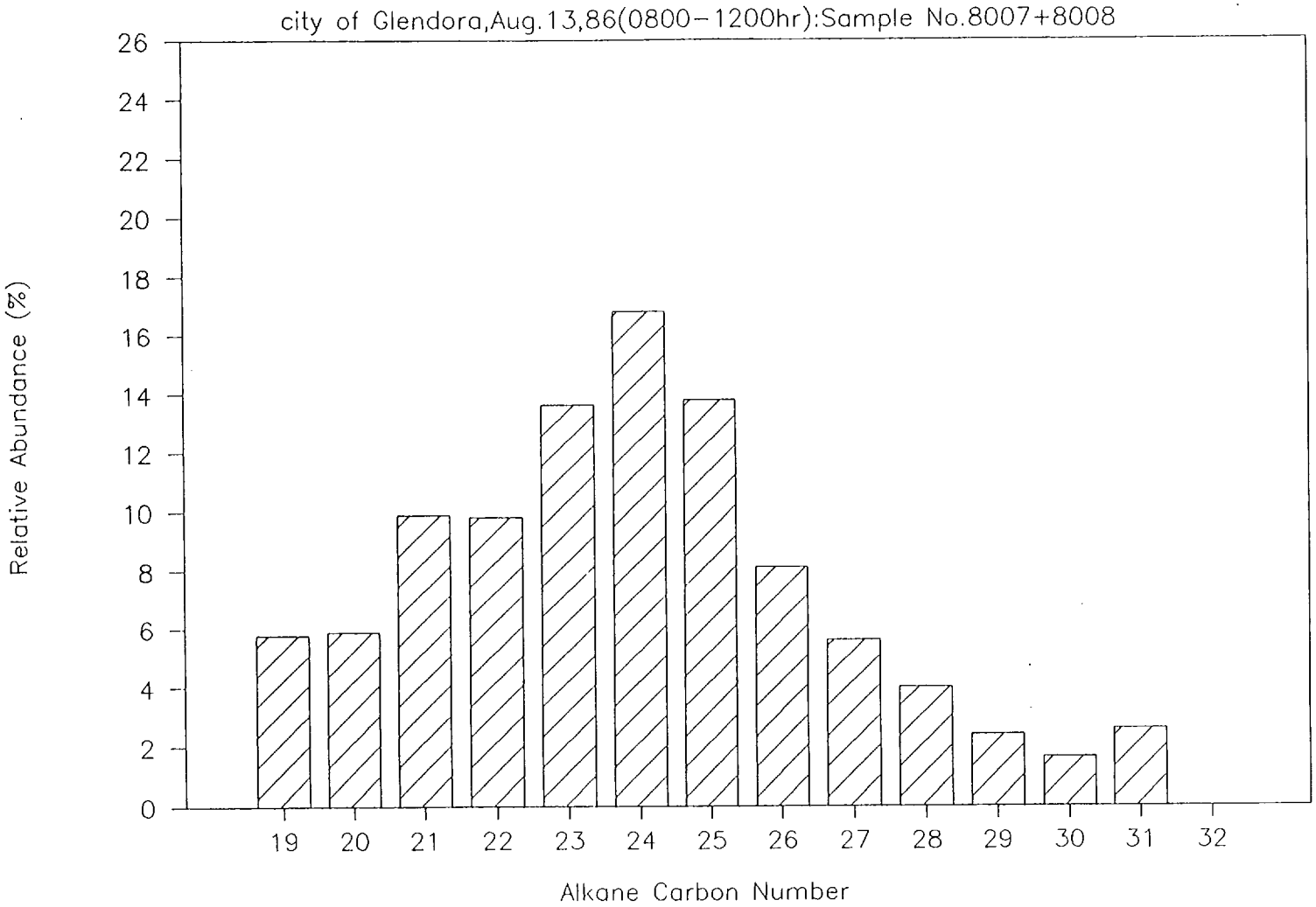


Figure IV-2

Alkane Distribution Pattern for Day Sample

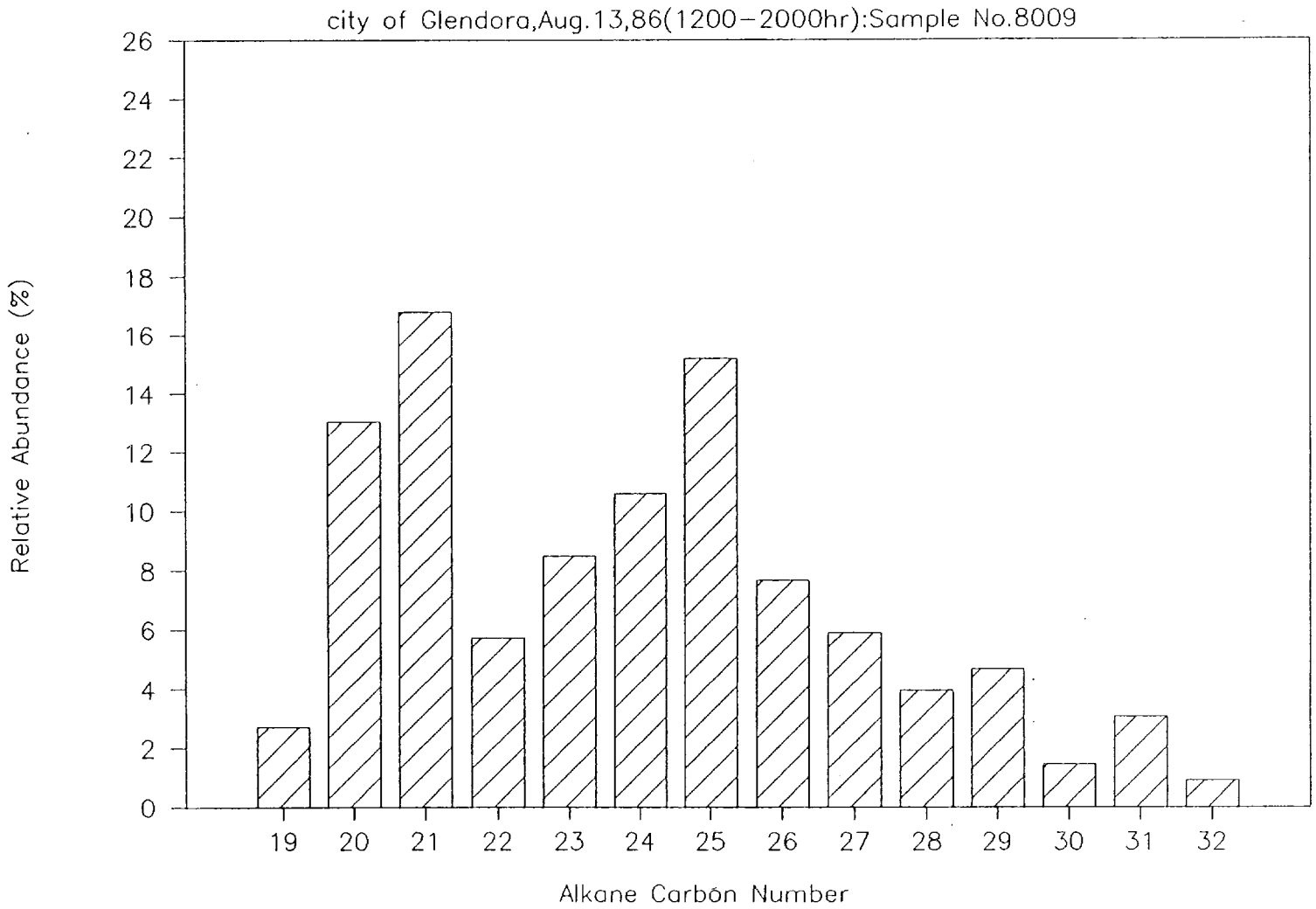


Figure IV-3

Alkane Distribution Pattern for Night Sample

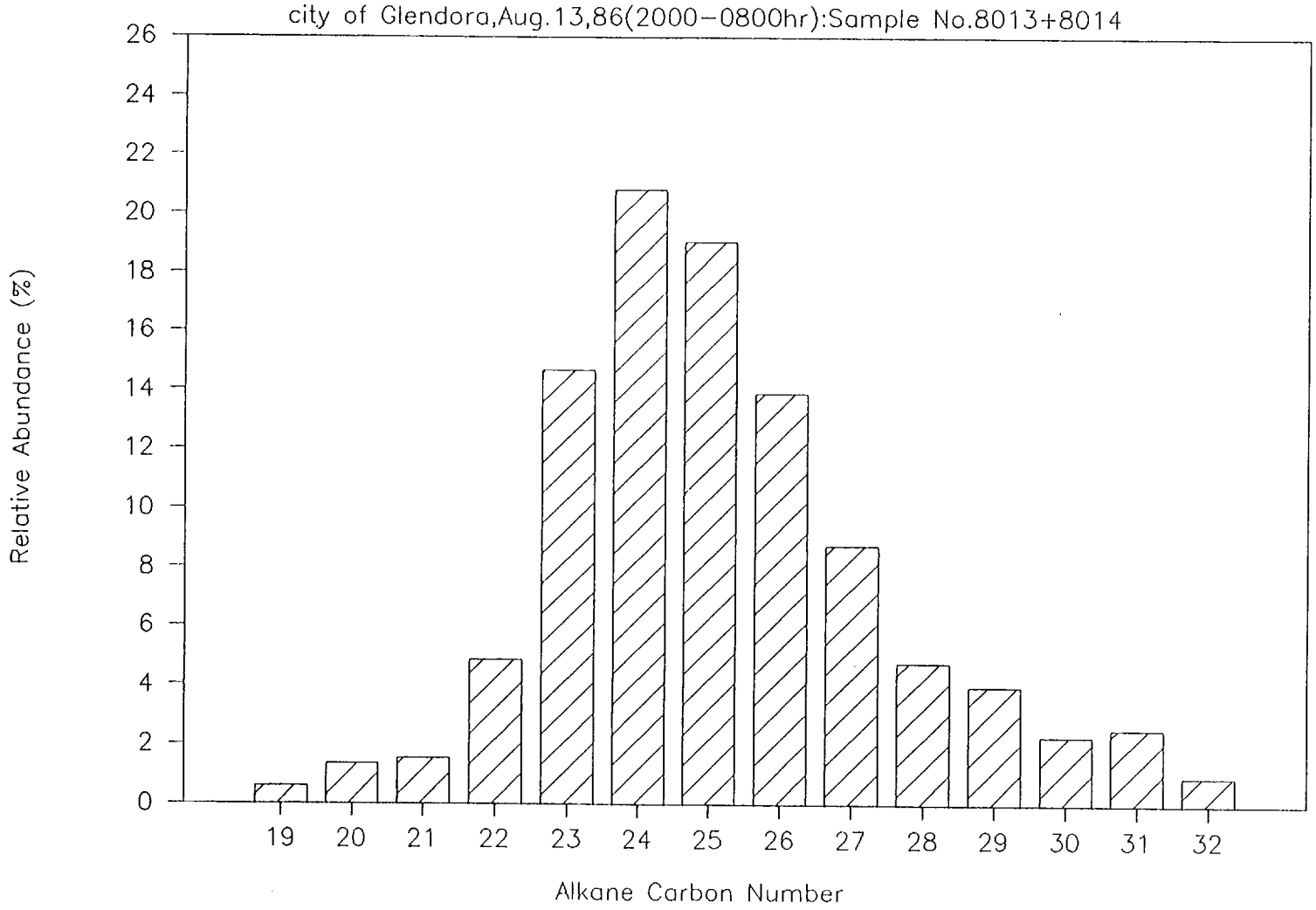


Figure IV-4

Alkane Distribution Pattern for Day Sample

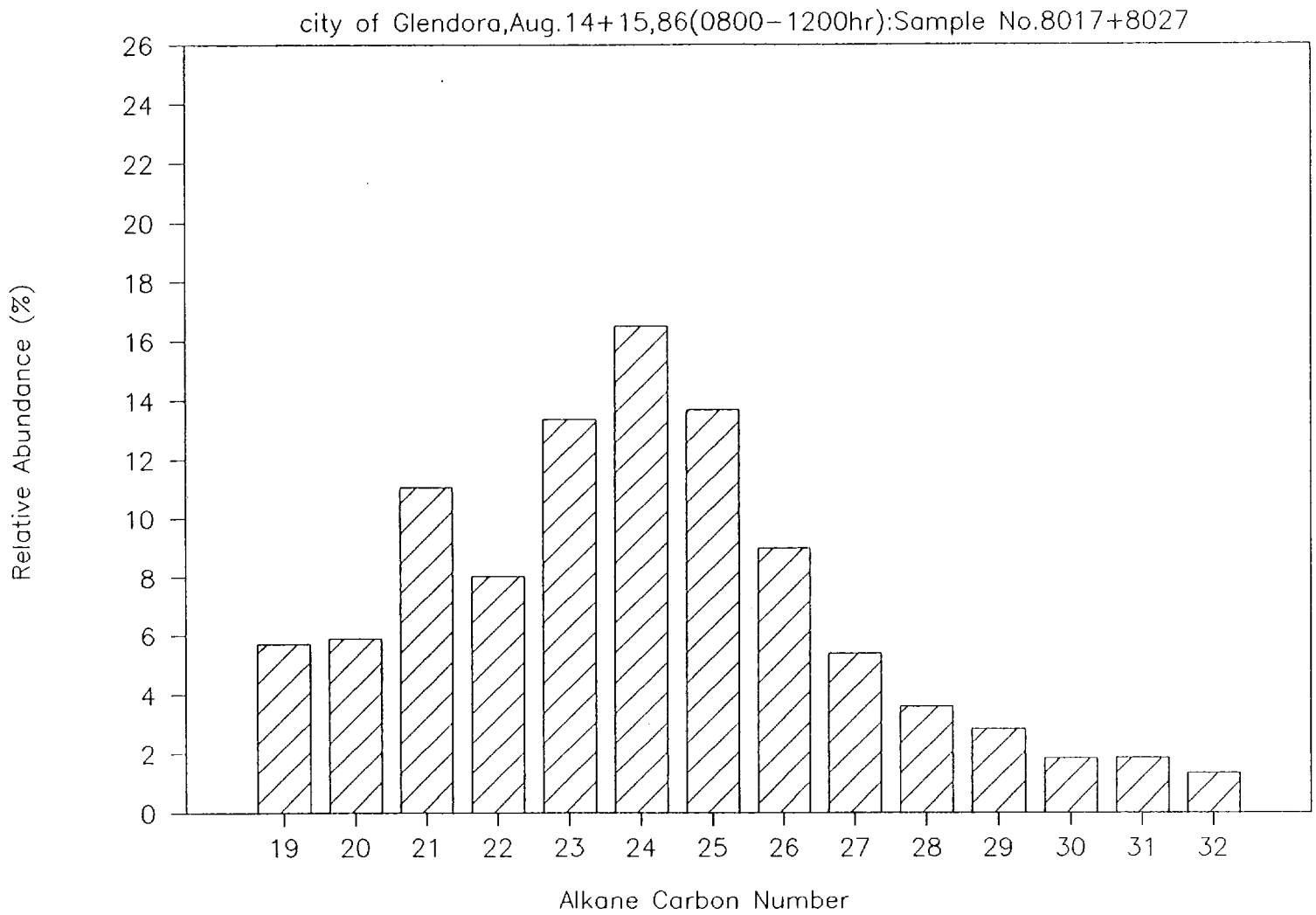


Figure IV-5

Alkane Distribution Pattern for Day Sample

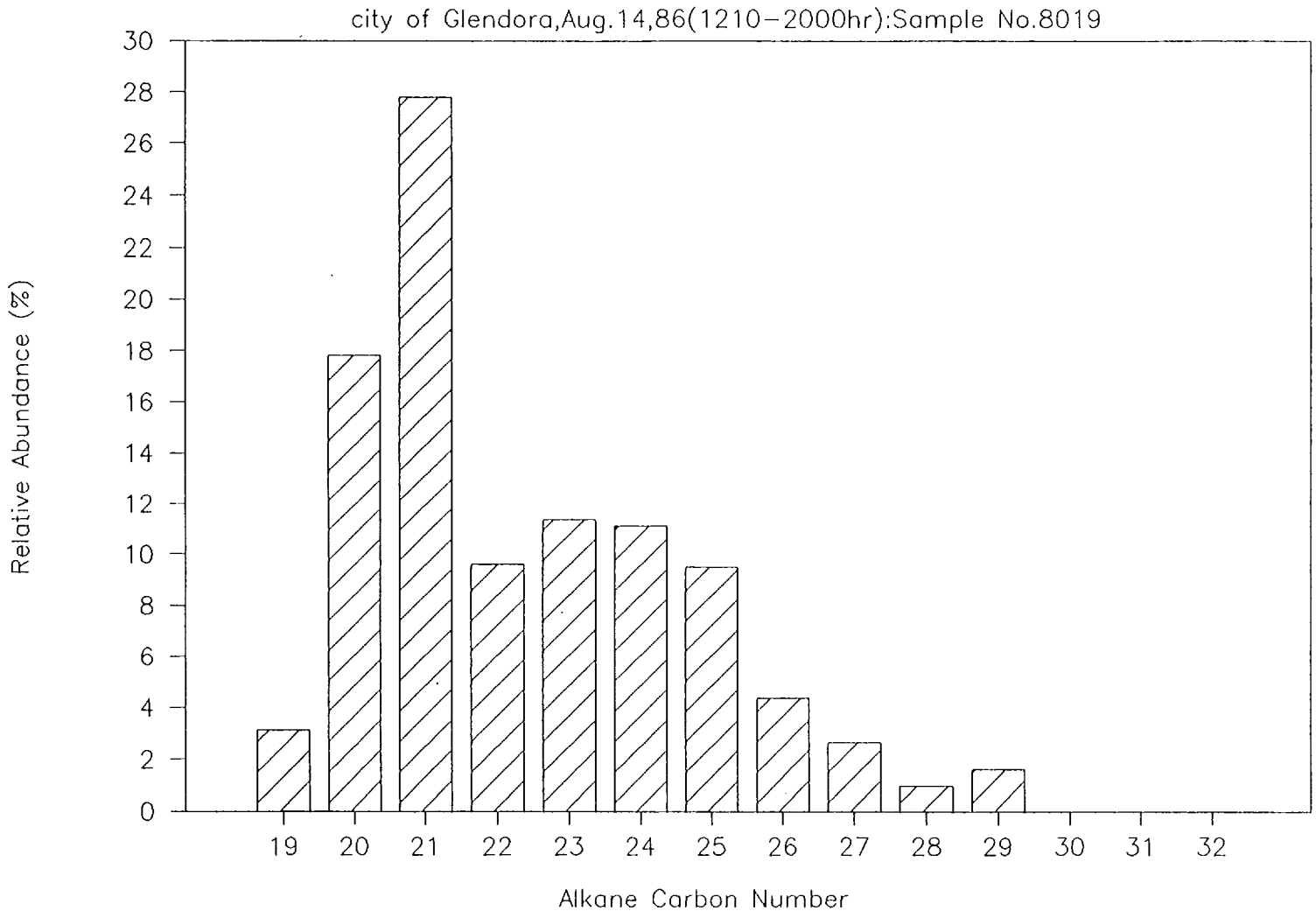


Figure IV-6

Alkane Distribution Pattern for Day Sample,#2

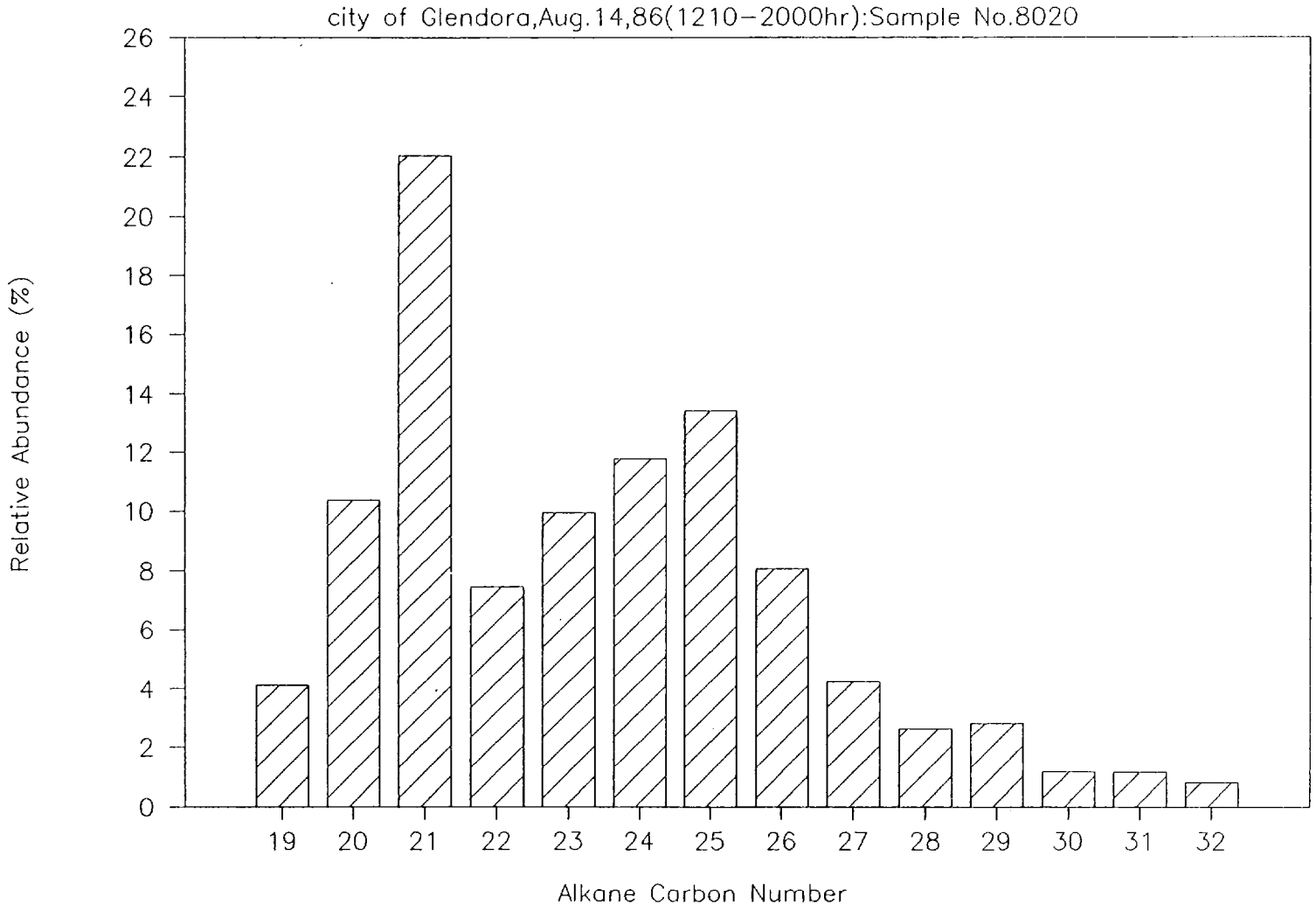


Figure IV-7

Alkane Distribution Pattern for Night Sample

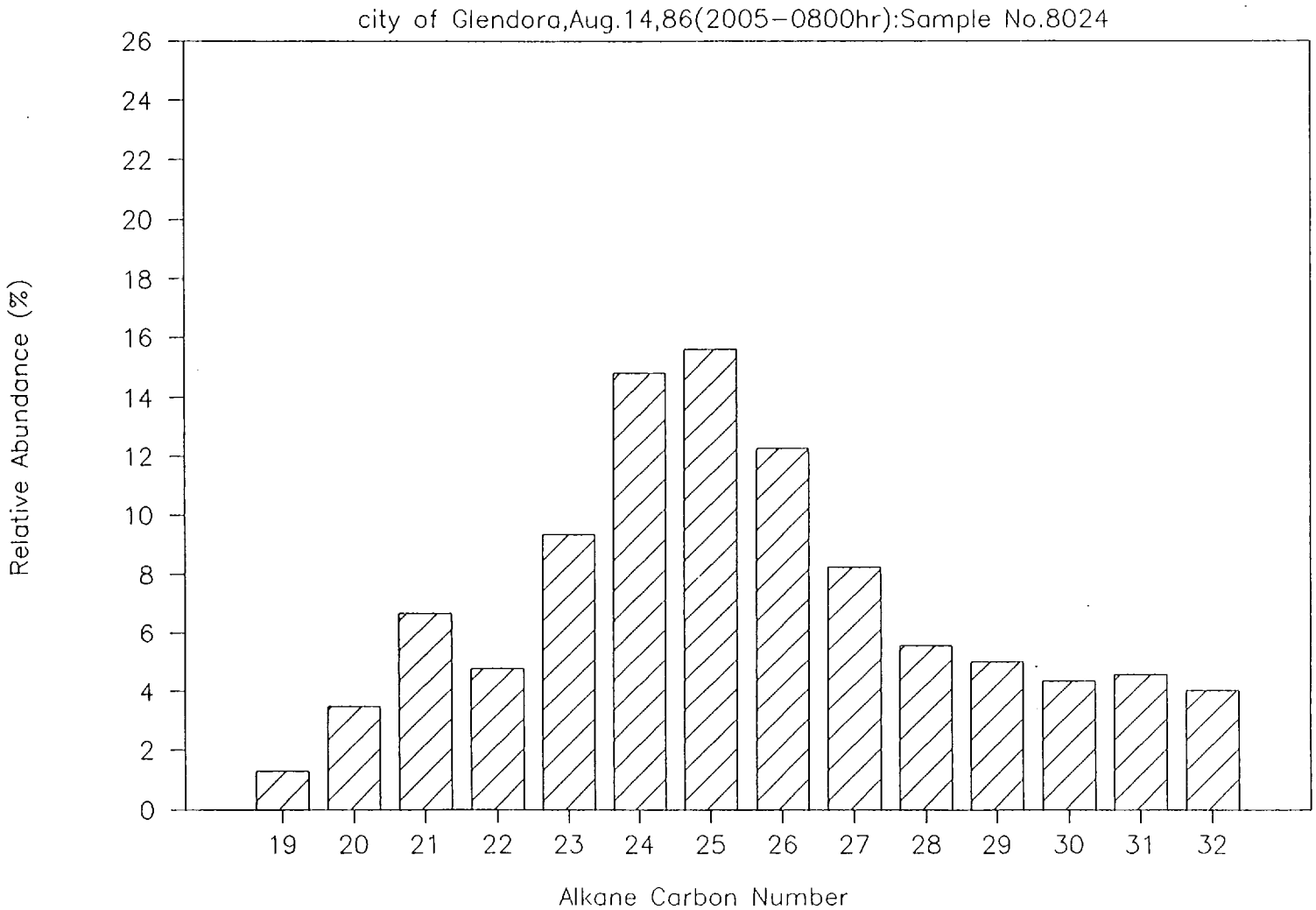


Figure IV-8

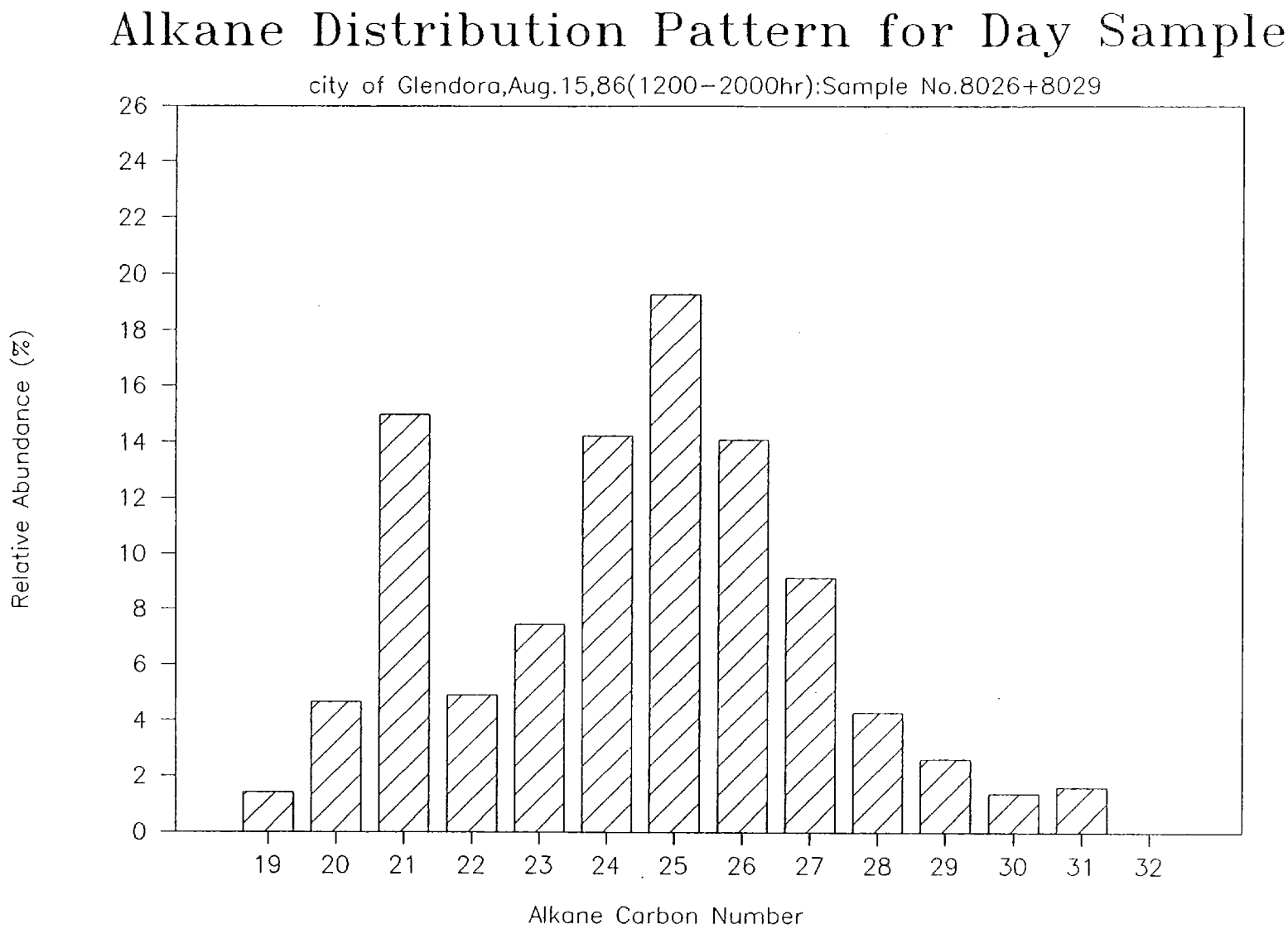

Alkane Distribution Pattern for Day Sample
city of Glendora,Aug.15,86(1200-2000hr):Sample No.8026+8029
Relative Abundance (%)
0
2
4
6
8
10
12
14
16
18
20
22
24
26
19
20
21
22
23
24
25
26
27
28
29
30
31
32
Alkane Carbon Number

