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ANALYSIS OF SEDIMENT AND WATER SAMPLES  
FROM BRUNY ISLAND FOR PETROLEUM HYDROCARBONS

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**ANALYSIS OF SEDIMENT AND WATER SAMPLES  
FROM BRUNY ISLAND FOR PETROLEUM HYDROCARBONS**

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DATE OF REPORT: October 26th., 1987

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## SAMPLES

Eight samples of sediment or water from various sites on Bruny Island were supplied by Mr. Ken Morrison for analysis of hydrocarbons in order to ascertain whether any contained petroleum residues. In particular, it was hoped to confirm data from an earlier analysis of hydrocarbons from Johnson's Well by ANALABS which suggested that hydrocarbons from a possible oil seep were present at that site. Samples provided were labelled C1, SP1, SP2 and 4-8. For the purposes of this report, samples numbered 4-8 are designated as B4-B8 to distinguish these from other samples being analysed at the same time. Samples SP2 and B7 were obtained from the same site as the original sample from Johnson's well.

## METHODS AND RESULTS

Each sample was extracted several times with hexane to obtain a total extract. In the case of sediments, the efficiency of the extraction was enhanced by the use of an ultrasonic probe. Hexane was used rather than more polar solvents since this is quite suitable for hydrocarbons and does not extract large amounts of polar lipids. Even so, many of the sample extracts still contained large amounts of polars relative to hydrocarbons reflecting the low abundance of the latter in these samples. A portion of the extract was analysed by Iatroscan thin-layer chromatography-flame ionisation detection (Volkman et al., 1986) from which the concentration of total hydrocarbons was calculated using appropriate calibration factors. Note that these amounts include all hydrocarbons, i.e. aliphatic and aromatic as well as biogenic and petrogenic. TLC-FID chromatograms are shown in Figures 1-3.

Hydrocarbons were separated by applying an aliquot of the total extract to a column of silica gel and eluting with hexane-toluene mixtures. These were then analysed by capillary gas chromatography on a non-polar methyl silicone fused silica capillary column. Gas chromatograms of the total hydrocarbons (aliphatics plus aromatics) are shown in Figures 4-11. Major constituents in most samples were straight-chain alkanes ranging in chain-length from C<sub>15</sub> to at least C<sub>37</sub>. Some n-alkane distributions showed a strong predominance of odd-carbon chain lengths which is typical of the plant waxes of vascular plants. Other distributions showed little or no predominance of odd chain-lengths. Although such distributions are typical of those found in crude oils, I believe it more likely that these alkanes originate from micro-organisms in the sediment or water samples. No sample showed a significant "unresolved complex mixture" (UCM or hump) which would have been expected had there been large amounts of petroleum hydrocarbons present.

In order to confirm the presence of hydrocarbons of petroleum origin, each of the hydrocarbon fractions was analysed by

capillary gas chromatography-mass spectrometry to obtain full scan electron-impact mass spectra. Preliminary analysis of these data showed that some samples contained trace amounts of polycyclic biomarkers typical of crude oils although these were very much less abundant than n-alkanes. In order to obtain useful data, it was necessary to separate these branched/cyclic alkanes from straight-chain compounds using molecular sieves. These branched/cyclic fractions were then reanalysed using the selected ion monitoring facility of the mass spectrometer. Data for ions  $m/z$  217 and 218 (steranes),  $m/z$  259 (diasteranes),  $m/z$  191 (hopanes),  $m/z$  177 and 205 (certain hopanes),  $m/z$  113 and 183 (acyclic isoprenoids) and various molecular ions were acquired. Representative mass fragmentograms are shown in Figures 12-45. These analyses are stored on computer disk should other presentations of the data be required. Quantitative data for selected biomarker parameters are shown in Table 1.

#### CHARACTERISATION OF PETROLEUM RESIDUES

Samples SP2, B5, B6, B7 and B8 were found to contain hydrocarbon biomarkers whose distributions were typical of a mature crude oil. Petroleum residues could not be detected in samples C1, SP1 or SP4. Each of these was a water sample and thus ultra-trace levels of petroleum hydrocarbons may have been below the level of detection. Each sample, however, contained easily detectable amounts of biogenic hydrocarbons (Figures 4,5,7).

Analyses of the isoprenoid and polycyclic alkane biomarkers (Table 1) are consistent with the proposition that trace amounts of a crude oil, of moderate maturity, are present in these samples. It should be stressed that the amounts are very small and considerably lower than might have been expected if petroleum was still actively seeping at these sites. It may be that a petroleum seepage occurred some time in the past, which would account for the present-day low abundance of light-end hydrocarbons. It is not possible to rule out from the geochemical data the possibility that the petroleum hydrocarbons originated from some form of pollution by man, but it is difficult to imagine how such pollution might have occurred at the various sites.

Geochemical analyses were made difficult by the low amounts of petroleum hydrocarbons present and occurrence of biogenic polycyclic alkanes and alkenes. It was not therefore possible to carry out the usual detailed range of analyses needed to fully characterise the presumed oil. The sterane and hopane data suggest that the oil was probably generated from source rocks at a vitrinite reflectance of about 0.6-0.7. A precise estimate is not possible but it is clear that the oil was generated well into the oil window. Although there are some differences in the proportions of the various source biomarkers, at this stage the limited data suggest the presence of a similar oil at most of the sites.

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(a) Acyclic isoprenoid alkanes. Pristane and phytane were detected in SP2 and B4-B8. The ratio of pristane to phytane was calculated from m/z 113 mass fragmentograms obtained from analysis of the total hydrocarbons and/or the branched cyclic fractions. Mass fragmentograms are shown in Figures 12-16. This ratio is often used as an indicator of depositional environment of the source rock. Calculated values were about 1.3 for B5-B8, and about 2.0 for B4. Values slightly greater than one are usually attributed to environments which are oxic for at least part of the time.

The pristane/phytane ratio for SP2 was much lower than the others at about 0.22. This sample contained surprisingly large amounts of phytane (Figure 12B). Such a low value is normally indicative of a highly reducing (anoxic) depositional environment. However, in environmental samples of this type it is always possible that natural sources of pristane and phytane could contribute to the hydrocarbon distributions so these interpretations need to be treated with care. It would be necessary to carry out a stereochemical analysis of both pristane and phytane to determine what proportion is derived from biogenic sources.

A search was also made for the unusual isoprenoid alkane, botryococcane, which has recently been identified as a major constituent of oil seep bitumens washed up onto South Australian beaches, but none could be detected. Amounts of sample were too small to check whether other isoprenoid alkanes are present in these samples.

(b) Pentacyclic triterpanes. Distributions of hopanes in each of the samples were quite similar. Analysis of the data was complicated in most of the samples by the presence of hopanes having an "immature"  $\beta\beta$  stereochemistry (which presumably are associated with the soil organic matter) as well as unsaturated hopenes derived from bacterial organic matter in the soil. The amounts of hopanes (and other biomarkers) were low in all samples and this presented a difficulty in their analysis due to a high bleed of m/z 191 from the capillary column at high temperatures. This is seen as a rising baseline in the m/z 191 mass fragmentograms.

The distributions of "geological" isomers are typical of those found in mature crude oils. Moretanes were much less abundant than 17 $\alpha$ (H)-hopanes as expected for a mature petroleum. The C<sub>27</sub> hopanes T<sub>s</sub> and T<sub>m</sub> were comparatively minor components of the hopane distributions which made accurate measurements of the T<sub>s</sub>/T<sub>m</sub> ratio difficult in some cases. In most cases, T<sub>s</sub> was slightly less abundant than T<sub>m</sub> which is typical of oils generated at vitrinite reflectance values less than 0.7.

One unusual feature that may be worth further investigation is the occurrence of anomalous values for the C<sub>31</sub> hopane 22S/(22S + 22R) ratio. This is usually about 60% in most petroleum because these two isomers isomerise to an equilibrium mixture at maturities well before the oil window. However, all of the

samples contained much more of the "C<sub>31</sub> 22R" hopane than would be expected for a mature oil leading to quite anomalous ratios calculated for this maturity parameter (Table 1). This is almost certainly due to co-elution of another compound (called "X" for convenience) with the 22R isomer since the ratios for the other extended C<sub>31</sub>-C<sub>35</sub> hopanes are typical of a mature oil. A possible candidate is the C<sub>30</sub> polycyclic alkane gammacerane which only occurs in a limited number of oils (e.g. Shi Ji-Yang et al, 1982). To confirm this identification it will be necessary to reanalyse the hydrocarbons by GC-MS using a more polar capillary column. If confirmed, this compound could be a useful marker for oil from the oil seep. A similar anomaly has been observed in the hydrocarbon distributions in sediments from the D'Entrecasteaux Channel. It is less likely than an alkene from bacteria in the sediment is coeluting because mass fragmentograms for m/z 410, the molecular ion of C<sub>30</sub> hopenes, did not give a peak at this retention time.

Tricyclic alkanes are comparatively minor constituents of these samples as judged by peak areas in the m/z 191 mass fragmentograms. The source rock is thus unlikely to be associated with Tasmanites which we have found to contain large amounts of these hydrocarbons (unpublished data). The unusual hopane bisnorhopane, which occurs in the Yolla #1 oil, was not detected in any of the samples. Demethylated hopanes were not detected in any of the samples using m/z 177 mass fragmentograms. These are commonly associated with highly biodegraded residues of crude oil (Volkman et al., 1983).

(c) Steranes. Samples SP2, B5, B6 and B7 contain small amounts of C<sub>27</sub> - C<sub>29</sub> steranes and lesser amounts of C<sub>21</sub> and C<sub>22</sub> steranes. The ratios of "geological" to "biological" isomers (Table 1) is typical of a moderately mature petroleum. Maturity parameters were very similar for all of the samples but there were slight variations the source parameters (Table 1). The amount of diasteranes (rearranged steranes) was quite variable between these samples which could reflect variations in the source rock. These compounds are typically abundant where the source rocks contain large amounts of clays which catalyse the steroid backbone rearrangement. The occurrence of approximately equal amounts of C<sub>27</sub> and C<sub>29</sub> steranes is typical of oils generated from mixed marine and terrigenous organic matter. There is presently some debate as to the merits of this ratio for predicting the type of source organic matter, although it is still very useful as a fingerprint for comparison with potential source rocks. The ratio of the "geological" 20S  $\alpha\alpha\alpha$ -isomer to the "biological" 20R-isomer (Table 1) is typical of hydrocarbons generated at a vitrinite reflectance of about 0.60-0.65. 4-Methyl steranes were not abundant in any of the samples.

## DETAILED DESCRIPTION OF GEOCHEMICAL DATA FOR EACH SAMPLE

Sample C1: This water sample was an algal scum from a dam at Craddock. One hundred ml of water was extracted for analysis. Hydrocarbons were very minor constituents and totalled only 30 ng/ml. A gas chromatogram of the total hydrocarbons is shown in Figure 4. Hydrocarbons consisted almost entirely of a suite of n-alkanes from C<sub>24</sub> to C<sub>35</sub> which showed only a slight predominance of odd-chain lengths. Short-chain alkanes were very minor components and there was no indication of a UCM. The peak for n-C<sub>25</sub> is enhanced due to co-elution with a phthalate ester which is a common contaminant in environmental samples. This contaminant is not a significant component of the other samples. GC-MS analysis revealed no peaks at retention times expected for steranes or hopanes and so the sample was judged to be lacking in petroleum residues.

Sample SP1: This algal scum was obtained from a dam at Johnson's Well. One hundred ml of water was extracted with hexane for analysis. Hydrocarbons were quite minor constituents and totalled only 14 ng/ml. A gas chromatogram is shown in Figure 5. The distribution was similar to that in sample C1 and consisted mainly of a distribution of n-alkanes from C<sub>26</sub> to C<sub>35</sub> which showed no predominance of odd-chain n-alkanes. There was some suggestion of a UCM at low carbon numbers but no petroleum hydrocarbons could be detected by GC-MS.

Sample SP2. This was a mud sample from Johnson's Well, taken a few meters away from the original sample. One hundred grams of sediment was sieved through a 500  $\mu$ m mesh to remove larger pieces of plant material and then extracted with hexane using sonication to yield total hydrocarbons. The total hydrocarbon concentration was 1.7  $\mu$ g/g which is fairly typical of unpolluted sediments. A gas chromatogram is shown in Figure 6. Major constituents were n-alkanes in the range from n-C<sub>19</sub> to n-C<sub>35</sub>. These showed a strong predominance of odd-chain lengths which is very typical of higher plants. Small peaks accompanied each of the higher molecular weight alkanes and these were identified as n-alkenes, also likely to be of higher plant origin. No obvious UCM was apparent in the gas chromatogram but analysis by GC-MS indicated that trace amounts of hydrocarbons typical of a crude oil were present in the sample.

(a) acyclic isoprenoids were minor components of the hydrocarbon extract (Figure 12). Pristane was much less abundant than n-C<sub>17</sub>, but phytane was more abundant than n-C<sub>18</sub> which is quite unusual. Assuming no biogenic contributions to pristane and phytane, the pristane/phytane ratio suggests a very reducing depositional environment for the presumed oil source rock.

(b) hopanes were detectable by mass fragmentogram of m/z 191, but the amounts were still quite small as evidenced by the low signal relative to column bleed. Hopanes with  $\beta\beta$  stereochemistry

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predominated and these are unlikely to be associated with the crude oil.  $T_s$  and  $T_m$  were barely detectable. The largest peak in the  $m/z$  191 mass fragmentogram eluted with the  $C_{31}$  22R hopane but, as discussed previously, the main contributor to this peak is probably compound "X".

(c) steranes were detected by mass fragmentograms of  $m/z$  217 and 218 (Figures 28 and 29).  $C_{27}$  steranes were only slightly more abundant than  $C_{29}$  steranes, with  $C_{28}$  steranes about one-third less abundant. The ratio of  $C_{29}$  sterane isomers was typical of a mature crude oil. Diasteranes were quite abundant and showed a similar ratio of  $C_{27}$ ,  $C_{28}$  and  $C_{29}$  pseudo-homologues as the steranes. Several extra peaks occurred in the  $m/z$  259 mass fragmentogram used to detect the diasteranes and the peak for the 20S- $C_{29}$  13 $\beta$ , 17 $\alpha$  sterane was much larger than expected suggesting that an additional compound was co-eluting.

Sample B4. This was a dark brown water sample. Larger pieces of plant material were removed by sieving through a 500  $\mu$ m mesh and then 250 ml was extracted with hexane. Iatroscan TLC-FID indicated that large amounts of hydrocarbons were present (720 ng/ml), but much of this consisted of carotenes, wax esters and alkenes of biogenic origin. The capillary gas chromatogram (Figure 7) revealed small quantities of n-alkanes showing a strong predominance of odd-chain lengths and no obvious UCM. Petroleum hydrocarbons could not be detected by GC-MS in SIM mode.

Sample B5. This water sample was obtained from a dam a few kilometers south of Johnson's well. Larger pieces of plant material were removed by sieving through a 500  $\mu$ m mesh and hydrocarbons extracted from 300 ml of water with hexane. Total hydrocarbon concentration was calculated to be 33 ng/ml from TLC-FID. A capillary gas chromatogram (Figure 8) showed a suite of n-alkanes from  $C_{15}$  to  $C_{37}$  which exhibited no predominance of odd-chain lengths. The major compound was squalene. A small UCM was present, but it was only obvious when the sample was concentrated and analysed at high sensitivities. GC-MS analysis of the total hydrocarbons in SIM mode revealed trace amounts of petroleum hydrocarbons. Hopanes were only just detectable and the amounts were not sufficient to calculate maturity parameters (Figure 19). Unlike the other samples, the ratio of  $C_{31}$  hopane 22R and 22S isomers was that expected for a crude oil, indicating that compound "X" was not present in this sample. Sterane distributions (Figures 31 and 32) were similar to those in SP2. Isomer ratios suggested a similar level of maturity and the ratio of  $C_{27}$  to  $C_{29}$  steranes was only slightly greater than in SP2. The  $m/z$  218 mass fragmentogram contained a major additional peak that is almost certainly not a sterane. Diasteranes were slightly more abundant than in SP2 but the ratio of isomers was similar. Once again, the  $m/z$  259 mass fragmentogram was complicated by the presence of other compounds.

sample B6. This was a mixed water and sediment sample. Approximately 3 g of wet sediment was extracted with hexane. The concentration of total hydrocarbons was quite high at 17  $\mu\text{g/g}$  (dry weight). Analysis by capillary gas chromatography (Figure 9) showed that the major constituents were high molecular weight alkanes in a distribution that is typical of higher plants. Small amounts of n-alkenes accompanied each of the n-alkanes and these are also likely to be from higher plants. Several short chain hydrocarbons eluted between n-C<sub>17</sub> and n-C<sub>20</sub> and these are thought to be from natural sources. There was no obvious sign of a UCM but analysis by GC-MS in SIM mode revealed that petroleum hydrocarbons were present in trace amounts. A portion of the total hydrocarbons was separated by molecular sieves into a branched/cyclic fraction which was analysed by GC-MS in SIM mode.

(a) isoprenoid alkanes were detected from m/z 113 mass fragmentograms (Figure 16A). Pristane was slightly more abundant than phytane, but both were very much less abundant than n-alkanes.

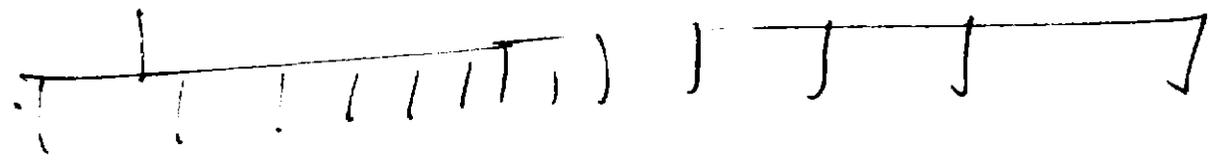
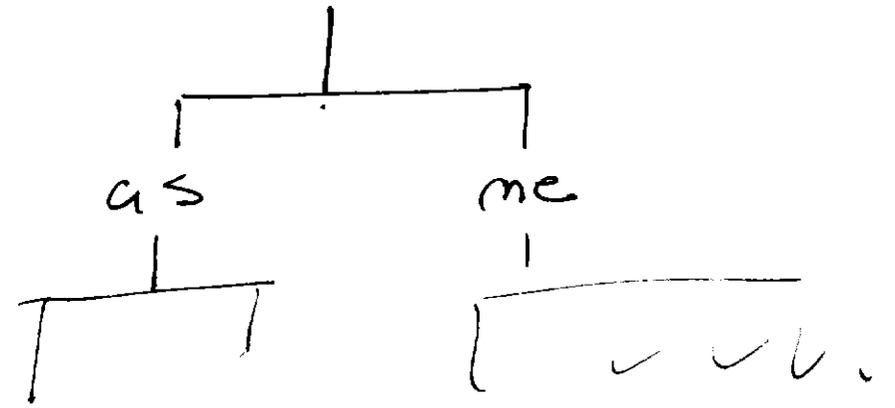
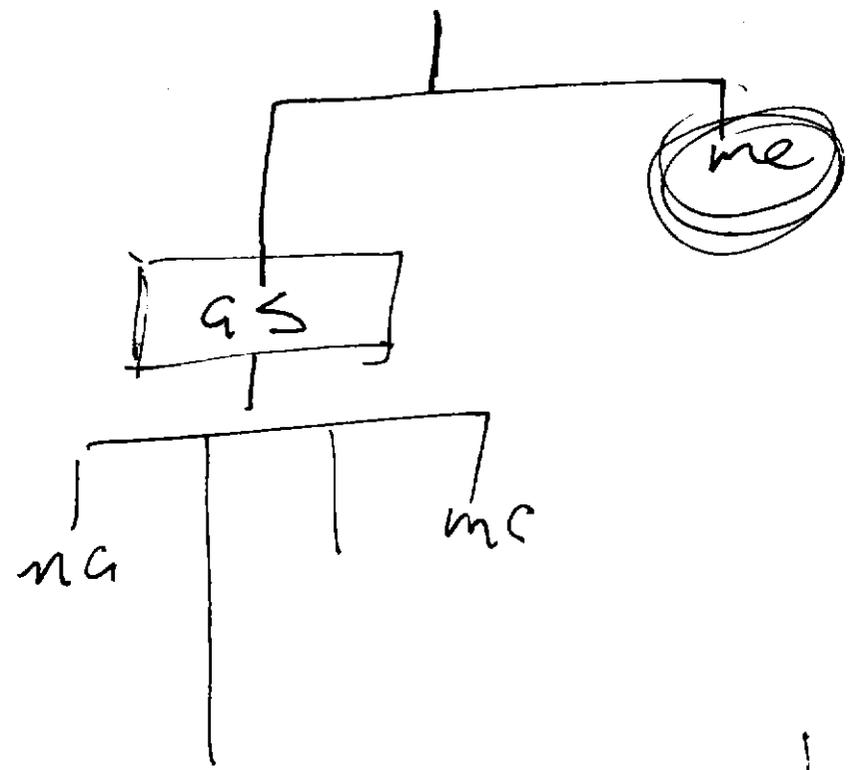
(b) hopanes were readily detected from m/z 191, 177 and 205 mass fragmentograms (Figures 21 and 22) and their distribution was very similar to that found in SP2 with the one exception that compound "X" was not abundant. Maturity parameters were typical of a mature crude oil.

(c) steranes were readily detected by m/z 217 and 218 mass fragmentograms (Figures 34 and 35), but these also contained major peaks attributable to other compounds. The ratio of sterane isomers was typical of a mature crude oil, although values of maturity parameters (Table 1) suggested a slightly lower maturity than that found in SP2. C<sub>27</sub> sterane were also less abundant than in SP2. Diasteranes were also less abundant suggesting that this oil was not identical with that found in SP2. The mass fragmentograms obtained for m/z 217 and 218 over the wider time window (Figure 35) showed major interferences from other compounds that were not steranes.

Sample B7. This sample was a dry sediment obtained from the same place as the original sample from Johnson's Well. Larger pieces of plant material were removed by sieving through a 500 $\mu\text{m}$  mesh. Approximately 40 g of dry sediment was extracted with hexane to give total hydrocarbons. The total amount of hydrocarbons was determined to be 400 ng/g from TLC-FID. The distribution of hydrocarbons was similar to that in B6 with n-alkanes of higher plant origin predominating. Short-chain hydrocarbons were less abundant and there was no indication of a UCM. Branched and cyclic hydrocarbons were obtained by treatment with molecular sieves and analysed by GC-MS in SIM mode.

(a) isoprenoid alkanes consisted mainly of pristane and phytane (Figure 14), with pristane more abundant than phytane (Table 1). In the Analabs analysis, the abundance of pristane was even higher, but this could be due to a contribution from biogenic pristane.

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(b) hopanes were readily detected from m/z 191, 177 and 205 mass fragmentograms (Figures 23 and 24) and showed a distribution of immature and mature isomers very similar to that found in the Analabs analysis. The only significant difference was a higher abundance of compound "X" coeluting with the 22R C<sub>31</sub> hopane, and higher amounts of the C<sub>31</sub> BB isomer. T<sub>m</sub>/T<sub>s</sub> and hopane/moretane ratios were typical of a mature crude oil. The C<sub>32</sub> extended hopanes were not apparent in the ANALABS analysis but for our data their ratio is that expected for a mature oil, clearly showing that the C<sub>31</sub> hopane ratio is anomalous.

(c) steranes were detected from m/z 217 and 218 mass fragmentograms (Figures 37 and 38) and their distribution was quite similar to that found in the Analabs analysis. The latter reported high concentrations of C<sub>27</sub> 20R and 20S  $\alpha\alpha$ -steranes, but it seems from our analysis that this is due to coelution with other compounds. C<sub>27</sub> steranes were slightly less abundant than C<sub>29</sub> steranes and matched fairly well the distributions in B6 and SP2. Diasteranes were slightly more abundant than in the other samples but the proportion of C<sub>29</sub> pseudo-homologues was greater (Table 1). Note that peak area of the C<sub>29</sub> 20S diasterane is greater than expected (Figure 39), as seen in some of the other samples, presumably due to co-elution with another compound. Isomer ratios were typical of a mature crude oil.

Sample B8. This sample consisted of roughly equal amounts of sediment and water. Approximately 40 g of sediment was extracted with hexane. The concentration of total hydrocarbons was determined to be 300 ng/g from TLC-FID. Hydrocarbons consisted of a suite of n-alkanes from n-C<sub>15</sub> to n-C<sub>37</sub> which showed only a slight predominance of odd-chain lengths. High amounts of squalene and shorter-chain hydrocarbons of biogenic origin were also present. No obvious UCM was evident. Branched and cyclic alkanes were isolated by molecular sieves and analysed by GC-MS in SIM mode which showed that small amounts of petroleum hydrocarbons were present.

(a) isoprenoid alkanes consisted mainly of pristane and phytane with pristane slightly more abundant (Figure 15).

(b) hopanes were readily detected from m/z 191, 177 and 205 mass fragmentograms (Figure 25) and showed a similar distribution to that found in SP2 and B7. Compound "X" was abundant, but amounts of immature BB isomers was much less than in the other samples. Maturity ratios were typical of a mature crude oil.

(c) steranes were detected from m/z 217 and 218 mass fragmentograms (Figures 40 and 41). C<sub>29</sub> steranes were slightly more abundant than C<sub>27</sub> steranes, but maturity parameters were similar to those in the other samples, with the exception that the abundance of the C<sub>29</sub> 20R sterane was slightly higher than expected considering the abundance of the 20S isomer. Diasterane distributions showed a lower abundance of C<sub>27</sub> pseudo-homologues than in the other samples.

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TABLE 1

## SELECTED BIOMARKER PARAMETERS FROM GC-MS ANALYSIS

SAMPLES: Sediment and water samples from Bruny Island supplied by Mr. K. C. Morrison.

MATURITY PARAMETERS	SP2	B5	B6	B7	B8
1. C <sub>27</sub> hopanes: T <sub>s</sub> /T <sub>m</sub>	0.63	nd	0.70	0.38	0.79
2. C <sub>30</sub> hopane/C <sub>30</sub> moretane	4.8	nd	7.4	3.1	6.0
3. C <sub>31</sub> 22S hopane/(C <sub>31</sub> 22R + 22S hopanes) X 100	6%	nd	37%	21%	28%
4. C <sub>32</sub> 22S hopane/(C <sub>32</sub> 22R + 22S hopanes) X 100	56%	nd	58%	55%	60%
5. C <sub>29</sub> ααα-steranes: 20S/20R	0.81	0.79	0.71	0.72	0.73
6. C <sub>29</sub> 20R steranes: αββ/ααα.	1.02	0.95	0.94	0.90	0.82
SOURCE PARAMETERS					
7. C <sub>27</sub> /C <sub>29</sub> steranes	0.93	0.71	0.78	0.98	0.73
8. C <sub>27</sub> /C <sub>29</sub> diasteranes	1.7	1.5	nd	1.0	0.77
9. Pristane/phytane	0.20	1.3	1.3	1.1	1.3

Parameters 1-4 calculated from m/z 191 mass fragmentograms

Parameters 5-7 calculated from m/z 217 and 218 mass fragmentograms

Parameter 8 calculated from m/z 259 mass fragmentograms

Parameter 9 calculated from m/z 113 mass fragmentograms.

nd: not determined due to co-elution with other compounds or too weak.

## LIST OF FIGURES

FIGURE 1. IATROSCAN TLC-FID CHROMATOGRAMS OF TOTAL EXTRACTABLE LIPIDS IN SAMPLES (a) BRUNY ISLAND "C1", (b) BRUNY ISLAND "SP1", (c) BRUNY ISLAND "SP2".

FIGURE 2. IATROSCAN TLC-FID CHROMATOGRAMS OF TOTAL EXTRACTABLE LIPIDS IN SAMPLES (a) BRUNY ISLAND "B4", (b) BRUNY ISLAND "B5", (c) BRUNY ISLAND "B6".

FIGURE 3. IATROSCAN TLC-FID CHROMATOGRAMS OF TOTAL EXTRACTABLE LIPIDS IN SAMPLES (a) BRUNY ISLAND "B7", (b) BRUNY ISLAND "B8".

FIGURE 4. CAPILLARY GAS CHROMATOGRAM OF TOTAL HYDROCARBONS IN BRUNY ISLAND SAMPLE "C1".

FIGURE 5. CAPILLARY GAS CHROMATOGRAM OF TOTAL HYDROCARBONS IN BRUNY ISLAND SAMPLE "SP1".

FIGURE 6. CAPILLARY GAS CHROMATOGRAM OF TOTAL HYDROCARBONS IN BRUNY ISLAND SAMPLE "SP2".

FIGURE 7. CAPILLARY GAS CHROMATOGRAM OF TOTAL HYDROCARBONS IN BRUNY ISLAND SAMPLE "B4".

FIGURE 8. CAPILLARY GAS CHROMATOGRAM OF TOTAL HYDROCARBONS IN BRUNY ISLAND SAMPLE "B5".

FIGURE 9. CAPILLARY GAS CHROMATOGRAM OF TOTAL HYDROCARBONS IN BRUNY ISLAND SAMPLE "B6".

FIGURE 10. CAPILLARY GAS CHROMATOGRAM OF TOTAL HYDROCARBONS IN BRUNY ISLAND SAMPLE "B7".

FIGURE 11. CAPILLARY GAS CHROMATOGRAM OF TOTAL HYDROCARBONS IN BRUNY ISLAND SAMPLE "B8".

FIGURE 12A. STRAIGHT-CHAIN AND ISOPRENOID ALKANES IN TOTAL HYDROCARBONS FROM BRUNY ISLAND SAMPLE "SP2".

FIGURE 12B. ISOPRENOID ALKANES IN BRANCHED/CYCLIC ALKANE FRACTION FROM BRUNY ISLAND SAMPLE "SP2".

FIGURE 13. STRAIGHT-CHAIN AND ISOPRENOID ALKANES FROM TOTAL HYDROCARBONS IN (a) BRUNY ISLAND SAMPLE "B4", (b) BRUNY ISLAND SAMPLE "B5".

FIGURE 14A. STRAIGHT-CHAIN AND ISOPRENOID ALKANES FROM TOTAL HYDROCARBONS IN BRUNY ISLAND SAMPLE "B7".

FIGURE 14B. ISOPRENOID ALKANES FROM BRANCHED/CYCLIC ALKANE FRACTION FROM BRUNY ISLAND SAMPLE "B7".

FIGURE 15A. STRAIGHT-CHAIN AND ISOPRENOID ALKANES FROM TOTAL HYDROCARBONS IN BRUNY ISLAND SAMPLE "B8".

FIGURE 15B. ISOPRENOID ALKANES FROM BRANCHED/CYCLIC ALKANE FRACTION FROM BRUNY ISLAND SAMPLE "B8".

FIGURE 16A. STRAIGHT-CHAIN AND ISOPRENOID ALKANES FROM TOTAL HYDROCARBONS FROM BRUNY ISLAND SAMPLE "B6"

FIGURE 16B. ISOPRENOID ALKANES FROM REFERENCE OIL SAMPLE WINDALIA OIL.

FIGURE 17. MASS FRAGMENTOGRAMS FOR M/Z 191 (HOPANES PLUS OTHER TRITERPANES) IN BRUNY ISLAND SAMPLE "SP2".

FIGURE 18A. MASS FRAGMENTOGRAM FOR M/Z 177 (C<sub>29</sub> HOPANES AND ALSO DEMETHYLATED HOPANES) IN BRUNY ISLAND SAMPLE "SP2".

FIGURE 18B. MASS FRAGMENTOGRAM FOR M/Z 205 (C<sub>31</sub> HOPANES) IN BRUNY ISLAND SAMPLE "SP2".

FIGURE 19. MASS FRAGMENTOGRAMS FOR M/Z 191 (HOPANES AND OTHER TRITERPANES) IN BRUNY ISLAND SAMPLE "B5".

FIGURE 20A. MASS FRAGMENTOGRAM FOR M/Z 177 (C<sub>29</sub> HOPANES PLUS DEMETHYLATED HOPANES) IN BRUNY ISLAND SAMPLE "B5".

FIGURE 20B. MASS FRAGMENTOGRAM FOR M/Z 205 (C<sub>31</sub> HOPANES) IN BRUNY ISLAND SAMPLE "B5".

FIGURE 21. MASS FRAGMENTOGRAMS FOR M/Z 191 (HOPANES AND OTHER TRITERPANES) IN BRUNY ISLAND SAMPLE "B6".

FIGURE 22A. MASS FRAGMENTOGRAM FOR M/Z 177 (C<sub>29</sub> HOPANES PLUS DEMETHYLATED HOPANES) IN BRUNY ISLAND SAMPLE "B6".

FIGURE 22B. MASS FRAGMENTOGRAM FOR M/Z 205 (C<sub>31</sub> HOPANES) IN BRUNY ISLAND SAMPLE "B6".

FIGURE 23. MASS FRAGMENTOGRAMS FOR M/Z 191 (HOPANES PLUS OTHER TRITERPANES) IN BRUNY ISLAND SAMPLE "B7".

FIGURE 24A. MASS FRAGMENTOGRAM FOR M/Z 177 (C<sub>29</sub> HOPANES PLUS DEMETHYLATED HOPANES) IN BRUNY ISLAND SAMPLE "B7".

FIGURE 24B. MASS FRAGMENTOGRAM FOR M/Z 205 (C<sub>31</sub> HOPANES) IN BRUNY ISLAND SAMPLE "B7".

FIGURE 25. MASS FRAGMENTOGRAMS FOR M/Z 191 (HOPANES PLUS OTHER TRITERPANES) IN BRUNY ISLAND SAMPLE "B8".

FIGURE 25A. MASS FRAGMENTOGRAM FOR M/Z 177 (C<sub>29</sub> HOPANES PLUS DEMETHYLATED HOPANES) IN BRUNY ISLAND SAMPLE "B8".

FIGURE 25B. MASS FRAGMENTOGRAM FOR M/Z 205 (C<sub>31</sub> HOPANES) IN BRUNY ISLAND SAMPLE "B8".

FIGURE 26. MASS FRAGMENTOGRAM FOR M/Z 191 (HOPANES PLUS OTHER TRITERPANES) IN REFERENCE SAMPLE WINDALIA OIL.

FIGURE 27A. MASS FRAGMENTOGRAM FOR M/Z 177 (C<sub>29</sub> HOPANES PLUS DEMETHYLATED HOPANES) IN REFERENCE SAMPLE WINDALIA OIL.

FIGURE 27B. MASS FRAGMENTOGRAM FOR M/Z 205 (C<sub>31</sub> HOPANES) FOR REFERENCE SAMPLE WINDALIA OIL.

