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ANNUAL REPORT
CONGA OIL PTY LTD

LICENCE EL 1/88

by

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CONGA-8

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Report prepared for Conga Oil Pty Ltd
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INTRODUCTION

This is the fifth "annual" report submitted by Conga Oil Pty Ltd in respect of its petroleum exploration of onshore Tasmania. Information gleaned during this period, and especially during recent months, is now such as to require a fundamental re-appraisal of the basement geology and relationships as well as of hydrocarbon potential.
These implications have only become obvious during the past year and are summarised in this report.

It was noted in the last annual report that Conga's activity has established that the exploration is both viable and worthwhile to the general satisfaction of the industry - as suggested by interest in presentations for farm ins - even though Tasmania, as an oil-bearing province, remains a difficult Cinderella. This is now clearly beyond any doubt since presentations have been converted into negotiations.

Conga Oil has been restricted during the year by cash flow and management problems and the fact that the consolidation of previous licences planned for June 1989 was not effected until late in 1989.
As many projects as possible were continued through this difficult period in order to avoid loss of momentum but mostly this has meant data collection rather than assessment. The results of archival searches, seep location implications and improvement of data bases are such as to force, and allow, considerable acceleration of the programme.

This report describes those activities undertaken since May 1989. Many projects are incomplete and this outline summarises current status.

LICENCES

Held in the name of Conga Oil Pty Ltd, Southern Tasmania.

All are held for oil.

Conga Oil previously held a set of thirteen licences in SE Tasmania. These have been listed in previous annual reports. Following application for a large part of central Tasmania and negotiation of realistic fees and commitments based on national hydrocarbon rates these licences were first consolidated as 29/84 and then, upon granting of the midlands area, further consolidated to form EL 1/88. This final consolidation was to have taken place on June 10, 1989, and is deemed to have been done at this date, but the final granting was some five months later.

The extent of the consolidated licence (EL 1/88) is shown in Figure 1 of Appendix 2.

Following work undertaken during the year, as described in this report, and some consideration of the surprising implications of that work a further onshore application has been made. This covers the bulk of Tasmania west of EL 1/88. Why an area composed largely of Precambrian rocks should be of interest is explained below. There are also, clearly, similar implications for adjacent offshore areas.

Some other small changes have occurred in the licence area during the past year. These relate to coastal waterways deemed "internal". A previous annual report described the debate and problems related to these. All have now been included in the licence, where relevant - as in southern Tasmania. This means that a significant part of Storm Bay is now included in the licence area.

EXPLORATION HISTORY AND OBJECTIVES

OUTLINE:

The exploration programme outlined in the previous annual report has been severely disrupted due to administrative matters as explained in the Introduction to this report.

Four programmes were reported in progress at May 1989; seep search, infill of gravity data base, source rock analysis, seismic processing tests and evaluation. Several other programmes were proposed; regional stratigraphic/palaeontology compilation, regional interpretatioan of gravity and magnetic data and further onshore seismic trials.

Due to the combination of problems only those programmes in progress have been continued, at reduced level, throughout the year.

Work proposed was designed to
1 permit finer resolution of issues already defined in the area south of Hobart and perhaps provide for well targetting,
2 provide a regional understanding of the area north of Hobart which is commensurate with that now extant for the southern area,
3 pinpoint any seepage concentrations anywhere in the expanded licence in order to confirm petroleum geochemistry and perhaps suggest foci for detailed exploration.

The reduced on-going program has maintained these objectives in so far as was possible. Data is now available which would allow 1 and 2, but 3 has been completed with startling results.

Seepages and geochemistry:

Seepages had been reported from the Ross, Brighton, Kempton and Collinsvale areas - as well as several sites around the D'Entrecasteaux Channel area. Samples from the Brighton and Poatina occurrences have already been analysed (Last Annual Report). This work showed that the material was not similar to samples from the Bruny region and that there are several related paradoxes. It is possible that the curious organic balance may have been generated either by heating of Permian organic material (coal?) by dolerite or by an intense bushfire at the natural tar occurrence. This work posed many questions which can only be answered by careful sampling and analysis of all sites in the hope that a pattern might emerge.
Further analytical work in the D'Entrecasteaux region has also suggested that much of the marine data may be, at least partly;, contaminated by pollution. While the marine data may be suspect the results of onshore sites remain definitive in terms of

correlation with local limestone sources - namely Gordon Group.

It is clear, however, that much more research and a bigger family of results is required before any weight should be placed on geochemical exploration, especially since only trace quantities have been recovered from any site to date.

This position was transformed by an archival seep search as reported in Appendix 1. This search showed that there have been many sightings of tars and oil in the Tasmanian region over the past century but there has been a general refusal to take the observers seriously. Even if it is assumed that many of the sightings are false, enough must be real since some eminent scientists have been convinced at various times. The occurrences are also very systematic and occur in patterns which, in hindsight, can be correlated with lineaments identified in magnetic and gravity data. These associations imply a reality that should not be ignored. But it is the general statewide distribution of the materials that is significant. For example, just how is oil found exuding from granites on King Island or upon quartzites inland from Port Davey?

Many samples were collected and stored in museums. These have now been recovered and analysed (Appendix 3). The results show that the tars from such disparate sites as Flinders Island, King Island and Port Davey have similar sterane proportions, were derived from a heavy oil which is not over mature but which lacks some of the hopane markers noted in, apparently, Ordovician limestone source materials. The necessity for detailed source rock studies, from Precambrian to Devonian rocks, is essential.

Geophysics:

Gravity infill surveys have been completed in the central north and Derwent valley areas. This work was undertaken by the Geophysics Branch of the Mines Department with acquisition costs paid by Conga Oil. More than 2500 new stations have been observed. All data acquired has been accumulated into the TASGRAV data base after correction and checking.

The gravity and magnetic compilations have been scanned for trends and many large structures are evident. Preliminary results of this type have been noted in Appendix 2.

No interpretation has yet been undertaken of the new or augmented data sets.
No extended interpretation of the D'Entrecasteaux data set has been undertaken since May 1988.

Conductivity data from the northern Midlands has been collated and will be interpreted in association with the magnetics and gravity data recently acquired.

Marine seismic data acquired by the Bureau of Mineral Resources in April 1988 has been partly processed and inspected.

Processing has continued very slowly over the past year due to funding and time restrictions but various processing options are now being tested.

The most recent tests with this data have shown that energy from events deep within the section has been recorded and it is hoped that revisions of the velocity profile and stacking parameters may clarify these.
Current analysis is being undertaken by P. Hill of the BMR.

The seismic data will be presented as soon as an acceptable processing sequence has been developed and results become available.

Implications:

The broad distribution of established seepages across onshore Tasmania and the suggestion that most, if not all, are sourced from rocks older than Devonian in age suggests a much broader source rock distribution than might have been suspected by inspection of a surface geological map which displays large tracts of Precambrian rocks. Yet some of these have been weeping hydrocarbons!

The association of the regional geophysical trends with the seepage distribution as now known and the previously inferred relationship between sightings and seismic activity early this century also indicates that the surface geology is misleading.
For several years past I have argued, for example in many Mt Read Volcanic Project Reports commissioned by the Mines Department, that large areas have been detached and overthrust. I had suggested, in the most recent of these reports (Late Precambrian and Palaeozoic relationships, 1988), that only a small part of the Tyennan core and some of the Rocky Cape core were insitu. This had been argued on the basis of the gravity field and the location of Devonian granites which reflect crustal mobility.

The wide distribution of hydrocarbons indicates that the thrust stack, in true alpine style, also incorporates source rocks. Some are obviously concealed beneath King Island and Port Davey. And also Flinders Island.

The ramifications are far reaching.
Instead of targets lying between the folded basement and Permian unconformity seals many targets could lie beneath thrust seals. Some could lie up to 5 or 6 km deep. The structural assessment, seismic resolution and relinquishment problems are amplified. But the potential of the area is increased.
Hydrocarbons have been generated, and have been able to migrate. Target evaluation and rating will be crucial.

PROGRESS FROM MAY 1989 TO DATE:

1. An archival seepage search has been completed for all of Tasmania.

2. Tar samples collected early this century and stored in museums have been re-located and analysed. These have shown reasonably consistent results and imply some quite general, probably Lower Palaeozoic, source. The great spread of samples suggests that the nature of the source and structural development of the entire island are in need of urgent investigation.

3. Gordon Group limestones remain the crucial proven source and provide a chemical reference for seepages. Analysis of recovered tars suggests that some source separation is possible and an array of possible sources rocks from the Late Precambrian to Devonian need to be tested.

4. The aeromagnetic survey of central and northern Tasmania has been briefly reviewed for trend character but no detailed interpretation has been undertaken.

5. The state gravity data base has been infilled in the northern and western Midlands. There is scope for much more work.

6. Marine seismic data from the southern waterways is being reviewed and processed (BMR).

PROGRAMMES IN PROGRESS:

1. The seep search programme for location of all reported sites and sampling is continuing. If other sites can be confirmed and some patterns established between seepage sites and structural interpretations it is believed that problems of target priorities will be greatly eased.
   This programme will include both sea bed and land searches and complete analyses of recovered samples.

2. Seismic processing tests and evaluation. This work is currently concentrated upon marine data from the southern part of the area.

PROGRAMMES PROPOSED:

1. A regional stratigraphic and palaeontologic compilation to assist well sample identifications.

2. Extension of gravity infill coverage north of Hobart.

3. Regional interpretation of gravity and magnetic data in the area north of Hobart.

4. Detailed gravity and magnetic interpretation of areas of particular interest as determined by (3) or seepage concentrations. Detailed work to be undertaken anywhere within 1/88.

5. Public assisted seepage search. It is hoped that this might lead to reasonable sample volumes and confirmation of source and fluid signatures. Geochemical work to continue in association with the search.

6. Further onshore seismic trials. Since it is clear that any well programme may be limited or forced toward purely stratigraphic objectives in the absence of specific structural controls the problems related to seismic data acquisition must be resolved. Only the coupling of gravity-magnetic implications with seep concentration foci and local seismic survey will lead to viable targetting.

7. A large scale source rock study to identify the fundamental source of hydrocarbons.

8. Thermal maturity study to enable assessment of the implications of the diverse implications of the general maturity of the hydrocarbons recovered and the conodont alteration index.

SUMMARY OF EXPLORATION OBJECTIVES

Recent work has demonstrated that the region has petroleum potential and must be explored. The presence or Ordovician or other Lower Palaeozoic - sourced hydrocarbons means that the so - called Tasmania Basin can no longer be considered a post Permian backwater with no potential.

Issues to be further evaluated include:

SOURCES:
Detailed review of Upper Cambrian to Lower Silurian rocks to identify specific or multiple sources or sourcing members within the Gordon Group. Chemical work by Dr Volkman indicates that much work is required on source-seep chemistries. Current suggestions of multiple sources, local and abnormal sources or contamination must be evaluated.

ASSESS SCALE OF GENERATION OR MIGRATION:
This problem is partly related to the nature of the source. However, any distribution of seepages or source indications defined upon analysis of such seepages will be critical. It is hoped that these indicators might be tied to inferred lithological or structural distribution as suggested from the geophysical or pyroclastic studies.
Although present work is incomplete there appears to be considerable spread in potential seepage sites. This is most encouraging but the distribution indicates that the source units may be repeated in an alpine thrustal stack.

PLAY DEFINITION:
Preliminary work to date suggests the possible presence of fold closures, rejuvenated troughs, unconformity seals, shelf deposition, rift margin rise shoulders and dolerite traps. Each of these feature styles will need to be defined, rated and drilled. Rating will be affected by inferred rock distributions and migration considerations and seismic data is likely to be essential to such appraisals. The economics and practicability of seismic methods has been established (although resolution must be further improved) in this environment but the high cost (approx $7000/km) will mean limited coverage and that traverses must be specifically located on other indicators (chemistry, seepages and gravity/magnetics).
The simpler trap styles listed above may not warrant the principal effort. The concept of a thrustal stack increases the target options and exploration problems while offering the possibility for some larger plays. All styles must be reviewed.

OVERALL:
To evaluate the region in such a way as to rationally assess its potential for Conga's purposes or to aid future explorers.

EXPENDITURE SUMMARY

The table below summarises expenditure for the past year.

Geology (regional appraisals, seep search, feeder location, consultants, etc)	$ 500
Geochemistry (analyses)	29850
Geophysics (regional study, data acquisition interpretation in progress)	163736
Drilling	18111
Administrative overheads (licence fees, accounting, management)	20771
Other (Drilling engineering, consultants, maps sundries, surveying etc,staff labour	70359
Total:	303327

The figures, and categorisation, quoted are as supplied to me by the financial manager of Conga Oil. A complete beakdown is available from the company ledgers.

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Report submitted on behalf of
Leaman Geophysics
by

D. Leaman

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May 5, 1990

APPENDIX 1

PETROLEUM

IN

TASMANIA.

M.R. BENDALL

January, 1990.

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CHAPTER 1.

It is now 115 years since the first sign of petroleum was recorded on-shore in Tasmania. Since then, 107 reported indications of petroleum, 127 exploration licences, and the sinking of 35 drill holes mark the oil exploration history of Tasmania.

It is remarkable that the only Paper to seriously look at the possibility of oil On-shore Tasmania ("The Search for Petroleum in Tasmania; W.H. Twelvetrees, 1917") is now 73 years old and still remains the most current Tasmanian Mines Department circular on the subject.

It is ironic that the first prospecting Syndicate recorded searching for oil on-shore Tasmania in 1915 not only identified the Ordovician limestone as the source of the shows of oil and tar at New River Lagoon but correctly correlated the rocks with the Trenton series of the Texas Pan-Handle, famous at that time for oil gushes, putting the rocks in the upper Ordovician (not Silurian as the Mines Department Geologists insisted, and not totally unsuitable for the generation of hydrocarbons as they also insisted), which was proved correct by Conga Oil Pty.Ltd., 1986.

If those original prospectors had been given a fair hearing, the whole history of oil exploration in Tasmania would have been changed. Apparently separate areas of seeps would have been recognised as having a common denominator, Ordovician limestone outcropping or at depth near the shows, this Paper would be recording the sunset not sunrise of oil field development in the State.

A fascinating history of false preconceptions, plain ignorance and meddlesone belligerance unfolds when observing the lack of scientific integrity with political and financial sabotage, which inevitably assaulted any honest attempt to develop the petroleum resources of the State, both by State Mines Ministers, Directors and Federal Members. Although history best forgotten for the sake of a brighter future, it must, however, be recorded to understand how oil exploration in Tasmania has been retarded.

Since everybody had forgotten the existence of oil exploration in the State, a six month archive search was undertaken.
This slowly brought to the surface the following players:

The Asphaltum Glance and Oil Syndicate	1915
The Bruni Island Oil Company	1916
The Tasman Oil Company	1921
The Mersey Valley Oil Company	1922
The Adelaide Oil Exploration Company	1922
The Tasmanian Oil Company	1929
The Austral Oil Drilling Syndicate	1936
Producers Oilwell Supplies	1939
Nudec Pty.Ltd.	1965
E.Z. Company Pty. Ltd.	1965
B.H.P. Ltd	1980
Conga Oil Pty.Ltd.	1984

The most recent drill hole was over 20 years ago and was drilled by Charlie Sulzberger's Company, Nudec Pty.Ltd.
An estimated 10 million dollars, in todays terms, was spent.
They found a gas show and two oil shows out of thirty five wells.
However, they were beaten by the knowledge they did not hold; that the source of the shows was not Tertiary, Cretaceous or Permian. The source is from a deeper, mature sequence which with pressure and temperature has moved into the oil window and lies with Primary, Secondary and Tertiary porosity below the younger capping rocks. This rock is Ordovician limestone.
Modern geophysics commended by Dr. David Leaman have betrayed the positions of these buried limestones. Fingerprints of tars in them, through modern G.C.M.S. techniques (J. Volkman, C.S.I.R.O.) have revealed seeps in the younger capping rocks as having an

Ordovician origin. Hence, old seep patterns are easily explained and alignments of seep occurrences understood.

Other patterns which evolved in the seep search revealed that the North-West seeps, including those on King Island are associated with the Pre-Cambrian dolomites and limestones. These rocks therefore present a target for serious oil exploration in Tasmania.

The structural nature and porosity of both the Pre-Cambrian and Ordovician limestones, with fold patterns two kilometres apart, make structural drilling into the top of anti-clines a realistic possibility, greatly increasing the chances of success.

The occurrences related to seeps, licences and drill holes, have been listed in time order (Appendix, 1) and demonstrate the extent of oil exploration in the past.

CHAPTER 2.

Groupings of occurrences are listed from South to North.

1. SOUTH COAST OCCURRENCES

The Asphaltum Glance Oil Syndicates oil leases were inspected by W.H. Twelvetrees in 1915 and reported under the title "Reconnaissance of Country between Recherche Bay and New River, Southern Tasmania". The Syndicate pointed to oozing tars in New River, tars in the Lagoon, Prion Beach, and oil scums off shore as strong indications that the Ordovician limestone was the source and also reservoir of the shows. They also correctly pointed to the Trenton limestone in America (Ordovician) and the Devonian limestone of Canada as prolific producers of oil and gas. They correlated the Gordon limestone of New River and the Devonian limestone (Dr. Clive Burrett, pers. comm.) of Rocky Boat Harbour correctly to those Northern Hemisphere rocks.

Twelvetrees insisted the limestone was of Silurian age and states incorrectly that "signs of bitumen or oil have never been detected".

He goes on to state, "In any case there is no reason for regarding the New River limestone as having any bearing on the question of the derivation of the pieces of asphaltum picked up off the New River Beach". He made this statement after accounting the oozing tars of New River to deep pockets of Tertiary within the Gordon limestone. A factually incorrect statement.

He did however determine that the specific gravities of the tars, as listed below, were remarkably similar as were their physical characteristics.

Upstream Gordon limestone	Asphaltum from Port Davey	1.0349
On Gordon limestone	Asphaltum from Rocky Boat Harbour	1.0429
On Gordon limestone	Asphaltum from Surprise River Beach	1.0426
On Gordon limestone	Asphaltum from North of Point Hibbs	1.0459

W.F. Ward, Government Analyst, states that "The Tasmanian Asphaltum as ranging from 1.0313 to 1.0459 (the S.C. of salt water is 1.03").

The most confounding of the tar's physical properties is that they all sink in salt water, a point that will be discussed later.

The Syndicate also held a lease for oil at Recherche Bay. The D'Entrecasteaux River catchment is mainly Gordon limestone, which has tars and has also been reported oozing oil, and is the main stream into Recherche Bay.

A kerosene stone reported at Southport, may be related to the Gordon limestone hydrocarbons, laying beneath the Permian, both there and Recherche Bay.

Leases taken out in 1915 around the Eastern mouth of the Davey River, at Deep Creek, are very interesting as a ½ tonne sample was taken to Hobart of Asphaltum which was heavier than salt water. The leases were on Pre-Cambrian rocks, Gordon limestone, however, outcrops upstream in the Davey River.
Another occurrence on the Pre-Cambrian is at Louisa Bay and on Triassic at South Cape Bay.

2. WEST COAST OCCURRENCES:

Tars at the mouth of the Mainwaring River are on Cambrian Rock, Ordovician rocks occur upstream and probably off shore.
The Devonian limestone of Point Hibbs, if similar to that of Rocky Boat Harbour, will at depth be unconformably in contact with the Gordon limestone, probably explaining the tars in that vicinity.
A recent drill hole at Point Hibbs went through the over thrust Pre-Cambrian into Cambrian, then into the Gordon limestone, perhaps explaining the tars in that vicinity.

The tars most extensively reported on the West Coast are those on Ocean Beach. In 1923, the Mersey Valley Oil Company and a Mr. H.E. Evenden pegged leases covering the area from the Strahan Township over to Ocean Beach and North towards the Henty River.

In 1942, Mr. W. Holmes, Manager of the Union Steamship Company, reported a stretch of water 4 miles long, suddenly becoming discoloured. This was just off Ocean Beach approximately due west of Strahan.
After a subsequent storm a large amount of tar was collected by the Coast Guard. In this same position 8 years later, over a period of two years, a school teacher, Mr. H. Fletcher, described oil seepages on Ocean Beach (irridescent films) and on the banks of a

Creek inland. He also describes a black patch just off the shore and tar being burnt in fires after storms.
Mr. Fletcher also made sightings in dune lakes north of the Henty River. The Henty River itself has also been reported as seeping gas, and tars can be found in the Gordon limestone south of Zeehan.
The historical evidence seems to indicate the tars originate from the strata at Ocean Beach and inland, not from off shore sources far removed. The possibility of an Ordovician source is highly likely since a thick Ordovician to Devonian sequence is exposed north and east of Strahan.

Tars within Macquarie Harbour, reported near Farm Cove (distinguished from fossil resins) caused an extensive search by a Sydney explorer in 1895 for a source but, none was found. Recently tars were located in the headwaters in the King River in Gordon limestone which had thermal maturity within the oil window. Sediment samples of the King River delta taken by C.S.I.R.O. revealed hydro carbons, but the source has not been determined.

3. D'ENTRECASTREAUX CHANNEL OCCURRENCES - SOUTH EAST TASMANIA

Six Companies concentrated their efforts in this district, in 1916; the Bruni Island Oil Company, in 1929, the Tasmanian Oil Company, in 1939, Producers Oilwell Supplies Pty.Ltd, in 1965, E.Z. Company, in 1980, B.H.P., in 1984, Conga Oil Pty.Ltd.

(a) DOVER AREA

Oil and gas was reported in shallow sea water by separate observers somewhere near Dover in 1933 and 1957.

(b) CYGNET AREA

Cygnet's first reported seep was in 1876 followed by two sightings in 1939 on opposite sides of the Permian Cygnet Dome structure, prompting a public meeting by Producers Oilwell Supplies, and another one in 1953. Nebulous reports of seeps at Crabtree, 20 km North of Cygnet occurred around 1960.

(c) <u>BRUNY ISLAND AREA</u>

This area consists mainly of Parmeener Supergroup sediments with Jurassic dolerite intrusions. The onshore seeps consist of tars, oils and gas mainly escaping through active Jurassic trends. The basement is probably mainly Pre-Cambrian with some remnant Ordovician sections, the edge of the main Cambrian trough being some 10 kilometres to the west of the Island itself. The source of the seeps is thought to be from Gordon limestone within this trough, certainly the seeps are sourced from mature Gordon limestone. (Analyses, Dr. J. Volkman)

In 1916, with a capital of 50,000 pounds, the Bruni Island Oil Company put down 7 shallow holes on the basis of 2 seeps of exuding tars cited in their prospectus. The deepest of their holes was 450 feet, totally inadequate for their target which is from an Ordovician source below the Parmeener rocks. After this failed attempt, the next try was by the Tasmanian Oil Company in 1929, drilling this time 3 holes on a confirmed show of oil and gas (McIntosh Reid, 1929) at the bottom of a well. Shows of oil were collected in bottles from the hole. A vague American petrol company connection and talk of a pay off were recollected to Parliament some years later by the local Police Sergeant, The promoter disappeared to America, never to return ! A son of one of the workers recalls bottles of oil filled from the hole until they ran out of containers.

Numerous leases have been held on Bruny Island, from Adventure Bay to Great Bay, exclusive to the middle third of the Island, on various seepages up until the present day. Various samples of marine sediment in the D'Entrecastreaux Channel collected by the C.S.I.R.O. and terrestrial samples on Bruny Island collected by Conga Oil Pty.Ltd. and analysed by the C.S.I.R.O. have shown Ordovician hydrocarbon signatures.

4. TAMAR LINEAMENT OCCURRENCES

Although the precise location of the lineament may be a point of discussion, there is a line of seeps reported along a corridor between Hobart and Launceston which will be recorded under this heading. In 1940 a seep of oil was reported in an army well at Fort Direction, South Arm, and 1 km North, in 1988 seeps were reported as having occurred over a period of at least 40 years on Spring Beach. Some 10 kilometres to the east in the lagoon behind Clifton Beach, a Mines Department seismic spread (1977) indicated an extensive sequence of reflections below the Permian cover which may possibly indicate a section of Palaeozoic rocks including limestone.

Seeps of light oil have been reported at Colebrook, Cambridge, Tunnack and Jericho. Reports of tars from Brighton and Dysart in recent times may indicate the reason for an exploration licence for oil taken out at Elderslie by S. Chapman, in 1919.

The salt Lakes at Mona Vale are particularly interesting as these are constantly replenishing. Salt Lakes have a sub-terranean source of brine and display a strong 12 kilometre N.W. - S.E. Lineament. At the north end of this Lineament are the gas shows reported at "Rose Neath", Ross, (1939) and 1 kilometre to the west is a reported show of oil in a water bore (1984, G. & G. Gleason).

A line of oozings from Newstead through Relbia to Evandale,

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was reported by W.H. Twelvetrees, 1917, and recent geophysical interpretation implies an Ordovician section below these seeps. A continuation of this trend North of Launceston extends to the site of the 1939 Producers Oilwell Supplies drill rig at Danbury Park. West of this hole at Bridgenorth (1962), oil was reported seeping from Permian rocks and at Rosevale (1921) from Tertiary rocks. The most northern seep recorded in this lineament is from a mine geologist at Beaconsfield. He reported seeps coming into the Mine water, presumably directly out of the Flowery Gully limestone (Gordon limestone)

5. THE DERWENT LINEAMENT OCCURRENCES THE WESTERN EDGE OF THE TASMANIAN BASIN

The reports start at Glenlusk, of oil noticed recently, then in the 1910 Annual Report to the Director of Mines, a bituminous exudation was reported on the banks of the Derwent River on Kenmore Estate, Macquarie Plains. Then 20 kms upstream, on the western bank, Mr. W.C. Inglis reported seeps of oil on his property in 1958. At "Lawrenny" on the eastern bank of the Derwent in 1920, a drill hole for oil was put down 520 feet but was abandoned at that depth after the rods "stuck". A Mr. G.C. Harris reported gas at Tarraleah in 1946 and is the last reported show before the unbroken line of oil leases between Lake St. Clair and Cradle Mountain taken up in 1921 "oil rush".

There is much confusion over the cause of the 1921 "oil rush", mainly because there was coal in the district which contained petroliferous layers of thin turbidites interbedded with it - indicative of varying lake levels. These occur in the Mersey Coal Measures and are also the equivalent of the Preolenna Oil Shales. I feel that the tars exhumed from the glacial

Moraines of the field and the Preolenna oil shales of the district in fact had no connection. Two quotes should clear up the matter, one a report on field operations from the Tasman Oil Company, the other, the report of a private Sydney Analyst (Mr. W.A. Dixon, F.I.C. F.C.S.)

(1) Report from the field of Operations, 1921.

On the 28th May, Mr. A.C. Black, Field Manager of the Tasman Oil Company, wired from Sheffield, Tasmania, to his Principals in Melbourne, as follows:-

> "Now in a position report absolutely, facts can be produced from data collected recent developments that oil exists at Barn Bluff".

In view of the fact that his consulting geologist had just returned from a visit to this region, the Secretary of the Melbourne Company wired to him asking for his opinion regarding Mr. Black's statement and to which he promptly replied:

> "I have no hesitation in confirming Black's statement that oil exists at Barn Bluff, gas and oil seepages being plainly manifest during my recent inspection there. Also the geological features of the field generally indicate that large quantities of oil have unquestionably been produced by natural process of distillation and may be confidently sought for in the Anti-clines."

(11) Report of Mr. W.A. Dixon, F.I.C. F.C.S., Sydney, 1893.

On distillation, pelionite (from glacial Moraines) yeilds hydrocarbons of the aromatic series (benzene, naphalene etc.) and not as are contained in the Preolenna kerosene shale those of the aliphatic series (olefines, paraffines etc.)

It is therefore plain upon present knowledge that the Preolenna

Kerosene Shale equivalent unit does outcrop in the Larn Bluff area but is waxy and immature, not able to account for gas shows in the area and not the same elemental composition as the "fossil tars" present in the glacial Moraine.

6. THE NORTHERN END OF THE TASMANIAN BASIN

(a) Seeps in Ordovician Outcrop.

One of the first recorded tars is described as occurring at Chudleigh in Pettards, 1896 "Catalogue of Tasmanian Minerals". He describes it as occurring about 4 miles from Chudleigh on the eastern bank of the Mersey River. It is perfectly black, sectile and burns with a dense smoke and strong odour. It occurs in drab coloured aluminous shale of Ordovician age.

In 1956, at Mole Creek, seven kilometres to the west, on the Cordon limestone, a well was reported to have seeps of oil. The other occurrence was from a small outcrop of Cordon limestone directly under the capping Parmeener Super group in Muddy Creek, Golden Valley, which was reported emitting flammable gas in 1932.

(b) The Cressy Graben Occurrences.

This structure is the most drilled for oil of any in Tasmania with 20 holes sunk in 1922-23, between the Mersey Valley Oil Company and the Adelaide Oil Exploration Company. Three more bores were sunk by C. Sulzberger, between 1966 and 1968. The original Companies were greatly encouraged by increased rates of seepage following an earthquake in 1922. The Adelaide Oil Exploration Company Field Manager reported increasing shows of oil near Devonport and reported sighting oil field luminosity at one site. Drill hole no. 8, of the Adelaide Oil Exploration Company at Port Sorell, is reported by A. McIntosh Reid, 10:9.1923, (a Government geologist) as penetrating a bed of natural gas under enormous compression causing an outbreak closing the hole, accompanied by a strong smell of gas. In the same report he sites numerous seeps of oil and gas escaping from both permian and Tertiary strata which he has confirmed in the Latrobe - Sassafras district.

A sample of mature oil was obtained by Conga Oil Pty.Ltd. from basal Permian rock at Poatina, it has neither a Permian Tasmanites nor Ordovician carbonate signature. It is connected with a Pre-Permian shale source possibly the Bell Shale from the G.C.M.S. configuration and its present occurrence was probably facilitated by fault movement of the south-west edge of the Cressy Graben.

(c) Occurrences along the Mount Read Volcanic Belt.

Oil on the west bank of Ray Creek at Nook was reported by McIntosh Reid (1923), and at Stoodley in 1930. Two separate sightings of oil and gas (1920 & 1966) escaping from the bedrock of the Forth River about 2 km inland from the mouth have been reported - in 1920 and 1966. In 1966, Mr. C. Flowers of Ulverstone, described a tar exuding from a stretched pebble conglomerate (Pre-Cambrian) providing a sample and photographs to the Department of Mines who did not bother to investigate the occurrence. Mr. J. Bates of Penguin, reported oil seeping at his property there in 1968 and a Mr. L.F. Egan reported a similar occurrence at Burnie in 1962.