Figure IV-9

Alkane Distribution Pattern for Night Sample

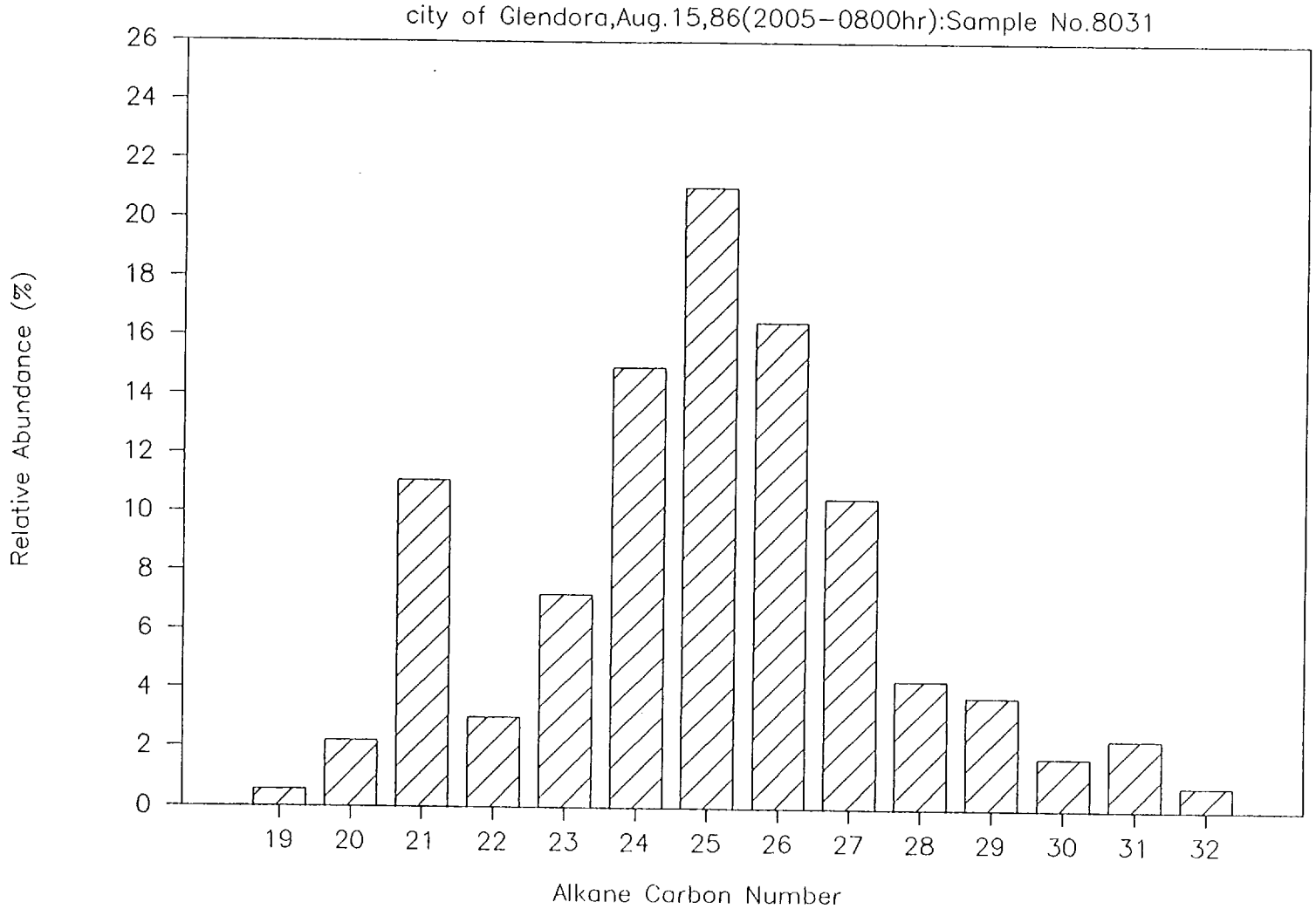


Figure IV-10

Alkane Distribution Pattern for Day Sample

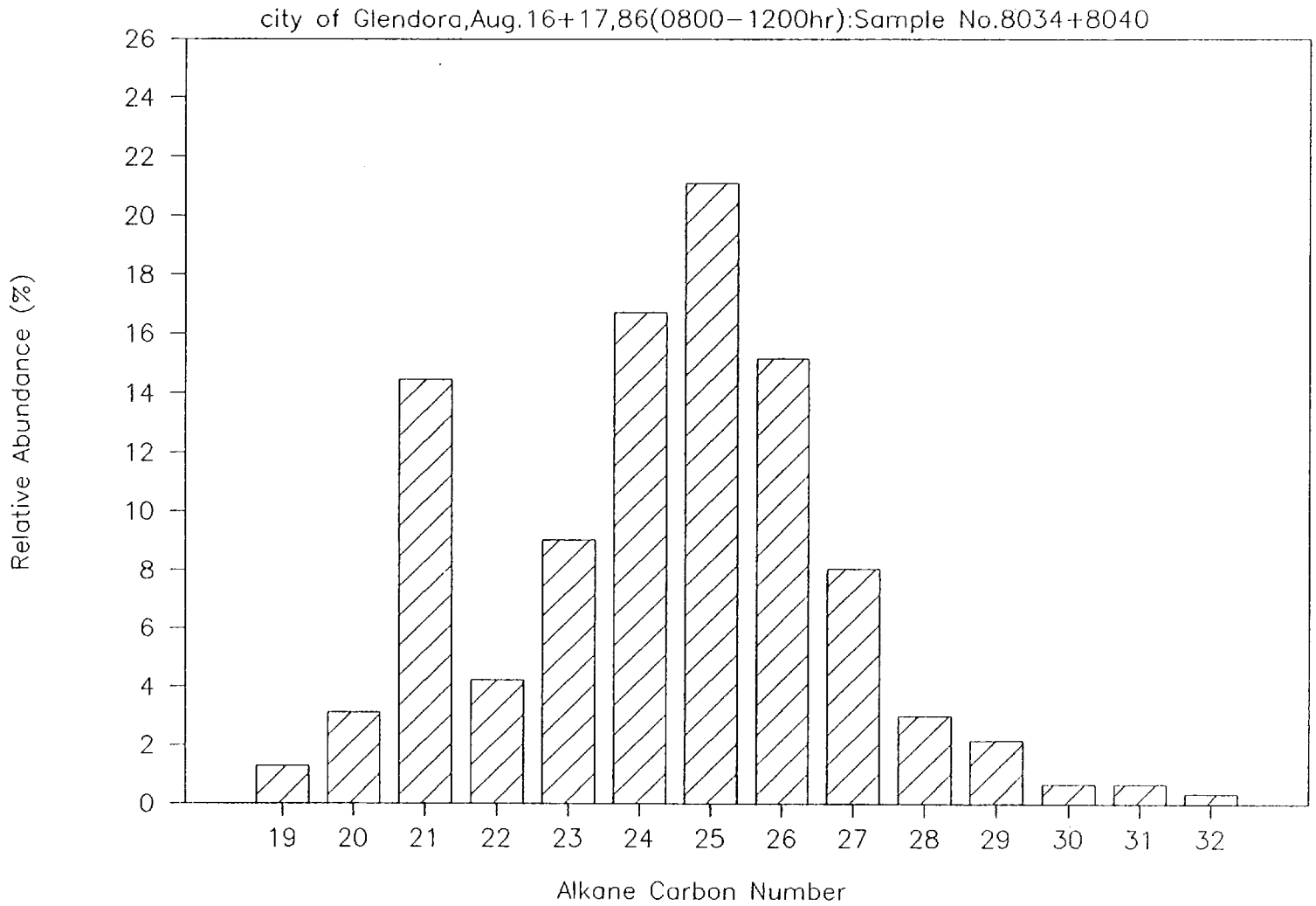


Figure IV-11

Alkane Distribution Pattern for Day Sample

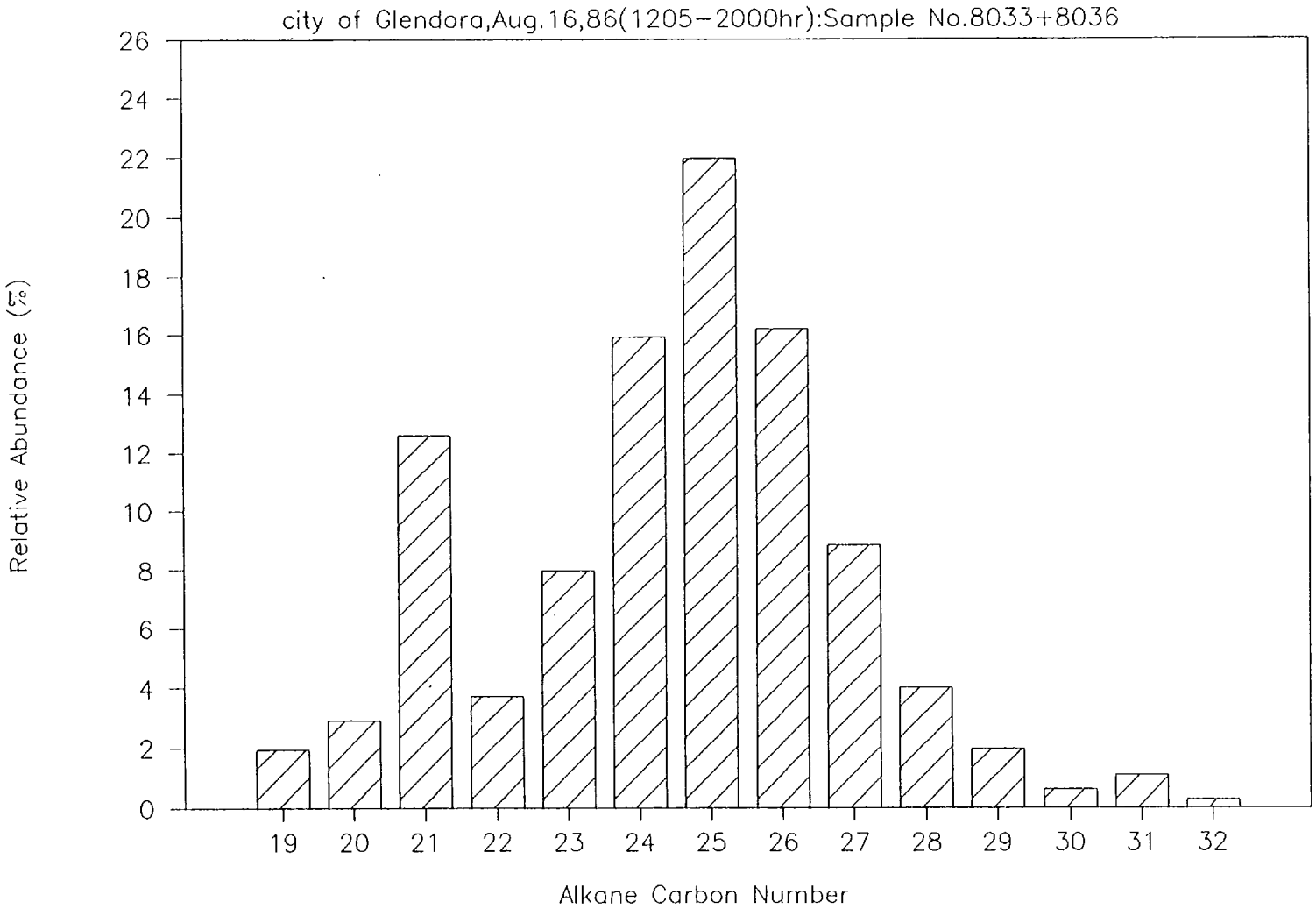


Figure IV-12

Alkane Distribution Pattern for Night Sample

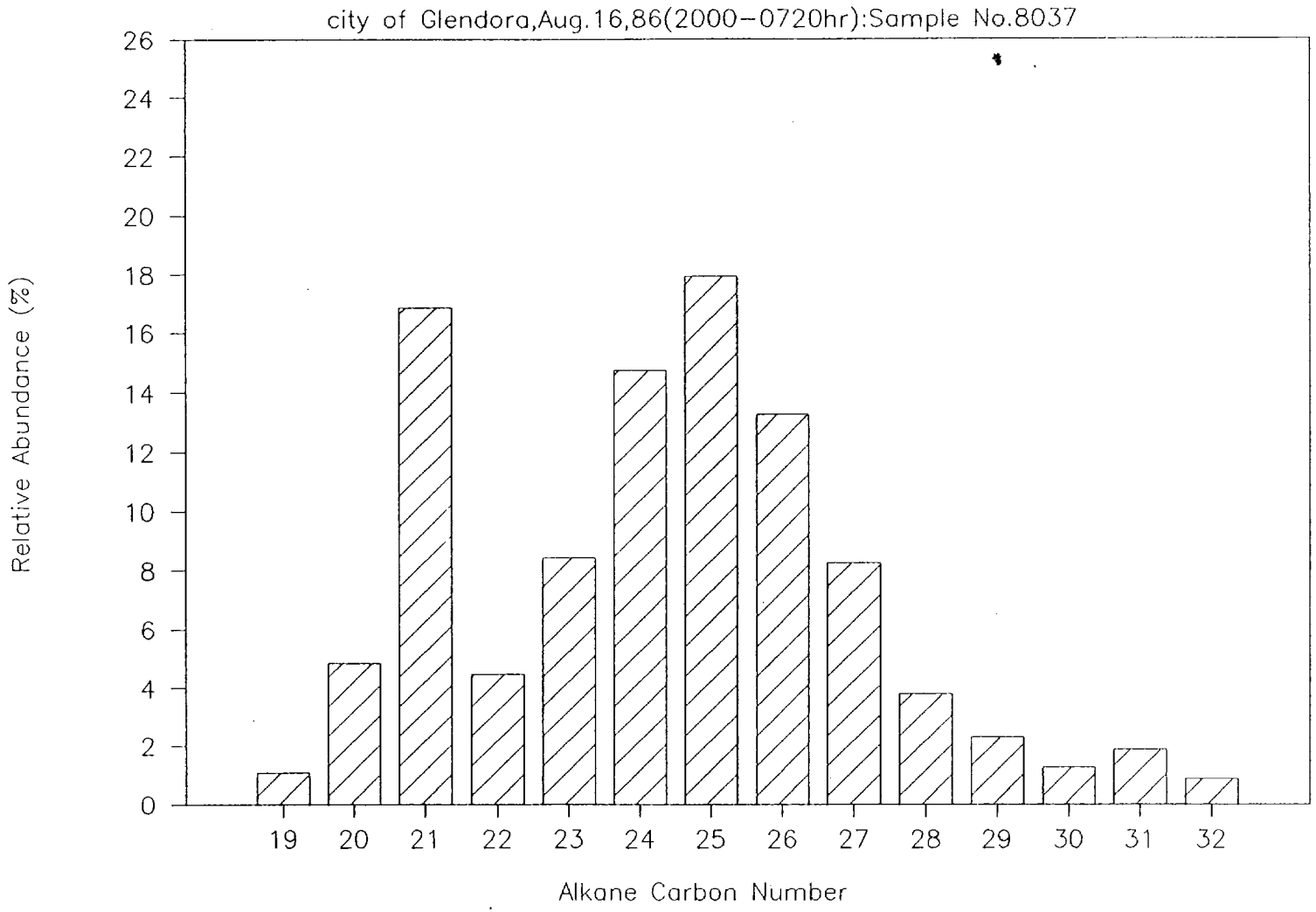


Figure IV-13

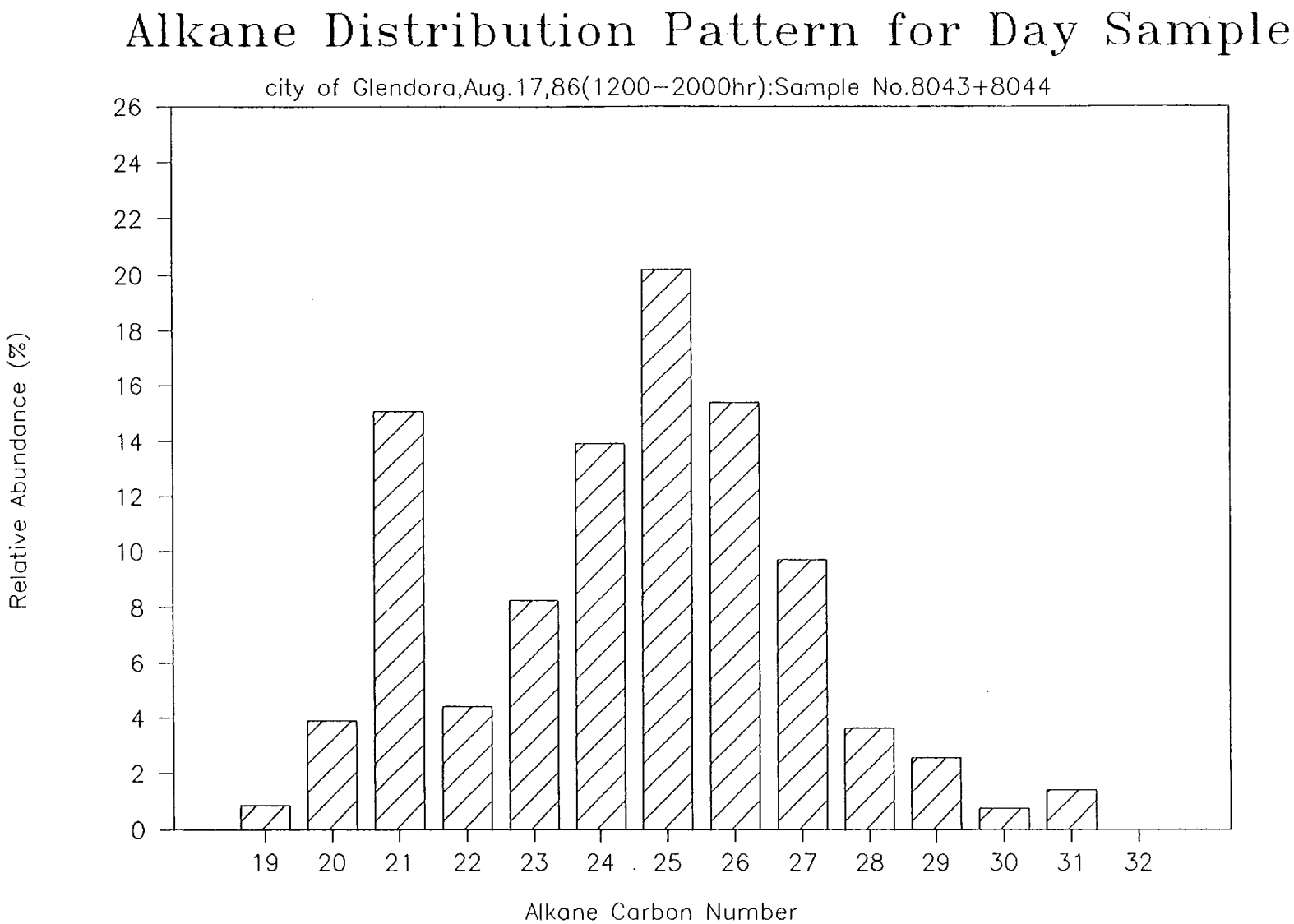

Alkane Distribution Pattern for Day Sample
city of Glendora,Aug.17,86(1200-2000hr):Sample No.8043+8044
Relative Abundance (%)
0
2
4
6
8
10
12
14
16
18
20
22
24
26
19
20
21
22
23
24
25
26
27
28
29
30
31
32
Alkane Carbon Number

Figure IV-14

Alkane Distribution Pattern for Night Sample

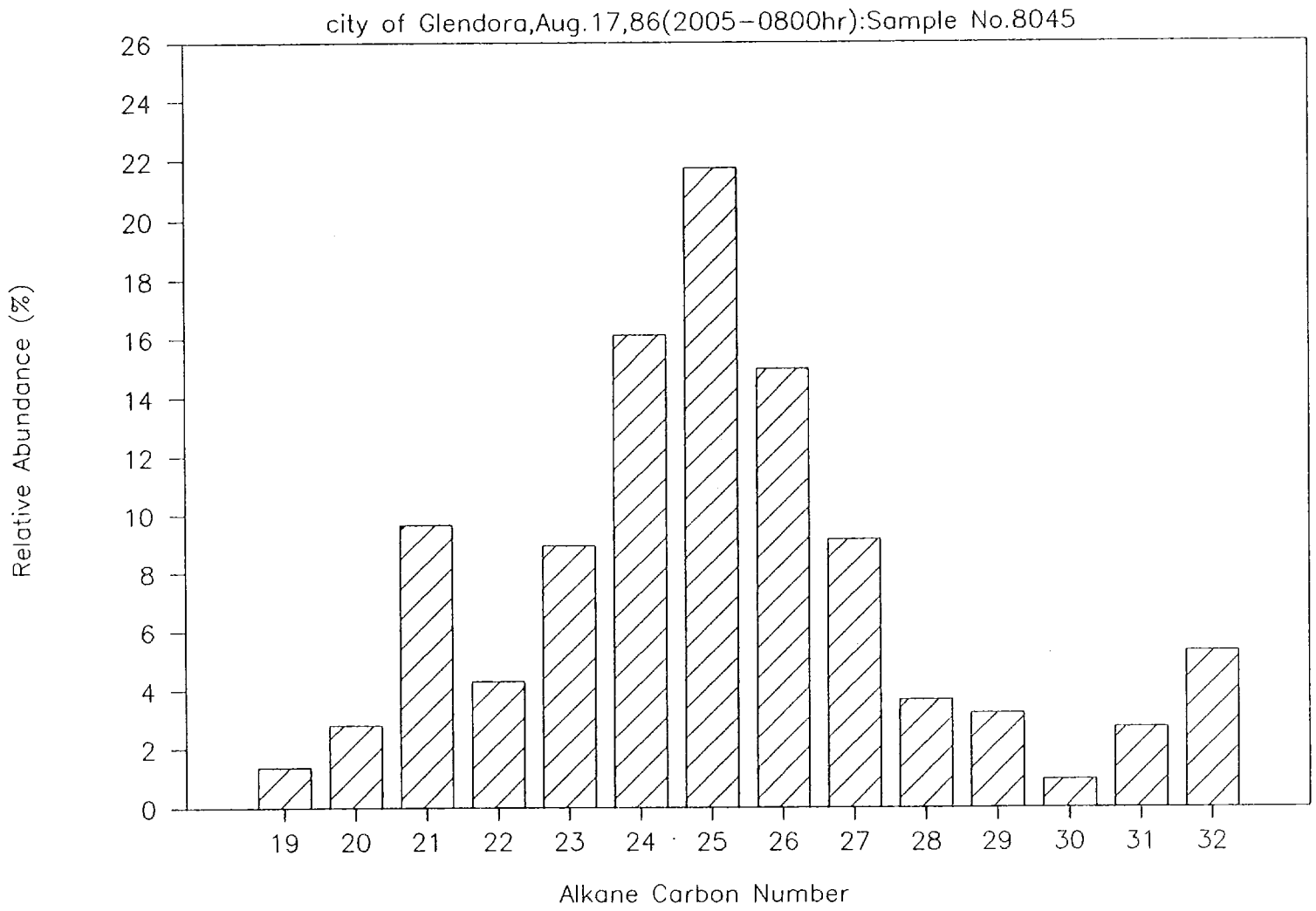


Figure IV-15

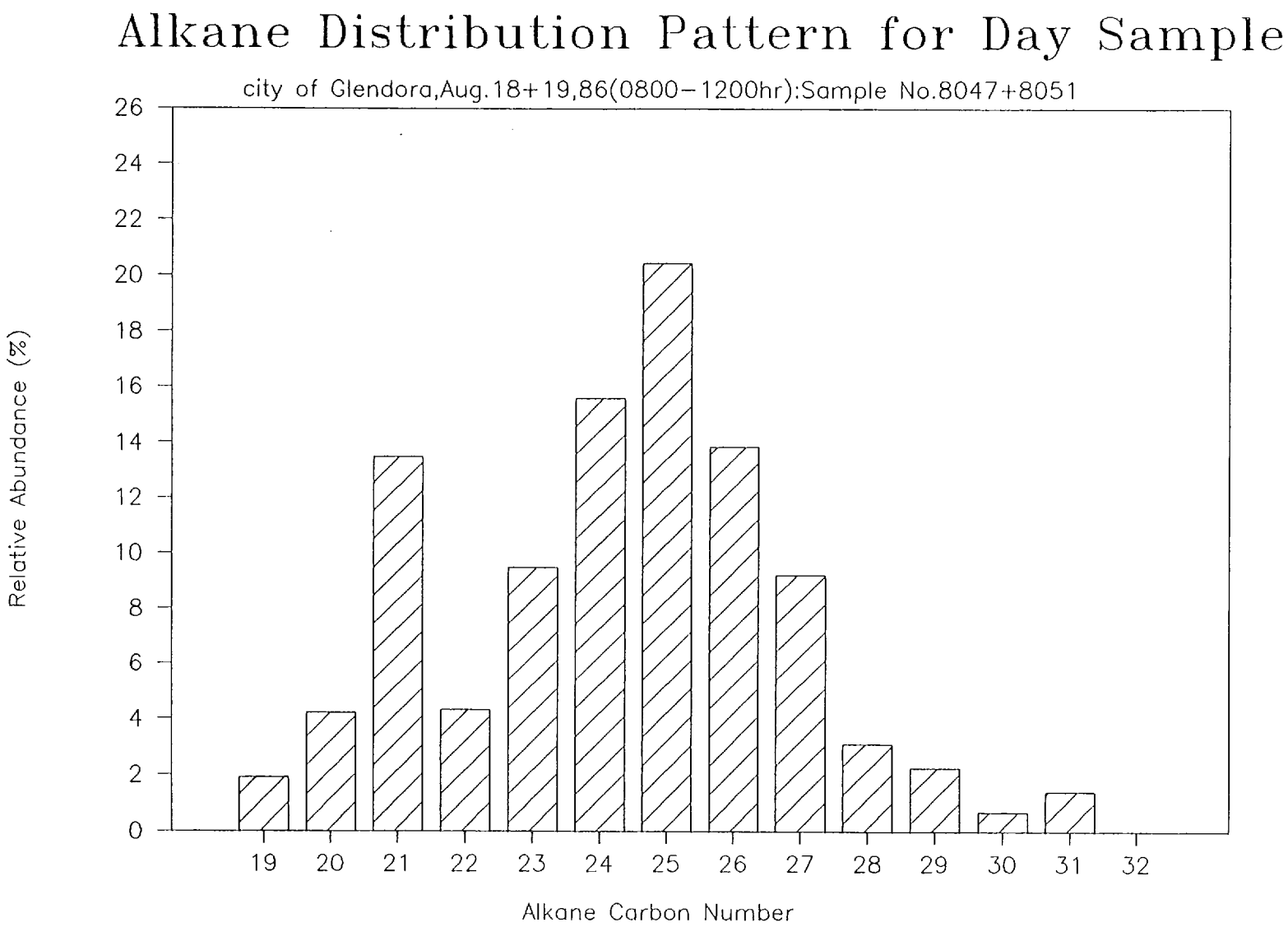

Alkane Distribution Pattern for Day Sample
city of Glendora,Aug.18+19,86(0800-1200hr):Sample No.8047+8051
Relative Abundance (%)
0
2
4
6
8
10
12
14
16
18
20
22
24
26
19
20
21
22
23
24
25
26
27
28
29
30
31
32
Alkane Carbon Number

Figure IV-16

Alkane Distribution Pattern for Day Sample

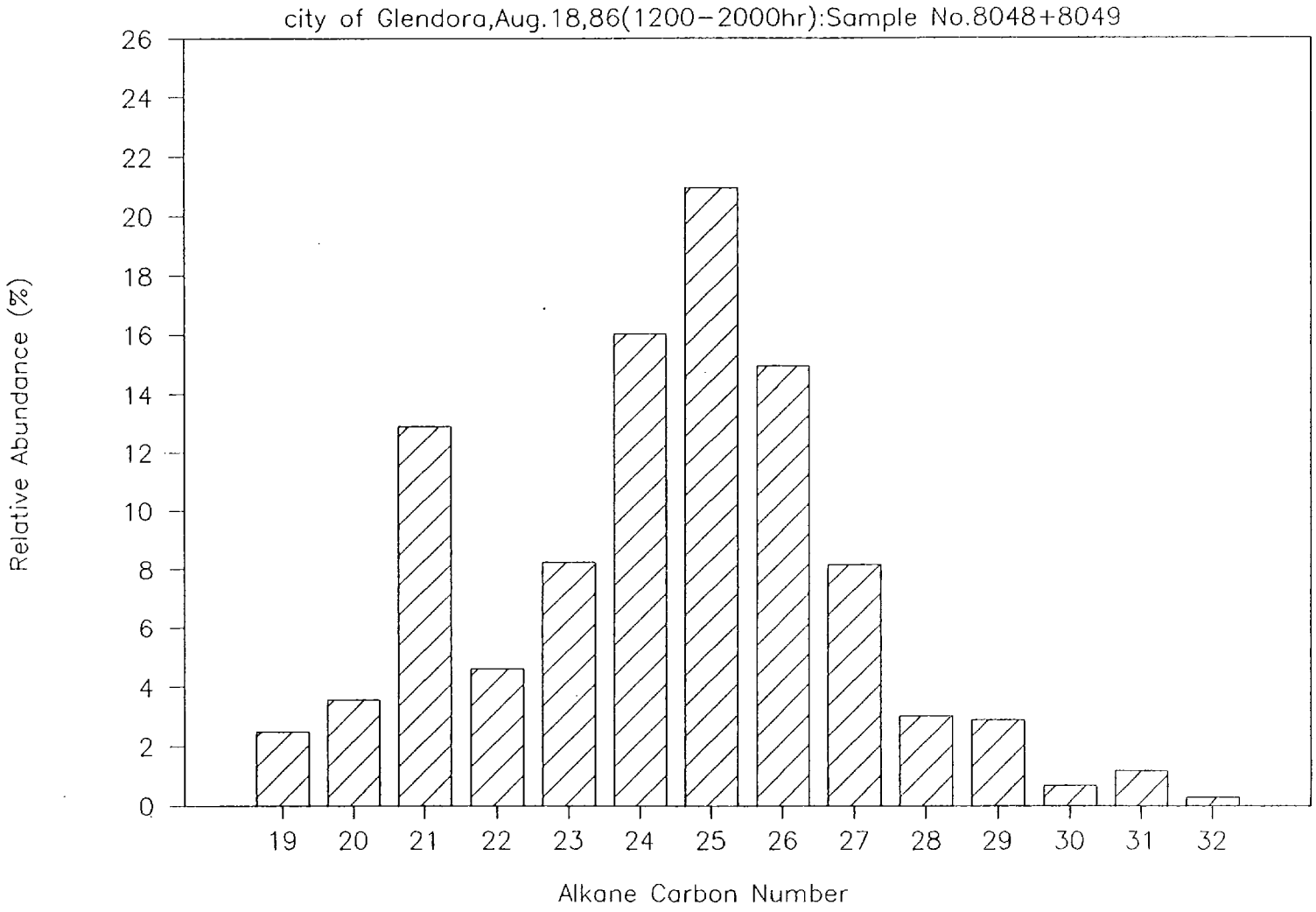


Figure IV-17

Alkane Distribution Pattern for Night Sample

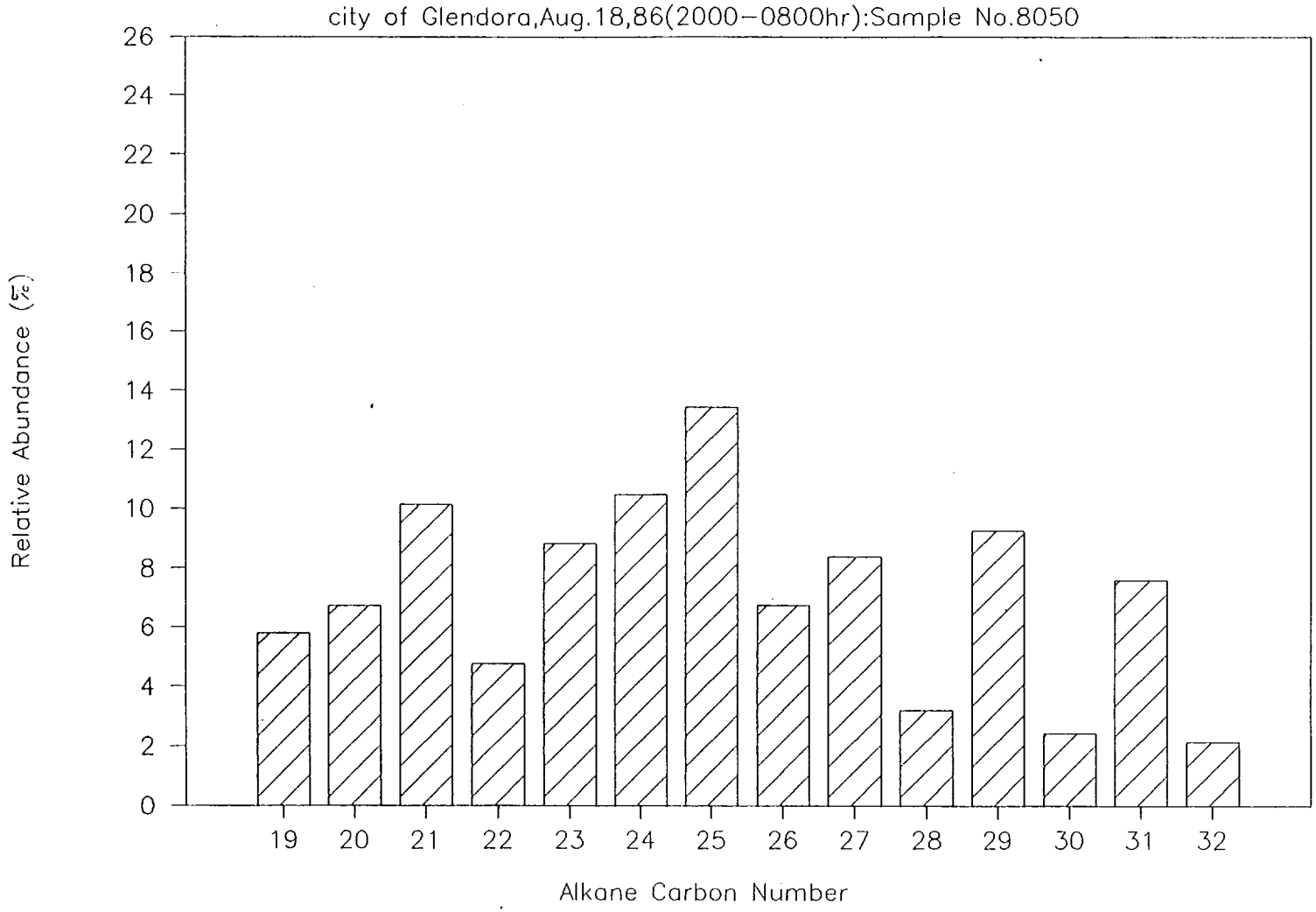


Figure IV-18

Alkane Distribution Pattern for Day Sample

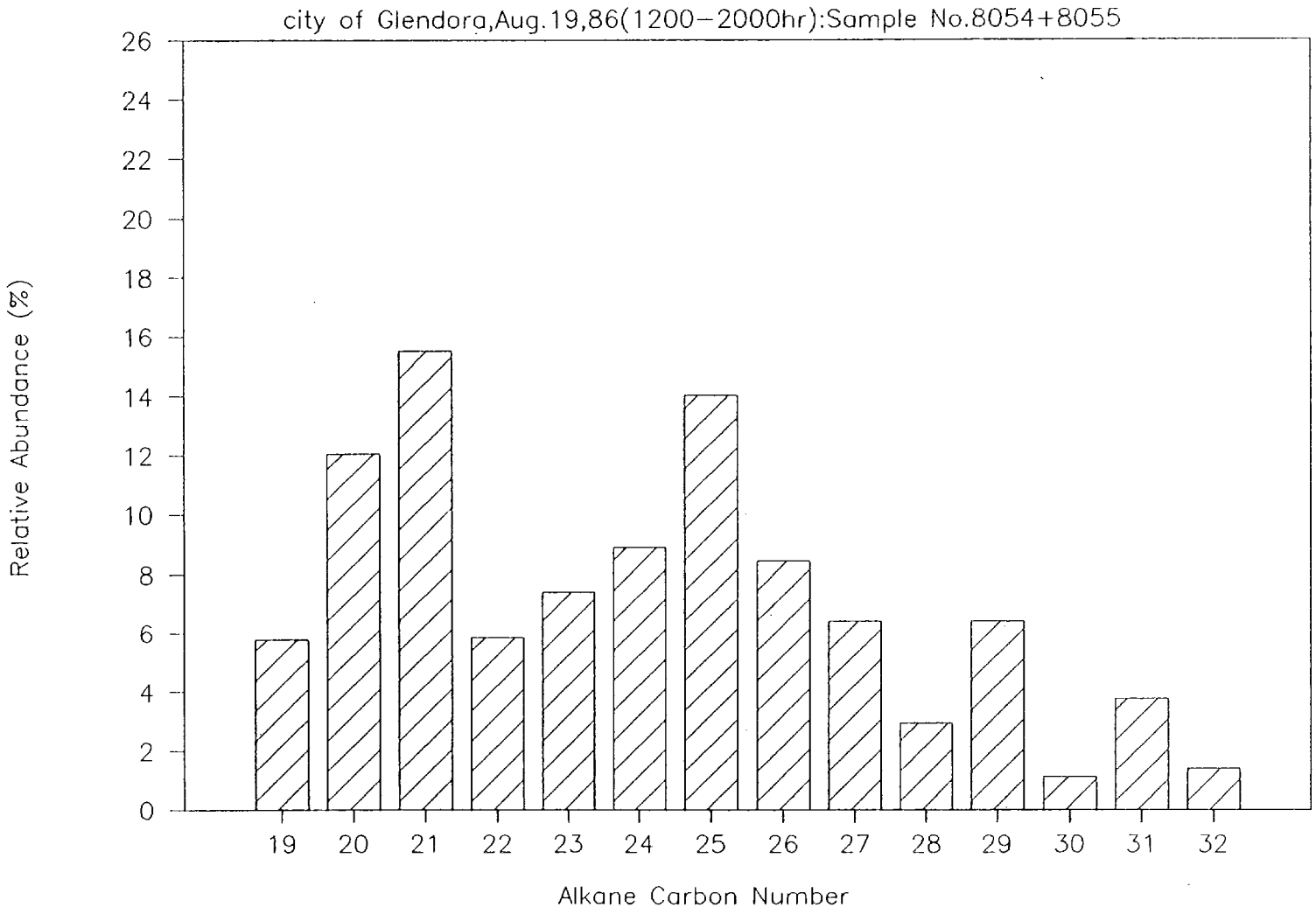


Figure IV-19

Alkane Distribution Pattern for Night Sample

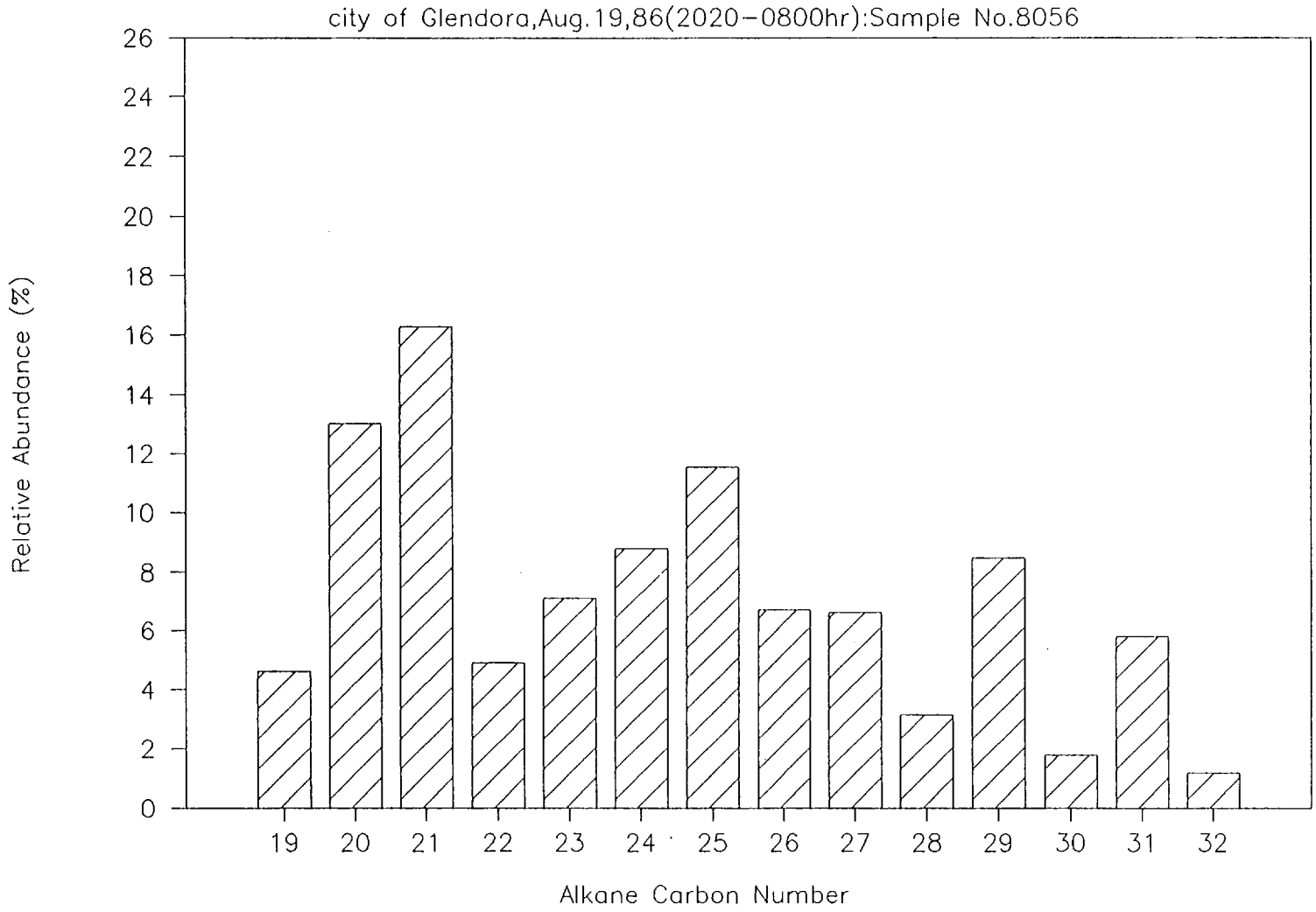


Figure IV-20

Alkane Distribution Pattern for Day Sample

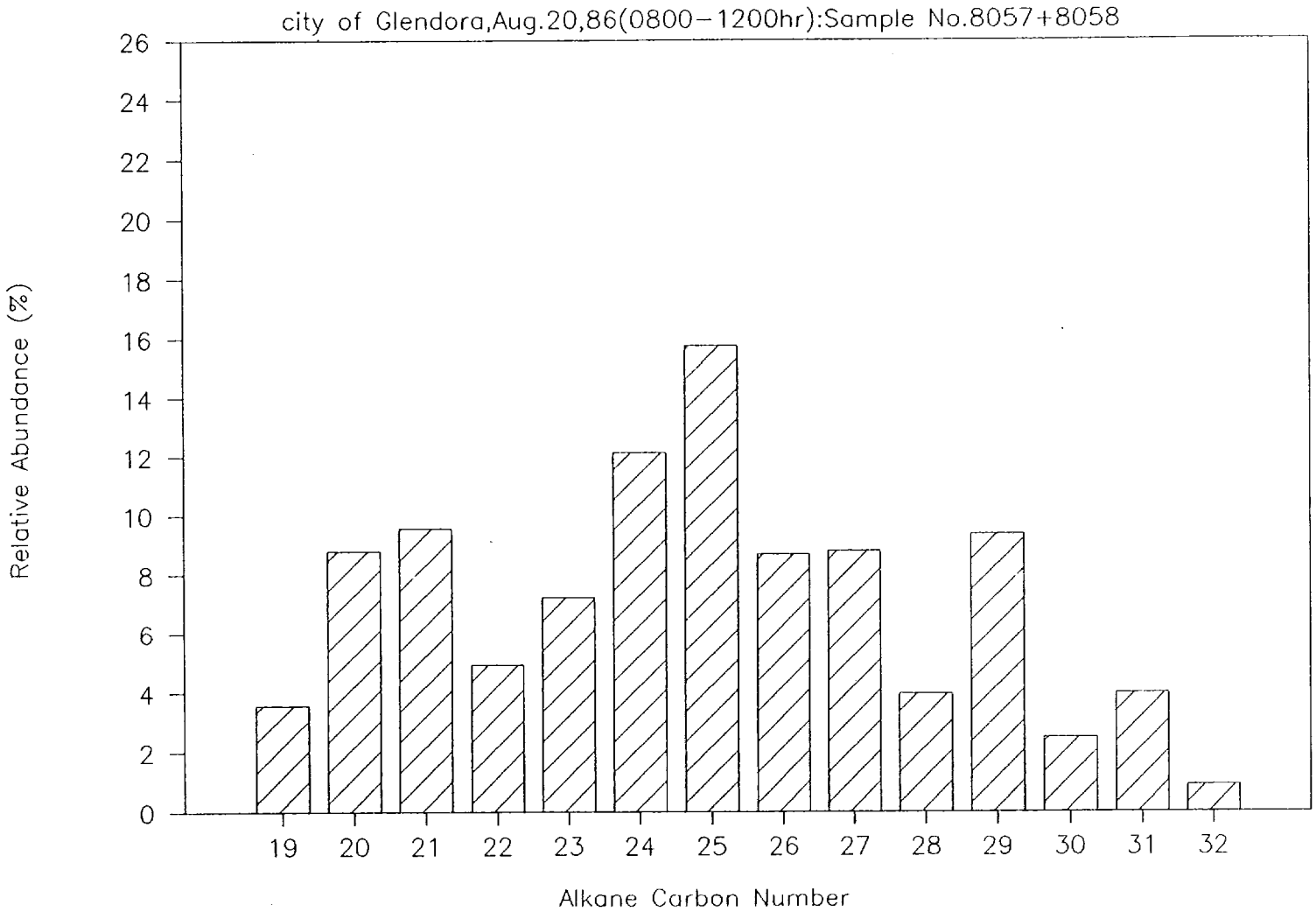


Figure IV-21

Alkane Distribution Pattern for Day Sample

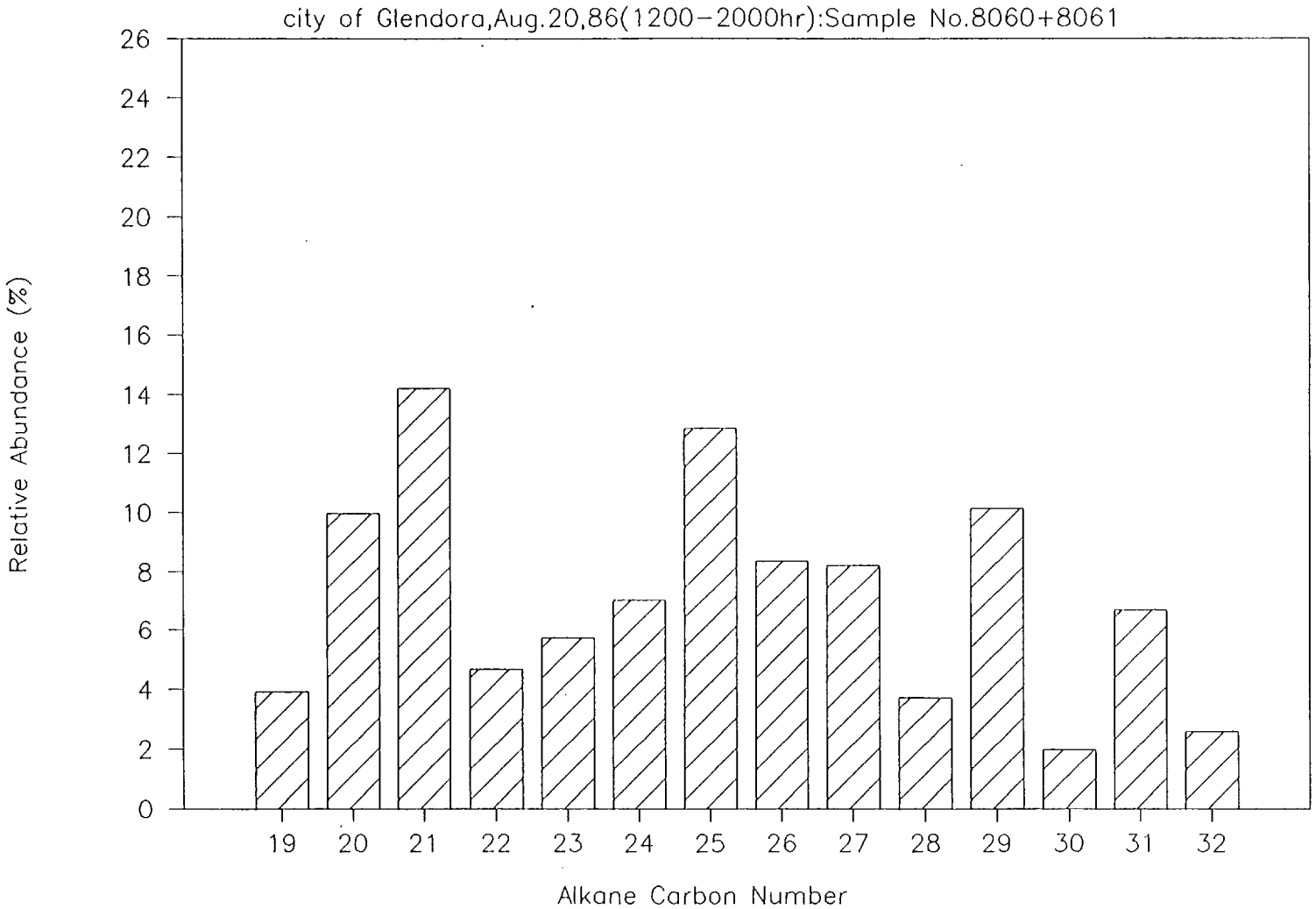


Table IV-3: Saturated hydrocarbon concentrations (ng/m3) in samples collected at the city of Duarte.

	Day				Night
Collection Date (AUG 1986)	13/14	13/15	17	19/20	13
Filter No.	8006 8018	8010 8025	8041	8053 8059	8015
Carbon No.					
19	3.7	1.4	0.9	1.8	0.6
20	7.4	6.0	3.3	3.4	2.0
21	13.7	9.2	14.3	4.7	2.9
22	6.9	3.7	5.6	2.1	2.0
23	10.2	5.2	11.9	2.5	3.2
24	11.6	5.9	18.5	3.3	3.9
25	10.2	7.5	28.4	5.6	4.2
26	5.6	6.6	20.7	2.9	2.8
27	4.1	4.1	13.2	3.4	2.8
28	3.1	3.1	5.0	1.7	1.6
29	3.2	3.8	3.6	3.3	1.8
30	2.5	2.5	0.9	0.9	1.5
31	2.2	2.8	2.4	1.8	1.8
32	1.6	1.7		0.5	0.7
CPI*	1.1	1.1	1.4	1.9	1.3
O/E**	1.0	1.2	1.0	2.0	1.2

* CPI is calculated from the following ratio

$$\frac{1}{2}\left[\frac{C25 + C27 + \ldots + C33}{C24 + C26 + \ldots + C32} + \frac{C25 + C27 + \ldots + C33}{C26 + C28 + \ldots + C34}\right]$$

$$** \text{ Odd/Even Ratio} = \frac{C29 + C31}{C28 + C30}$$

Table IV-4: Relative amounts of saturated hydrocarbons in samples collected at the city of Duarte.