FIGURE 28. MASS FRAGMENTOGRAMS FOR M/Z 217 AND 218 (C<sub>27</sub> - C<sub>30</sub> STERANES) IN BRUNY ISLAND SAMPLE "SP2".

FIGURE 29. MASS FRAGMENTOGRAMS FOR M/Z 217 AND 218 (C<sub>20</sub> - C<sub>30</sub> STERANES) IN BRUNY ISLAND SAMPLE "SP2".

FIGURE 30. MASS FRAGMENTOGRAM FOR M/Z 259 (DIASTERANES) IN BRUNY ISLAND SAMPLE "SP2".

FIGURE 31. MASS FRAGMENTOGRAMS FOR M/Z 217 AND 218 (C<sub>27</sub> - C<sub>30</sub> STERANES) IN BRUNY ISLAND SAMPLE "B5".

FIGURE 32. MASS FRAGMENTOGRAMS FOR M/Z 217 AND 218 (C<sub>20</sub> - C<sub>30</sub> STERANES) IN BRUNY ISLAND SAMPLE "B5".

FIGURE 33. MASS FRAGMENTOGRAM FOR M/Z 259 (DIASTERANES) IN BRUNY ISLAND SAMPLE "B5".

FIGURE 34. MASS FRAGMENTOGRAMS FOR M/Z 217 AND 218 (C<sub>27</sub> - C<sub>30</sub> STERANES) IN BRUNY ISLAND SAMPLE "B6".

FIGURE 35. MASS FRAGMENTOGRAMS FOR M/Z 217 AND 218 (C<sub>20</sub> - C<sub>30</sub> STERANES) IN BRUNY ISLAND SAMPLE "B6".

FIGURE 36. MASS FRAGMENTOGRAM FOR M/Z 259 (DIASTERANES) IN BRUNY ISLAND SAMPLE "B6".

FIGURE 37. MASS FRAGMENTOGRAMS FOR M/Z 217 AND 218 (C<sub>27</sub> - C<sub>30</sub> STERANES) IN BRUNY ISLAND SAMPLE "B7".

FIGURE 38. MASS FRAGMENTOGRAMS FOR M/Z 217 AND 218 (C<sub>20</sub> - C<sub>30</sub> STERANES) IN BRUNY ISLAND SAMPLE "B7".

FIGURE 39. MASS FRAGMENTOGRAM FOR M/Z 259 (DIASTERANES) IN BRUNY ISLAND SAMPLE "B7".

FIGURE 40. MASS FRAGMENTOGRAMS FOR M/Z 217 AND 218 (C<sub>27</sub> - C<sub>30</sub> STERANES) IN BRUNY ISLAND SAMPLE "B8".

FIGURE 41. MASS FRAGMENTOGRAMS FOR M/Z 217 AND 218 (C<sub>20</sub> - C<sub>30</sub> STERANES) IN BRUNY ISLAND SAMPLE "B8".

FIGURE 42. MASS FRAGMENTOGRAM FOR M/Z 259 (DIASTERANES) IN BRUNY ISLAND SAMPLE "B8".

FIGURE 43. MASS FRAGMENTOGRAMS FOR M/Z 217 AND 218 (C<sub>27</sub> - C<sub>30</sub> STERANES) IN REFERENCE SAMPLE WINDALIA OIL.

FIGURE 44. MASS FRAGMENTOGRAMS FOR M/Z 217 AND 218 (C<sub>20</sub> - C<sub>30</sub> STERANES) IN REFERENCE SAMPLE WINDALIA OIL.

FIGURE 45. MASS FRAGMENTOGRAM FOR M/Z 259 (DIASTERANES) IN REFERENCE SAMPLE WINDALIA OIL.

## NOTES ON FIGURES

FIGURES 1-3. Iatroscan TLC-FID chromatograms give an indication of what lipid classes are in a sample and also their concentrations. The area under the peak is converted to a concentration value using calibration factors determined in earlier work (Volkman et al., 1986). The abbreviations are: POLARS: polar lipids, ST: sterols, HC: hydrocarbons. "Hydrocarbons" includes some contribution from wax esters and pigments such as  $\beta$ -carotene. Total hydrocarbon concentrations are quite low in all samples.

FIGURES 4-11. These figures are capillary gas chromatograms obtained for hydrocarbon fractions that had been purified from other lipids by silic gel chromatography. Each peak represents a different compound (in a few cases two or more compounds may elute at the same retention time), and the area under the peak is directly proportional to the amount of that compound. Alkanes are given by n-C<sub>x</sub> where "x" is the number of carbon atoms.

FIGURES 12-16. These show mass fragmentograms for m/z 113 obtained by GC-MS analysis of either the total hydrocarbons or branched/cyclic hydrocarbons that had been purified using molecular sieves. This ion is enhanced in the mass spectra of isoprenoid alkanes and thus enables the distribution of isoprenoid alkanes to be seen clearly in complex mixtures. This ion is also found in straight-chain alkanes and so n-alkanes also appear in these mass fragmentograms. Abbreviations are: Pr: pristane, Ph: phytane, TMTD: C<sub>16</sub> isoprenoid alkane.

FIGURES 17-27. These show mass fragmentograms for m/z 199, 177 and 205 obtained by GC-MS analysis of the total hydrocarbons or branched/cyclic fraction as indicated. All regular hopanes give very intense m/z 191 in their mass spectra so this ion is typically used to characterise hopanes distributions. C<sub>29</sub> hopanes also have a major fragment ion at m/z 177 and so are readily detected using this ion. Hopanes which lack at C-10 methyl group (called demethylated hopanes) also give a strong ion at m/z 177 as seen in the mass fragmentograms for the Windalia oil reference sample. C<sub>31</sub> hopanes give a strong ion at m/z 205 and thus are readily distinguished by this ion. Note that the ratio of C<sub>31</sub> 22R and 22S isomers is anomalous in the m/z 205 mass fragmentogram as well as in the m/z 191 mass fragmentogram.

Mass fragmentograms for m/z 191 are given for two different time windows to make the distribution of C<sub>27</sub> - C<sub>31</sub> hopanes clearer. Note the high level of m/z 191 contributed by the column bleed. Normally this is insignificant relative to the amount of hopanes (e.g. Windalia sample) but not in this case because of the very low amounts of hopanes present.

The abbreviations used are: T<sub>s</sub>: C<sub>27</sub> hopane 18 $\alpha$ (H)-22,29,30-trisnorhopane, T<sub>m</sub>: C<sub>27</sub> sterane 17 $\alpha$ (H)-22,29,30-trisnorhopane, C<sub>x</sub>H: 17 $\alpha$ (H)-hopane of carbon number "x", C<sub>x</sub>M: 17 $\beta$ (H),21 $\alpha$ (H)-moretane of carbon number "x", C<sub>x</sub> $\beta\beta$ : hopanes of carbon number "x"

having  $17\beta(H), 21\beta(H)$ -stereochemistry (immature isomers), "X": an unknown triterpane which might be gammacerane. In extended hopanes (i.e. carbon numbers  $>C_{30}$ ), two isomers called R and S can occur at position C-22 in the sidechain. The ratio of these two isomers changes in a systematic way with increasing maturity.

FIGURES 28-45. These show mass fragmentograms for  $m/z$  217 and 218 over two different time windows. These ions are characteristic of regular steranes, but interferences can occur due to the presence of certain hopenes and other compounds. The ion  $m/z$  218 is enhanced in isomers with  $\alpha, \beta, \beta$ -stereochemistry, and so it is useful for identifying these compounds. Diasteranes (steranes which have undergone a major rearrangement of the ring system) give small peaks in the  $m/z$  217 mass fragmentogram so these are usually detected using  $m/z$  259 mass fragmentograms. In a few of the samples (especially B5, B6 and B8), this procedure was unsatisfactory due to major interferences with other compounds. This usually is not a problem with crude oils and must reflect the fact that these environmental samples contain large amounts of biogenic hydrocarbons and diagenetic compounds typical of recent sediments.

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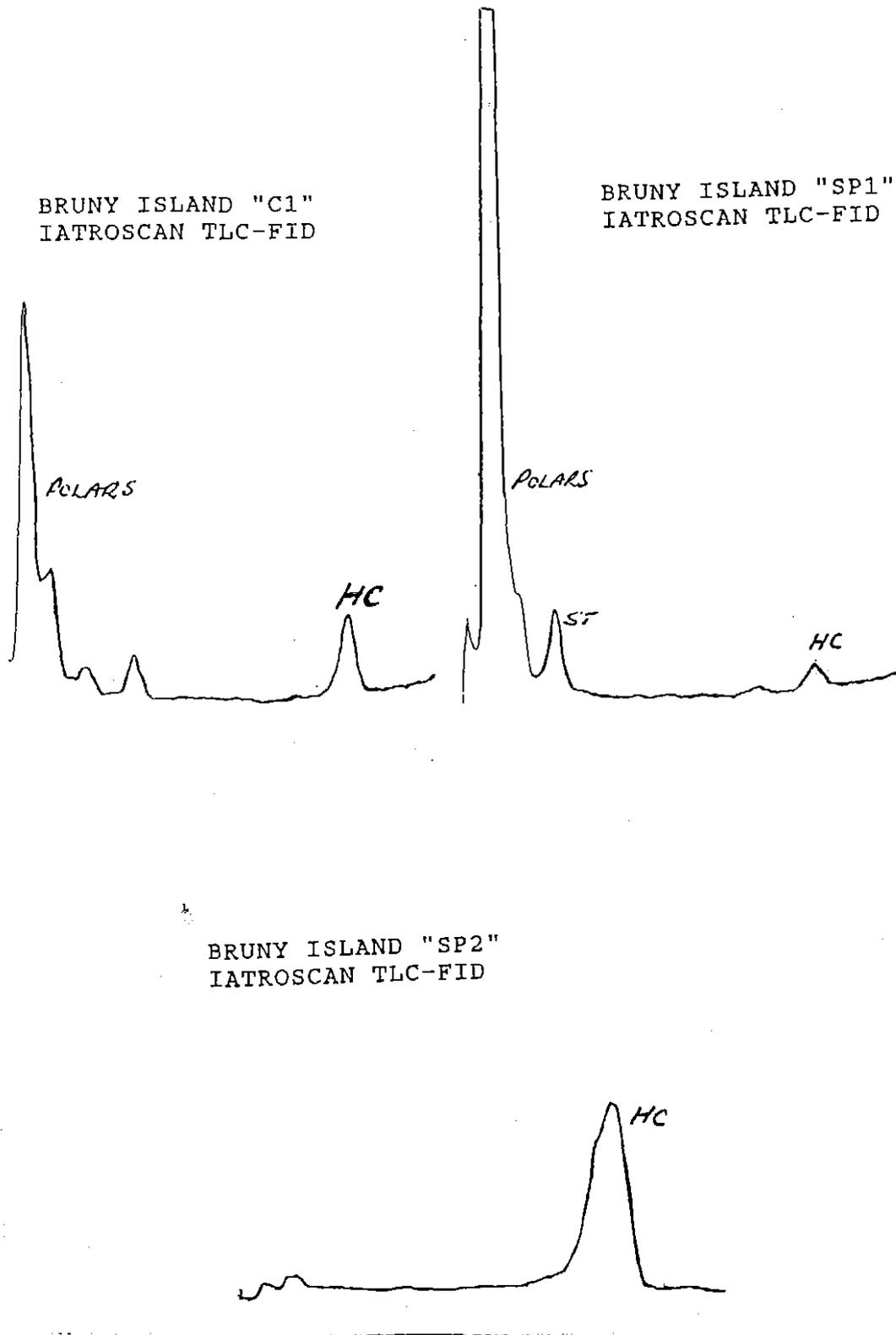


FIGURE 1. IATROSCAN TLC-FID CHROMATOGRAMS OF TOTAL EXTRACTABLE LIPIDS IN SAMPLES (a) BRUNY ISLAND "C1", (b) BRUNY ISLAND "SP1", (c) BRUNY ISLAND "SP2".

010

BRUNY ISLAND "B4"  
IATROSCAN TLC-FID

*POLARS*

*HC*

BRUNY ISLAND "B5"  
IATROSCAN TLC-FID

*POLARS*

*HC*

BRUNY ISLAND "B6"  
IATROSCAN TLC-FID

*HC*

FIGURE 2. IATROSCAN TLC-FID CHROMATOGRAMS OF TOTAL EXTRACTABLE LIPIDS IN SAMPLES (a) BRUNY ISLAND "B4", (b) BRUNY ISLAND "B5", (c) BRUNY ISLAND "B6".

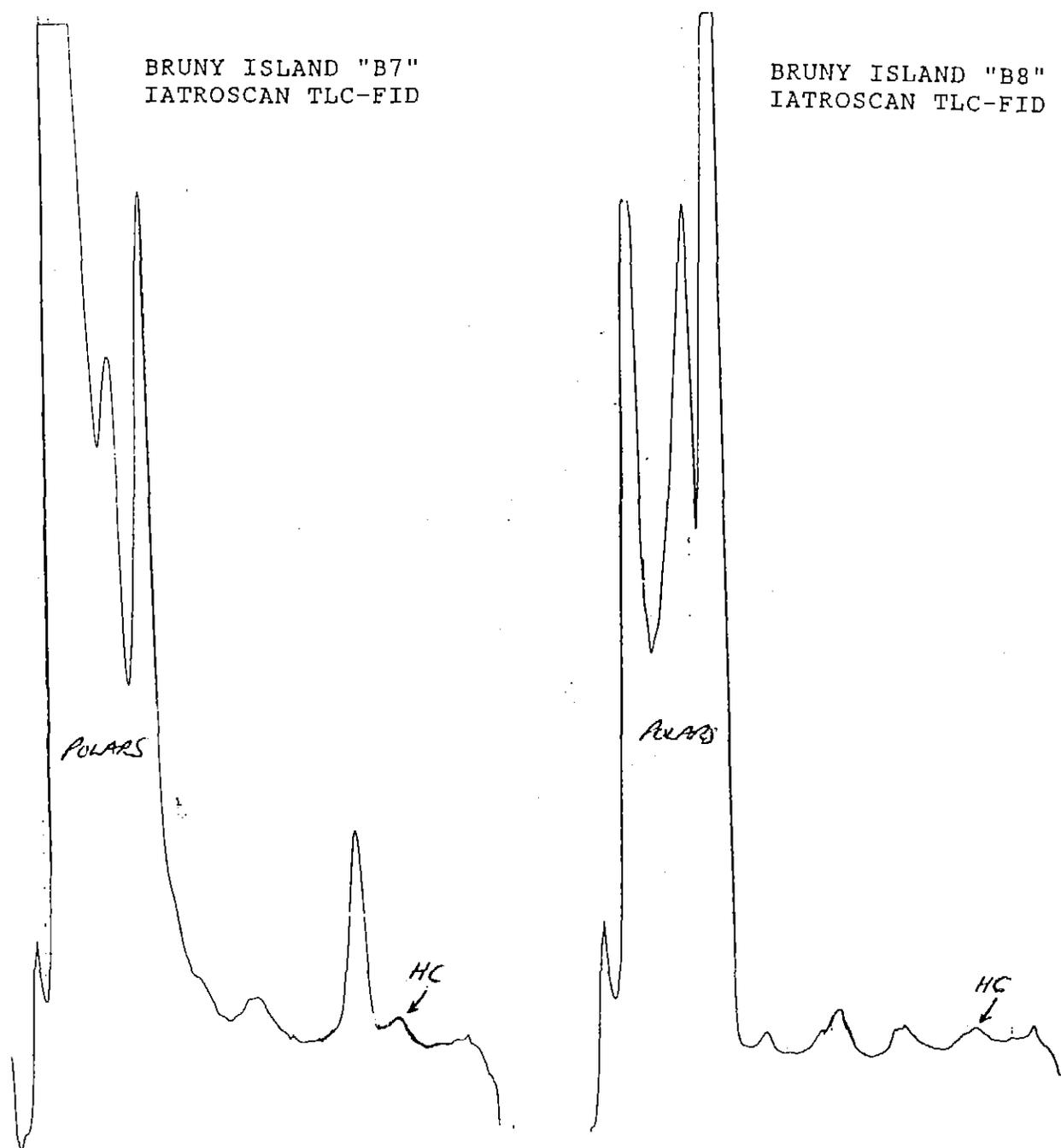


FIGURE 3. IATROSCAN TLC-FID CHROMATOGRAMS OF TOTAL EXTRACTABLE LIPIDS IN SAMPLES (a) BRUNY ISLAND "B7", (b) BRUNY ISLAND "B8".

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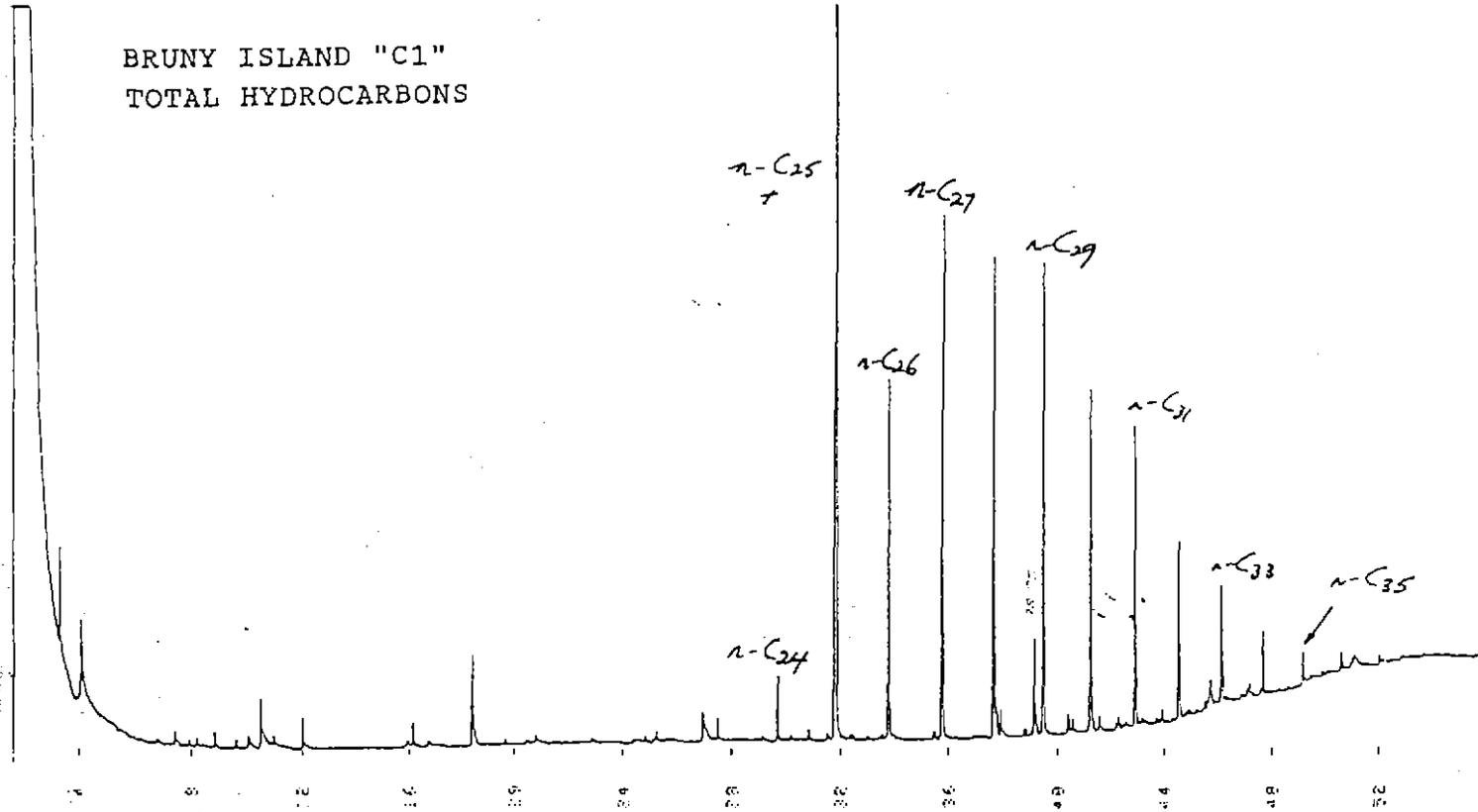


FIGURE 4. CAPILLARY GAS CHROMATOGRAM OF TOTAL HYDROCARBONS IN BRUNY ISLAND SAMPLE "C1".

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BRUNY ISLAND "SP1"  
TOTAL HYDROCARBONS

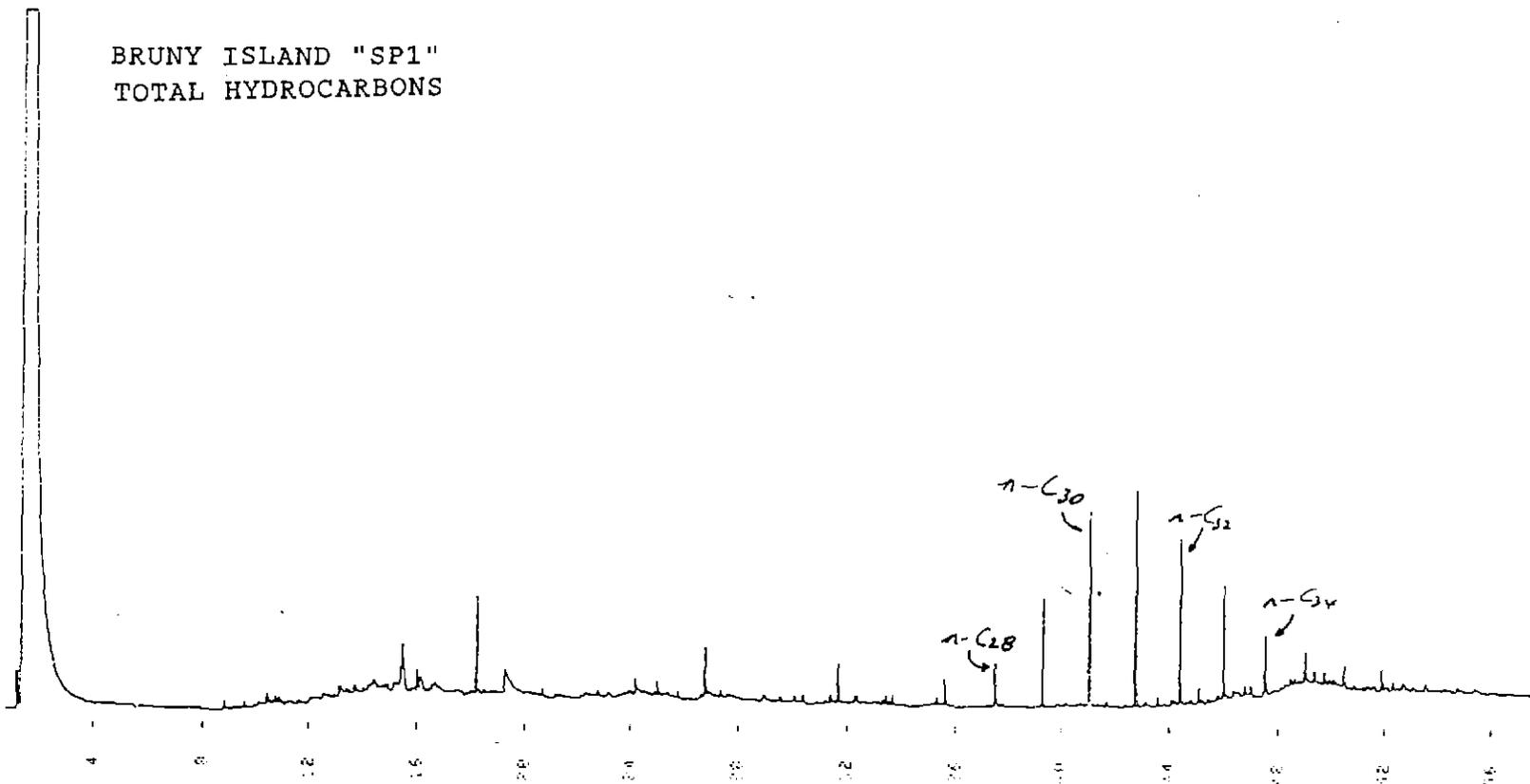


FIGURE 5. CAPILLARY GAS CHROMATOGRAM OF TOTAL HYDROCARBONS IN  
BRUNY ISLAND SAMPLE "SP1".

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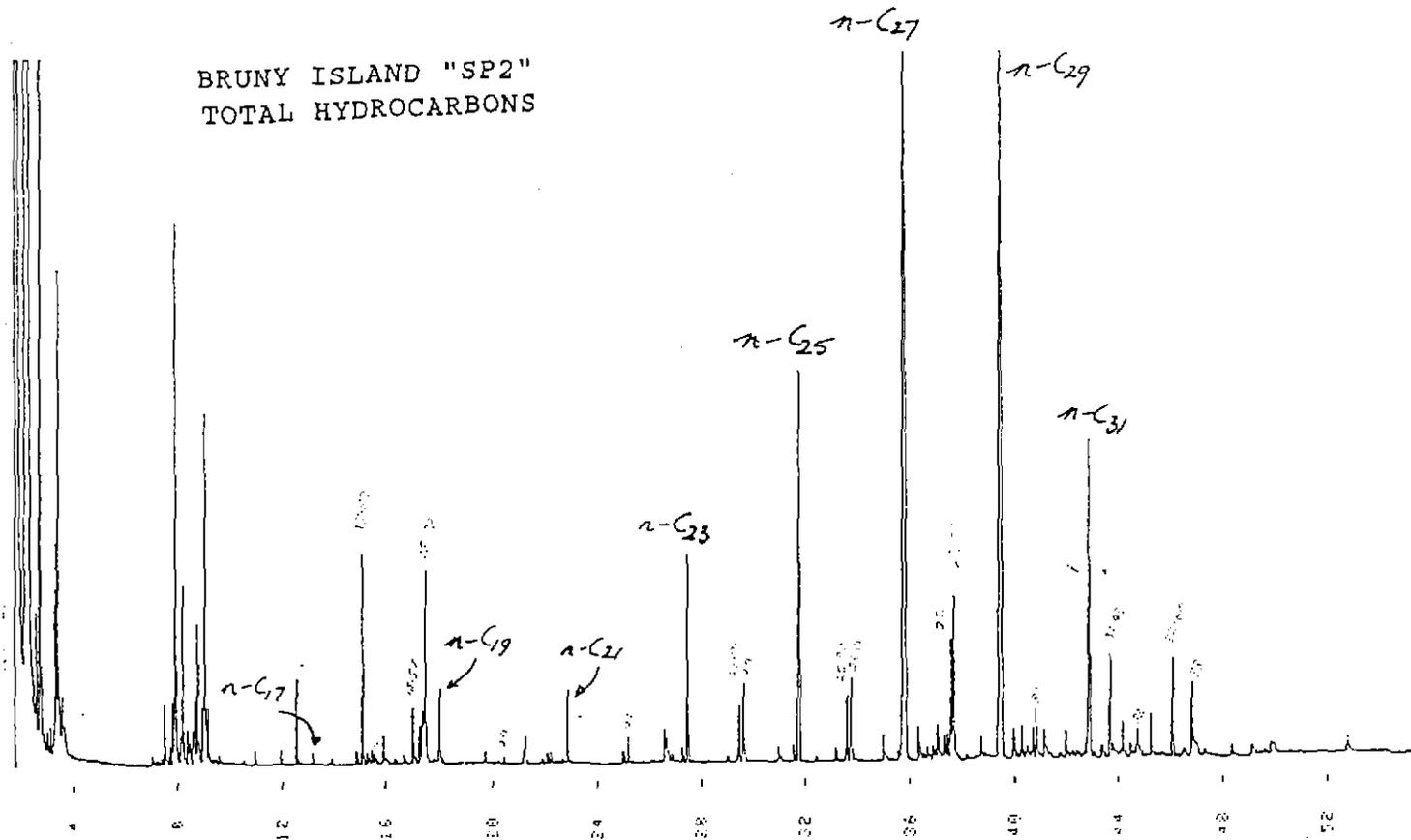


FIGURE 6. CAPILLARY GAS CHROMATOGRAM OF TOTAL HYDROCARBONS IN BRUNY ISLAND SAMPLE "SP2".

U24

388035

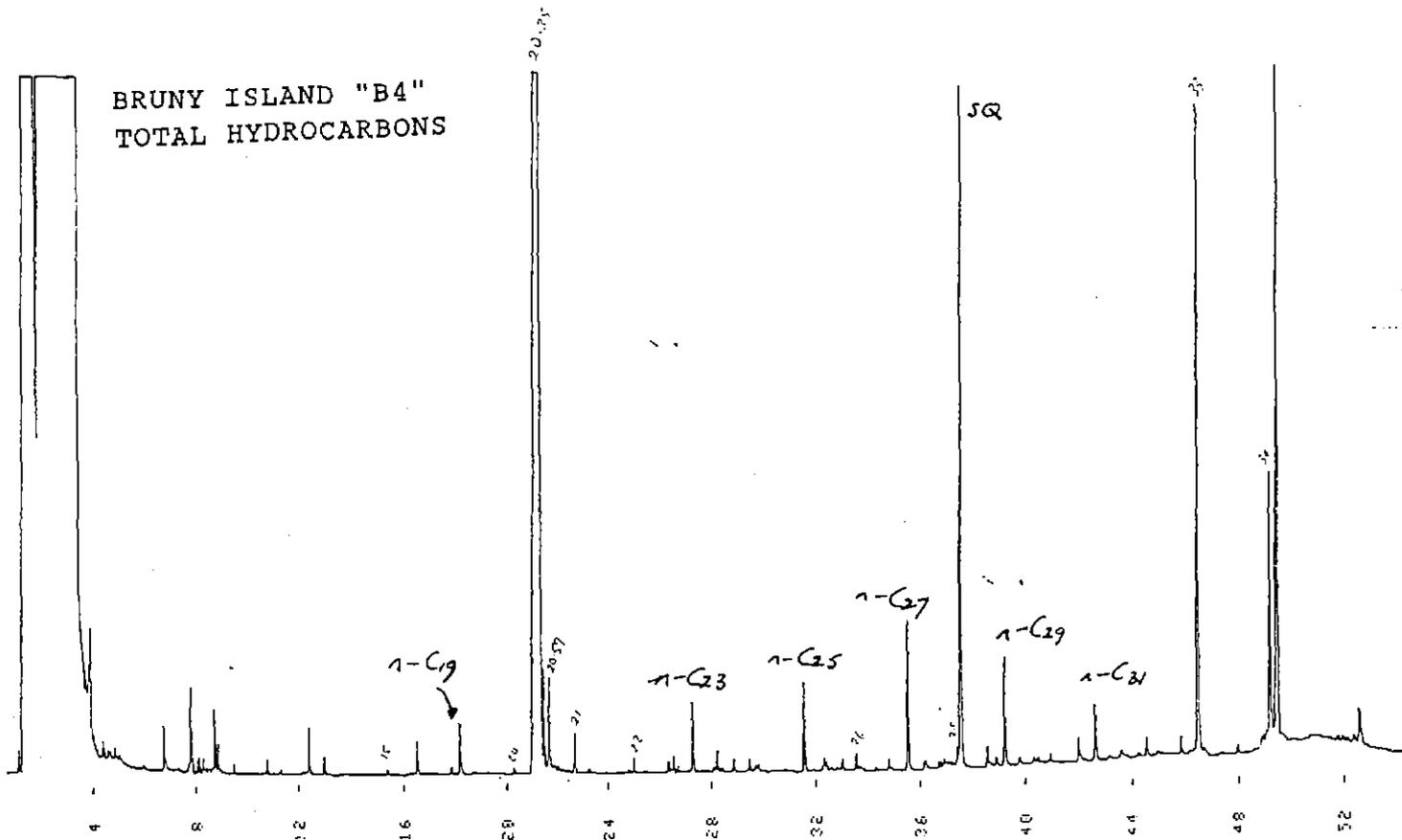


FIGURE 7. CAPILLARY GAS CHROMATOGRAM OF TOTAL HYDROCARBONS IN BRUNY ISLAND SAMPLE "B4".

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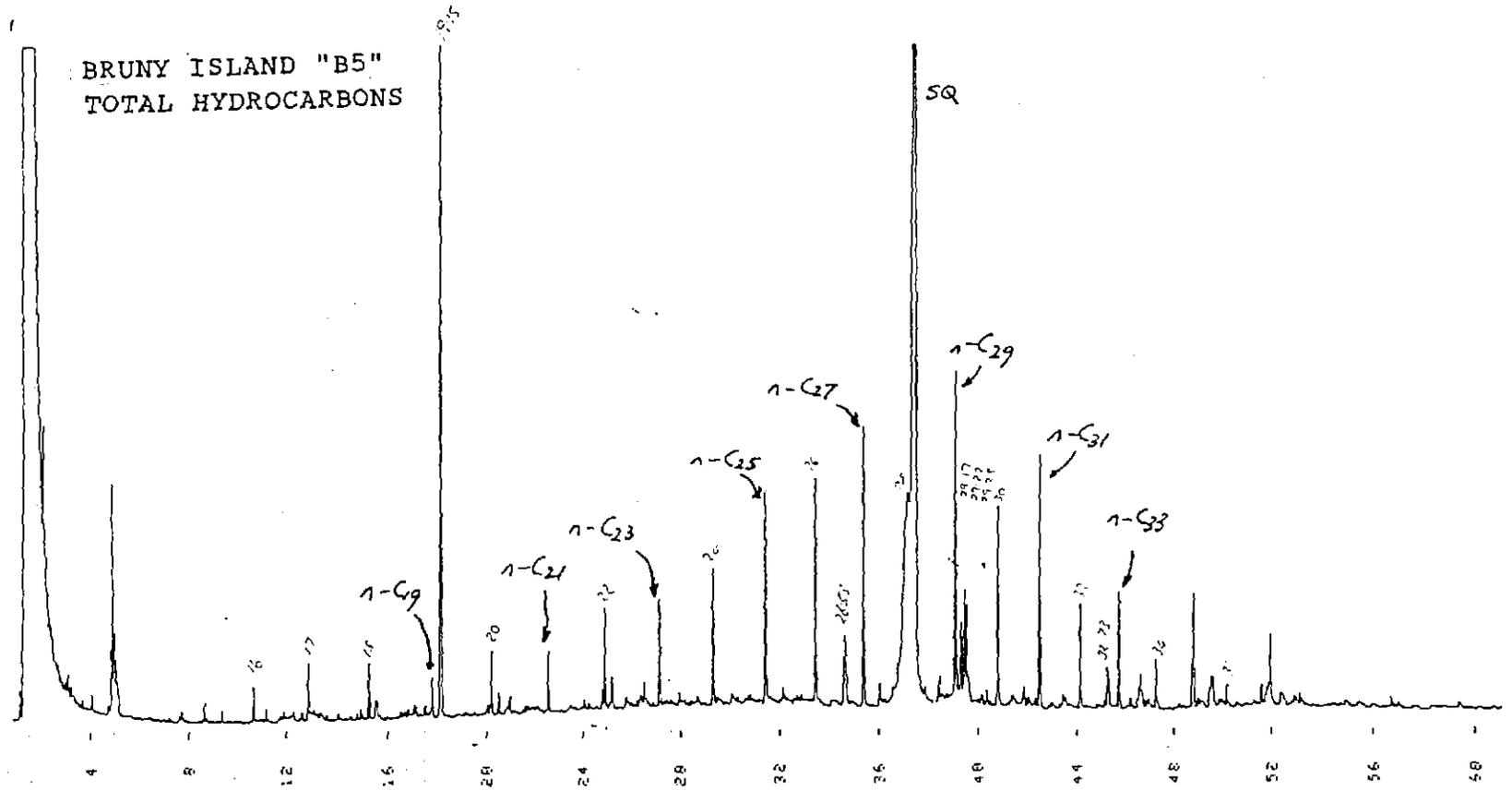


FIGURE 8. CAPILLARY GAS CHROMATOGRAM OF TOTAL HYDROCARBONS IN BRUNY ISLAND SAMPLE "B5".