(d) Permian Basin Occurrences Between Cam & Flowerdale Rivers.

There are ten different occurrences reported in this area, the first in 1915, was that of tar on the beach at Wynyard. Shows of oil have been reported since in that area at Table Cape (1963), Fossil Bluff (1965), Flowerdale (1925) and Distillery Creek (1962). Three licences to search for oil were issued in the Inglis River which is also on the Western side of the basin. In 1956, Mr. E.A. Farquhar reported oil seeps in the centre of the basin at West Takone, and in 1921, Mr. N.J. Richardson reported oil seeping at his property at Cam Road, Somerset, which is on the western edge of the basin.

7. OCCURRENCES RELATED TO UNMETAMORPHOSED PRE-CAMBRIAN DOLOMITES AND LIMESTONES OF N.W. TASMANIA.

(a) Mainland.

In 1921, a licence to search for oil was issued to F.W. Heritage on Pre-Cambrian rocks between the Interview and Lagoon Rivers. As far back as 1876, Mr. T.B. Moore, reported numerous tars on the beaches both north and south of Sandy Cape. Only Pre-Cambrian rocks, including some carbonates, occur on the rivers flowing to these beaches. At Green Point, (1962) and Redpa (1948) oil shows occurred in the Pre-Cambrian limestones and at Mt. Cameron in 1925, tar was reported seeping from the limestone. Constant reports of seeps at Mengha from 1930 are also near Pre-Cambrian limestone (dolomite).

(b) King Island.

In 1915, W.H. Twelvetrees reported on tars occurring at King Island on the beach presuming them to have been washed there. However, the Pre-Cambrian Granites on the foreshore contain a surprise - seeping Petroleum in the fractures which yields oozing tars at the surface. This phenomenon was confirmed by the Department of National Development when Mr. S.P.J. Adams took samples to Canberra in 1960 after failing to get a hearing by the Tasmanian Department of Mines. He held two licences to search for oil in 1960, one in his own name and one in his wife's name. Earlier in 1955 a Mrs. A.J. Smith held a licence to search and also offered to show the Mines Department the oozing tars. She stated her son would blast the rock to prove they were oozing and also sited seeps of tar inland up the Pass River but failed to stir any activity. In that same period a licence to search for oil was issued to a Mr. W.K. Westley, in 1960. There are no records of what occurrences prompted his application.

The Pre-Cambrian granites of the King Island West Coast had a metamorphic effect on the Pre-Cambrian sediments up to about 8 kilometres east from the contact. Pockets of metamorphosed rocks further away probably indicate the granite under lies there at shallow depth. The gentle folding of the Pre-Cambrian rocks would be favourable to the accumulation of any thermally degraded organic material.

8. NORTH EAST TASMANIA

(a) Flinders Island.

The "Oil rush" of 1936 was led by the Austral Oil Drilling Syndicate who cited abundant limestone and glauconite of Cape Barren and Flinders Island as excellent indicators of oil. Large

Lagoons burned for years when ignited after being drained, the corky substance yeilded 85 gallons per tonne of oil. Similar material was reported near Smithton and is thought to be derived by algal activity. The material should be re-analysed with modern C.C.M.S. techniques to check its composition and maturity.

(b) Bridport

Mr. A.H. Thorpe was very insistent that oil was seeping to the surface in Muddy Creek, Bridport. He took up a licence to search but no concrete evidence was ever found to support his claim.

CHAPTER 3.

SUMMARY AND CONCLUSION

It is clear Tasmania does contain onshore petroleum reservoirs and despite the weight of evidence piled up before polititians and bureaucrats in the past, the State has pursued an economically suicidal path which currently sees millions of dollars of oil burnt at Bell Bay per week to our detriment, not benefit. We are now paying for the narrow minded, unscientific backwater psychology of the endless list of bureaucratic opponents to oil exploration. Every attempt by more educated, cosmopolitan thinkers to locate these reservoirs and determine their worth has been swiftly met with malicious delays, lies and betrayals leading to the explorers spending exploration funds on legal fees to trap the cowardly bureaucrats (behind the skirt of the Solicitor General of the day). This pathetic history would be funny if it had not cost Tasmania so much and those unfortunate enough to have invested money in ventures then actively discouraged by the Government and its Agents. Such a past is unbelievable but it recurred in the present day. Indeed, Conga Oil Pty.Ltd. is the only oil explorer (to date) in Tasmanian history NOT to sue some government Minister or Agency. I might add it wasn't for lack of suitably qualified subject matter, but more an eye on the ball tactic executed with remarkable restraint! It was a peculiar history, with Federal Agents empowered to give exploration incentives and State Agencies resisting any development since Tasmania was settled.

ACOSCE

Since appointment as Acting Director of the Department of Mines (1989) Rod Hargreaves has been actively assisting the program. He has made old files available and provided gravity infill through Dr. Robert Richardson and help in geochemical finger printing through Peter Baillie who is taking an active interest in the program.

The geological evidence then in conclusion is as follows:

1. The Ordovician Gordon limestone and the Devonian limestone are within the oil window. (Conga - Burrett - C.S.I.R.O. research)

2. Tars reported around the State do not float and are indicative of heavy crudes, their source cannot be very far from their occurrences and most probably is the Gordon limestone.

3. Seeps seem to show definite groupings and lineaments and display hydrocarbon signatures consistant with Gordon limestone source.

4. The "oil rushes" of Mt. Pelion, Cressy Graben, Bruny Island, New River Lagoon and Port Davey all seem to be connected to the Gordon limestone.

5. Gas, oil and tars have been recorded coming from the Gordon limestone and can still be collected today. Tests by Amdel, Analabs and C.S.I.R.O. all confirm this.

The original prospectors of New River (1915) deduced the importance of the oil seeps and tars, identified the Gordon limestone source and correlated it to similar prolific oil producing limestones in the United States. The discovery of oil and gas in limestones of Ordovician age on mainland Australia, mainly the Amadeus Basin which supplies Darwin's natural gas, points to the increased validity of the play concept. Current evidence and historical data can lead to no other conclusion than THE LACK OF EXPLORATION WORK FOR OIL AND GAS DOES NOT REFLECT UPON THE PROSPECTIVITY OF THE FIELD nor lack of indications of petroleum, but an apathy and disinterest based on ignorance up until the present day. This Paper attempts to explain the past views and hence with the light of current knowledge indicate the exciting future ahead.

APPENDIX 1.

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CHRONOLOGICAL LIST OF OIL SEEPS, LICENCES AND DRILL HOLES

Date	Place	Occurrence	Name
1871	Prime Seal Is.	Tar	Mr. Chas. Gould
1876	Sandy Cape	Tar	T.B. Moore
1876	Mainwaring River	Tar	T.B. Moore
1876	Point Hibbs	Tar	T.B. Moore
1876	Farm Cove	Tar	T.B. Moore
1876	Cygnet	Oil	Robert Taylor
1889	Ross	Salt	Mr. Earwick
1893	Barn Bluff	Oil	A. Montgomery
1895	Port Davey	Tar	P. Hutchings
1896	Chudleigh	Tar	M. Pettard
1895	Macquarie Harbour	Tar	Sydney Explorer
1910	Deep Crk, Port Davey	Tar	Twelvetrees
1910	Hamilton (River Bank)	Tar	Twelvetrees
1915	Nth. Bruny Island	Tar	Bruni Is. Oil Company
1915	New River	Lease	The Asphaltum Glance & Oil Syndicate
1915	Davey River	Tar	W.H. Twelvetrees
1915	New River	Lease	The Asphaltum Glance & Oil Syndicate.
1915	New River	Tar, Oil	The Asphaltum Glance & Oil Syndicate
1915	New River	Lease	" " "
1915	Three Hummock Is.	Tar	W.H. Twelvetrees
1915	Cape Barren Is.	Tar	W.H. Twelvetrees
1915	Wynyard Beach	Tar	W.H. Twelvetrees
1915	King Island	Tar	W.H. Twelvetrees
1915	Point Hibbs	Tar	W.H. Twelvetrees
1915	Louisa Bay	Tar	W.H. Twelvetrees
1915	New River	Tar	W.H. Twelvetrees
1915	Rocky Boat Harbour	Tar	W.H. Twelvetrees
1915	Surprise River Beach	Tar	W.H. Twelvetrees
1915	South Cape Bay	Tar	W.H. Twelvetrees
1915	New River	Tar	W.H. Twelvetrees
1915	Recherche Bay	Oil	The Asphaltum Glance & Oil Syndicate
1916	North Bruny Is.	Drill Holes 1-7.	Bruni Is. Oil Company

Date	Place	Occurrence	Name
1916	Nth. Bruny Is.	Tar	Bruni Is. Oil Company
1917	Southport	Tar, oil	Twelvetrees
1917	Arthur River	Tar	Twelvetrees
1917	Newstead	oil	Twelvetrees
1917	Relbia - Evandale	Oil	Twelvetrees
1917	Longford	Oil	Twelvetrees
1918	Zeehan	Tar	Fredrick Chapman
1918	Nth. Bruny Is.	L.S.	W.H.T. Brown
1918	Nth Bruny Is.	L.S.	R.J.P. Davey
1919	Barn Bluff	Tar	A. McIntoch Reid
1919	Elderslie	L.S.	S. Chapman
1920	Spring Bay	Oil	Mr. Fieldler
1920	Hamilton 'Lawrenny'.	Drill 1	C.A. Brock
1920	Sth. Bruny Is.	L.S.	V.A. Chipman
1920	Sth. Bruny Is.	L.S.	C.C. Brown
1920	Davey River	L.S.	M.J. Donellan, C.Smith & J. Jones.
1920	Forth River	Oil	E. Eastall, C.Richardson & A. Stocks.
1920	Barn Bluff	L.S.	C.C. Manton & A.C.Black
1920	Barn Bluff	L.S.	A.C.D. Bernaceli
1920	Barn Bluff	L.S.	P. Evans
1920	Cradle Mountain	L.S.	The Granville Prospecting & Mining Co.
1920	Mt. Olympus	L.S.	L.C. Thompson
1920	Narcissus River	L.S.	L.M. Stackhouse
1920	Sth. Bruny Is.	L.S.	S. Perry
1920	Barn Bluff	L.S.	W. Mudie
1920	Barn Bluff	L.S.	A.L. Nichols
1920	Mt. Achilles	L.S.	C.C. Reilly
1920	Barn Bluff	L.S.	E. Hawson
1920	Lake St. Clair	L.S.	T. McDonald
1920	Davey River	L.S.	W.T.A. Cleveland
1921	Sth. Bruny Is.	Oil	V.A. Chipman
1921	Sth. Bruny Is.	L.S.	S. Perry
1921	Sth. Bruny Is.	L.S.	C.C. Brown
1921	Sth. Bruny Is.	Oil	J.L. Frizoni
1921	Nth. Bruny Is.	Oil	H. Thomas
1921	Nth. Bruny Is.	Oil	E. Thomas

Date	Place	Occurrence	Name
1921	Sth. Bruny Is.	Oil	J.L. Frizoni
1921	Somerset. Cam Rd.	Oil	N.J. Richardson
1921	Between Lagoon & Interview River	Tar, L.S	F.W. Heritage
1921	Douglas River	L.S.	H.G.R. McWilliams
1921	Mt. Pelion	L.S.	L.W. Mudie
1921	Mt. Pelion	L.S.	J. West
1921	Mt. Pelion	L.S.	J.T. Moate
1921	Mt. Pelion	L.S.	T.B. Harrington
1921	Mt. Pelion	L.S.	J.N. Duncan
1921	Mt. Pelion	L.S.	A.W. Duncan
1921	Mt. Pelion	L.S.	A.L. Kirkham
1921	Mt. Pelion	L.S.	R.P. Kirkham
1921	Mt. Pelion	L.S.	R.H. Nicholson
1921	Barn Bluff	L.S.	A.J. Forster
1921	Mt. Pelion	L.S.	Jean MacKenzie
1921	Mt. Pelion	L.S.	F.W. James
1921	Mt. Pelion	L.S.	K.B.C. Kirkham
1921	Mt. Pelion	L.S.	E.L. Potter
1921	Mt. Pelion	L.S.	A. Baker
1921	Mt. Pelion	L.S.	Stella Moate
1921	Mt. Pelion	L.S.	T.B. Harrington
1921	Mt. Pelion	L.S.	L.M. Beckwith
1921	Mt. Pelion	L.S.	R. Duncan
1921	Barn Bluff	L.S.	Lena Mofflin
1921	Mt. Pelion	L.S.	E.J. Stott
1921	Barn Bluff	L.S.	R.A. Mofflin
1921	Mt. Pelion	L.S.	C.H. Augas
1921	Barn Bluff	L.S.	G.B. McCutcheon
1921	Barn Bluff	Lease	R.J. McCutcheon
1921	Mt. Pelion	L.S.	C. Adams
1921	Mt. Pelion	L.S.	S.C. Hocking
1921	Mt. Pelion	L.S.	R. Sharples
1921	Mt. Pelion	L.S.	F.W. Reid
1921	Dulverton	L.S.	E. Morse
1921	Railton	L.S.	F.D. Kite
1921	Mersey	L.S.	J. Stewart
1921	Sth. Bruny Is.	L.S.	V.A. Chipman
1921	Sth. Bruny Is.	L.S.	C.C. Brown
1921	Barn Bluff	L.S.	C. Simson Hope
1921	Barn Bluff	L.S.	A.W. Craig

Date	Place	Occurrence	Name
1921	Barn Bluff	L.S.	H.B. Denniston
1921	Adventure Bay	L.S.	J.L. Frizoni
1921	Sth. Bruny Is.	L.S.	J.L. Frizoni
1921	Nth. Bruny Is.	L.S.	H. Thomas
1921	Nth. Bruny Is.	L.S.	E. Mathias
1921	Rosevale	Oil	Loftus Hills
1921	Barn Bluff	Oil & Gas	Mr. Black, Field Manager-Consulting geologist confirming seeps.
1922	Inglis River	L.S.	J.A. Wauchope
1922	Inglis River	L.S.	J.A. Wauchope
1922	Inglis River	L.S.	J.A. Wauchope
1922	Mersey	L.S.	G.D. Mendall
1922	Jericho	Oil	R. White
1922	Sth. Bruny Is.	L.S.	W.T. Rope
1922	Davey River	L.S.	W.C. Hart
1922	Davey River	Tar	W.T.A. Cleveland
1922	Kermode	L.S.	The Mersey Valley Oil Co.
1922	Latrobe	Drill No. 1	The Mersey Valley Oil Co.
1922	Railton	Drill No. 1	Adelaide Oil Exploration Company.
1922	Barn Bluff	Drill	
1922	Latrobe	Drill No. 2	The Mersey Valley Oil Co.
1922	Latrobe	Drill No. 3	The Mersey Valley Oil Co.
1922	Latrobe	Drill No. 4	The Mersey Valley Oil Co.
1922	Latrobe	Drill No. 5	The Mersey Valley Oil Co.
1922	Latrobe	Drill No. 6	The Mersey Valley Oil Co.
1922	Latrobe	Drill No. 7	The Mersey Valley Oil Co.
1922	Latrobe	Drill No. 8	The Mersey Valley Oil Co.
1922	Latrobe	Drill No. 9	The Mersey Valley Oil Co.
1922	Latrobe	Drill No. 2	Adelaide Oil Exploration Company.
1922	Latrobe	Drill No. 3	Adelaide Oil Exploration Company.
1922	Latrobe	Drill No. 4	Adelaide Oil Exploration Company.
1922	Latrobe	Drill No. 5	Adelaide Oil Exploration Company.
1922	Latrobe	Drill No. 6	Adelaide Oil Exploration Company.
1922	Latrobe	Drill No. 7	Adelaide Oil Exploration Company.
1922	Latrobe	Drill No. 8	Adelaide Oil Exploration Company.

Date	Place	Occurrences	Name
1922	Latrobe	Drill No. 9	Adelaide Oil Exploration Company.
1922	Latrobe	Drill No.10	Adelaide Oil Exploration Company.
1922	Latrobe	Drill No.11	Adelaide Oil Exploration Company.
1922	Latrobe	Drill No.12	Adelaide Oil Exploration Company.
1923	Rockliffes Farm	Oil & Gas	A. McIntosh Reid
1923	Roches Farm	Oil & Gas	A. McIntosh Reid
1923	Harford	L.S.	W.B. Cocker
1923	Burgess	L.S.	J.A. Wauchope
1923	Mersey	L.S.	D.M.C. Griffin
1923	Port Sorell	L.S.	R.C. Grubb
1923	Port Sorell	L.S.	G.N. Levy & A. Brown
1923	Port Sorell	L.S.	J.D. Johnstone
1923	Port Sorell	L.S.	E. Baker
1923	Franklin Rivulet	L.S.	L.J. Douglas
1923	Burgess	L.S.	F.M. McDonald
1923	Burgess	L.S.	E.J. McDonald
1923	Port Sorell	L.S.	J.H. Addison
1923	Burgess	L.S.	H.D. Green
1923	Port Sorell	L.S.	R.W. MacKenzie
1923	Barn Bluff	L.S.	G.R. Plante
1923	Barn Bluff	L.S.	L. Mudie
1923	Barn Bluff	L.S.	E.E. Black
1923	Barn Bluff	L.S.	R. Stoneham
1923	Little Henty River	Tar	S.A. Clark
1923	Strahan	L.S.	H.E. Evenden
1923	Strahan	L.S.	The Mersey Valley Oil Co
1924	New River	L.S.	F.T. Boddy
1924	New River	L.S.	E. Hawson
1924	New River	L.S.	F. Heritage
1924	Henty River	L.S.	J.A. Wauchope
1924	Barn Bluff	L.S.	B.H. Edwards
1924	Barn Bluff	L.S.	E.D. Reynolds
1925	New River	L.S.	E.F. Heritage
1925	New River	L.S.	H.E. Evenden
1925	Flowerdale	L.S.	D. Berechree
1925	Mt. Cameron	Tar	F.F. Ford
1926	Barn Bluff	L.S. Oil	C.S. Hope

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Date	Place	Occurrence	Name
1928	Nth. Bruny Is.	L.S.	H.M. Boddy
1928	King Island	L.S. Tar	O. Bonney
1928	Nth. Bruny Is.	L.S. Oil	C.F. Boddy
1928	Nth. Bruny Is.	L.S.	A.G. Black
1928	Nth. Bruny Is.	L.S.	M. Hayton
1928	Sth. Bruny Is.	L.S.	A.H. Jackson
1929	North Bruny Is.	Drill 1.	Tasmanian Oil Co.
1929	North Bruny Is.	L.S.	A.J. Miller
1929	North Bruny Is.	Drill 2	Tasmanian Oil Co.
1929	Great Bay, Nth.Bruny Is.	Oil & Gas	A.McIntosh Reid
1929	North Bruny Is.	Drill 3	Tasmanian Oil Co.
1929	North Bruny Is.	Oil, Tar & gas	Tasmanian Oil Co.
1929	Sth. Bruny Is.	Oil	(Sgd) L.W. Marsden
1929	Henty River	Gas	J.H. Robertson
1930	Nth. Bruny Is.	L.S.	J. McD. Hay
1930	King Island	L.S.	L. Gatenby
1930	Stoodley	Oil	A. Wright
1930	Mengah	Oil	J. Healy
1931	Cradoc	Oil	W.J. Armstrong
1931	Leprena	Oil (Kerosene)	G.H. Smith
1933	Dover	Oil	Lloyd J. Owens
1933	Golden Valley	Gas	B.H. Whittle
1936	Flinders Is.	L.S.	A.A. Summerhayes
1936	Flinders Is.	L.S.	Austral Oil Drilling Syndicate
1936	Flinders Is.	L.S.	C.S. Demaine
1936	Flinders Is.	L.S.	A.W. Imray
1939	Cygnet	Oil	R. Taylor
1939	Cradoc	Oil & Gas	Producers Oilwell Supplies Ltd.
1939	Danbury Park	Drill 1	Producers Oilwell Supplies Ltd.
1939	Ross	Gas	C. Davis
1940	South Arm	Oil	E.Z. Company
1940	Port Davey	L.S. Tar	H.E. Evendon
1941	Tunnack	Oil	A. Mackie
1942	Ocean Beach, Strahan	Tar	Mr.,W. Holmes
1944	Bridport	Oil	A.H. Thorpe
1945	Flinders Island	Oil	W. Carry
1946	Tarraleah	Gas	G. Harris
1948	Redpa	Oil	C. Burt Senr.

Date	Place	Occurrence	Name
1952	Cambridge	Oil	F.W. Evans
1953	Cygnet	Oil	R. Dunning
1953	Strahan	Oil, Tar	H. Fletcher
1955	Prion Beach	Tar	H. Akerley
1955	King Island	L.S.	Mrs. A.J. Smith
1956	Arthur River	L.S.	R.K. Cumming
1956	West Takone	L.S.	B.A. Farquhar
1956	King Island	Tar	Mrs. A.J. Smith
1956	Mole Creek	Oil	Eva Marchant
1957	Dover	Oil, Gas	E.A. Haigh
1958	Tinderbox	Oil	Mrs. Wilkinson
1958	Hamilton	Oil	T.B. Gulline
1960	Crabtree	Oil	Unknown
1960	Port Sorell	Gas	C. Sulzberger
1960	King Island	L.S.	Mr. S.P.J. Adams
1960	Marawah	Tar	F.W. Ford
1960	King Island	L.S.	F.J. Adams
1960	King Island	L.S.	W.K. Westly
1960	Central Highlands	Oil	K. Slater
1960	Detention River	Oil	C.R. Pyke
1962	Jericho	Oil	R. White
1962	Bridgenorth	Oil	W. Rattray
1962	Marrawah	Oil	C.K. Hine
1962	Burnie	Oil	L.F. Egan
1962	Distillery Crk. Wynyard	Oil	J. Carol
1963	Table Cape	Oil, Gas	Mr. Jackson
1965	S.E. Tasmania	Lease	E.Z. Company
1965	Fossil Bluff	Oil	S. Veenstra
1965	Ulverstone	Tar	Mr. C. Flowers
1966	Forth River	Gas	H.E. Flight
1966	Hagley	Drill 1 + Lease	C. Sulzberger
1967	Hagley	Drill 2 + Lease	C. Sulzberger
1968	Cressy	Drill 3 + Lease	C. Sulzberger
1968	Penguin	Oil	J. Bates
1969	Hagley	Oil	C. Sulzberger
1980	S.E. Tasmania	Oil Lease	B.H.P.
1984	Ross	Oil	G. & G. Gleason
1986	Glenlusk	Oil	Unknown

Date	Place	Occurrence	Name
1986	Nth. Bruny Is.	Oil & Gas	Conga Oil Pty.Ltd.
1987	Ida Bay	Tar	R. Bender
1987	Nth. Bruny Is.	Oil & Gas	C.S.I.R.O.
1987	Queenstown	Tar	Conga Oil Pty.Ltd.
1987	Sth. Bruny Is. Cole Pt.	Oil	A. Farmer
1988	Spring Beach, South Arm	Oil	Mr. Morris Potter
1989	Cape Pillar	Oil	A. Billingham
1989	Sth. Bruny Is.	Tar	Steve Forsyth
1989	Brighton	Tar	C. Wallis
1989	Lysart	Tar	D. Green (Mines Dept)
1989	Beaconsfield	Oil	Mine Geologist
1989	Colebrook	Tar	C. Wallis

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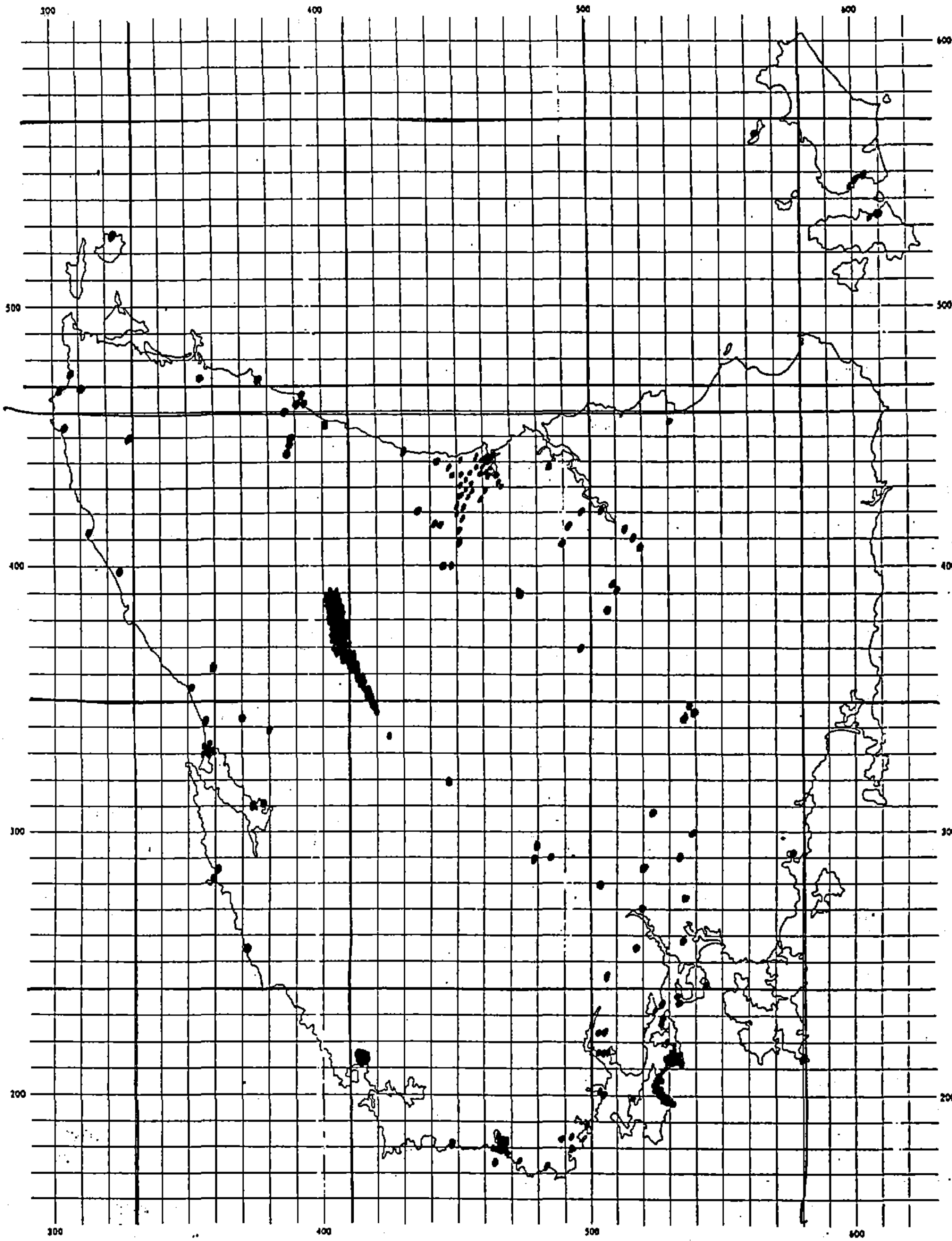
APPENDIX 2.

MAP OF OCCURRENCES



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APPENDIX 2

044

CONGA OIL PTY. LTD.

Oil Exploration and Drilling Company

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Registered Office:
84 Wells Parade,
BLACKMANS BAY, Tasmania 7052
Telephone: (002) 29 6576
Fax: (002) 29 2153

CONGA OIL

CURRENT EXPLORATION STATUS

PROJECT D'ENTRECASTEAUX
SOUTH EAST TASMANIA

Notes prepared by

Dr. D.E. Leaman
Leaman Geophysics
GPO Box 320D
Hobart Tas. 7001

March 1990

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SUMMARY STATEMENT

Conga Oil Pty Ltd first claimed part of the D'Entrecasteaux Region of Southern Tasmania in June 1984 in order to verify reports of hydrocarbon sightings. Since then it has acquired exploration rights to a large part of Tasmania and has established:

1. Oil has definitely been generated. Reported seepages have been located. Material analysed, including tars, demonstrates that the source is not Permian oil shale as all earlier workers have presumed. An Ordovician carbonate source has been proven although there may be other Lower Palaeozoic or even Precambrian source rocks.

2. Source rock studies of vitrinite reflectance and conodont alteration index confirm that Ordovician carbonates exposed around the region are within the oil window (mature). (Post Carboniferous materials are not).

3. Although seepage studies are incomplete there is evidence that very low volume seepage is still occurring over a large area. The volumes released, and reports of sightings, appear to be related to seismic activity.
While not all archival sightings have been confirmed, or all sites yet visited and samples collected, the locations display patterns inconsistent with random distributions or neighbourhood bias yet show a high correlation with geophysically-defined upper crustal lineaments. This correlation between diverse reports over a century and modern data suggests that the observations are generally reliable.

4. Permian and younger rocks unconformably overlie a range of Palaeozoic and Precambrian units. The young rocks, including massive Jurassic dolerite intrusions, create an array of exploration problems but gravity-magnetic analysis has already defined a major Lower Palaeozoic basin beneath them SW of Hobart and near Launceston. Further analysis is in progress or planned.

5. Basin development began in the Late Precambrian, was most active during the early Cambrian, but continued up to Middle Devonian times. By the Early Ordovician a relatively stable environment was established and a sequence of Ordovician carbonates and Silurian sandstones and shales was deposited. Deposition was terminated by a Middle Devonian folding event but uplift was not accompanied by granite intrusion in central Tasmania.

6. Possible reservoirs include the Ordovician limestone or Silurian sandstone. Weathering or development of secondary porosity is known to have been preserved near the base Permian unconformity.

7. Silurian shales or, more likely, Lower Permian mudstones and dolerite at the unconformity offer seal conditions. Many traps styles can be conceived; no targets are yet defined.

8. Massive disruption was associated with intrusion of the Jurassic dolerites into the post-unconformity sequence but only limited segments of the region were significantly affected by regional Tertiary extension faulting.

9. The escaping hydrocarbons were possibly generated following a Cretaceous thermal event for which there is island-wide evidence although *normal* time-burial functions may be adequate for the older source rocks implied. Heat flows remain abnormal.

10. Seepages in the Bruny region may represent migration up dip, along the unconformity to Jurassic faults disturbed during the Tertiary, from the eastern margin of the concealed Lower Palaeozoic basin some 10 to 20 kilometres to the west.

    Seepages elsewhere, some of which have fully impregnated Triassic rocks, have not yet been appraised but initial work indicates the existence of major pre-Permian structures near each location.