	Relative Percent of Total Saturated Hydocarbons				
	Day				Night
Collection Date (AUG 1986)	13/14	13/15	17	19/20	13
Filter Number	8006 8018	8010 8025	8041	8053 8059	8015
Carbon No.					
19	4.3	2.3	0.7	4.9	2.0
20	8.6	9.5	2.6	9.1	6.3
21	15.9	14.4	11.1	12.2	9.2
22	8.0	5.8	4.3	5.6	6.4
23	11.9	8.2	9.2	6.8	10.0
24	13.4	9.3	14.4	8.7	12.0
25	11.9	11.8	22.1	14.6	13.3
26	6.5	10.4	16.1	7.4	8.9
27	4.8	6.5	10.3	9.2	8.7
28	3.6	5.0	3.8	4.5	5.2
29	3.8	6.0	2.8	8.9	5.7
30	3.0	4.0	0.7	2.2	4.7
31	2.5	4.4	1.9	4.7	5.4
32	1.9	2.6		1.2	2.3
CPI*	1.1	1.1	1.4	2.0	1.3
O/E**	1.0	1.1	1.0	2.0	1.1

* CPI is calculated from the following ratio

$$\frac{1}{2}\left[\frac{C25 + C27 + \ldots + C33}{C24 + C26 + \ldots + C32} + \frac{C25 + C27 + \ldots + C33}{C26 + C28 + \ldots + C34}\right]$$

$$** \text{ Odd/Even Ratio} = \frac{C29 + C31}{C28 + C30}$$

Figure IV-22

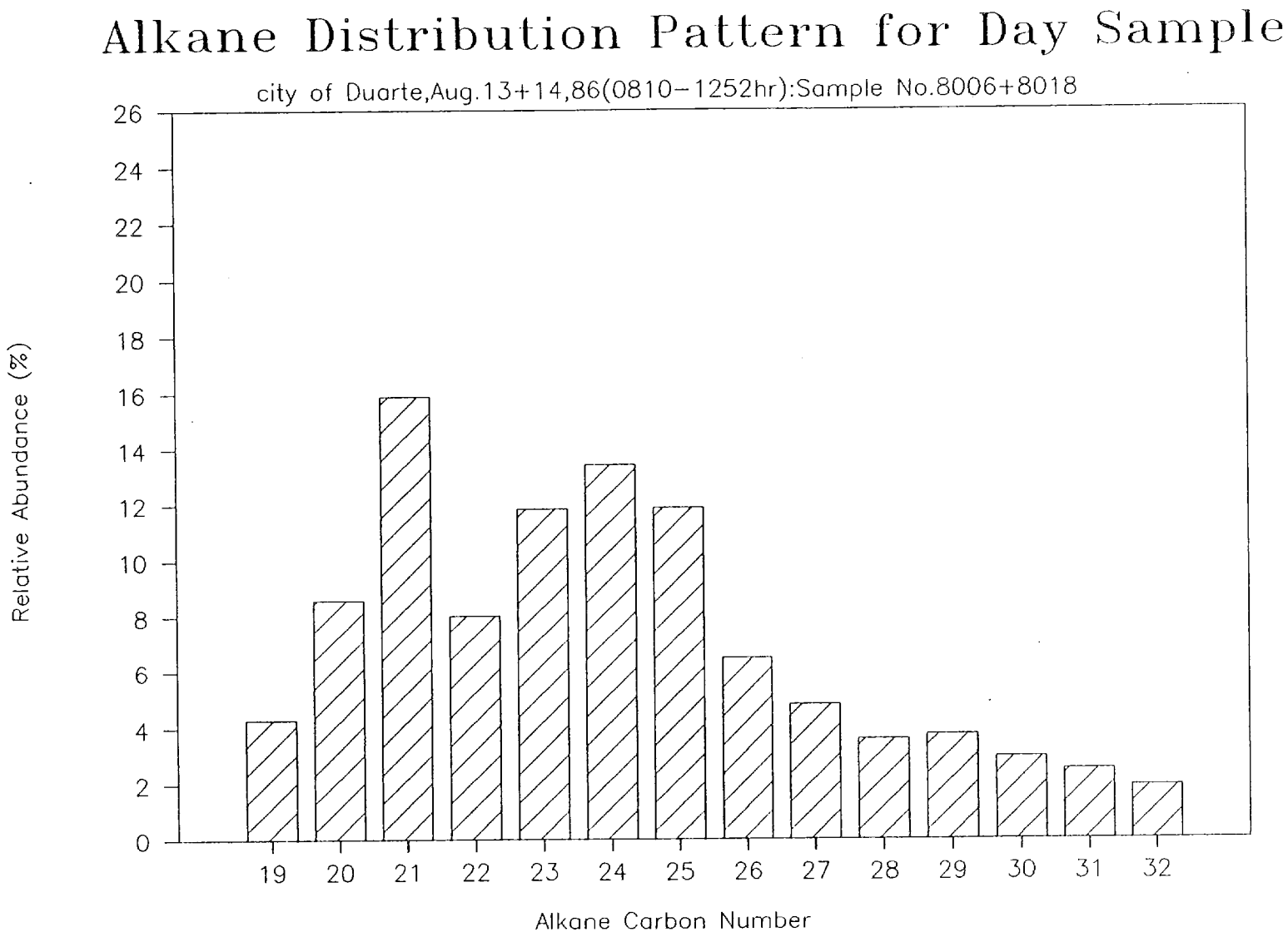

Alkane Distribution Pattern for Day Sample
city of Duarte,Aug.13+14,86(0810-1252hr):Sample No.8006+8018
Relative Abundance (%)
0
2
4
6
8
10
12
14
16
18
20
22
24
26
19
20
21
22
23
24
25
26
27
28
29
30
31
32
Alkane Carbon Number

Figure IV-23

Alkane Distribution Pattern for Day Sample

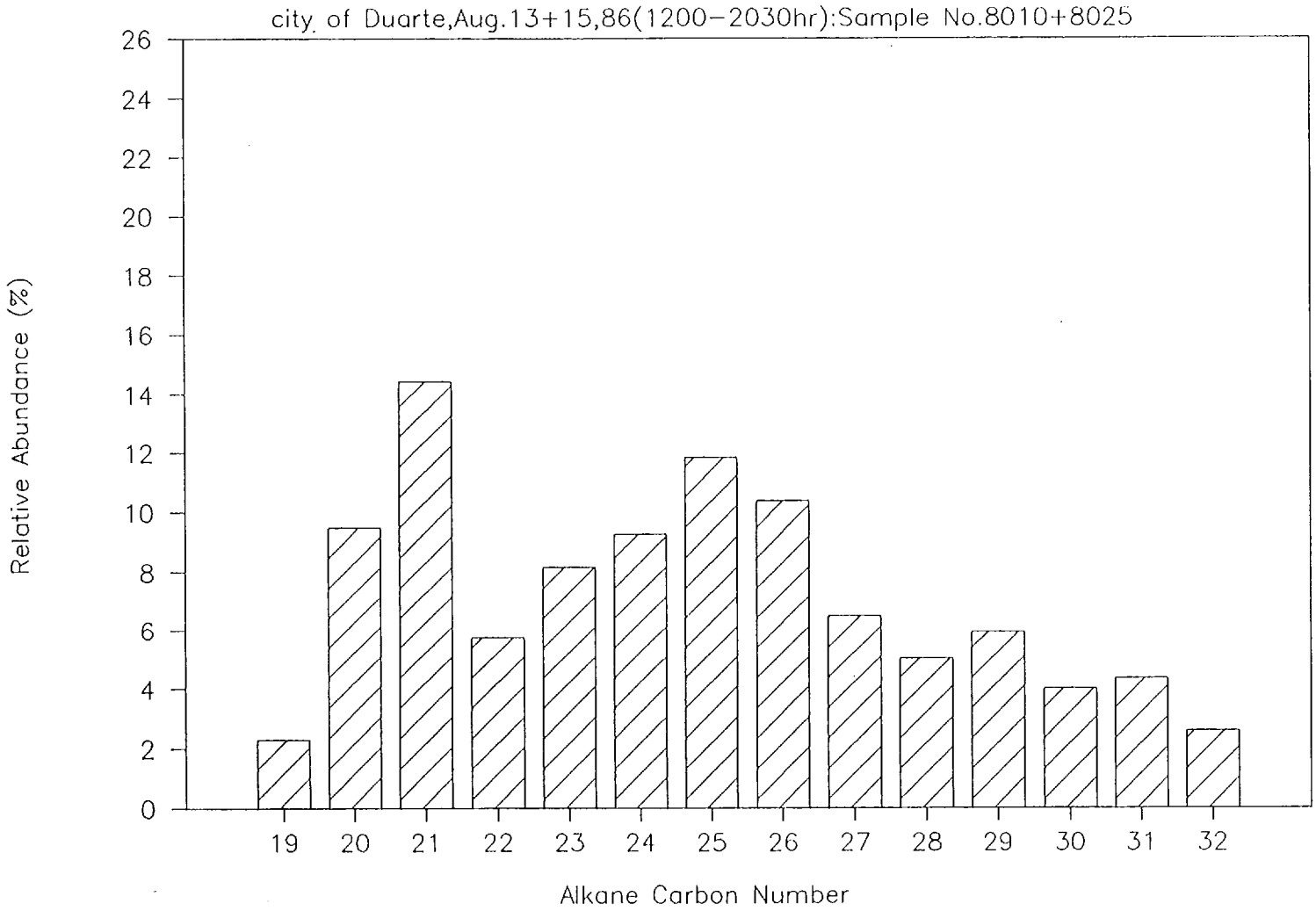


Figure IV-24

Alkane Distribution Pattern for Night Sample

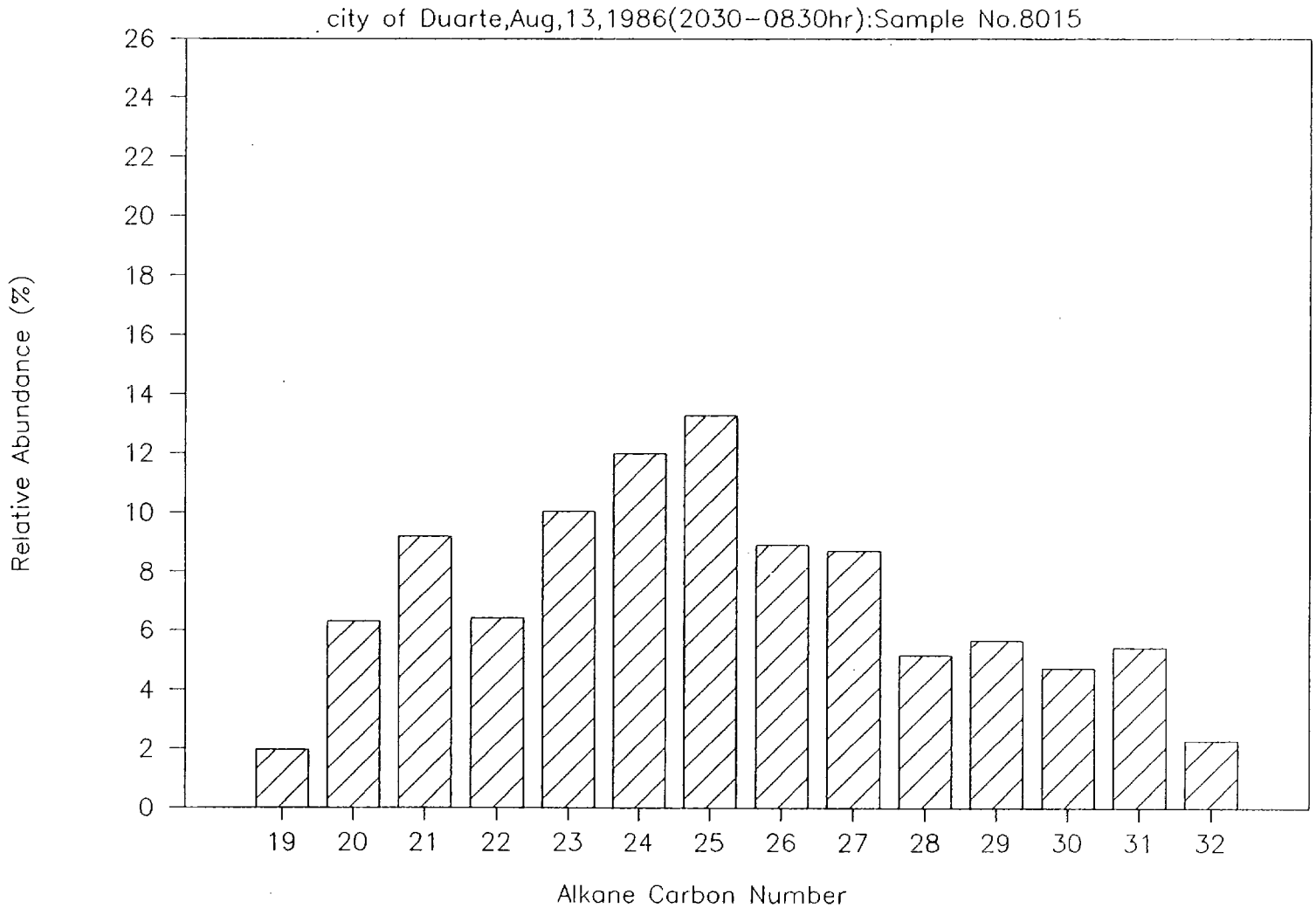


Figure IV-25

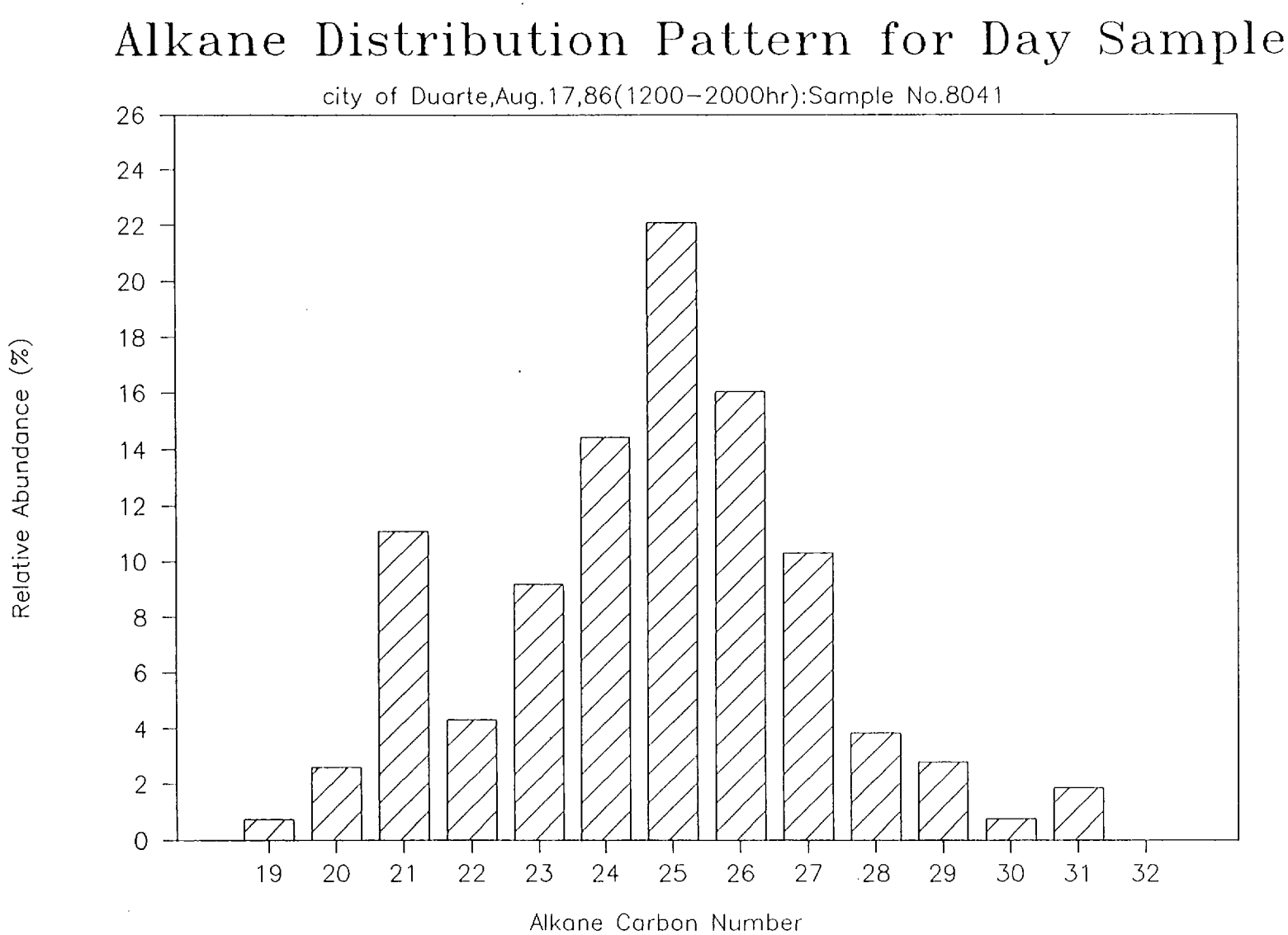

Alkane Distribution Pattern for Day Sample
city of Duarte,Aug.17,86(1200-2000hr):Sample No.8041
Relative Abundance (%)
0
2
4
6
8
10
12
14
16
18
20
22
24
26
19
20
21
22
23
24
25
26
27
28
29
30
31
32
Alkane Carbon Number

Figure IV-26

Alkane Distribution Pattern for Day Sample

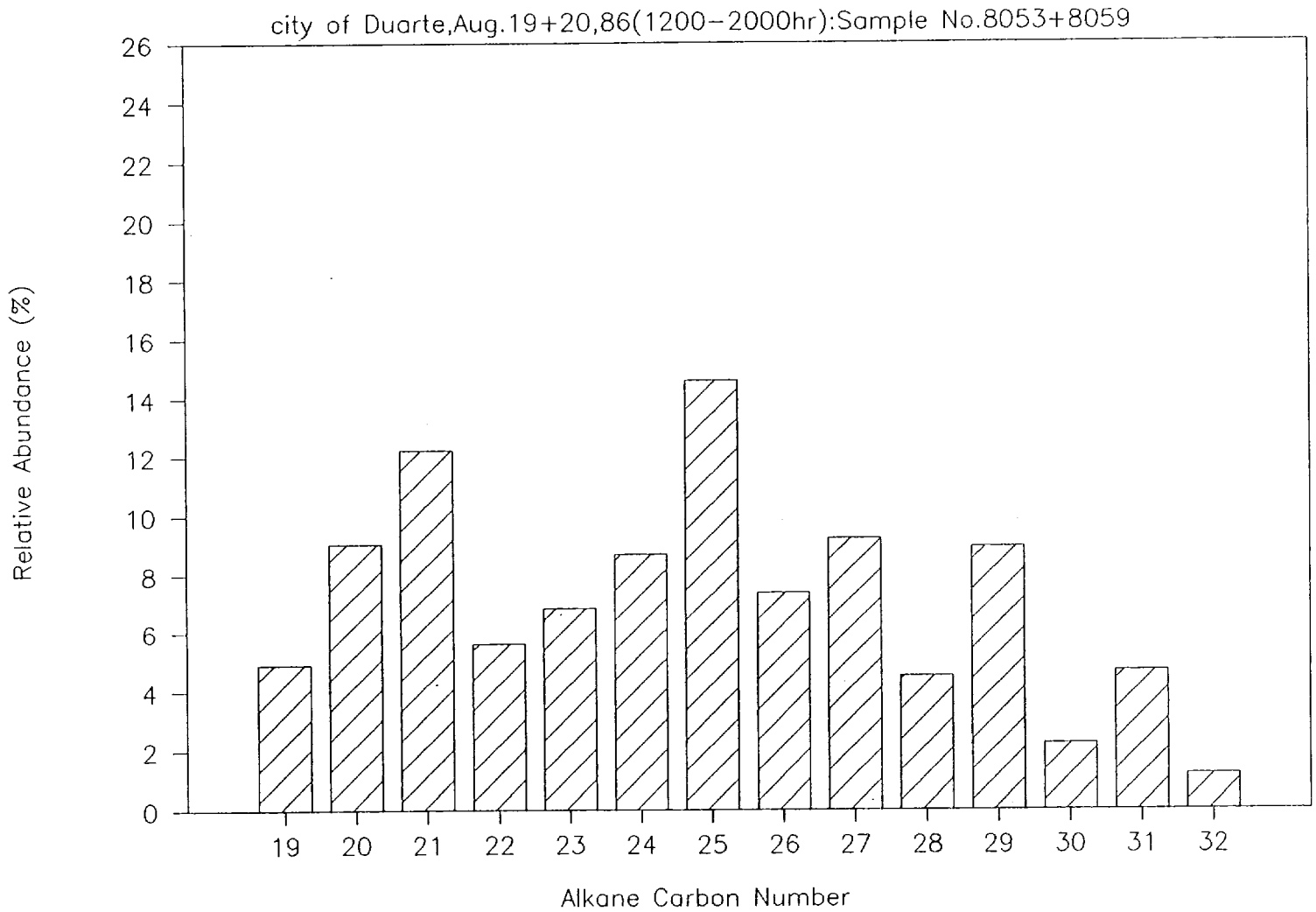


Table IV-5: Saturated hydrocarbon concentrations (ng/m3) in samples collected at the Caldecott Tunnel.

Collection Date (AUG 1989)	10/Day	10/Night	10/Night
Filter Number	3809	3813	3814
Carbon No.			
19	6.8	2.6	3.7
20	13.4	4.5	10.9
21	16.8	6.0	15.9
22	12.4	5.6	26.5
23	6.3	3.0	16.4
24	4.3	2.4	16.0
25	7.2	3.7	21.9
26			
27			
28			
29			
30			
31			
32			
CPI*			
O/E**			

* CPI is calculated from the following ratio

$$\frac{1}{2}\left(\frac{C25 + C27 + \ldots + C33}{C24 + C26 + \ldots + C32} + \frac{C25 + C27 + \ldots + C33}{C26 + C28 + \ldots + C34}\right)$$

$$** \quad \text{Odd/Even} = \frac{C29 + C31}{C28 + C30}$$

Table IV-6: Relative amounts of saturated hydrocarbons in samples collected at the Caldecott Tunnel.

Collection Date (AUG 1989)	10/Day	10/Night	10/Night
Filter Number	3809	3813	3814
Carbon No.	Relative Percent of --- Total Saturated Hydrocarbons ---		
19	10.1	9.4	3.3
20	19.9	16.2	9.8
21	25.1	21.7	14.3
22	18.5	20.1	23.8
23	9.4	10.8	14.7
24	6.4	8.6	14.4
25	10.7	13.2	19.7
26			
27			
28			
29			
30			
31			
32			
CPI*			
O/E**			

* CPI is calculated from the following ratio

$$1/2 \left(\frac{C25 + C27 + \ldots + C33}{C24 + C26 + \ldots + C32} + \frac{C25 + C27 + \ldots + C33}{C26 + C28 + \ldots + C34} \right)$$

$$** \text{ Odd/Even} = \frac{C29 + C31}{C28 + C30}$$

Figure IV-27

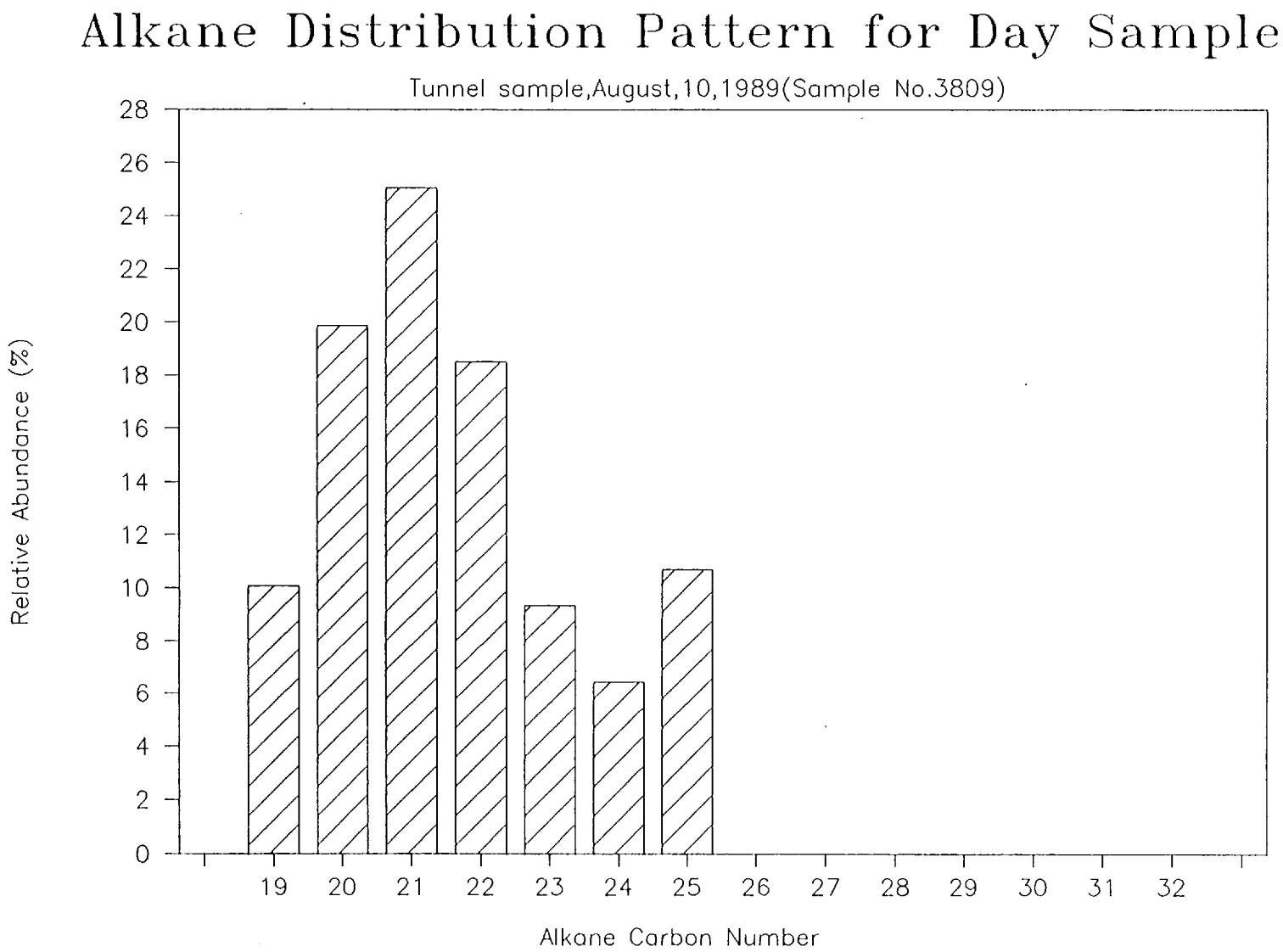

Alkane Distribution Pattern for Day Sample
Tunnel sample,August,10,1989(Sample No.3809)
Relative Abundance (%)
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
19
20
21
22
23
24
25
26
27
28
29
30
31
32
Alkane Carbon Number

Figure IV-28

Alkane Distribution Pattern for Night Sample

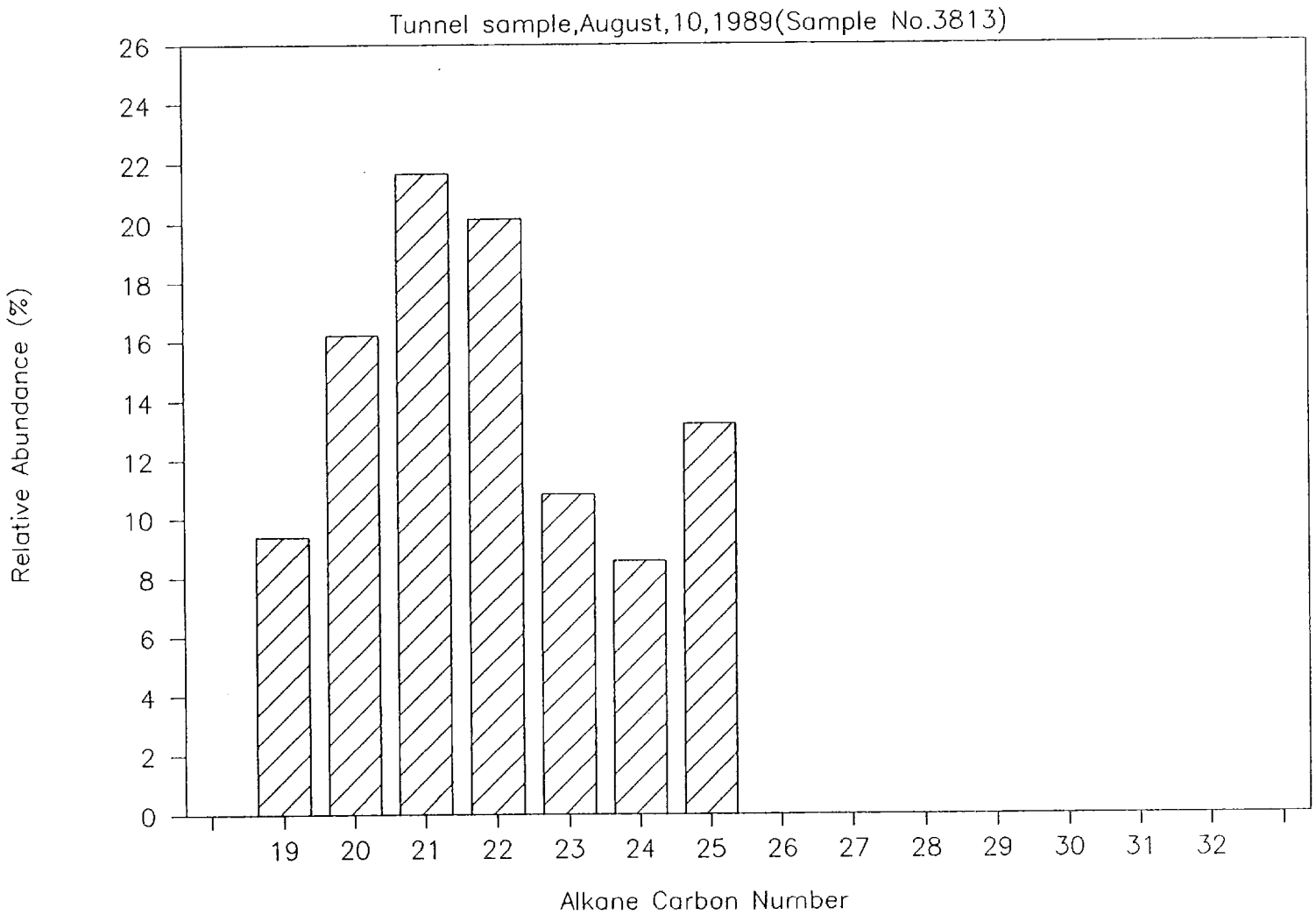


Figure IV-29

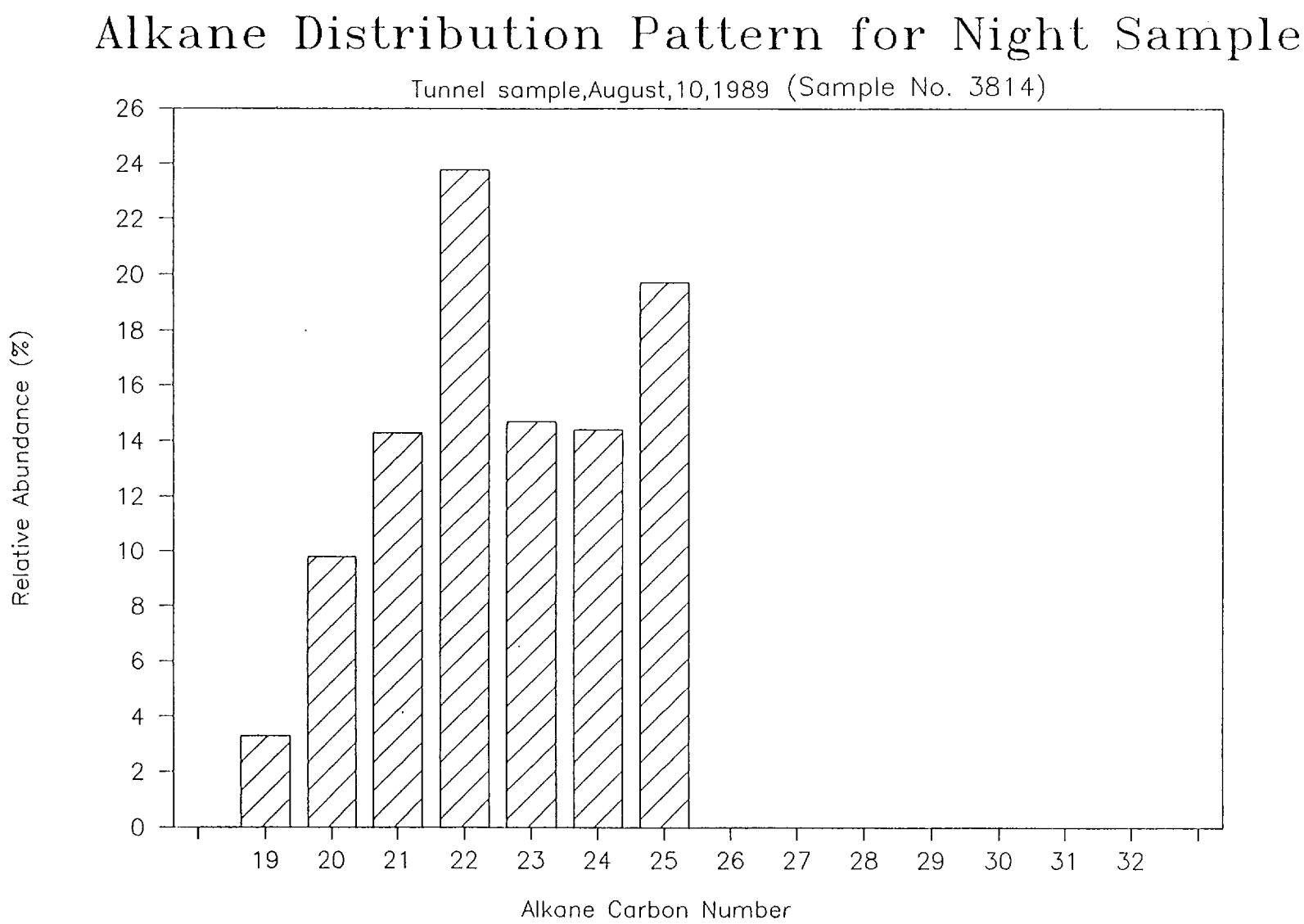
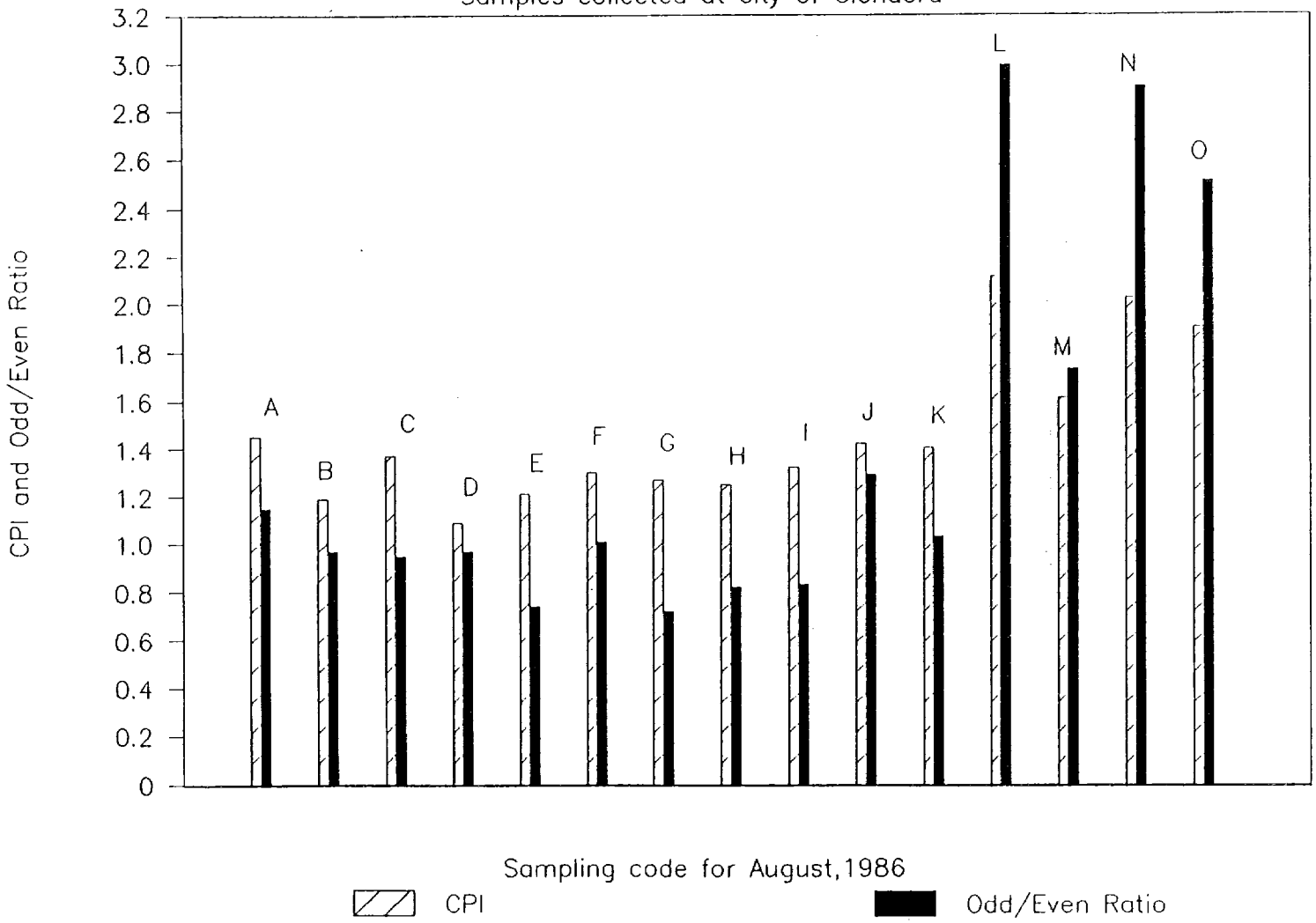

Alkane Distribution Pattern for Night Sample
Tunnel sample,August,10,1989 (Sample No. 3814)
Relative Abundance (%)
0
2
4
6
8
10
12
14
16
18
20
22
24
26
19
20
21
22
23
24
25
26
27
28
29
30
31
32
Alkane Carbon Number

Figure IV-30

CPI and Odd/Even Ratios

Samples collected at city of Glendora



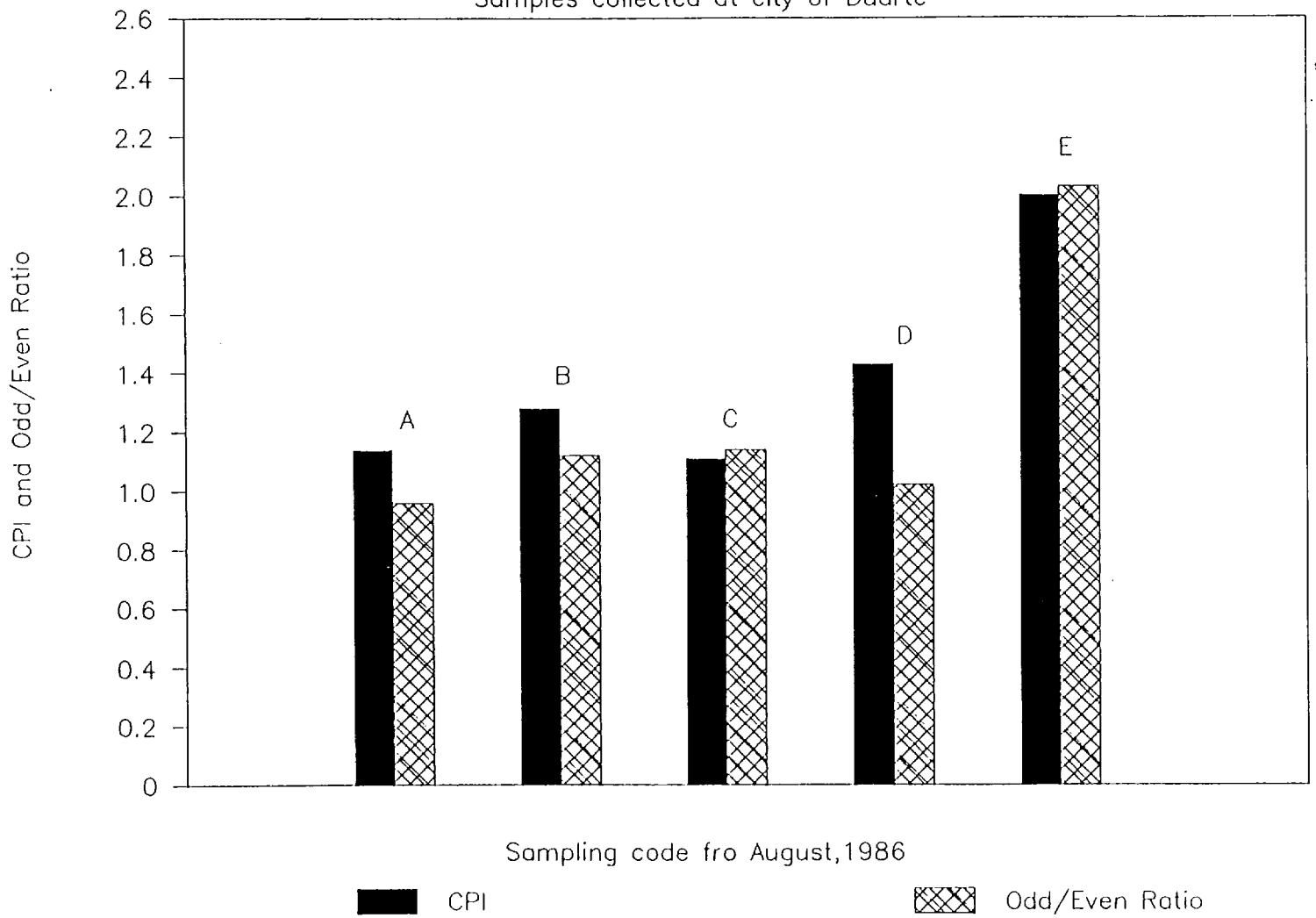
Key

Sample ID	Sampling Date	Sampling Time: Day or Night	Sampling Time: Time
A	8/13/86	D	0800-2000
B	8/13/86	N	2000-0800
C	8/14/86	D	0800-2000
D	8/14/86	N	2000-0800
E	8/15/86	D	0800-2000
F	8/15/86	N	2000-0800
G	8/16/86	D	0800-2000
H	8/16/86	N	2000-0720
I	8/17/86	D	0800-2000
J	8/17/86	N	2005-0800
K	8/18/86	D	0800-2000
L	8/18/86	N	2000-0800
M	8/19/86	D	0800-2015
N	8/19/86	N	2020-0800
O	8/20/86	D	0800-2000

Figure IV-31

CPI and Odd/Even Ratios

Samples collected at city of Duarte



Key

Sample ID	Sampling Date	Sampling Time: Day or Night	Sampling Time: Time
A	8/13/86	D	0810-1230
A	8/14/86	D	0830-1252
B	8/13/86	N	2030-0830
C	8/13/86	D	1230-2030
C	8/15/86	D	1200-2000
D	8/17/86	D	1200-2000
E	8/19/86	D	1200-2000
E	8/20/89	D	1200-2000

} combined samples

V. POLYNUCLEAR AROMATIC HYDROCARBON (PAH) CONTENTS

V. POLYNUCLEAR AROMATIC HYDROCARBON CONTENTS

The distribution pattern of polynuclear aromatic hydrocarbons (PAH) detected ranged from o-xylene (one ring) to coronene (7 rings). The aliphatic side chain was generally restricted to a single methyl group. This is a strong indication for the PAH origin coming from combustion sources. The distribution of the various identified PAH compounds was not uniform and certain compounds such as dibenzothiophene (commonly present in California crude oils) was found in some of the samples from Glendora (Table V-1), in none of the samples from Duarte (Table V-2) and in all the tunnel samples (Table V-3). Surprisingly, in the tunnel samples dibenzothiophene was detected in the night samples in much lower concentration than in the day samples, which may reflect a lower number of diesel fueled vehicles using the tunnel at night than during the day.

The content of PAH was generally higher in the ambient air night samples than in the day samples, with the exceptions of samples collected on 8/13/86 and 8/14/86 and 8/20/90. Otherwise the night samples were highest for both Glendora and Duarte. There was no significant difference in the tunnel samples between the day and night collections.

One of the major reasons for examining the PAH fraction was to identify a source for wood combustion. Trees contain abiotic acid, which on heating is converted to retene, a three ring PAH. No retene was identified in the individual filter aerosols. However, several of the filters were composited and concentrated and in the first chromatographic fraction of the concentrate, only trace (unquantifiable) amounts of retene was identified in one composite. This indicates that wood burning from structural fires or wild fires was not important in the regions of collection during the times of collection.

Table V-1. Concentration of individual polynuclear aromatic hydrocarbons in samples collected at the city of Glendora.