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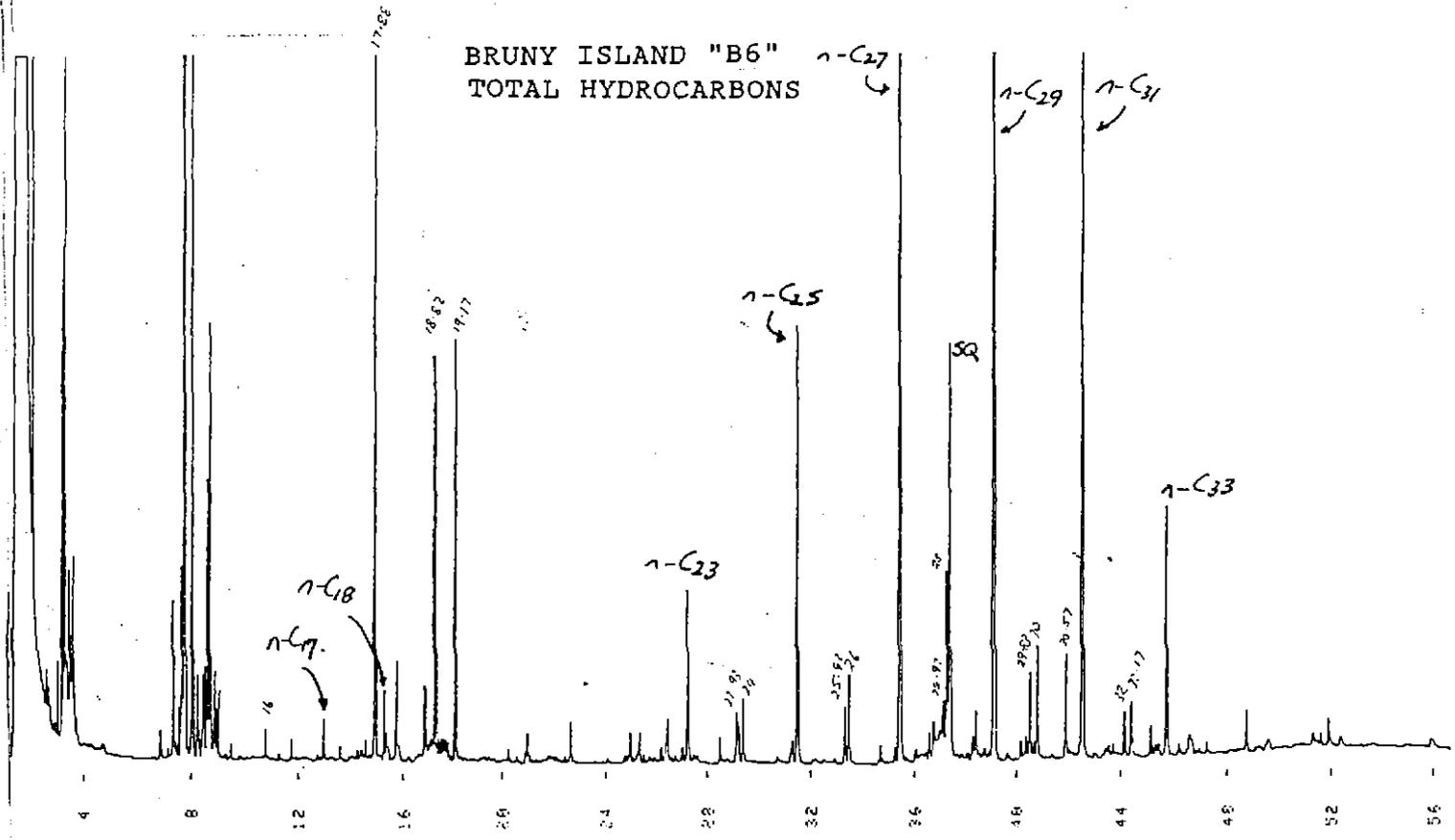


FIGURE 9. CAPILLARY GAS CHROMATOGRAM OF TOTAL HYDROCARBONS IN BRUNY ISLAND SAMPLE "B6".

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BRUNY ISLAND "B7"  
TOTAL HYDROCARBONS

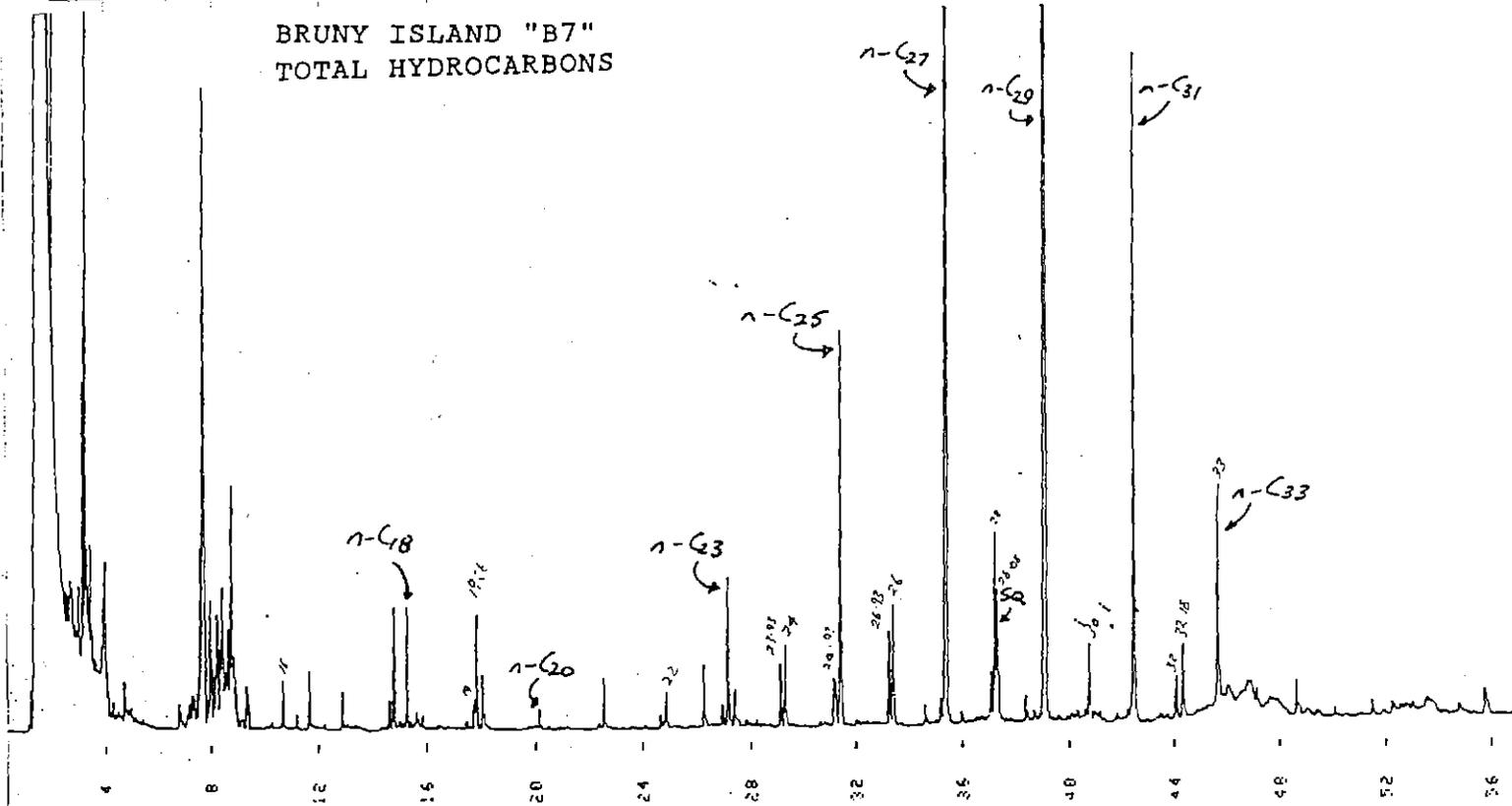


FIGURE 10. CAPILLARY GAS CHROMATOGRAM OF TOTAL HYDROCARBONS IN  
BRUNY ISLAND SAMPLE "B7".

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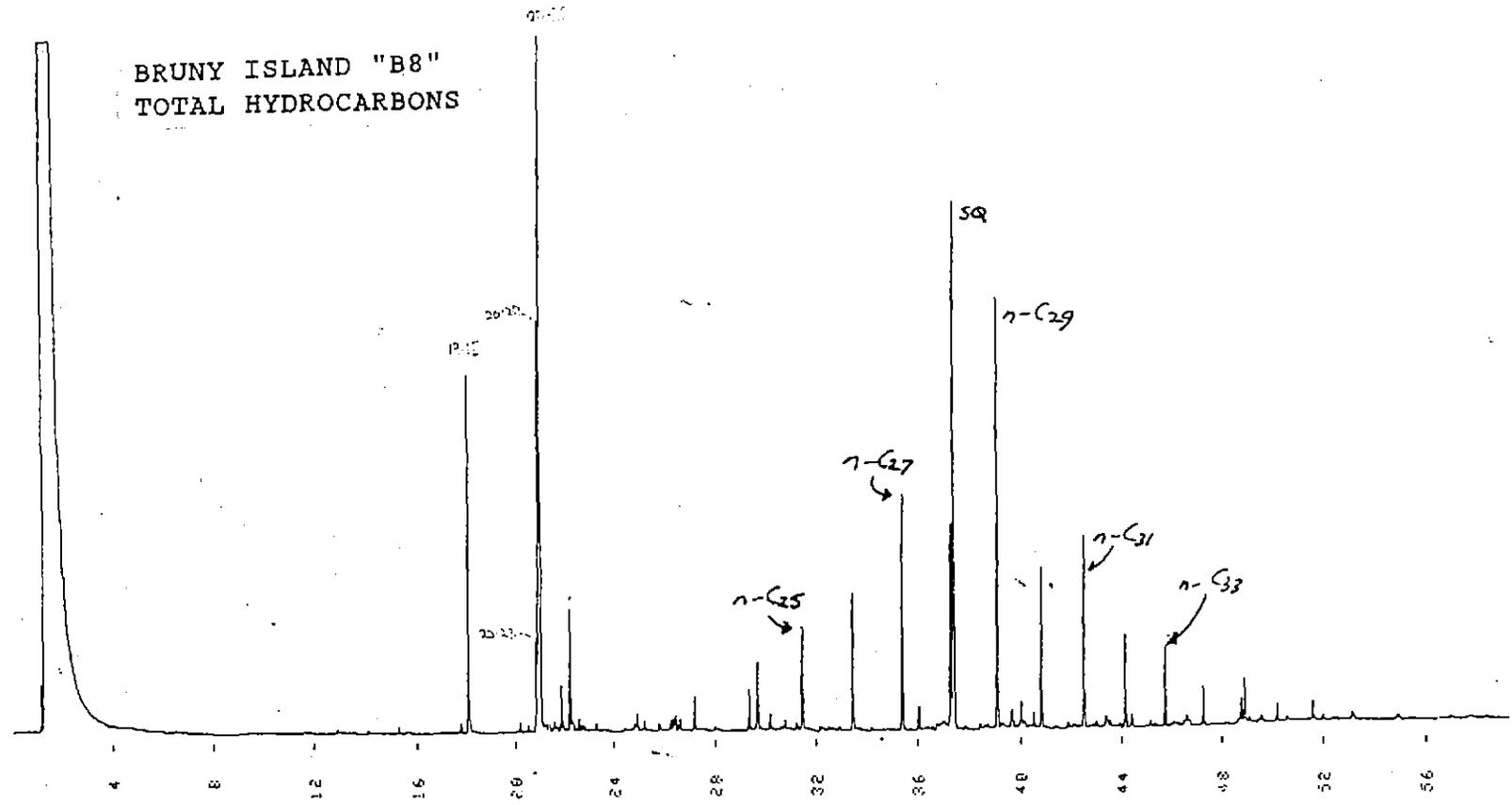


FIGURE 11. CAPILLARY GAS CHROMATOGRAM OF TOTAL HYDROCARBONS IN BRUNY ISLAND SAMPLE "B8".

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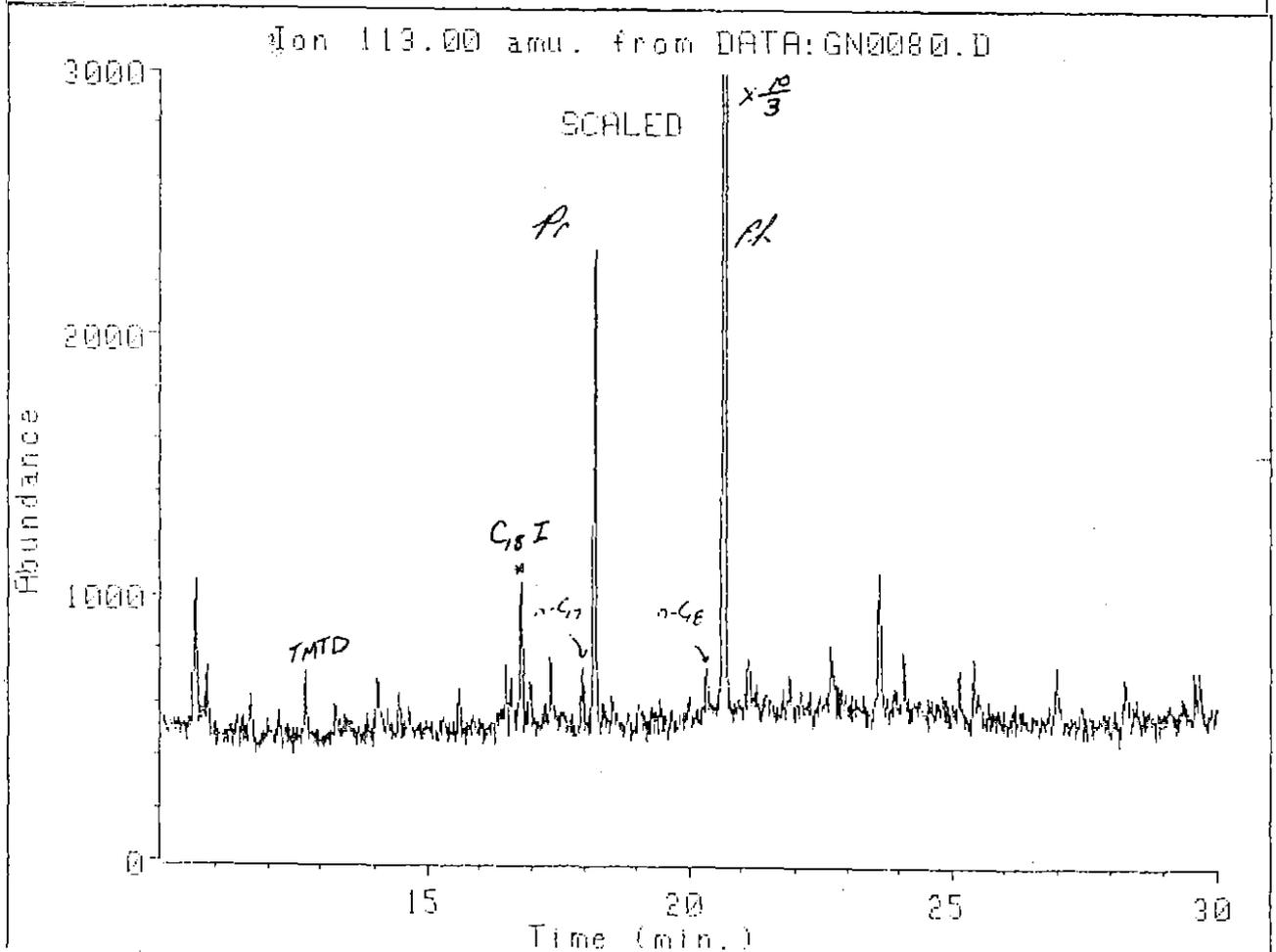
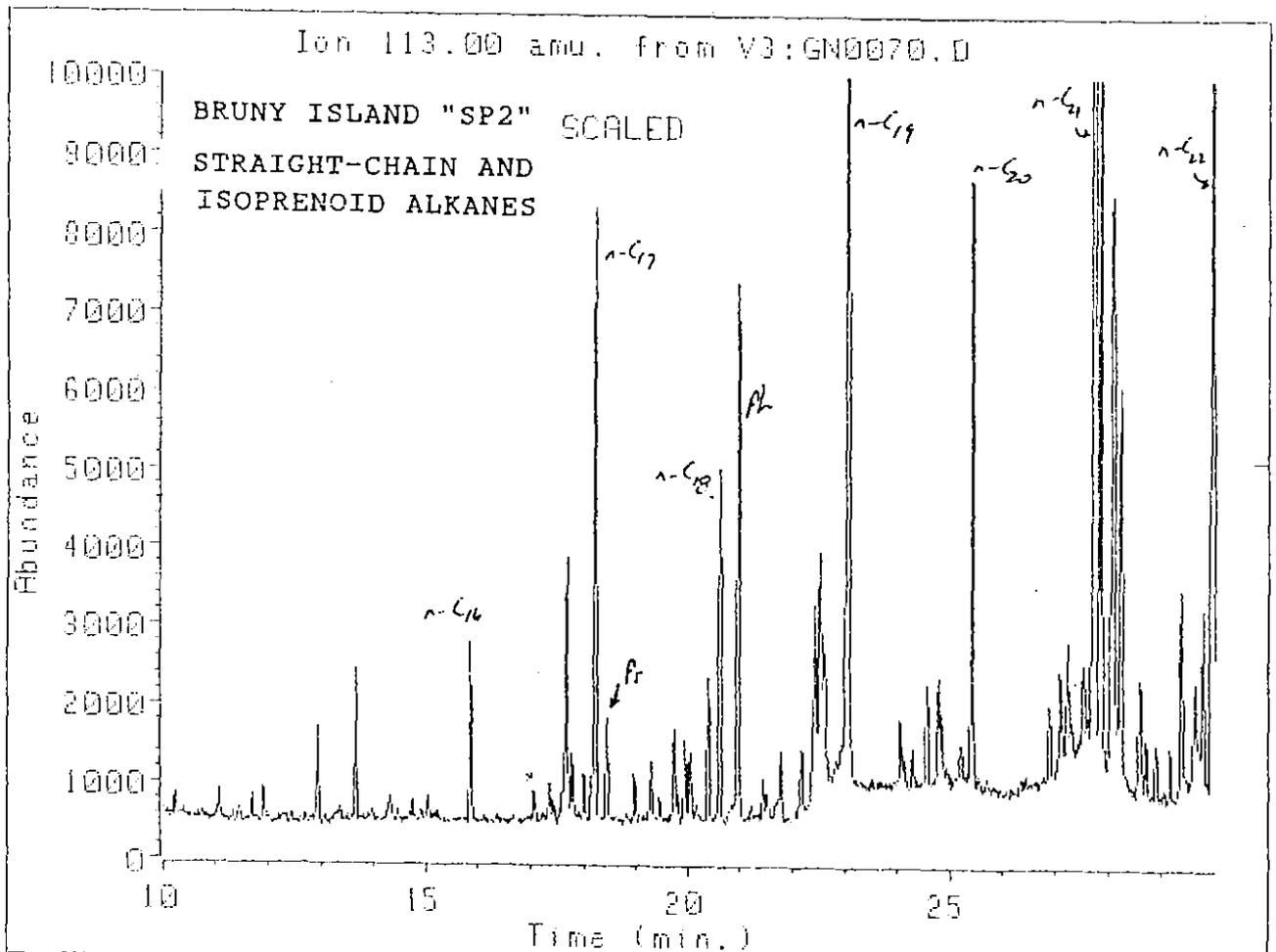


FIGURE 12A. STRAIGHT-CHAIN AND ISOPRENOID ALKANES IN TOTAL HYDROCARBONS FROM BRUNY ISLAND SAMPLE "SP2".

FIGURE 12B. ISOPRENOID ALKANES IN BRANCHED/CYCLIC ALKANE

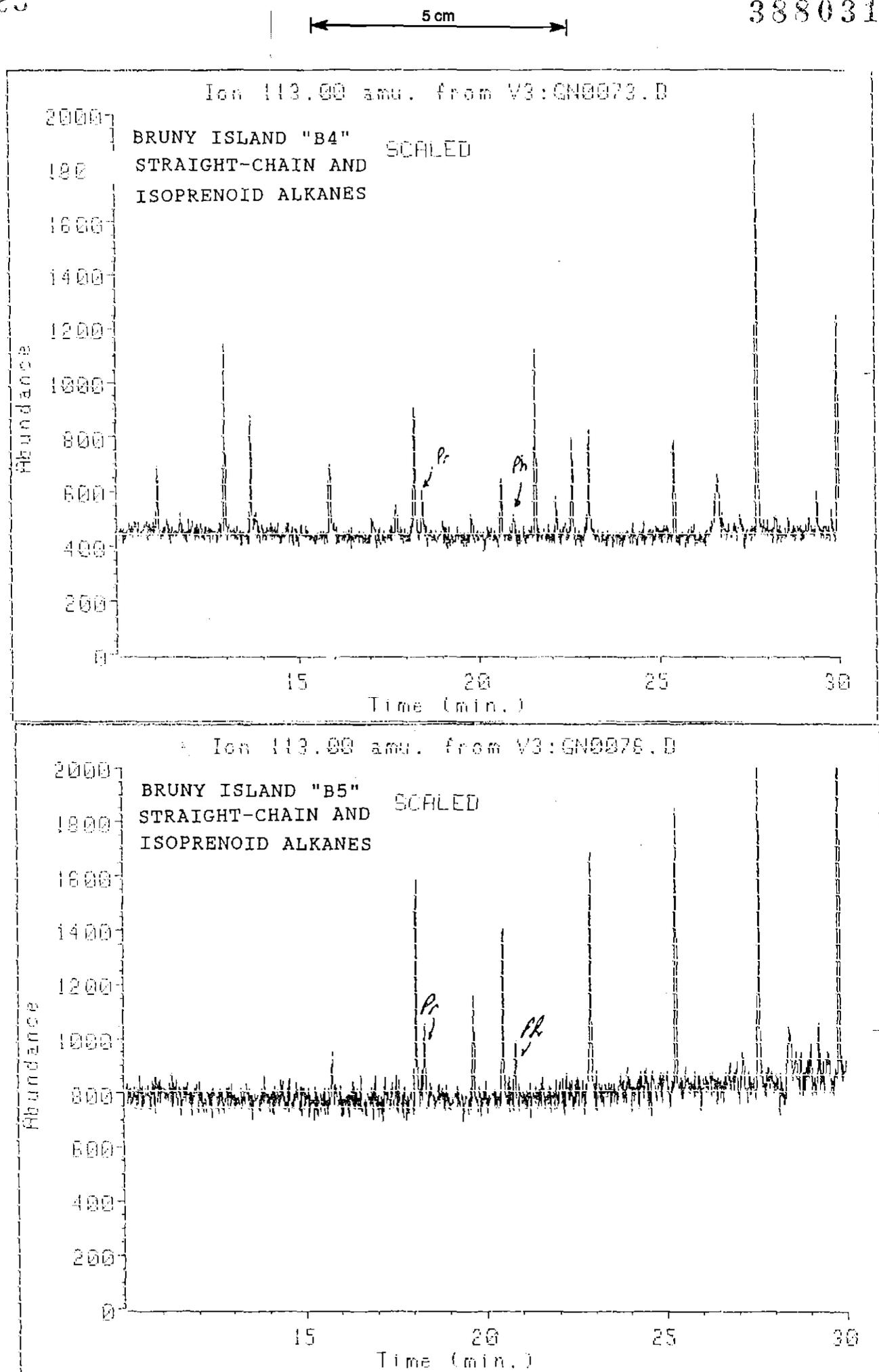


FIGURE 13. STRAIGHT-CHAIN AND ISOPRENOID ALKANES FROM TOTAL HYDROCARBONS IN (a) BRUNY ISLAND SAMPLE "B4", (b) BRUNY ISLAND SAMPLE "B5"

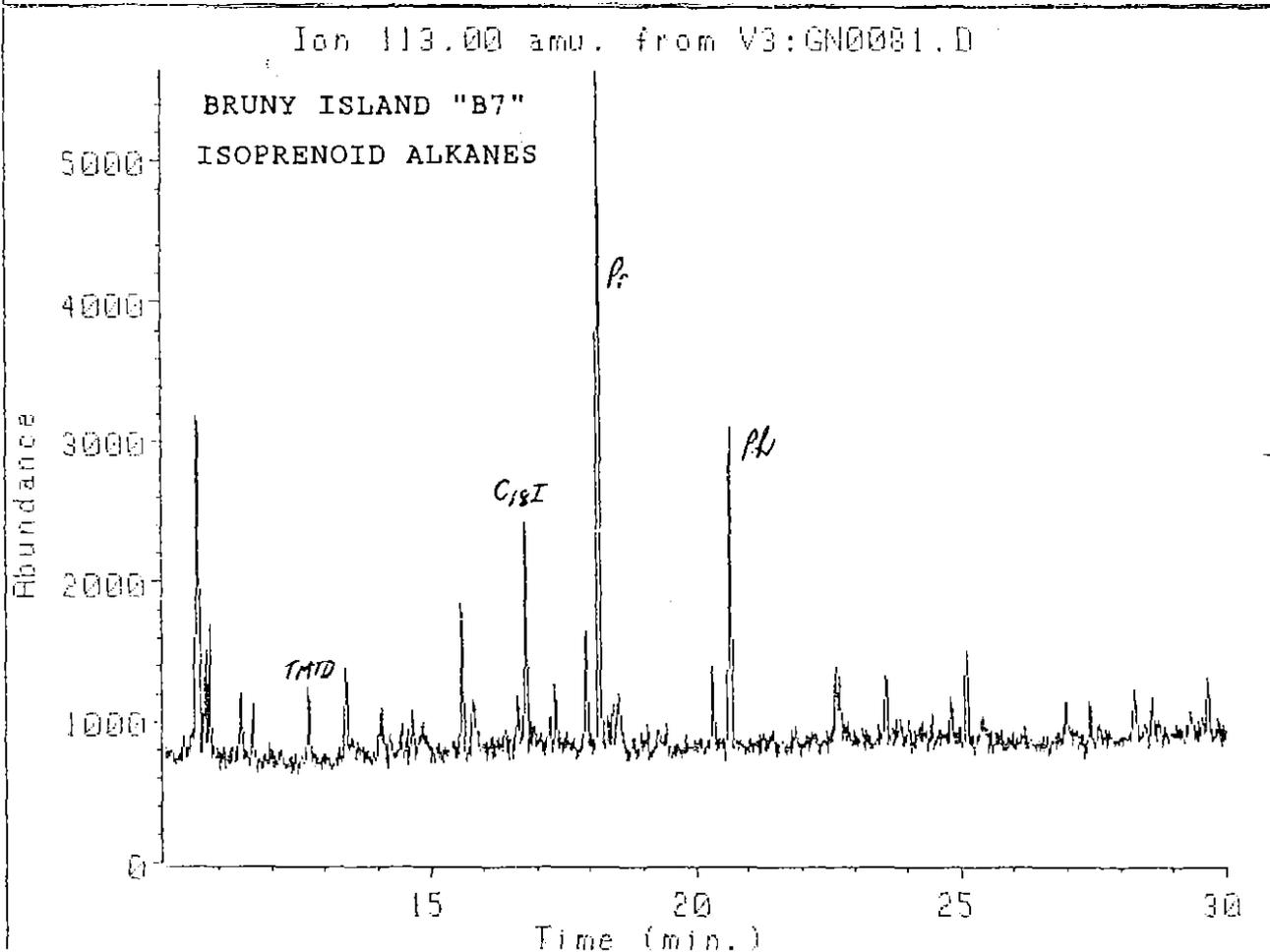
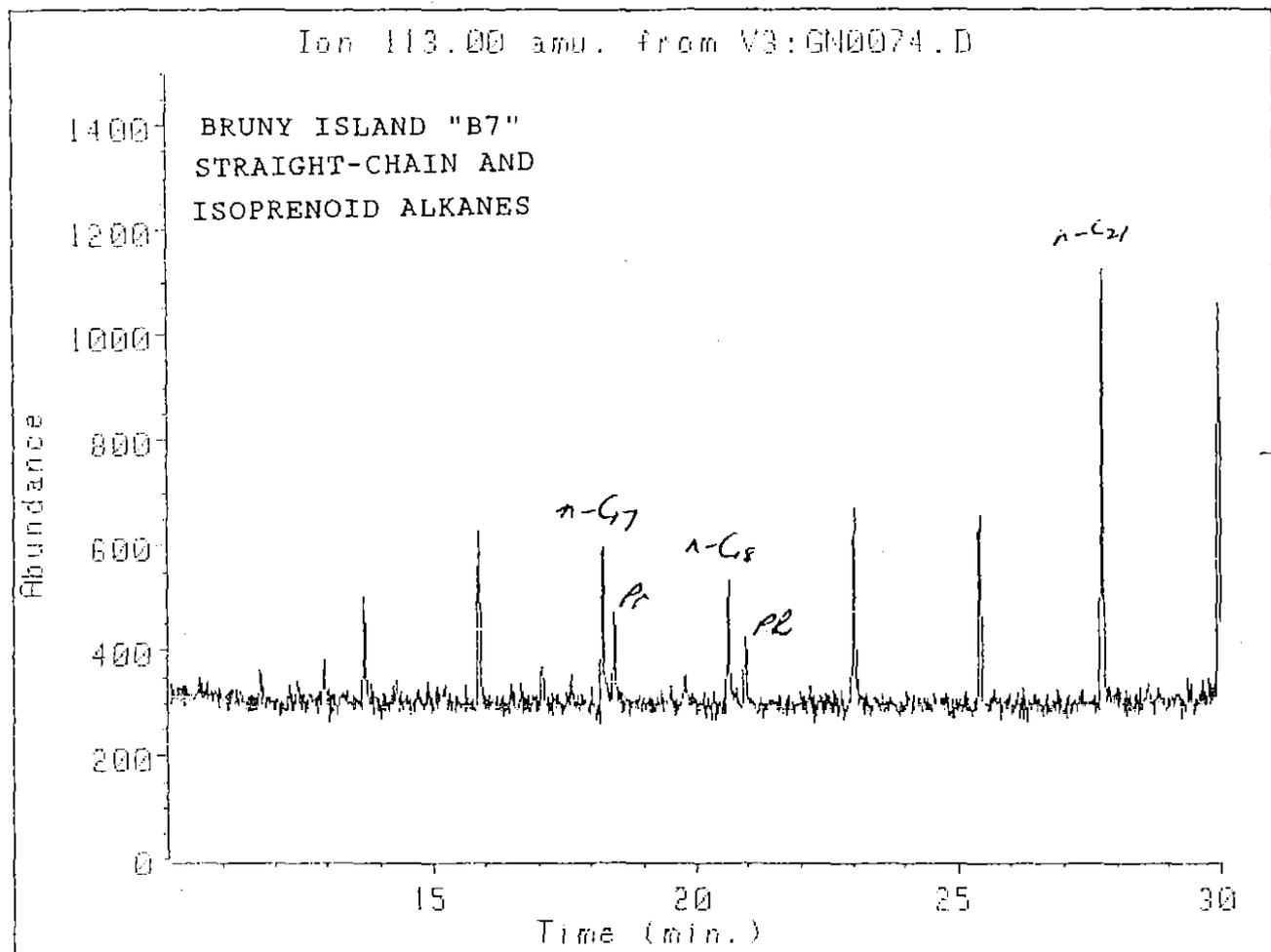


FIGURE 14A. STRAIGHT-CHAIN AND ISOPRENOID ALKANES FROM TOTAL HYDROCARBONS IN BRUNY ISLAND SAMPLE "B7".