11. Exploration to date has emphasized gravity and magnetic methods. This partly reflects the stage of exploration, budgetary issues and the crucial impact of Jurassic dolerite within the moderate to high relief terrain. Extended use of such methods allows cost effective evaluation of Palaeozoic basin orientation, content and post unconformity structuring. Definition of the thin, folded, wedge remnants of the Ordovician-Silurian rocks was quite poor in first pass interpretation. These materials occur patchily and are not universal beneath the unconformity. Other units and features were well defined.

    These methods have been supported by geochemical studies and an archival search in order to determine how common seepages might have been, whether occurrences are grouped over a long period, and if so to explain the generally negative oil exploration climate in Tasmania.

12. Gravity and magnetic data can be used to orient specific seismic surveys but will also be required to interlock seismic surveys. Advanced but proven technology is required and the geophysical method mix for target definition will never be current industry balance due to the geological and technical problems posed.
    Although the seismic method may never have predominance in this region its application and requirements are becoming established. More research is required. Usage will involve high acquisition costs. Trials have shown that variable but usable seismic data can be obtained in difficult conditions.

Conga Oil has elevated a region previously considered quite unprospective into a province with established source rocks, escaping fluids, good seal conditions and a geological history to support generation and preservation. Some confirmatory work is still required but the exploration problems related to prospect definition have been assessed and a methodology established for dealing with most of them.

SUPPORTING EXPLANATION

INTRODUCTION

Although the "Tasmania Basin" has some history of hydrocarbon occurrence and failed exploration it is not known as a province with hydrocarbon potential. In fact, no basin with an appropriate structural history is obvious or exposed. In this respect the region is similar to many other complex provinces before the crucial insights were made.

The term "Tasmania Basin" should not be misunderstood. It is usually taken to refer to the post Carboniferous rocks which cover much of the island.

Conga Oil has accepted that old petroleum-related records might be valid and has sought to confirm or deny them. Having done so, and reviewed the implications, it has now established that the region may have considerable potential where none was previously credited.
This document reviews previous exploration history, crucial discoveries to date, and the objectives of present and future programmes. The nature of the geological and geophysical problems facing the explorer are discussed in some length.

Because Tasmania lacks an onshore Petroleum Act (no perceived oil potential) Conga's tenements were originally acquired under the terms of the Mining Act. After initial examination of tenements south of Hobart, and recognition of the implications, Conga Oil sought a whole "basin" tenement. The application succeeded in view of the lack of current competition or industry-perceived value. The government was required, however, to arrange new regulations, fee schedules and work commitment agreements. These regulations are comparable to others applicable in other states of Australia and have brought the operation to industry norms. At the same time all previous holdings were consolidated.

The total area covered by consolidated licence 1/88 is 20989 sq km and is shown in Figure 1. Extracts from the licence agreement have been reproduced as Figures 2A, 2B. These show that relatively light financial commitments have actually been imposed but there are drilling requirements and consequently much more effort is implied than suggested by the required, minimum, expenditure. Due to the history of the licence sub areas there are also varied relinquishment conditions.

The region is of moderate to high relief generally and a large part is crown forest. Much of the remainder is privately owned farmland divided into relatively small lots. The climate is temperate with a moderate annual rainfall (600-1000 mm).

HISTORY

Between 1800 and the present there have been many reports of hydrocarbon occurrences across the island of Tasmania. Few have been seen by observers "acceptable" to the bureaucratic or scientific establishment; exceptions being Twelvetrees in 1909, Wade (1915), McIntosh Reid (1929), and fewer had been confirmed to universal satisfaction. Modern chemical techniques offer the means to resolve the issues. Reports have often been encouraging and companies were floated to drill wells on many occasions (e.g. 1915, 1929-30). Very limited depths were drilled (max 130m) until 1965 due to limited budgets and unsatisfactory equipment.

While these wells were sited at seepages and often yielded much more oil than had been visible at surface (as at Bruny Island in 1929) no well penetrated the post Carboniferous cover or provided any useful augmentation of geological knowledge.

The economic failure of these projects led to a loss in interest.

It may be commented here that only a handful of holes, mainly diamond drilled, have ever penetrated to pre- Carboniferous 'basement' anywhere in the entire eastern half of Tasmania. And all of these were stopped soon after. This paucity of drilling, partly related to the thickness of cover which rarely exceeds 1000 to 1200 m, reflects fear of drilling much dolerite and perceptions that there is no point. These fears are receding due to some understanding of the massive dolerite intrusions and all the holes referred to have been drilled in the past twenty years, mostly in the last ten, for stratigraphic information about the Permian sequence.

A search of records has shown that the area has never been held for any regional or specific exploration although a general reconnaissance of surface geology was undertaken some years ago. There have been many smaller lease-type holdings over the past century. Each of these has tended to contain one or more seep sites.

It has always been presumed, both by many companies and individuals as well as by all evaluating bureaucrats, that any oil seepage reported, or oil generated, would be derived from the Permian oil shales. Rating of Tasmania's hydrocarbon potential on this basis has always been poor; the rocks are exposed, not sealed and reservoir conditions are virtually non existent. This basic assumption has rarely been challenged and in absence of any satisfactory alternatives the province known as the Tasmania Basin overall has been downrated. These presumptions coupled with the general difficulty of exploration (see below) has meant that no deep geological assessment has ever been attempted previously.

It is also necessary to recount, as revealed in archival records, that personalities and unscientific arrogance coupled with ignorance have produced a "no oil in Tasmania" psychology notwithstanding the evidence of many observers including two highly qualified government geologists. This philosophy has retarded entreprenurial activity and exploration and depressed those very few professionals who actually realised that the hydrocarbons were often not derived from Permian rocks.

General geological mapping has continued as has development of technology to evaluate dolerite structures (Leaman (1972b, 1975) which compound problems of structural assessment and research into pre Permian rocks. Unfortunately such mapping deals with the post Permian cover almost exclusively.

Conga Oil was founded in 1984 to seek out the reported sites on Bruny Island and assess their origin if located. The original area of 49 sq km has expanded as understanding of the distribution of structures and materials beneath the Permian cover has grown. The ability to assess the larger areas has also improved with experience. This work has been relatively low budget fundamental research. The problem today is not whether exploration is justified, but which sub area should bear the cost of initial target development. Possession of several target areas, each worthy of further investigation, is a very comforting position, but rating will not be possible until more regional studies have been completed.

SEEP AND SOURCE ROCK STUDIES

Until late 1986 the prevailing view concerning any possible hydrocarbon generation (seepages) in Tasmania was that it must be related to Permian oil shales. Since this unit is patchily developed and often exposed its potential as a source rock is limited. Reservoir conditions are most unlikely and this has often been stressed. These realities and this assumption has led to neglect of the province as recounted above.

Neither Conga Oil nor any of those observers (including the writer) who have seen bitumens and tars in Ordovician limestone exposed in western, southern or northern Tasmania were convinced that the oil shales represented the only possible source.

Dr. Burrett, of the University of Tasmania, reported to Conga Oil that the conodont colour alteration index for Ordovician carbonates in SW Tasmania was within the mature oil window (1.5 to 2.0). Subsequent vitrinite reflectance determinations of Upper Cambrian and Ordovician carbonates from the periphery of this area have also yielded values of 0.7 to 1.12 with total organic carbon levels consistent with weathered surface samples.

This work was particularly relevant to the original tenements in the D'Entrecasteaux Channel area south and south west of Hobart. Most of the completed project studies undertaken by Conga Oil are from this initial 4500 sq km area (see Figure 1). This work provided the confirmation that seepages were real, that sources existed, that some description of concealed units was possible, and that a much wider area should also be considered to protect the interests of the company, its pioneering work, and perhaps provide alternative targets.

Relocation of reported seepage sites in the Bruny Island region has produced some confirmatory analyses (by Dr. J. Volkman, CSIRO, Hobart). The chemical signature of the released hydrocarbons is distinctive (Figures 3A to 3C) and considered indicative of an Ordovician source rock on the basis of hydrocarbon compositions; m-hopanes are the critical indicators. The signature observed from trace seepages both on and around Bruny Island has been matched with hydrocarbons within the Ordovician Gordon Group limestone exposed both at Ida Bay and near Queenstown. While it may be argued that some of the samples from Channel muds may be polluted by Middle East derived crudes - also with carbonate sources - this cannot be true of the onshore samples. The uniformity suggests a single origin over a wide area.
Let there be no doubt; the hydrocarbons from this southern area are not derived from Tasmanites oil shale of Permian age.

Recovery of oil in an ephemeral stream (Miles Creek on Bruny Island) shows that low volume release is still occurring. Hydrocarbon concentrations in the confirmed samples have been very low. The volume of oil being released today is clearly much less than was reported in 1929 when oil was seen escaping from rock fissures at Johnsons Well (McIntosh Reid, 1929) and encountered at 27 m during drilling. Eyewitness reports describe storage of the fluid light oil in drums.

Release may be controlled by periods of seismic activity. Although earthquake records are of variable quality sufficient analysis has been completed for the last hundred years to show that periods of high activity have been followed by long periods of quiescence (Dr. M. Michael-Leiba, Bureau of Mineral Resources Canberra, pers. comm.). Comparison of frequency patterns and seep sightings suggests that most are within five years of the occurrence of either much minor activity or events greater than magnitude 4. Tasmania has been seismically quiet since 1958 and there have been relatively few seep sightings in this modern period.

Bacterial activity coupled with low release volumes probably explains the absence of residual products at most modern sites although these have been described in the past from many localities. Many tar samples have been preserved in museum collections. These are now being analysed.

Although Ordovician limestone has been identified as source for the hydrocarbons in southern Tasmania it is not yet known whether it is a general source. Nor has the particular member of the Gordon Group been identified. The suggestion of other sources derive from analysis of hydrocarbons in a basal Permian mudstone at Poatina in northern Tasmania, where the oil was shown to be different from any derived from Gordon Limestone or Permian shales, and from the distribution of recorded sightings (Figure 4). A Silurian or Devonian shale may also provide source potential. This remains to be confirmed.

All geochemical studies to date have shown that it is possible to unambiguously distinguish Permian-sourced hydrocarbons - which also have immature sources - due to their peculiar chemistry. It is not yet clear how many mature sources are present; the Ordovician limestone may not be the predominant source and clarification of this matter may affect ultimate target selection and rating.

Figure 4 summarises current knowledge of the distribution of proven or reported seepages based primarily upon archival search. Many of these sites have yet to be inspected, or sampled. Analysis of a number of these widely distributed sites should clarify the source issue. It is also suspected that the sites shown represent only a sub set of actual sites since the figure is drawn from filed correspondence and thus reflects only those observers interested enough to seek advice. (Few received any)

Figure 4 is important in several respects. It shows that Tasmania has as many seepage sites per unit area as anywhere else, and may have more than most parts of Australia. Those sites are patterned and related in believable ways. Most sites are adjacent to, or overlie areas known to contain Ordovician rocks, or are related to drainage pinch points from catchments containing such rocks. The distribution is also highly suggestive that some Late Precambrian dolomites may also be sources. While the patterns marked are geologically believable their credibility is established by comparison with trends noted in recently acquired magnetic data and inferences drawn from it (such as Leaman & Richardson, 1990)(Figure 5G). This arrangement of sites also suggests that most reports are of hydrocarbons, and not of iron oxide scums on water as often assumed in the past, and that there is no bias in the records due to neighbourhood vanity or any attempt to report what has not been seen.

GEOLOGY

Before scenarios for generation, storage, sealing and migration can be presented it is necessary to consider the geological peculiarities of the "Tasmania Basin". Jurassic dolerite dominates the region, the upper parts of the section and the topography. Various Permian and Triassic formations complete the exposures. The relationships are suggested in Figures 5A, 5B. Permian oil shales are not known outside the central north of the tenement although formation correlates are well exposed elsewhere. In any event current studies suggest that Ordovician rocks may be significant sources. The known distribution of Ordovician rocks is shown in Figure 5C.

Williams (1975) presents knowledge of the pre Permian geology prior to commencement of Conga's exploration programme. This blank map, so far as central Tasmania is concerned, was hardly modified until Conga completed its first stage investigation of southern Tasmania in 1987. Coreholes at Glenorchy, Woodbridge and near Ross demonstrate that Lower Palaeozoic and Upper Precambrian units of west Tasmania affinity extend as far east as Ross-Oatlands and Sorell.

The base of the Permo-Triassic cover, with its stockwork of massive dolerite intrusions, is probably never less than 500m deep for most of the region but, depending on topography and stratigraphic position, may exceed 1500m. Locally thinner sequences may be associated with rare basal Permian units or the rare windows in the cover, such as occur near Poatina.

The base of the Permian succession is marked by a major unconformity which may be locally irregular and possess relief of more than 300m. Depressions are often filled with tillite marking Late Carboniferous glaciation.

Some indication of the nature and distribution of materials likely beneath the unconformity can be provided by the work undertaken for the D'Entrecasteaux region south of Hobart. Figures 5B, 5D, 5E, 5F summarise interpretation of data from many sources including gravity, magnetic surveys and inspection of volcanic vents and tills. An equivalent appraisal has yet to be undertaken for the remainder of the tenement but the geophysical data are now available (as of January 1990). Figure 5A also includes a section from NW Tasmania and an indication of the style of dolerite problems.

Figure 5E presents the current understanding of the distribution of Lower Palaeozoic and Precambrian rocks as projected onto the unconformity and was derived from a primary gravity-magnetics interpretation. Formation properties and the first order techniques used to date have not permitted resolution of post Cambrian rocks, although some inferences are possible.

The interpretation coupled with analogies based on exposures west of the tenements indicates that siliceous Precambrian (Tyennan) basement is deeply buried by younger Precambrian dolomite and argillite sequences and an early Palaeozoic trough. The most active trough developments were probably Cambrian in age. The dominant Cambrian components include mafic and felsic volcanics and some ultramafics. All aspects are comparable to the Dundas Trough of Western Tasmania (Figure 5F).

Leaman & Richardson (1990) indicate that comparable structures persist throughout the eastern midlands of central Tasmania and in northern Tasmania (Figure 5G).

There have been several periods of deformation; in the Early Cambrian, Middle-Late Cambrian and Early Ordovician. The last was followed by gentle sag deposition within, or near the margins of the main troughs. The limestones providing the dominant(?) source rocks were deposited at this time. Deposition may not have been universal but Ordovician- Silurian units may have been up to 4 km thick locally. A relatively gentle orogeny in the Middle Devonian folded and uplifted all units. Granite intrusions appear to have been restricted to the regions marginal to the tenement (e.g. Figure 5E). This may indicate that the core region of central Tasmania did not experience the full sequence of upper crustal development and may have provided a more stable shelf environment throughout. All areas were, however, affected by long wavelength folding.

All units were exposed following the Devonian orogeny. Many were eroded. Recrystallization, weathering and development of secondary porosity was developed in the limestones.

The scale of the residual trough in southern Tasmania is suggested in Figure 5F but the volume and nature of the material between the Upper Cambrian and the Permian unconformity has not yet been resolved. It appears to be relatively thin (500-1000 m) in much of the southern area.
Figures 5B, 5D and 5E suggest a possible distribution for the truncated folded volumes of Ordovician-Devonian rocks. Exploration is not yet sufficiently advanced to be able to assess the reliability of the inferences shown in respect of these materials and such work has yet to be extended to the entire tenement.

Figure 5F suggests the primary structural orientations and significant block boundaries. Present understanding indicates considerable rejuvenation of structural elements and implies that the modern coastline reflects Jurassic and Tertiary incarnations of Late Precambrian structures. There is, however, no evidence of continued uplift over basement highs and isostatic stability was probably achieved before deposition of the Permian formations. Figure 5E summarises the present understanding in the absence of seismic data (see below) of fold systems. Only one closure has been established - in the Cygnet region - but this large structure is related to Cretaceous intrusions.

After the Late Carboniferous glaciation the area was subject to gentle subsidence until Middle Jurassic intrusion of massive dolerite sheets. The post Carboniferous section was completely disrupted but the older rocks were probably not greatly affected. This was a significant thermal event. The area was uplifted and eroded throughout the Cretaceous. In the Late Cretaceous the rocks near the unconformity were intruded by a syenite laccolith centred on Cygnet. This has domed the Permian rocks and inserted a fracture fill dyke swarm, and some sheets in the roof.

Gravity-magnetic analysis suggests that the syenite mass has a diameter of about 20 km with a possible extension toward Kettering (see dotted area, Figure 5E). The discovery of this body accounts for the enigmas discussed by Leaman and Naqvi (1967), and resolves many of the apparent conflicts outlined by Farmer (1985). This was also a significant thermal event since many sedimentary palaeomagnetic indicators were reset (Sharples and Klootwijk, 1981). Significant Cretaceous activity also occurred in Bass Basin north of the tenement.

Within the exposed rocks Jurassic faulting is predominant but not always obvious and the region largely escaped Tertiary extensional faulting.
In south east Tasmania most Tertiary disruption occurred east of Hobart, Dennes Point and Adventure Bay although some offsets were translated through North West Bay. Tertiary deposition, once more general, is restricted to valley fill accumulations (see Farmer, 1985).

Some more detailed interpretation was begun in the region of North Bruny Island. This showed that when the Jurassic dolerite was stripped away, by careful analysis of the intrusions using gravity and magnetic data, that underlying structures were revealed which are not consistently reproduced in the exposed rocks which form a roof above the intrusions. These structures may offer leakage paths and reflect the major basement (pre-Permian) structures.

The pattern is similar throughout eastern Tasmania. Tertiary structuring is limited to belts; the Storm Bay region in the south (above), the Port Sorell to Tamar region in the north, the Derwent Valley in the centre. Few structures of this age persist through the midlands but many Jurassic structures do.

Although the available geological maps for virtually the entirety of the tenement show only relatively young rocks enough is now known of the underlying materials and structural trends, from Conga's trail blazing research, to recognise details within Jurassic and Tertiary structuring and patterns which suggest the nature of underlying features. An example is offered from the Hobart area (see map of Leaman, 1972a).
South of Kingston and north of Sandy Bay the River Derwent and its associated Tertiary structures trend NNW whereas between Kingston and Sandy Bay the trend is NNE. Several Jurassic

features match these trends but the primary Jurassic structures in this region are E-W or ENE. If the anomalous trend belt is viewed from west or east it is found to contain major dolerite boundaries and two feeder dyke offsets. It cannot be argued that these displacements are Jurassic or post Jurassic; rather, the dolerite has been controlled upon intrusion by pre-existing fracture systems at shallow depth and that these display shear offsets (usually sinistral). Indeed the entire Jurassic and Tertiary pattern, when compiled, reflects the rejuvenated impression of major basement structures. The writer suspects but cannot yet prove other suggestions of possible major fold systems which have been impressed into the surface rocks of the Hobart area but this style of insight might well be applied profitably to most of the tenement.

The geological and geophysical problems presented are peculiar to Eastern Tasmania and their solution requires much experience and local knowledge. An ability to assess dolerite forms, strip the post-Carboniferous cover and thereby increase resolution of Jurassic faulting and the pre-unconformity rocks is critical to the present exploration.

GENERATION AND PRESERVATION

Given the geological history of the region, and the Ordovician limestones in particular, it is unlikely that any hydrocarbons generated prior to the Devonian orogeny would be preserved. The depth of burial may have been inadequate in any case in light of the alteration indices. It is, however, possible to conceive situations in which hydrocarbons generated after the Permian could migrate into anticlines sealed by Silurian shales, porous limestone or other units at the unconformity where a seal of Permian mudstones is present.

The Jurassic and Cretaceous thermal events are likely to have been critical. While the entire post unconformity succession was disrupted during the Jurassic event all breaks were sealed by the cooling intrusions (Leaman, 1975). The disruptive influence of the Cretaceous event was spatially restricted geographically to the Cygnet area and stratigraphically to the rocks immediately above and below (?) the unconformity there. Both events could have led to enhanced generation without significant loss of hydrocarbons (see also trap conditions).

It has been suggested that seepages might be related to dolerite feeder systems. These may have generated small volumes of hydrocarbons from suitable materials but the widespread release or distribution of hydrocarbons suggested by the old reports and Conga's own findings (Figure 4), composition findings and the general immaturity of post Carboniferous rocks generally rules against this possibility.

A more plausible explanation of the seepages east of the syenite intrusion (near Cygnet, D'Entrecasteaux region) and the eastern margin of the southern basin is that oil generated by the Cretaceous event, from Lower Palaeozoic sources, has migrated up dip along the unconformity and is escaping along the primarily Jurassic faults of the region. These structures, which lie close to the limits of Tertiary activity, have probably been disturbed. Even so, leakage volumes are very small. A clearer view may emerge when the distribution of seepages, and their source chemistry, is better known. This type of long migration path, or displaced seepage-reservoir relationship may be general in Tasmania given the obvious fracture controls on release points.

There is little evidence at the present time for any occurrence of the probable source rocks on the shelf of Late Precambrian rocks which underlie the unconformity at North Bruny Island. This comment is made in order to widen some of the issues.
Bruny Island seepages, which have been the subject of considerable study, have been related (above) to weeping migration paths. If, however, the general distribution of seepages is considered, as presented in Figure 4, then other admissions may be made. The Late Precambrian rocks in north western Tasmania, especially, are associated with many reported occurrences. These rock suites include carbonates and the units beneath the Huon-Bruny and South Tamar regions possess properties comparable with altered dolomitic sequences. It is possible, but not yet tested or proven, that some seepages might be related to these materials. All evidence to date, from the Bruny region for example, suggests an Ordovician source only but the possibility of other sources must be recognised. Further careful source analyses and comparisons are necessary to evaluate all possible sources. If such sources are established then the issue and range of trap conditions will be expanded.

Heat flows throughout Tasmania are elevated and this may have encouraged generation in relatively recent times. It has always been presumed that elevated thermal conditions have dated from the breakup of Gondwana; first stage Lower Jurassic, second stage mid Cretaceous; an association with igneous activity and continental separation.

RESERVOIR AND TRAP CONDITIONS

A number of possible reservoir rocks can be conceived. The Silurian formations, if present, offer paired reservoir and seal units; thick sandstones and shales. The Ordovician limestones, whether present as reefal accumulations or not, offer many storage possibilities. Reef and shelf limestones are known to exist in the southern part of the region. Thick sections of the limestone at Lune River have been recrystallized and have high porosity. Where the limestone was exposed prior to the onset of Permian sedimentation karsts and deep weathering porosity have also been developed.

The Lower Permian formations - tillite and Woody Island Siltstone / Quamby Mudstone (and correlates) - are widespread with a total thickness never less than about 200 metres. They are either very fine grained or possess a very fine grained matrix. They could be expected to form an excellent seal on the unconformity. Their efficiency as seals, given Jurassic dislocation and breakage, may account for the trace seepages.

Other Permian formations are passable aquifers with strong bedding heterogeneity. These may offer limited local reservoir potential, especially if sealed by dolerite intrusions or traps formed by faulting or dolerite dykes.

Optimum reservoir - trap conditions, however, probably lie below, or at, the unconformity and involve the carbonates.

GEOPHYSICS AND PROSPECT EVALUATION

The geology of the "Tasmania Basin", its historical development and the nature and properties of some of the rock units present make an unusual bias to the exploration programme essential when compared with normal industry practice. This is unlikely to change, as discussed below, due to the combination of geological considerations, costs, access, data quality and political factors.

The approach employed to date has been designed to provide a descriptive basis of formation distribution for totally unseen and previously unsuspected units. It has proven able to provide a regional setting and geological history such as described above for the southern portion of the tenement. This description, coupled with other economic indicators or patterns, such as seeps, will eventually form the basis for targetting and target-refining seismic survey.

The twin pillars upon which all exploration in the Tasmania Basin must rest are the gravity and magnetics data bases (Samples are shown in Figures 6A-D). Comprehensive surveys have been now been completed for most of the consolidated tenement but primary analysis has only been completed for the southern area (previous section and Figures 5B to 5F). The analysis is not yet exhaustive and, as seismic traverses or survey segments become available, the evaluation can and must be expanded. Both methods are able to assess the impact of Jurassic structuring and intrusions in the post unconformity sequences and provide a basis for linking seismic surveys after stripping the covering materials. This implies extended application of these methods and state-of-art 3D whole geology techniques.

Extracts from magnetic surveys undertaken by Conga Oil are shown in Figures 6A and 6B. Figure 6A presents the survey of the D'Entrec- asteaux region. This survey was flown at a barometric height of 1000 m with a line spacing of 2.5 km. Most of the high relief responses are sourced by dolerite feeders but other systematic features reflect concealed basin structures and Cambrian volcanic fills. Figure 6B shows part of the Central Tasmania survey flown at a height of 1600 m. Some major trends are evident but full separation of structures, deep and shallow, or dolerite has not yet been effected.

Figures 6C and 6D present a compilation of gravity data for the southern and part of the northern areas. This data is even more informative than the magnetic data but requires more evaluation. The coupling of the two methods is extremely powerful.

The sections and solutions illustrated in Figures 5B and 5D indicate the style of structuring and detail of solution deducible from primary interpretation. Very little more advanced interpretation has yet been undertaken, or called for, but tests around North Bruny Island show that is is feasible and may be able to dovetail seismic analysis.

But why is this unusual and non industry-standard approach necessary (essential)? There are several reasons. The seismic method can not yet be relied upon to yield high quality data in Tasmania but adequate results can be achieved. Due to terrain, access, environmental and political issues a very high acquisition cost is inevitable and the method can only be employed selectively. There is no possibility of acquiring a first order regional grid without considerable expense and research to select survey and processing parameters area by area, and the gravity-magnetic coupling has already attained most of the objectives of such a coverage.

The extant interpretation for southern Tasmania already suggests where seismic surveys should be concentrated and what line orientation will be most effective. This approach is efficient and will reduce future exploration costs.

The equivalent guide interpretations have not yet been undertaken for the remainder of the tenement. Magnetic data acquisition was completed in 1989 and some infill of the state gravity data base was completed, to levels allowed by 1989 budgets, in early 1990.

The seismic reflection method has not been used extensively onshore in Tasmania and where it has been used has rarely provided clear records. Production of exemplary records has always required some considerable experimentation with energy sources, geophone arrays and careful selection of the traverse location. Each site or area surveyed has required specific and different survey specifications. These conditions arise due to the variable surface geology, high surface velocities and topography. Leaman (1978) examined a large number of sites and geological conditions in an attempt to obtain some standard specifications for high resolution reflection surveys. Some sites were found in which clear reflections were observed over many seconds of record. Examples of such sites are shown in Figure 6E. Many other sites were tested at which no reflections were observed or recognised. The tests reported by Leaman (1978) cover small areas and there are few examples of long line tests. The rare examples of such surveys reproduced the problems noted in advance sounding trials. Jurassic dolerite, at surface or within the upper 500 m of section, with its very high velocity appears to be the primary source of difficulty.

Conga Oil has commissioned one survey of its own; on Bruny Island. The processed result is shown in Figure 6F. This survey established some specification requirements and indicated the kilometre cost of an explosive source survey. The results appear very poor until it is realised that they are wholly consistent with the gravity and magnetic interpretation for the same area. These interpretations (Figures 5B, 5D) indicated a veneer of post Carboniferous rocks on Late Precambrian basement. Dolerite near surface creates a blind zone which obscures the unconformity but the rest of the record is consistent with this interpretation, including the irregular reflector at about 2 seconds. At a velocity of about 5000 m/s this is consistent with the intra Precambrian interface implied from gravity analysis at about 2.5 to 3 km. *The record is, therefore,* probably representative of a section lacking significant or extensive cover of Lower Palaeozoic sequences (contrast Figure 6E).

Marine data from the Storm Bay region has also been examined with a view to assessing any reflection character and possible indications of structural styles beneath the unconformity. Very little marine data is of better quality than the land data. This is surprising given the improved source conditions and suggests that some fundamental geological factors are controlling energy transmission.
Marine data acquired by Amoco between 1968 and 1975 in Storm Bay is of poor quality. The sea bed and any cover on high velocity bedrock, an irregular surface, is recognisable; but only noise (apparently) thereafter. The high contrast interface between Recent or Tertiary sediments and Permian rocks or dolerite generates a strong reflection, many multiples and a blind zone which is often half a second thick. This situation is comparable with most land sites and suggests either little transmission or poor reflectors beneath the Permian cover. These are typical problems in high velocity environments and more research and perhaps use of much greater source energy is required.

Some further attempts have been made to resolve this issue. Following Conga's 1987 Bruny survey and its apparently poor result an agreement was reached between Conga Oil and the Bureau of Mineral Resources for profiling in the Channel region. This was to be done as an extension of traverses from the continental margin while the ship was en route to and from the port of Hobart for resupply. It was hoped that such profiles observed using modern equipment and at least two energy sources and cable arrays could either be correlated with the onshore survey or provide clarification of deep section.

Processing and analysis of this data has only recently been completed but it seems to confirm all previous indications (see Figures 6G, 6H for samples). Although the amount of energy transmitted through the base Permian unconformity is minimal it has been possible to suggest deeper character in a manner which is at least consistent with the rare onshore sites where good reflections are obtained as well as that at Bruny Island. All events from rocks younger than the dolerite are clearly represented. And the unconformity itself can be recognised on some records for the first time.
The problems posed by the reflection shadows and high velocities at shallow depth seem to have been partly overcome. The results are comparable with those obtained on Bruny Island and all are consistent with Permian rocks directly overlying Late Precambrian units.
No sample data sets for traverses across regions where the Permian rocks are known to overlie Lower Palaeozoic rocks are yet available. Traverses south of Tasmania have not provided clear data. Processing tests are continuing (BMR, Canberra).

CURRENT AND FUTURE PROGRAMMES

Although Conga Oil Pty. Ltd. began work in 1984 most of the results presented here were obtained in 1987 and 1988 after a reported seepage was relocated and analysed. Consolidation of licences and applications for the current coverage, coupled with establishment of state regulations and funding and ownership issues has limited expenditure and work up to the time of preparation of this summary. Even so, the search for seepages - both in the field and in old records - has continued; there have been some further chemical analyses and an aeromagnetic survey was completed for the entire area in early 1989. Most subsequent effort has been directed at infill of the Tasmanian gravity data base. Much of this work was completed as a joint venture between the Tasmanian Department of Resources and Energy and Conga Oil. The first revised maps of the gravity field in central Tasmania became available in early 1990.
The new (post 1988) geophysical data have not yet been examined or interpreted.