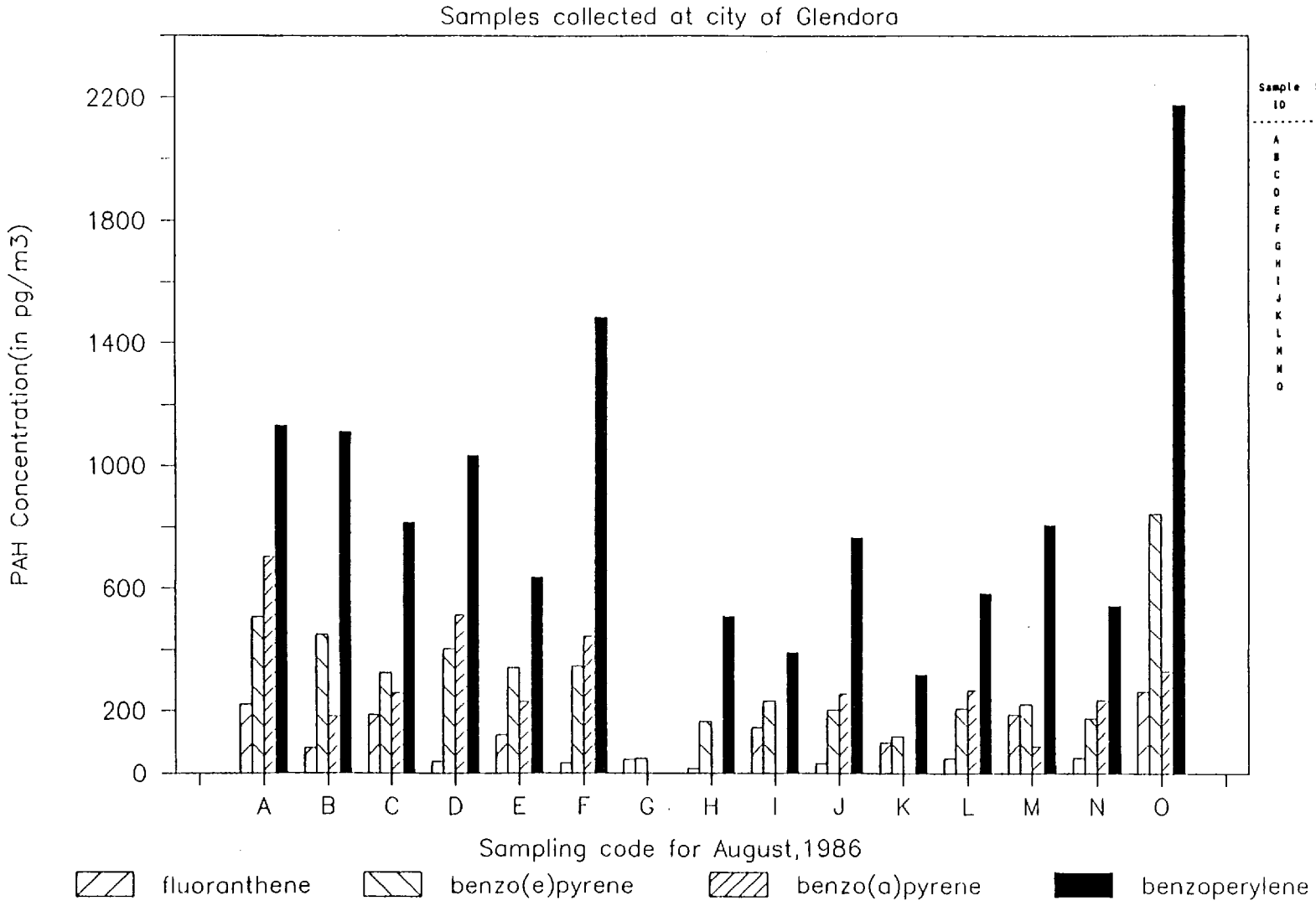
	Concentration in pg/m3																				
	Day														Night						
Collection Date (AUG 1986)	13	13	14/15	14	14	15	16	16/17	17	18/19	18	19	20	20	13	14	15	16	17	18	19
Filter Number	8007 8008	8009	8017 8027	8019	8020	8026 8029	8033 8036	8034 8040	8043 8044	8047 8051	8048 8049	8054 8055	8057 8058	8060 8061	8013 8014	8024	8031	8037	8045	8050	8056
N-DODECYLBENZENE (INTERNAL STD.)																					
O-XYLENE	14.0	--	5.9	--	--	6.9	--	102.4	23.1	9.0	--	13.6	11.9	10.6	6.0	--	--	--	--	--	--
ISOPROPYLBENZENE (CUMENE)	--	--	--	--	--	3.4	--	--	--	4.0	--	--	--	4.6	--	--	--	--	--	--	--
INDAN	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
NEOPENTYLBENZENE	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
1,2,3,4-TETRAMETHYLBENZENE	--	--	--	--	--	--	--	--	7.3	--	--	--	--	--	--	--	--	--	--	--	--
NAPTHALENE	--	5.1	9.8	16.4	--	7.4	48.2	14.1	44.9	10.0	30.9	29.2	39.8	12.5	13.8	--	23.8	10.6	6.7	--	17.2
2-METHYLNAPHTHALENE	--	13.0	32.3	32.9	--	21.2	52.1	42.2	36.9	27.1	22.3	23.3	53.8	15.8	13.1	--	13.6	10.6	6.7	3.3	20.6
1-METHYLNAPHTHALENE	--	5.1	23.5	32.9	5.5	13.7	34.3	39.1	12.5	11.0	10.9	13.6	42.8	--	6.0	--	6.8	--	--	3.3	--
1,3,5-TRIISOPROPYLBENZENE	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
BIPHENYL	--	10.0	--	16.4	5.5	--	10.6	14.1	8.6	--	--	13.6	18.9	--	--	--	3.4	3.5	--	3.3	3.4
2,6-DIMETHYLNAPHTHALENE	--	20.0	--	21.9	11.1	--	19.8	--	--	--	--	7.1	26.9	--	--	3.4	--	--	--	--	--
HEXAMETHYLBENZENE	--	--	--	--	--	--	--	--	--	--	--	--	19.9	15.8	--	--	--	--	6.7	--	--
ACENAPHTHENE (1,2-DIHYDROACENAPHTHYLENE)	--	3.0	--	21.9	11.1	--	--	--	--	--	--	9.7	--	--	--	--	--	--	--	--	3.4
2,3,5-TRIMETHYLNAPHTHALENE	--	3.0	--	11.0	5.5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
FLUORENE	--	--	--	11.0	16.6	--	--	--	--	--	--	14.9	34.8	--	--	3.4	--	3.5	--	--	--
2-METHYLFLUORENE	--	32.9	--	11.0	11.1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	6.9
DIBENZOTHIOPHENE	--	--	--	--	--	--	--	--	--	--	--	8.4	19.9	--	--	3.4	--	--	--	--	6.9
PHENANTHRENE	134.0	--	89.2	39.5	60.9	45.8	--	159.6	59.4	133.5	66.4	99.1	196.2	99.0	32.3	40.8	44.2	35.4	37.0	53.4	--
ANTHRACENE	28.0	--	15.7	--	--	--	63.4	--	--	147.6	--	20.1	--	--	14.8	--	--	--	--	56.8	--

Table V-1. Concentration of individual polynuclear aromatic hydrocarbons in samples collected at the city of Glendora (continued).

	Concentration in pg/m3																				
	Day														Night						
Collection Date (AUG 1986)	13	13	14/15	14	14	15	16	16/17	17	18/19	18	19	20	20	13	14	15	16	17	18	19
Filter Number	8007 8008	8009	8017 8027	8019	8020	8026 8029	8033 8036	8034 8040	8043 8044	8047 8051	8048 8049	8054 8055	8057 8058	8060 8061	8013 8014	8024	8031	8037	8045	8050	8056
FLUORANTHENE	137.0	38.0	114.7	69.2	60.9	65.8	--	86.3	101.6	118.5	37.8	129.6	160.4	104.3	79.0	37.4	30.6	14.2	30.2	46.8	48.2
PYRENE	143.0	45.5	126.4	44.5	77.6	69.8	--	105.4	89.1	96.4	38.3	122.5	222.1	103.6	76.9	51.0	27.2	14.2	23.5	50.1	65.4
2,3-BENZOFLUORENE	--	5.1	--	--	--	--	--	--	--	--	--	23.3	58.8	46.9	349.8	10.2	--	--	--	--	10.3
1,1'-BINAPHTHALENE	--	--	--	34.6	16.6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
BENZO(A)ANTHRACENE	78.0	--	300.8	--	--	--	--	63.2	--	--	--	68.7	486.0	52.8	290.3	200.6	--	--	--	--	154.8
CHRYSENE/TRIPHENYLENE	--	45.5	97.0	--	--	56.1	--	12.0	42.2	68.3	25.7	74.5	156.4	75.9	93.7	68.0	--	--	--	--	44.7
BENZO(B+K)FLUORANTHENE	574.0	--	631.1	--	177.3	237.4	--	237.9	213.8	425.7	115.0	--	1397.4	138.6	971.4	527.0	431.8	272.6	245.3	257.2	213.3
BENZO(E)PYRENE	508.0	--	334.7	158.1	--	173.9	--	95.4	184.8	65.3	84.7	190.5	653.4	190.7	451.2	405.0	346.8	166.4	201.6	207.1	175.4
BENZO(A)PYRENE	697.0	7.6	459.1	29.6	--	--	--	--	--	--	--	84.9	244.0	--	184.1	513.4	445.4	--	258.7	267.2	233.9
PERYLENE	--	--	--	44.5	16.6	--	12.5	--	--	--	--	--	--	--	--	37.4	27.2	--	--	--	31.0
9,10-DIPHENYLANTHRACENE	--	5.1	--	34.6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
1,2,5,6-DIBENZANTHRACENE	--	10.1	22.5	--	--	--	--	--	--	--	--	--	--	--	107.8	85.0	57.8	--	--	--	--
BENZO(G,H,I)PERYLENE	934.0	197.3	621.3	242.1	265.9	327.8	--	--	393.4	639.5	--	487.9	1687.2	427.0	1112.8	1034.0	1485.8	509.8	769.4	584.5	543.5
ANTHANTRENE	--	30.4	--	54.3	16.6	--	--	--	--	--	--	--	--	--	38.6	78.2	27.2	--	--	--	488.5
CORONENE	--	207.5	37.7	192.7	--	40.0	--	--	97.0	115.5	--	169.8	--	60.7	588.7	493.0	1009.8	300.9	611.5	377.4	--
1,2,4,5-DIBENZOPYRENE	--	--	--	49.4	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
TOTAL	2687.0	665.4	2290.8	1151.0	759.0	831.7	241.0	971.4	1314.7	1871.5	431.9	1604.4	5530.8	1358.9	3450.7	3590.0	3981.4	1341.7	2200.8	1910.5	2067.4

Figure V-1

Concentration of Selected Polynuclear Aromatic Hydrocarbon Compounds

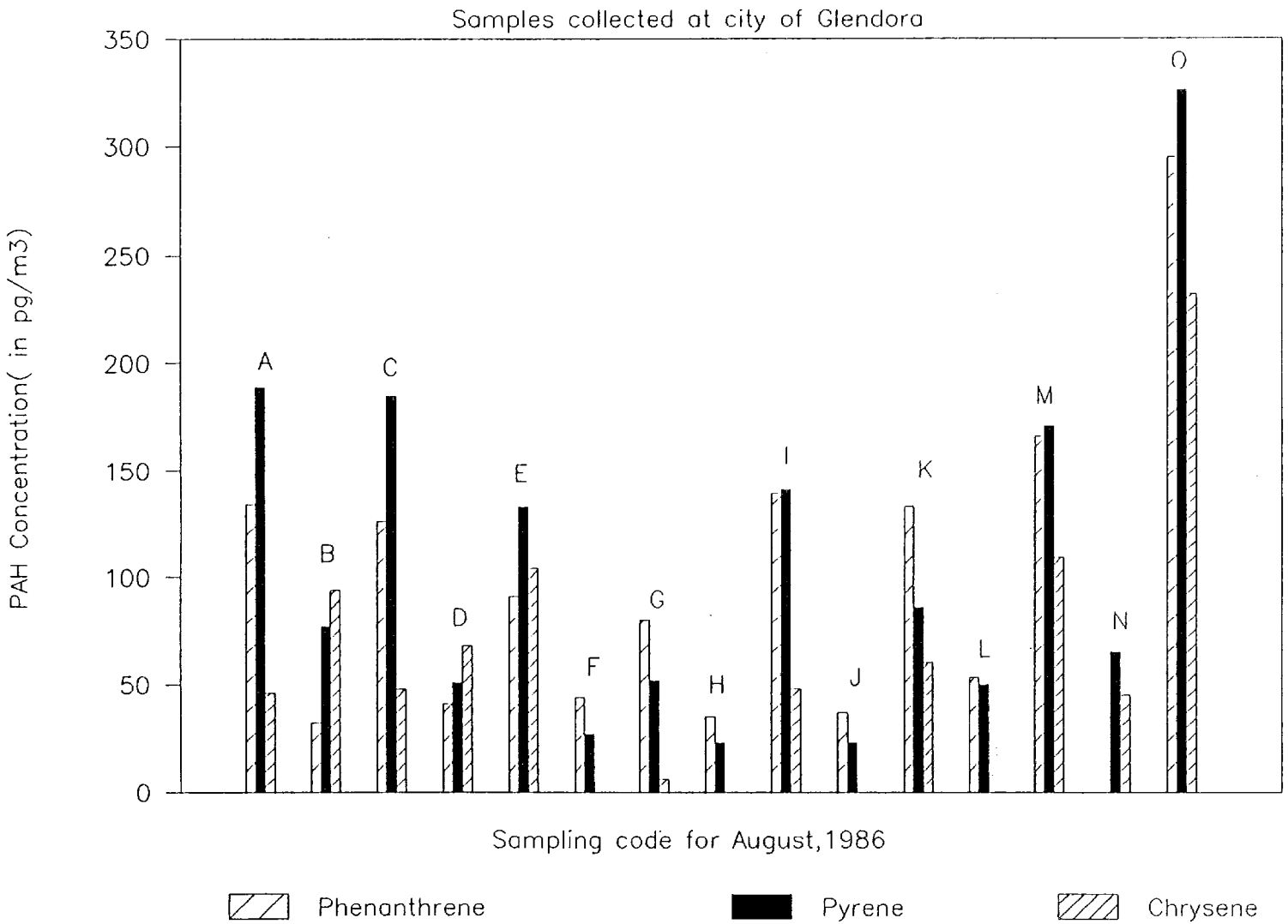


Key

Sample ID	Sampling Date	Sampling Time: Day or Night	Sampling Time: Time
A	8/13/86	D	0800-2000
B	8/13/86	N	2000-0800
C	8/14/86	D	0800-2000
D	8/14/86	N	2000-0800
E	8/15/86	D	0800-2000
F	8/15/86	N	2000-0800
G	8/16/86	D	0800-2000
H	8/16/86	N	2000-0720
I	8/17/86	D	0800-2000
J	8/17/86	N	2005-0800
K	8/18/86	D	0800-2000
L	8/18/86	N	2000-0800
M	8/19/86	D	0800-2015
N	8/19/86	N	2020-0800
O	8/20/86	D	0800-2000

Figure V-2

Concentration of Selected Polynuclear Aromatic Hydrocarbon Compounds



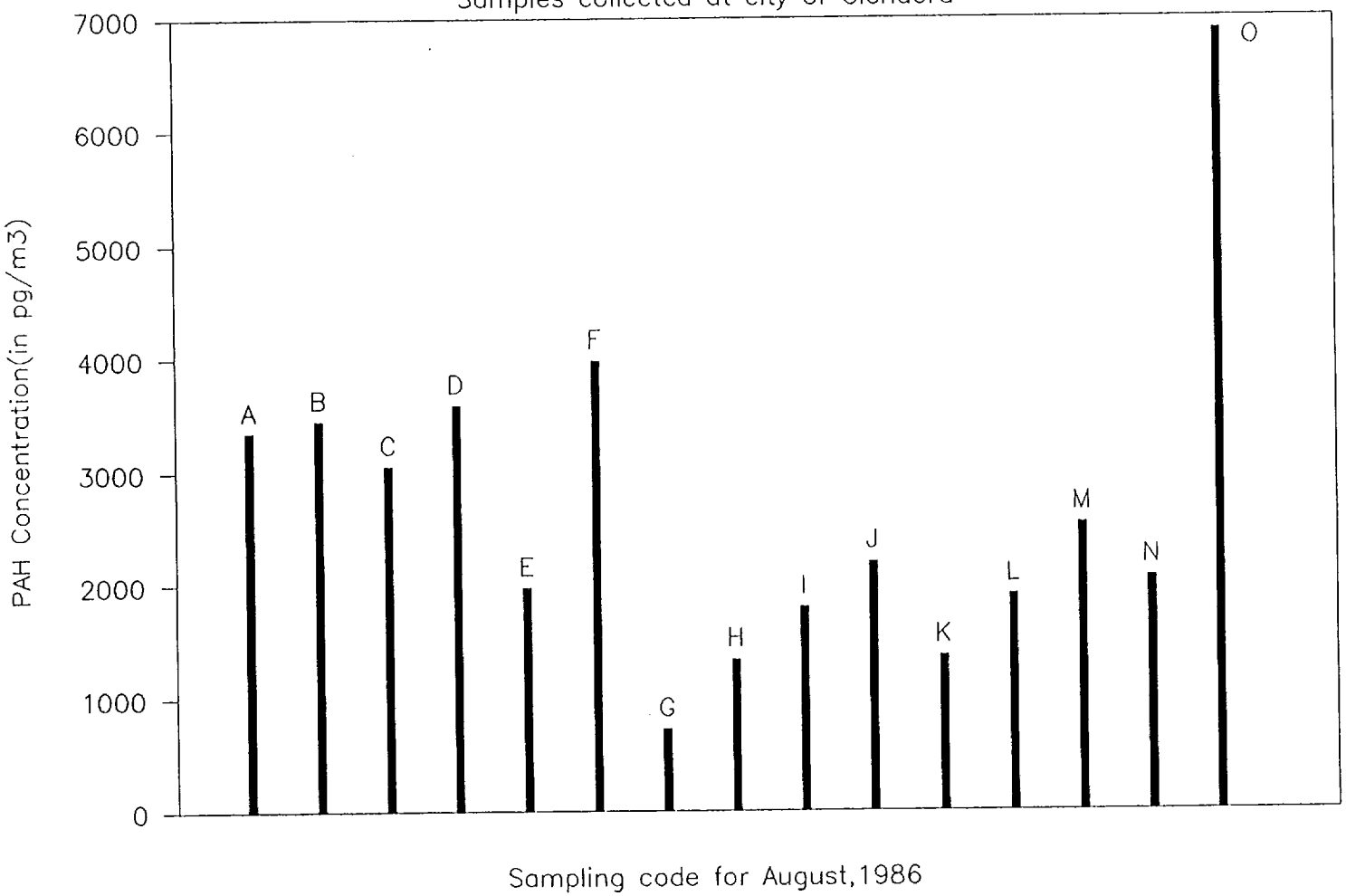
Key

Sample ID	Sampling Date	Sampling Time: Day or Night	Sampling Time: Time
A	8/13/86	D	0800-2000
B	8/13/86	N	2000-0800
C	8/14/86	D	0800-2000
D	8/14/86	N	2000-0800
E	8/15/86	D	0800-2000
F	8/15/86	N	2000-0800
G	8/16/86	D	0800-2000
H	8/16/86	N	2000-0720
I	8/17/86	D	0800-2000
J	8/17/86	N	2005-0800
K	8/18/86	D	0800-2000
L	8/18/86	N	2000-0800
M	8/19/86	D	0800-2015
N	8/19/86	N	2020-0800
O	8/20/86	D	0800-2000

Figure V-3

Total Polynuclear Aromatic Hydrocarbon Concentration

Samples collected at city of Glendora



Key

Sample ID	Sampling Date	Sampling Time: Day or Night	Sampling Time: Time
A	8/13/86	D	0800-2000
B	8/13/86	N	2000-0800
C	8/14/86	D	0800-2000
D	8/14/86	N	2000-0800
E	8/15/86	D	0800-2000
F	8/15/86	N	2000-0800
G	8/16/86	D	0800-2000
H	8/16/86	N	2000-0720
I	8/17/86	D	0800-2000
J	8/17/86	N	2005-0800
K	8/18/86	D	0800-2000
L	8/18/86	N	2000-0800
M	8/19/86	D	0800-2015
N	8/19/86	N	2020-0800
O	8/20/86	D	0800-2000

Table V-2: Concentration of individual polynuclear aromatic hydrocarbons in samples collected at city of Duarte.

	Concentration in pg/m3				
	Day				Night
Collection Date (AUG 1986)	13/14	13/15	17	19/20	13
Filter Number	8006 8018	8010 8025	8041	8053 8059	8015
N-DODECYLBENZENE (INTERNAL STD.)					
O-XYLENE	--	5.1	12.4	4.9	--
ISOPROPYLBENZENE (CUMENE)	--	--	--	--	--
INDAN	--	--	--	--	--
NEOPENTYLBENZENE	--	--	--	--	--
1,2,3,4-TETRAMETHYLBENZENE	--	--	--	--	--
NAPTHALENE	20.1	15.7	17.7	2.3	--
2-METHYLNAPHTHALENE	21.0	18.2	26.3	4.9	10.1
1-METHYLNAPHTHALENE	--	9.7	18.4	2.3	--
1,3,5-TRIISOPROPYLBENZENE	--	--	--	--	--
BIPHENYL	--	--	10.5	--	--
2,6-DIMETHYLNAPHTHALENE	--	--	9.8	--	--
HEXAMETHYLBENZENE	--	--	--	--	--
ACENAPHTHENE (1,2-DIHYDROACENAPHTHYLENE)	--	--	--	--	--
2,3,5-TRIMETHYLNAPHTHALENE	--	--	--	--	--
FLUORENE	--	--	25.6	--	--
2-METHYLFLUORENE	--	--	--	--	--
DIBENZOTHIOPHENE	--	--	--	--	--
PHENANTHRENE	84.2	60.1	90.8	33.4	--
ANTHRACENE	45.7	--	--	3.5	49.3
FLUORANTHENE	99.8	70.3	--	51.8	--
PYRENE	113.5	78.8	40.8	66.7	--
2,3-BENZOFLUORENE	23.8	--	--	--	21.6
1,1'-BINAPHTHALENE	--	--	--	--	--
BENZO(A)ANTHRACENE	40.3	--	--	--	--
CHRYSENE/TRIPHENYLENE	109.8	74.3	10.5	--	--

Table V-2: Concentration of individual polynuclear aromatic hydrocarbons in samples collected at city of Duarte (continued).

	Concentration in pg/m3				
	Day				Night
Collection Date (AUG 1986)	13/14	13/15	17	19/20	13
Filter Number	8006 8018	8010 8025	8041	8053 8059	8015
BENZO(B+K)FLUORANTHENE	--	86.7	60.5	140.6	--
BENZO(E)PYRENE	--	185.5	--	90.4	--
BENZO(A)PYRENE	44.8	--	--	124.1	--
PERYLENE	--	--	--	--	287.3
9,10-DIPHENYLANTHRACENE	--	--	--	--	--
1,2,5,6-DIBENZANTHRACENE	--	--	--	--	14.8
BENZO(G,H,I)PERYLENE	505.5	353.9	--	252.3	--
ANTHANTRENE	--	--	--	--	1008.0
CORONENE	--	72.6	--	39.2	--
1,2,4,5-DIBENZOPYRENE	--	--	--	--	--
TOTAL	1109.0	944.4	323.8	816.5	1391.2

Figure V-4

Concentration of Selected Polynuclear Aromatic Hydrocarbon Compounds

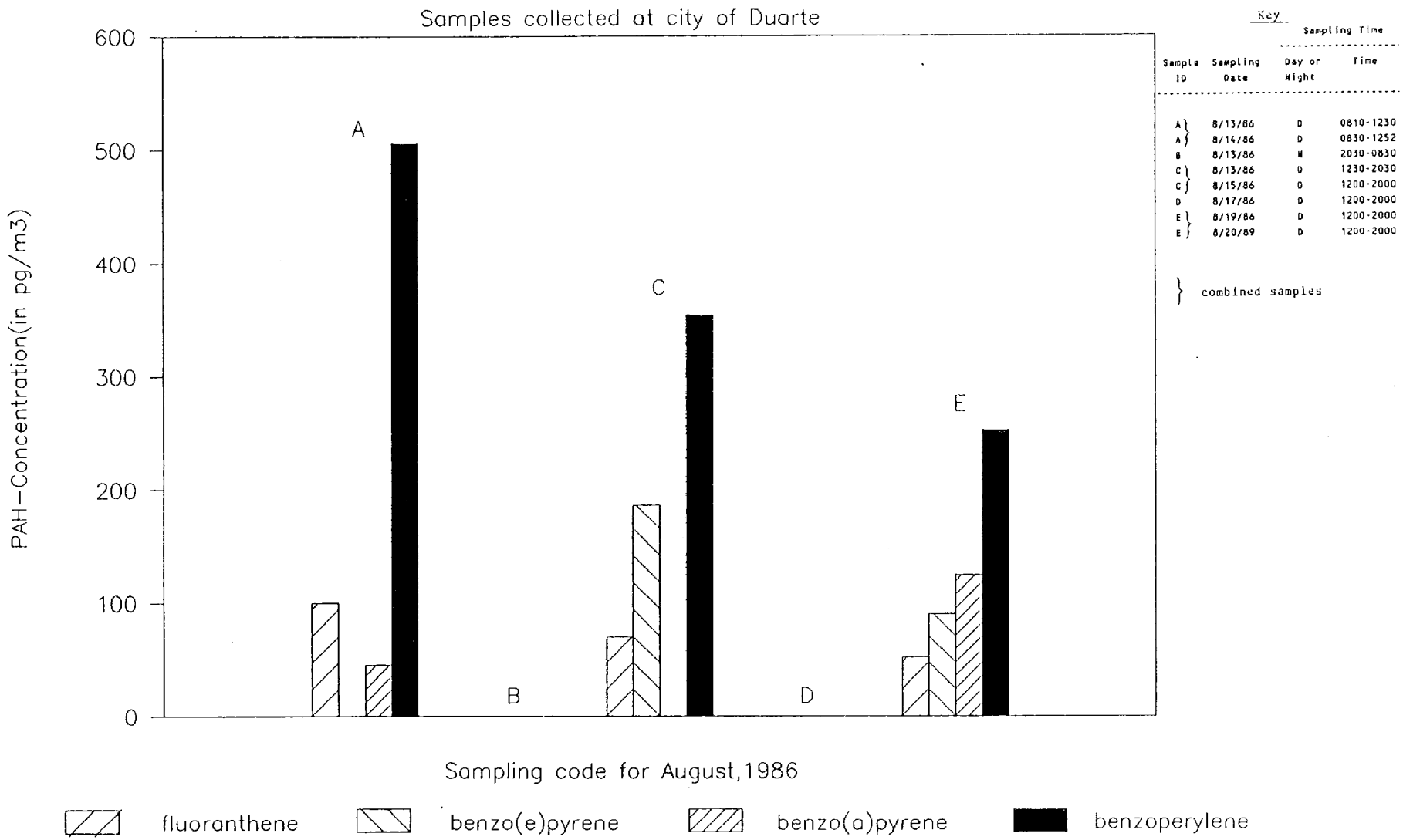


Figure V-5

Concentration of Selected Polynuclear Aromatic Hydrocarbon Compounds

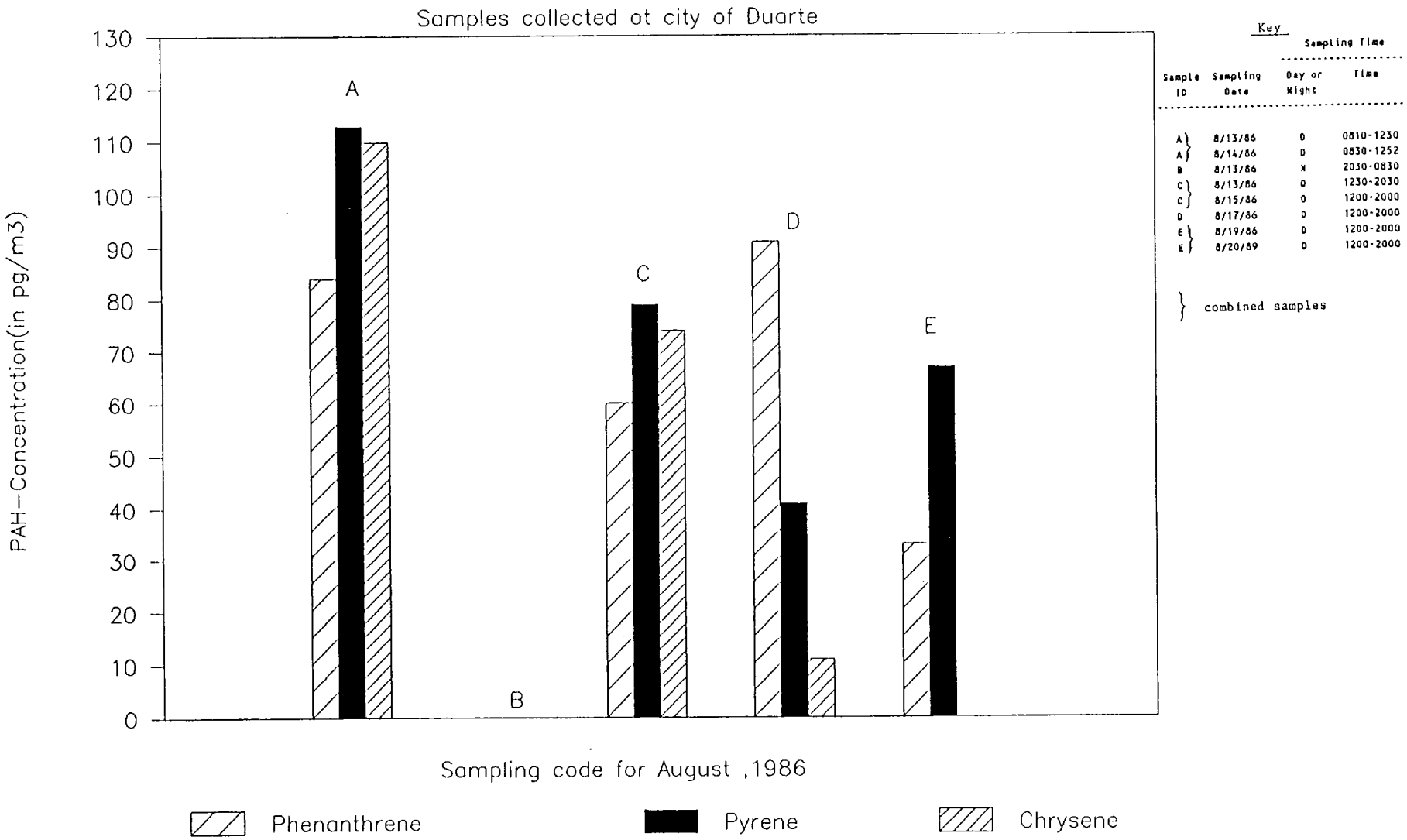
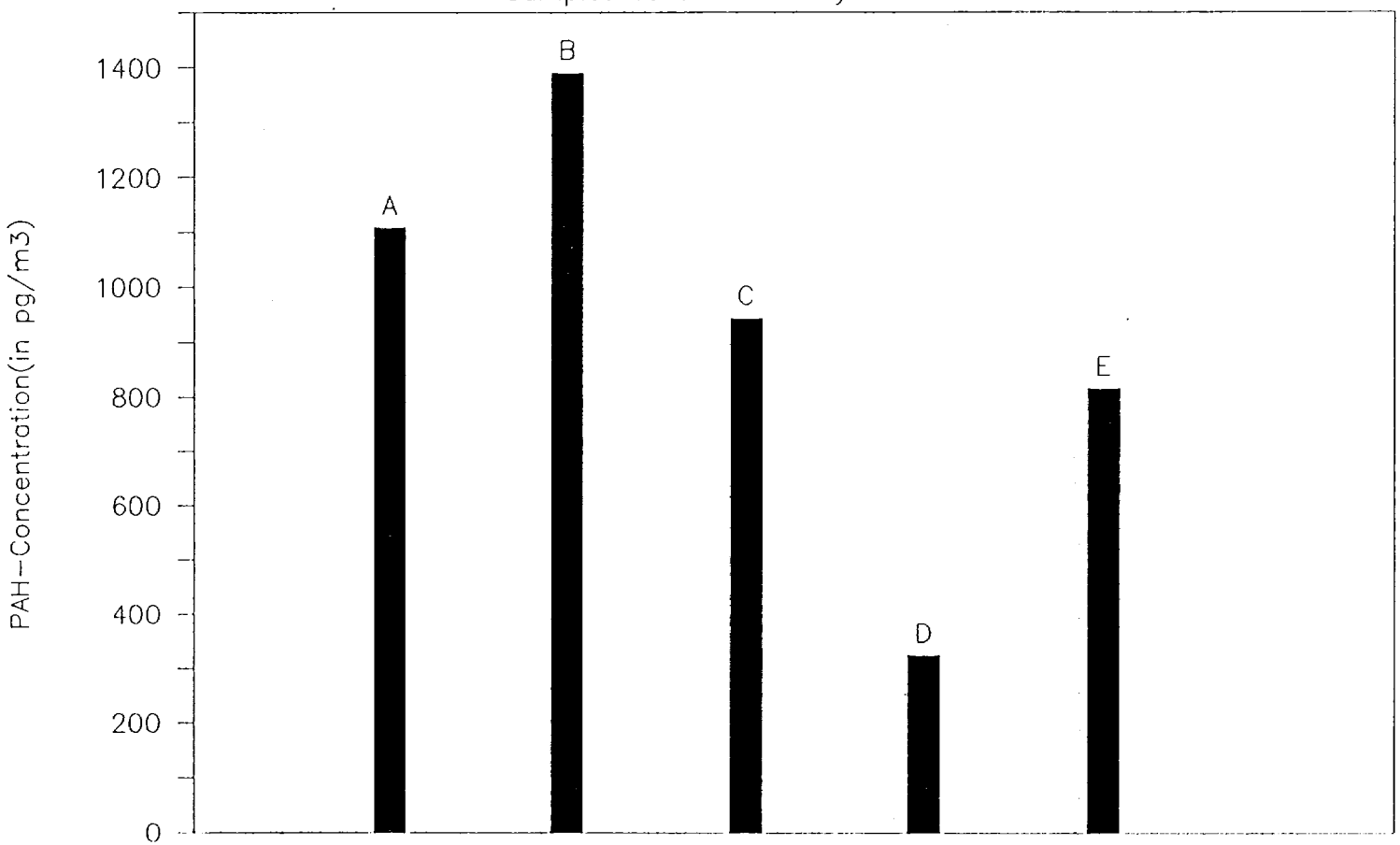


Figure V-6

Total Polynuclear Aromatic Hydrocarbon Concentration

Samples collected at city of Duarte



Sampling code for August,1986

Key

Sample ID	Sampling Date	Sampling Time: Day or Night	Sampling Time: Time
A	8/13/86	D	0810-1230
A	8/14/86	D	0830-1252
B	8/13/86	N	2030-0830
C	8/13/86	D	1230-2030
C	8/15/86	D	1200-2000
D	8/17/86	D	1200-2000
E	8/19/86	D	1200-2000
E	8/20/89	D	1200-2000

} combined samples

Table V-3: Concentration of individual polynuclear aromatic hydrocarbons in samples collected at Caldecott Tunnel.

	Concentration in pg/m3				
	Day		Night		
Collection Date (AUG 1989)	10	10	10	10	10
Filter Number	3809	3809(D)	3813	3813(D)	3814
N-DODECYLBENZENE (INTERNAL STD.)					
O-XYLENE	--	--	--	--	--
ISOPROPYLBENZENE (CUMENE)	--	--	--	--	--
INDAN	--	--	--	--	--
NEOPENTYLBENZENE	--	--	--	--	--
1,2,3,4-TETRAMETHYLBENZENE	--	--	--	--	--
NAPTHALENE	3.9	13.5	--	--	--
2-METHYLNAPHTHALENE	19.3	32.8	5.1	2.6	--
1-METHYLNAPHTHALENE	13.5	25.1	3.9	1.9	--
1,3,5-TRIISOPROPYLBENZENE	--	--	--	--	--
BIPHENYL	19.3	25.1	7.1	4.5	--
2,6-DIMETHYLNAPHTHALENE	32.8	42.5	--	--	--
HEXAMETHYLBENZENE	--	--	--	--	--
ACENAPHTHENE (1,2-DIHYDROACENAPHTHYLENE)	7.7	9.7	--	--	--
2,3,5-TRIMETHYLNAPHTHALENE	23.2	46.3	8.4	7.7	--
FLUORENE	36.7	52.1	16.1	12.8	--
2-METHYLFLUORENE	27.0	42.5	--	--	--
DIBENZOTHIOPHENE	98.5	102.0	19.7	18.0	--
PHENANTHRENE	751.0	952.0	210.0	203.0	--
ANTHRACENE	139.0	178.0	46.3	47.5	14.2
FLUORANTHENE	3216.0	3959.0	431.0	461.0	478.0
PYRENE	4797.0	5990.0	652.0	693.0	842.0
2,3-BENZOFLUORENE	790.0	1131.0	227.0	282.0	338.0
1,1'-BINAPHTHALENE	--	--	--	--	--
BENZO(A)ANTHRACENE	1664.0	2083.0	2604.0	2890.0	2232.0
CHRYSENE/TRIPHENYLENE	847.0	1008.0	967.0	938.0	1169.0
BENZO(B+K)FLUORANTHENE	--	--	3592.0	3760.0	3815.0
BENZO(E)PYRENE	--	--	2047.0	2128.0	1672.0
BENZO(A)PYRENE	--	--	1222.0	1153.0	519.0

Table V-3: Concentration of individual polynuclear aromatic hydrocarbons in samples collected at Caldecott Tunnel (continued).