FIGURE 14B. ISOPRENOID ALKANES FROM BRANCHED/CYCLIC ALKANE FRACTION FROM BRUNY ISLAND SAMPLE "B7"

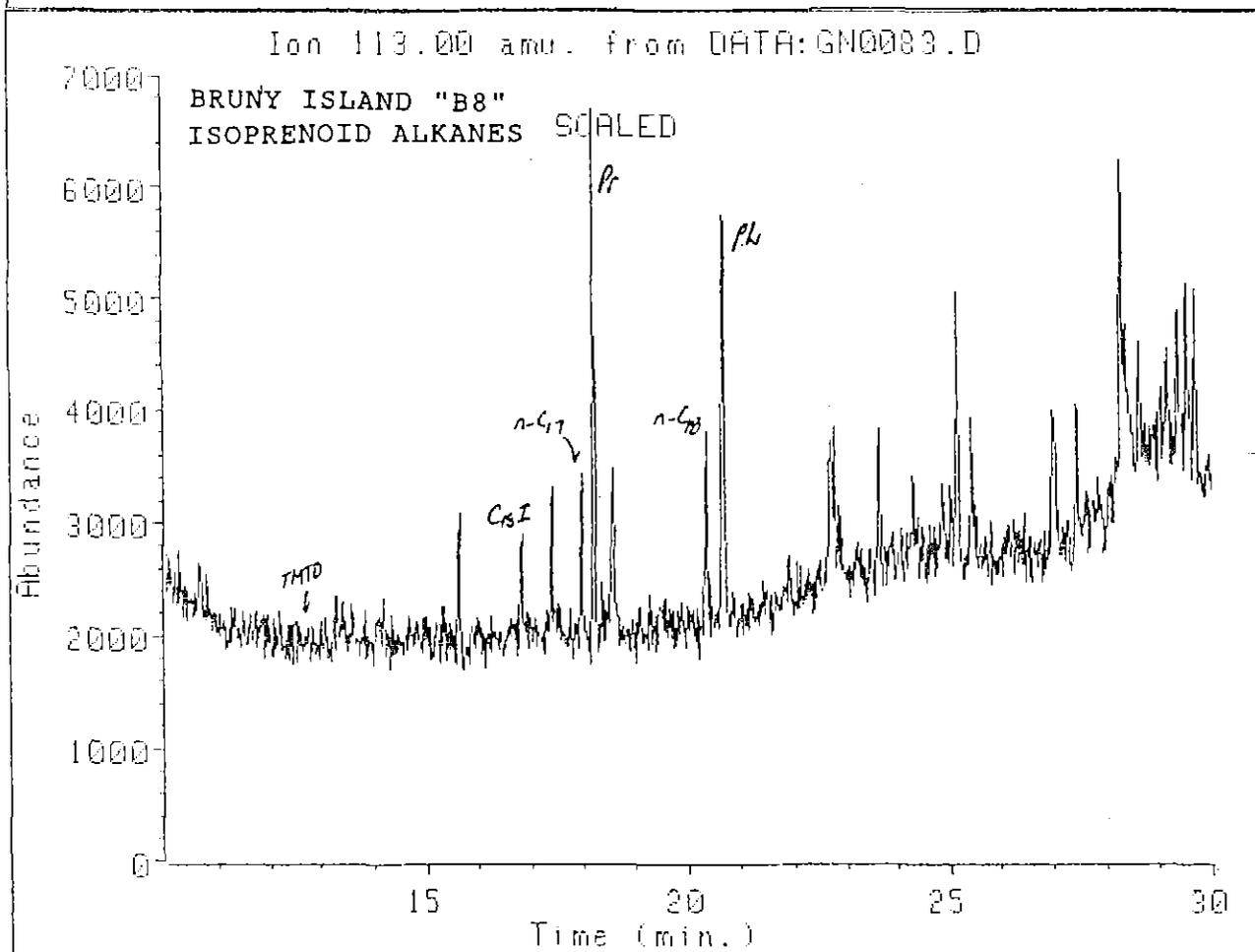
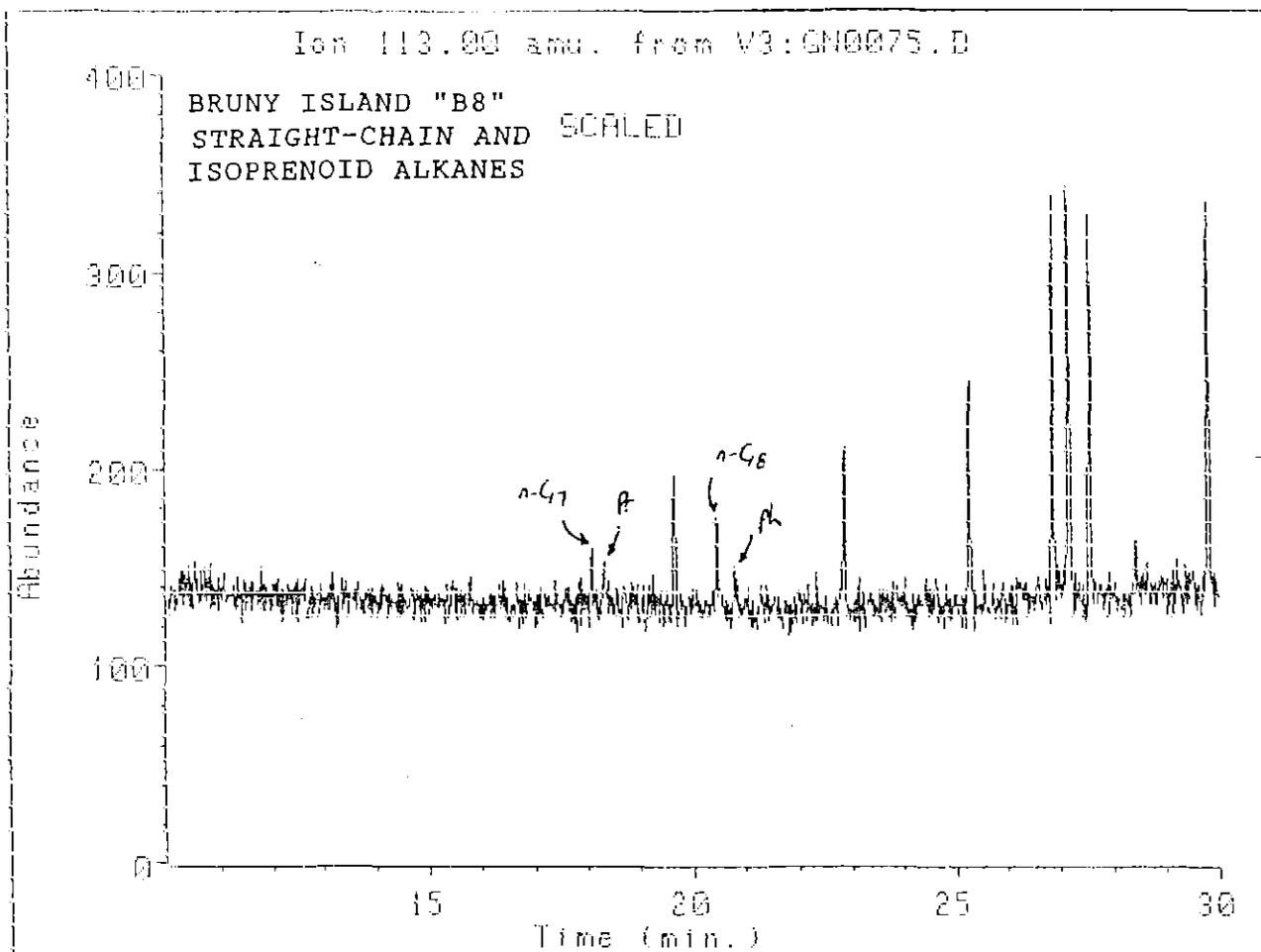


FIGURE 15A. STRAIGHT-CHAIN AND ISOPRENOID ALKANES FROM TOTAL HYDROCARBONS IN BRUNY ISLAND SAMPLE "B8".

FIGURE 15B. ISOPRENOID ALKANES FROM BRANCHED/CYCLIC ALKANE FRACTION FROM BRUNY ISLAND SAMPLE "B8"

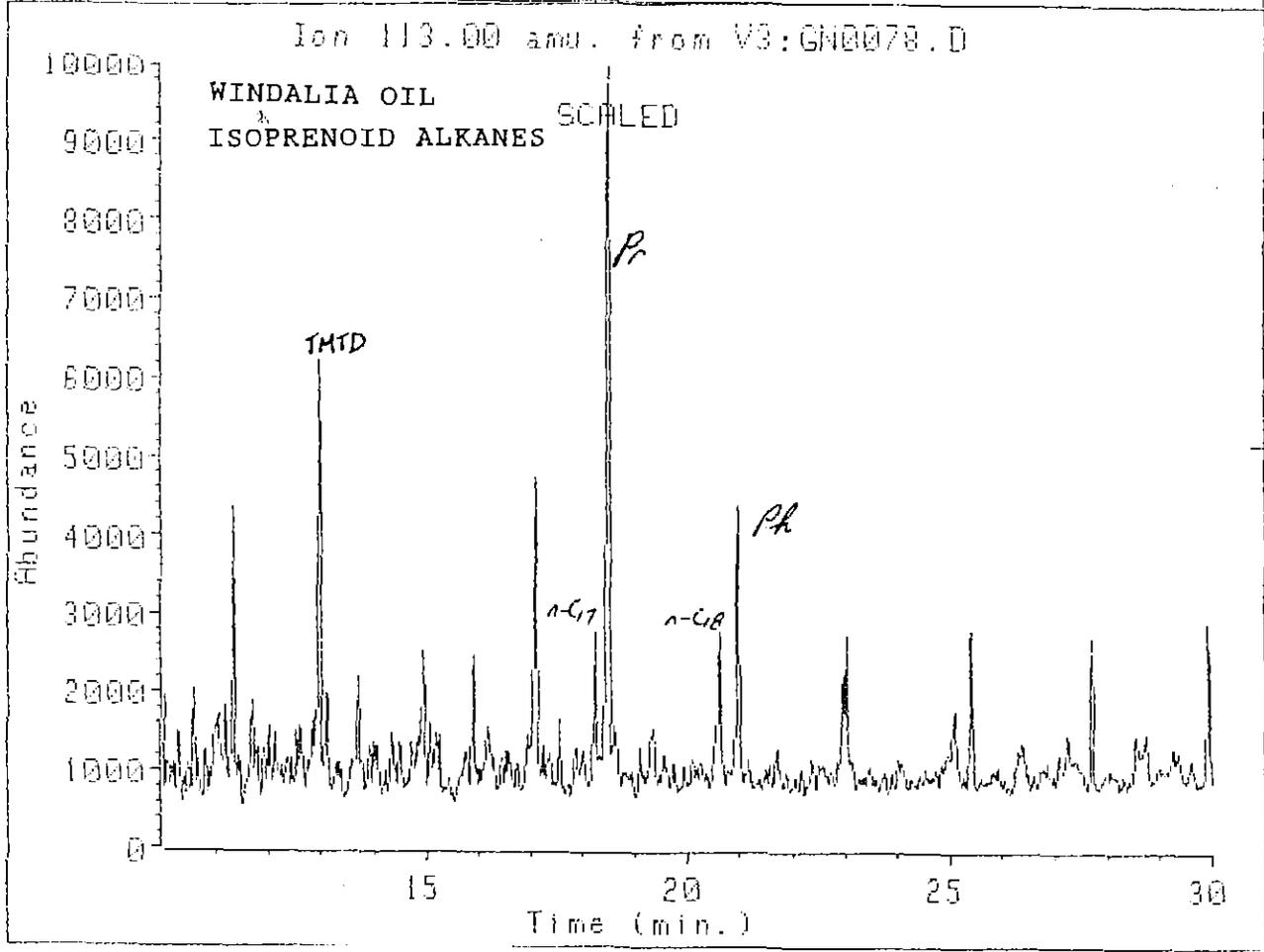
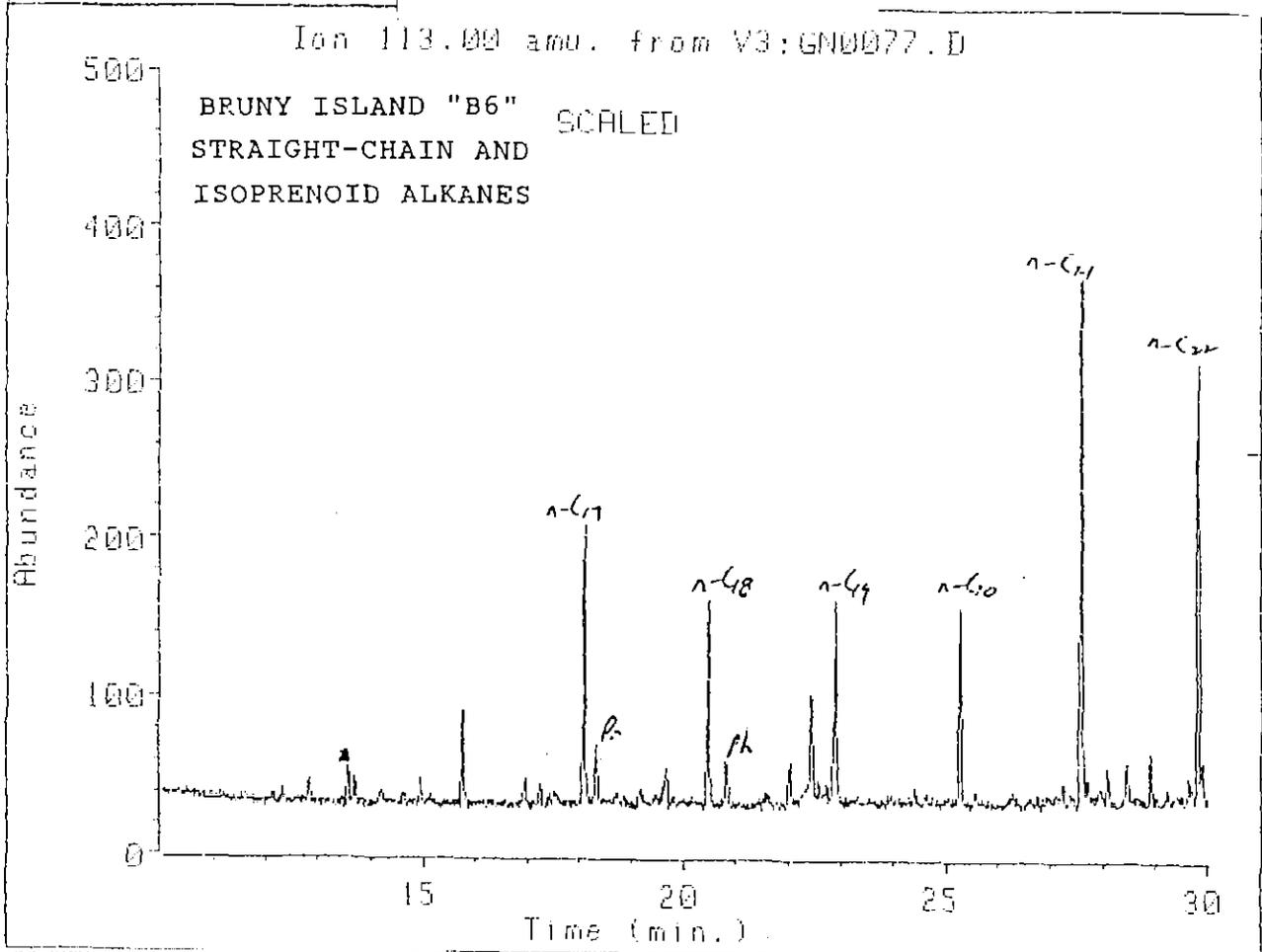


FIGURE 16A. STRAIGHT-CHAIN AND ISOPRENOID ALKANES FROM TOTAL HYDROCARBONS FROM BRUNY ISLAND SAMPLE "B6"  
FIGURE 16B. ISOPRENOID ALKANES FROM REFERENCE OIL SAMPLE WINDALIA OIL.

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5 cm

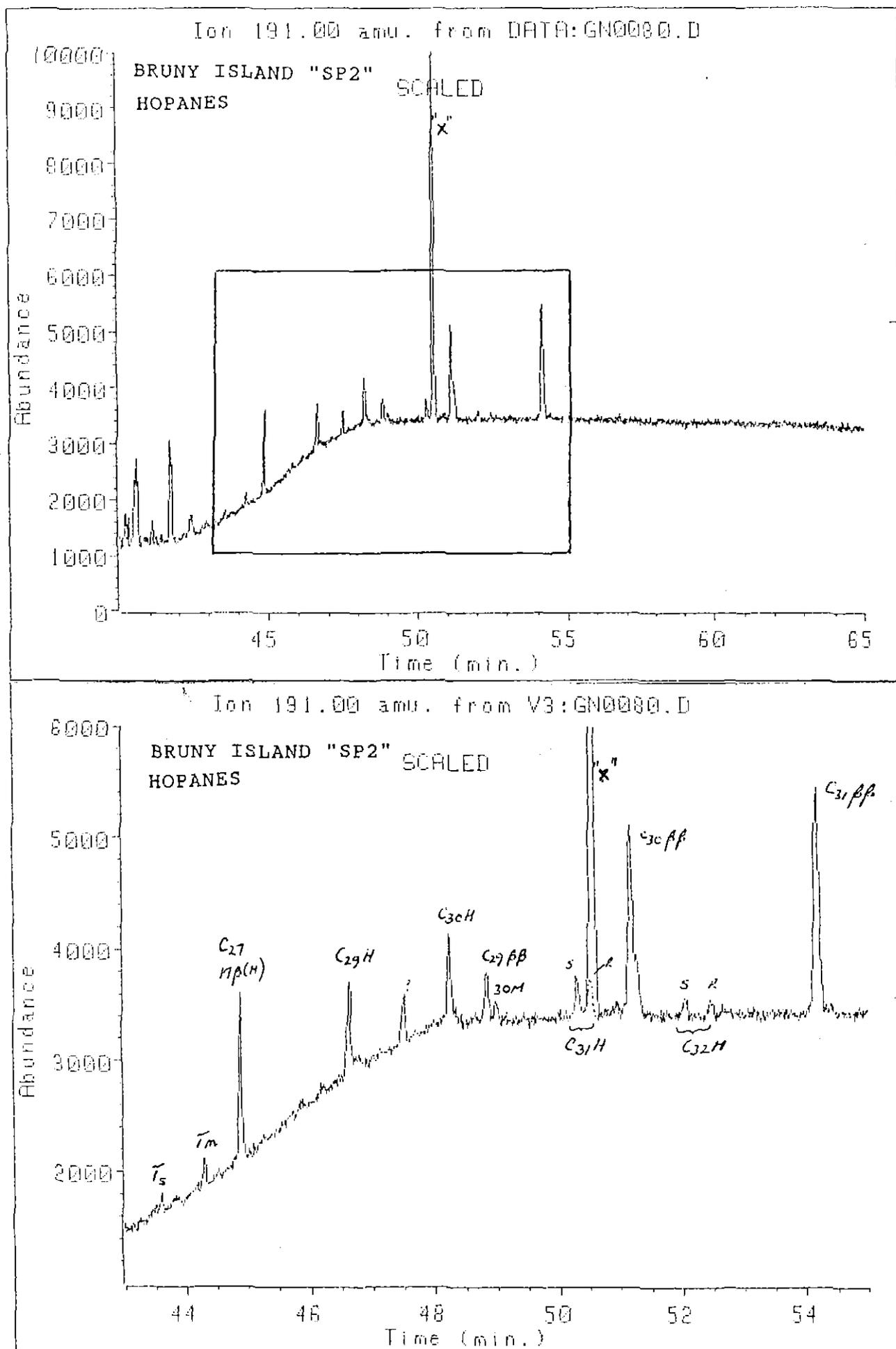


FIGURE 17. MASS FRAGMENTOGRAMS FOR M/Z 191 (HOPANES AND OTHER  
 AND OTHER SAMPLE "SP2")

034

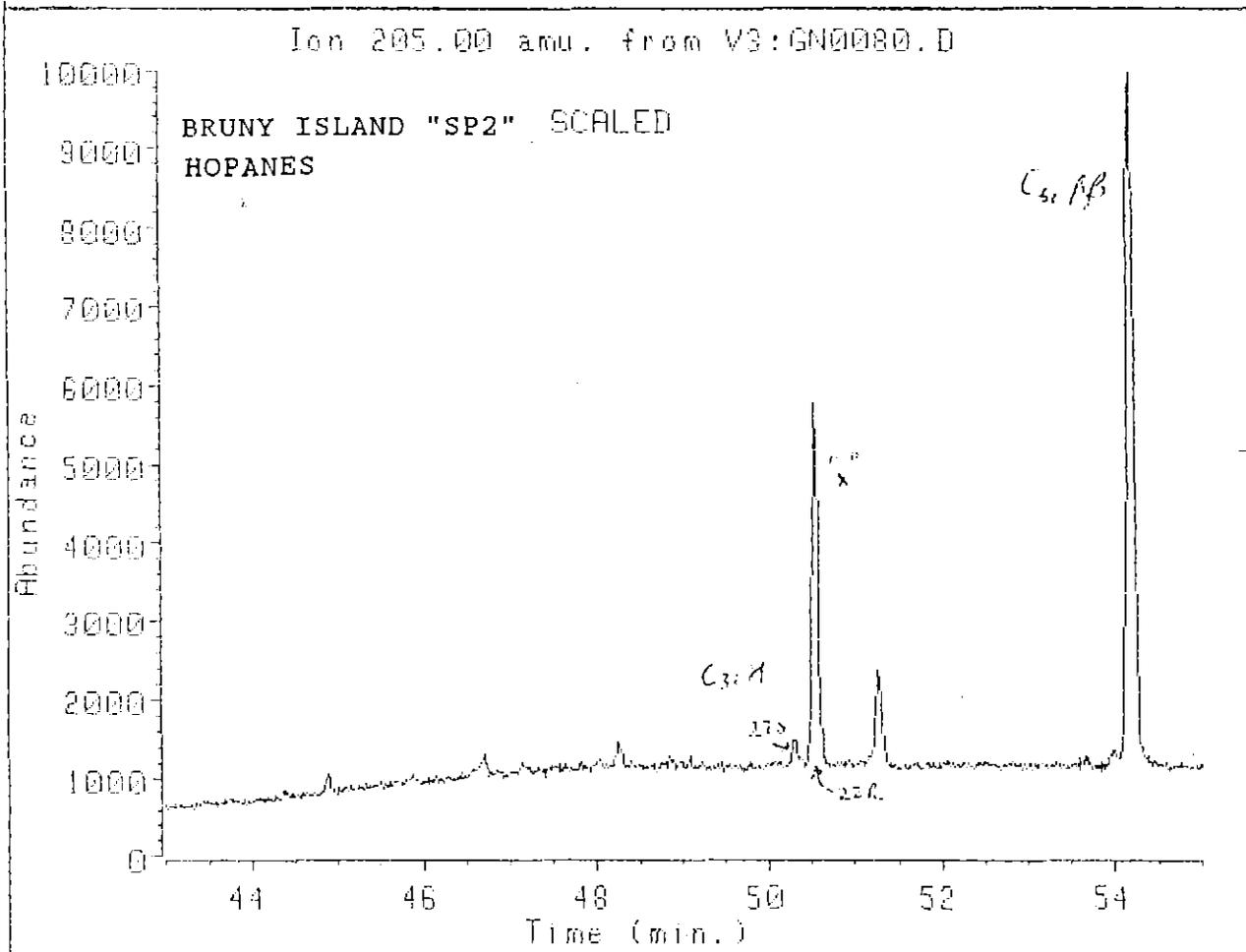
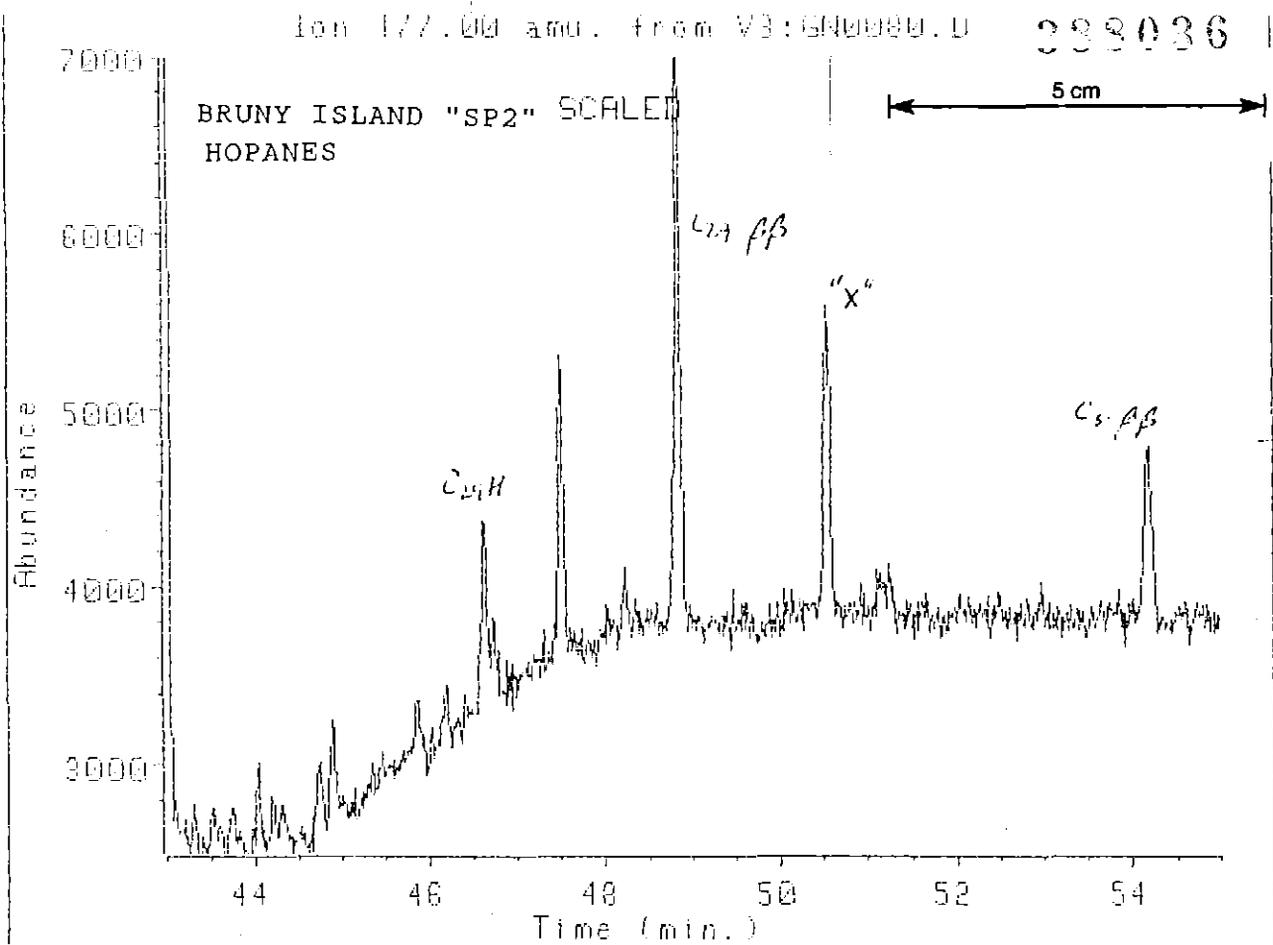


FIGURE 18A. MASS FRAGMENTOGRAM FOR M/Z 177 ( $C_{29}$  HOPANES AND ALSO DEMETHYLATED HOPANES) IN BRUNY ISLAND SAMPLE "SP2".

FIGURE 18B. MASS FRAGMENTOGRAM FOR M/Z 205 ( $C_{31}$  HOPANES) IN BRUNY ISLAND SAMPLE "SP2".

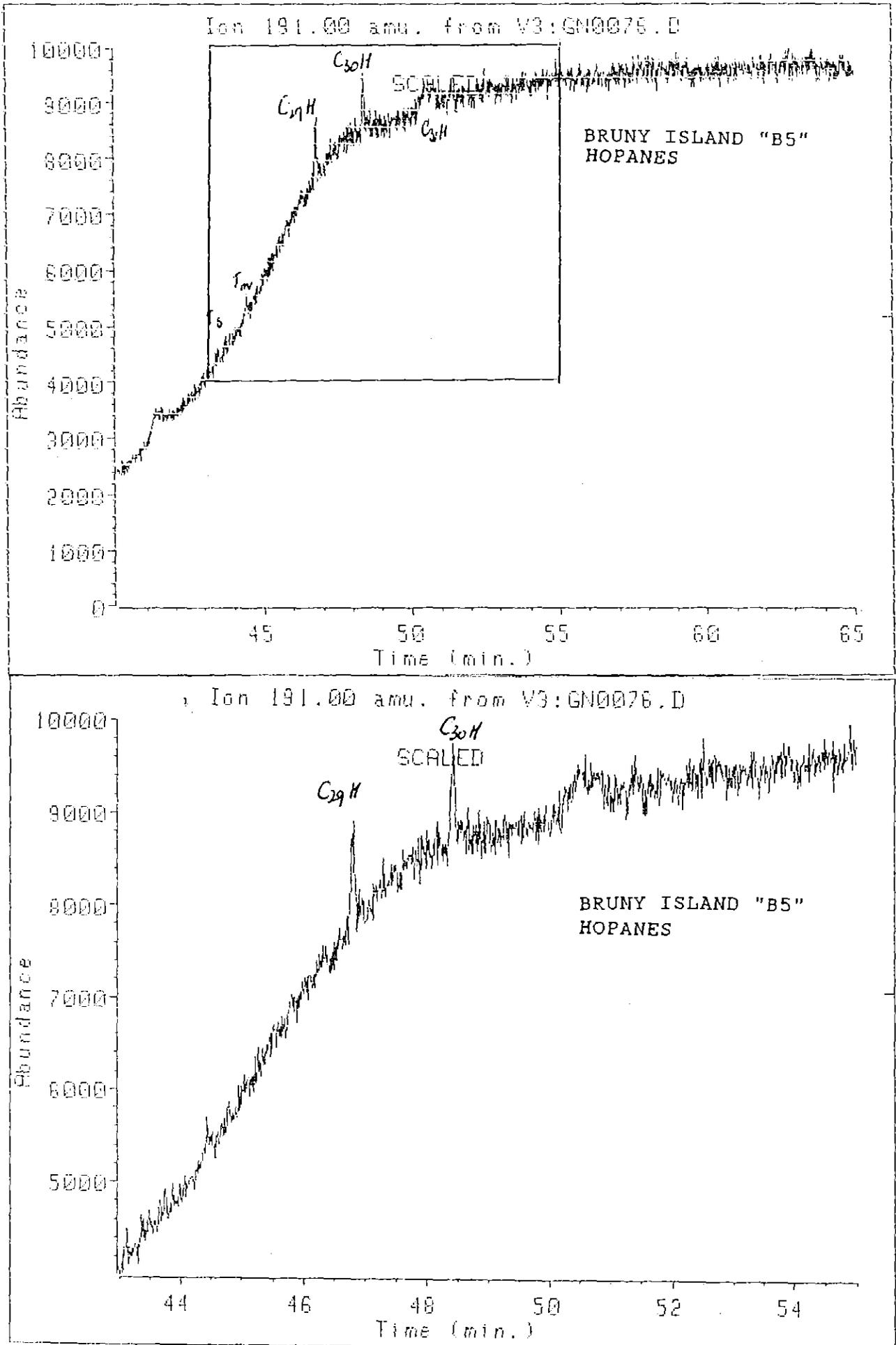


FIGURE 19. MASS FRAGMENTOGRAMS FOR M/Z 191 (HOPANES AND OTHER TRITERPANES) IN BRUNY ISLAND SAMPLE "B5".

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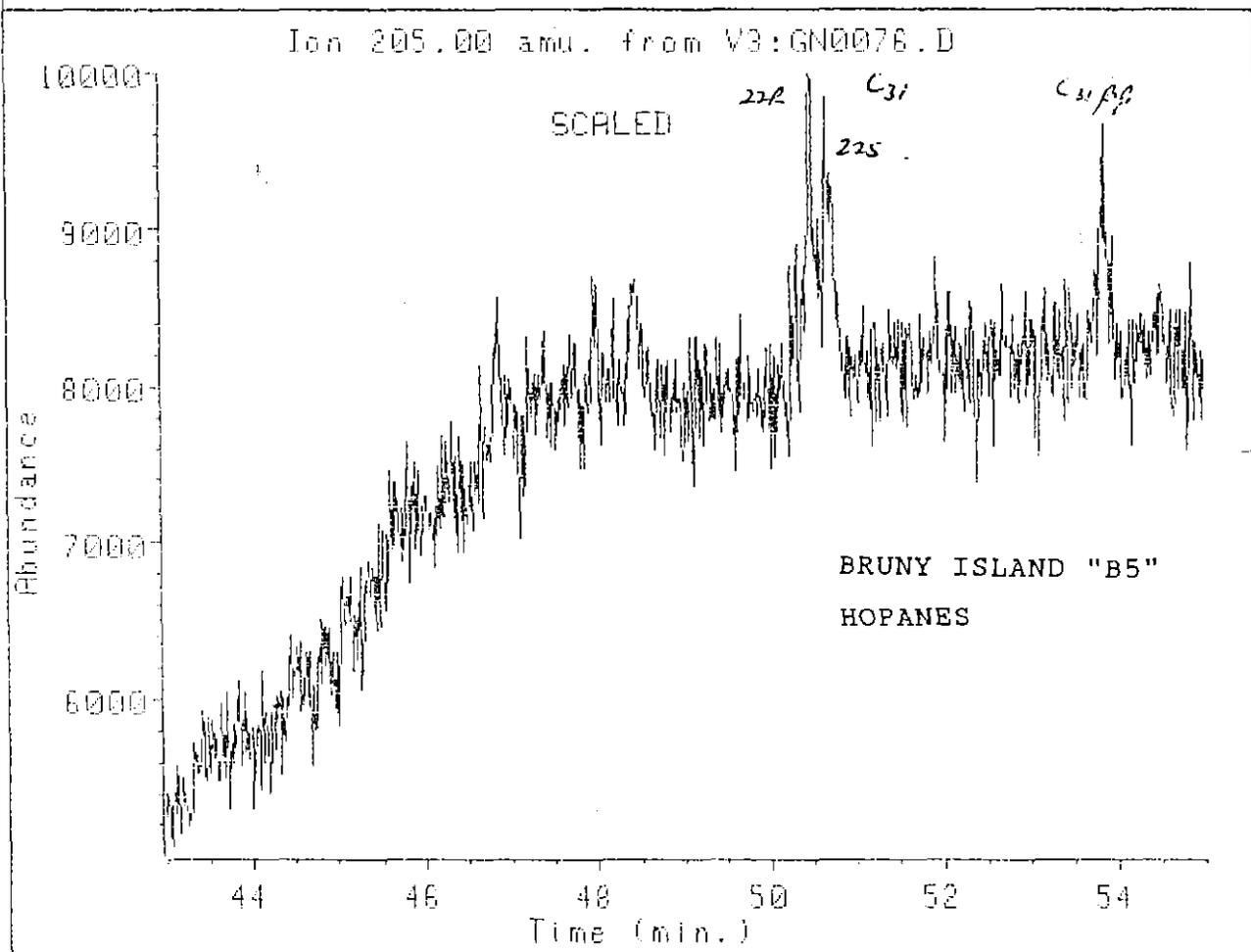
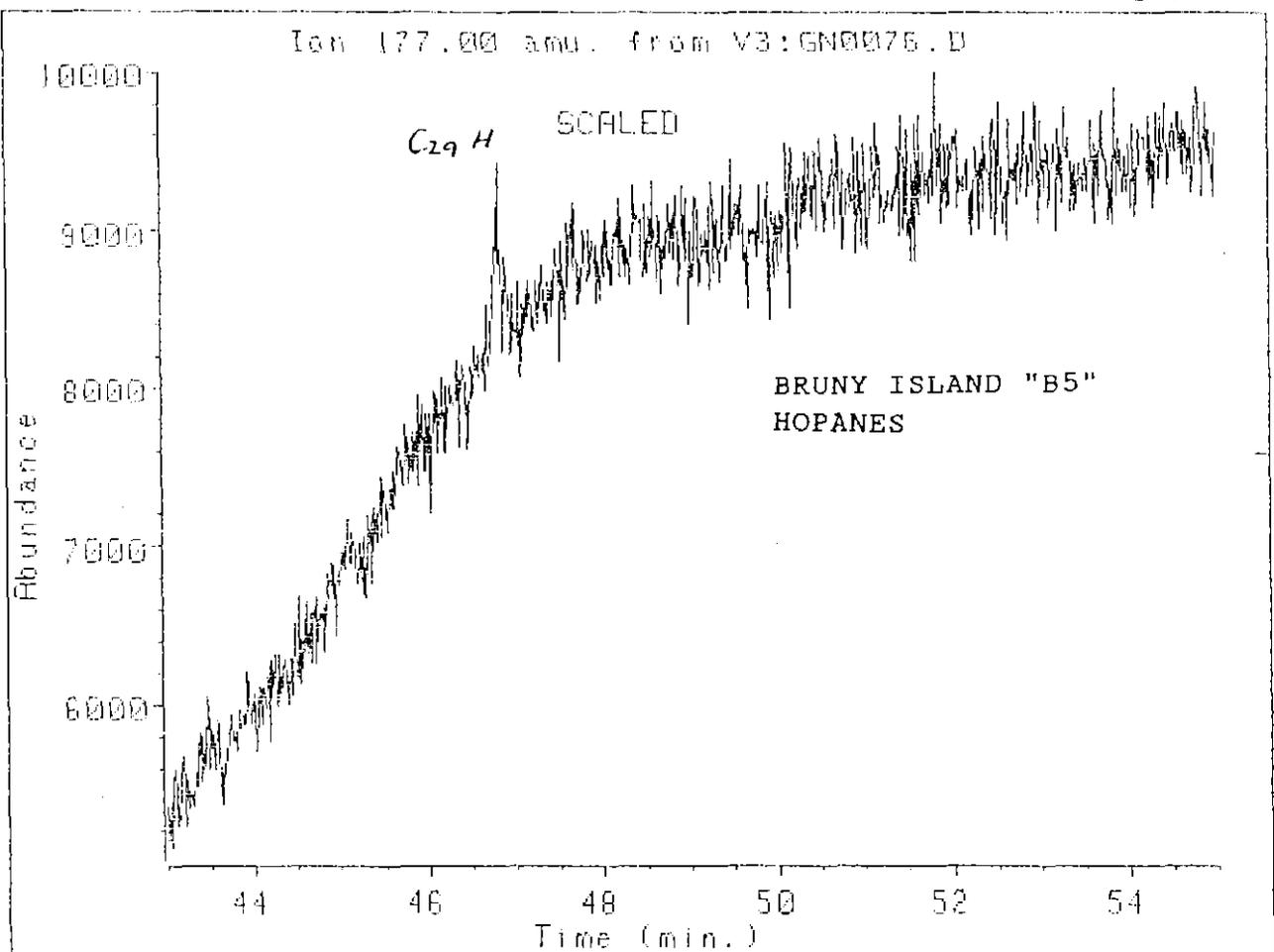


FIGURE 20A. MASS FRAGMENTOGRAM FOR M/Z 177 ( $C_{29}$  HOPANES PLUS DEMETHYLATED HOPANES) IN BRUNY ISLAND SAMPLE "B5".