There has been considerable progress this difficult, virgin province; a status which also accounts for the bias toward the more universal and less costly gravity and magnetic methods and the limited amount of seismic data available to date. The groundwork for seismic application has been laid since research programmes have established that the method can yield usable results, albeit variable in quality and at high cost.

Past programmes have established that the province has hydrocarbon potential and suggested the source of much of the material reported. The reasons for patchy or small volume release, and the distribution of seeps, have also been suggested; major old structures, local seismicity and a good

seal at the Permian unconformity. Regional geophysics can identify many of the vertical structures and suggest the nature of the concealed geology. The style of traps or general structuring may be inferred from this. Specific, target structures have not yet been defined.
Most previous work has been concentrated in the southern parts of the tenement which were the original holding.

Future programmes must extend the present level of treatment and understanding of the pre-Permian rocks across the entire tenement. Programmes proposed include:

1 Primary interpretation of the newly acquired gravity and magnetic data for central Tasmania and definition of possible location of Lower Palaeozoic sequences, and critical structures to a level comparable to that already achieved in the southern part of the tenement.

2 Expansion of the seep search to field visits and sampling followed by chemical analysis to confirm occurrence and source patterns. The geochemical programme and search is directed toward evaluation of focal sites of leakage, the probable source in each zone, and implications for storage.

3 Linkage of the above programmes to provide foci for seismic trials and targetting surveys. These surveys may require support from specific analysis of the potential field data.

CONCLUSIONS

Much of Tasmania possesses the hallmarks of a potentially productive petroleum province. There are proven source rocks, hydrocarbons have been generated, either generation is continuing (improbable) or reservoirs are leaking since seeps remain active, and likely relationships between structures, basins, source rocks, reservoirs and traps are well understood and known to occur. An Ordovician source for the oil, at least, has been proven.

The region would appear to have potential at least equivalent to the Amadeus and Canning Basins. The very few previous workers - of two generations past - to have realised this associated the province with conditions in parts of Texas and the Trenton Limestone. The sealing unconformity, and the rocks above it, provides an insurance of this potential as well as producing difficult exploration conditions.

Target definition in the prevailing conditions will not be a simple process and will require a judged balance between gravity, magnetic and seismic methods supported by careful review of surface indicators and chemical studies. No single method will prove adequate or cost effective.

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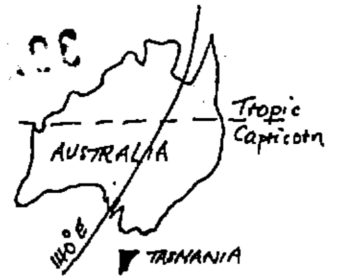
Prepared March 19, 1990

Dr. D.E. Leaman, B.Sc., Ph.D.,
M.Aus.I.M.M., M.M.I.C.A

392066

TASMANIA

EL 1/88 Conga Oil



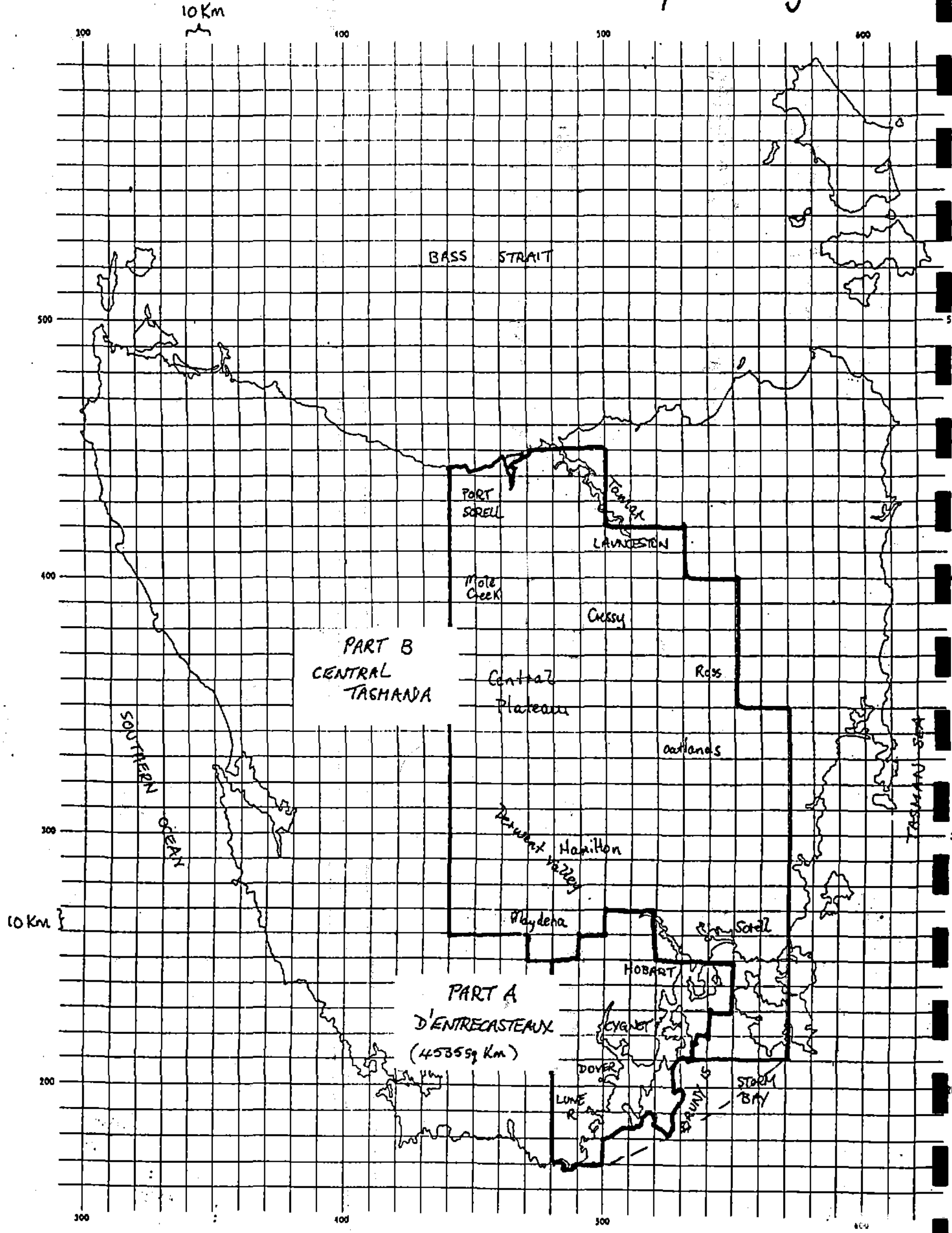


FIGURE 1

060

3?? ?C

No. E.L. 1/88

TASMANIA

392067

(Regulation 6A)

The Mining Act 1929

EXPLORATION LICENCE/RETENTION LICENCE

Issued to CONGA OIL PTY LTD of 84 WELLS PARADE, BLACKMANS BAY, TASMANIA. 7052

in respect of 20,989 square kilometres ~~of land in the Land District of~~

vicinity of HOBART/DEVONPORT as described in the schedule hereto.

This licence shall remain in force until the TENTH day of JUNE, 19 89.

This licence is subject to the following conditions:—

1. That the licensee shall immediately on the issue of this licence take steps to commence preliminary works necessary for the investigation of the area.
2. That the licensee shall carry out investigations as may be necessary to determine the mineral potential of the area, and will fulfil the proposals set out in the exploration programme and approved by the Director of Mines.
3. That the licensee shall employ such technical and other staff and equipment as may be necessary effectively to carry out such investigations.
4. This licence shall apply to oil.
5. The licensee shall notify the owner and occupier of private land, in writing, at least three days before entering such land.
6. That the security (Private Land Deposit) provided by Section 15E (1)(a) & (b) of the Mining Act, 1929, (see below) shall be lodged with the Director of Mines before entering private land.
7. The licensee shall observe, perform and fulfil the conditions as set forth in Schedule 'A' (Revised) attached hereto.
8. The licensee shall be liable to pay the cost of any work carried out to remedy any damage arising from any breach of the conditions of this licence.

OSK 5806

A. B. CAUDELL, Government Printer, Tasmania

EXTRACT FROM EXPLORATION LICENCE 1/88

FIGURE 2A

067

Grimes Lagoon
Tooms Lake
Lake Dulverton
Wayatinah Lagoon
South West
Chauncy Vale
Derwent River

392068

APPENDIX IV
PROTECTED AREAS:

Central Plateau
Seven Mile Beach

ADDITONAL CONDITIONS

The licence shall now include the following additional conditions agreed to by Conga Oil Pty Ltd and the Department of Mines.

(i) The amalgamated licence shall be treated as a new licence commencing on and from 10 June 1989.

(ii) The licence shall not be extended beyond 10 June 1995.

(iii) The licensee shall relinquish at least 50% of the area held at 10 June 1989, by 10 June 1992.

(iv) The licensee shall relinquish at least 50% of that area formerly held under E.L. 29/84 by 10 June 1992.

(v) The licensee shall expend a minimum of $300,000 prior to 10 June 1992.

(vi) The licensee shall complete at least two drill holes by 10 June 1992, such drill holes shall extend to the pre Permian.

(vii) The licensee shall arrange and keep in good standing public liability insurance to the minimum of $1,000,000. Evidence of currency shall be produced on demand.

EXCLUSIONS

As previously shown.

MINISTER FOR MINES

FURTHER EXTRACT FROM EXPLORATION LICENCE 1/88 FIGURE 2B

METHYL HOPANES

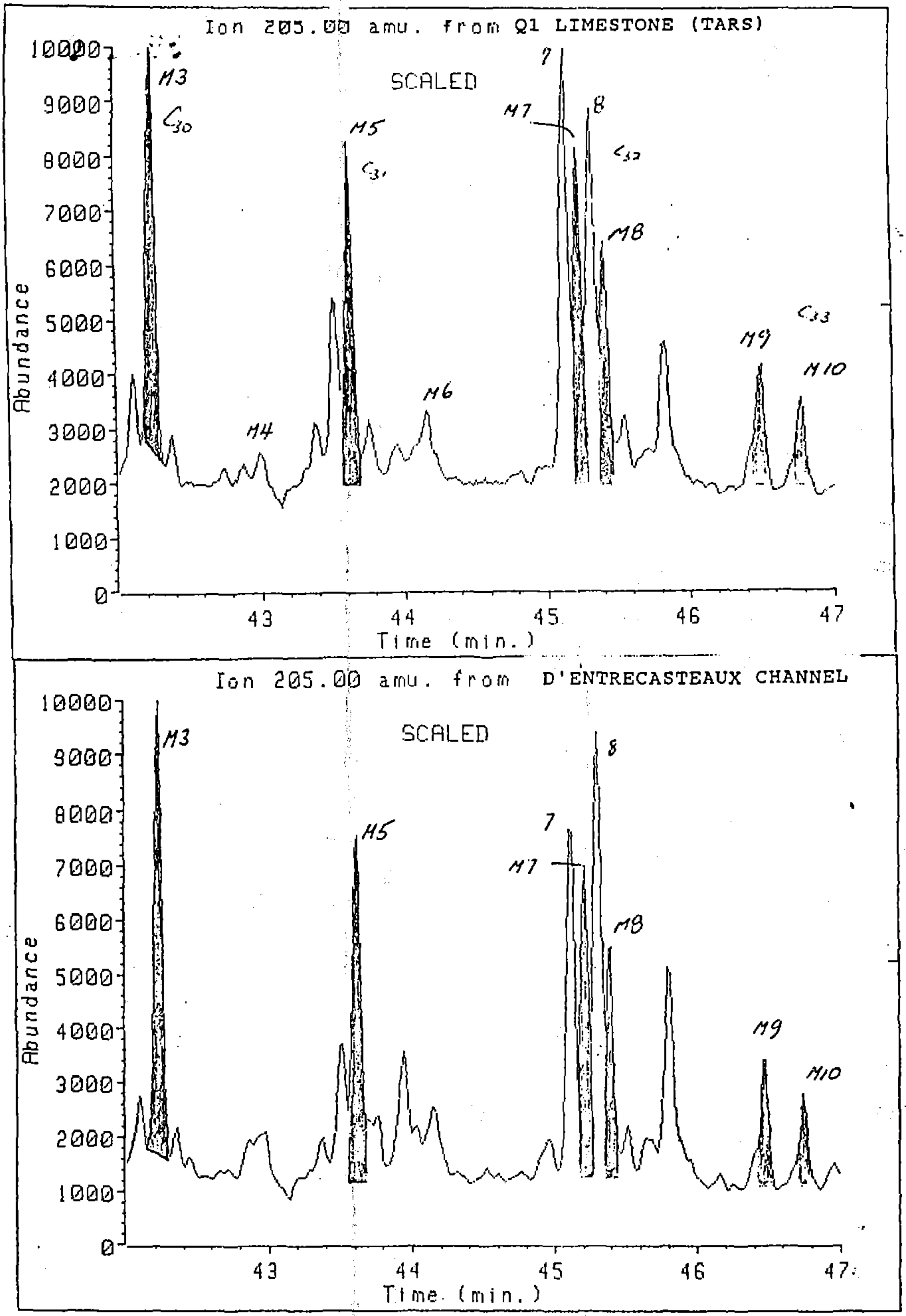
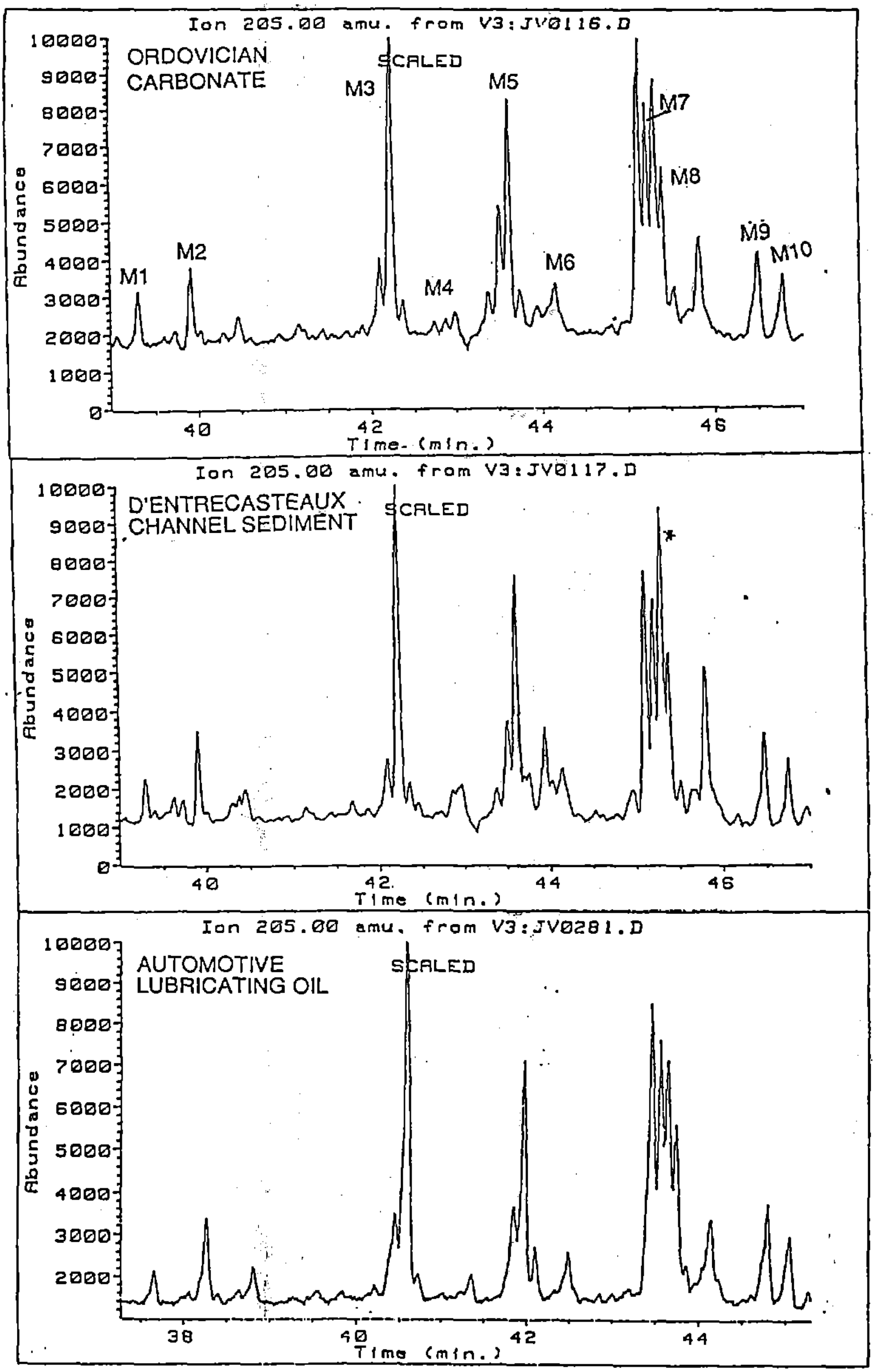


Figure 13a,b: Mass fragmentograms for m/z 205 showing distibution of C_{30}-C_{33} methyl hopanes in sample Q1 and a sediment from the D'Entrecasteaux Channel.

M-HOPANES : COMPARATIVE ANALYSIS OF LIMESTONE TARS AND BAY FLOOR SEDIMENTS Analysis by J. Volkmann, CSIRO FIGURE 3A

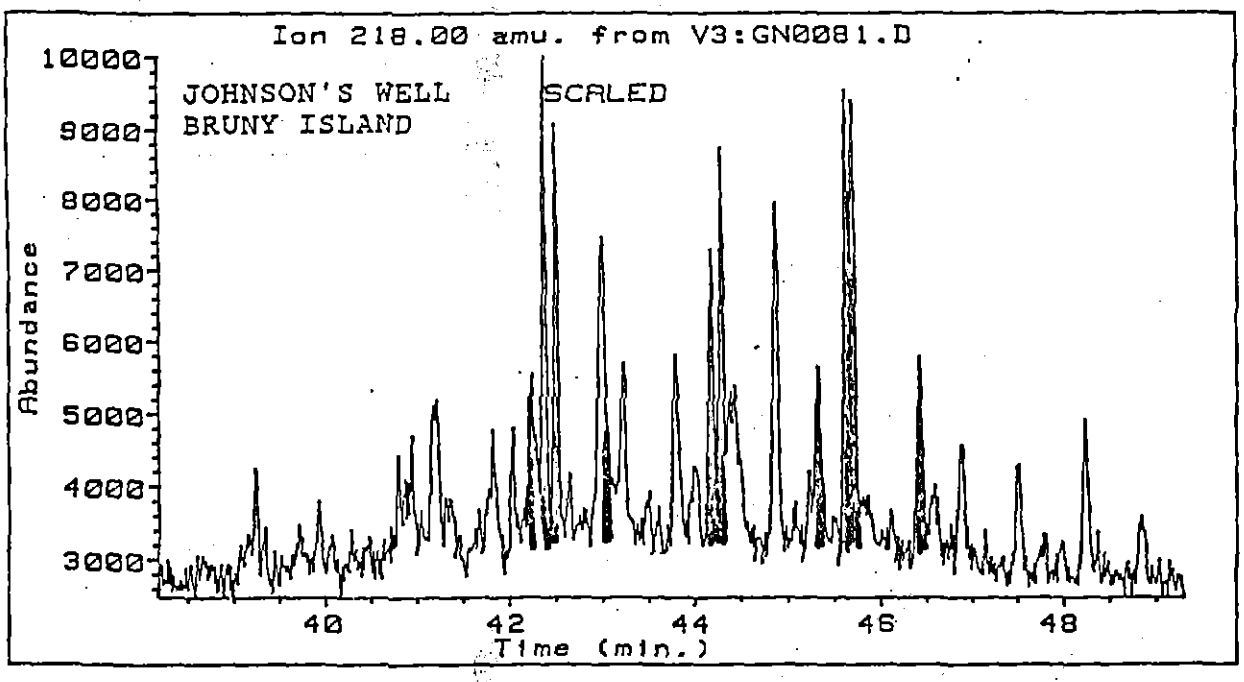
392070

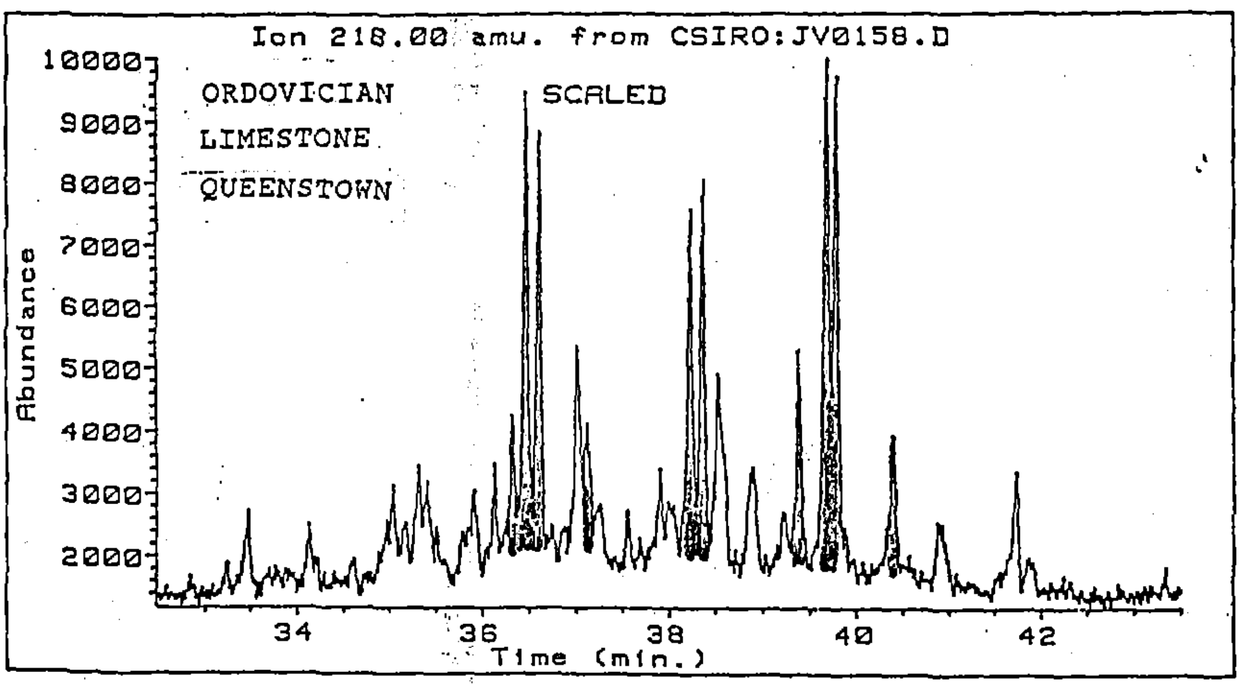
DISTRIBUTIONS OF METHYL HOPANES



M-HOPANES : COMPARATIVE ANALYSIS OF LIMESTONE, SEDIMENT AND ARABIAN OIL DERIVATIVE Analyses by J. Volkmann, CSIRO. Results show sediments might contain modern pollution or seepages although distribution suggests latter.

STERANES IN A SEDIMENT FROM BRUNY ISLAND
AND AN ORDOVICIAN CARBONATE



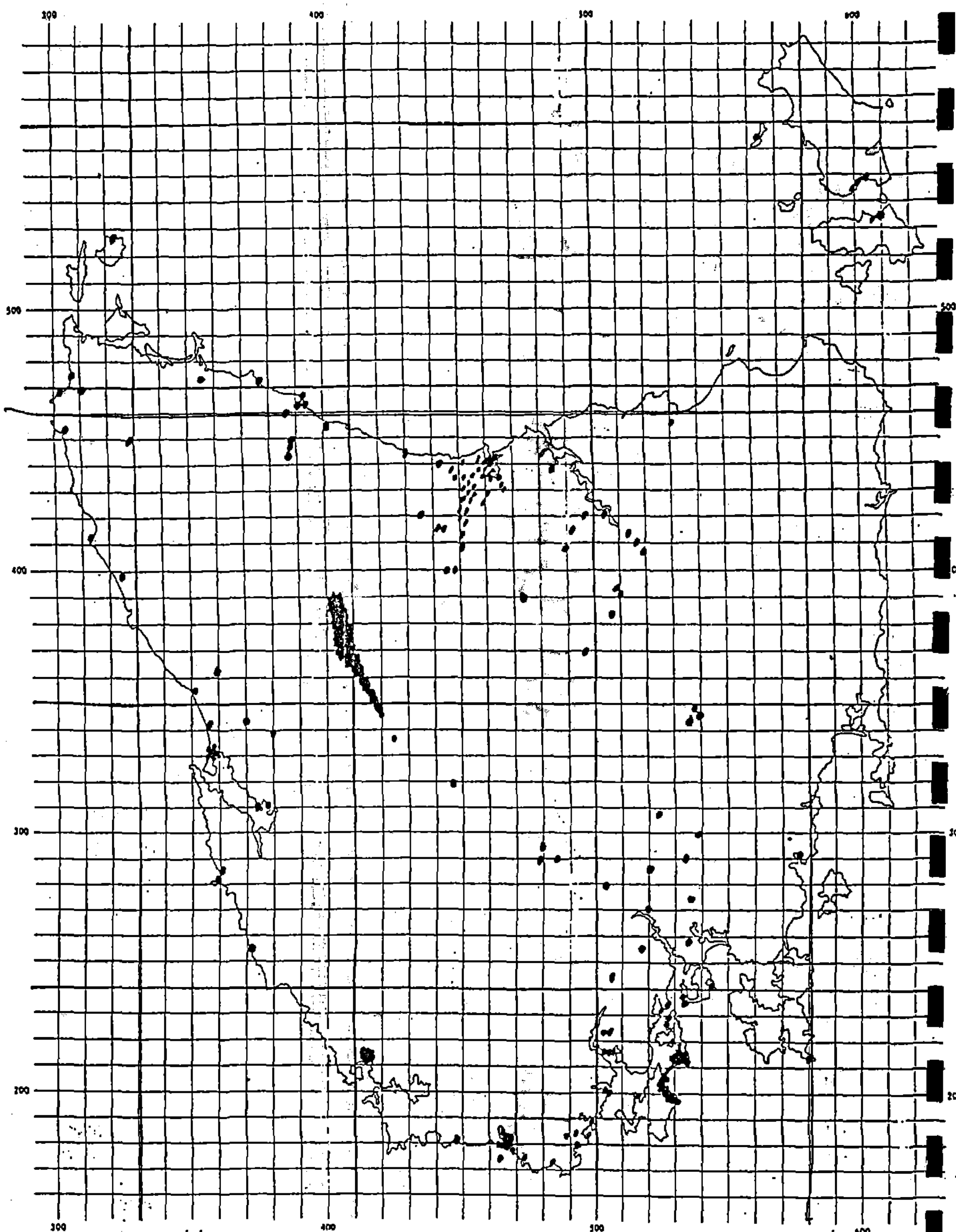


STERANES : COMPARATIVE ANALYSIS OF LIMESTONE AND ONSHORE SEEPAGE
BRUNY ISLAND

FIGURE 3C

392072

MAP OF OCCURRENCES



DISTRIBUTION OF PROVEN AND REPORTED SEEPAGES AND TARS (ARCHIVAL)
Note patterns and groupings. Compare Figures 3B, 3D

FIGURE 4

392073

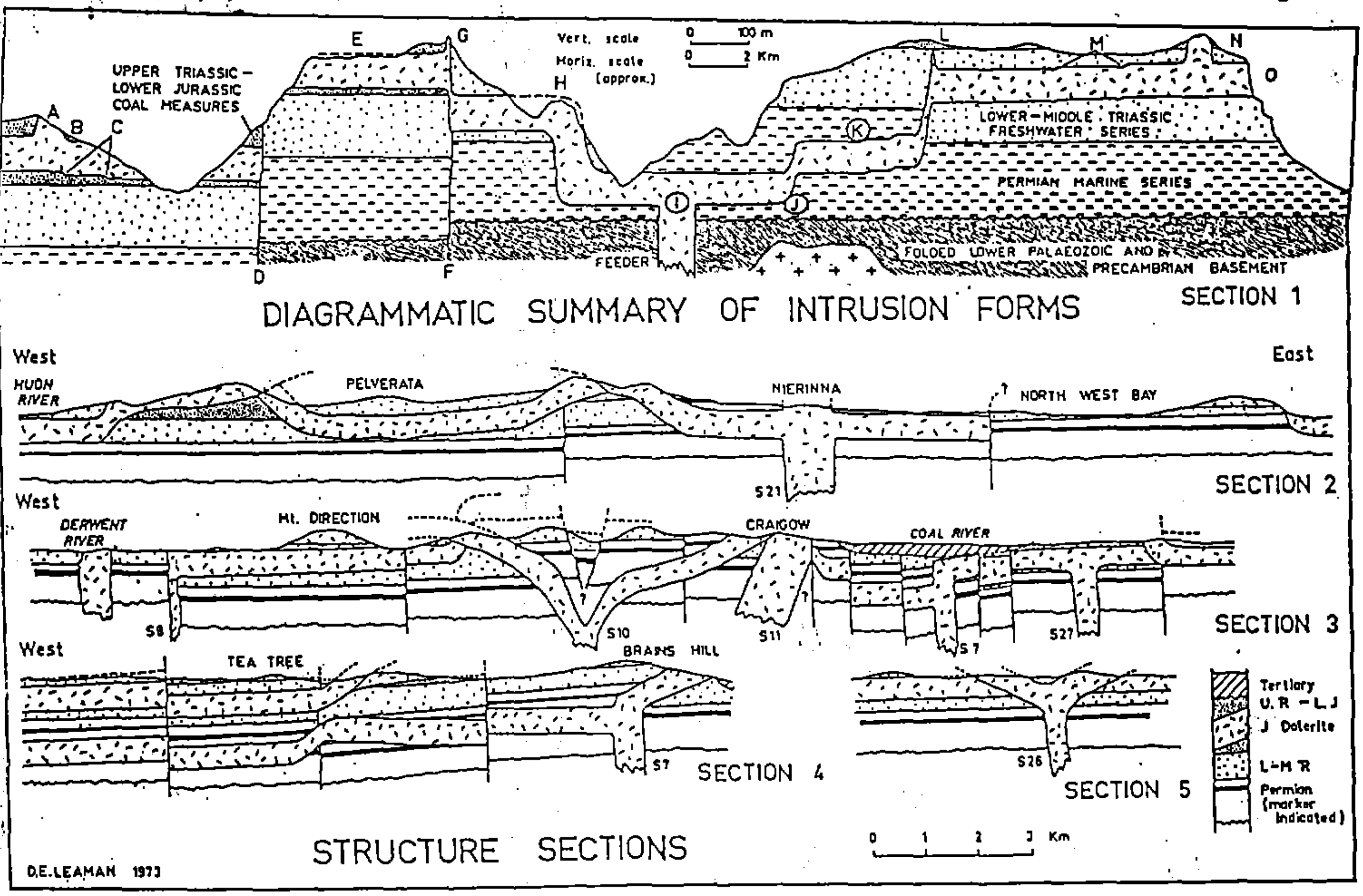
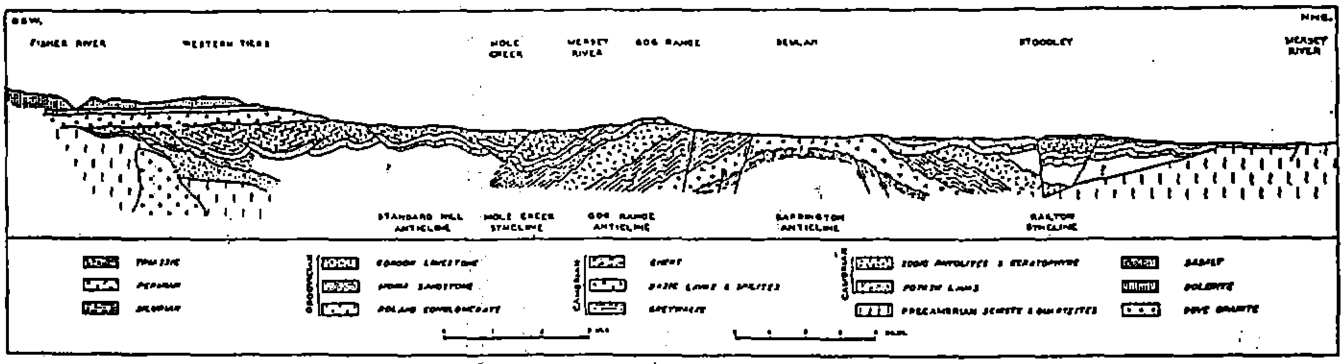


Fig. 2: Vertical sections of dolerite intrusion forms. 1: Diagrammatic summary of intrusion forms. Capital letters indicate features discussed in text. 2, 3, 4, and 5: East to west geological sections located by reference to Fig. 1 and Fig. 3. S7, S11, etc., refer dolerite sheets to their appropriate feeding sources in Fig. 3.