	Concentration in pg/m3				
	Day		Night		
Collection Date (AUG 1989)	10	10	10	10	10
Filter Number	3809	3809(D)	3813	3813(D)	3814
PERYLENE	--	--	262.0	250.0	269.0
9,10-DIPHENYLANTHRACENE	57.9	36.7	--	--	--
1,2,5,6-DIBENZANTHRACENE	--	--	107.0	107.0	--
BENZO(G,H,I)PERYLENE	112.0	208.0	1382.0	1511.0	1769.0
ANTHANTRENE	--	--	49.5	24.0	--
CORONENE	--	--	128.0	108.0	--
1,2,4,5-DIBENZOPYRENE	--	--	--	--	--
TOTAL	12656.0	15938.0	13986.0	14562.0	13117.0

Figure V-7

Concentration of Selected Polynuclear Aromatic Hydrocarbon Compounds

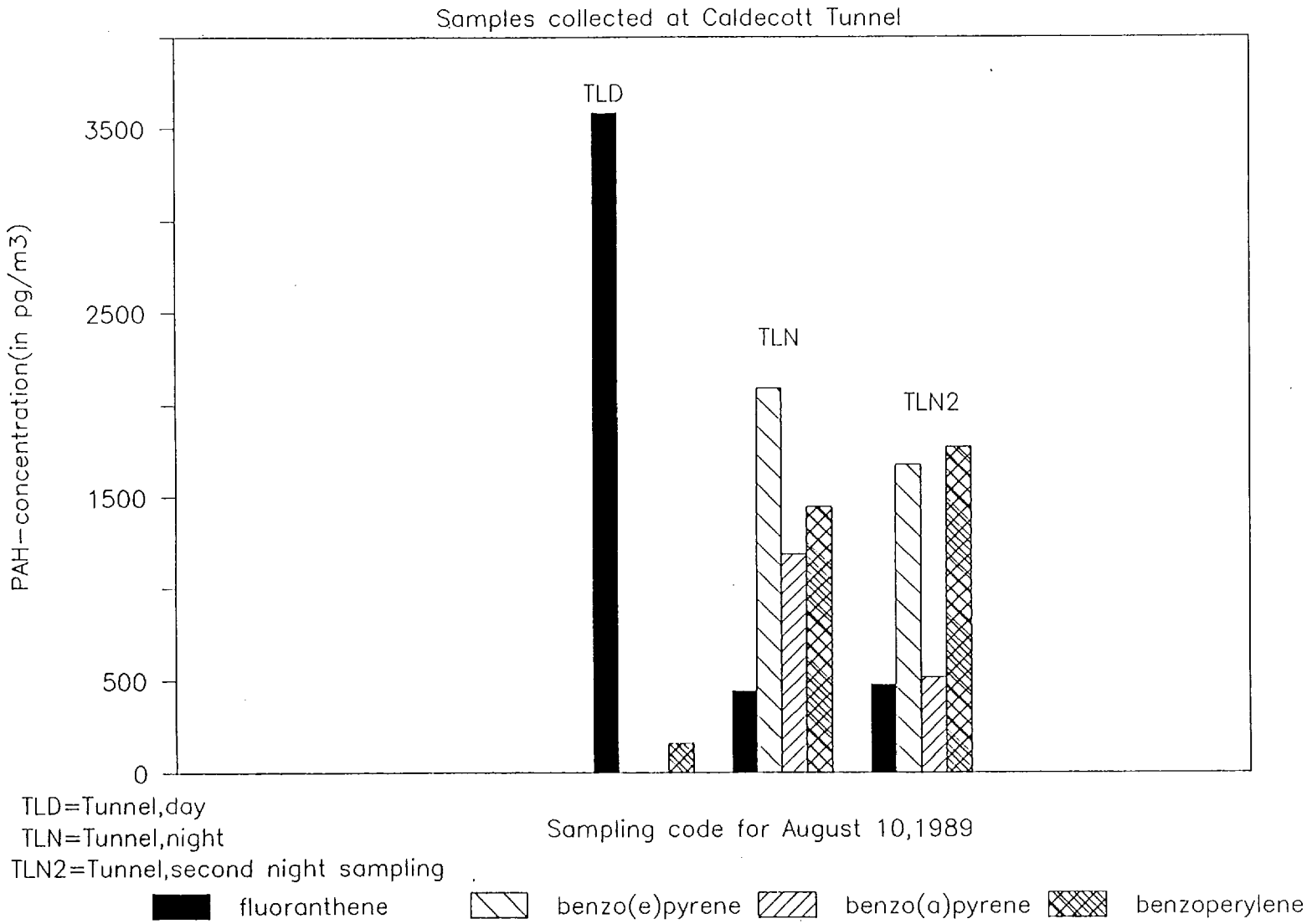
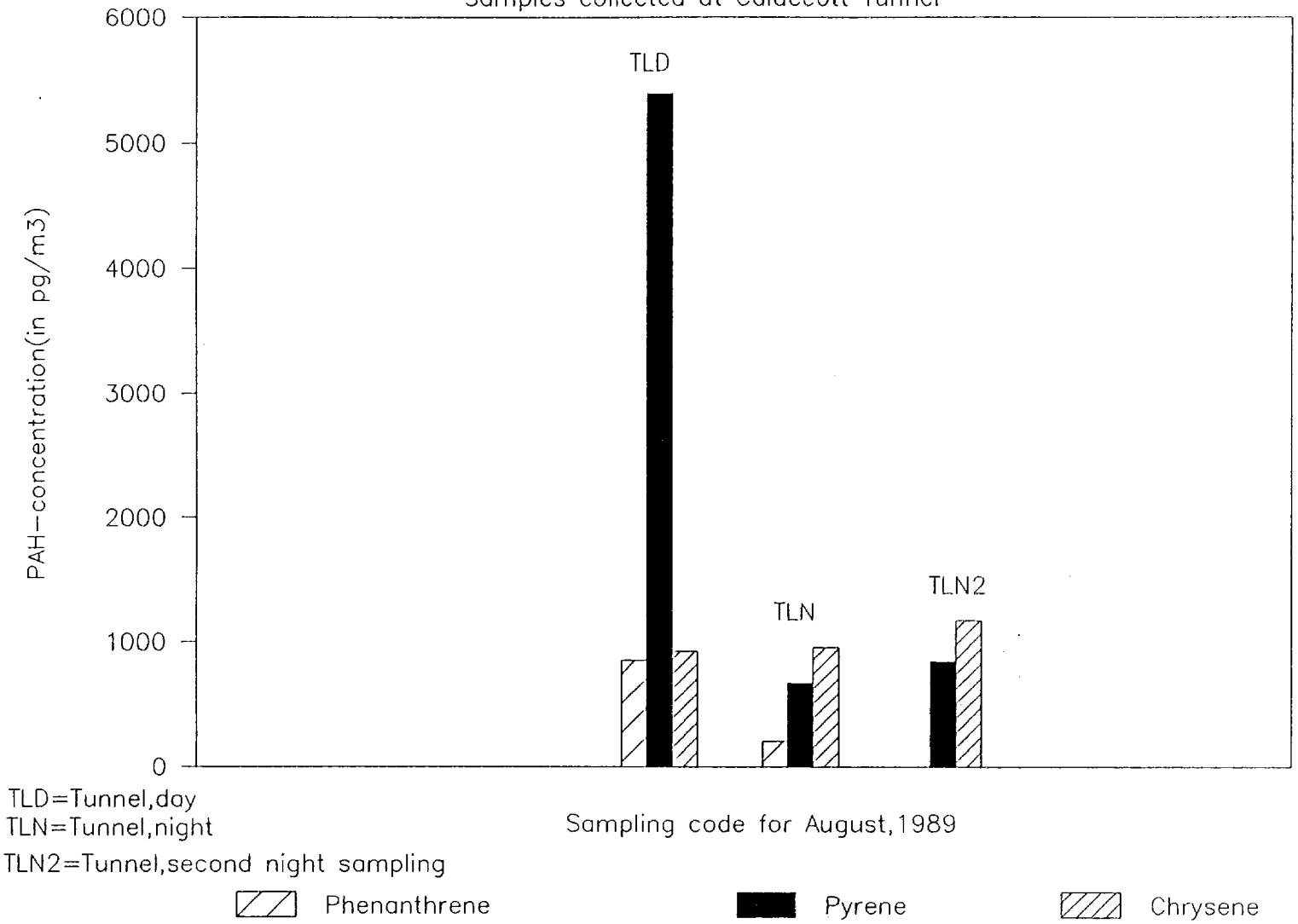


Figure V-8

Concentration of Selected Polynuclear Aromatic Hydrocarbon Compounds

Samples collected at Caldecott Tunnel



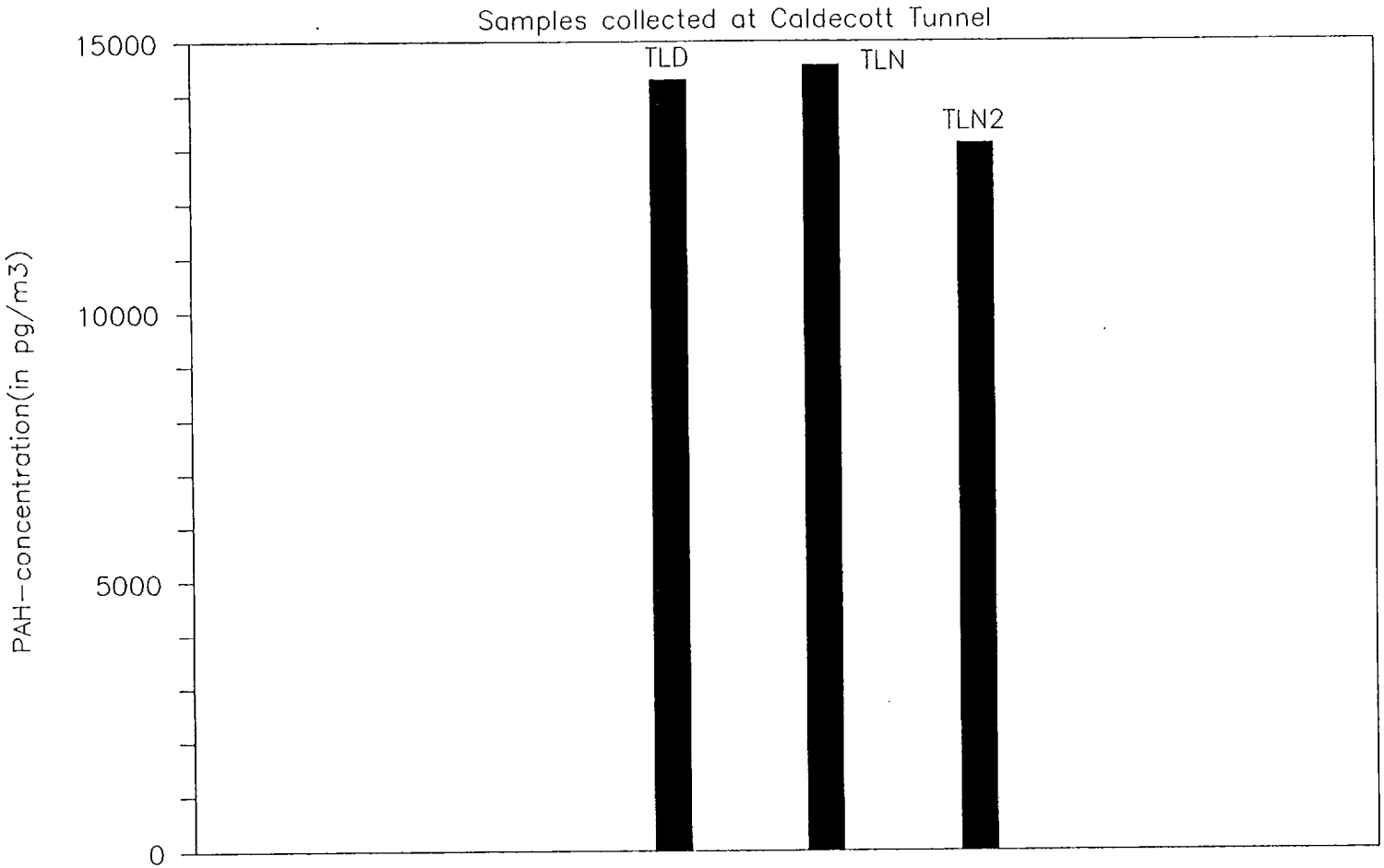
TLD=Tunnel,day
TLN=Tunnel,night
TLN2=Tunnel,second night sampling

Key

	Filter No.	Sampling Date	Sampling Time
TLD	3809	08/10/89	day
TLN	3813	08/10/89	night
TLN2	3814	08/10/89	night

Figure V-9

Total Polynuclear Aromatic Hydrocarbon Concentration



Key

	Filter No.	Sampling Date	Sampling Time
TLD	3809	08/10/89	day
TLN	3813	08/10/89	night
TLN2	3814	08/10/89	night

TLD=Tunnel,day

TLN=Tunnel,night

TLN=Tunnel,second night sampling

Sampling code for August,1989

VI. ALIPHATIC BIOMARKER DATA FOR GLENDORA COMPOSITE SAMPLES AND FOR CALDECOTT TUNNEL SAMPLES

VI. ALIPHATIC BIOMARKER DATA FOR GLENDORA COMPOSITE SAMPLES AND FOR CALDECOTT TUNNEL SAMPLES.

The term biomarkers has been applied to the sterane and triterpane classes (Figure VI-1) which have survived from biological lipids and still retain much of the complex stereochemistry of their source materials (Mair, 1964; Huang and Meinschein, 1979; Moldowan et al, 1985, 1986; Volkman, 1986; Mackenzie, 1984). There are twenty or thirty related compounds in each of these classes that are commonly observed in fossil fuel or oil shale, and whose distribution varies considerably from one petroleum source to another. Because of the large diversity of the numerous isomers among the various polycyclic biomarkers, it is possible to correlate similarities and differences among various products. This fact makes their analysis a powerful tool for demonstrating similarity or dissimilarity among petroleum materials from different sources and also provides information on processes to which these petroleum products have been subjected.

Gas chromatography-mass spectrometry analysis was performed on Glendora and Caldecott aerosol samples to study their biomarkers. Due to the very small quantity of aliphatic biomarkers, the hydrocarbon fractions of Glendora samples collected at a similar time were combined (Table VI-1), whereas the three Caldecott samples were analyzed individually. The biomarker content in Caldecott sample 3814 was very small and therefore the results are very poor.

The biomarker distribution patterns (triterpane, m/z 191 and sterane, m/z 217 mass fragmentograms, Figures VI-2 to VI-12 and VI-13 to VI-23 respectively) of saturate/aromatic hydrocarbon fractions from Glendora (composites #1, 2, 3 and 4) and Caldecott Tunnel (Filter #'s 3809, 3813 and 3814) aerosol samples indicate that they are closely similar to each other and are largely derived from petroleum residues.

The triterpane distribution of both Glendora and Caldecott samples consist

of 17α(H), 21β(H)-hopanes in the C27-C34 range, with a maximum at C30. C28-bisnorhopane, a common biomarker in California type crude oil and its products (Figures VI-24 to VI-27), was identified in Glendora aerosol samples, whereas its concentration in the Caldecott Tunnel samples is below the detection limit (VI-10 to VI-12). The predominance of the more thermally stable 22S-isomer over the 22R-isomer (which predominates in biological samples) in hopane homologs C_{31}-C_{34}, is typical of light oils and petroleum products and supports the evidence for input of petroleum products in these samples (Table VI-2).

The sterane (m/z 217) mass fragmentograms of all the Glendora composite samples and to some extent the tunnel samples, resemble each other, showing that sterane and diasterane hydrocarbons ranging from C27 to C29 are abundant (Figures VI-13 to VI-23). These steroidal hydrocarbons, especially the diasteranes, show distribution patterns similar to that found in crude oil and/or petroleum products (VI-28 to VI-33). However, the 20R-isomer (biological origin) predominates over the 20S-isomer of the regular steranes (C_{27}-C_{29}, both $\alpha\alpha\alpha$ and $\alpha\beta\beta$). This predominance appears in all four composite samples (Figures VI-13 to VI-20) and suggests that a portion of the hydrocarbons present in Glendora aerosol samples may contain hydrocarbons originating from local vegetation (Table VI-3). By contrast this is not so evident in the tunnel samples (Figures VI-21 to VI-23 and Table VI-3.

The presence of a higher relative abundance of diasteranes in the tunnel samples, which is characteristic of refined products of Alaska crude oil (Figure VI-32 and VI-33), indicates that the hydrocarbons present in the tunnel samples are partly derived from products of Alaska type crude oils. This is not surprising, as California used equal amounts of California and Alaskan crude oil for refining in the late 1980's.

In summary, the suites of biomarkers (triterpanes and steranes) detected in

both Glendale composite samples and Caldecott tunnel samples confirm the input of petroleum components which are derived from a mixture of California and Alaska refined crude oils (Figure VI-34). This may be further confirmed by evaluating the stable isotope ($\delta^{13}C$ and δD) values of the aerosol samples and comparing them with those of both California and Alaska crude oils and/or their products (see section VIII).

Table VI-1. Key for identification of hydrocarbon fraction from city of Glendora filter extract samples which were combined to make the Composites Nos. 1, 2, 3 and 4.

Collection Date (AUG 1986)	Composite No. 1 Day 1	Collection Date (AUG 1986)	Composite No. 2 Day 2	Collection Date (AUG 1986)	Composite No. 3 Day 2	Collection Date (AUG 1986)	Composite No. 4 Night
Sampling Period	(0800-1200)		(1200-2000)		(1200-2000)		(2000-0800)
13	8007	13	8009	17	8043	13	8013
13	8008	14	8019	17	8044	13	8014
14	8017	14	8020	18	8048	14	8024
15	8027	15	8026	18	8049	15	8031
16	8034	15	8029	19	8054	16	8037
17	8040	16	8033	19	8055	19	8054
18	8047	16	8036	20	8060	18	8050
19	8051			20	8061	19	8056
20	8057						
20	8058						

Table VI:2 Triterpane biomarker parameters (ratios) calculated for four composite filters and three Tunnel samples analyzed. Examples are also given for a Monterey Formation crude oil from the Los Angeles basin and from a diesel fuel sold in Los Angeles and a crude oil from Alaska.

Sample No.	GC/MS#	1	2	3	4	5	6	7	8	9	10	11	12
SAMPLE #1 COMPOSITE*	2783	1.4	1.2		0.2	1.1	0.2		0.7	7.9			0.1
SAMPLE #2 COMPOSITE*	2733	1.6	1.2	0.1	0.1	0.8	0.1		0.7	9.2	0.1	0.2	0.1
SAMPLE #3 COMPOSITE*	2734	1.3	1.5	0.1	0.1	0.9	0.1		0.7	7.0	0.1	0.3	0.1
SAMPLE #4 COMPOSITE*	2735	1.2	1.2	0.2	0.2	1.0	0.1		0.7	11			0.1
Tunnel Filter #3809**	1445	1.2	1.3	0.1	0.1	0.8	0.4		0.9				
Tunnel Filter #3813**	1449	1.5	1.2	0.1	0.1	0.7	0.5		1.1				
Tunnel Filter #3814**		--	--	--	--	--	very poor sample			--	--	--	--
Crude Oil from California	1971	1.0	1.7	0.2	0.1	0.6	0.1		0.7	6.2	0.2	0.4	0.3
Crude Oil from Alaska	2598	1.4	1.4	0.1	0.1	1.6	0.1	0.1	0.6	7.1			
Diesel from California	3144	1.7	1.2	0.4	0.2	2.2	0.1	0.1	0.5	2.7	0.4	1.1	0.2

1: C_{31}(22S)-17α,21β-30-homohopane/C_{31}(22R)-17α,21β-30-homohopane
2: C_{32}(22S)-17α,21β-30,31-bishomohopane/C_{32}(22R)-17α,21β-30,31-bishomohopane
3: C_{29}-17β,21α-30-normoretane/C_{29}-17α,21β-30-norhopane
4: C_{30}-17β,21α-moretane/C_{30}-17α,21β-hopane
5: C_{27}-17α-22,29,30-trisnorhopane (Tm)/C_{27}-18α-22,29,30-trisnorhopane (Ts)
6: C_{27}-18α-22,29,30-trisnorhopane/C_{30}-17α,21β-hopane
7: C_{29}-17α-25-norhopane/C_{29}-17α,21β-30-norhopane
8: C_{29}-17α,21β-30-norhopane/C_{30}-17α,21β-hopane
9: C_{30}-17α,21β-hopane + C_{29}-17α,21β-norhopane/C_{27}-17α-22,29,30-trisnorhopane + C_{28}-17α-28,30-bisnorhopane
10: C_{28}-17α-28,30-bisnorhopane/C_{30}-17α,21β-hopane
11: C_{28}-17α-28,30-bisnorhopane/(C_{28} + C_{29})-17α-diterpanes
12: C_{30}-18α-oleanane/C_{30}-17α,21β-hopane
13: C_{23}-tricyclic/C_{24}-tetracyclic terpane

* For collection dates see Table VI-1
** Collection date, August 10, 1989

Table VI-3: Sterane biomarker parameters (ratios) calculated for four composite filters and three Tunnel samples analyzed. Examples are also given for a Monterey Formation crude oil from the Los Angeles basin and from a diesel fuel sold in Los Angeles and a crude oil from Alaska.

Sample No.	GC/MS#	A	B	C	D	E	F	G	H	J	K	L	M	N	O	P	Q
SAMPLE #1 COMPOSITE*	2783	0.7	0.9	0.8	0.7	48.4	41.6	1.5	0.4	53	0.4	0.9	3.6	42.3	22.5	35	0.4
SAMPLE #2 COMPOSITE*	2733	0.9	0.8	0.8	0.9	49.0	48.2	1.3	0.4	56	0.3	0.8	3.2	37.7	34.2	28	0.4
SAMPLE #3 COMPOSITE*	2734	0.8	0.9	0.8	0.8	47.5	43.5	1.3	0.3	62	0.3	0.7	2.8	34.2	37.8	28	0.4
SAMPLE #4 COMPOSITE*	2735	0.8	0.9	1.4	1.0	52.5	43.5	1.3	0.3	62	0.4	0.7	2.3	28.4	31.9	40	0.4
Tunnel Filter #3809**	1445	1.0	0.7	0.6	1.8	55.2	51.1	2.9	0.5	59	0.6	3.7	2.7	53.3	12.7	34	0.7
Tunnel Filter #3813**	1449	1.2	0.9	0.4	1.4	50.7	55.2	2.2	0.6	66	0.5	4.9	2.7	61.0	17.0	22	0.6
Tunnel Filter #3814**		--	--	--	--	--	very poor sample				--	--	--	--			
Crude Oil from California	1971	0.4	0.11	0.7	0.4	28.5	27.1	0.4	0.3	55	0.1	0.1	0.5	35.9	38.8	25.3	0.1
Crude Oil from Alaska	2598	1.0	1.0	1.1	1.1	51.7	49.9	1.4	0.6	64	0.4	1.2	2.2	32.1	31.0	37	0.5
Diesel from California	3144	0.6	0.5	2.7	0.4	36.7	38.1	0.5	0.2	63	0.2	0.1	0.6	15.2	43.6	41	0.2

A: C_{29}(20S)-14α(H),17α(H)-sterane/C_{29}(20R)-14α(H),17α(H)-sterane
B: C_{29}(20S)-14β(H),17β(H)-sterane/C_{29}(20R)-14α(H),17α(H)-sterane
C: C_{29}(20R)-14α(H),17α(H)-sterane/C_{27}(20R)-14α(H),17α(H)-sterane
D: C_{29}(20R)-14β(H),17β(H)-sterane/C_{29}(20R)-14α(H),17α(H)-sterane
E: C_{29}(20S+20R)-14β(H),17β(H)-steranes/[Same + C_{29}(20S+20R)-14α(H),17α(H)-steranes] x 100
F: C_{29}(20S)-14α(H),17α(H)-sterane/[Same + C_{29}(20R)-14α(H),17α(H)-sterane] x 100
G: C_{29}(20S+20R)-13β(H),17α(H)-diasteranes/C_{29}(20S+20R)-14α(H),17α(H)-steranes
H: C_{27}(20R)-13β(H),17α(H)-diasterane/C_{29}(20R)-13β(H),17α(H)-diasterane
I: C_{29}(20S)-13β(H),17α(H)-diasterane/C_{27}(20R)-13β(H),17α(H)-diasterane
J: C_{27}(20S)-13β(H),17α(H)-diasterane/[Same + C_{27}(20R)-13β(H),17α(H)-diasterane] x 100
K: C_{27}(20R)-13β(H),17α(H)-diasterane/Same + C_{27}(20R)-14α(H),17α(H)-sterane
L: C_{27}(20S)-13β(H),17α(H)-diasterane/C_{29}(20R)-14α(H),17α(H)-sterane
M: C_{30}-17α,21α-hopane/C_{29}(20R+20S)-14α(H),17α(H)-steranes + C_{29}(20R+20S)-14β(H),17β(H)-steranes
N: C_{27}(20R)-14α(H),17α(H)-sterane/[(C_{27}+C_{28}+C_{29})(20R)-14α(H),17α(H)-steranes] x 100
O: C_{28}(20R)-14α(H),17α(H)-sterane/[(C_{28}+C_{27}+C_{29})(20R)-14α(H),17α(H)-steranes] x 100
P: C_{29}(20R)-14α(H),17α(H)-sterane/[(C_{29}+C_{27}+C_{28})(20R)-14α(H),17α(H)-steranes] x 100
Q: C_{27}(20S+20R)-13βH),17α(H)-diasterane/Same + C_{27}(20S+20R)-14α(H)-17α(H)-steranes

* For collection dates see Table VI-1
** Collection date, August 10, 1989

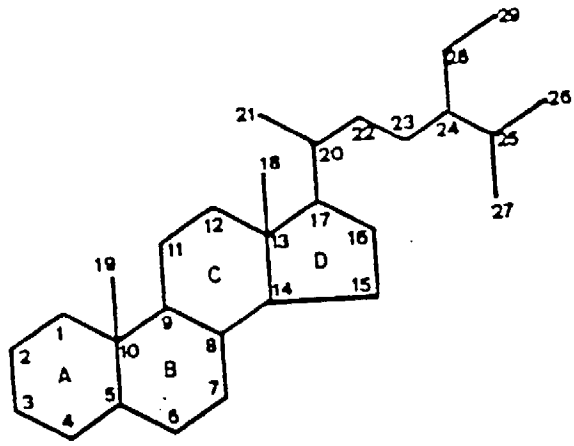
Table VI-4. Key for
Tricyclic, Tetracyclic, and Pentacyclic Terpanes
Identification (m/z 191 Fragmentograms)

Code	Identity	Carbon No.
0	C_{20}-Tricyclic Terpane	20
1	C_{21}-Tricyclic Terpane	21
2	C_{22}-Tricyclic Terpane	22
3	C_{23}-Tricyclic Terpane	23
4	C_{24}-Tricyclic Terpane	24
5	C_{25}-Tricyclic Terpane	25
Z4	C_{24}-Tetracyclic terpane	24
6	C_{26}-Tricyclic Terpane	26
7	C_{27}-Tricyclic Terpane	27
A	C_{28}-Tricyclic Terpane #1	28
B	C_{28}-Tricyclic Terpane #2	28
C	C_{29}-Tricyclic Terpane #1	29
D	C_{29}-Tricyclic Terpane #2	29
E	18α-22,29,30-Trisnorneohopane (Ts)	27
F	17α-22,29,30-Trisnorhopane (Tm)	27
G	17β-22,29-30-Trisnorhopane	27
H	17α-23,28=Bisnorhopane	28
10a	C_{30}-Tricyclic Terpane #1	30
10b	C_{30}-Tricyclic Terpane #2	30
I	17α-28,30-Bisnorhopane	28
11a	C_{31}-Tricyclic Terpane #1	31
J	17α-25-Norhopane	29
11b	C_{31}-Tricyclic Terpane #2	31
K	17α,21β-30-Norhopane	29
L	17β-21α-30-Normoretane	29
M	18α-Oleanane	30
N	17α,21β-Hopane	30
O	17β,21α-Moretane	30
13a	C_{33}-Tricyclic Terpane #1	33
13b	C_{33}-Tricyclic Terpane #2	33
P	22S-17α,21β-30-Homohopane	31
Q	22R-17α,21β-30-Homohopane	31
R	Gammacerane	30
14a	C_{34}-Tricyclic Terpane #1	34
S	17β,21α-Homomoretane	31
14b	C_{34}-Tricyclic Terpane #2	34
T	22S-17α,21β-30-Bishomohopane	32
U	22R-17α,21β-30-Bishomohopane	32
15a	C_{35}-Tricyclic Terpane #1	35
15b	C_{35}-Tricyclic Terpane #2	35
V	17β,21α-C_{32}-Bishomomoretane	32
WS	22S-17α,21β-30,31,32-Trishomohopane	33
WR	22R-17α,21β-30,31,32-Trishomohopane	33
16a	C_{36}-Tricyclic Terpane #1	36
16b	C_{36}-Tricyclic Terpane #2	36
XS	22S-17α,21β-30,31,32,33-Tetrahomohopane	34
XR	22R-17α,21β-30,31,32,33-Tetrahomohopane	34
YS	22S-17α,21β-30,31,32,33,34-Pentahomohopane	35
YR	22R-17α,21β-30,31,32,33,34-Pentahomohopane	35

Table VI-5. Key for
Steranes Identification (m/z 217 fragmentogram)

Code	Identity	Carbon No.
1	13β,17α-diacholestane (20S)	27
2	13β,17α-diacholestane (20R)	27
3	13α,17β-diacholestane (20S)	27
4	13α,17β-diacholestane (20R)	27
5	24-methyl-13β,17α-diacholestane (20S)	28
6	24-methyl-13β,17α-diacholestane (20R)	28
7+7a+7D	14α,17α-cholestane (20S) + 5β-cholestane (20R) + 24 methyl-13α,17β-diacholestane (20S)	27+27 28
8+8D	14β,17β-cholestane (20R) + 24-ethyl-13β,17α-diacholestane (20S)	27+29
9+9D	14β,17β-cholestane (20S) + 24-methyl-13α,17β-diacholestane (20R)	27+28
10	14α,17α-cholestane (20R)	27
11	24-ethyl-13β,17α-diacholestane (20R)	29
12	24-ethyl-13α,17β-diacholestane (20S)	29
13	24-methyl-14α,17α-cholestane (20S)	28
14+14a+14D	24-methyl-14β,17β-cholestane (20R) + 24-ethyl-13α,17β-diacholestane (20R) + 24-methyl-5β-cholestane	28+29 28
15	24-methyl-14β,17β-cholestane (20S)	28
16	24-methyl-14α,17α-cholestane (20R)	28
17	24-ethyl-14α-cholestane (20S)	29
18+18a	24-ethyl-14β,17β-cholestane (20R) + 24-ethyl-5β-cholestane	29
19	24-ethyl-14β,17β-cholestane (20S)	29
20	24-ethyl-14α,17α-cholestane (20R)	29
21	C_{30}-cholestane	30

STERANE



TRITERPANE

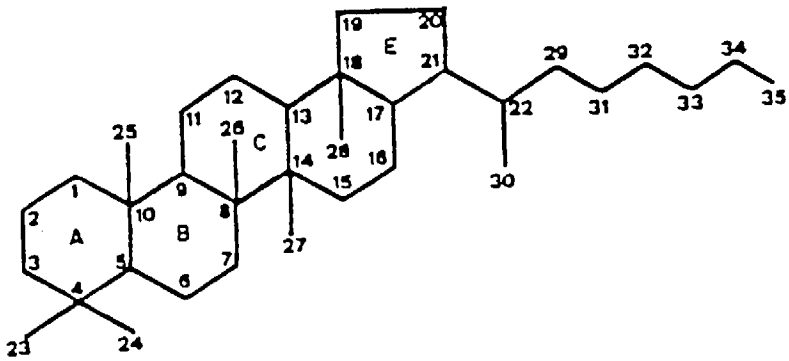


Figure VI-1. Sterane and Triterpane Compound Structures.

Figure VI-2

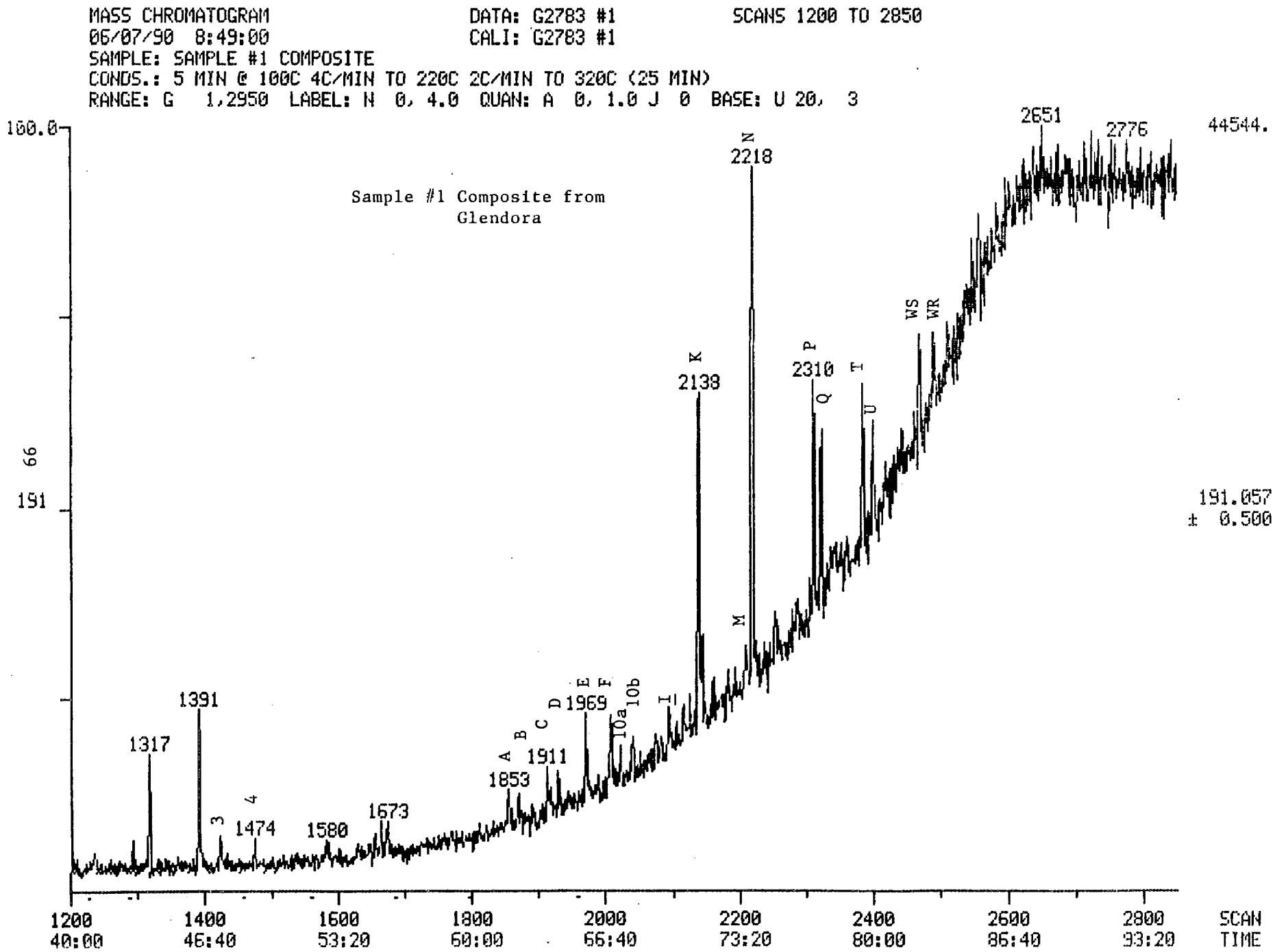

MASS CHROMATOGRAM
06/07/90 8:49:00
SAMPLE: SAMPLE #1 COMPOSITE
CONDS.: 5 MIN @ 100C 4C/MIN TO 220C 2C/MIN TO 320C (25 MIN)
RANGE: G 1,2950 LABEL: N 0, 4.0 QUAN: A 0, 1.0 J 0 BASE: U 20, 3
DATA: G2783 #1
CALI: G2783 #1
SCANS 1200 TO 2850
Sample #1 Composite from Glendora
100.0
66
191
44544.
191.057
± 0.500
1317
1391
3
4
1474
1580
1673
A
B
C
D
1853
1911
1969
E
F
10a
10b
I
K
2138
M
N
2218
P
2310
Q
T
U
WS
WR
2651
2776
1200
40:00
1400
46:40
1600
53:20
1800
60:00
2000
66:40
2200
73:20
2400
80:00
2600
86:40
2800
93:20
SCAN
TIME

Figure VI-3

Terpane Distribution

SAMPLE #1 COMPOSITE
from Glendora

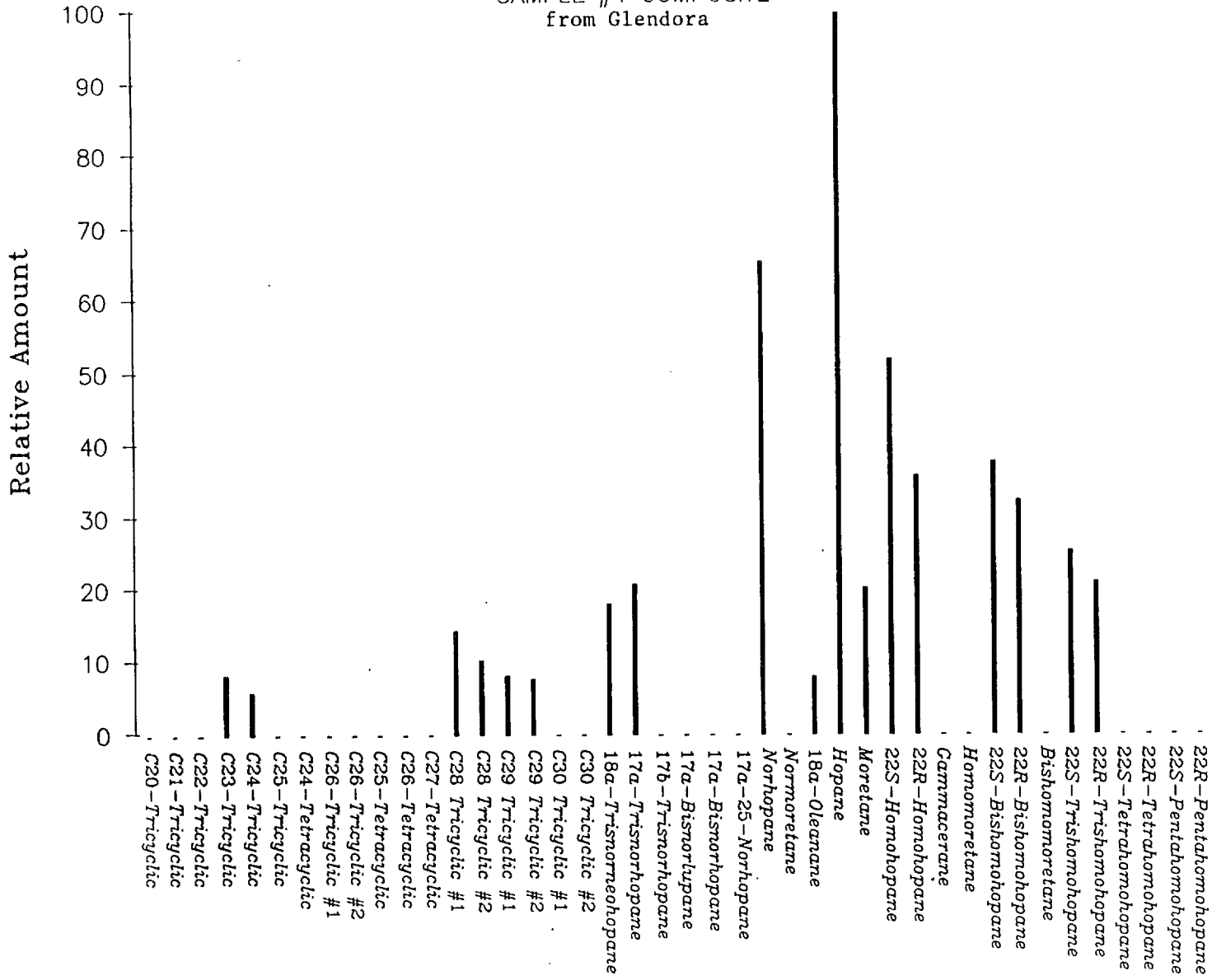


Figure VI-4

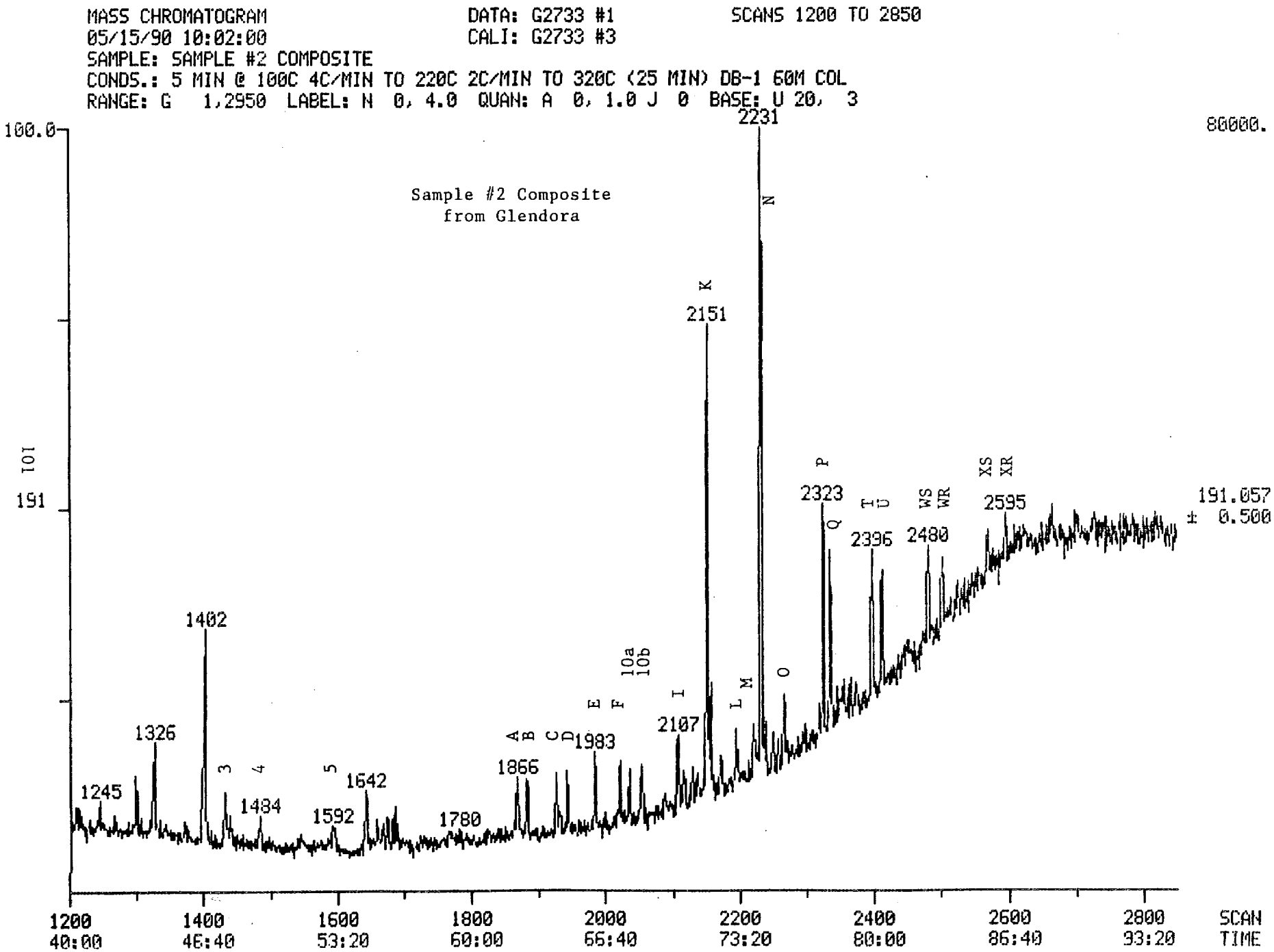

MASS CHROMATOGRAM
05/15/90 10:02:00
SAMPLE: SAMPLE #2 COMPOSITE
CONDS.: 5 MIN @ 100C 4C/MIN TO 220C 2C/MIN TO 320C (25 MIN) DB-1 60M COL
RANGE: G 1,2950 LABEL: N 0, 4.0 QUAN: A 0, 1.0 J 0 BASE: U 20, 3
DATA: G2733 #1
CALI: G2733 #3
SCANS 1200 TO 2850
Sample #2 Composite
from Glendora
100.0
80000.
191
191.057
± 0.500
1245
1326
1402
1484
1592
1642
1780
1866
1983
2107
2151
2231
2323
2396
2480
2595
SCAN
TIME

Figure VI-5

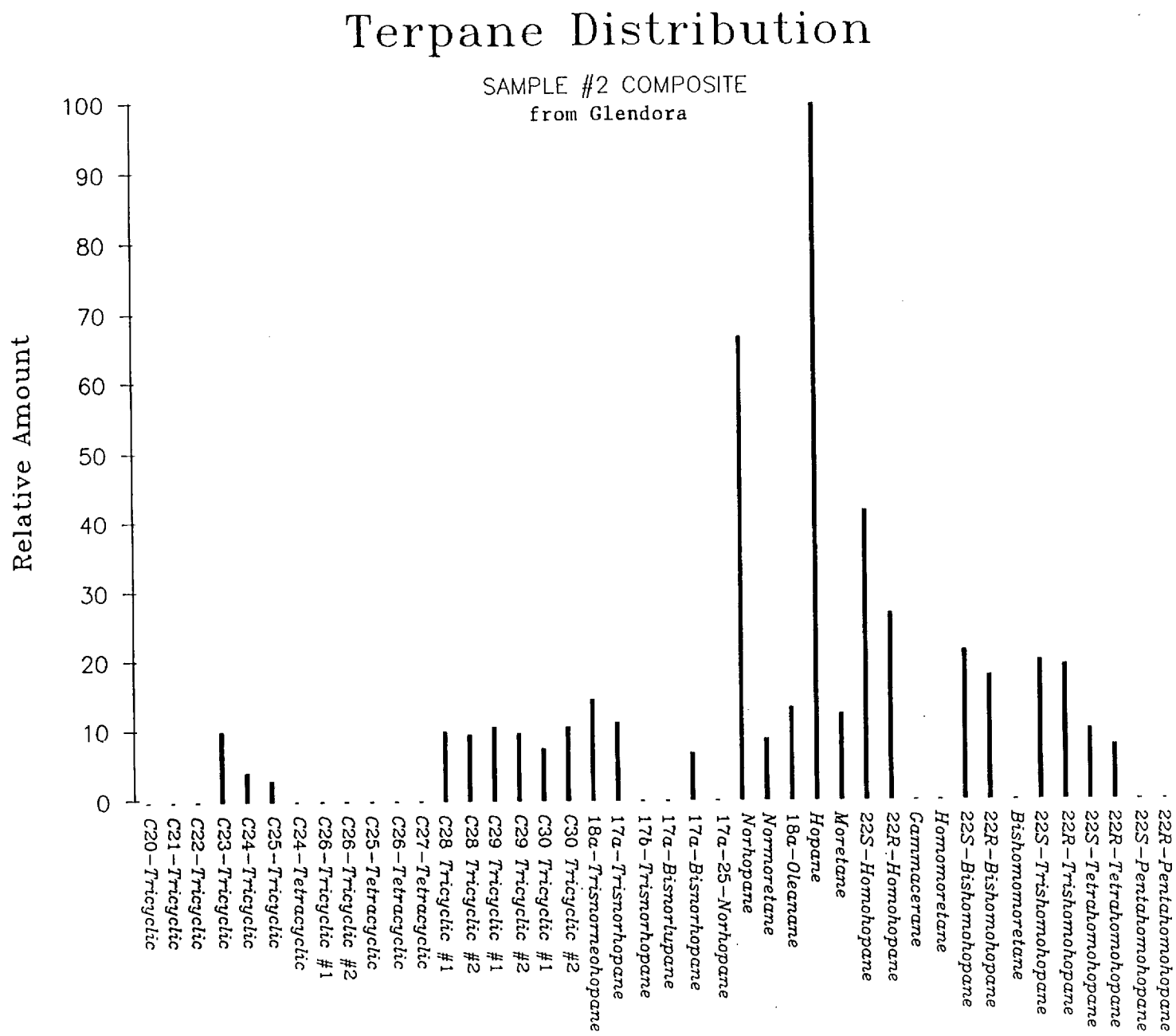

Terpane Distribution
SAMPLE #2 COMPOSITE
from Glendora
Relative Amount
100
90
80
70
60
50
40
30
20
10
0
C20-Tricyclic
C21-Tricyclic
C22-Tricyclic
C23-Tricyclic
C24-Tricyclic
C25-Tricyclic
C24-Tetracyclic
C26-Tricyclic #1
C26-Tricyclic #2
C25-Tetracyclic
C26-Tetracyclic
C27-Tetracyclic
C28 Tricyclic #1
C28 Tricyclic #2
C29 Tricyclic #1
C29 Tricyclic #2
C30 Tricyclic #1
C30 Tricyclic #2
18α-Trisnorneohopane
17α-Trisnorhopane
17β-Trisnorhopane
17α-Bisnorlupane
17α-Bisnorhopane
17α-25-Norhopane
Norhopane
Normoretane
18α-Oleanane
Hopane
Moretane
22S-Homohopane
22R-Homohopane
Gammacerane
Homomoretane
22S-Bishomohopane
22R-Bishomohopane
Bishomomoretane
22R-Trishomohopane
22S-Trishomohopane
22R-Tetrahomohopane
22S-Tetrahomohopane
22S-Pentahomohopane
22R-Pentahomohopane