FIGURE 20B. MASS FRAGMENTOGRAM FOR M/Z 205 ( $C_{31}$  HOPANES) IN BRUNY ISLAND SAMPLE "B5".

5 cm

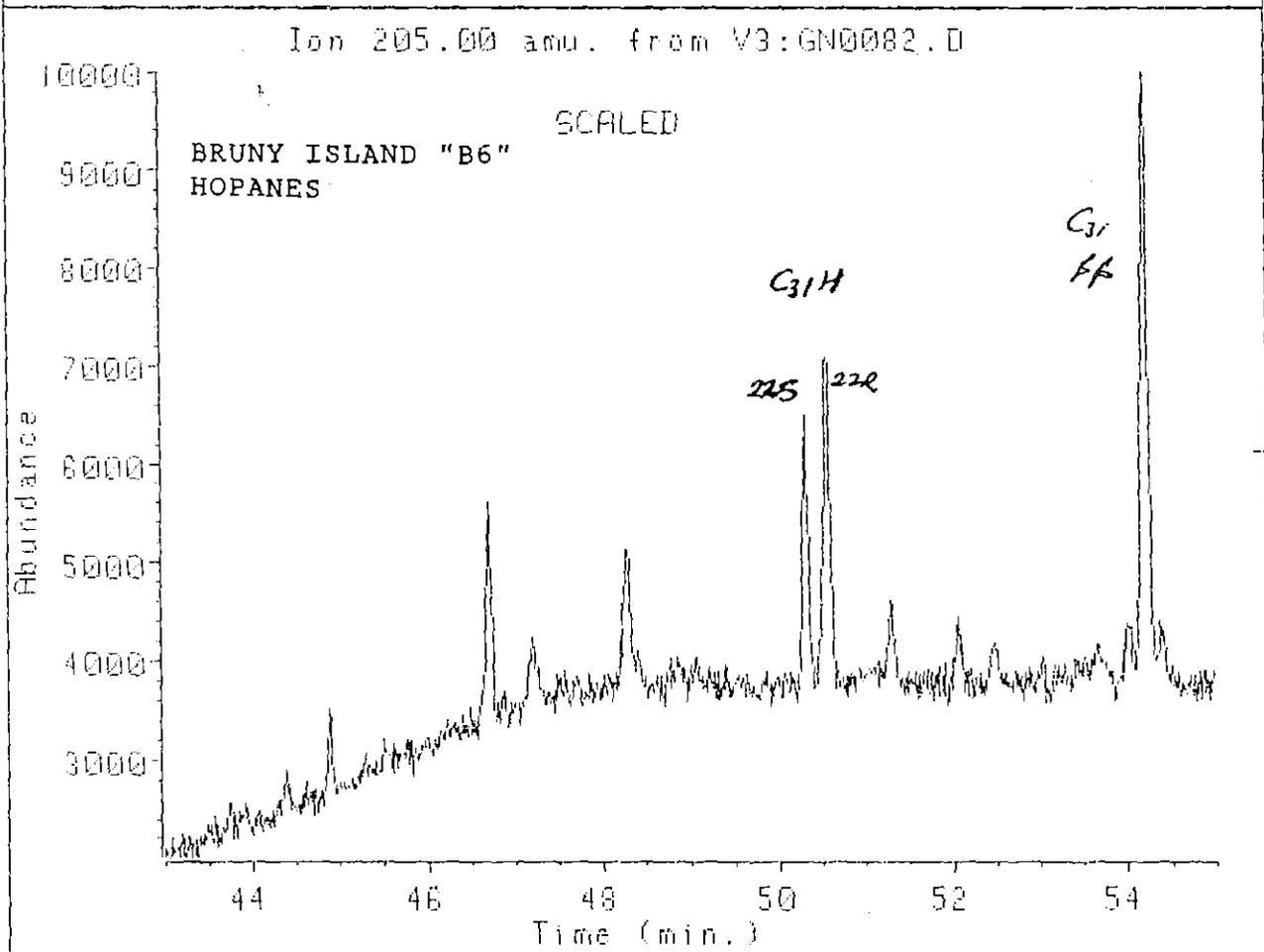
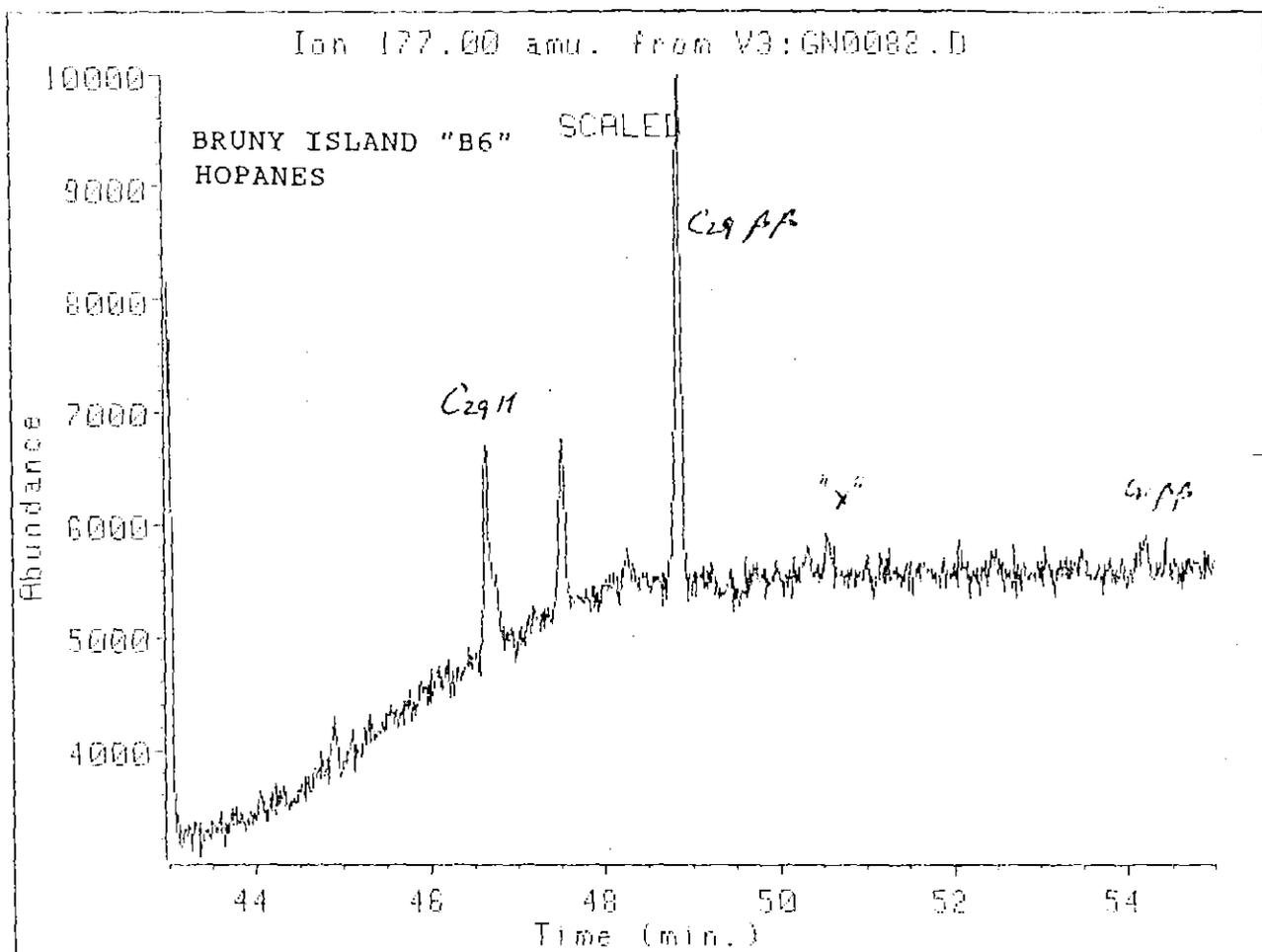


FIGURE 22A. MASS FRAGMENTOGRAM FOR M/Z 177 ( $C_{29}$  HOPANES PLUS DEMETHYLATED HOPANES) IN BRUNY ISLAND SAMPLE "B6".

FIGURE 22B. MASS FRAGMENTOGRAM FOR M/Z 205 ( $C_{31}$  HOPANES) IN BRUNY ISLAND SAMPLE "B6".

030

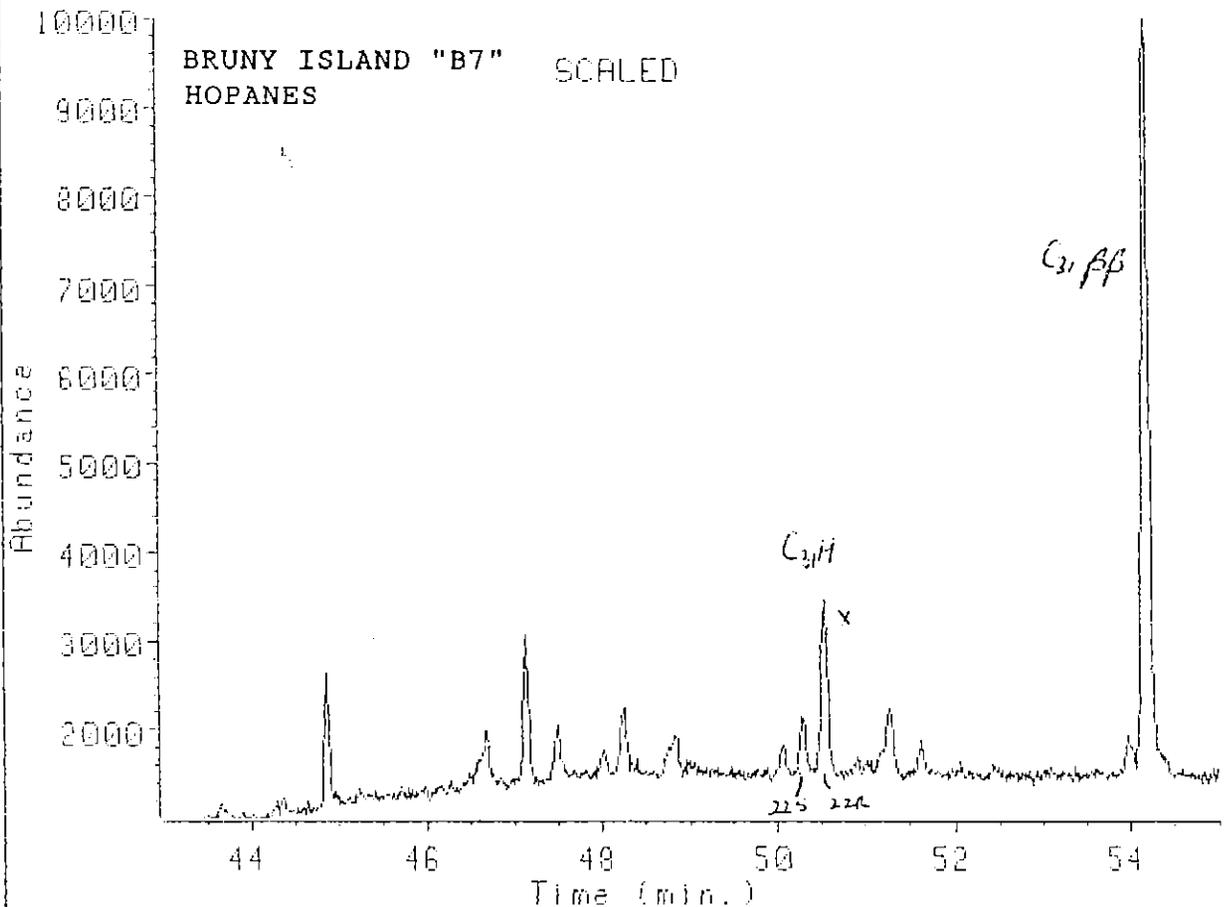
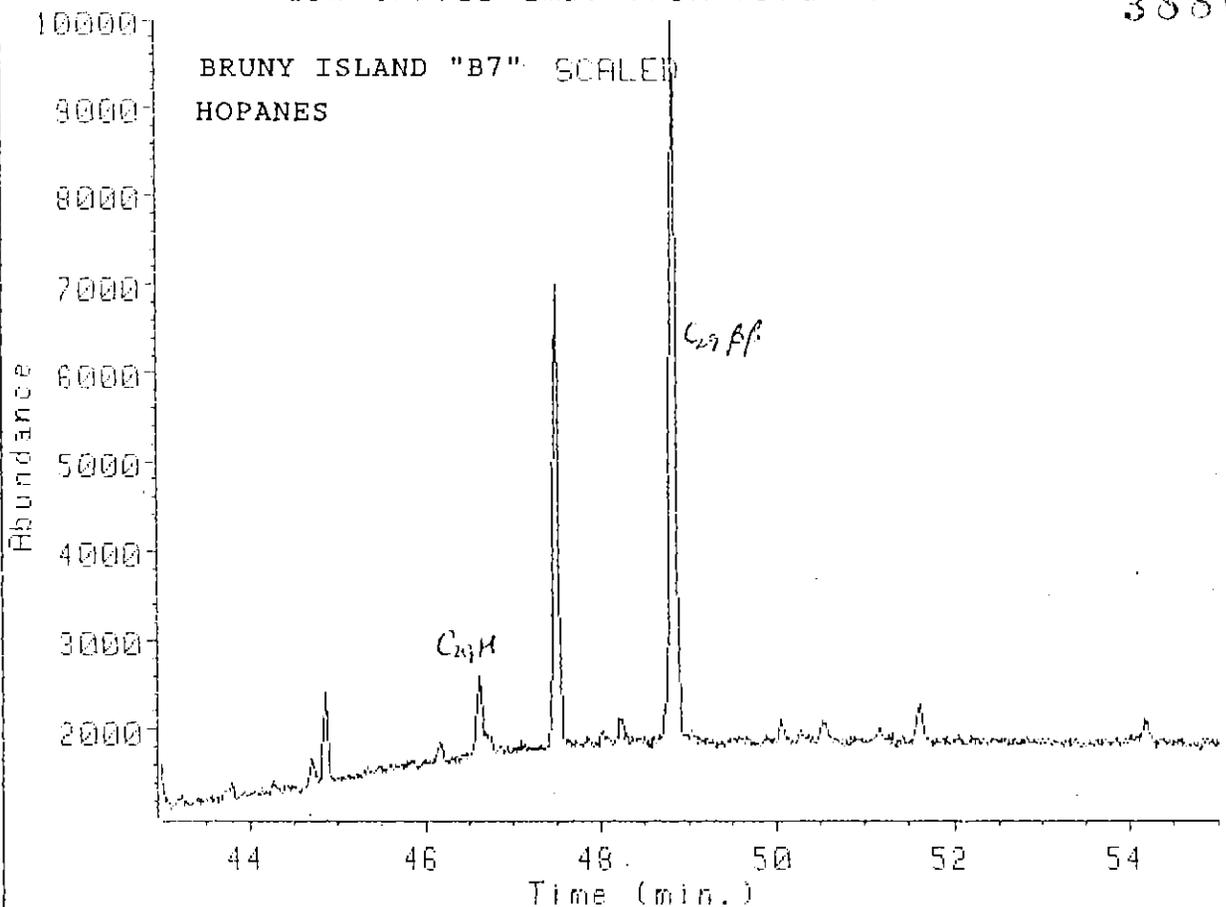
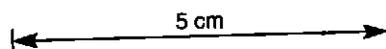


FIGURE 24A. MASS FRAGMENTOGRAM FOR M/Z 177 ( $C_{29}$  HOPANES PLUS DEMETHYLATED HOPANES) IN BRUNY ISLAND SAMPLE "B7".

FIGURE 24B. MASS FRAGMENTOGRAM FOR M/Z 205 ( $C_{31}$  HOPANES) IN BRUNY ISLAND SAMPLE "B7".



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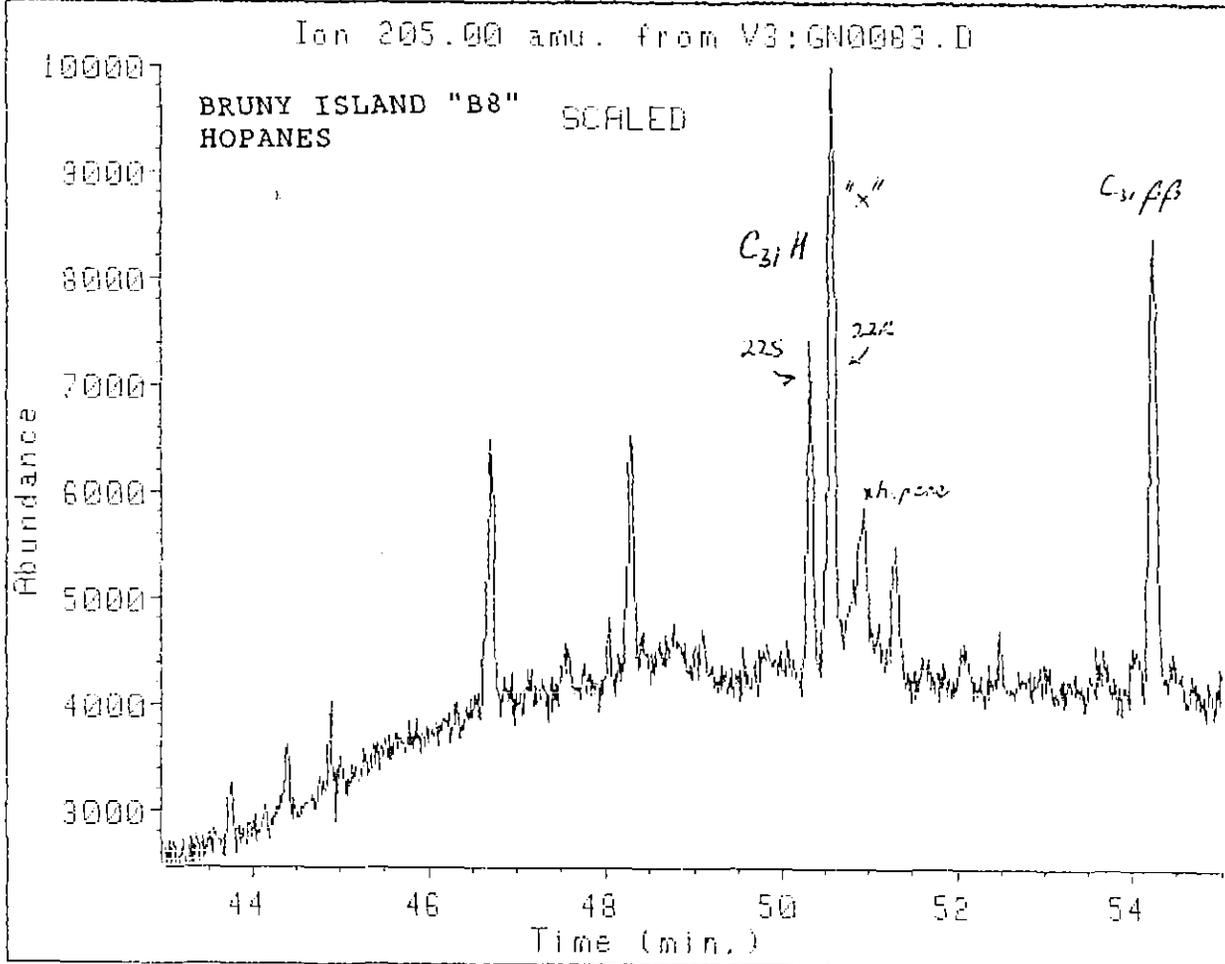
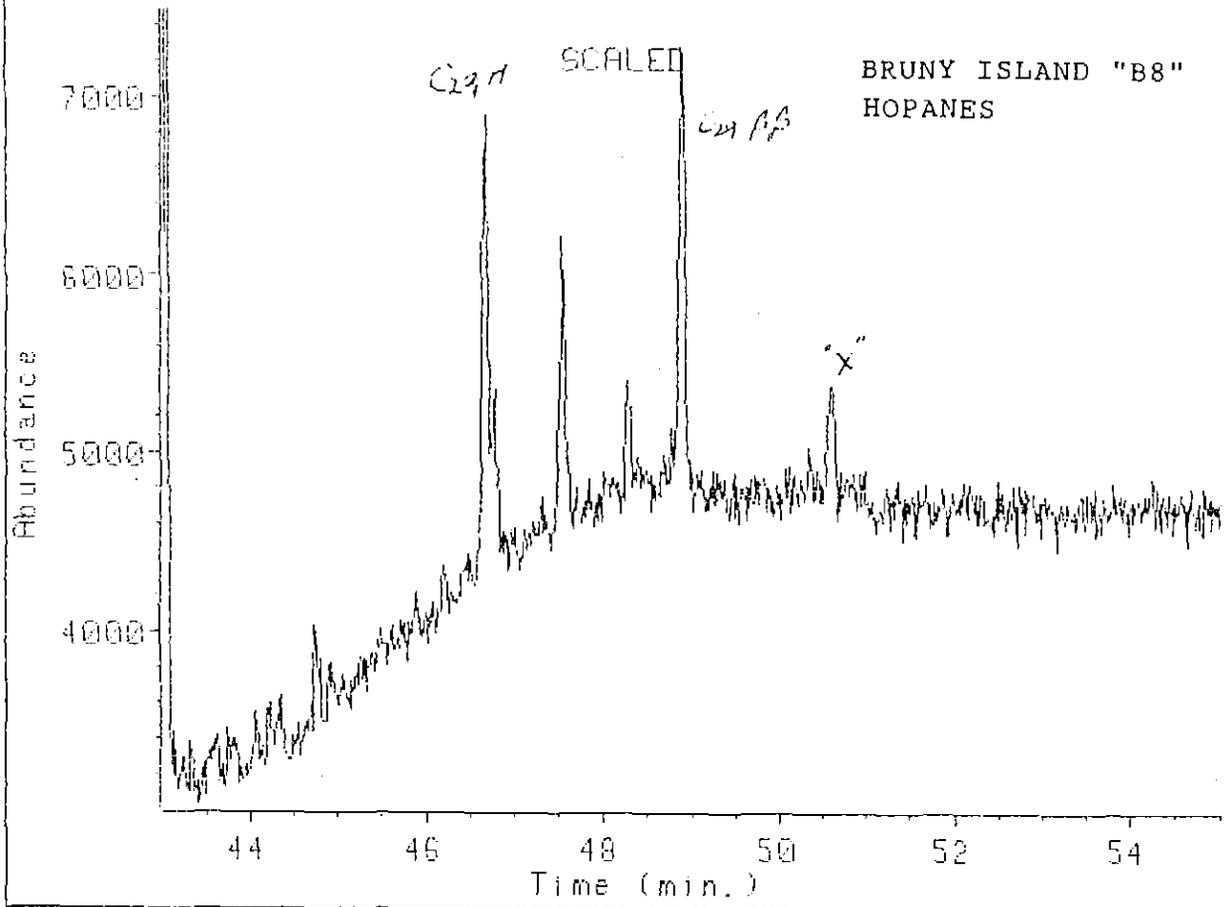
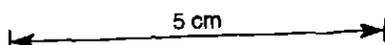
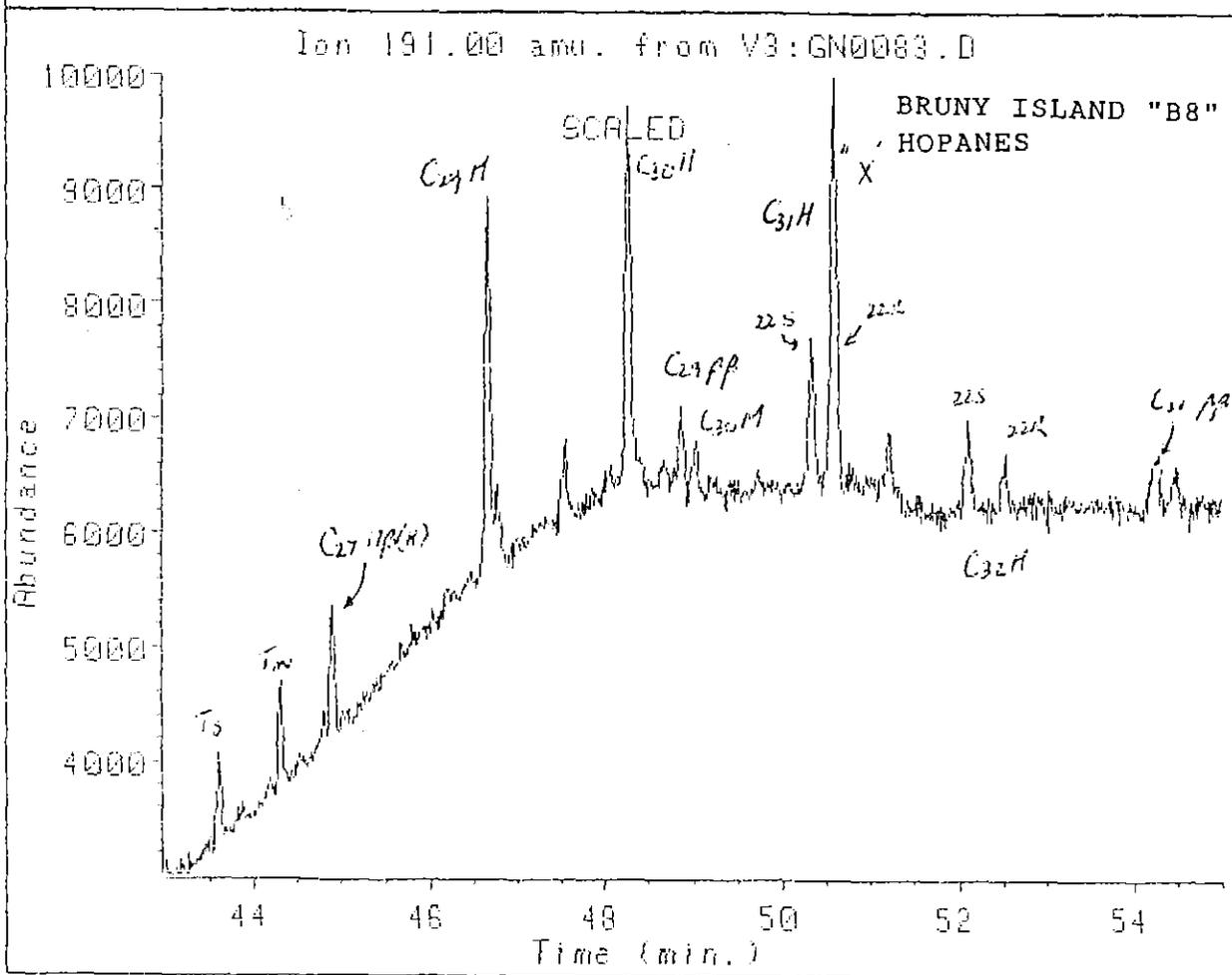
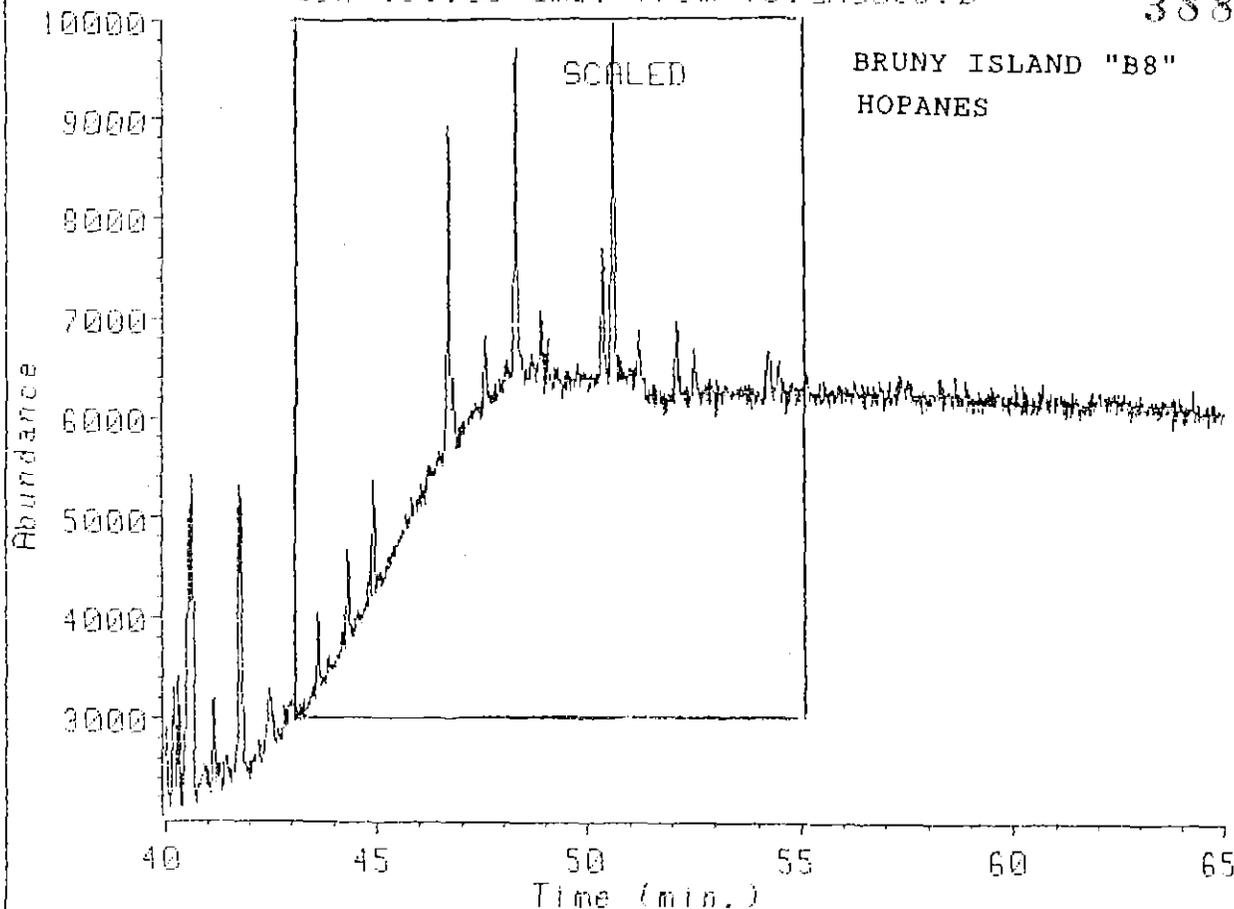


FIGURE 25. MASS FRAGMENTOGRAMS FOR M/Z 191 (HOPANES PLUS OTHER TRITERPANES) IN BRUNY ISLAND SAMPLE "B8".