POST CARBONIFEROUS SECTION: SUMMARY OF RELATIONSHIPS
(after Leaman, 1975)

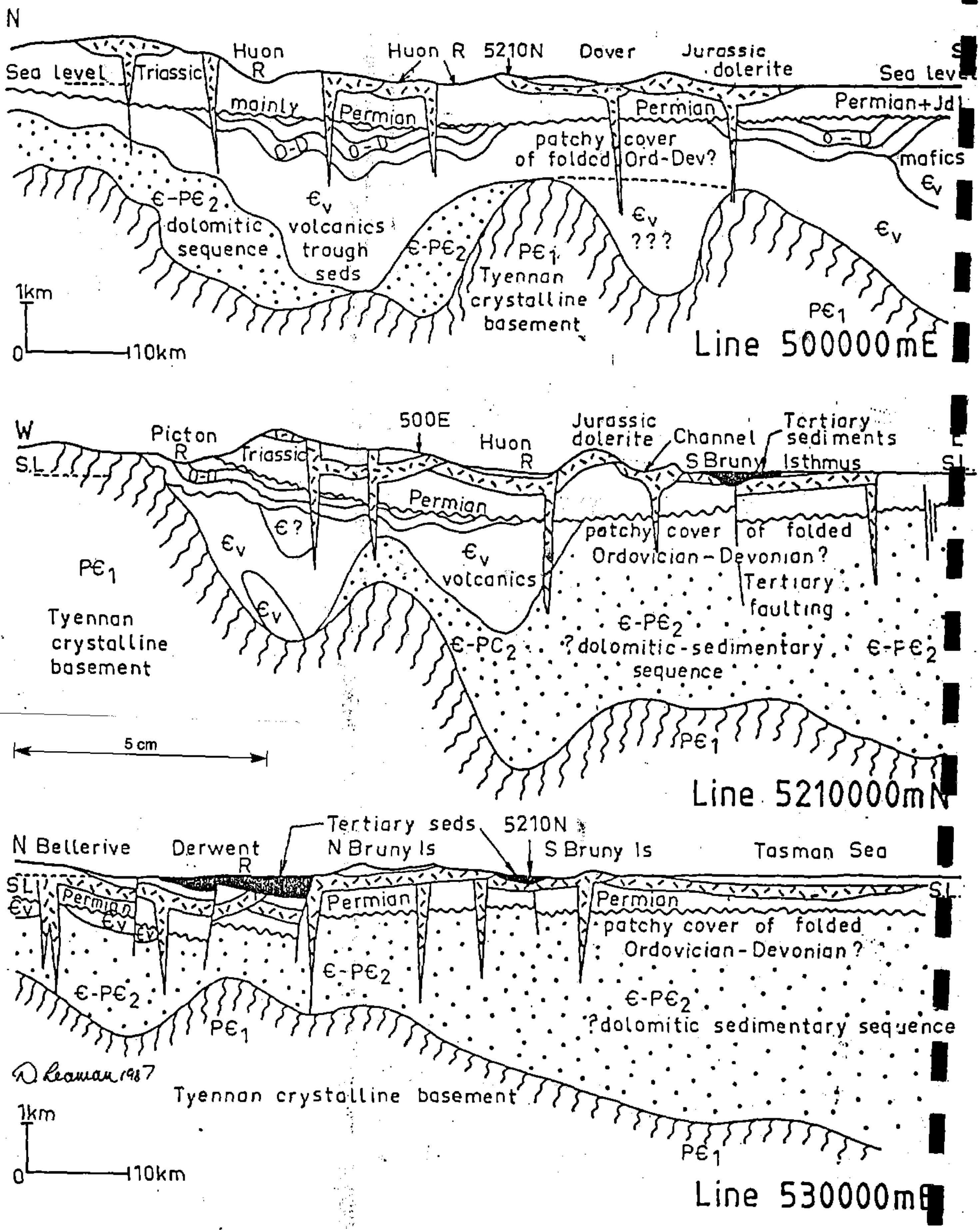


Section through the North-West Coast (I. B. Jennings).

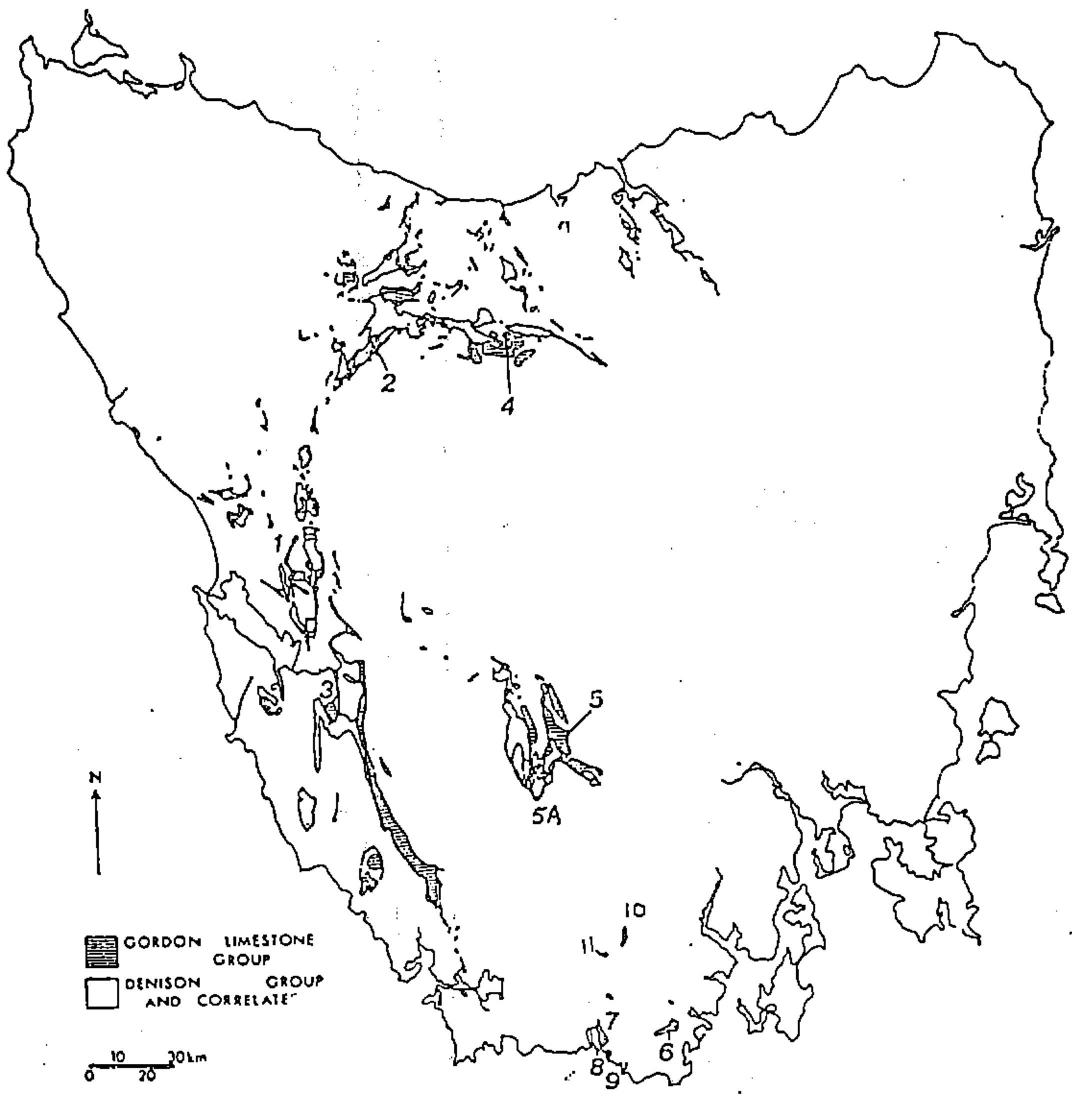
PRE CARBONIFEROUS SECTION: SUMMARY OF RELATIONSHIPS
(from Geology of Tasmania, J.geol.Soc.Aust., 9, 1962)

5 cm

FIGURE 5A



SECTIONS : INTERPRETED RELATIONSHIPS IN SOUTH EAST TASMANIA



5 cm

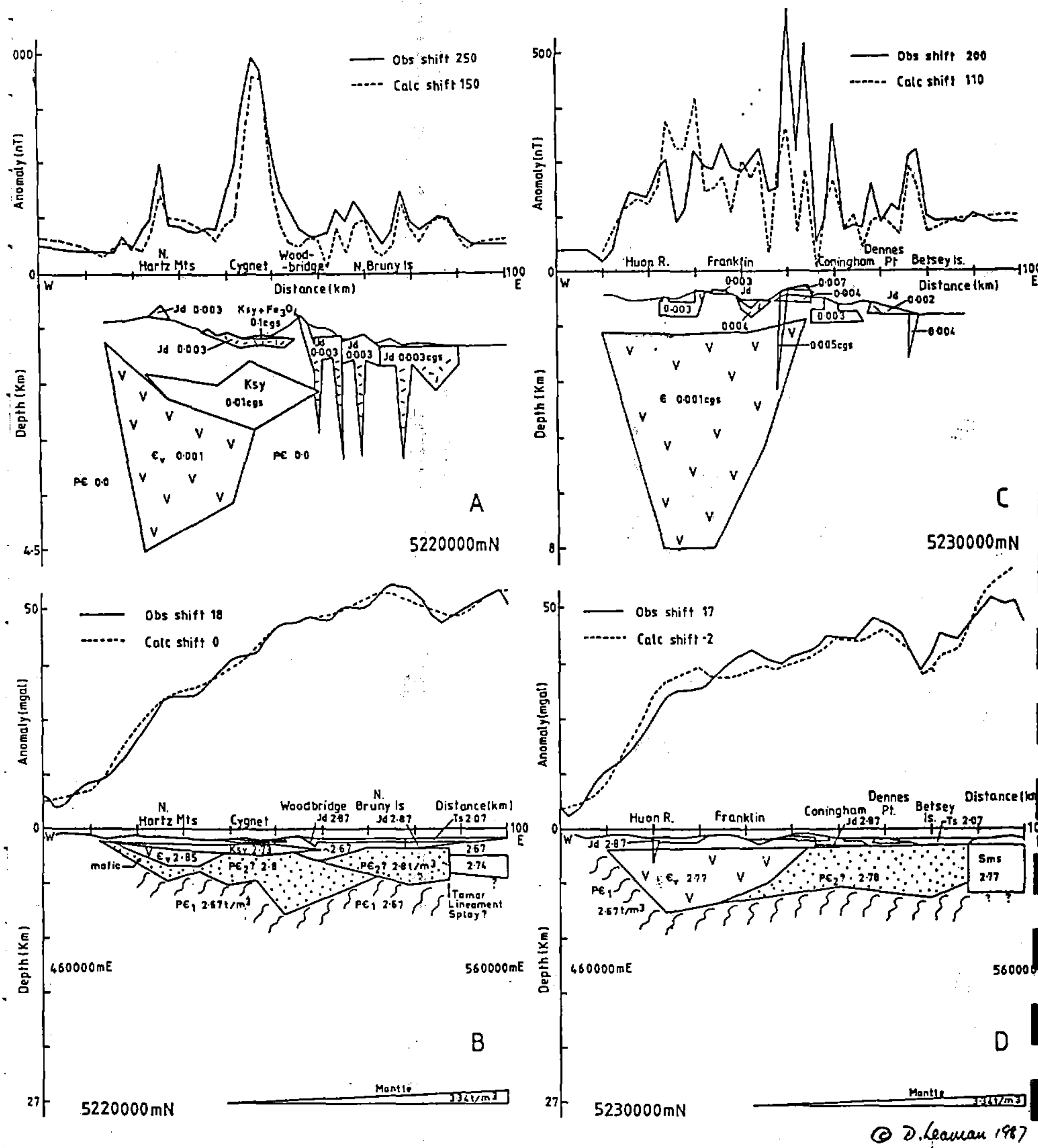
EXPOSURE OF ORDOVICIAN ROCKS
(map after Burrett)

Table: Conodont alteration index for sites 5 to 11

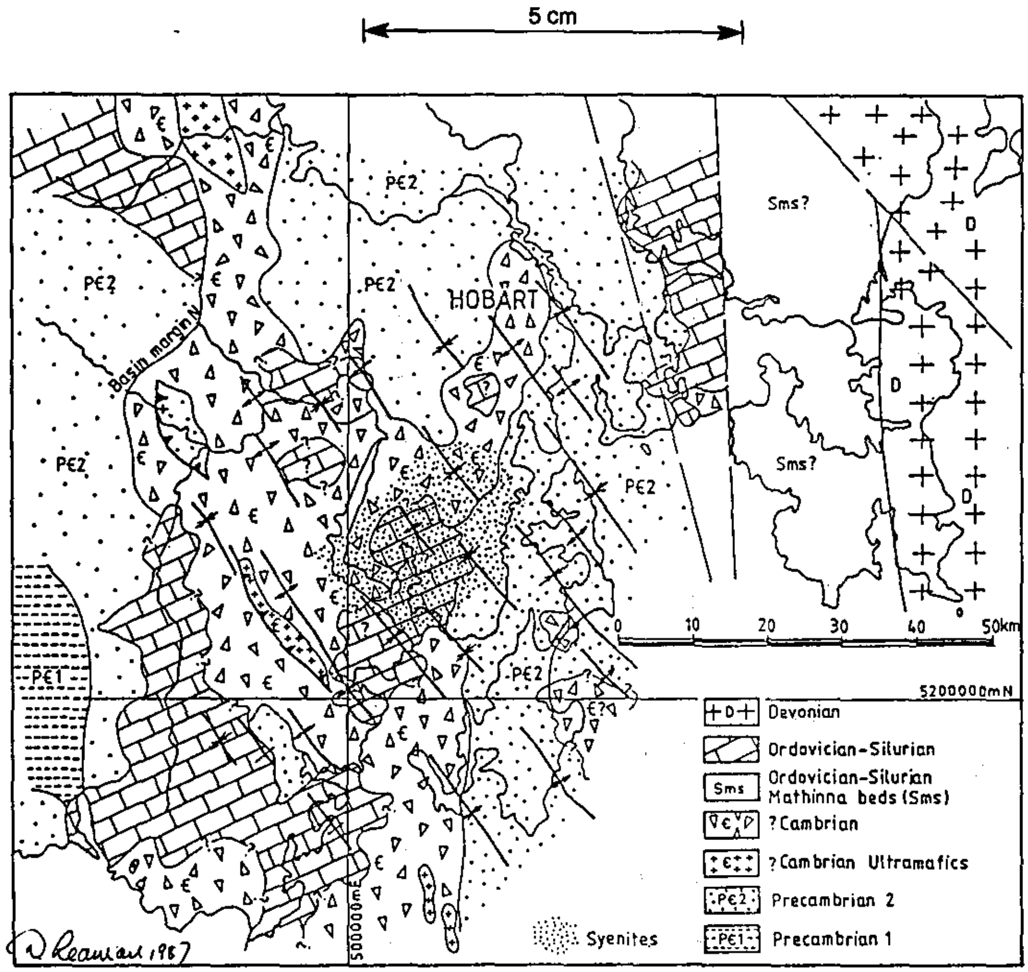
site	index
5	2
5A	4
6	1.5
7	2
8	1.5
10	1.5
11	5

FIGURE 5C

392076



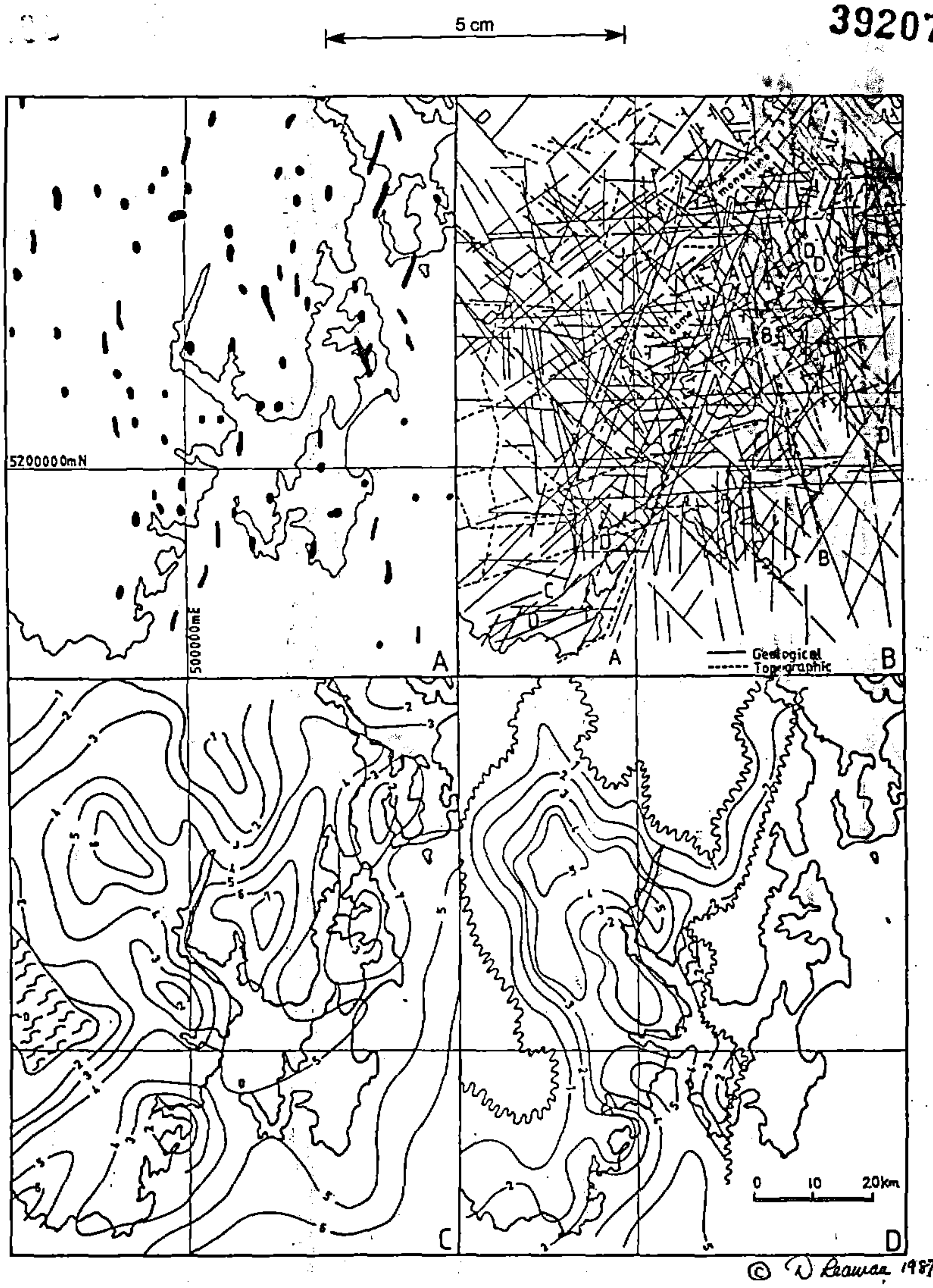
EXAMPLES OF INTERPRETATION MODELS AND CHARACTER OF MAGNETIC AND GRAVITY FIELDS IN SOUTH EAST TASMANIA FIGURE 5D
Compare Figures 5B and 5F.



NATURE OF GEOLOGY INFERRED BENEATH PERMIAN UNCONFORMITY IN SOUTHERN TASMANIA
(based on initial geophysical interpretations. Provisional)
Note that distribution of Ordovician-Silurian rocks is not yet well defined and will be the subject of second order refined analysis. The indicated fold systems are likewise sketchy at this stage.
Compare this plan with sections and basin structure contours in Figures 5B, 5D and 5F.

FIGURE 5E

974 ... 392078



SUMMARY OF STRUCTURAL INFORMATION DEDUCED FROM GRAVITY AND MAGNETIC DATA IN SOUTH EAST TASMANIA. See also Figures 5B, 5D, 5E.

A: Location and orientation of Jurassic dolerite feeders. The pattern is non random and is related to older flexures.

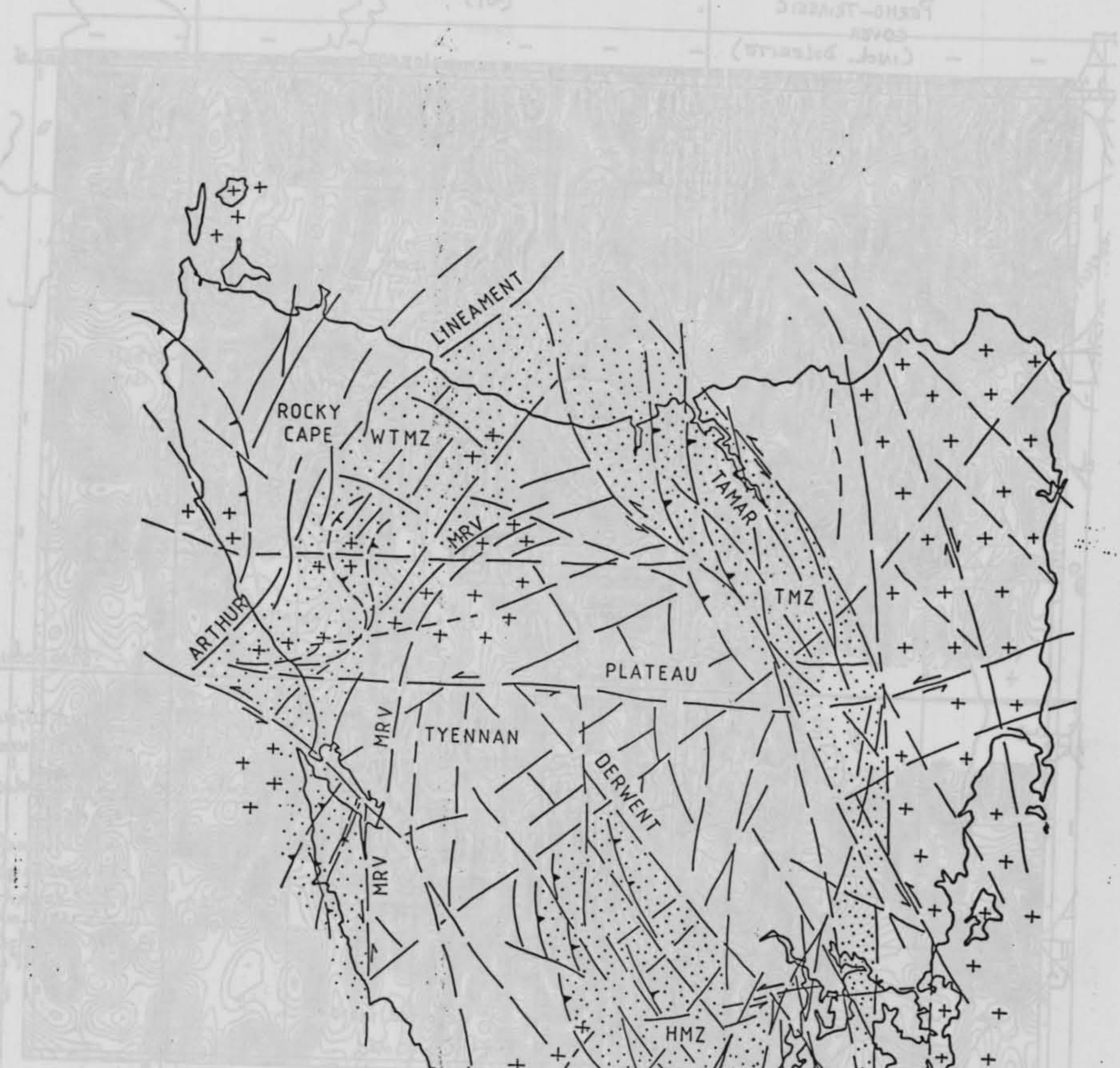
B: Trend summary diagram, all data. Labelled structures exemplify major axes rejuvenated.

C: Contours in km below sea level of depth to crystalline basement.

D: Contours in km below sea level of base of Cambrian (?) units - incl. volcanics. Gap between C and D represents a variable thickness of Late Precambrian dolomitic sequences.

FIGURE 5F

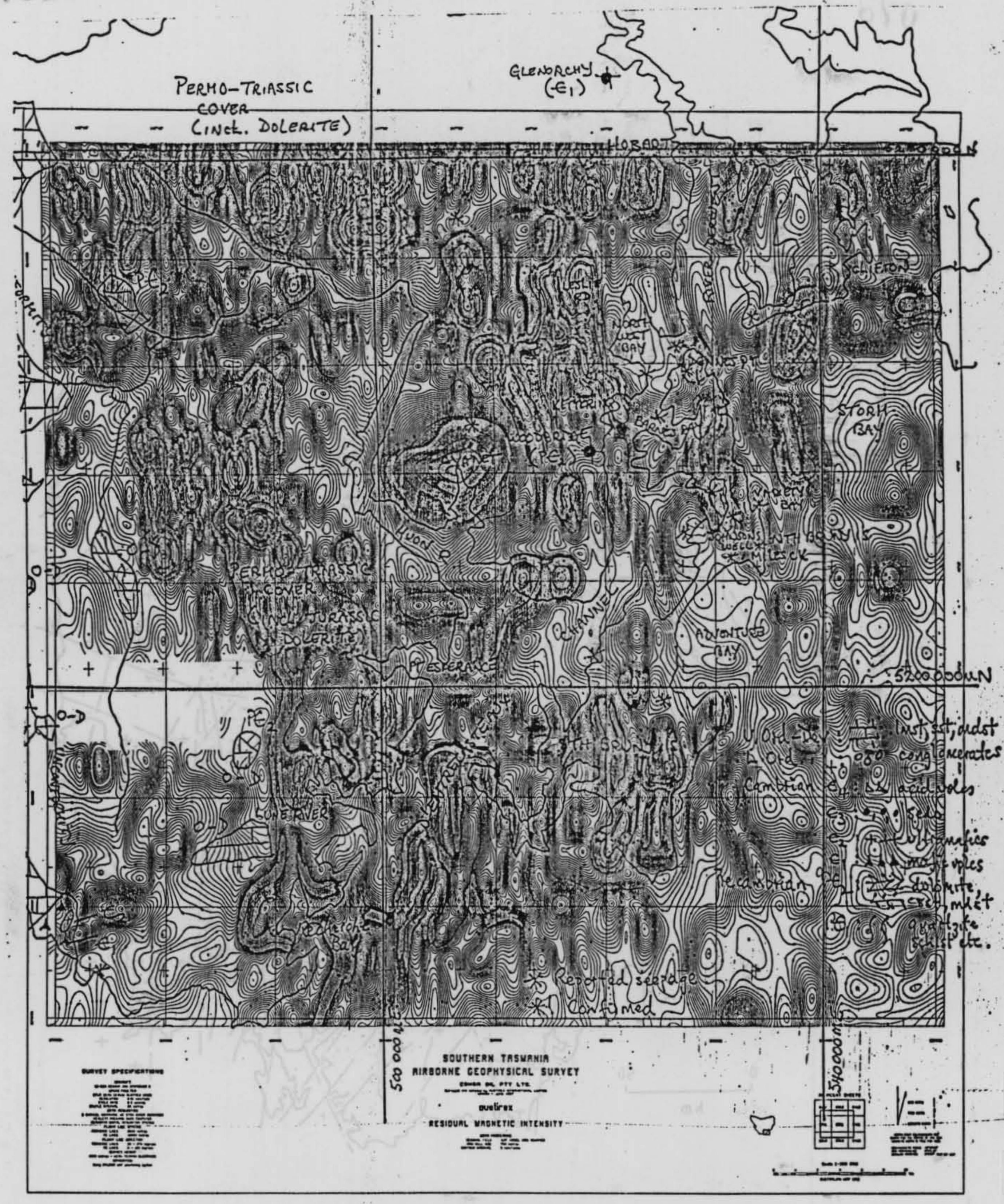
392079



REGIONAL SUMMARY OF MAJOR STRUCTURES AND LINEAMENTS INFERRED IN THE UPPER CRUST OF TASMANIA (after Leaman & Richardson, 1990) Note that many of these features and trends can be easily recognised in gravity and magnetic data (Figures 6B, 6D), and also in seep patterns (Figure 4).