Figure VI-6

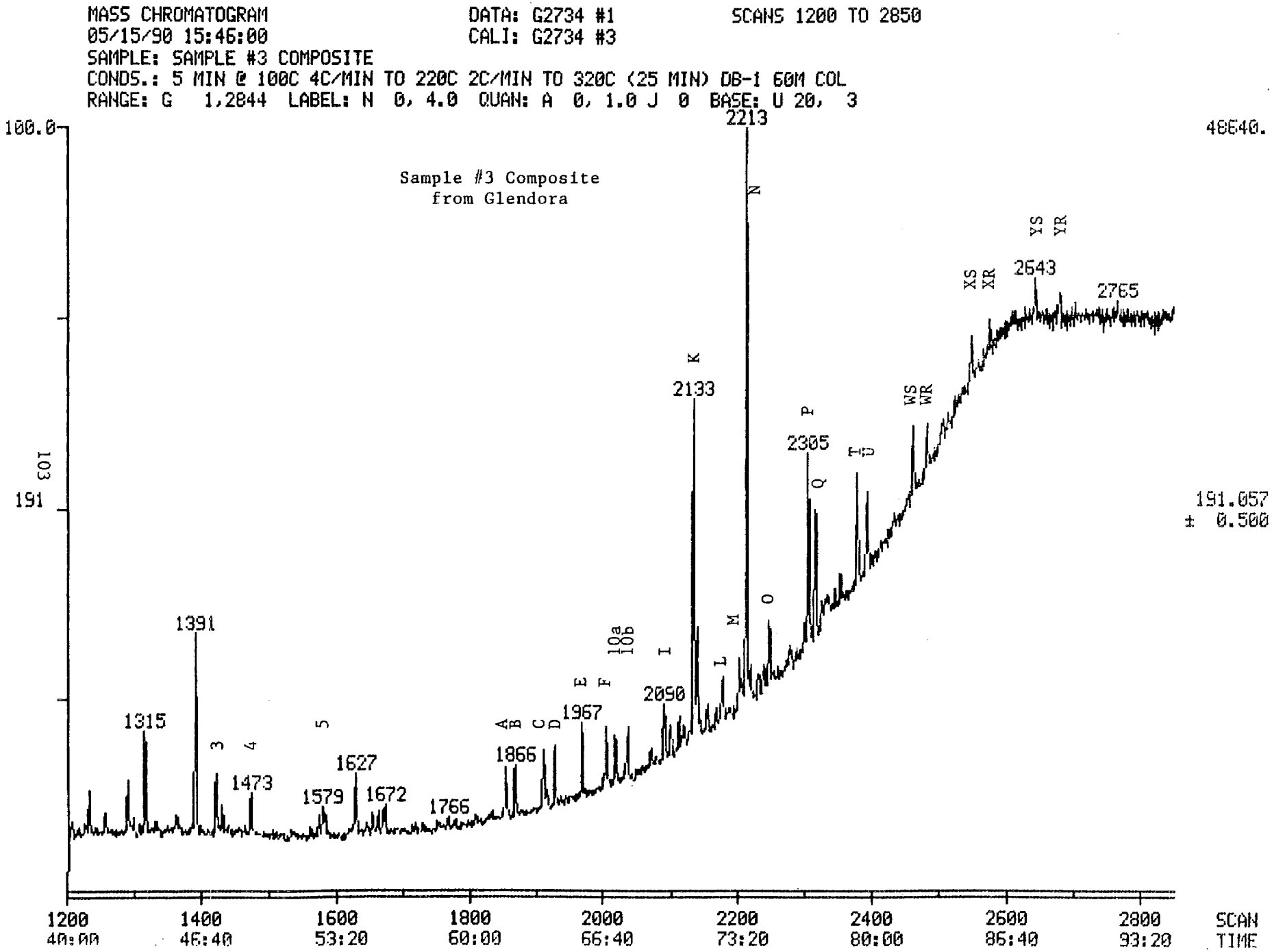

MASS CHROMATOGRAM
05/15/90 15:46:00
SAMPLE: SAMPLE #3 COMPOSITE
CONDS.: 5 MIN @ 100C 4C/MIN TO 220C 2C/MIN TO 320C (25 MIN) DB-1 60M COL
RANGE: G 1,2844 LABEL: N 0, 4.0 QUAN: A 0, 1.0 J 0 BASE: U 20, 3
DATA: G2734 #1
CALI: G2734 #3
SCANS 1200 TO 2850
Sample #3 Composite
from Glendora
100.0
191
103
48640.
191.057
± 0.500
1315
1391
3
4
1473
5
1579
1627
1672
1766
A
B
1866
C
D
E
1967
F
10a
10b
I
2090
K
2133
L
M
N
2213
O
P
2305
Q
T
U
WS
WR
XS
XR
YS
YR
2543
2765
1200
40:00
1400
46:40
1600
53:20
1800
60:00
2000
66:40
2200
73:20
2400
80:00
2600
86:40
2800
93:20
SCAN
TIME

Figure VI-7

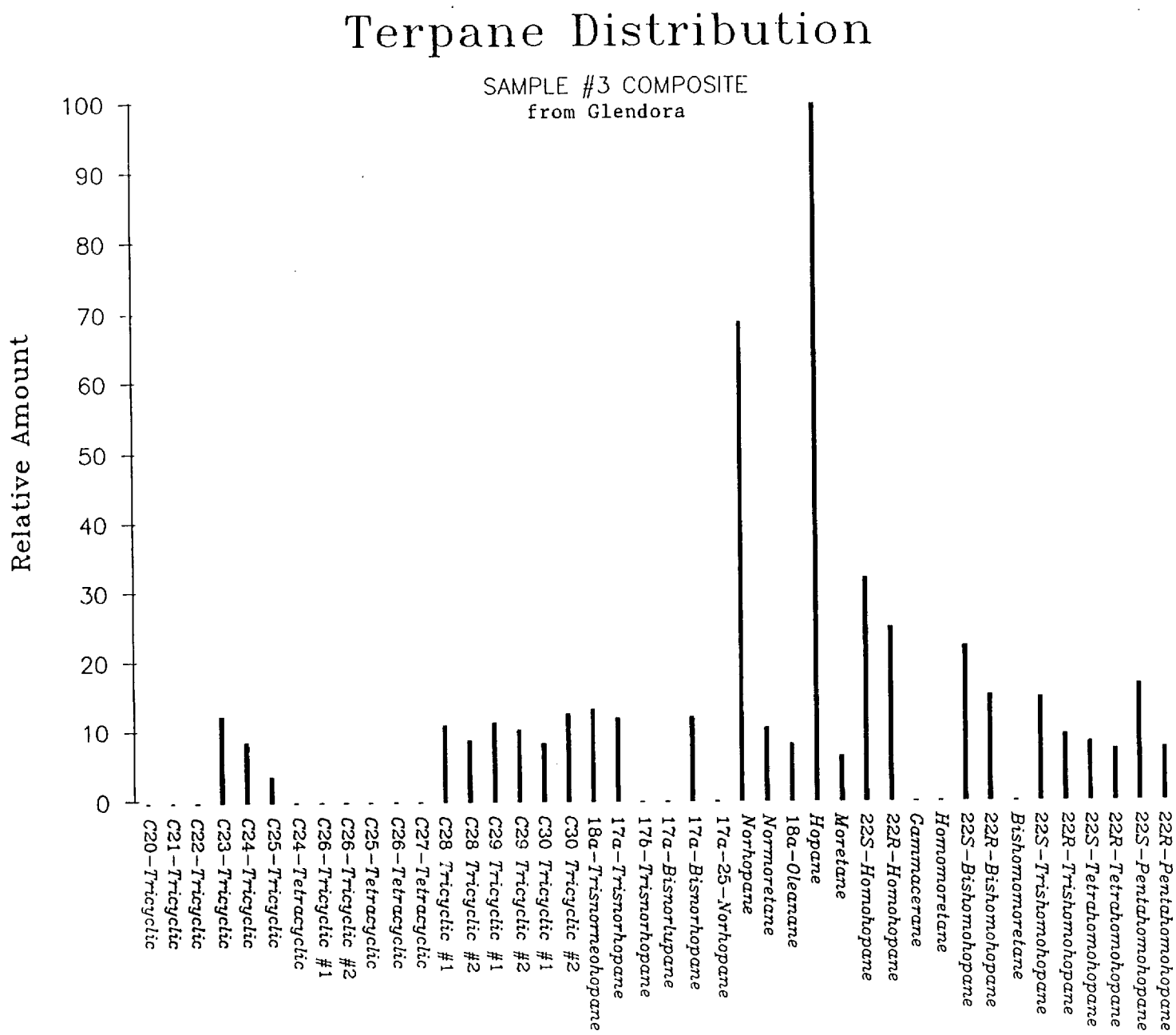

Terpane Distribution
SAMPLE #3 COMPOSITE
from Glendora
Relative Amount
100
90
80
70
60
50
40
30
20
10
0
C20-Tricyclic
C21-Tricyclic
C22-Tricyclic
C23-Tricyclic
C24-Tricyclic
C25-Tricyclic
C24-Tetracyclic
C26-Tricyclic #1
C26-Tricyclic #2
C25-Tetracyclic
C26-Tetracyclic
C27-Tetracyclic
C28 Tricyclic #1
C28 Tricyclic #2
C29 Tricyclic #1
C29 Tricyclic #2
C30 Tricyclic #1
C30 Tricyclic #2
18a-Trisnorneohopane
17a-Trisnorhopane
17b-Trisnorhopane
17a-Bisnortupane
17a-Bisnorhopane
17a-25-Norhopane
Norhopane
Normoretane
18a-Oleanane
Hopane
Moretane
22S-Homohopane
22R-Homohopane
Gammacerane
Homomoretane
22S-Bishomohopane
22R-Bishomohopane
Bishomomoretane
22S-Trishomohopane
22R-Trishomohopane
22S-Tetrahomohopane
22R-Tetrahomohopane
22S-Pentahomohopane
22R-Pentahomohopane

Figure VI-8

MASS CHROMATOGRAM DATA: G2735 #1 SCANS 1200 TO 2850
05/15/90 14:01:00 CALI: G2735 #3
SAMPLE: SAMPLE #4 COMPOSITE
CONDS.: 5 MIN @ 100C 4C/MIN TO 220C 2C/MIN TO 320C (25 MIN) DB-1 60M COL
RANGE: G 1,2950 LABEL: N 0, 4.0 QUAN: A 0, 1.0 J 0 BASE: U 20, 3

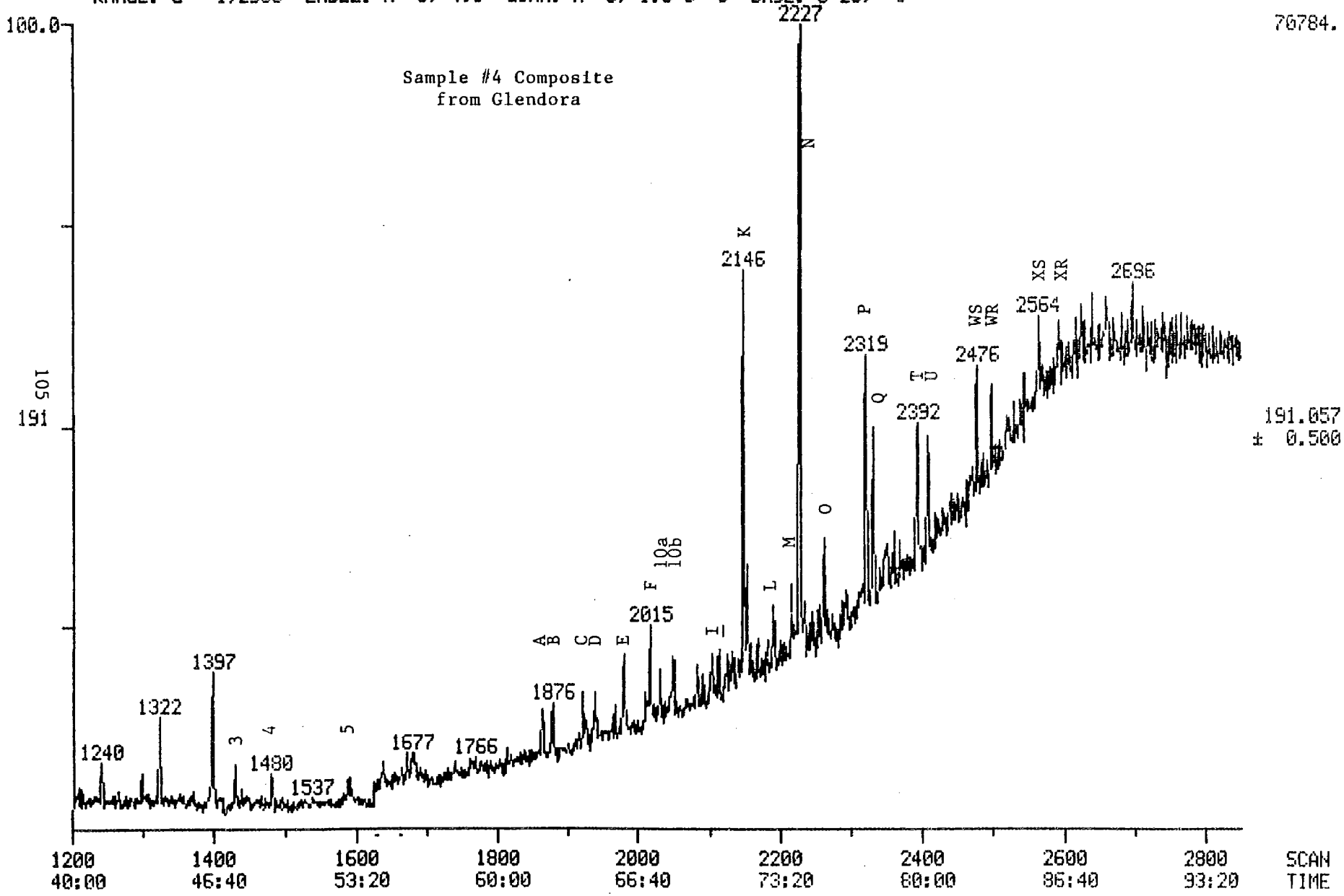


Figure VI-9

Terpane Distribution

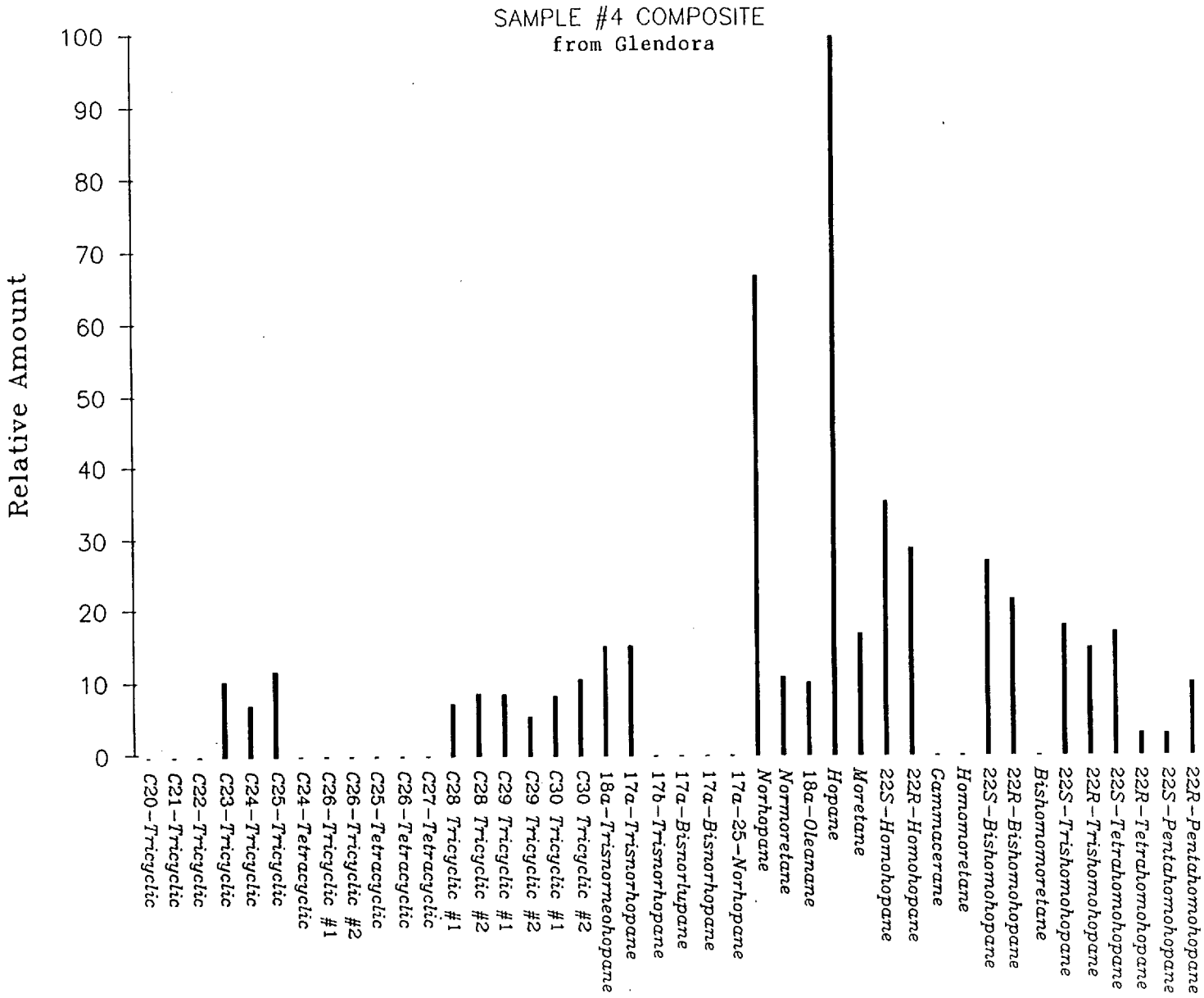


Figure VI-10

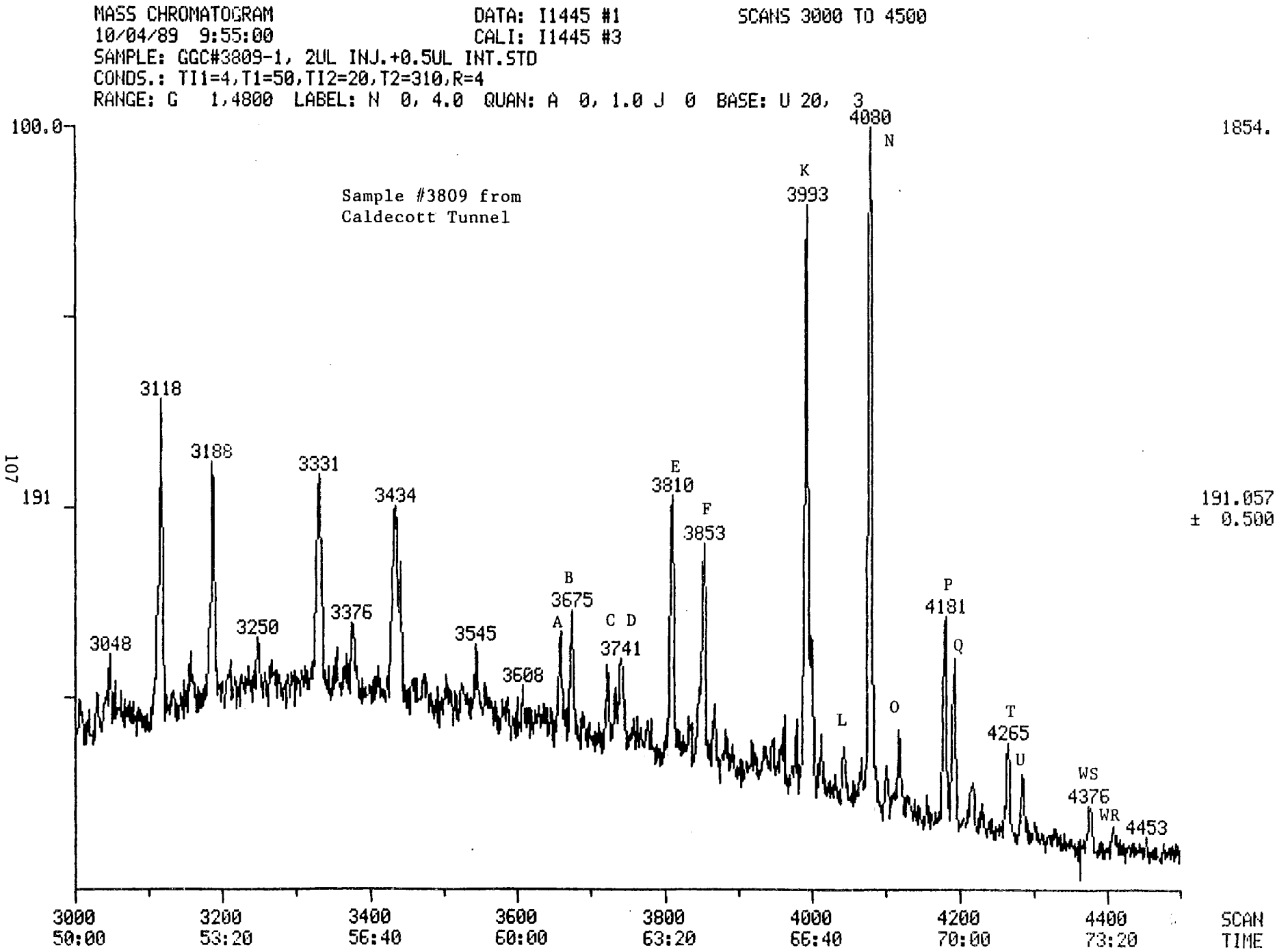

MASS CHROMATOGRAM
10/04/89 9:55:00
DATA: I1445 #1
CALI: I1445 #3
SCANS 3000 TO 4500
SAMPLE: GGC#3809-1, 2UL INJ.+0.5UL INT.STD
CONDS.: TI1=4,T1=50,TI2=20,T2=310,R=4
RANGE: G 1,4800 LABEL: N 0, 4.0 QUAN: A 0, 1.0 J 0 BASE: U 20, 3
100.0
1854.
Sample #3809 from
Caldecott Tunnel
107
191
191.057
± 0.500
3048
3118
3188
3250
3331
3376
3434
3545
3608
A
B
3675
C D
3741
E
3810
F
3853
K
3993
L
4080
N
O
P
4181
Q
T
4265
U
WS
4376
WR
4453
3000
50:00
3200
53:20
3400
56:40
3600
60:00
3800
63:20
4000
66:40
4200
70:00
4400
73:20
SCAN
TIME

Figure VI-11

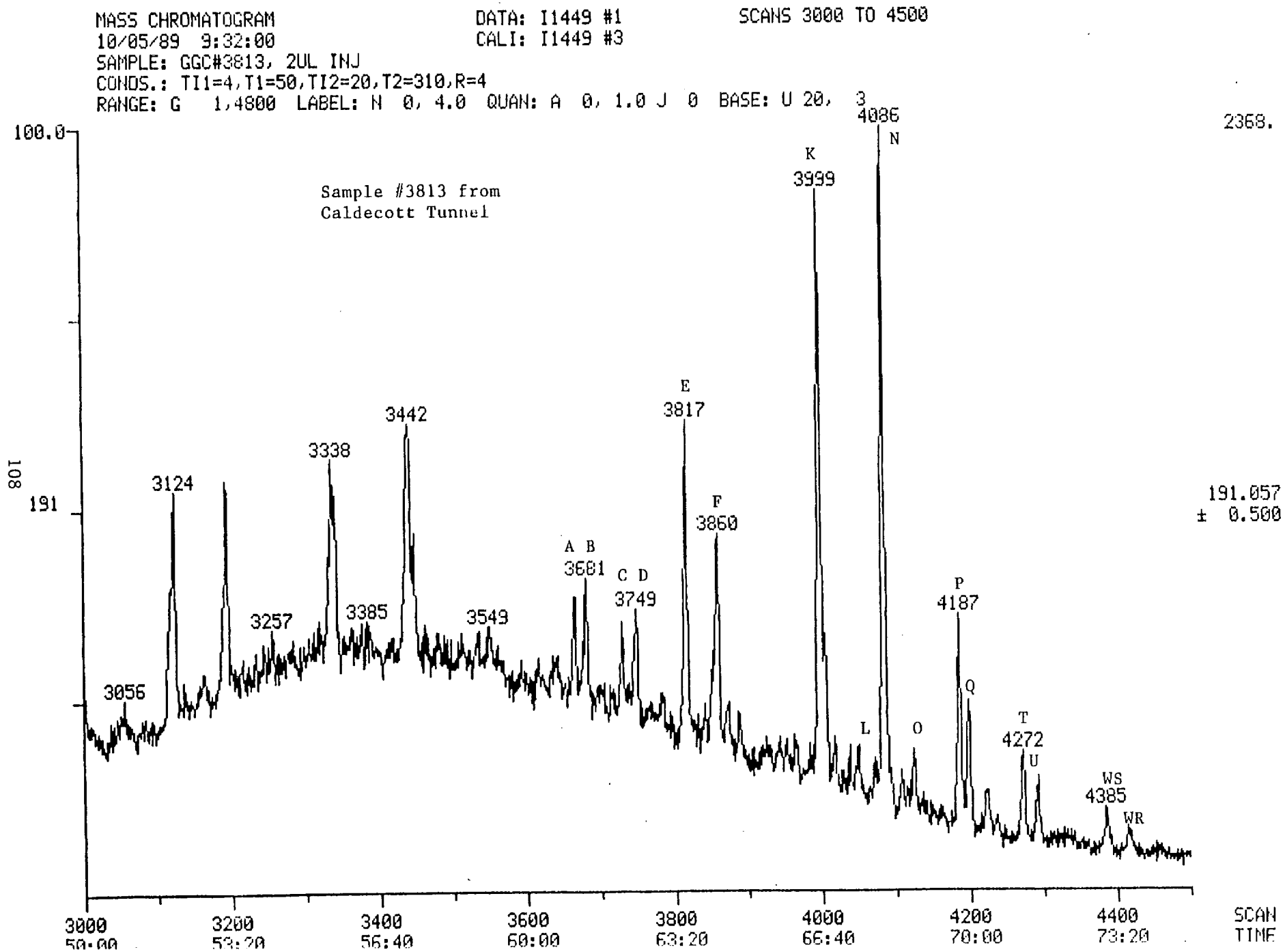

MASS CHROMATOGRAM
10/05/89 9:32:00
SAMPLE: GGC#3813, 2UL INJ
CONDS.: TI1=4,T1=50,TI2=20,T2=310,R=4
RANGE: G 1,4800 LABEL: N 0, 4.0 QUAN: A 0, 1.0 J 0 BASE: U 20, 3
DATA: I1449 #1
CALI: I1449 #3
SCANS 3000 TO 4500
2368.
100.0
108
191
191.057
± 0.500
Sample #3813 from
Caldecott Tunnel
3056
3124
3257
3338
3385
3442
3549
A B
3681
C D
3749
E
3817
F
3860
K
3999
4086
N
L
O
P
4187
Q
T
4272
U
WS
4385
WR
3000
50:00
3200
53:20
3400
56:40
3600
60:00
3800
63:20
4000
66:40
4200
70:00
4400
73:20
SCAN
TIME

Figure VI-12

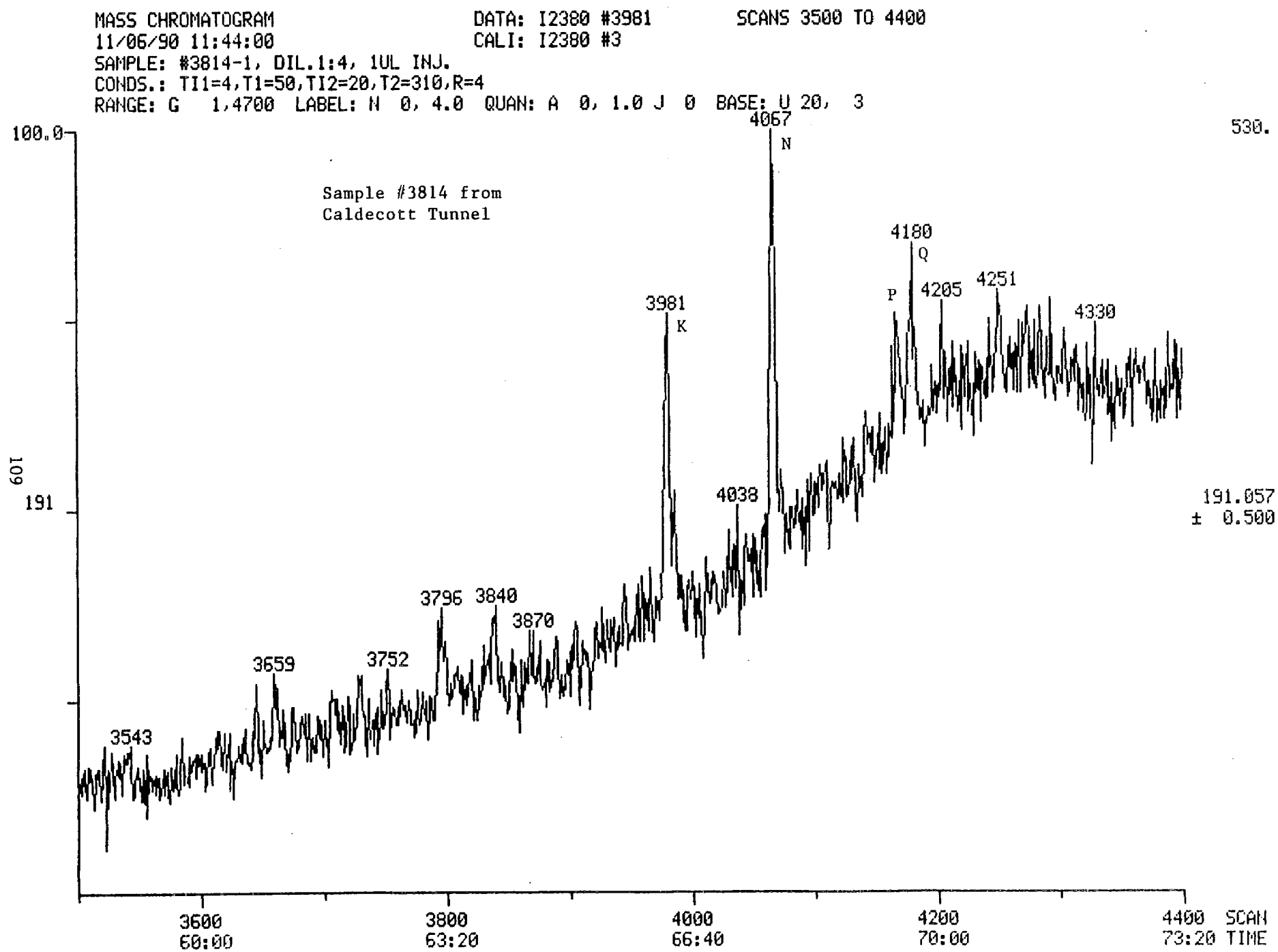

MASS CHROMATOGRAM
11/06/90 11:44:00
DATA: I2380 #3981
CALI: I2380 #3
SCANS 3500 TO 4400
SAMPLE: #3814-1, DIL.1:4, 1UL INJ.
CONDS.: TI1=4,T1=50,TI2=20,T2=310,R=4
RANGE: G 1,4700 LABEL: N 0, 4.0 QUAN: A 0, 1.0 J 0 BASE: U 20, 3
100.0
530.
Sample #3814 from
Caldecott Tunnel
4067
N
4180
Q
P
4205
4251
4330
3981
K
4038
3543
3659
3752
3796
3840
3870
191
191.057
± 0.500
3600
60:00
3800
63:20
4000
66:40
4200
70:00
4400 SCAN
73:20 TIME

Figure VI-13

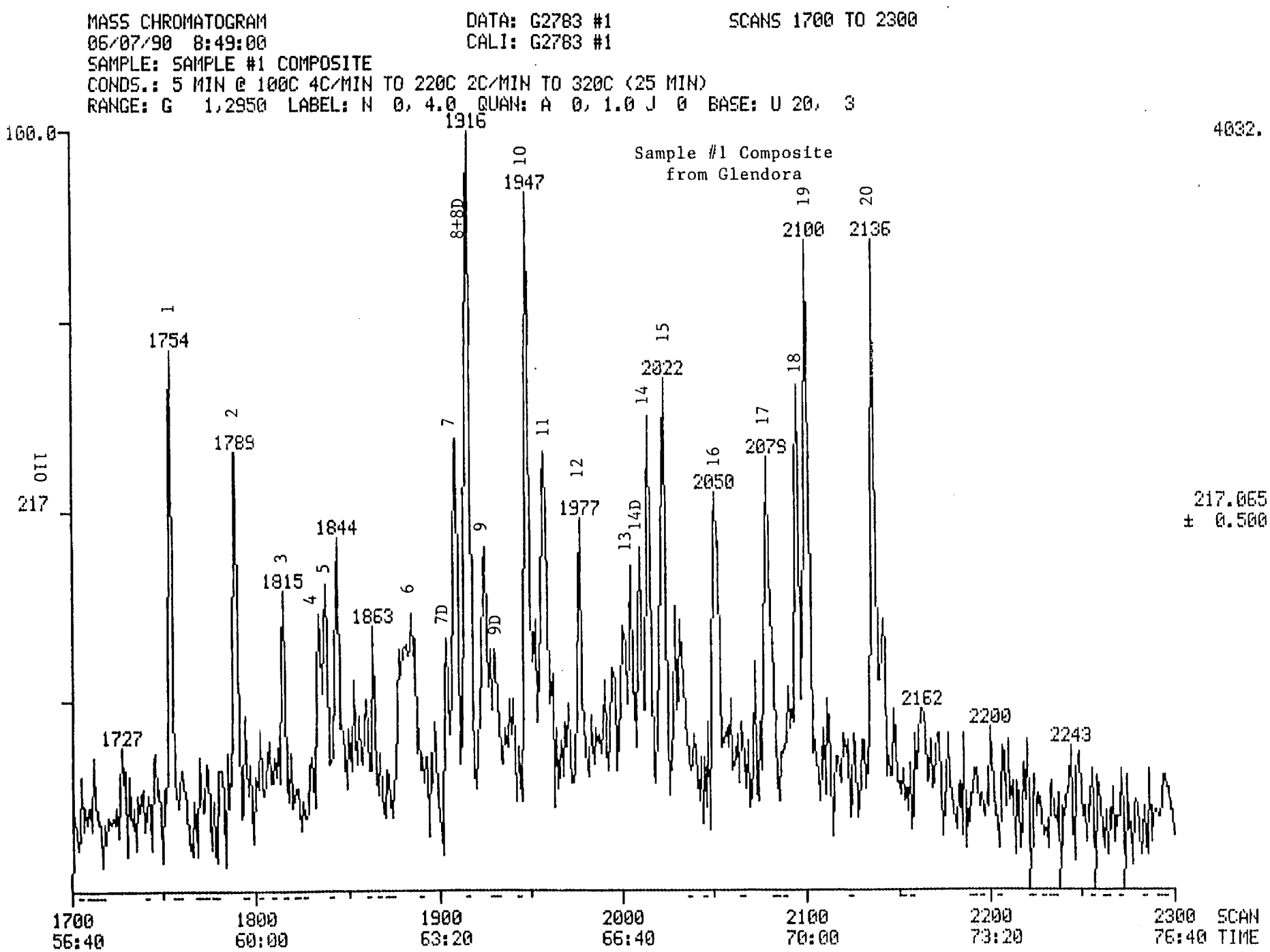

MASS CHROMATOGRAM
06/07/90 8:49:00
SAMPLE: SAMPLE #1 COMPOSITE
CONDS.: 5 MIN @ 100C 4C/MIN TO 220C 2C/MIN TO 320C (25 MIN)
RANGE: G 1,2950 LABEL: N 0, 4.0 QUAN: A 0, 1.0 J 0 BASE: U 20, 3
DATA: G2783 #1
CALI: G2783 #1
SCANS 1700 TO 2300
Sample #1 Composite
from Glendora
100.0
4032.
217
110
217.065
± 0.500
1727
1754
1789
1815
1844
1863
1916
1947
1977
2022
2050
2079
2100
2136
2162
2200
2243
1
2
3
4
5
6
7
7D
8+8D
9
9D
10
11
12
13
14
14D
15
16
17
18
19
20
1700
56:40
1800
60:00
1900
63:20
2000
66:40
2100
70:00
2200
73:20
2300
76:40
SCAN
TIME

Figure VI-14

Sterane Distribution

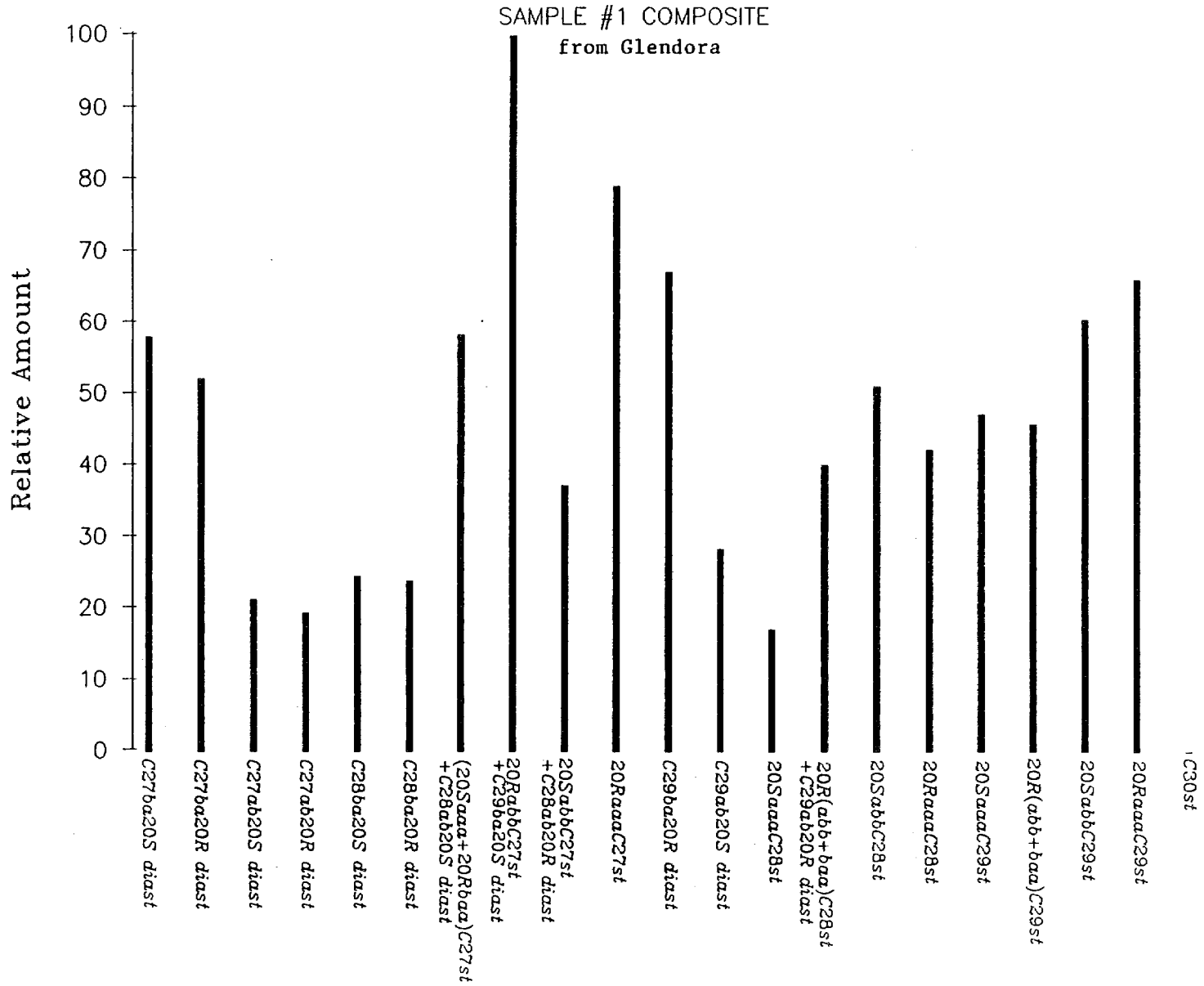


Figure VI-15

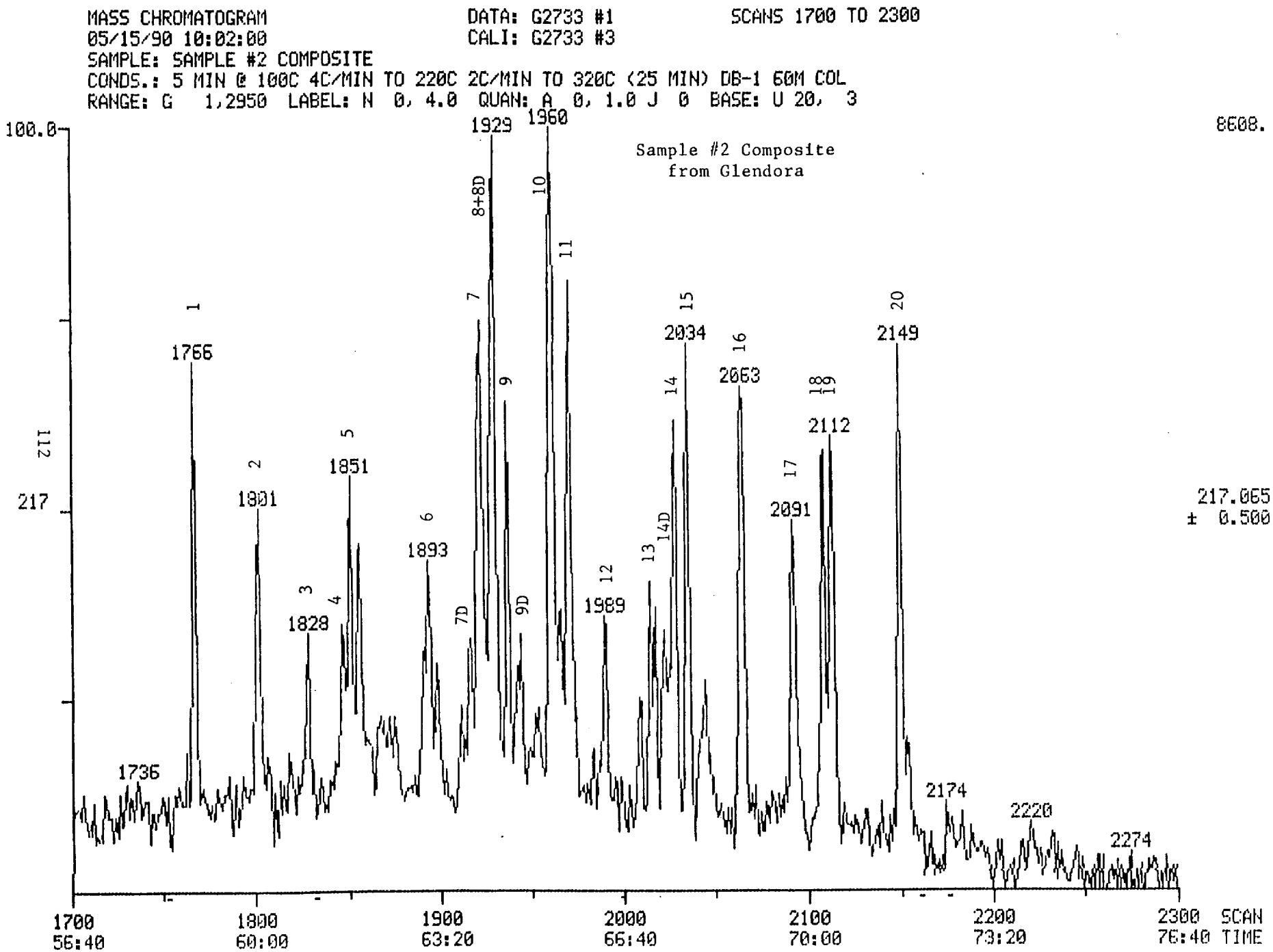

MASS CHROMATOGRAM
05/15/90 10:02:00
SAMPLE: SAMPLE #2 COMPOSITE
CONDS.: 5 MIN @ 100C 4C/MIN TO 220C 2C/MIN TO 320C (25 MIN) DB-1 60M COL
RANGE: G 1,2950 LABEL: N 0, 4.0 QUAN: A 0, 1.0 J 0 BASE: U 20, 3
DATA: G2733 #1
CALI: G2733 #3
SCANS 1700 TO 2300
Sample #2 Composite
from Glendora
100.0
217
112
8608.
217.065
± 0.500
1736
1766
1801
1828
1851
1893
1929
1960
1989
2034
2063
2091
2112
2149
2174
2220
2274
1
2
3
4
5
6
7
7D
8+8D
9
9D
10
11
12
13
14
14D
15
16
17
18
19
20
1700
56:40
1800
60:00
1900
63:20
2000
66:40
2100
70:00
2200
73:20
2300
76:40
SCAN
TIME