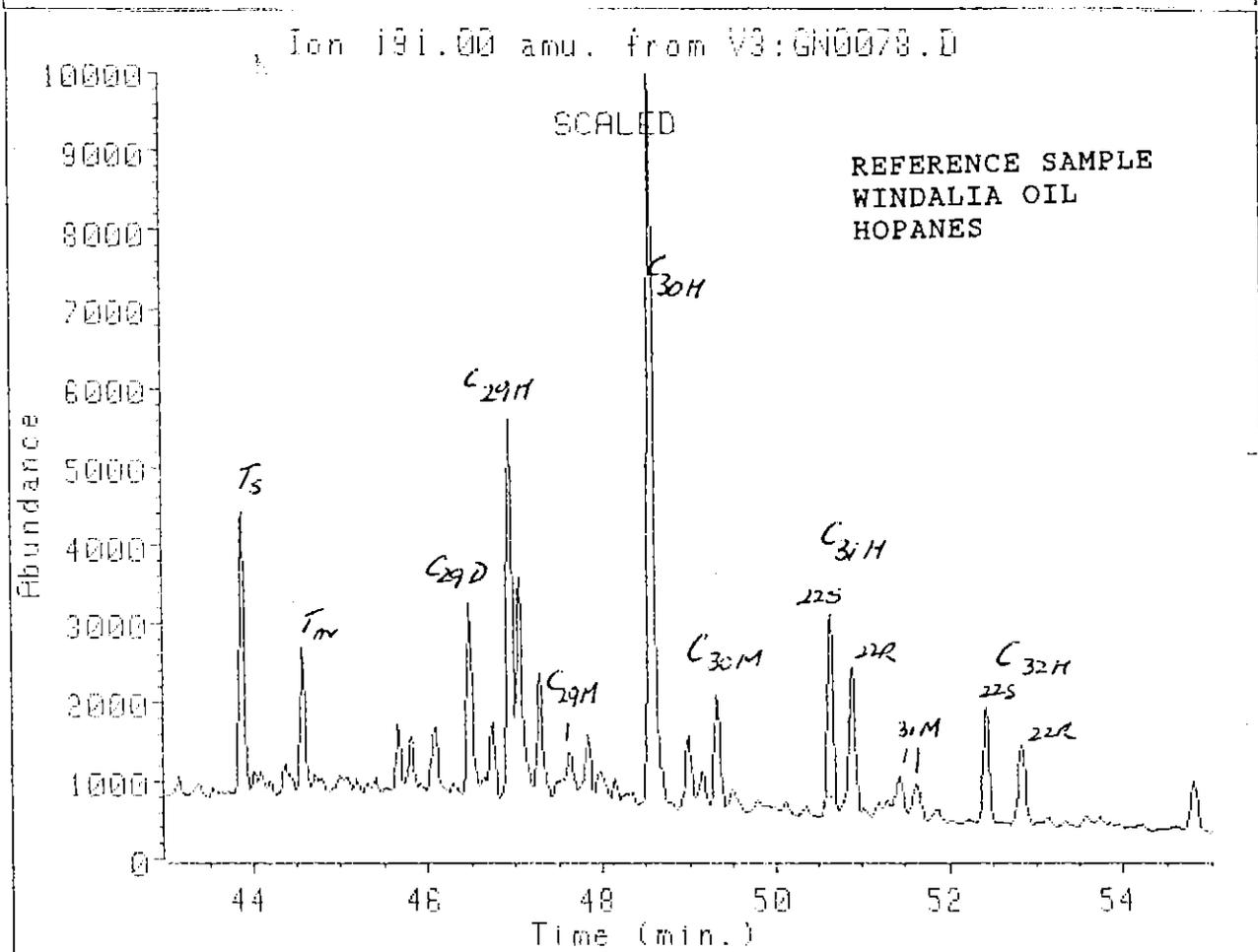
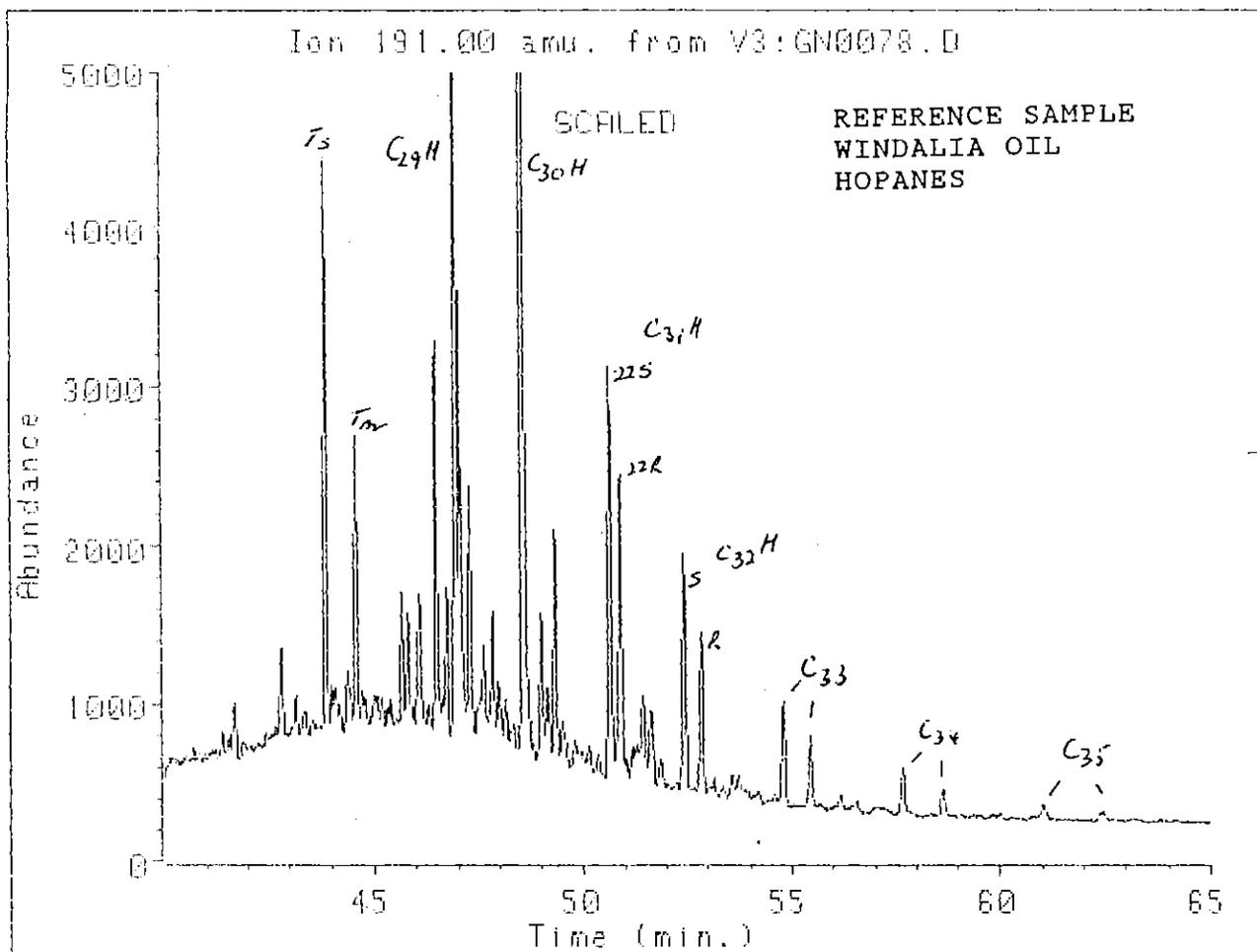
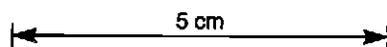


FIGURE 26. MASS FRAGMENTOGRAM FOR M/Z 191 (HOPANES PLUS OTHER TRITERPANES) IN REFERENCE SAMPLE WINDALIA OIL.

042

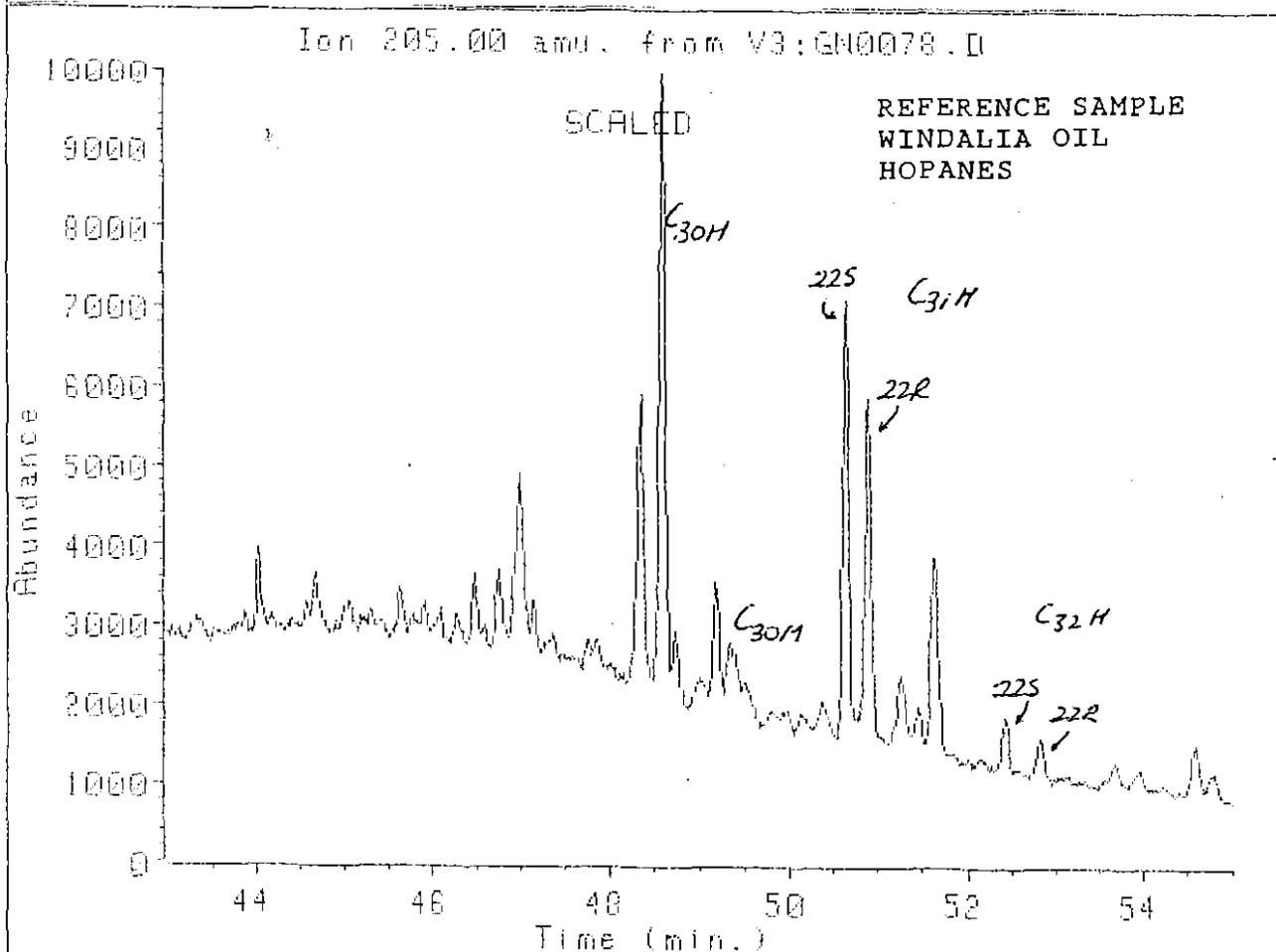
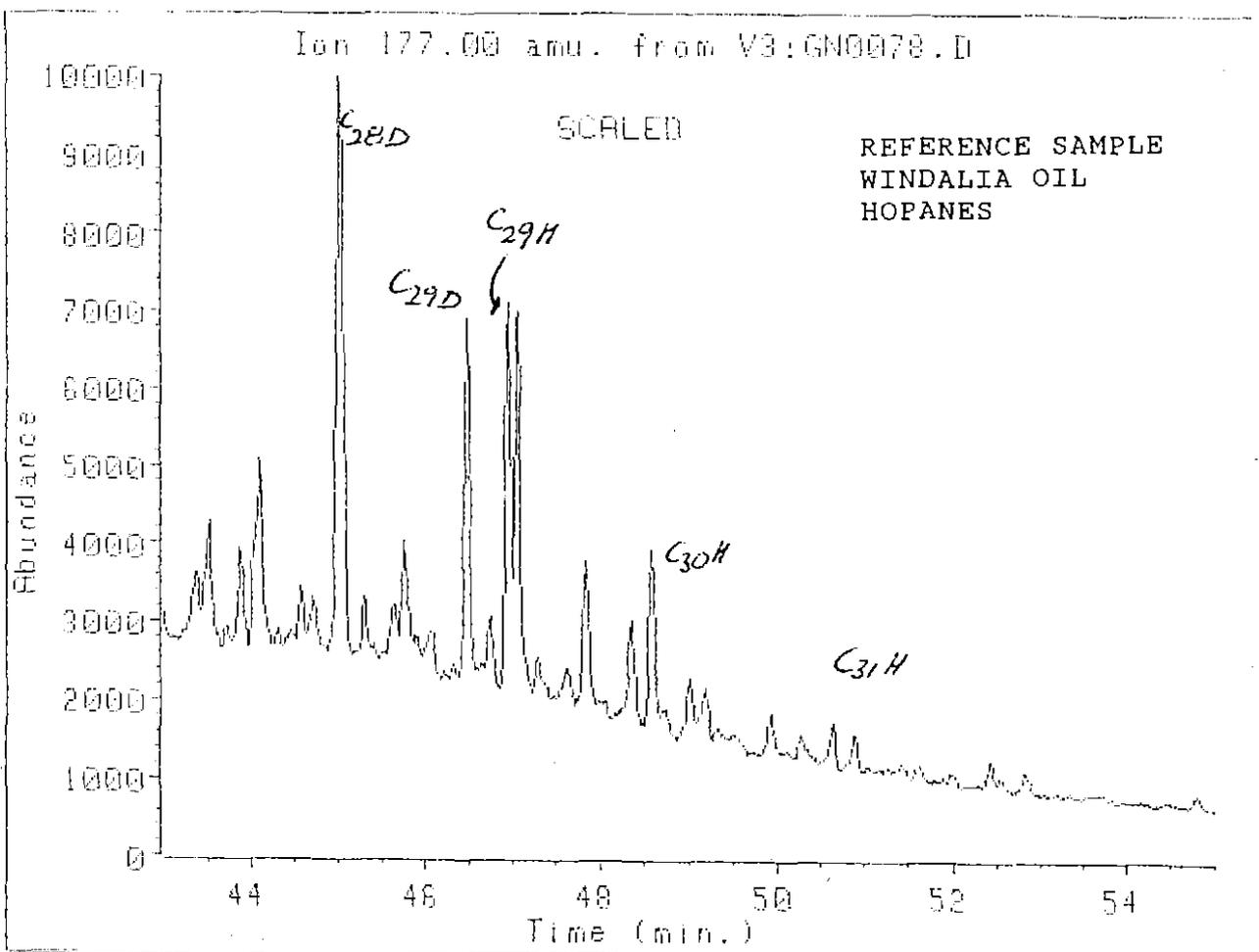


FIGURE 27A. MASS FRAGMENTOGRAM FOR M/Z 177 ( $C_{29}$  HOPANES PLUS DEMETHYLATED HOPANES) IN REFERENCE SAMPLE WINDALIA OIL.

FIGURE 27B. MASS FRAGMENTOGRAM FOR M/Z 205 ( $C_{31}$  HOPANES) FOR REFERENCE SAMPLE WINDALIA OIL.

5 cm

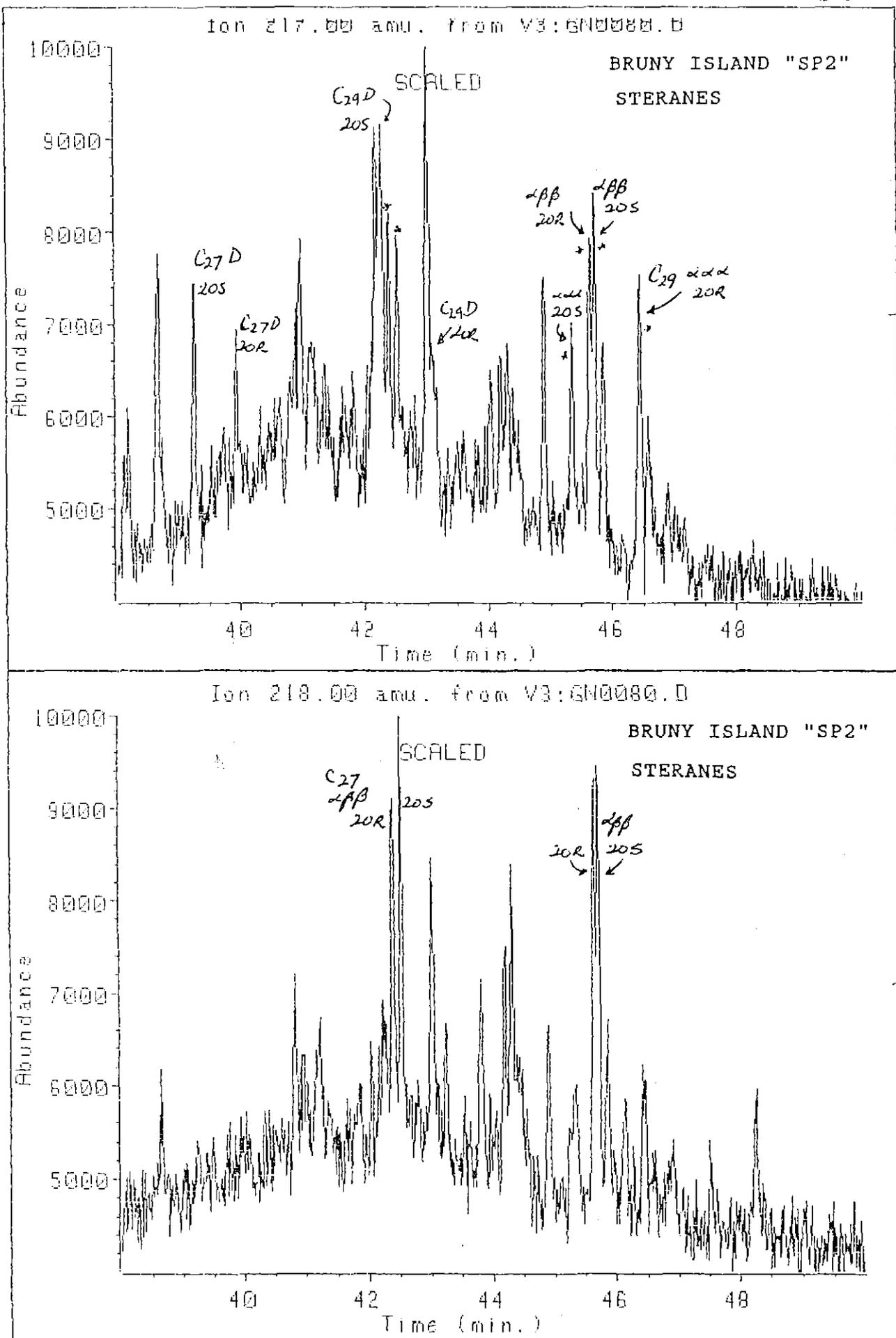


FIGURE 28. MASS FRAGMENTOGRAMS FOR M/Z 217 AND 218 (C<sub>27</sub> - C<sub>30</sub> STERANES) IN BRUNY ISLAND SAMPLE "SP2".

5 cm

5 cm

14

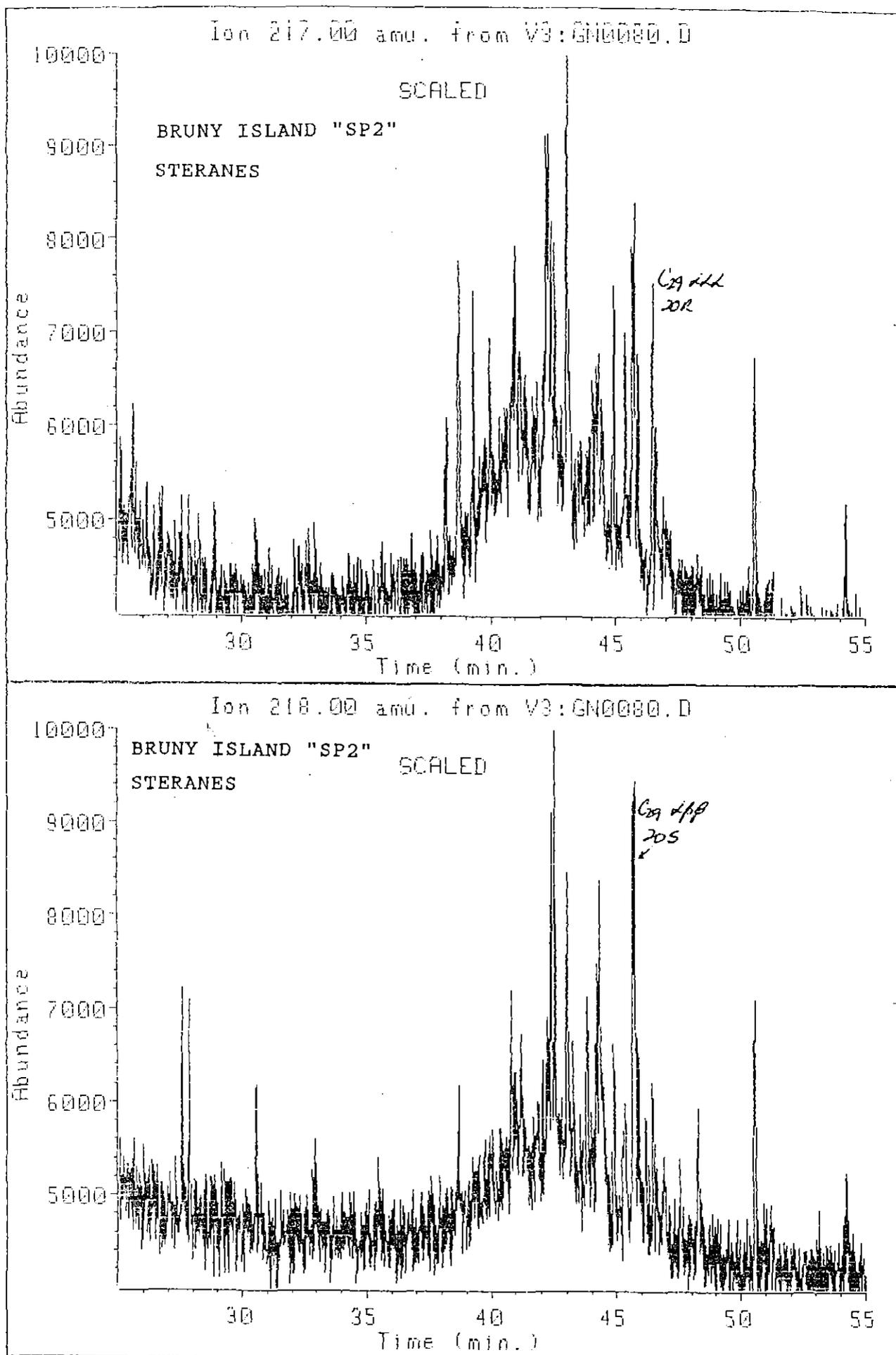


FIGURE 29. MASS FRAGMENTOGRAMS FOR M/Z 217 AND 218 (C<sub>20</sub> - C<sub>30</sub> STERANES) IN BRUNY ISLAND SAMPLE "SP2".

043

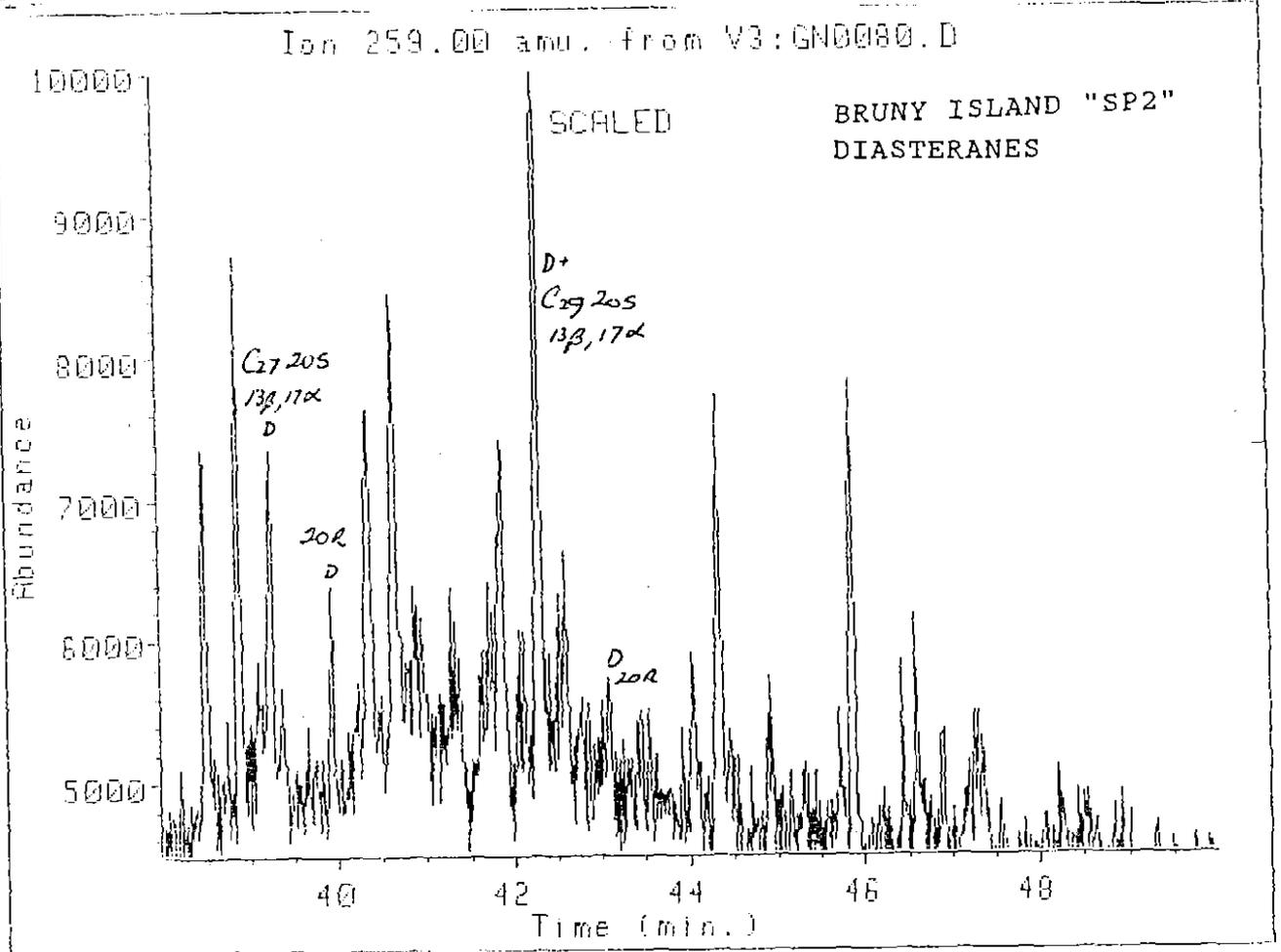
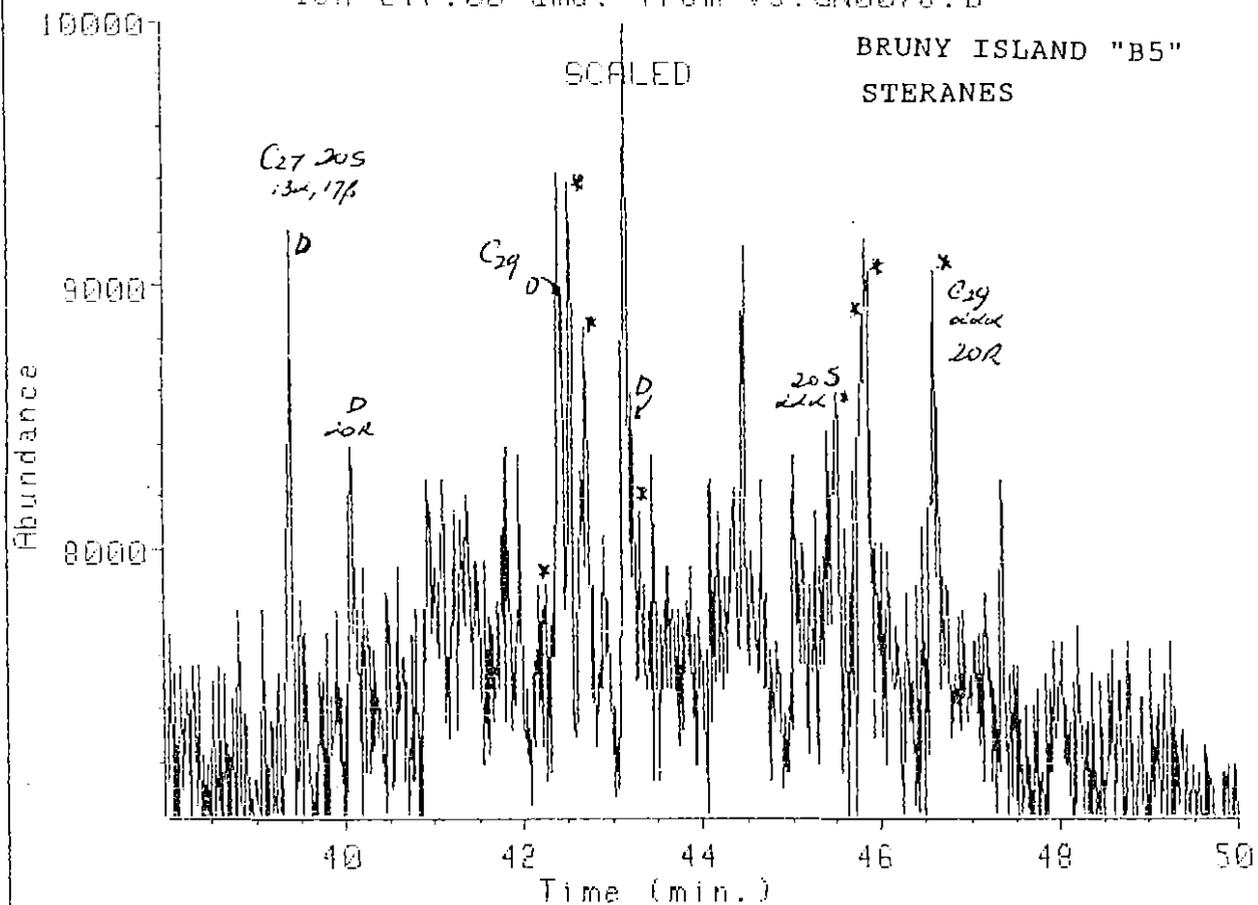


FIGURE 30. MASS FRAGMENTOGRAM FOR M/Z 259 (DIASTERANES) IN BRUNY ISLAND SAMPLE "SP2".

5 cm

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Ion 218.00 amu. from V3:GN0076.D

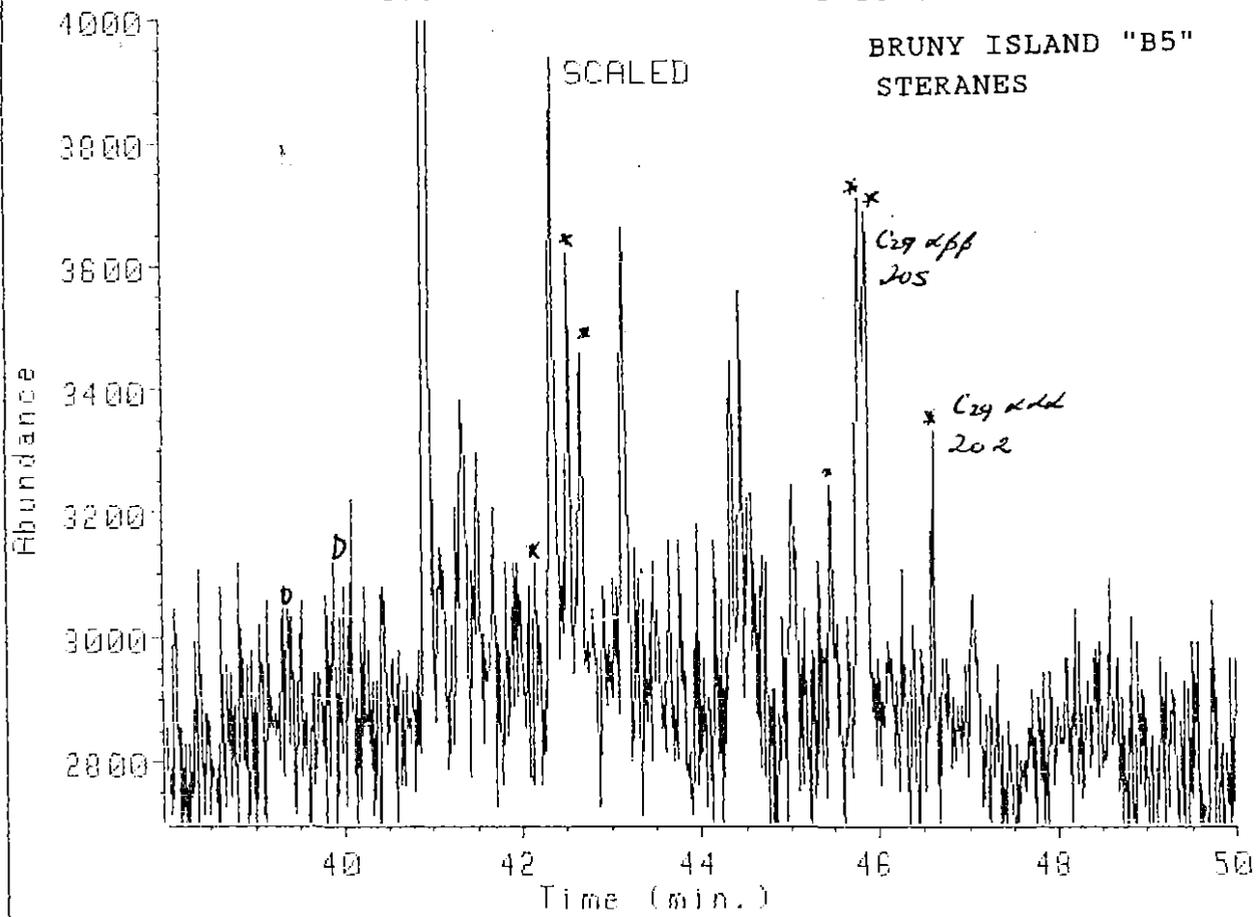
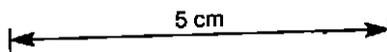


FIGURE 31. MASS FRAGMENTOGRAMS FOR M/Z 217 AND 218 (C<sub>27</sub> - C<sub>30</sub> STERANES) IN BRUNY ISLAND SAMPLE "B5".