FIGURE 5G

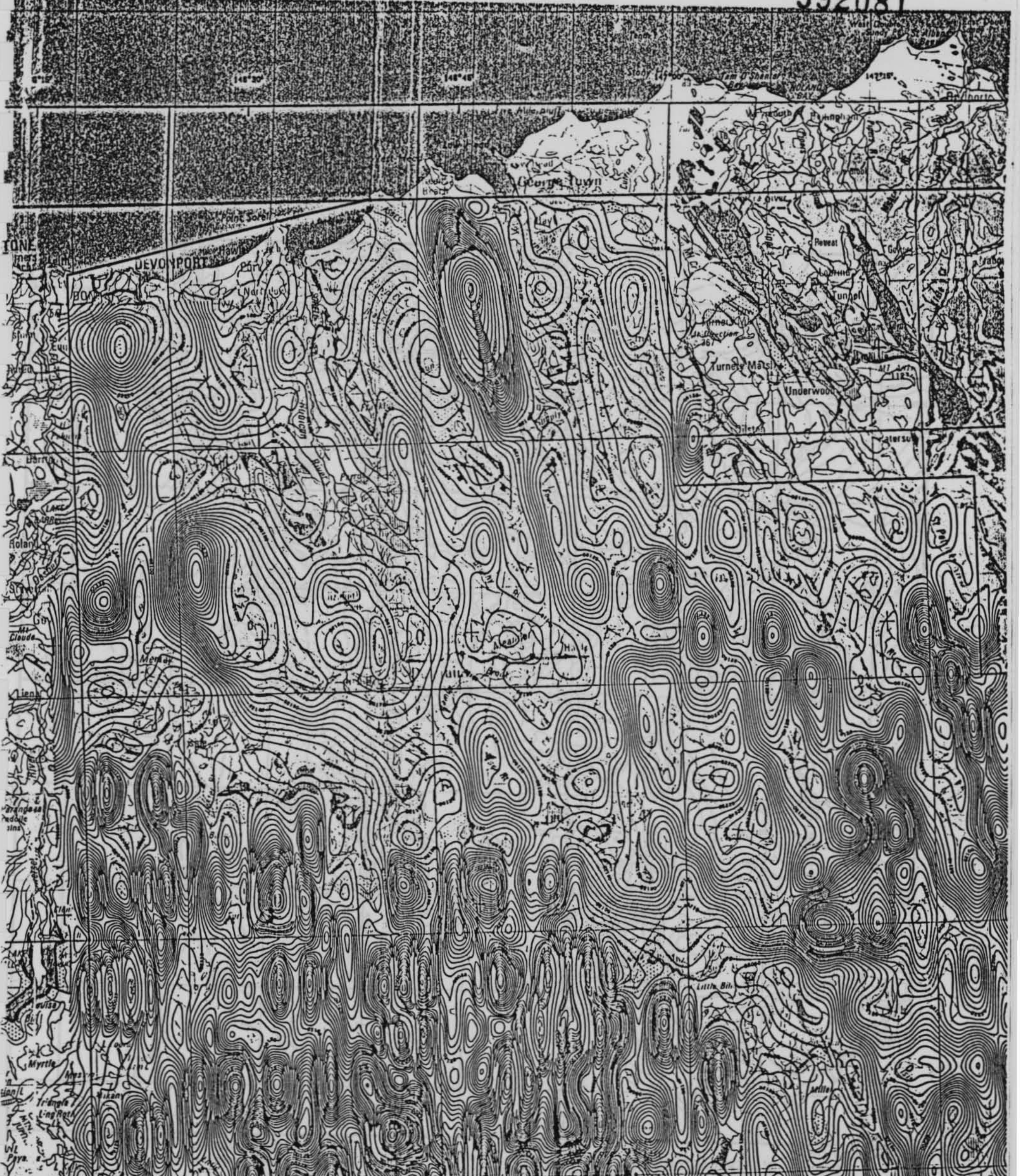
392080



5 cm

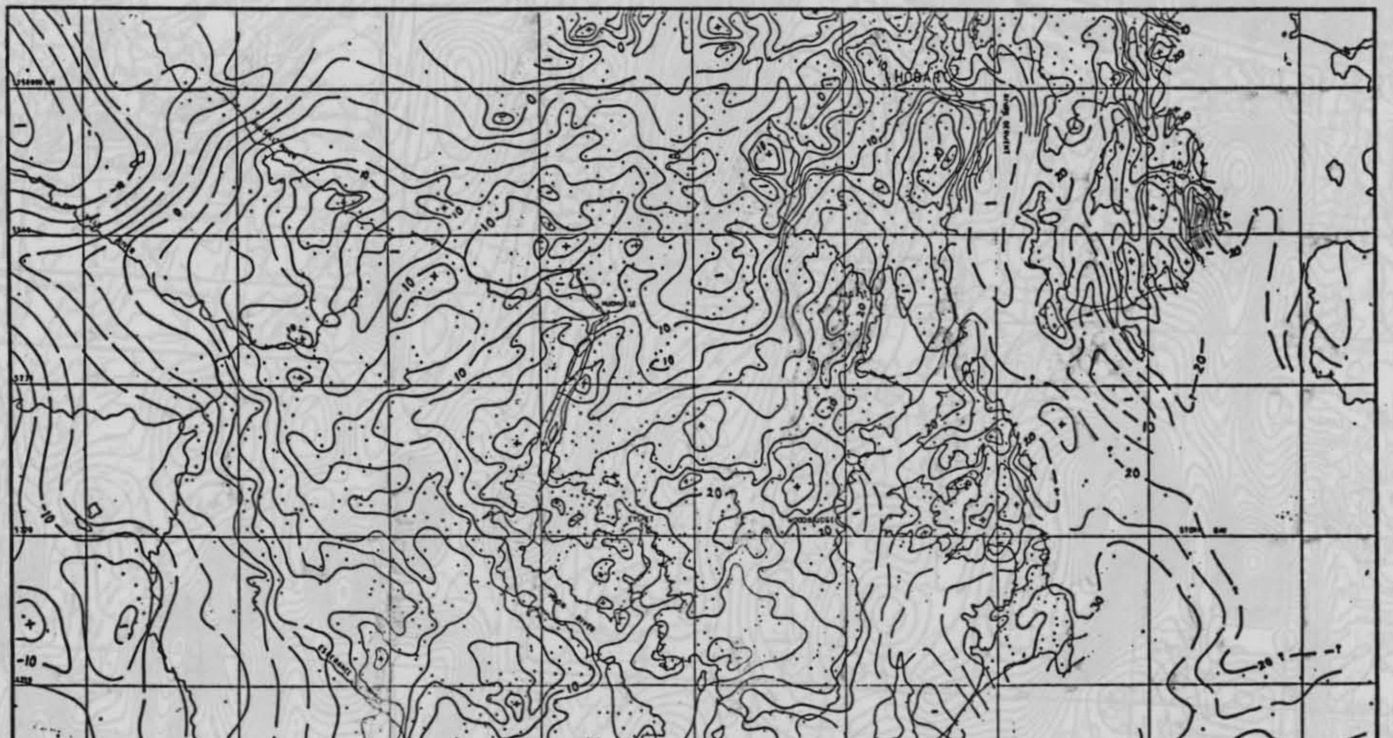
MAGNETIC SURVEY OF SOUTH EAST TASMANIA
Coastline and some locations provided. The more obvious anomalies are related either to dolerite feeders (see Figure 5F) or the trough fills containing Cambrian volcanics (see Figure 5D).

FIGURE 6A

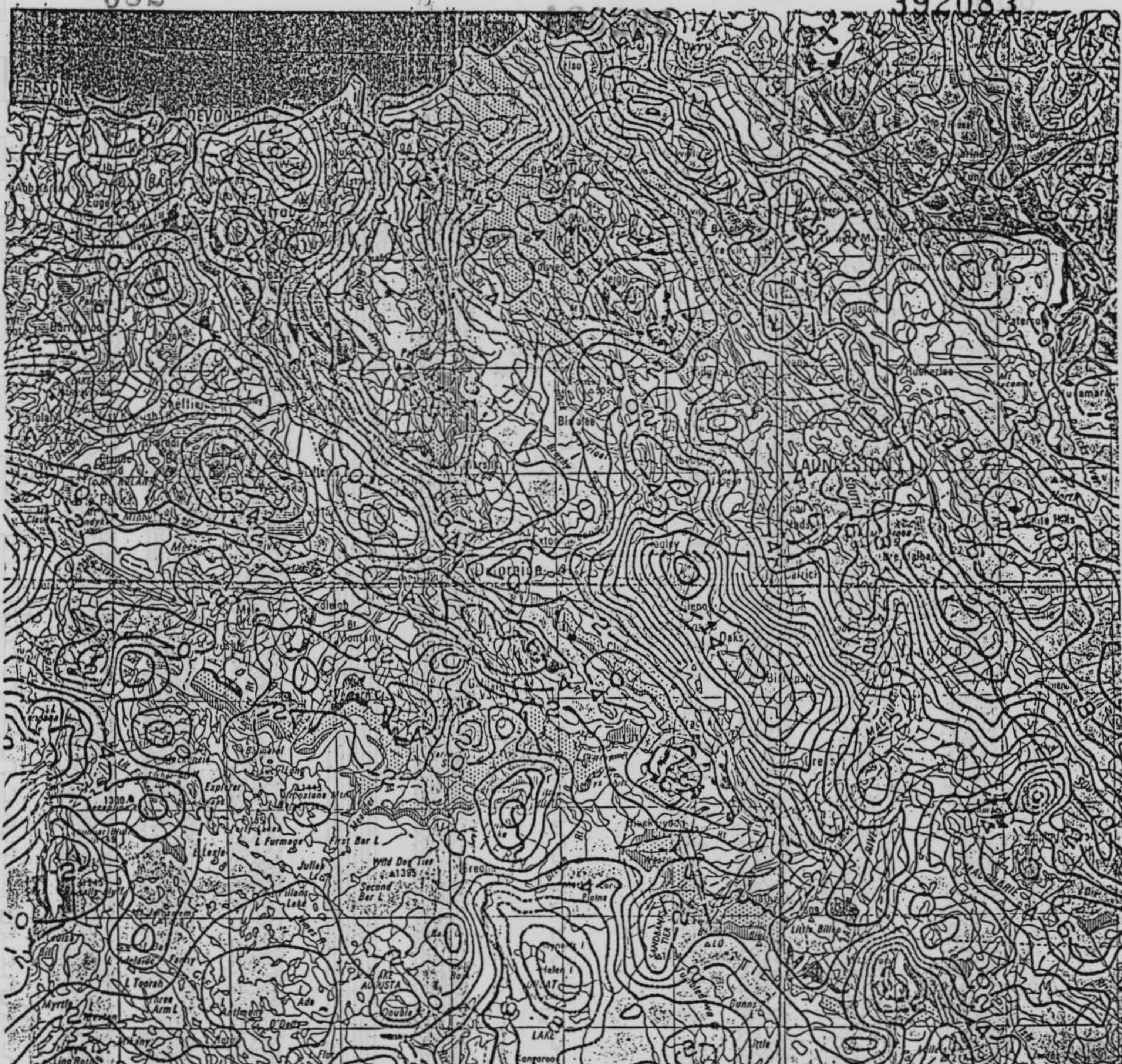


EXTRACT FROM MAGNETIC SURVEY OF CENTRAL TASMANIA
Note the well defined, deep source lineaments west of Launceston. The "noisy" field in the SW of the figure reflects dolerite capping of the central plateau less than 400 m below the magnetometer. Note that the contours describing the dolerite character are to some extent line biassed. Even so definite character of more regional origin is imposed. FIGURE 6B

392082

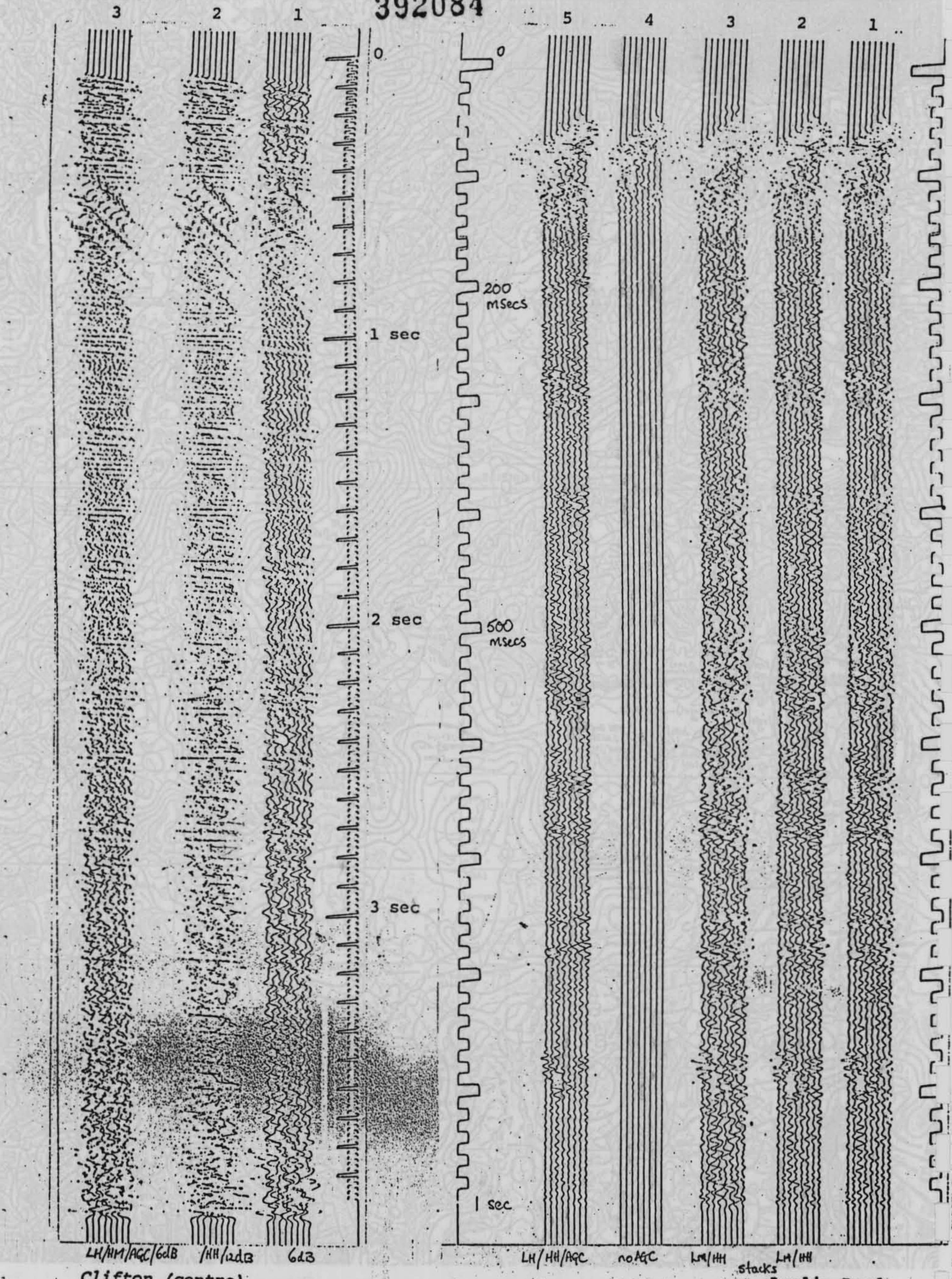


GRAVITY FIELD IN SOUTH EAST TASMANIA FIGURE 6C



RESIDUAL GRAVITY ANOMALIES IN NORTH-CENTRAL TASMANIA
Residual anomalies produced by the Mantle-88 separation process of Leaman & Richardson (1989).

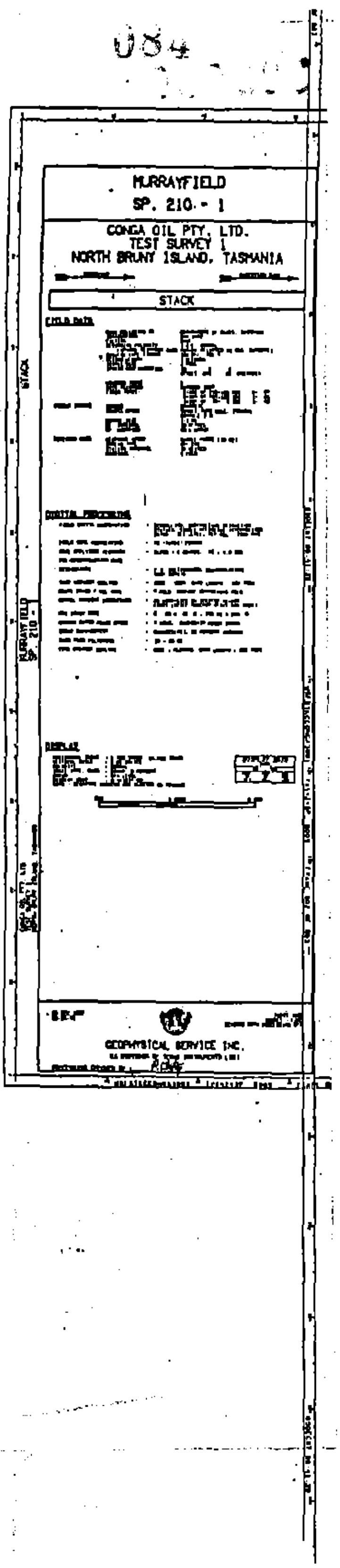
FIGURE 6D

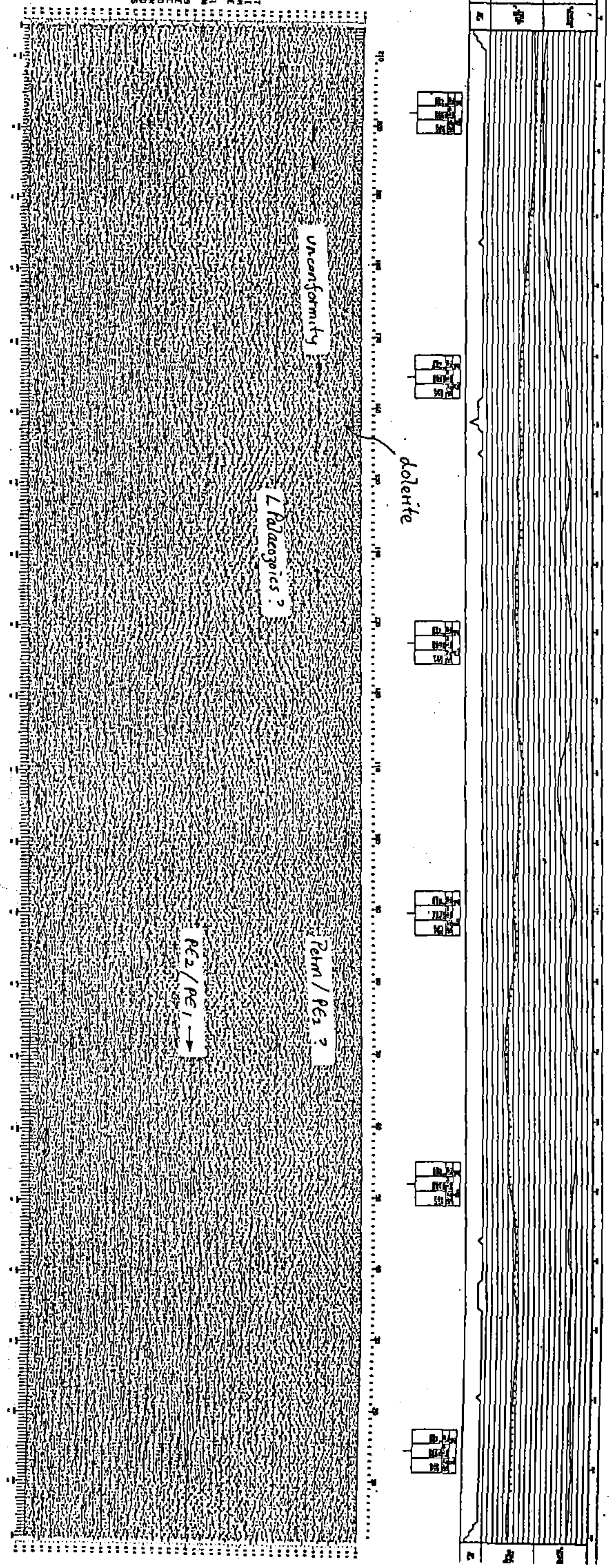


SEISMIC REFLECTION RESEARCH TRIALS : CLIFTON AND LESLIE RD
Data show that deep reflections can be observed at good sites.

FIGURE 6E

392085

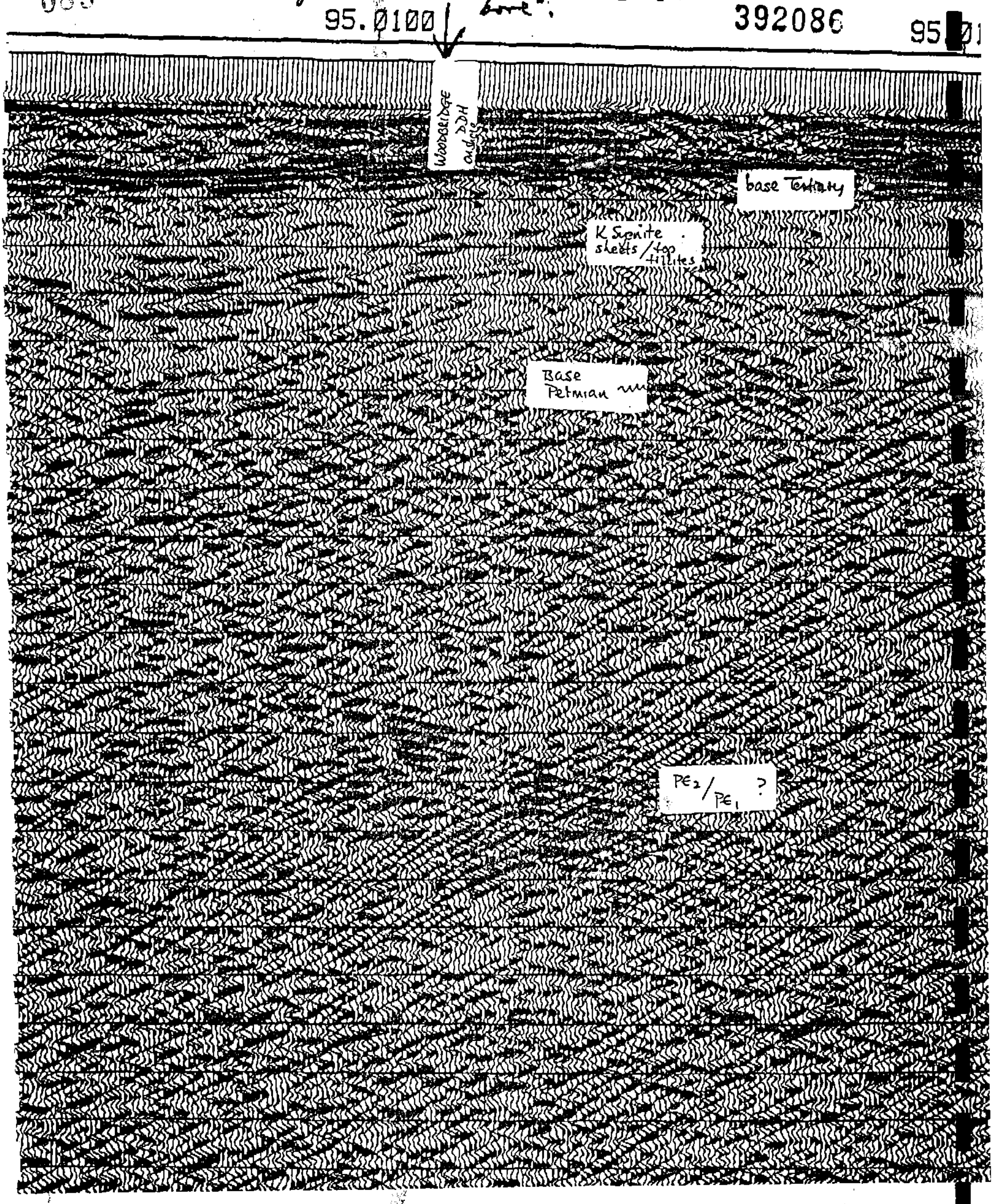




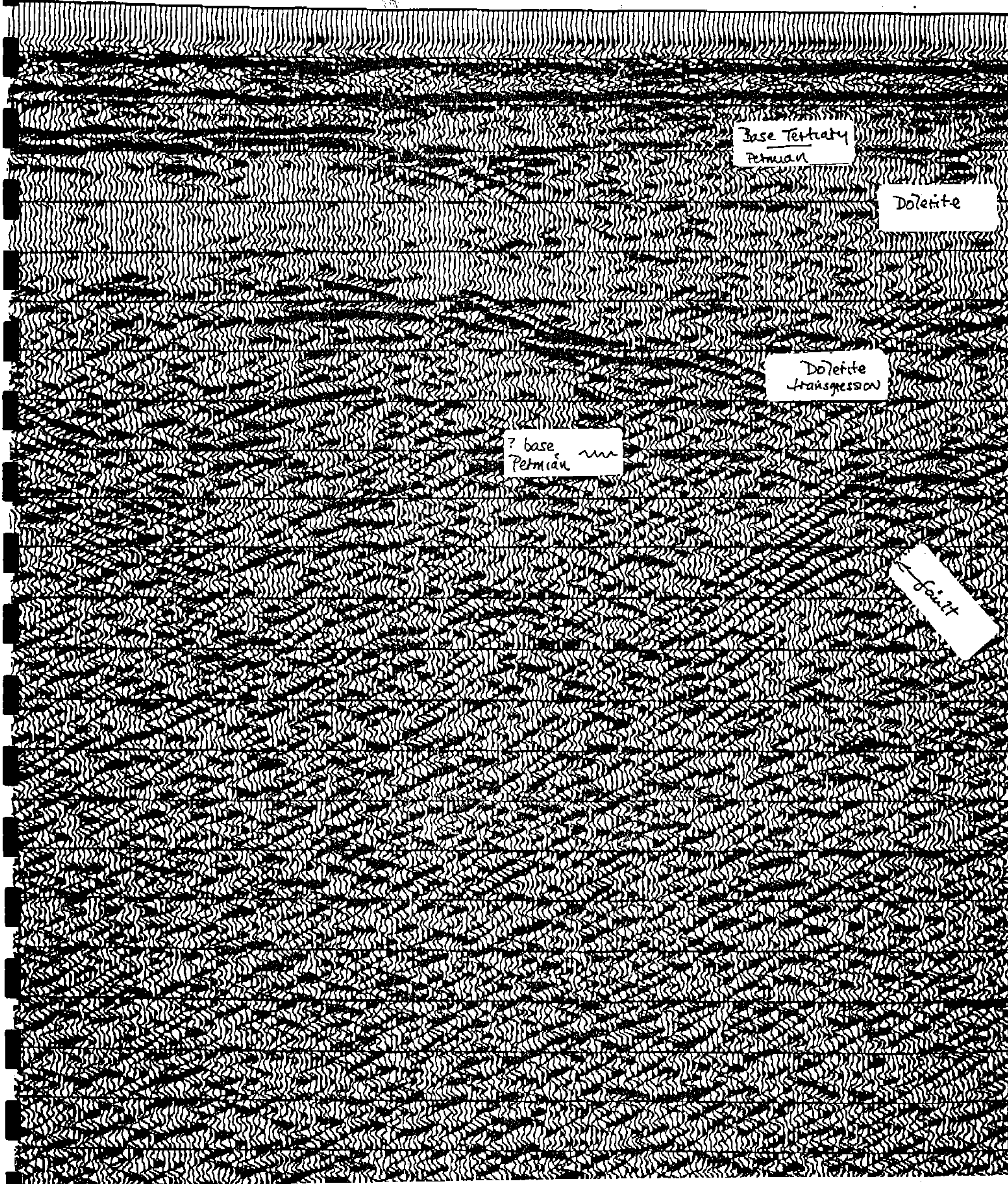
MURRAYFIELD TRAVERSE
NORTH BRUNY ISLAND

FIGURE 6F

5 cm



EXAMPLE OF MARINE SEISMIC DATA, D'ENTRECASTEAUX CHANNEL NEAR WOODBRIDGE.
Note deep character extracted by AGC. Relatively low amplitude information from 0.2 to 0.8 secs is typical and in the past has limited extraction of useful information.
Data and processing [illegible] (BMR, Canberra) [illegible]



EXAMPLE OF MARINE SEISMIC DATA, D'ENTRECASTEAUX CHANNEL NEAR GORDON.
Interpretation shown is not verified. This region contains complex dolerite intrusion forms. Note, as in Figure 6G, that there are no clear deep reflections. This is consistent with the implications of Figures 5B and 5E. FIGURE 6H

087

392088

APPENDIX 3

CSIRO
Marine Laboratories

REPORT 90-HC1

PRELIMINARY REPORT ON THE ORGANIC GEOCHEMISTRY OF SOME TASMANIAN BITUMENS

Prepared by: J. K. Volkman and T. O'Leary
CSIRO Division of Oceanography, Hobart

For: Mr Malcolm Bendall
Managing Director
Conga Oil Pty. Ltd.
84 Wells Parade
Blackmans Bay
Tasmania

May 7, 1990

CSIRO
AUSTRALIA

SAMPLES

This report documents the hydrocarbon compositions of 13 bitumen samples obtained from the Victoria Museum in Launceston and Tasmanian Museum in Hobart by Mr P. Baillie of the Tasmanian State Government Department of Resources and Energy. These analyses have been undertaken at the request of Conga Oil Pty. Ltd.

The data presented have not been examined in detail so that any interpretations must be considered as preliminary. A more complete report will be provided later. Full GC and GC-MS data are shown in the Appendix. Data from the Flinders Island bitumen sample, which are generally representative of all the samples, are shown in the body of the text for illustrative purposes.

The samples were all hard, black, shiny asphaltic bitumens. They show a characteristic concoidal fracture when broken. They contain no inorganic matter and dissolve completely in polar organic solvents such as chloroform. The samples were originally collected from coastal sites around the west coast of Tasmania and from King and Flinders Island to the north in Bass Strait. Many of these samples are mentioned in a report on petroleum exploration in Tasmania by the Government geologist W. H. Twelvetrees (1917) and thus are presumed to have been collected from the turn of the century. A list of samples is provided in Table 1 together with their museum identification codes. Note that the Launceston samples were recatalogued in 1956-57 and thus the "date code" does not refer to their date of collection.