Figure VI-16

Sterane Distribution

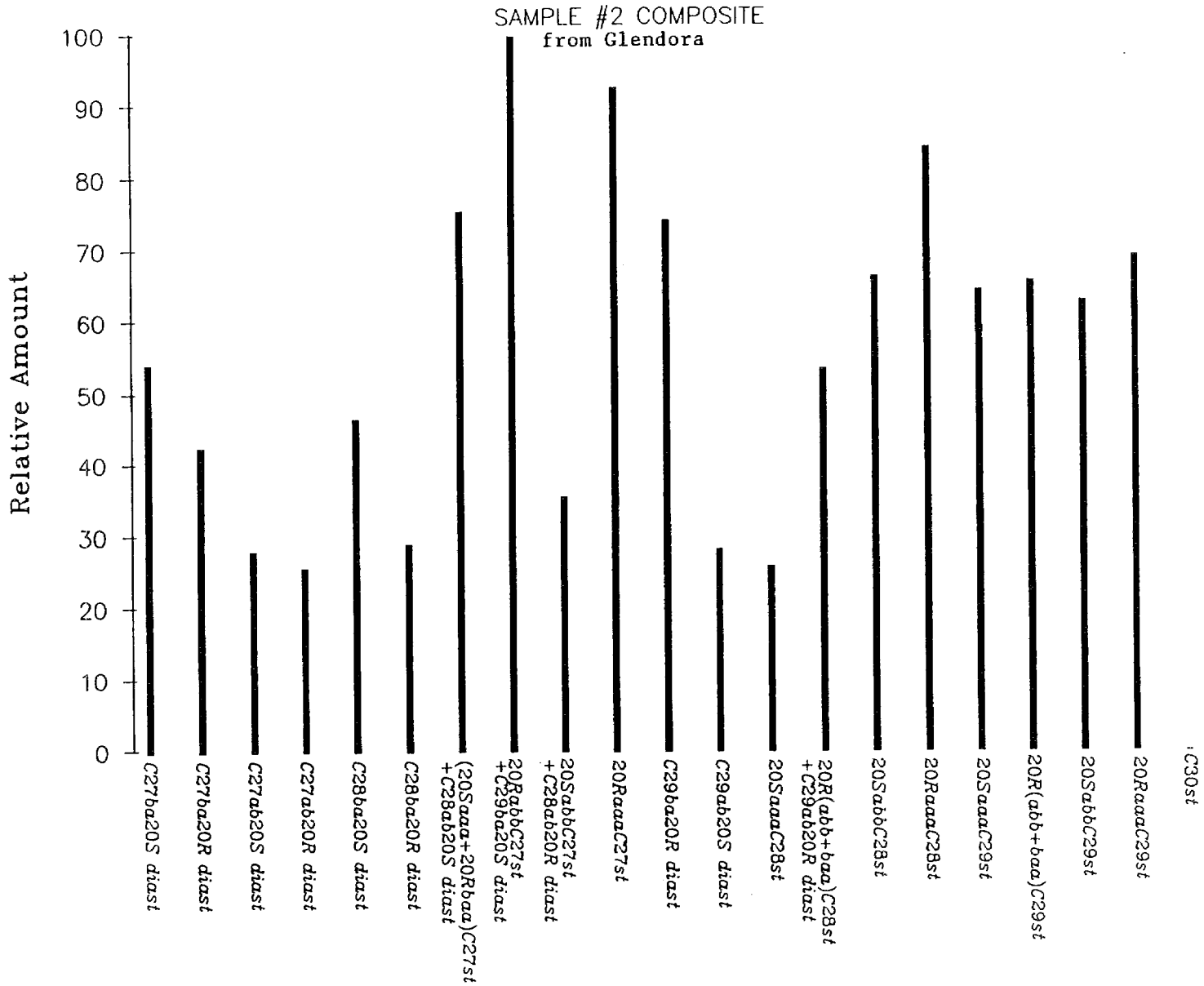


Figure VI-17

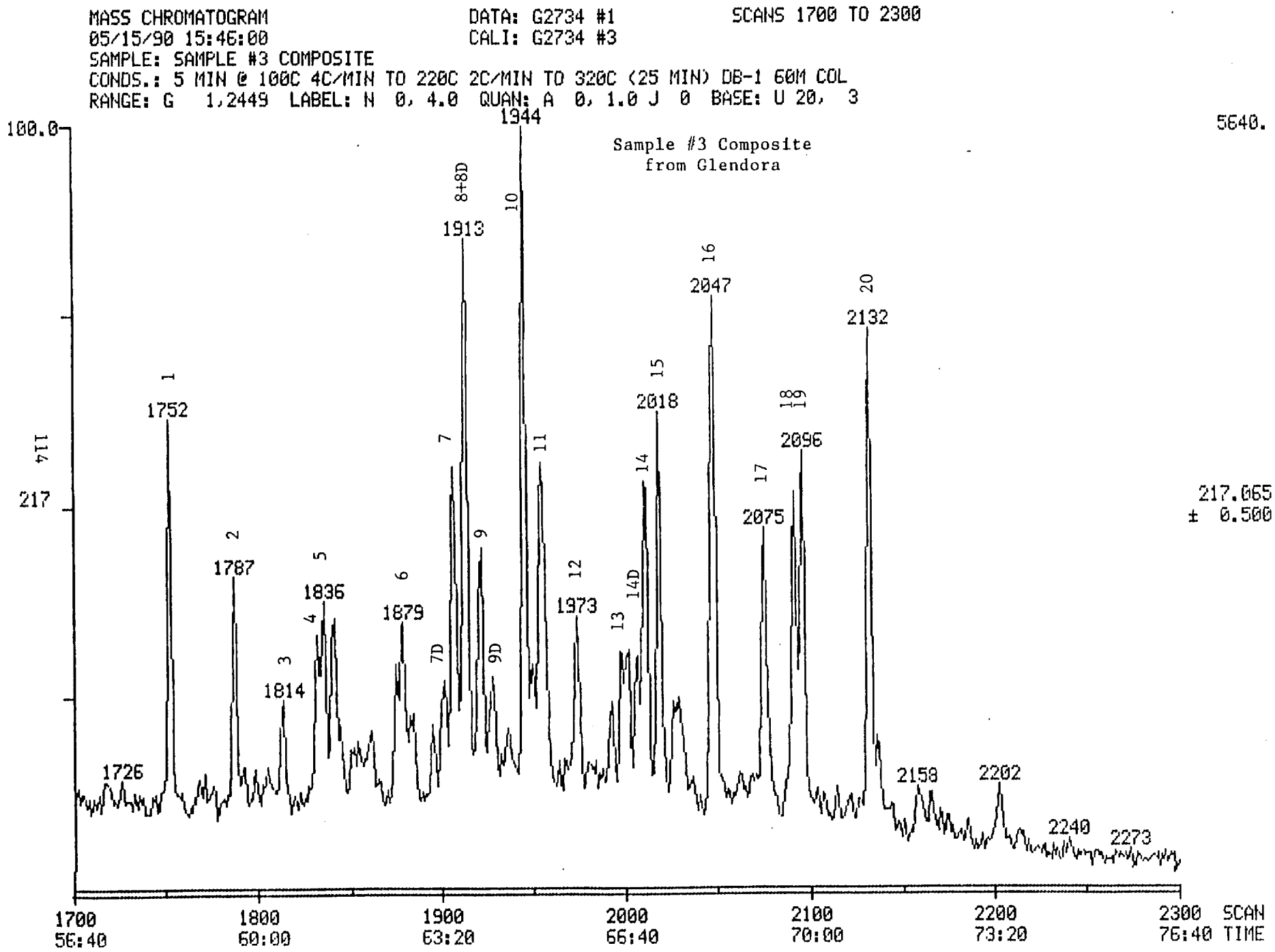

MASS CHROMATOGRAM
05/15/90 15:46:00
SAMPLE: SAMPLE #3 COMPOSITE
CONDS.: 5 MIN @ 100C 4C/MIN TO 220C 2C/MIN TO 320C (25 MIN) DB-1 60M COL
RANGE: G 1,2449 LABEL: N 0, 4.0 QUAN: A 0, 1.0 J 0 BASE: U 20, 3
DATA: G2734 #1
CALI: G2734 #3
SCANS 1700 TO 2300
Sample #3 Composite
from Glendora
100.0
217
114
5640.
217.065
± 0.500
1726
1752
1787
1814
1836
1879
1913
1944
1973
2018
2047
2075
2096
2132
2158
2202
2240
2273
1700
56:40
1800
60:00
1900
63:20
2000
66:40
2100
70:00
2200
73:20
2300
76:40
SCAN
TIME

Figure VI-18

Sterane Distribution

SAMPLE #3 COMPOSITE
from Glendora

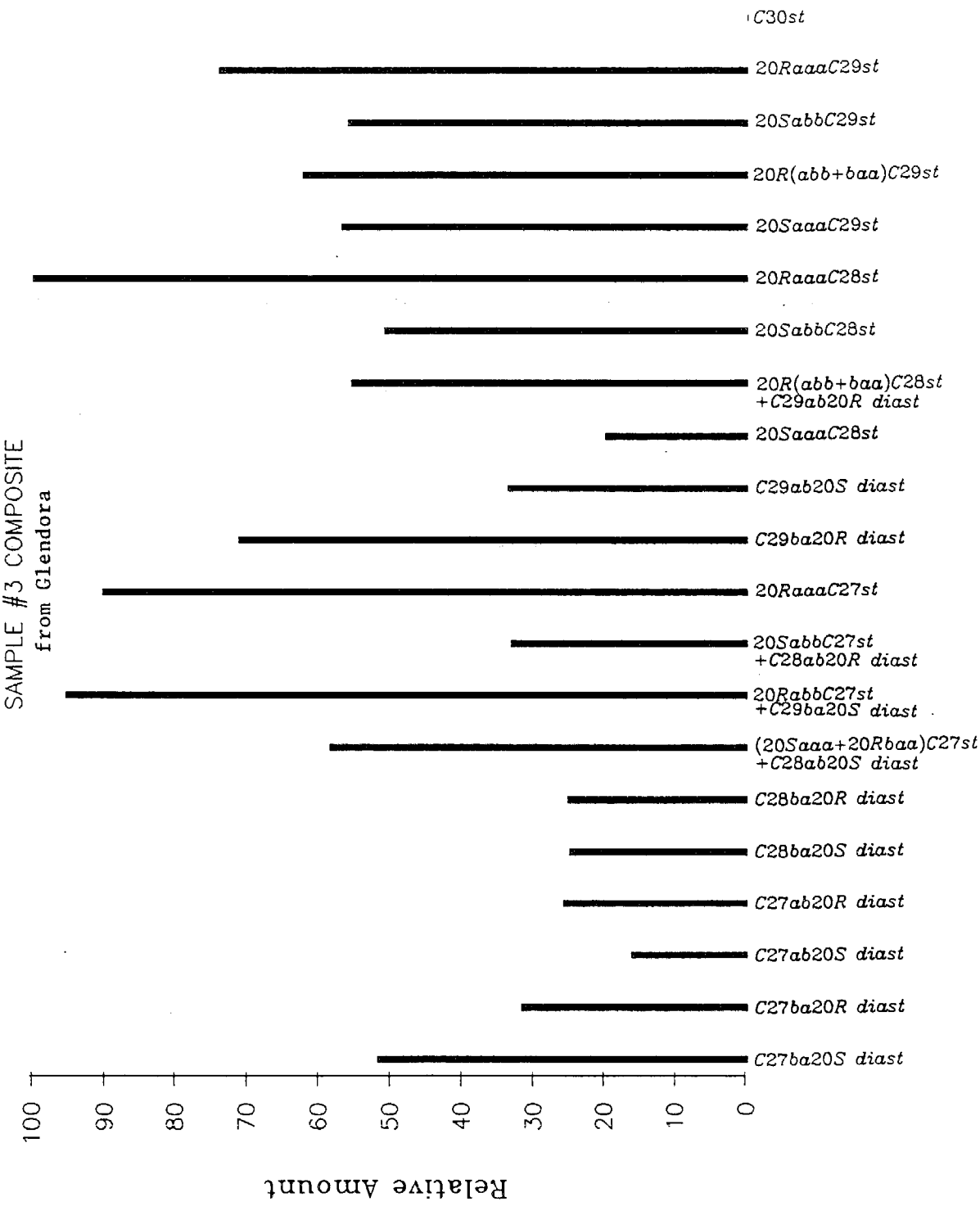


Figure VI-19

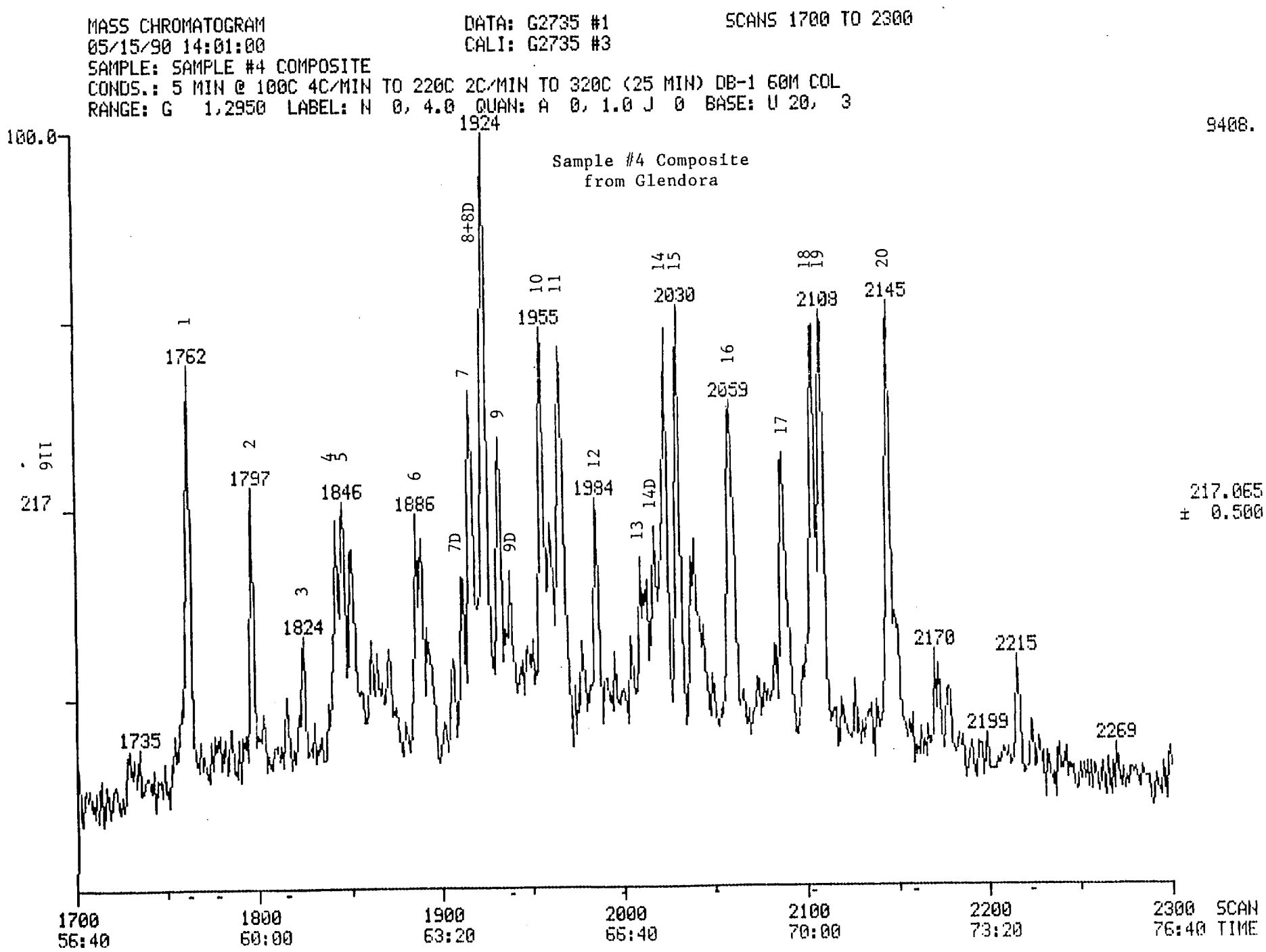

MASS CHROMATOGRAM
05/15/90 14:01:00
SAMPLE: SAMPLE #4 COMPOSITE
CONDS.: 5 MIN @ 100C 4C/MIN TO 220C 2C/MIN TO 320C (25 MIN) DB-1 60M COL
RANGE: G 1,2950 LABEL: N 0, 4.0 QUAN: A 0, 1.0 J 0 BASE: U 20, 3
DATA: G2735 #1
CALI: G2735 #3
SCANS 1700 TO 2300
Sample #4 Composite
from Glendora
100.0
9408.
217
116
217.065
± 0.500
1735
1762
1797
1824
1846
1886
1924
1955
1984
2030
2059
2108
2145
2170
2199
2215
2269
1
2
3
4
5
6
7
7D
8+8D
9
9D
10
11
12
13
14
14D
15
16
17
18
19
20
1700
56:40
1800
60:00
1900
63:20
2000
65:40
2100
70:00
2200
73:20
2300
76:40
SCAN
TIME

Figure VI-20

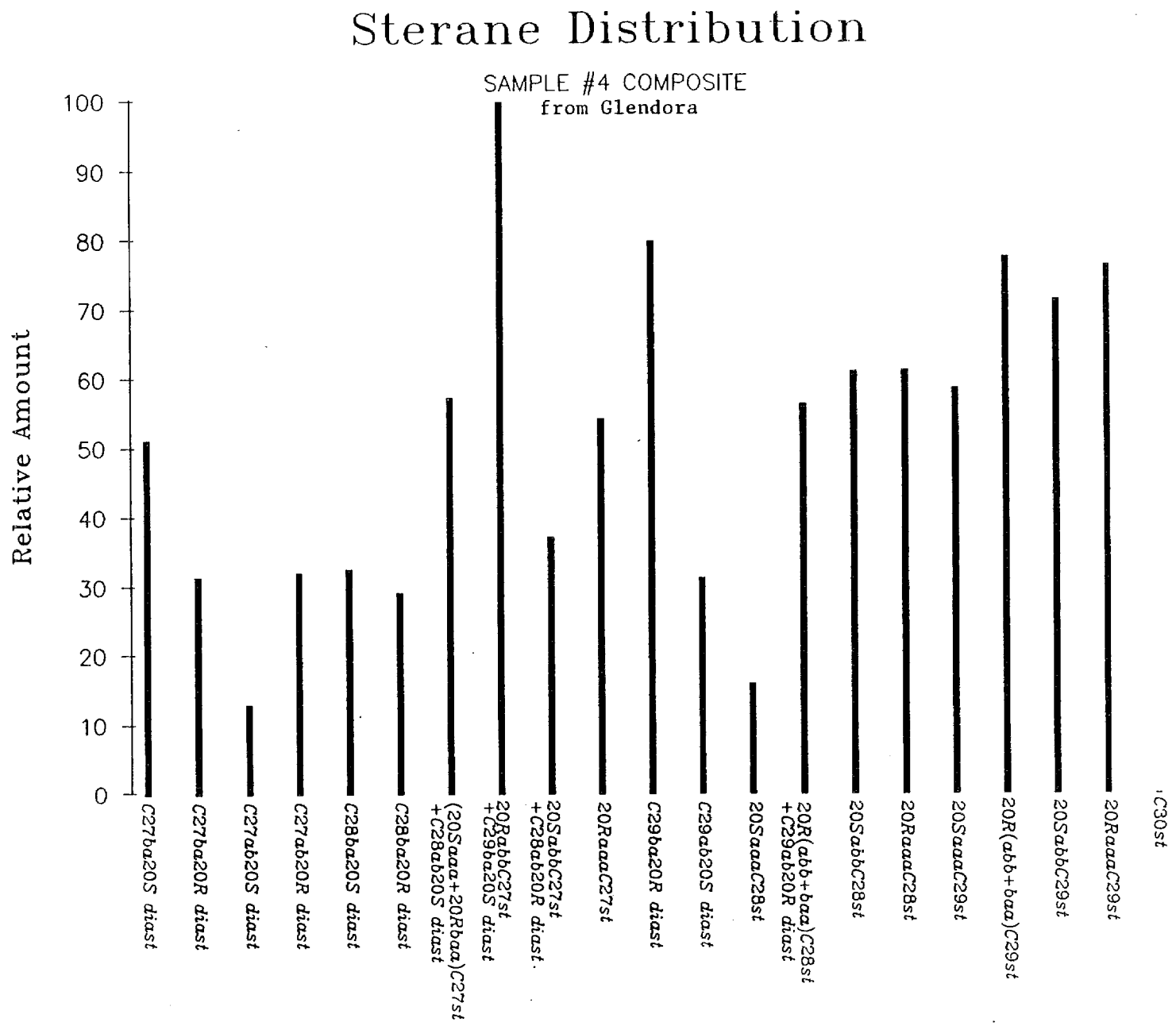

Sterane Distribution
SAMPLE #4 COMPOSITE
from Glendora
Relative Amount
100
90
80
70
60
50
40
30
20
10
0
C27ba20S diast
C27ba20R diast
C27ab20S diast
C27ab20R diast
C28ba20S diast
C28ba20R diast
(20Saaa+20Rbaa)C27st
+C28ab20S diast
20RabbC27st
+C29ba20S diast
20SabbC27st
+C28ab20R diast
20RaaaC27st
C29ba20R diast
C29ab20S diast
20SaaaC28st
20R(abb+baa)C28st
+C29ab20R diast
20SabbC28st
20RaaaC28st
20SaaaC29st
20R(abb+baa)C29st
20SabbC29st
20RaaaC29st
C30st

Figure VI-21

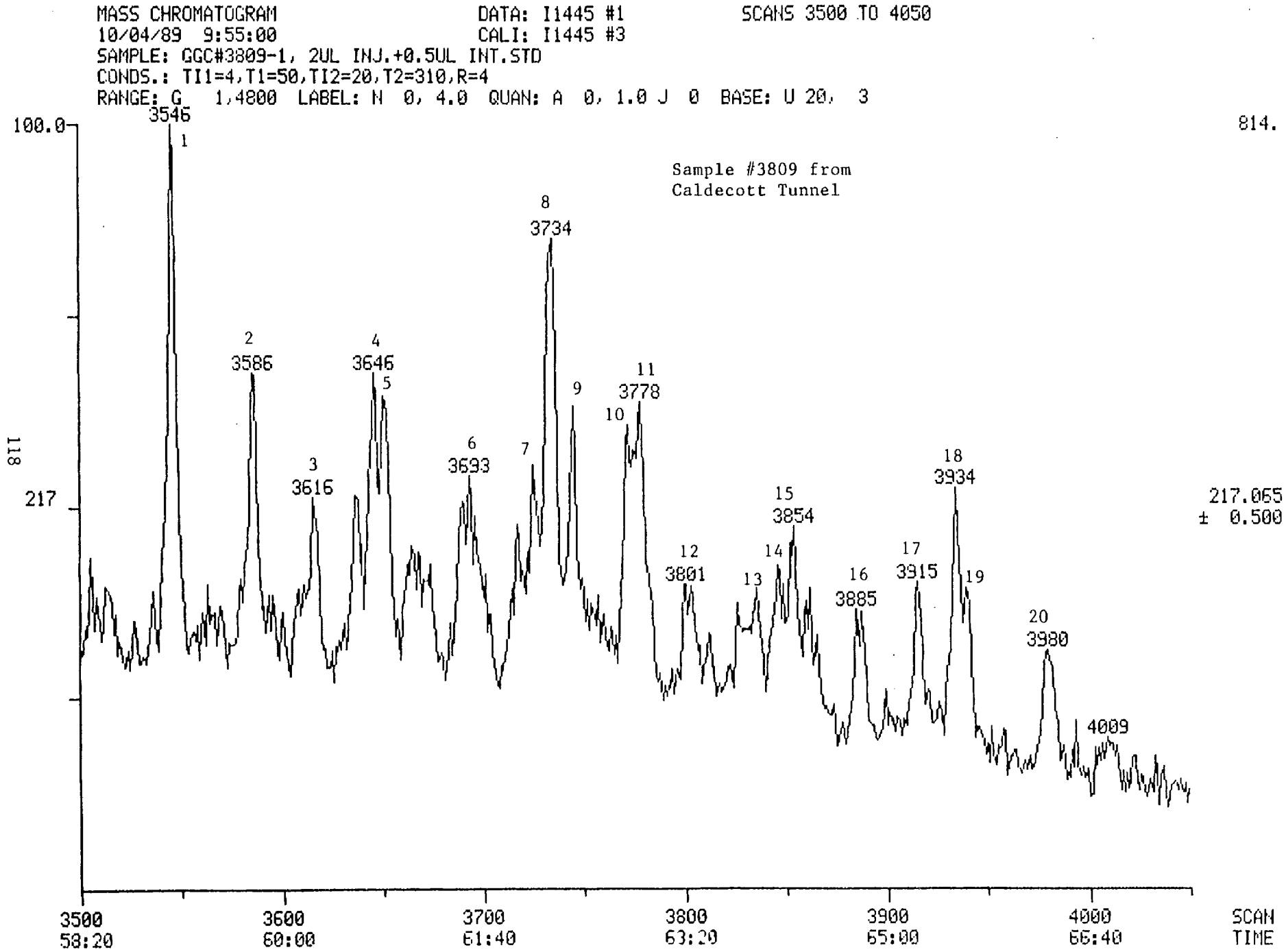

MASS CHROMATOGRAM
10/04/89 9:55:00
DATA: I1445 #1
CALI: I1445 #3
SCANS 3500 TO 4050
SAMPLE: GGC#3809-1, 2UL INJ.+0.5UL INT.STD
CONDS.: TI1=4,T1=50,TI2=20,T2=310,R=4
RANGE: G 1,4800 LABEL: N 0, 4.0 QUAN: A 0, 1.0 J 0 BASE: U 20, 3
100.0
814.
Sample #3809 from
Caldecott Tunnel
118
217
217.065
± 0.500
1 3546
2 3586
3 3616
4 3646
5
6 3693
7
8 3734
9
10
11 3778
12 3801
13
14
15 3854
16 3885
17 3915
18 3934
19
20 3980
4009
3500 58:20
3600 60:00
3700 61:40
3800 63:20
3900 65:00
4000 66:40
SCAN TIME

Figure VI-22

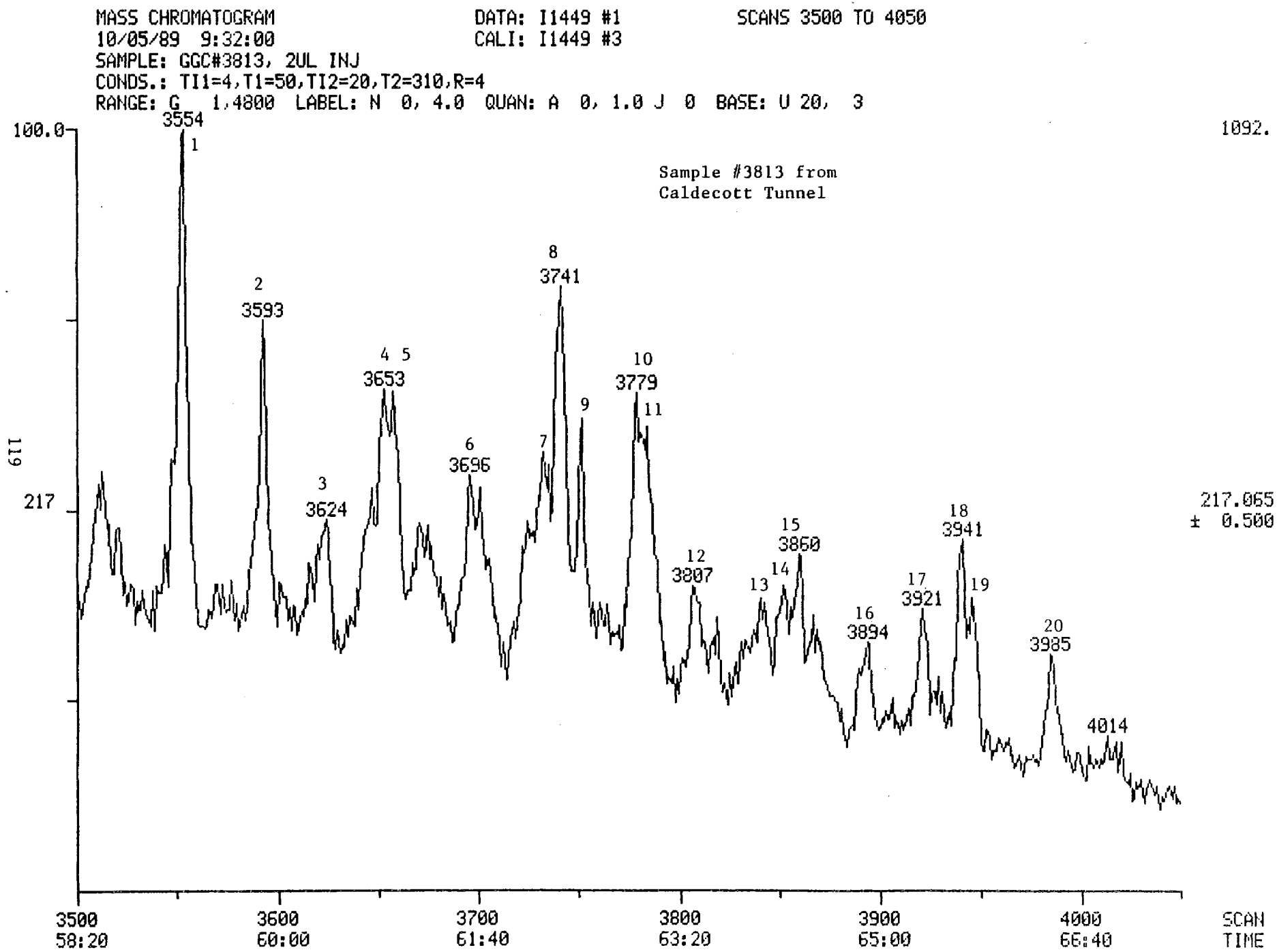

MASS CHROMATOGRAM
10/05/89 9:32:00
SAMPLE: GGC#3813, 2UL INJ
CONDS.: TI1=4,T1=50,TI2=20,T2=310,R=4
RANGE: G 1,4800 LABEL: N 0, 4.0 QUAN: A 0, 1.0 J 0 BASE: U 20, 3
DATA: I1449 #1
CALI: I1449 #3
SCANS 3500 TO 4050
Sample #3813 from
Caldecott Tunnel
100.0
1092.
217
217.065
± 0.500
119
1 3554
2 3593
3 3624
4 5 3653
6 3696
7
8 3741
9
10 3779
11
12 3807
13
14
15 3860
16 3894
17 3921
18 3941
19
20 3985
4014
3500 58:20
3600 60:00
3700 61:40
3800 63:20
3900 65:00
4000 66:40
SCAN TIME

Figure VI-23

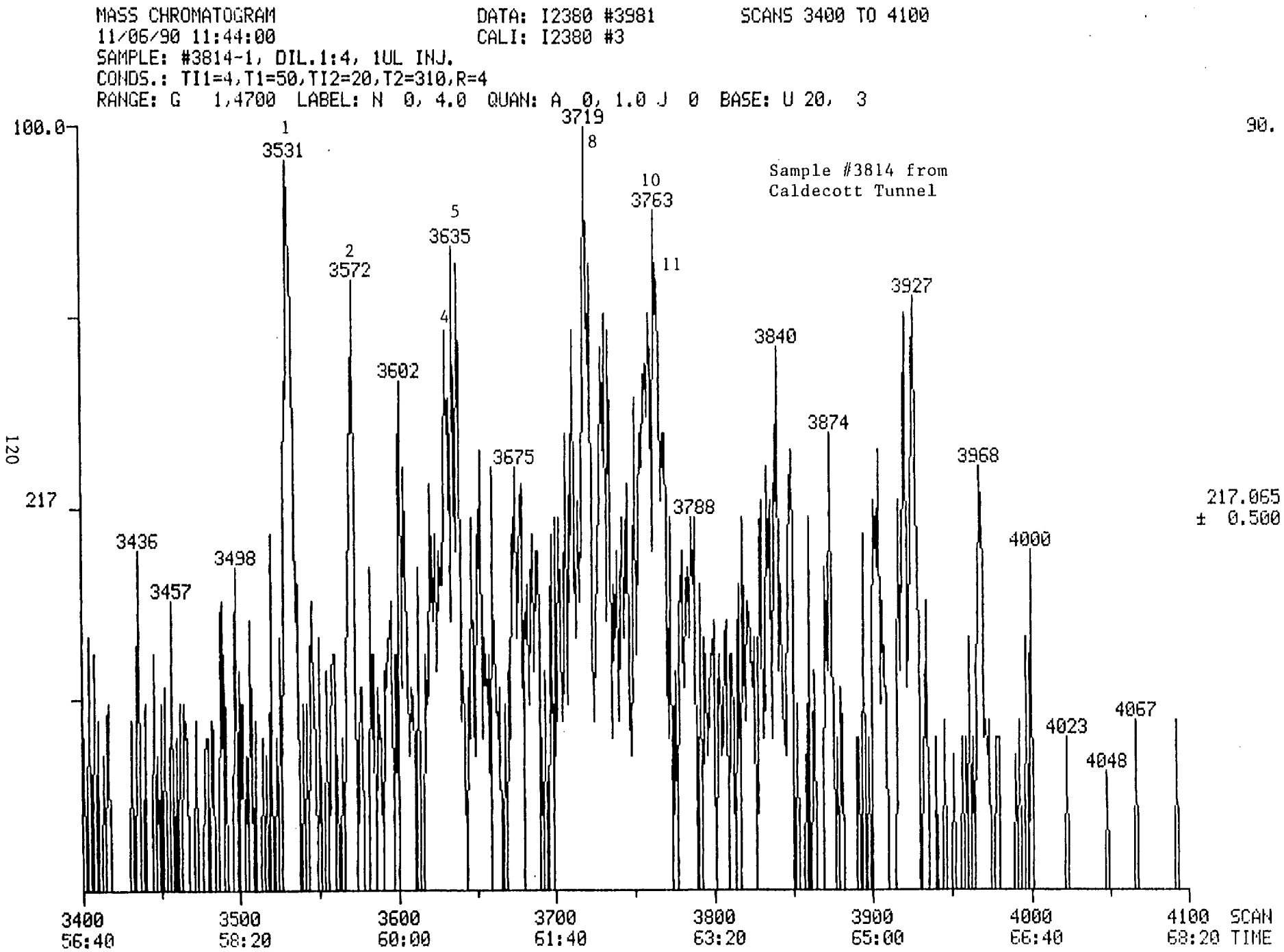

MASS CHROMATOGRAM
11/06/90 11:44:00
DATA: I2380 #3981
CALI: I2380 #3
SCANS 3400 TO 4100
SAMPLE: #3814-1, DIL.1:4, 1UL INJ.
CONDS.: TI1=4,T1=50,TI2=20,T2=310,R=4
RANGE: G 1,4700 LABEL: N 0, 4.0 QUAN: A 0, 1.0 J 0 BASE: U 20, 3
100.0
90.
120
217
217.065
± 0.500
Sample #3814 from
Caldecott Tunnel
1
3531
2
3572
3602
4
5
3635
3675
3719
8
10
3763
11
3788
3840
3874
3927
3968
4000
4023
4048
4067
3436
3457
3498
3400
56:40
3500
58:20
3600
60:00
3700
61:40
3800
63:20
3900
65:00
4000
66:40
4100
68:20
SCAN
TIME

Figure VI-24

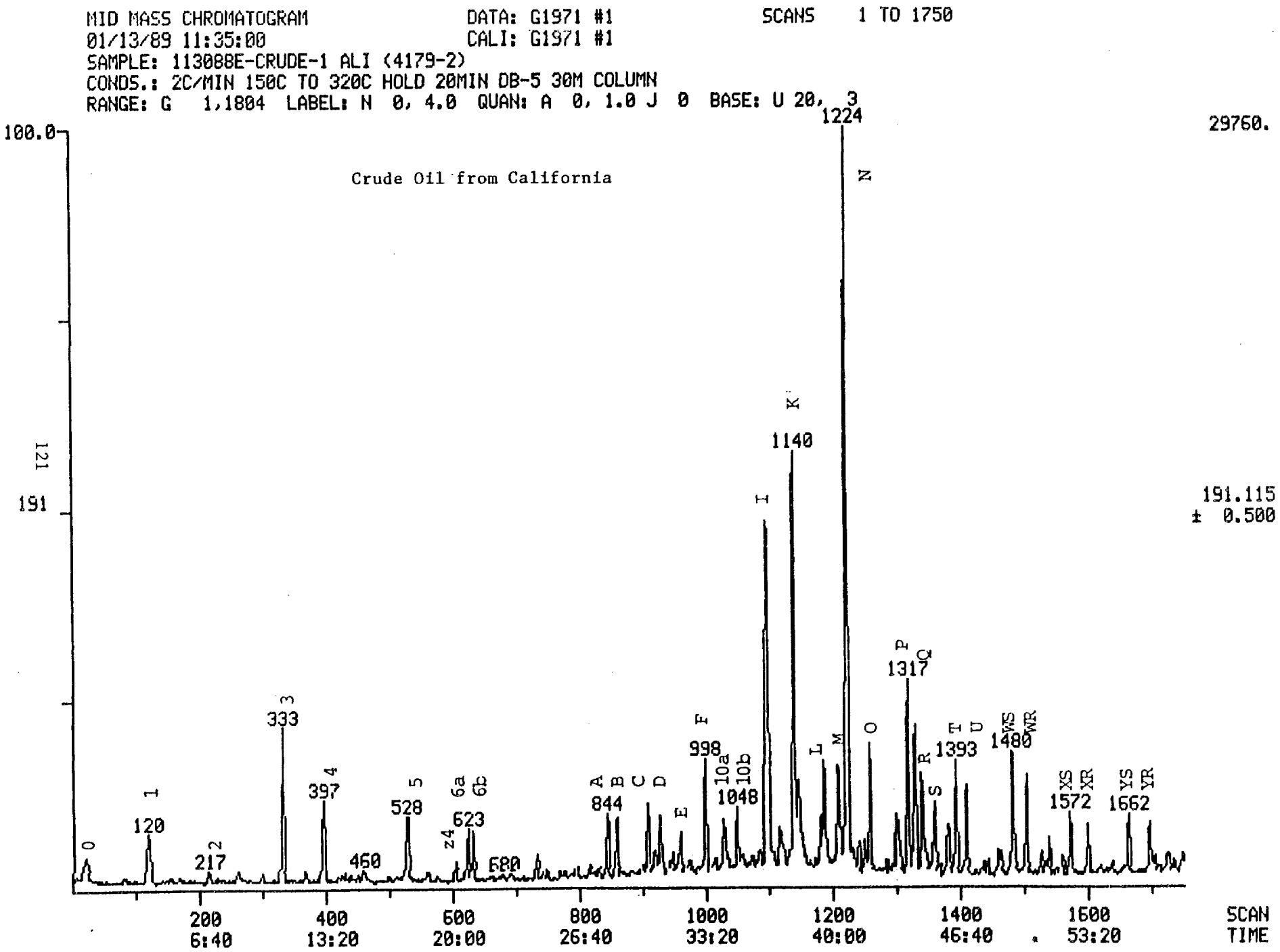

MID MASS CHROMATOGRAM
01/13/89 11:35:00
DATA: G1971 #1
CALI: G1971 #1
SCANS 1 TO 1750
SAMPLE: 113088E-CRUDE-1 ALI (4179-2)
CONDS.: 2C/MIN 150C TO 320C HOLD 20MIN DB-5 30M COLUMN
RANGE: G 1,1804 LABEL: N 0, 4.0 QUAN: A 0, 1.0 J 0 BASE: U 20, 3
Crude Oil from California
100.0
191
29760.
191.115
± 0.500
1224
1140
1317
1393
1480
1572
1662
998
1048
844
333
397
528
623
120
217
460
680
200
6:40
400
13:20
600
20:00
800
26:40
1000
33:20
1200
40:00
1400
46:40
1600
53:20
SCAN
TIME