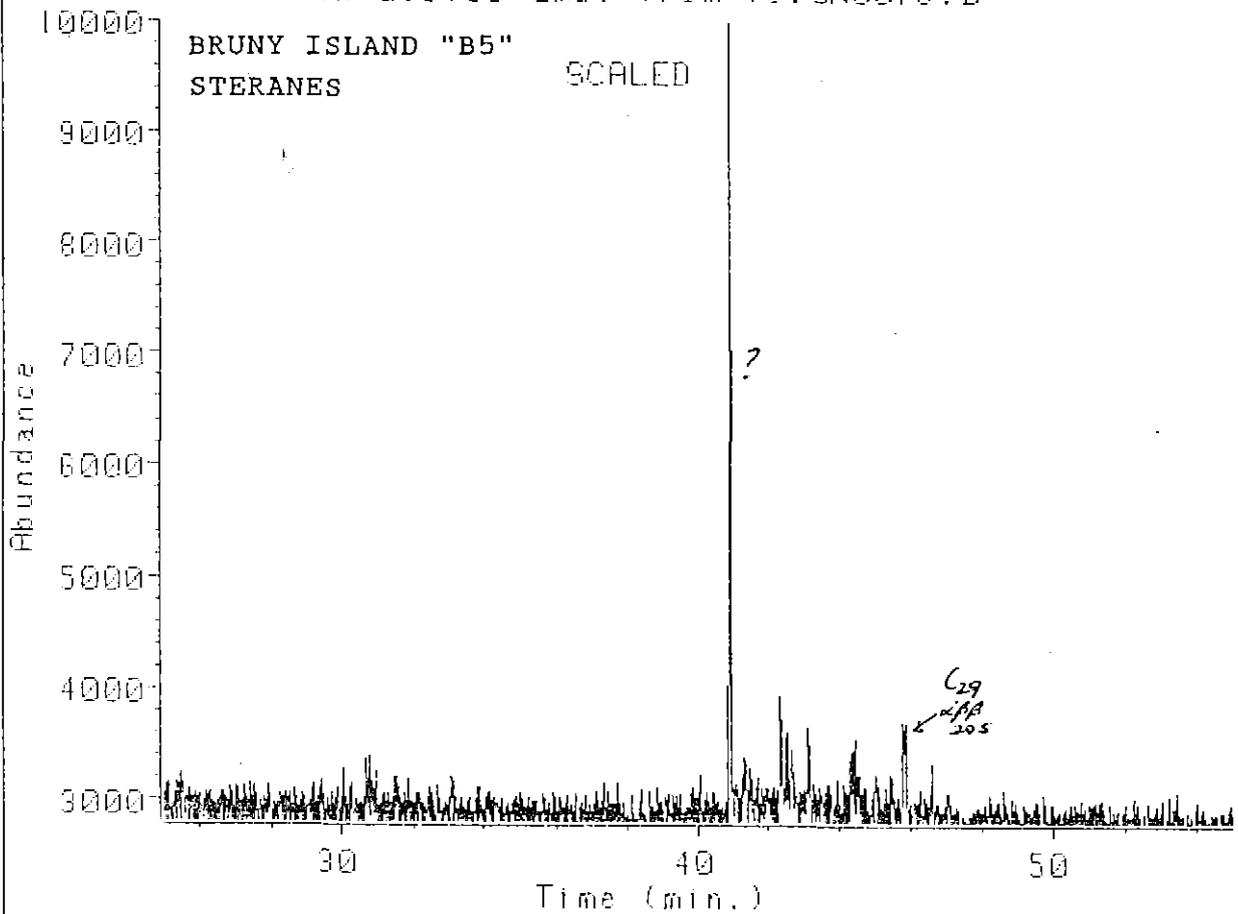
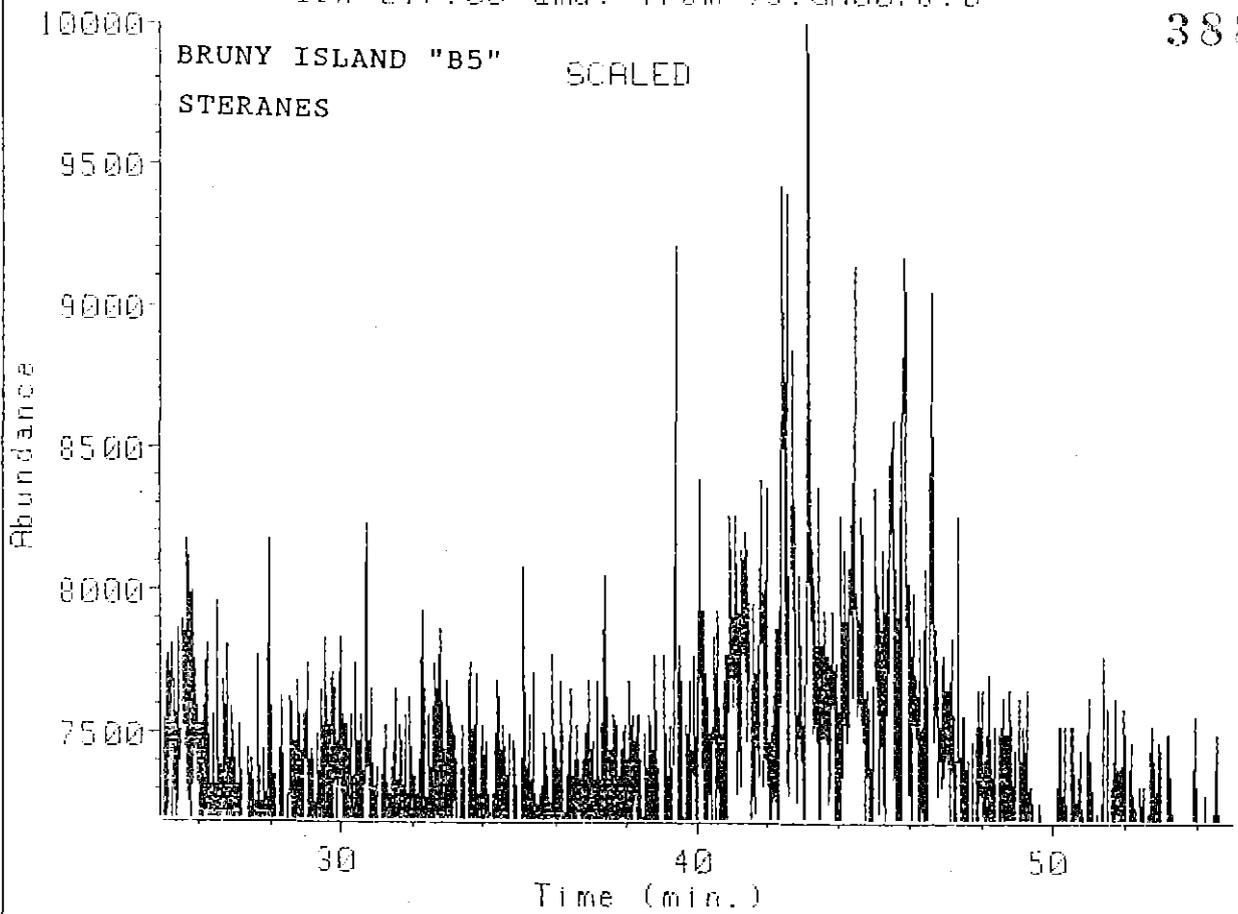
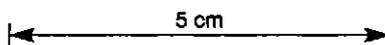


FIGURE 32. MASS FRAGMENTOGRAMS FOR M/Z 217 AND 218 (C<sub>20</sub> - C<sub>30</sub> STERANES) IN BRUNY ISLAND SAMPLE "B5".



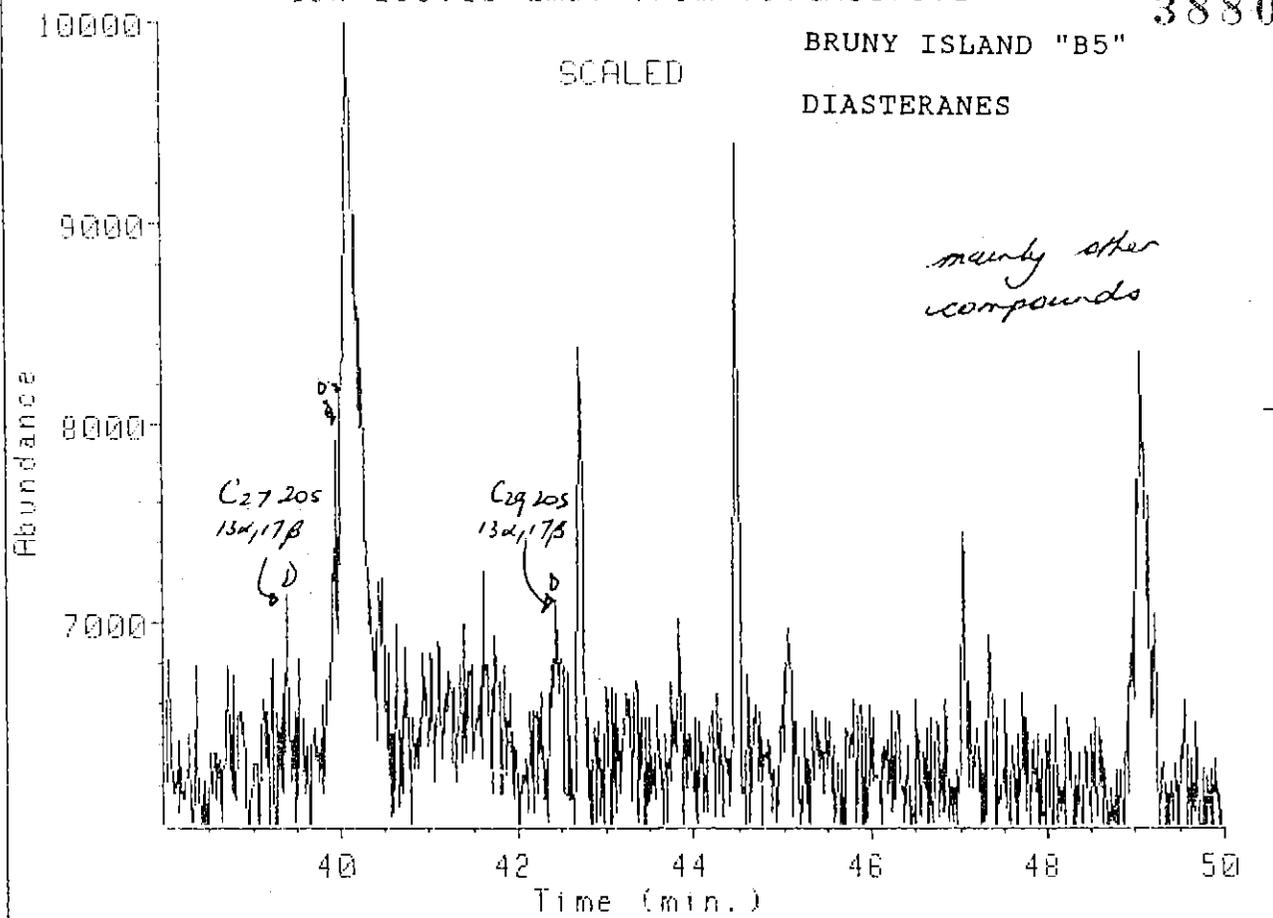


FIGURE 33. MASS FRAGMENTOGRAM FOR M/Z 259 (DIASTERANES) IN BRUNY ISLAND SAMPLE "B5".

5 cm

045

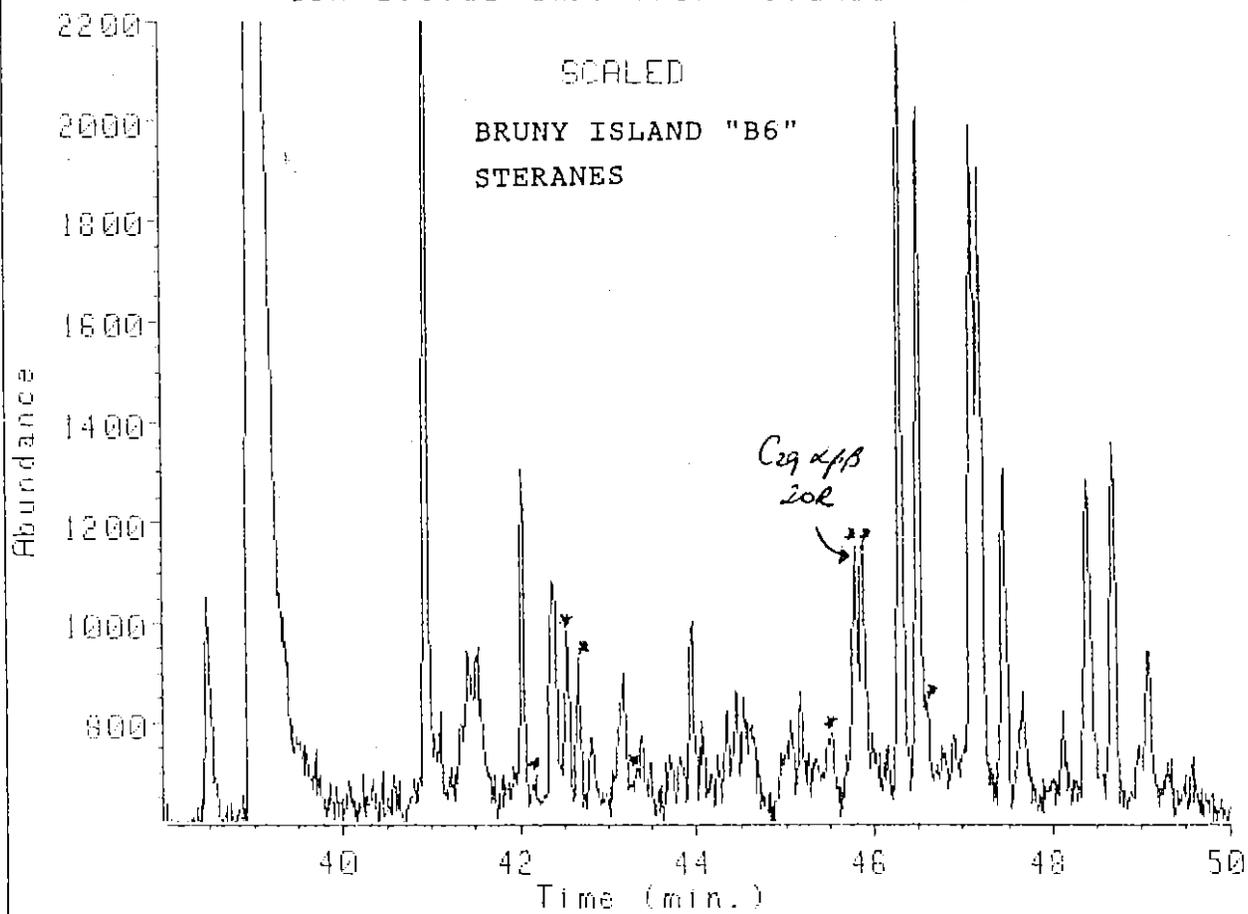
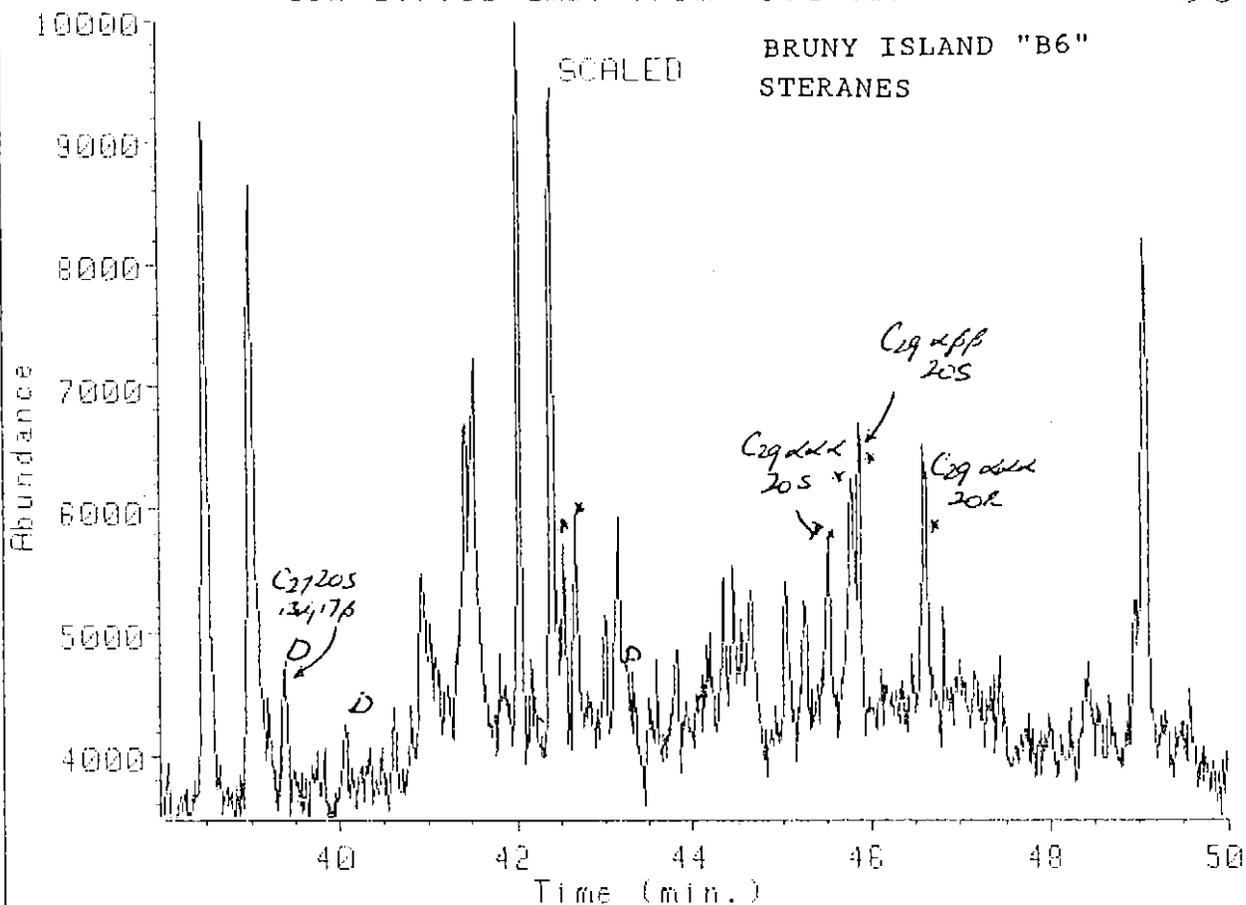


FIGURE 34. MASS FRAGMENTOGRAMS FOR M/Z 217 AND 218 (C<sub>27</sub> - C<sub>30</sub> STERANES) IN BRUNY ISLAND SAMPLE "B6".

5 cm

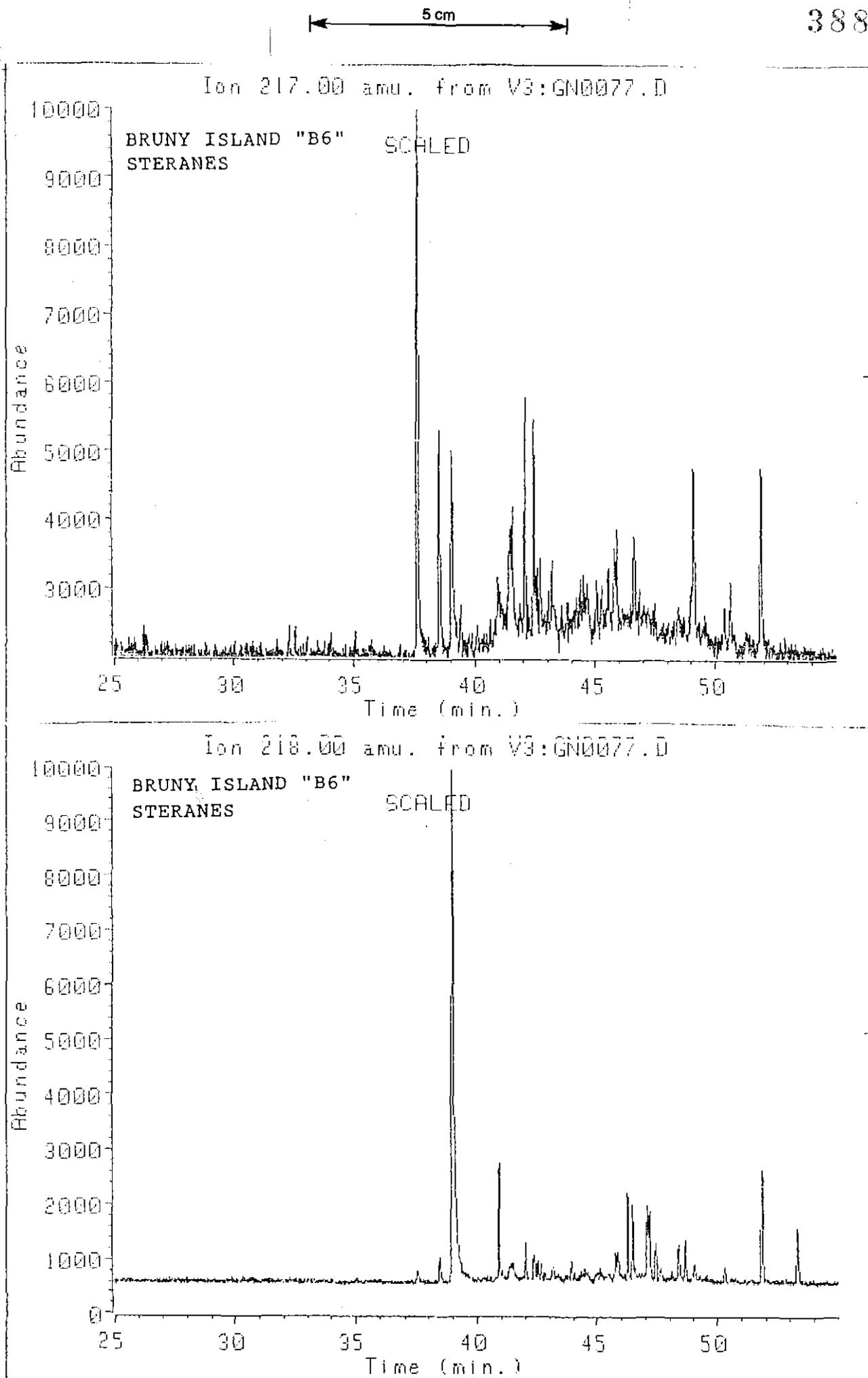


FIGURE 35. MASS FRAGMENTOGRAMS FOR M/Z 217 AND 218 (C<sub>20</sub> - C<sub>30</sub> STERANES) IN BRUNY ISLAND SAMPLE "B6".

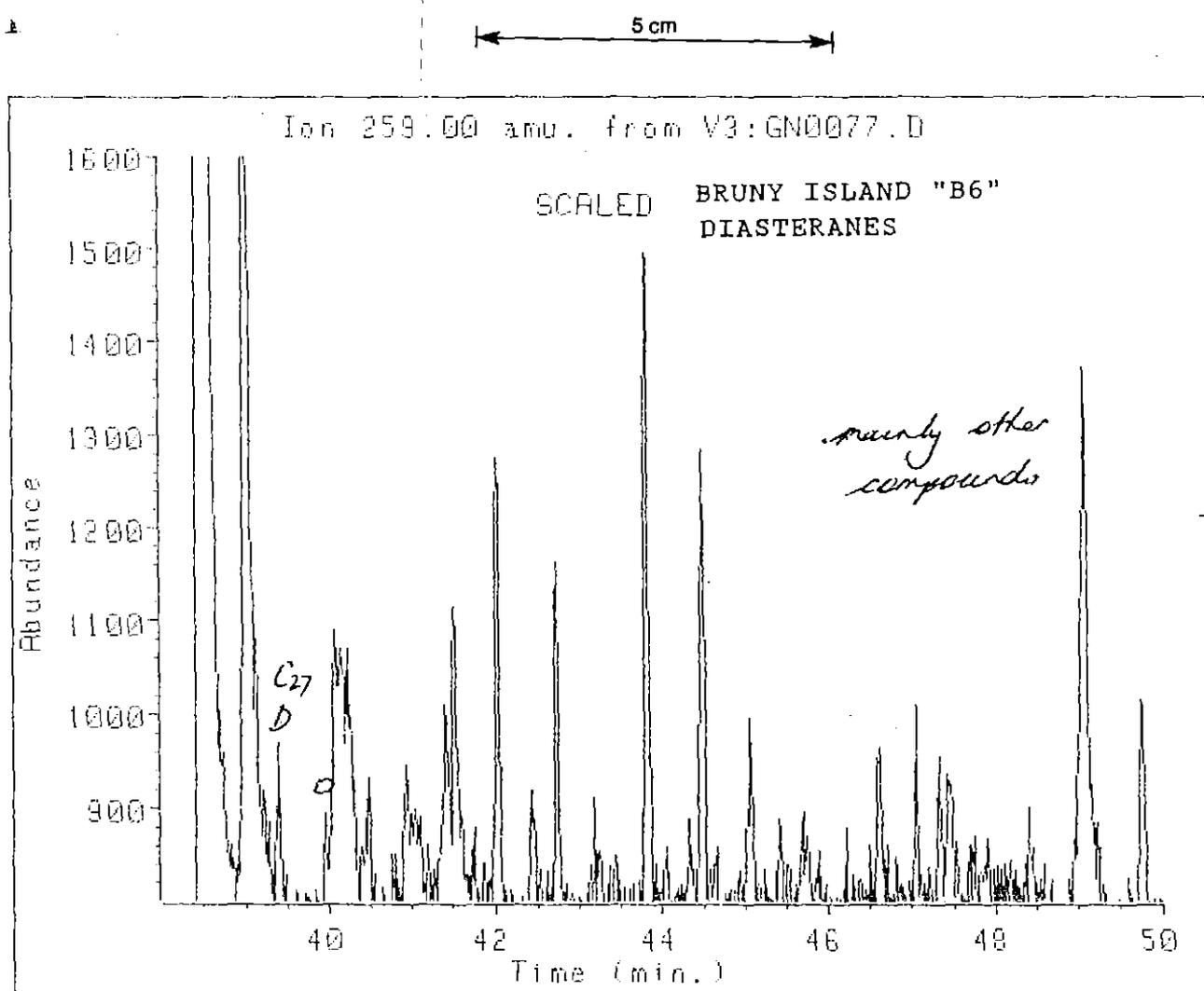


FIGURE 36. MASS FRAGMENTOGRAM FOR M/Z 259 (DIASTERANES) IN BRUNY ISLAND SAMPLE "B6".

052

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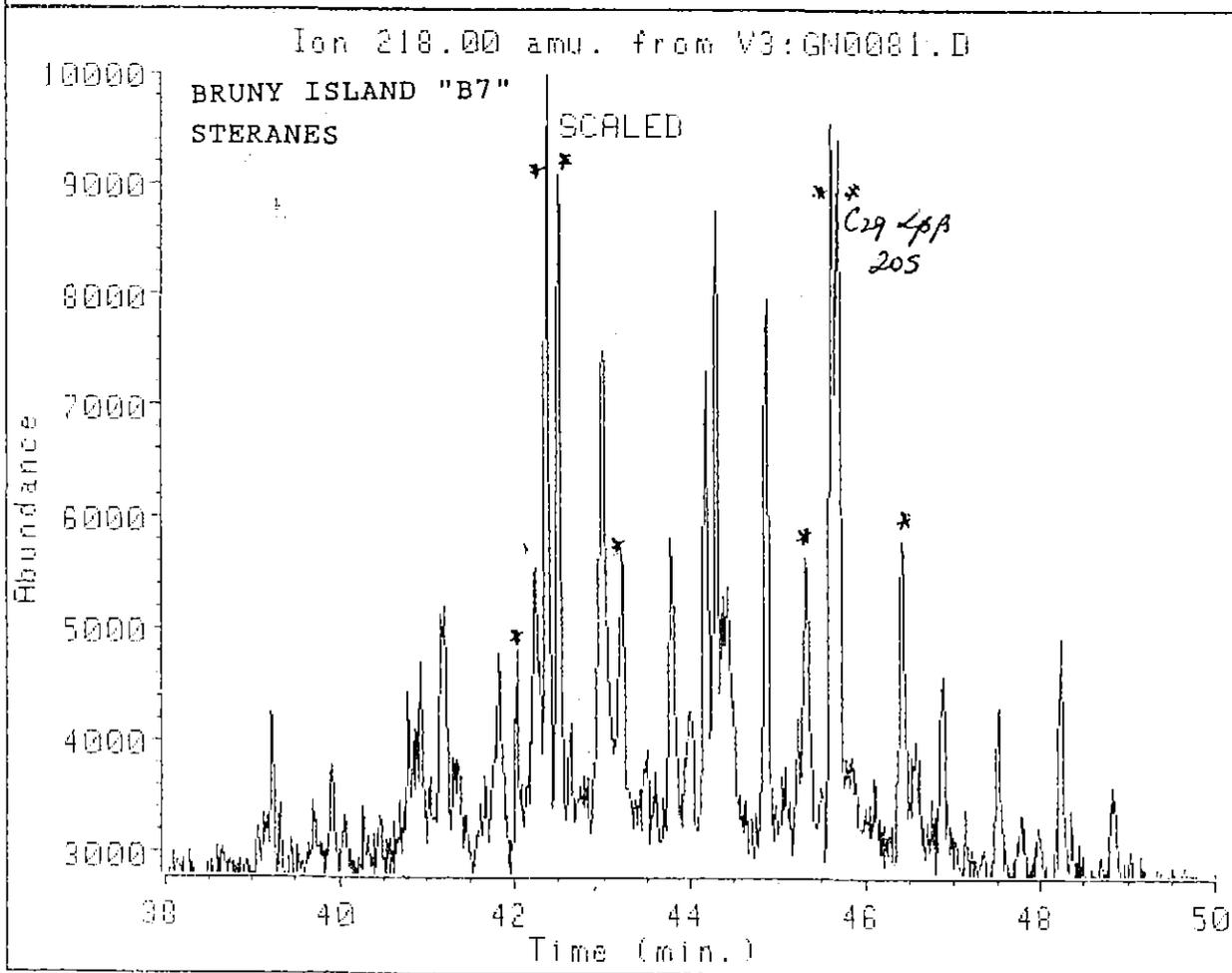
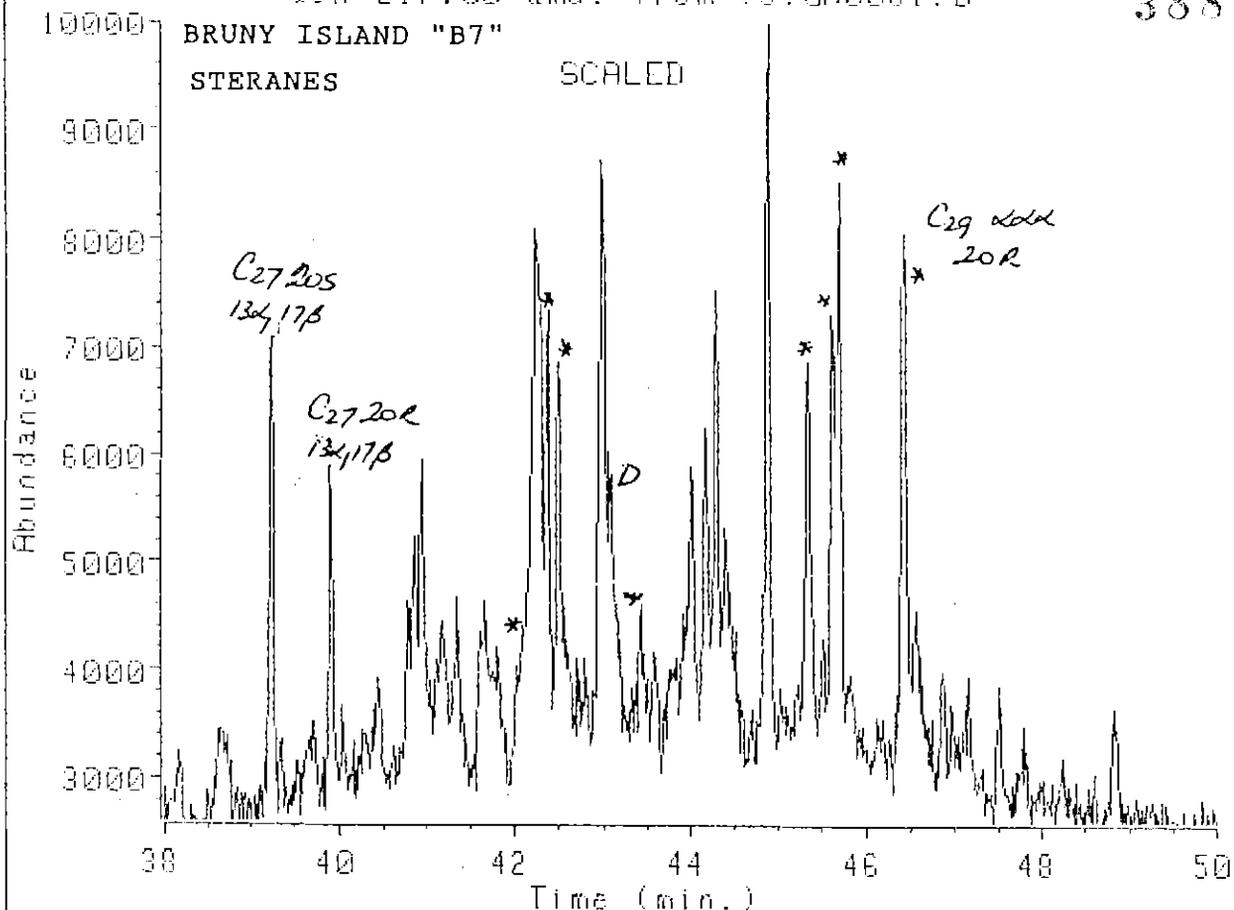
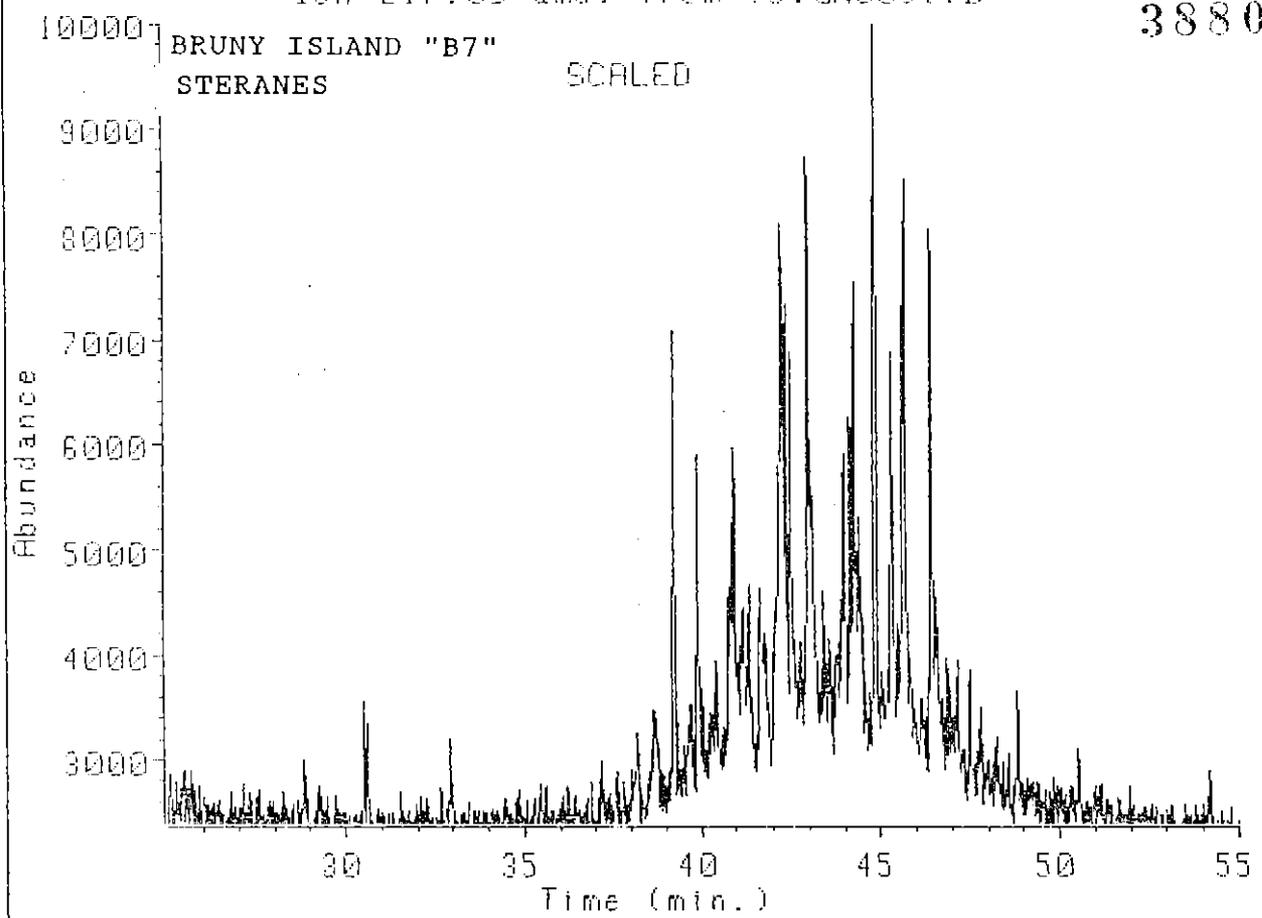


FIGURE 37. MASS FRAGMENTOGRAMS FOR M/Z 217 AND 218 (C<sub>27</sub> - C<sub>30</sub> STERANES) IN BRUNY ISLAND SAMPLE "B7".