METHODS AND RESULTS

Total Hydrocarbon Content

A portion of the chloroform extract was analysed by Iatroscan thin-layer chromatography-flame ionisation detection (Volkman *et al.*, 1986) to determine the total hydrocarbon concentration in each bitumen. Typical TLC-FID chromatograms are shown in Figure 1. Quantitative data are shown in Table 1. Aliphatic plus aromatic hydrocarbons represented 17.1 - 21.1 % of the total extract with the remainder consisting of polar resins and asphaltenes. This method has an accuracy of about 6 %, so the values obtained are probably not statistically different.

TABLE 1. Hydrocarbon and asphaltene contents of Tasmanian bitumens.

Museum Code	Location	Hydrocarbons %	Asphaltenes %
1956-33-357	Flinders Island	18.4	81.6
1956-33-359	Deep Creek, Port Davey	19.4	80.6
1956-33-360	Rocky Boat Harbour	18.9	81.1
1956-33-361	Albina (A)	20.5	79.5
1956-33-361	Albina (B)	18.6	81.4
1956-33-362	Mouth of Deep Creek, Port Davey	20.4	79.6
1956-33-364	Surprise River Beach	19.0	81.0
1957-33-944	Port Hibbs	20.6	79.4
1957-33-946	Beach at Port Davey	17.1	82.9
1957-33-948	King Island	21.0	79.0
1957-33-949	New River	20.0	80.0
X2283*	Marrawah	19.3	80.7
X3256*	Flinders Island	21.1	78.9

* Samples from Tasmanian Museum, Hobart. All other samples from Queen Victoria Museum, Launceston.

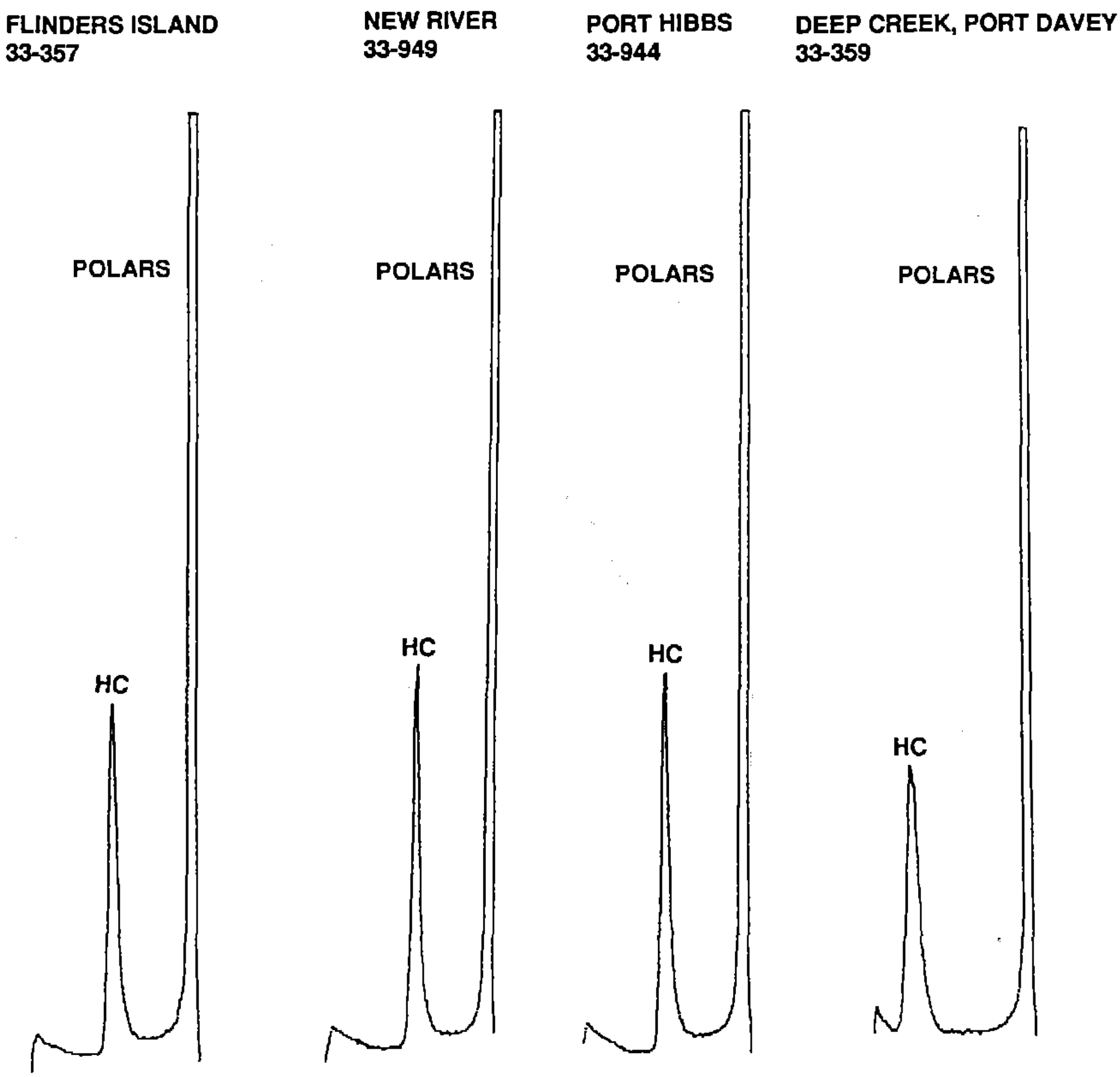


Figure 1. Representative Iatroscan thin layer chromatography-flame ionisation detection (TLC-FID) chromatograms of the solvent extract from the bitumens. POLARS-asphaltenes and resins; HC-hydrocarbons. Solvent system: hexane:diethyl ether 94:6.

Saturated and aromatic hydrocarbons were isolated by applying 30 mg of extract to a column of 3 g of silicic acid (100-200 mesh) capped with 1 g of activated alumina (BDH). Aliphatics were eluted with hexane (20 ml), and a second fraction containing aromatic hydrocarbons was obtained by eluting with toluene:hexane (1:1; 20 ml). Resins and asphaltenes were eluted with chloroform (20 ml) and methanol (10 ml).

Hydrocarbon fractions were analysed by capillary gas chromatography on a 50 metre non-polar methyl silicone fused silica capillary column. A gas chromatogram of the aliphatic hydrocarbons is shown in Figure 2. The temperature program was 50 ^{o}C for 1 minute followed by a ramp of 30 ^{o}C/min. to 150 ^{o}C, then a ramp of 2 ^{o}C/min. to 250 ^{o}C and then a ramp of 5 ^{o}C/min. to 300 ^{o}C. The oven was maintained isothermally at 300 ^{o}C for 15 minutes. Note that this gives very good separation in the middle regions of the chromatogram and tends to sharpen the late-eluting peaks which appear higher than might otherwise be expected. Peak areas were measured using DAPA software.

Aliphatic Hydrocarbons

Each bitumen shows a remarkably similar distribution of aliphatic hydrocarbons which is similar to that of a mature crude oil except that volatile hydrocarbons (<n-C_{10}) are absent. Volatile hydrocarbons are incompletely recovered by the extraction procedures, but the reduced abundance of (n-C_{11} - n-C_{15}) alkanes is not an artifact of the extraction procedure and clearly a genuine feature of all the samples.

Homologues extend at least to n-C_{35} (Fig. 2), but these higher molecular weight components are not abundant indicating that the bitumens are not derived from the type of waxy crude oil more commonly associated with Gippsland Basin crudes. The major n-alkane in all but 2 samples is n-C_{16}. The exceptions are the two samples obtained from the Tasmanian Museum (Marrawah X2283 and Flinders Island X3256) in which n-C_{18} is the major n-alkane (Appendix). These variations may reflect different effects due to weathering or storage. We do not know whether these samples were collected at the same times as those in the Victoria Museum.

A complex mixture of branched and cyclic alkanes is obvious in the chromatograms as clusters of peaks eluting between the n-alkanes, but they are relatively minor constituents compared with the n-alkanes. Pristane and phytane are the most conspicuous branched constituents in all samples. Longer-chain isoprenoids are comparatively minor components and botryococcane was not detected. The pristane/phytane ratios of most samples fall in the range 1.30-1.38. The exceptions are #33-946 from Port Davey and #33-948 from King River which have values of 1.22 and 1.26 respectively. Values only slightly greater than 1 are usually associated with a low oxygen or dysaerobic environment.

The two samples from the Tasmanian Museum have significantly lower pristane/phytane ratios of 0.94 (Marrawah) and 1.08 (Flinders Island) as well as lower concentrations of the C_{16} isoprenoid alkane. If we compare the two Flinders Island samples, the "loss" of n-C_{17} and pristane compared with n-C_{18} is very similar (25% and 14%) implying that the changes in isoprenoid ratios may simply be due to physical removal processes (e.g. evaporation on storage or due to weathering) rather than indicating a different source. We can state that the differences are not due to biodegradation since isoprenoids are not affected until the n-alkanes are substantially removed (Volkman *et al.*, 1983).

All the chromatograms show a small "unresolved complex mixture" (UCM or hump) throughout the chain-length range. The UCM is generally considered to represent a complex mixture of branched and cyclic alkanes that cannot be resolved into individual components, although recent theories suggest the presence of linear components joined together into "T-shaped" molecules (Gough and Rowland, 1989). The UCM appears to be bimodal, although this feature is not conspicuous in all samples.

The aliphatic hydrocarbon distributions give an overall impression of a non-waxy, weathered heavy crude oil. There is little to indicate that the samples have been water washed to any great extent and certainly they have been subjected to little biodegradation. It seems unlikely that they could have been floating in the sea for more than a few days (if at all), and that it is probable that they were derived from a source close to where they were collected.

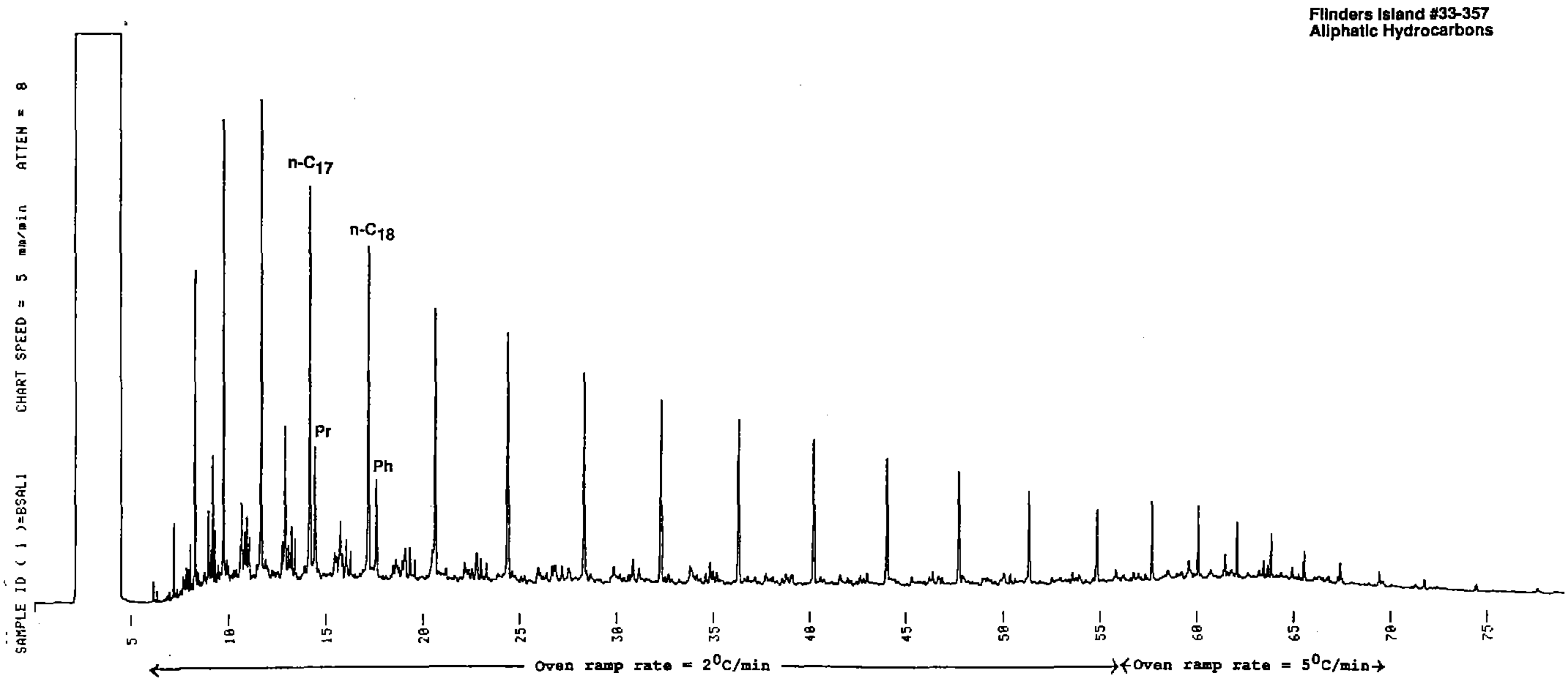


Figure 2. Capillary gas chromatogram of aliphatic hydrocarbons in the Flinders Island bitumen #33-357. Pr: pristane; Ph: phytane. n-Alkanes are denoted by n-C_x where "x" is the number of carbon atoms.

Biomarkers

To obtain more detailed information about the hydrocarbon composition, each aliphatic hydrocarbon fraction was analysed by gas chromatography-mass spectrometry in selected ion monitoring mode (SIM). n-Alkanes were not removed beforehand since their concentration in the biomarker region were quite low and did not interfere with the analysis.

Ion chromatograms for ions m/z 217 and 218 (steranes), m/z 259 (diasteranes), m/z 231 (methyl steranes), m/z 191 (hopanes and other triterpanes), m/z 177 (demethylated hopanes), m/z 205 (methyl hopanes) are shown in the Appendix.

(a) Steranes

Steranes are readily detectable constituents in all of the bitumens and the distributions in each case are remarkably similar. These hydrocarbons provide information about the maturity and source of a crude oil. Typical mass fragmentograms for m/z 217 and m/z 218 are shown in Figs. 3a and 4a.

C_{27} steranes predominate, but are only slightly more abundant than the C_{29} steranes and C_{28} steranes which occur in similar amounts (Fig. 3a). This feature is also found in hydrocarbons isolated from Ordovician limestones obtained from Ida Bay and Queenstown (Fig. 3b and 4b). Indeed the distributions are remarkably similar, even to the presence of significant amounts of diasteranes. Steranes in Tasmanites show a much higher predominance of C_{29} components and the diasterane/sterane ratio is also quite different (Denwer, 1986). Oils from the Gippsland and Bass Basins (Fig. 5) also typically show a high predominance of C_{29} steranes (presumably reflecting the importance of higher plants as source material), so it seems unlikely that the bitumens are associated with oils presently recovered from those basins. For the same reason, one can rule out coal as a source of the bitumens.

Lower molecular weight C_{21} and C_{22} steranes (Fig. 6a and 7a) are also present in the bitumens. The latter are usually associated with thermal cracking of higher molecular weight steranes. The m/z 218 mass fragmentograms in this region also resemble those in the limestones, but the m/z 217 mass fragmentograms of the latter show more peaks than is found in the bitumens (Fig. 6b and 7b).

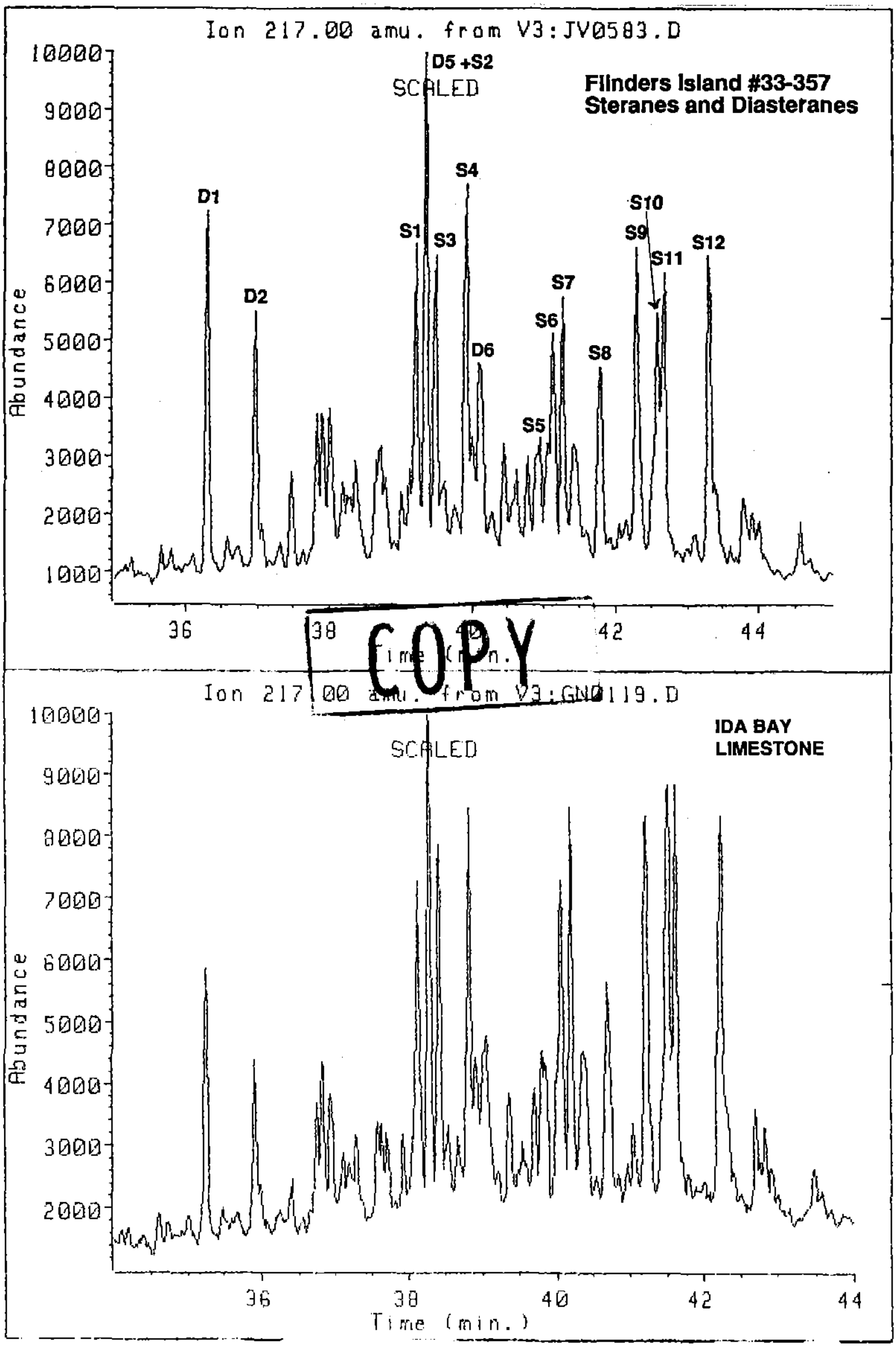


Figure 3. Mass fragmentograms for m/z 217 showing distribution of C_{26} - C_{30} steranes (labelled S) and diasteranes (labelled D) in (a) Flinders Island bitumen #33-357 and (b) Ida Bay Ordovician limestone. See accompanying Key for peak identifications. Note the high abundance of diasteranes which is often associated with sediments containing a high clay content.

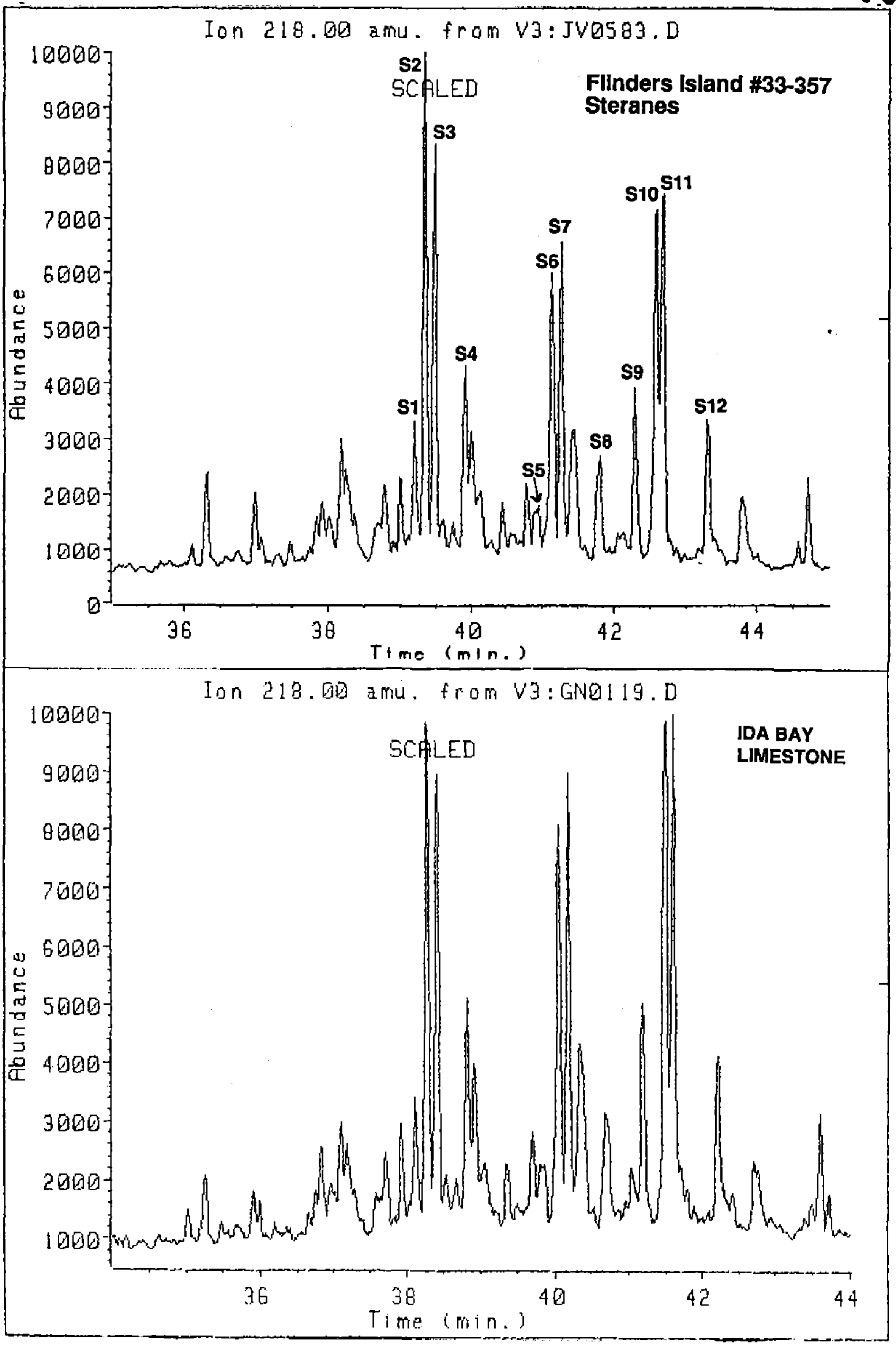


Figure 4. Mass fragmentograms for m/z 218 showing distribution of C_{26} - C_{30} steranes (labelled S) in (a) Flinders Island bitumen #33-357 and (b) Ida Bay Ordovician limestone. See accompanying Key for peak identifications. Note the higher abundance of C_{27} steranes.

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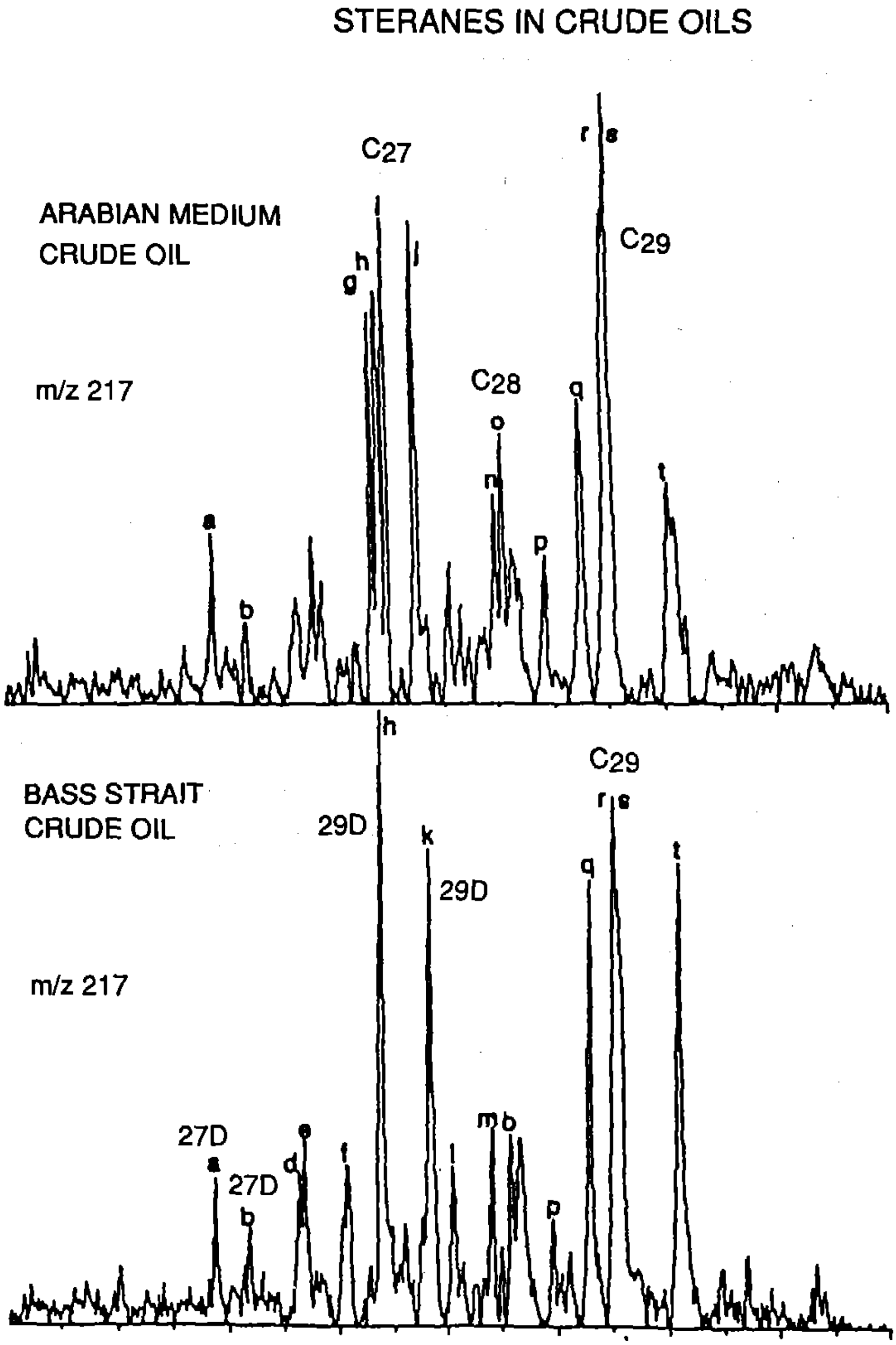


T.D. Gilbert (1987)
Proc. 9th. Aust. Anal. Conf. **1**, 17-20.

Figure 5. Mass fragmentograms for m/z 217 showing distribution of C_{26} - C_{30} steranes in Bass Strait and Middle East crude oils.