Figure VI-25

Terpane Distribution

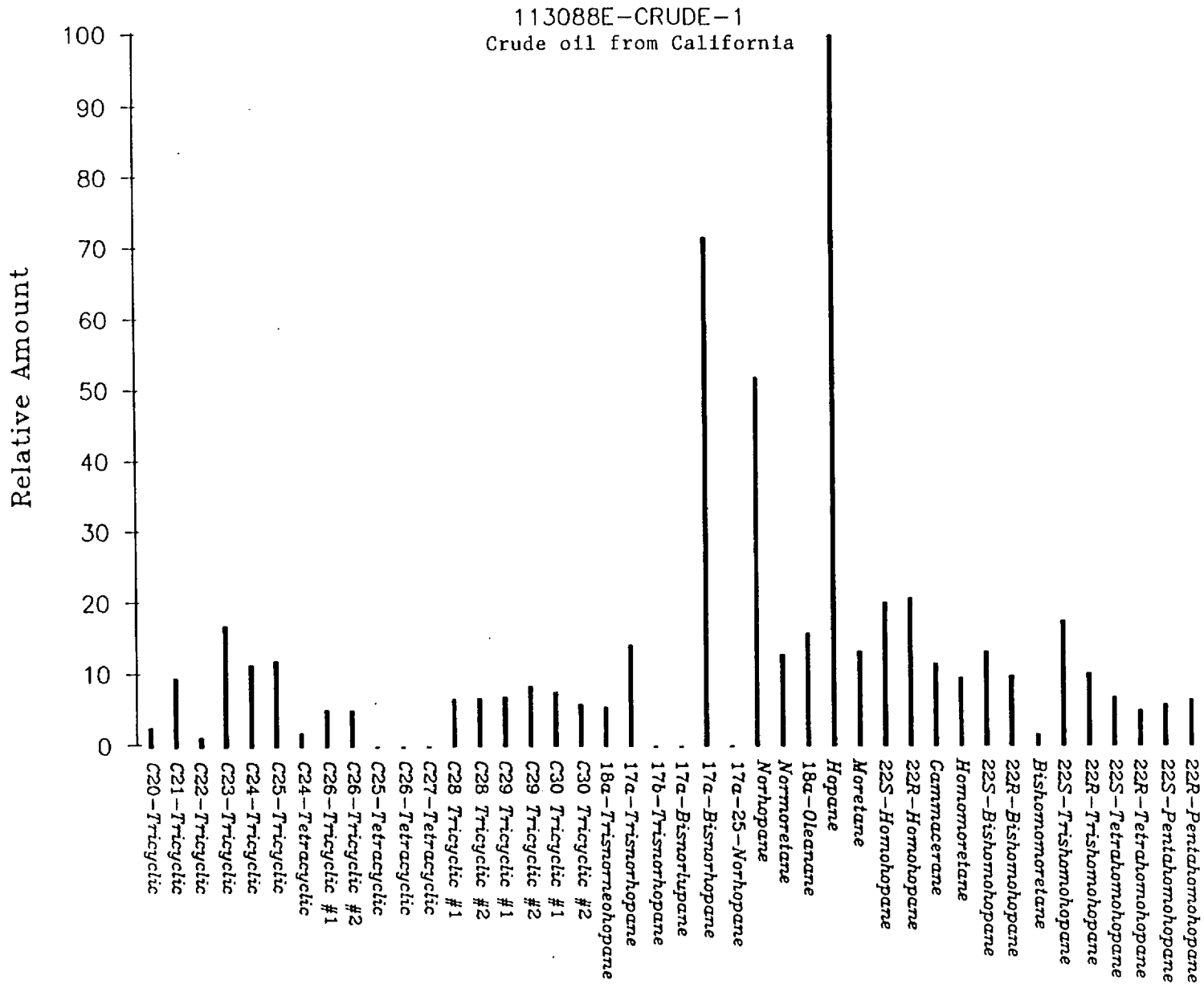


Figure VI-26

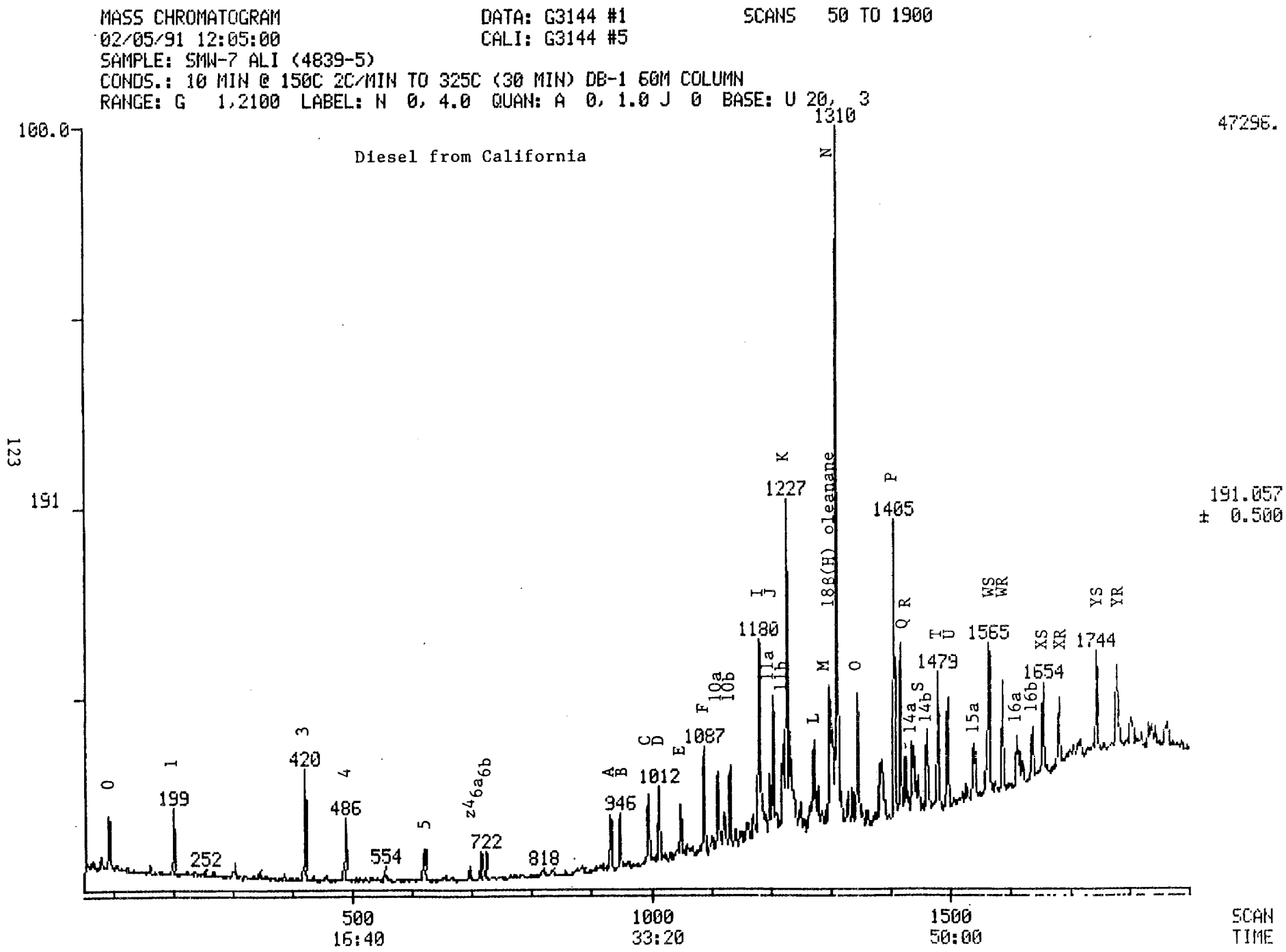

MASS CHROMATOGRAM
02/05/91 12:05:00
SAMPLE: SMW-7 ALI (4839-5)
CONDS.: 10 MIN @ 150C 2C/MIN TO 325C (30 MIN) DB-1 60M COLUMN
RANGE: G 1,2100 LABEL: N 0, 4.0 QUAN: A 0, 1.0 J 0 BASE: U 20, 3
DATA: G3144 #1
CALI: G3144 #5
SCANS 50 TO 1900
Diesel from California
100.0
191
123
47296.
191.057
± 0.500
18β(H) oleanane
SCAN
TIME
500
16:40
1000
33:20
1500
50:00

Figure VI-27

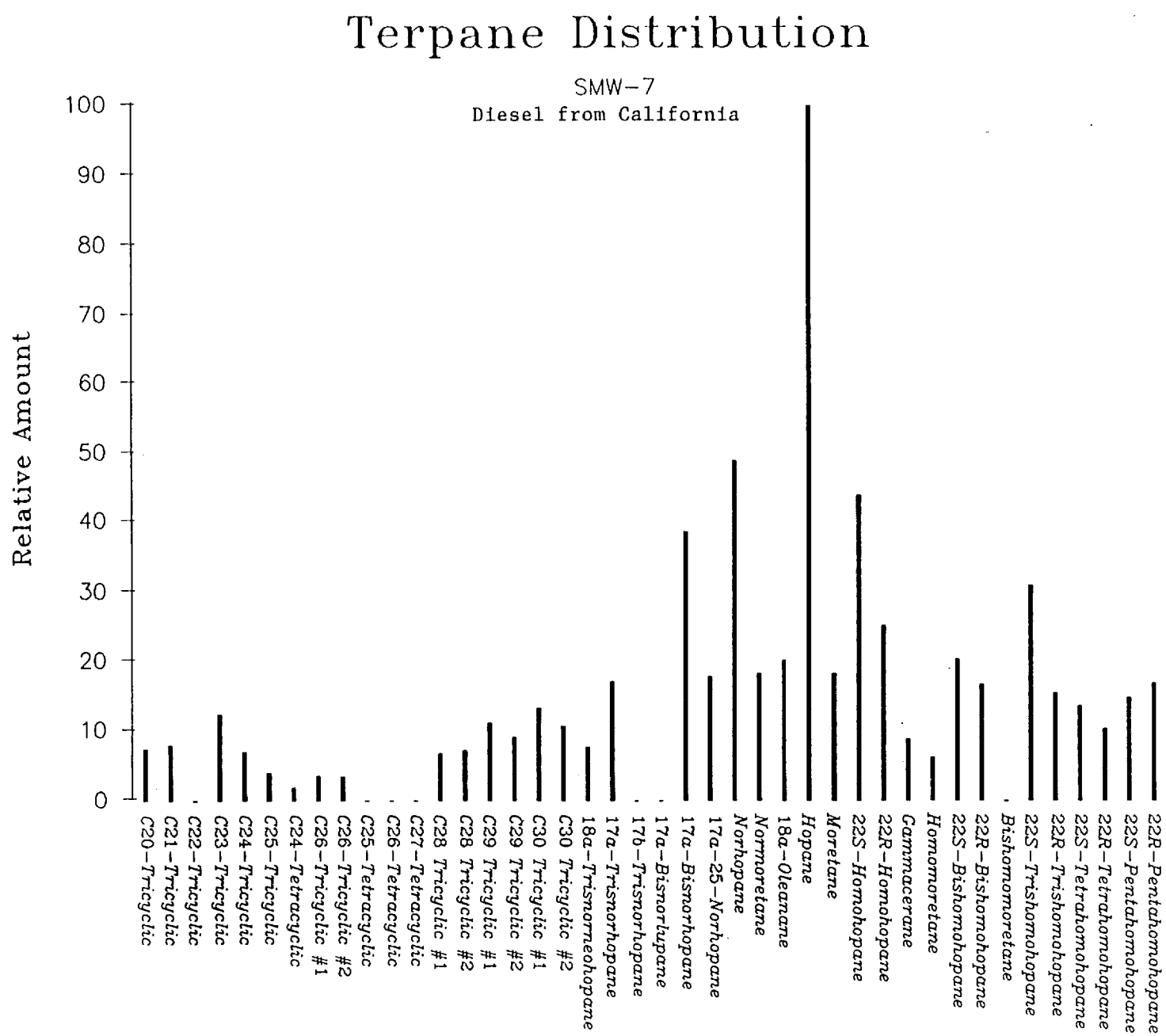

Terpane Distribution
SMW-7
Diesel from California
Relative Amount
100
90
80
70
60
50
40
30
20
10
0
C20-Tricyclic
C21-Tricyclic
C22-Tricyclic
C23-Tricyclic
C24-Tricyclic
C25-Tricyclic
C24-Tetracyclic
C26-Tricyclic #1
C26-Tricyclic #2
C25-Tetracyclic
C26-Tetracyclic
C27-Tetracyclic
C28 Tricyclic #1
C28 Tricyclic #2
C29 Tricyclic #1
C29 Tricyclic #2
C30 Tricyclic #1
C30 Tricyclic #2
18a-Trisnorneohopane
17a-Trisnorhopane
17b-Trisnorhopane
17a-Bisnorlupane
17a-Bisnorhopane
17a-25-Norhopane
Norhopane
Normoretane
18a-Oleanane
Hopane
Moretane
22S-Homohopane
22R-Homohopane
Gammacerane
Homomoretane
22S-Bishomohopane
22R-Bishomohopane
Bishomomoretane
22S-Trishomohopane
22R-Trishomohopane
22S-Tetrahomohopane
22R-Tetrahomohopane
22S-Pentahomohopane
22R-Pentahomohopane

Figure VI-28

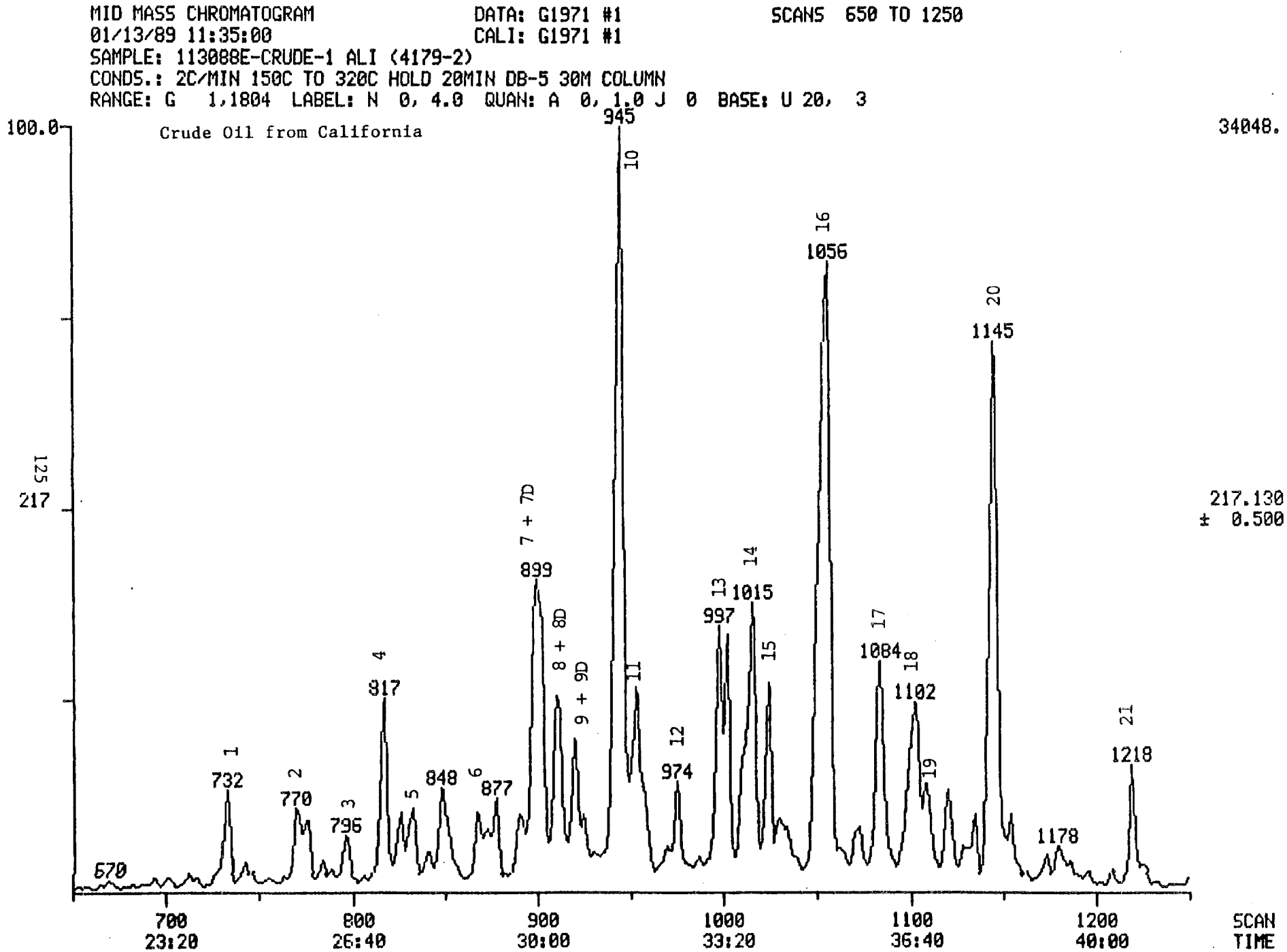

MID MASS CHROMATOGRAM
DATA: G1971 #1
SCANS 650 TO 1250
01/13/89 11:35:00
CALI: G1971 #1
SAMPLE: 113088E-CRUDE-1 ALI (4179-2)
CONDS.: 2C/MIN 150C TO 320C HOLD 20MIN DB-5 30M COLUMN
RANGE: G 1,1804 LABEL: N 0, 4.0 QUAN: A 0, 1.0 J 0 BASE: U 20, 3
Crude Oil from California
100.0
125
217
34048.
217.130
± 0.500
670
732
770
796
817
848
877
899
945
974
997
1015
1056
1084
1102
1145
1178
1218
1
2
3
4
5
6
7 + 7D
8 + 8D
9 + 9D
10
11
12
13
14
15
16
17
18
19
20
21
700
23:20
800
26:40
900
30:00
1000
33:20
1100
36:40
1200
40:00
SCAN
TIME

Figure VI-29

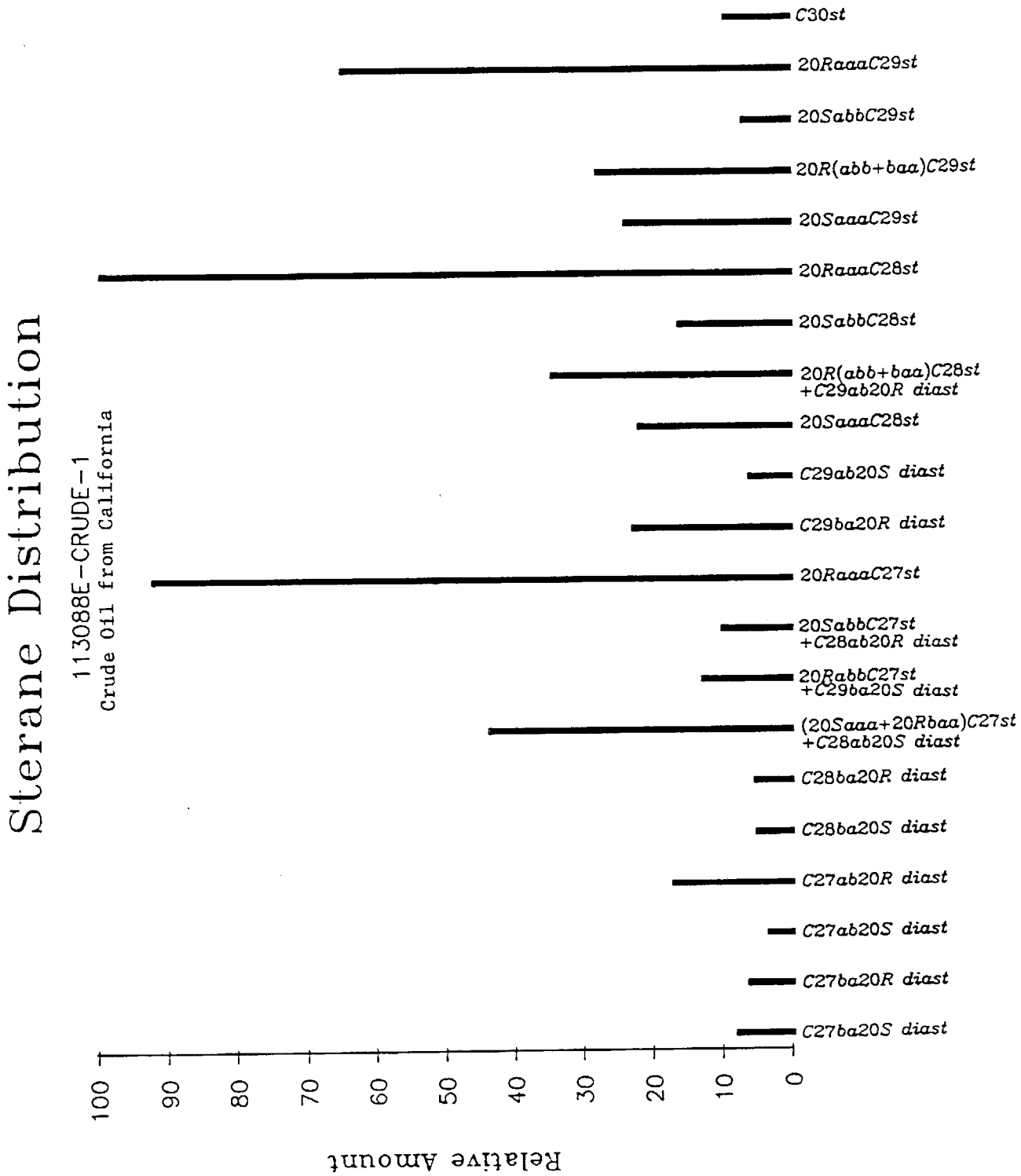

Sterane Distribution
113088E-CRUDE-1
Crude Oil from California
C30st
20RaaaC29st
20SabbC29st
20R(abb+baa)C29st
20SaaaC29st
20RaaaC28st
20SabbC28st
20R(abb+baa)C28st
+C29ab20R diast
20SaaaC28st
C29ab20S diast
C29ba20R diast
20RaaaC27st
20SabbC27st
+C28ab20R diast
20RabbC27st
+C29ba20S diast
(20Saaa+20Rbaa)C27st
+C28ab20S diast
C28ba20R diast
C28ba20S diast
C27ab20R diast
C27ab20S diast
C27ba20R diast
C27ba20S diast
100
90
80
70
60
50
40
30
20
10
0
Relative Amount

Figure VI-30

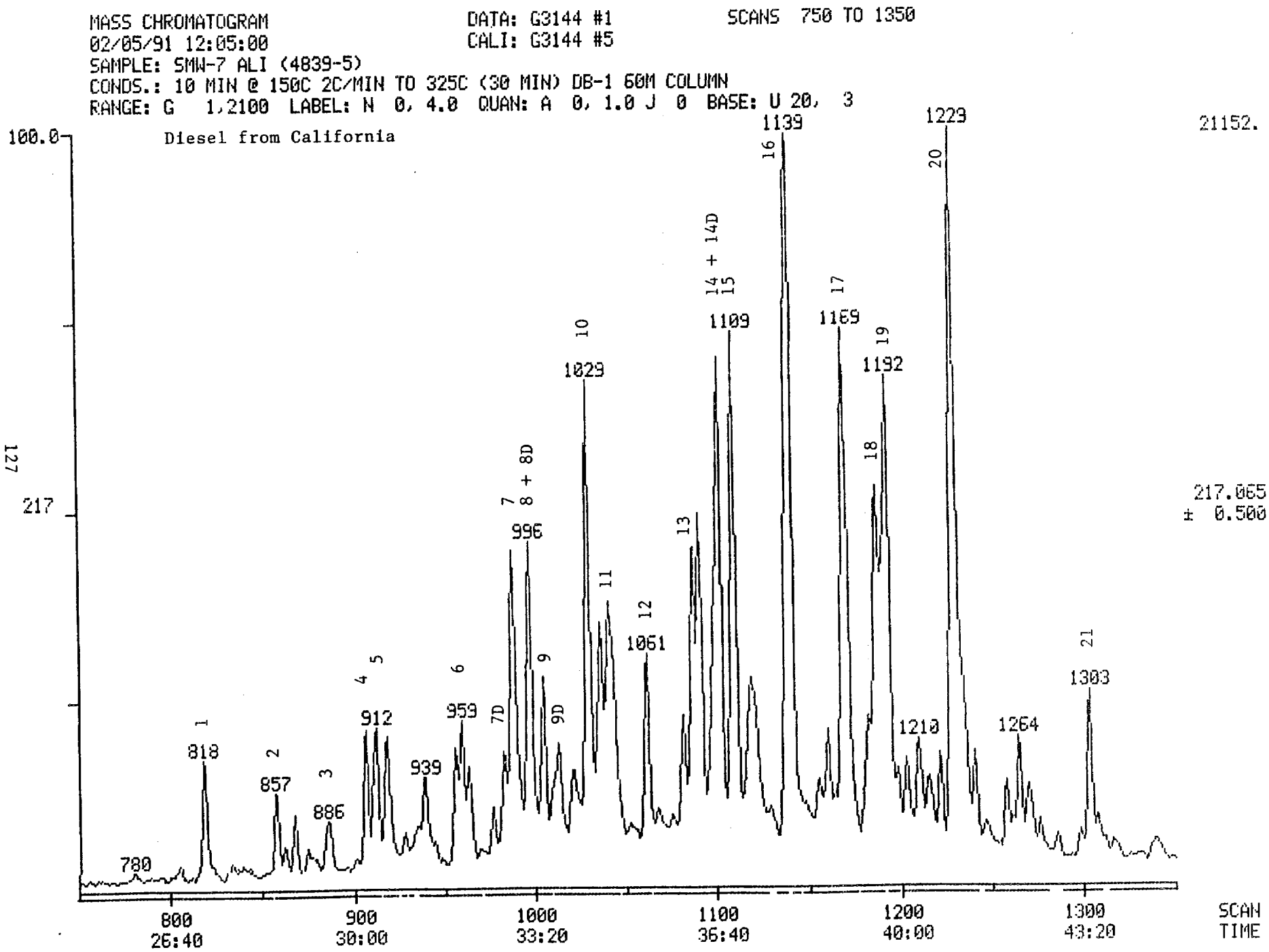

MASS CHROMATOGRAM
02/05/91 12:05:00
SAMPLE: SMW-7 ALI (4839-5)
CONDS.: 10 MIN @ 150C 2C/MIN TO 325C (30 MIN) DB-1 60M COLUMN
RANGE: G 1,2100 LABEL: N 0, 4.0 QUAN: A 0, 1.0 J 0 BASE: U 20, 3
DATA: G3144 #1
CALI: G3144 #5
SCANS 750 TO 1350
Diesel from California
100.0
127
217
21152.
217.065
± 0.500
780
818
857
886
912
939
959
996
1029
1061
1109
1139
1169
1192
1210
1229
1264
1303
1
2
3
4
5
6
7D
7
8 + 8D
9
9D
10
11
12
13
14 + 14D
15
16
17
18
19
20
21
800
26:40
900
30:00
1000
33:20
1100
36:40
1200
40:00
1300
43:20
SCAN
TIME

Figure VI-31

Sterane Distribution

SMW-7

Diesel from California

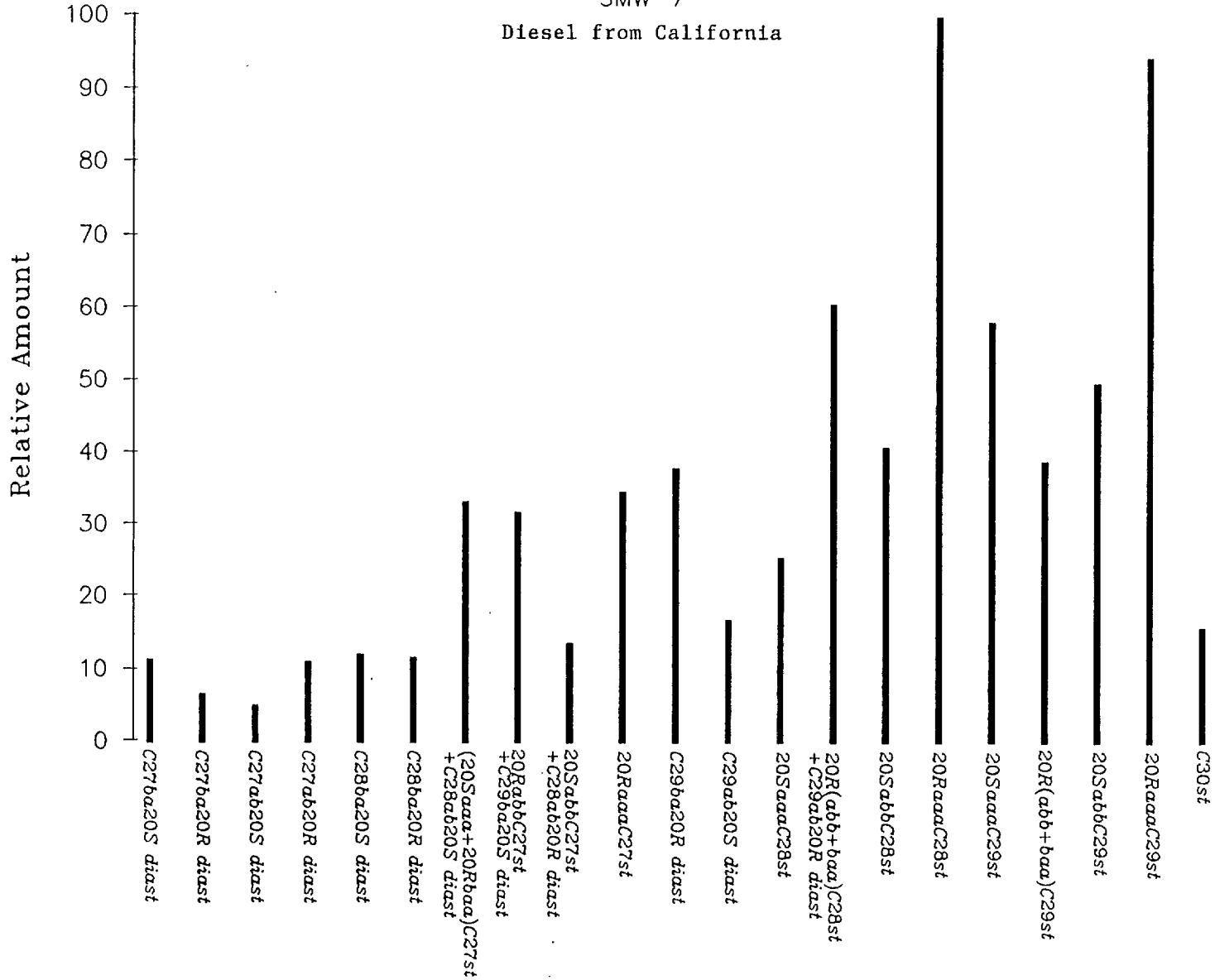


Figure VI-32

MASS CHROMATOGRAM DATA: G2598 #1 SCANS 800 TO 1400
03/15/90 13:28:00 CALI: G2598 #2
SAMPLE: CRUDE OIL (VOY 900) ALI
CONDS.: 2C/MIN 150C TO 320C (30 MIN) DB-1 60M COLUMN
RANGE: G 1,1424 LABEL: N 0, 4.0 QUAN: A 0, 1.0 J 0 BASE: U 20, 3

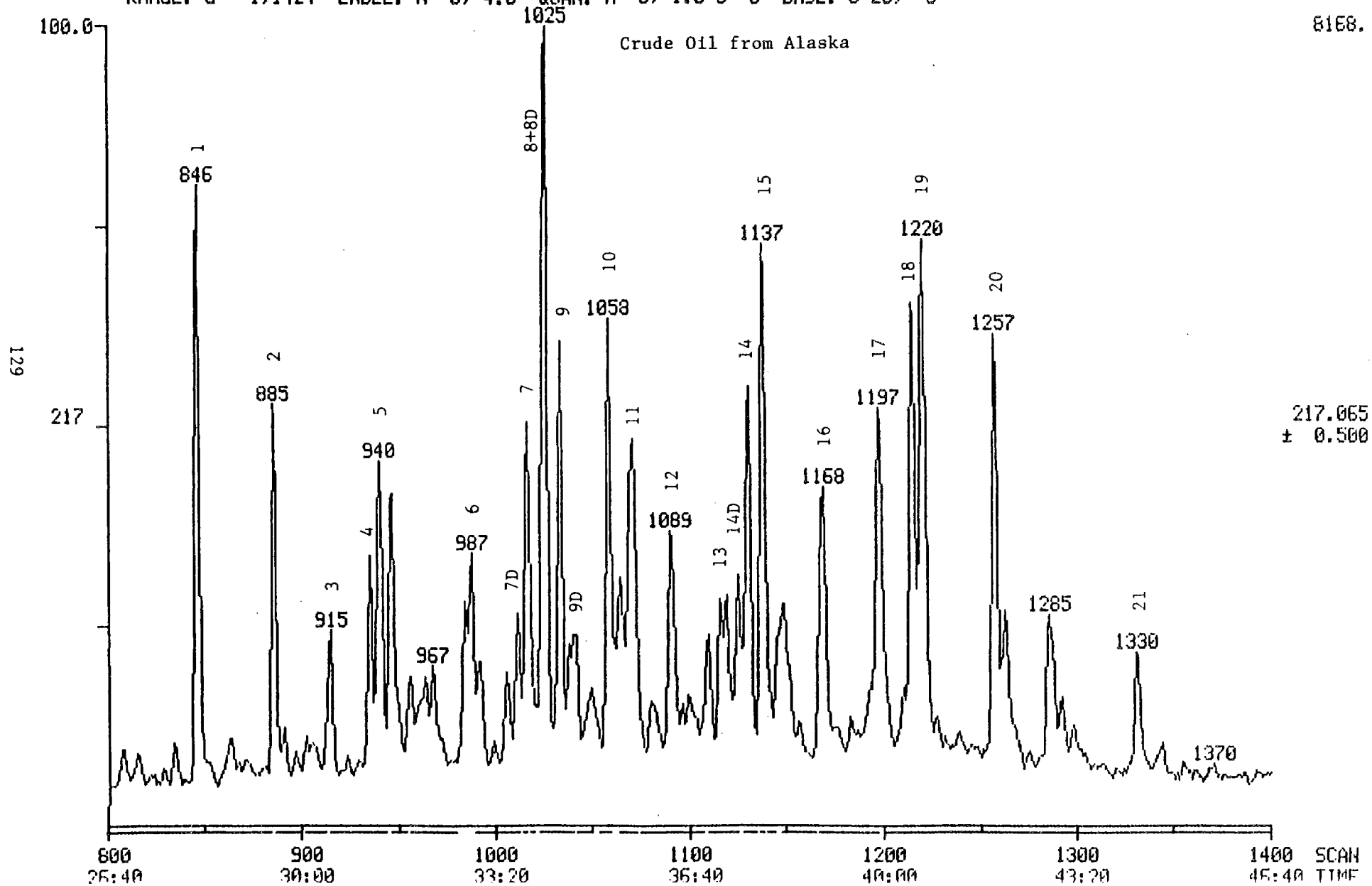


Figure VI-33

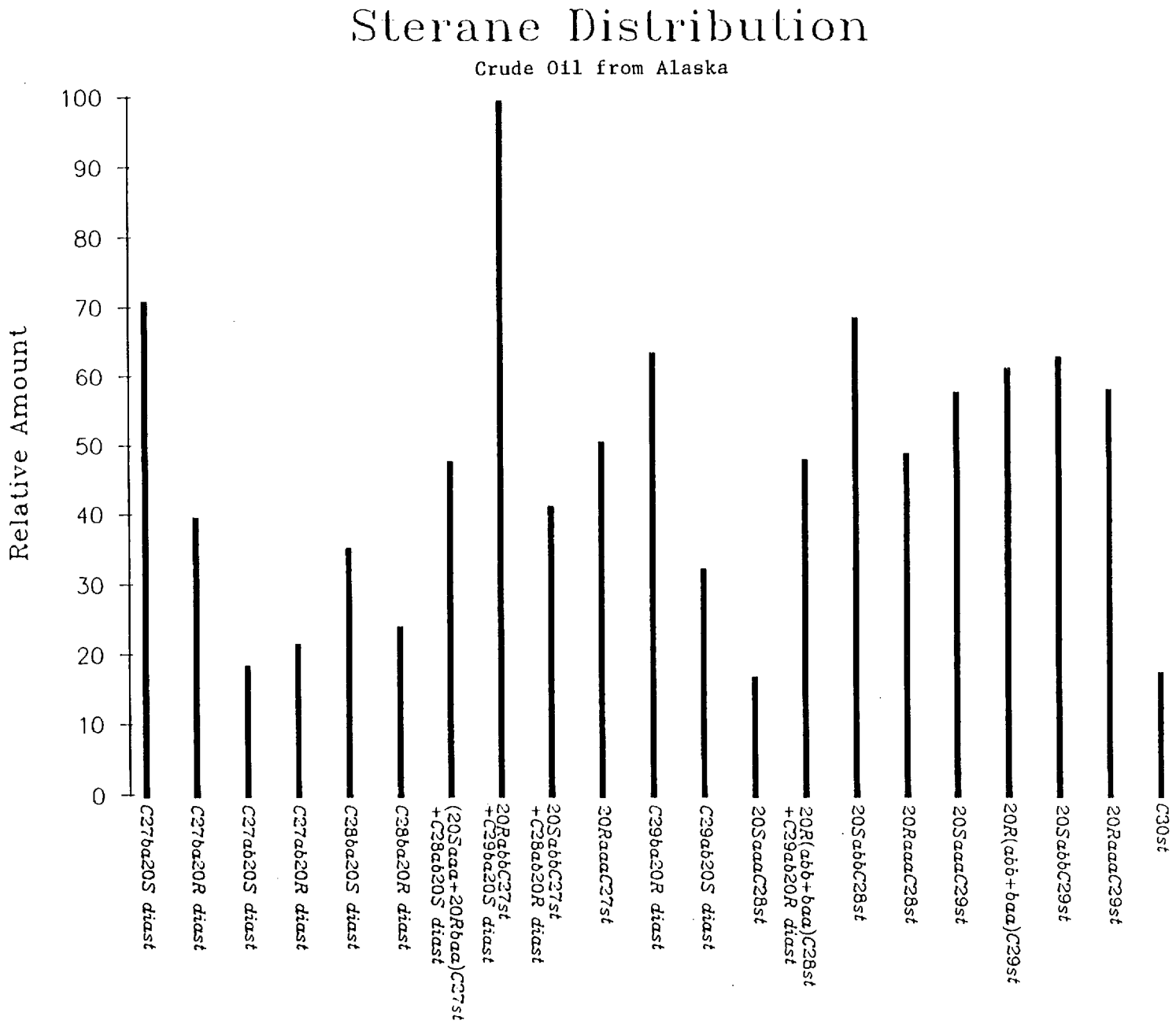
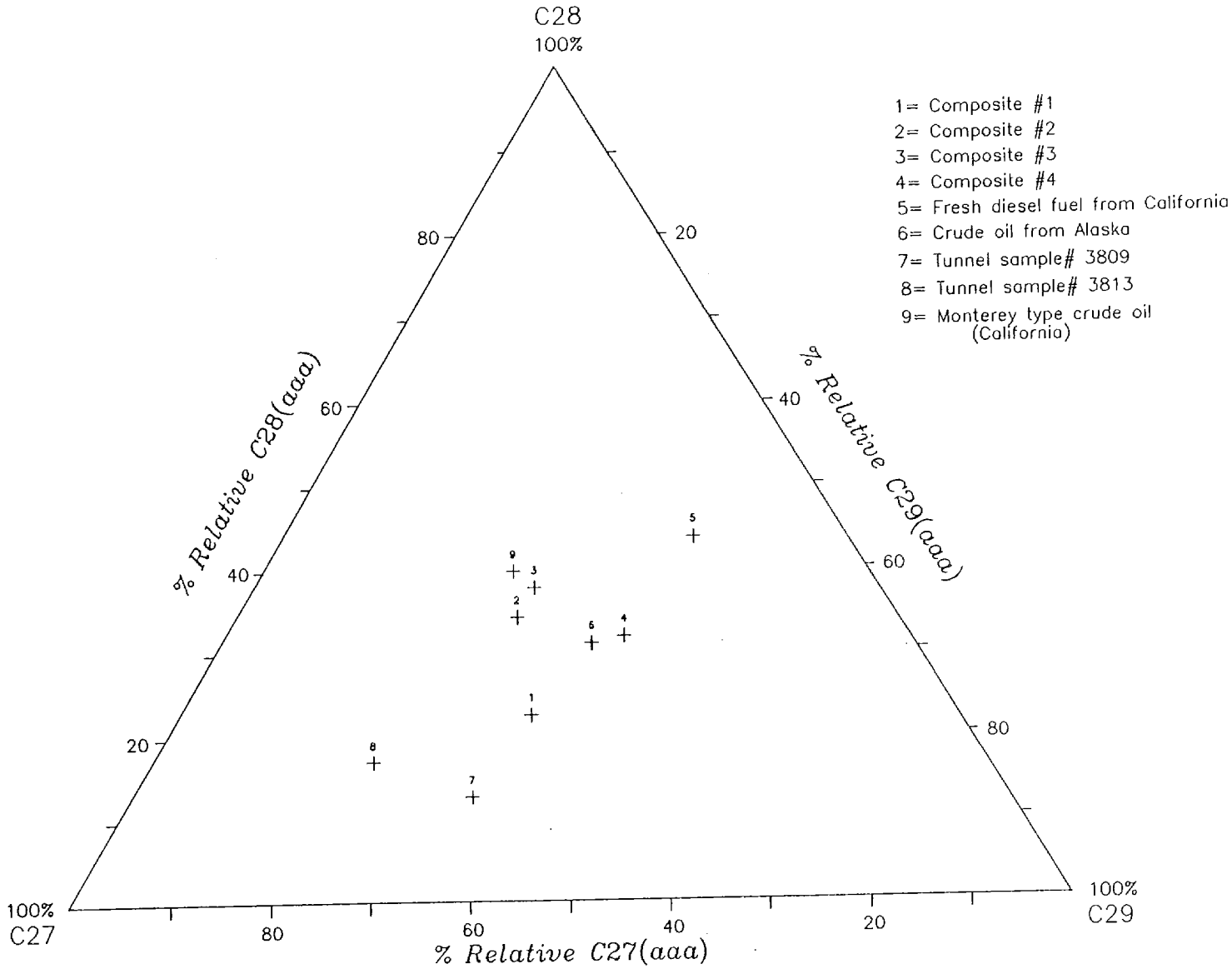

Sterane Distribution
Crude Oil from Alaska
Relative Amount
100
90
80
70
60
50
40
30
20
10
0
C27ba20S diast
C27ba20R diast
C27ab20S diast
C27ab20R diast
C28ba20S diast
C28ba20R diast
(20Saaa+20Rbaa)C27st +C28ab20S diast
20RabbC27st +C29ba20S diast
20SabbC27st +C28ab20R diast
20RaaaC27st
C29ba20R diast
C29ab20S diast
20SaaaC28st
20R(abb+baa)C28st +C29ab20R diast
20SabbC28st
20RaaaC28st
20SaaaC29st
20R(abb+baa)C29st
20SabbC29st
20RaaaC29st
C30st

Figure VI-34

Sterane Carbon Number Distribution