5 cm

Ion 217.00 amu. from V3:GN0081.D



Ion 218.00 amu. from V3:GN0081.D

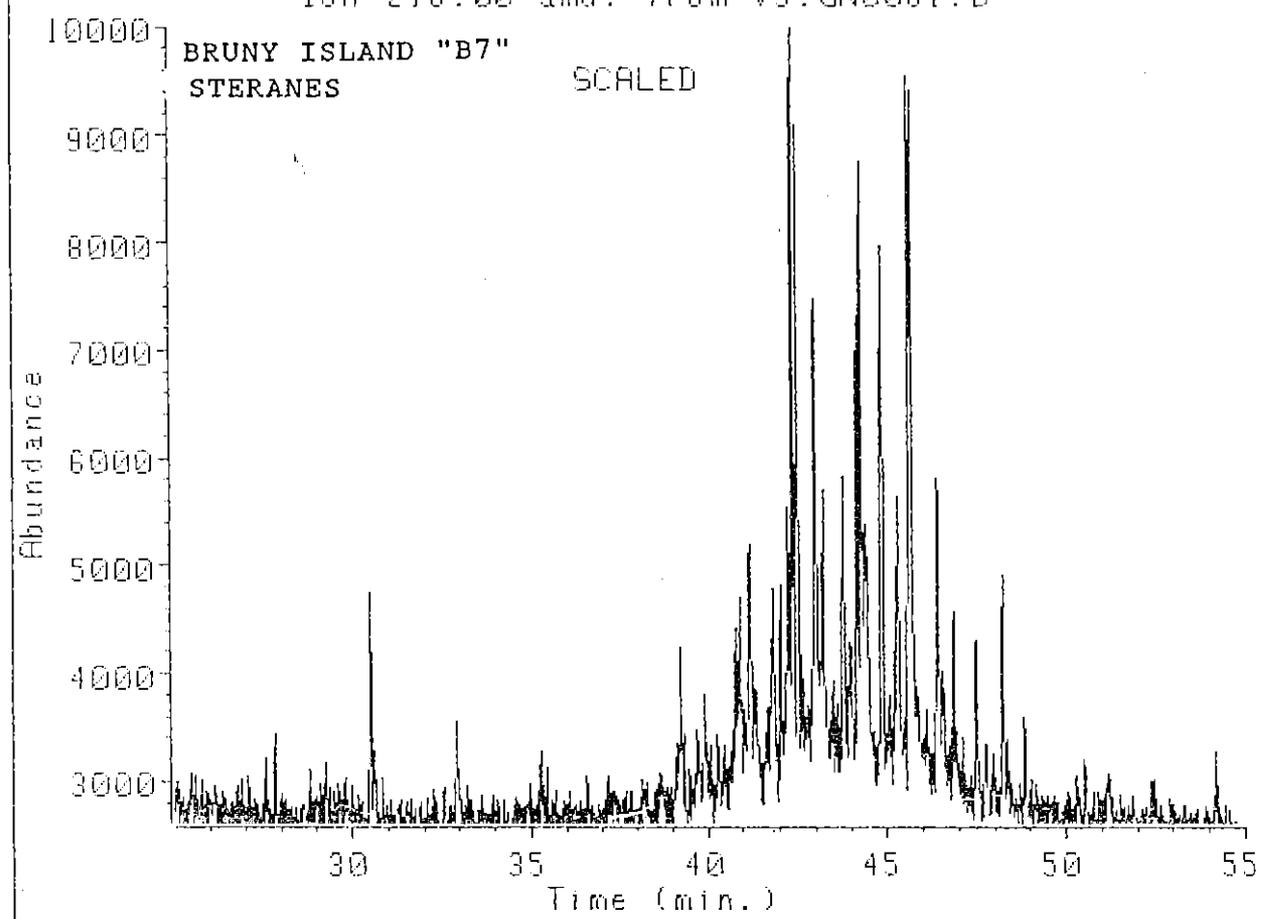
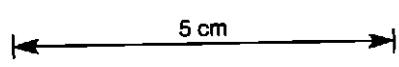


FIGURE 38. MASS FRAGMENTOGRAMS FOR M/Z 217 AND 218 (C<sub>20</sub> - C<sub>30</sub> STERANES) IN BRUNY ISLAND SAMPLE "B7".



95.

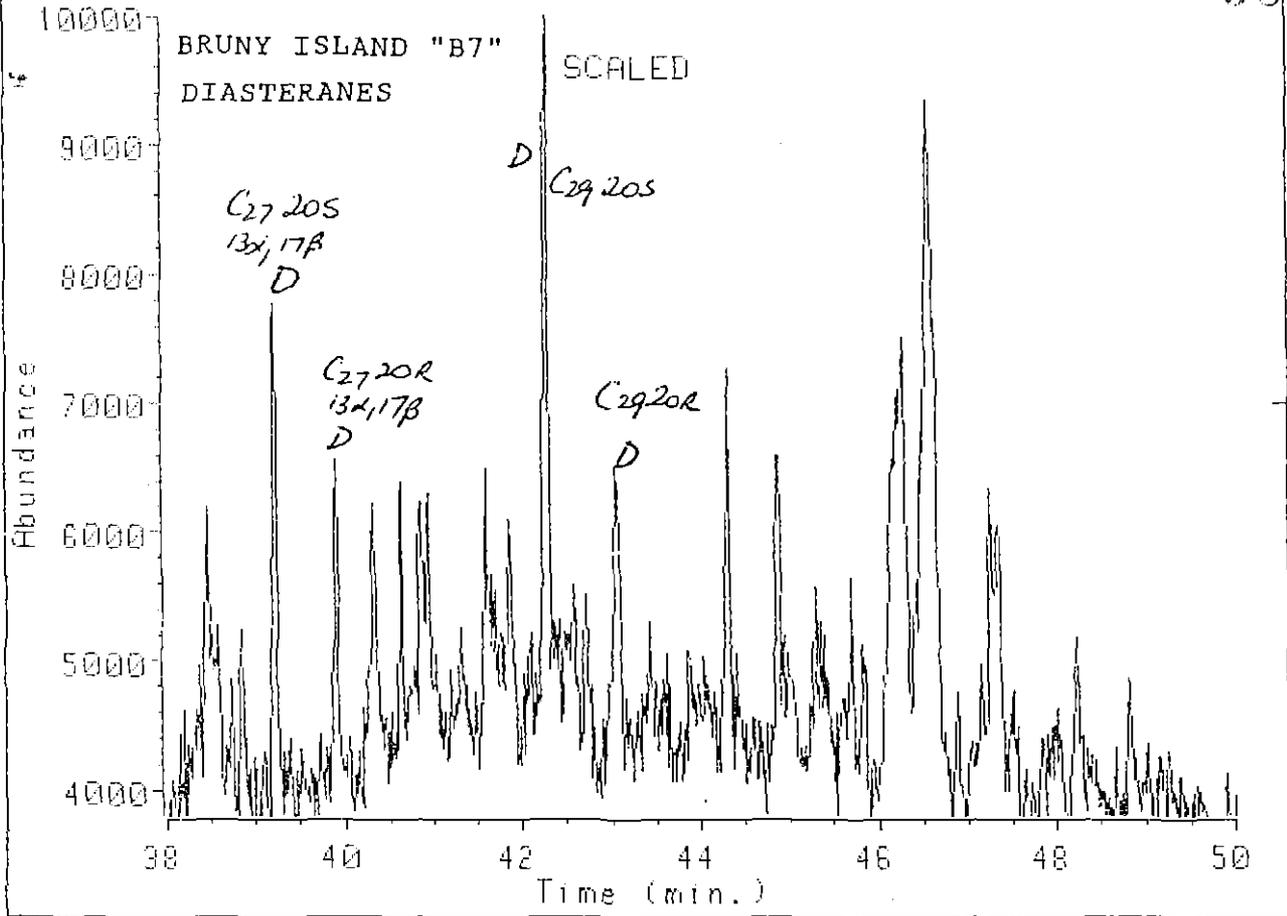


FIGURE 39. MASS FRAGMENTOGRAM FOR M/Z 259 (DIASTERANES) IN BRUNY ISLAND SAMPLE "B7".

5 cm

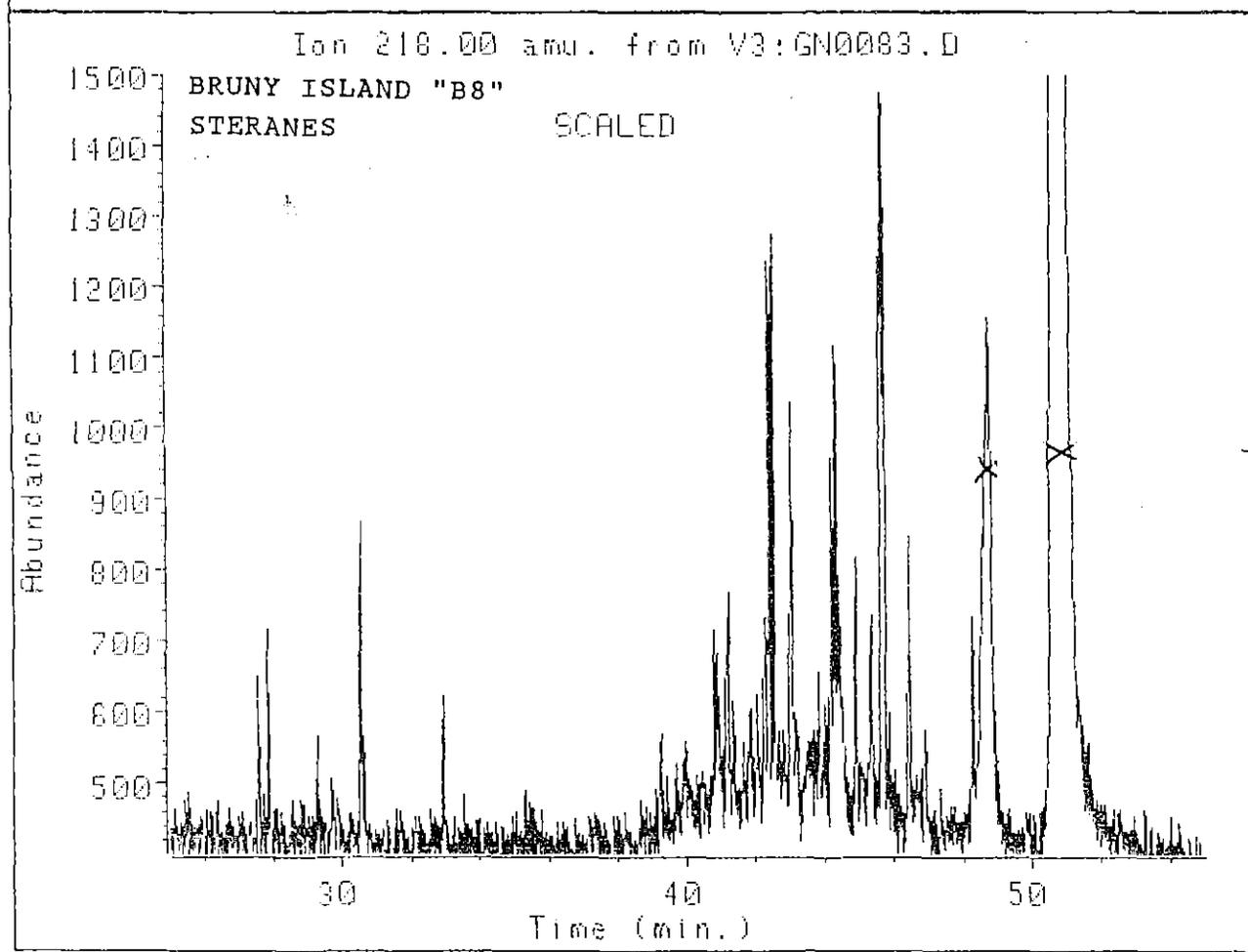
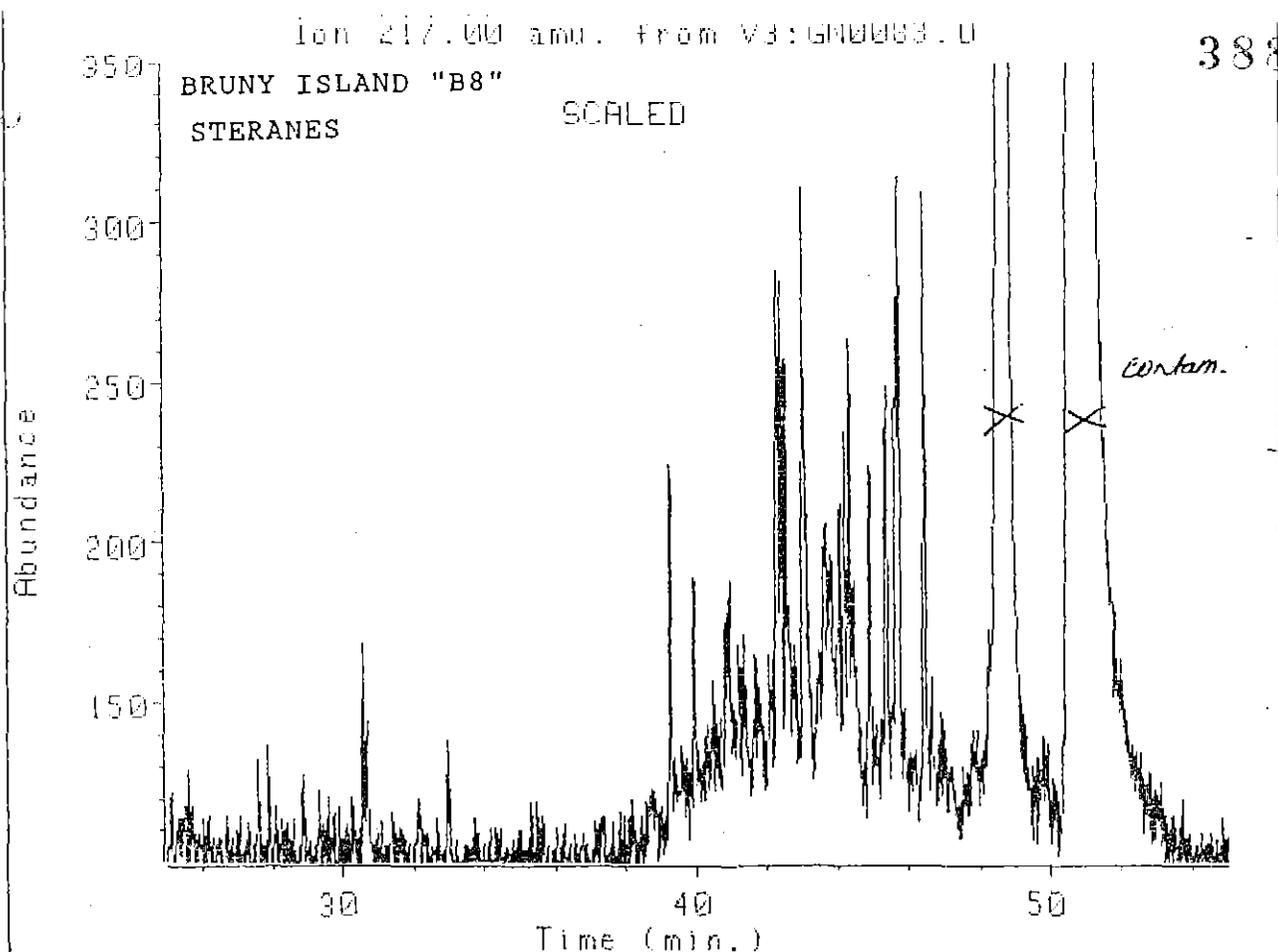
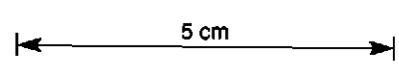


FIGURE 41. MASS FRAGMENTOGRAMS FOR M/Z 217 AND 218 (C<sub>20</sub> - C<sub>30</sub> STERANES) IN BRUNY ISLAND SAMPLE "B8".



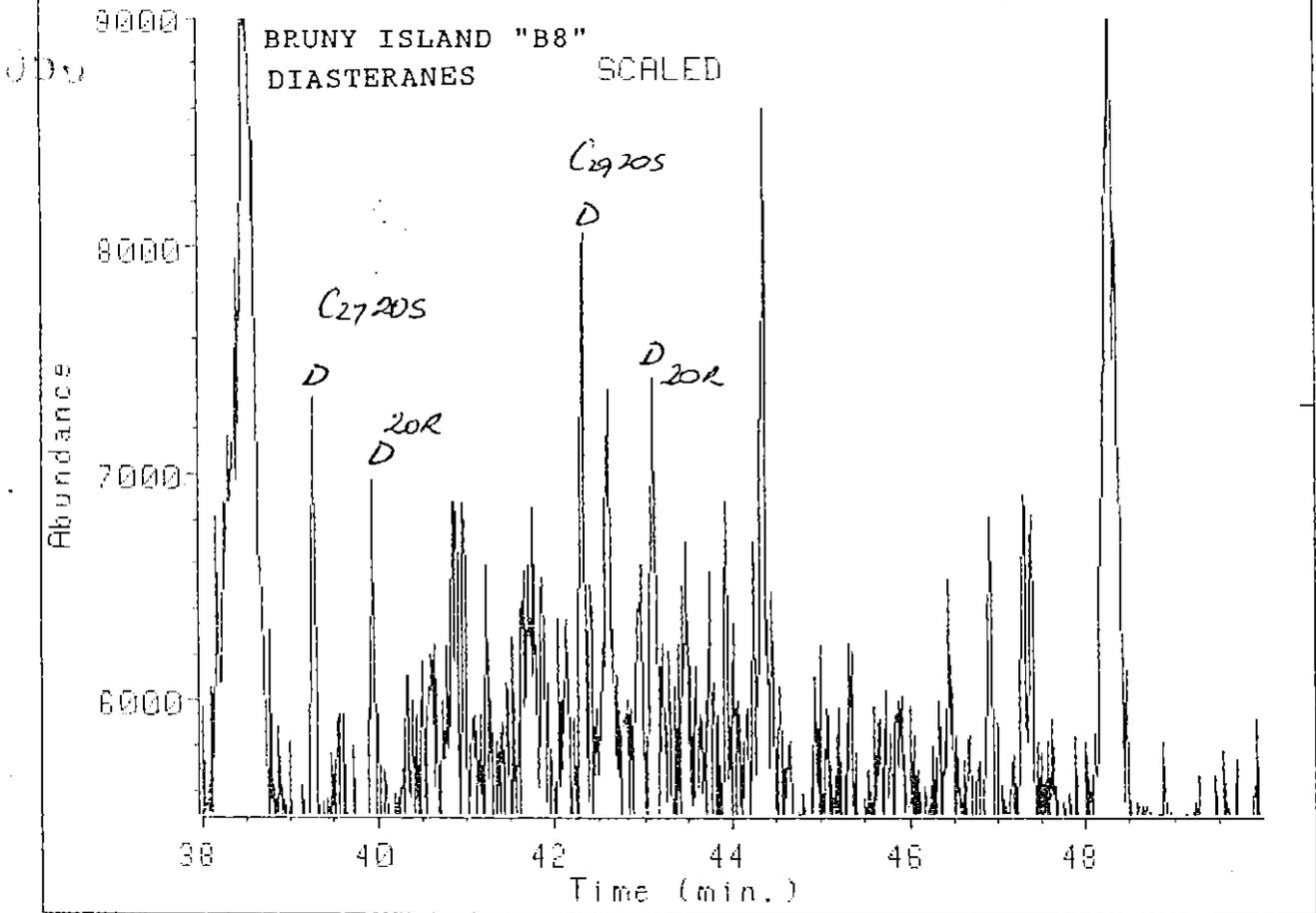
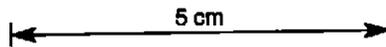


FIGURE 42. MASS FRAGMENTOGRAM FOR M/Z 259 (DIASTERANES) IN BRUNY ISLAND SAMPLE "B8".



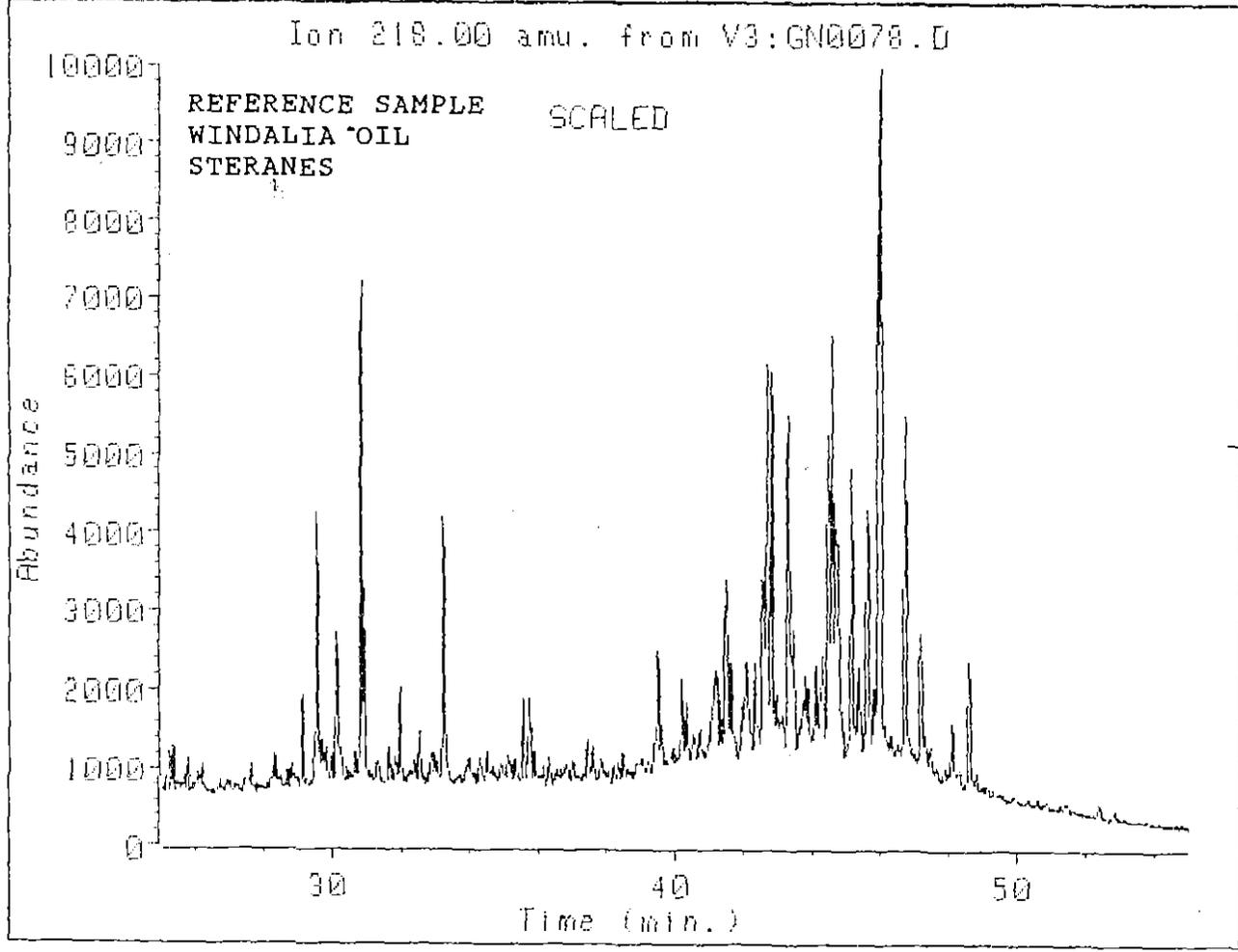
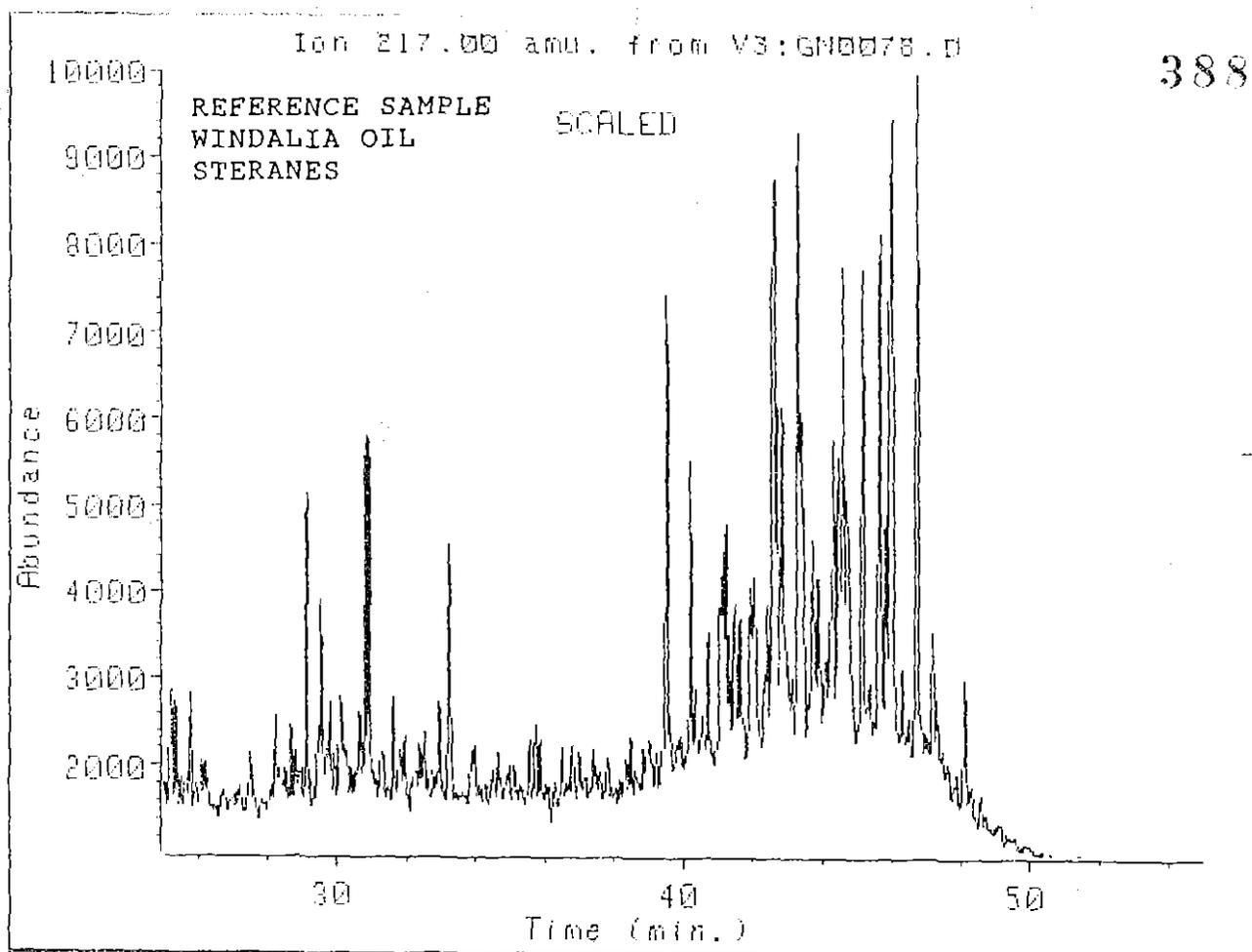
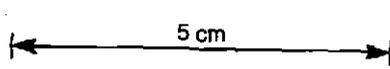


FIGURE 44. MASS FRAGMENTOGRAMS FOR M/Z 217 AND 218 (C<sub>20</sub> - C<sub>30</sub> STERANES) IN REFERENCE SAMPLE WINDALIA OIL.



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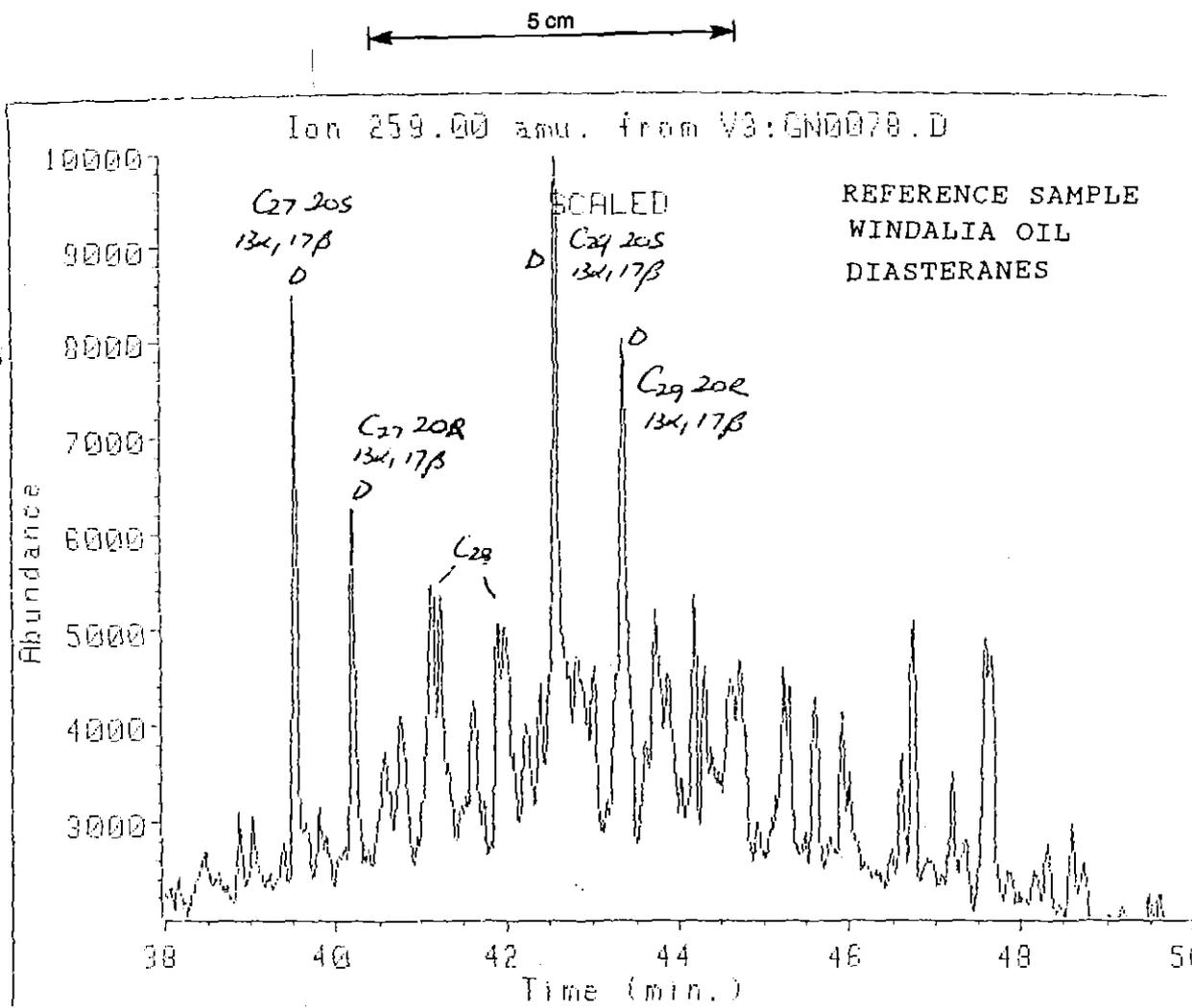


FIGURE 45. MASS FRAGMENTOGRAM FOR M/Z 259 (DIASTERANES) IN REFERENCE SAMPLE WINDALIA OIL.