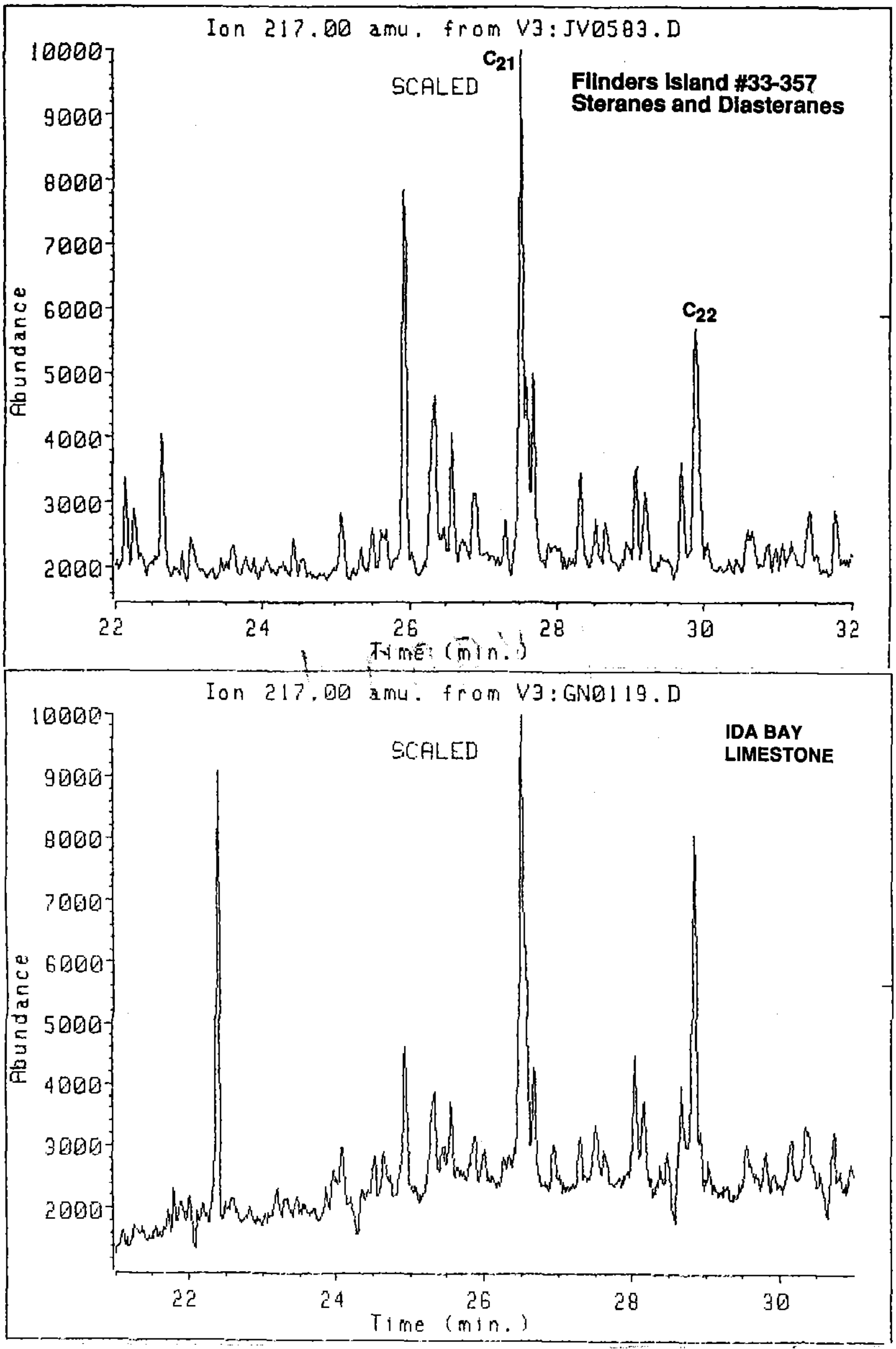
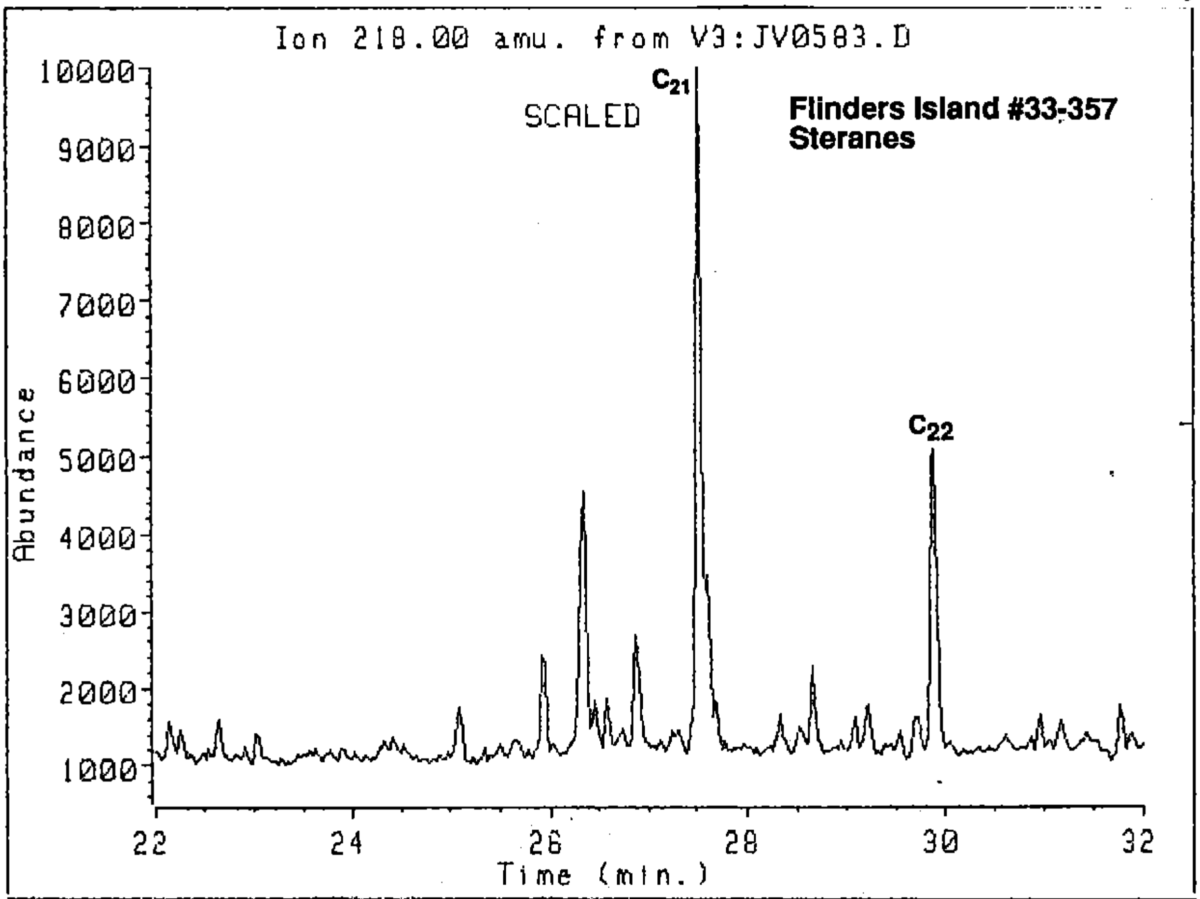


Figure 6. Mass fragmentograms for m/z 217 showing distribution of C_{21} - C_{23} steranes (labelled S) and diasteranes in (a) Flinders Island bitumen #33-357 and (b) Ida Bay Ordovician limestone.



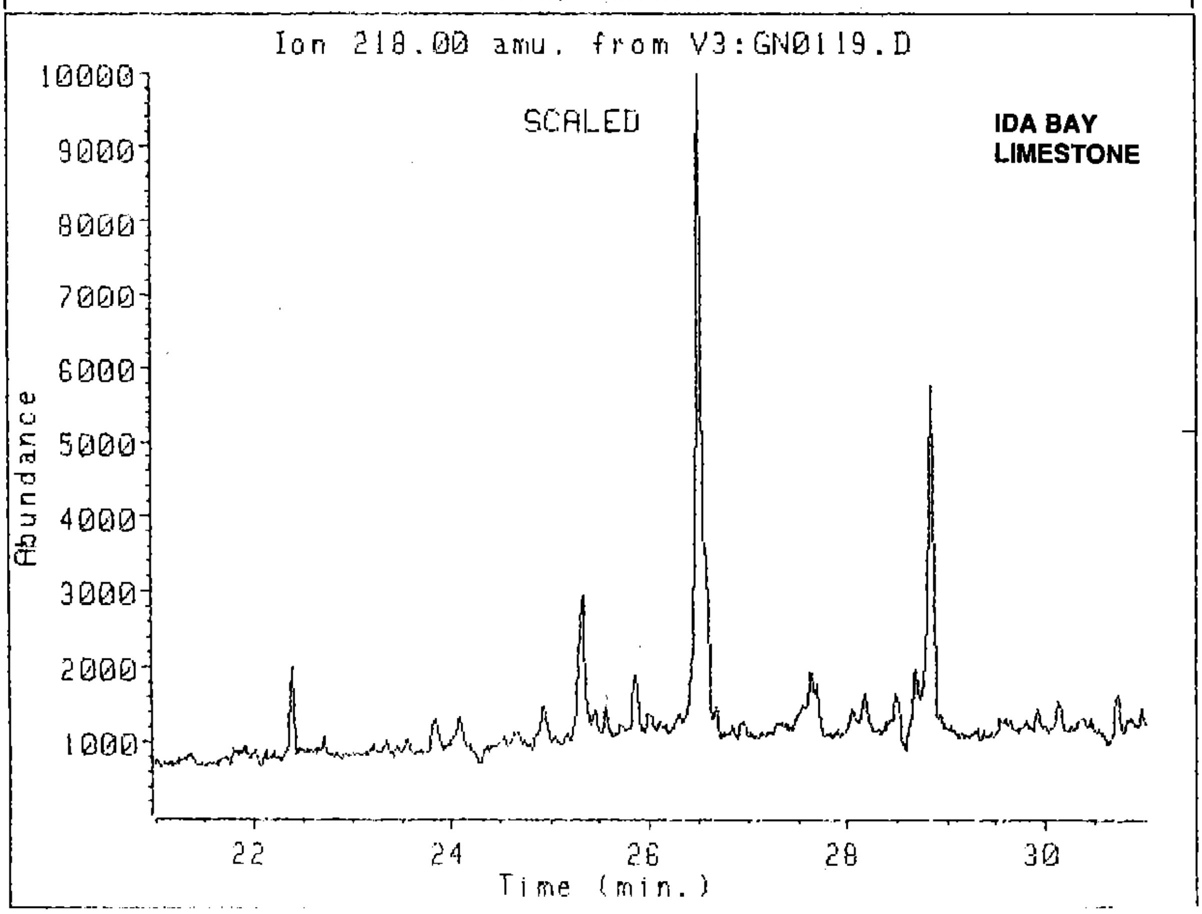
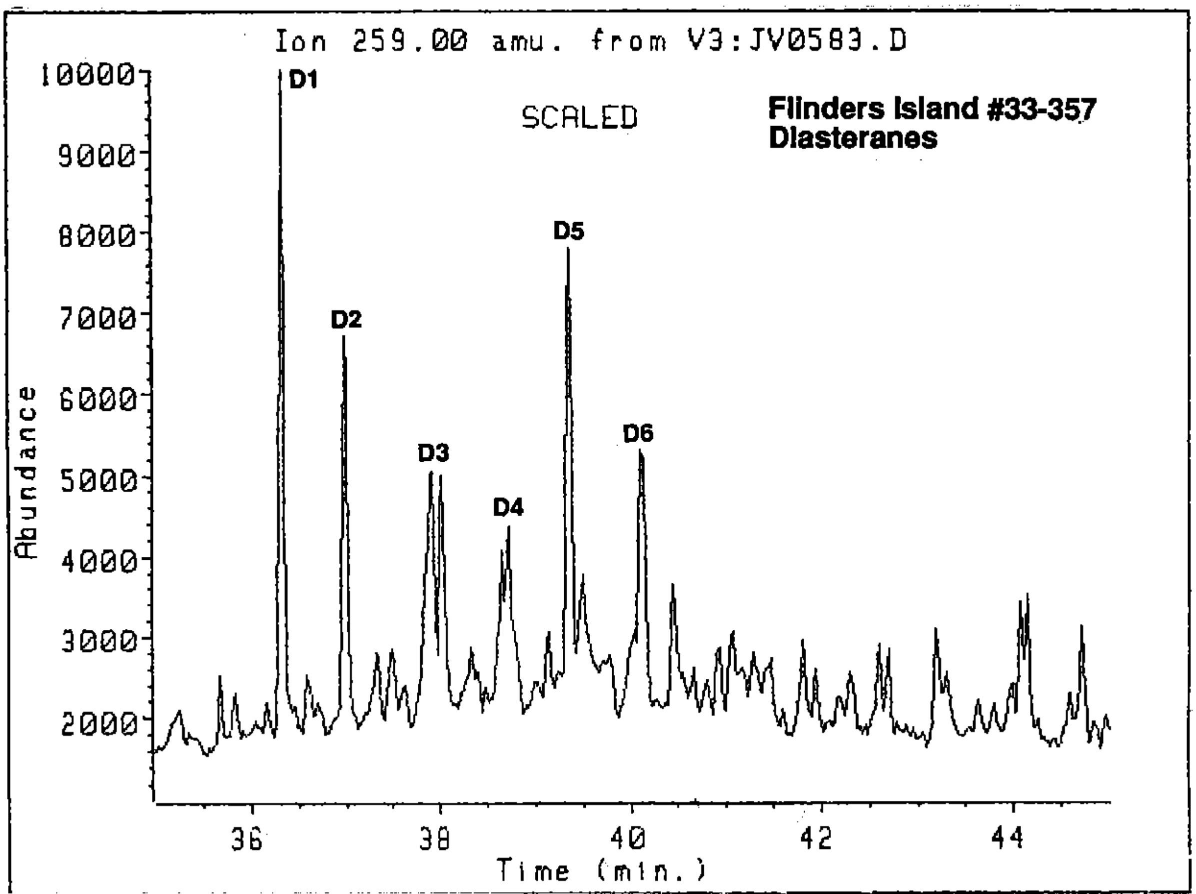


Figure 7. Mass fragmentograms for m/z 218 showing distribution of C_{21} - C_{23} steranes (labelled S) in (a) Flinders Island bitumen #33-357 and (b) Ida Bay Ordovician limestone.



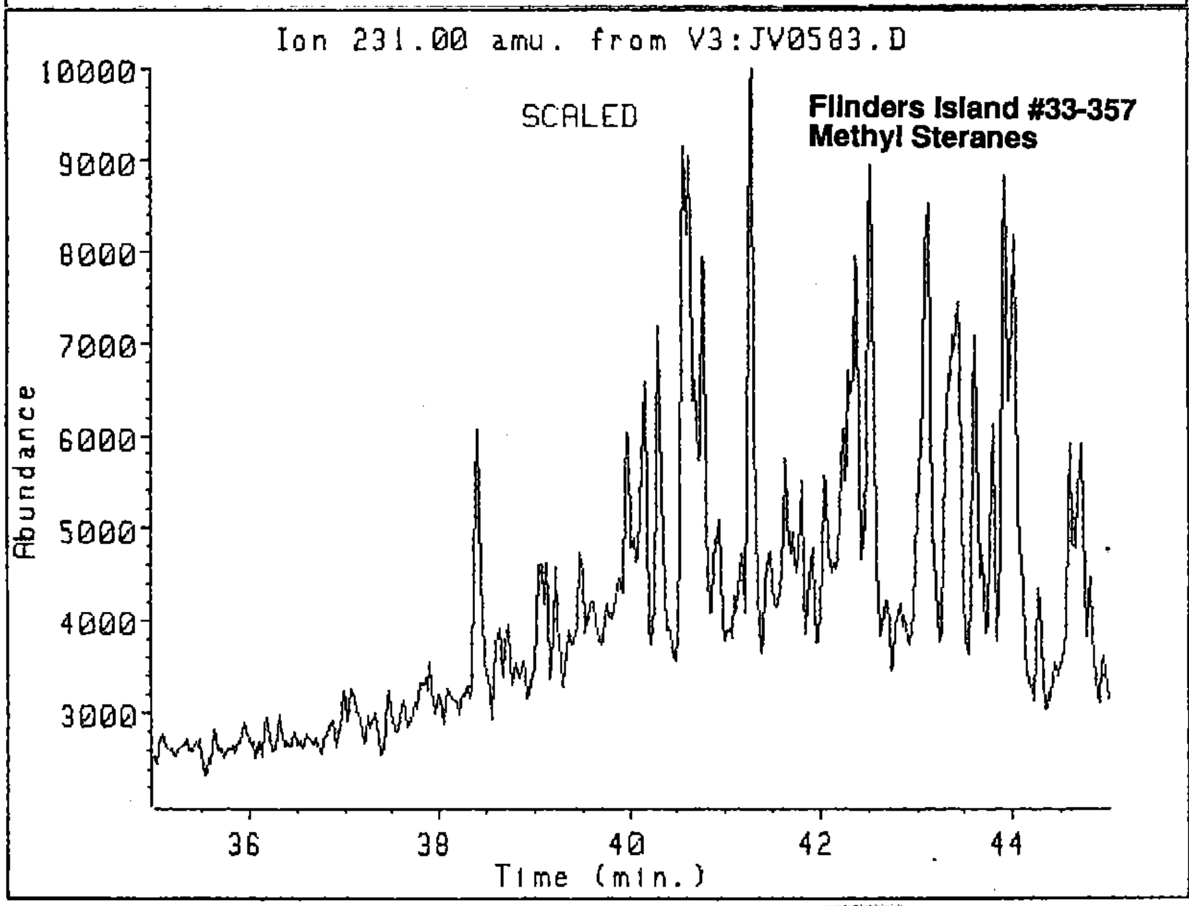


Figure 8. Mass fragmentograms for (a) m/z 259 showing distribution of C_{27} - C_{30} diasteranes (labelled D), and (b) m/z 231 showing distribution of C_{28} - C_{30} 4-methyl steranes in Flinders Island bitumen #33-357.

Sterane maturity parameters are consistent with a low to moderately mature oil. C_{29} sterane $\alpha\beta\beta$ isomers (peaks S10 and S11) are slightly less abundant in the m/z 217 mass fragmentograms compared with $\alpha\alpha\alpha$ isomers (peaks S9 and S12). The ratio of 20S and 20R isomers of the latter is typical of that found in moderately mature crude oils. The sterane isomer distributions are very similar to those found in the Ordovician limestones (Figs 3 and 4; Volkman, 1988), and show little variation between samples indicating the same source and level of maturity for all the bitumens.

(b) Diasteranes

C_{27} and C_{29} diasteranes (rearranged steranes) are abundant (peaks labelled D in Figs. 3 and 8a), which is typical of source rocks that contain significant amounts of clays which catalyse the steroid backbone rearrangement. C_{27} constituents are more abundant than C_{29} diasteranes which is consistent with the carbon number distribution of non-rearranged steranes. These constituents are not common in pure carbonates, and thus are not found or are of low abundance in most Middle East crude oils (Fig. 5). They are very abundant in Gippsland Basin crudes (Fig. 5).

(c) Methyl steranes

Mass fragmentograms for m/z 231 show that small amounts of methyl steranes are present in all the bitumens (Fig. 8b). C_{30} components predominate although lower molecular weight constituents are also present. Identification of side-chain structure (24-ethyl or 23,24-dimethyl) and confirmation of the present of C_{30} desmethyl steranes could provide useful information on the age and type of likely source rocks. The presence of these compounds is consistent with an algal-rich source rock, but more detailed studies are required using Metastable Reaction Monitoring (MRM) techniques to confirm this. Expertise is available at the BMR in Canberra and Dr Summons is willing to analyse samples on a commercial basis.

(d) Tricyclic alkanes

Tricyclic alkanes were much less abundant than hopanes in the higher molecular weight region of the m/z 191 mass fragmentograms (Fig. 9). This rules out an origin from the Tasmanites oil shale where these compounds are abundant (Denwer, 1986; Simoneit *et* *al.*, 1986). Tricyclic alkanes are more abundant in the hydrocarbons from the Ordovician limestones.

(e) Hopanes

Hopane distributions as represented by mass fragmentograms of the major fragment ion m/z 191 over the C_{26}-C_{36} carbon number ranges are shown in Fig. 9a. An expanded chromatogram is shown in Fig. 10a. Comparable data from the hydrocarbons isolated from the Ordovician limestones from Ida Bay are shown in Figs. 9b and 10b.

The hopane distributions are quite distinctive with a high predominance of the C_{30} hopane (peak H5; Figs. 9a and 10a), and much lower abundance of the C_{29} hopane (peak H3). Neither hopenes or hopanes having an "immature" 17ß(H),21ß(H)- stereochemistry were detected indicating that the hydrocarbons were not derived from thermally immature source rocks. The abundance of moretanes (peaks H4, H6 and H9) is fairly low indicating a moderately mature oil.

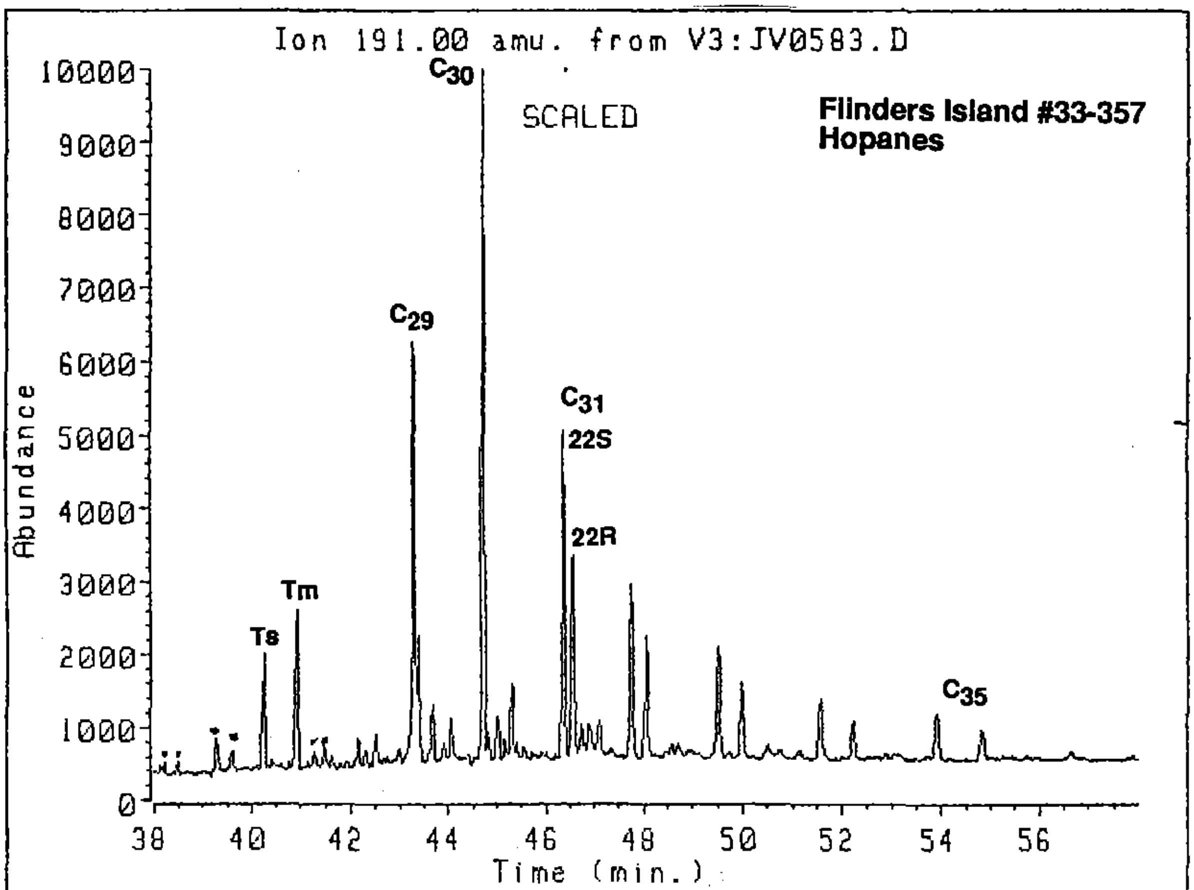
Hopane distributions can be used to ascertain the degree of thermal maturity from the relative proportions of key isomers. Very similar values are obtained for the bitumens and the hydrocarbons in the limestones.

(i) In the extended hopanes (i.e. $>C_{30}$) the 22S epimer is more abundant than the 22R epimer (e.g. peaks H7 and H8) and their ratio is typical of a mature oil. Note that these isomers isomerise to an equilibrium mixture before the onset of the oil window.

(ii) Moretanes (peaks H4, H6 and H9) are very minor components compared with 17α(H),21ß(H)-hopanes of the same chain-length (peaks H3, H5 and H7/H8). Similar ratios are found in moderately mature crude oils.

(iii) The ratio of the two C_{27} hopanes Ts (peak H1) and Tm (peak H2) is a sensitive indicator of thermal maturity. Ts is less abundant than Tm in all samples implying that all bitumens were generated at closely similar thermal maturities. The equivalent vitrinite reflectance would probably be less than 0.6.

In contrast to the steranes, the hopane distributions are quite different from those found in Ordovician limestones from Queenstown and Ida Bay (Figs. 9b and 10b; Volkman, 1988), and more similar to the ratios found in Gippsland Basin crudes (Fig. 11). The hopanes in



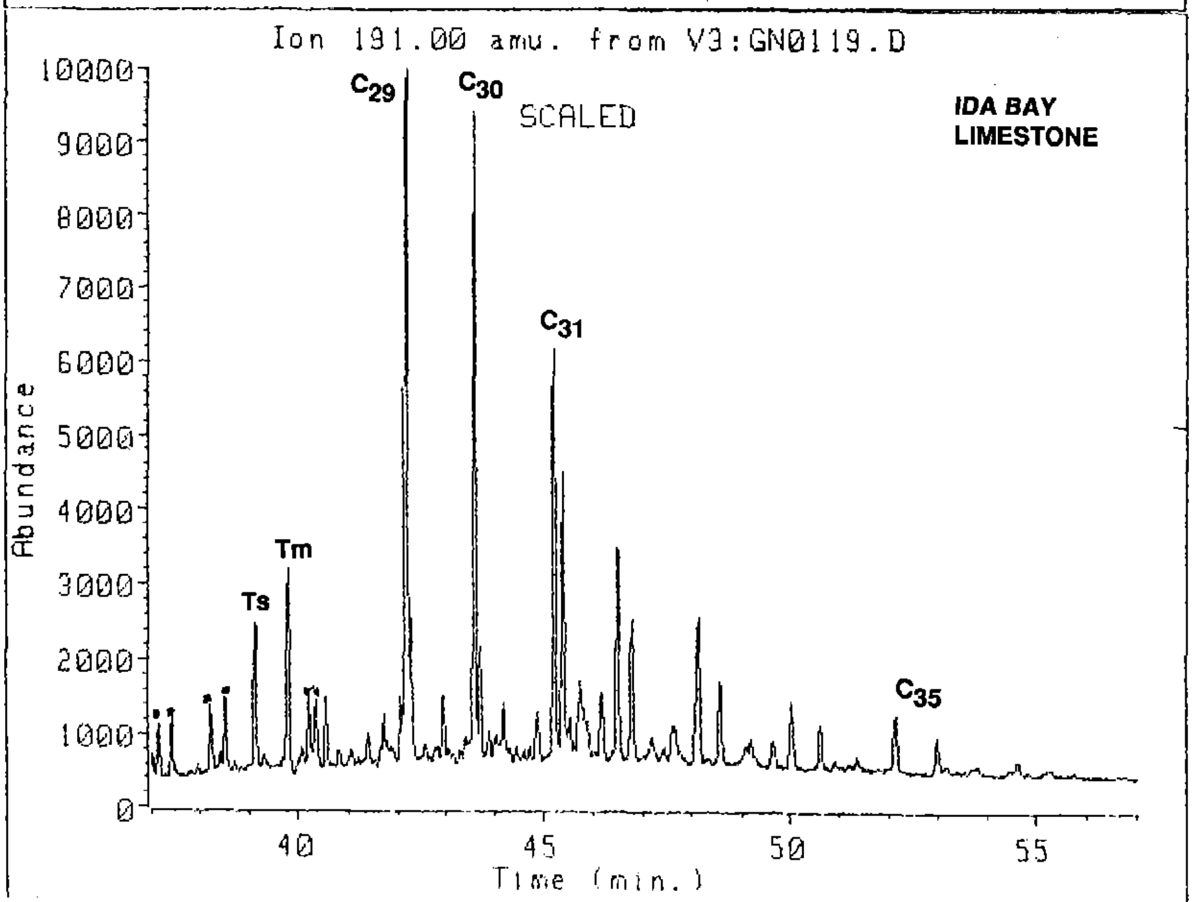


Figure 9. Mass fragmentograms for m/z 191 showing distribution of C_{27} - C_{35} hopanes in (a) Flinders Island bitumen #33-357 and (b) Ida Bay Ordovician limestone. See accompanying Key for peak identifications. Note the lack of significant amounts of tricyclic alkanes (*).

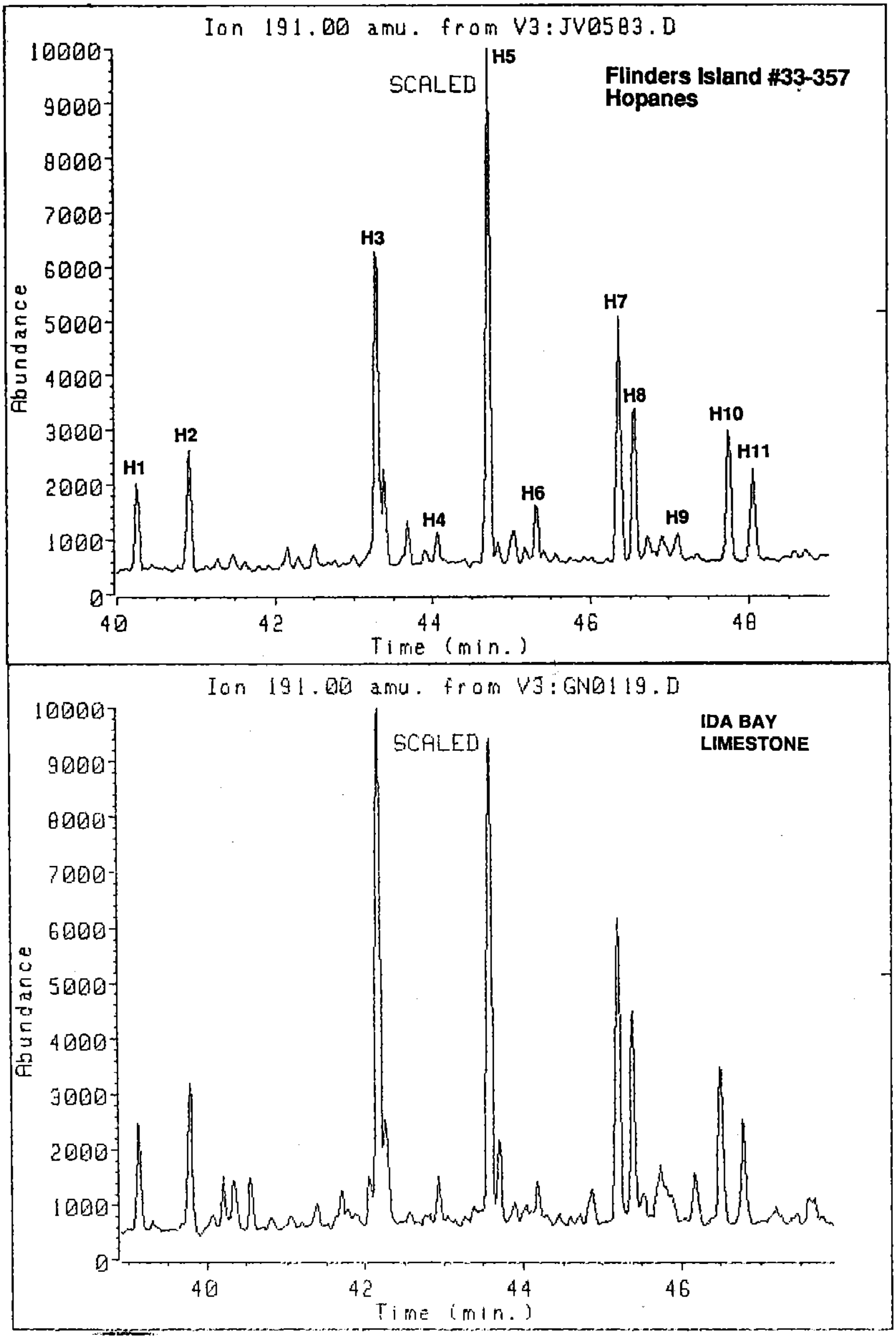


Figure 10. Mass fragmentograms for m/z 191 showing distribution of C_{27} - C_{32} hopanes in (a) Flinders Island bitumen #33-357 and (b) Ida Bay Ordovician limestone.

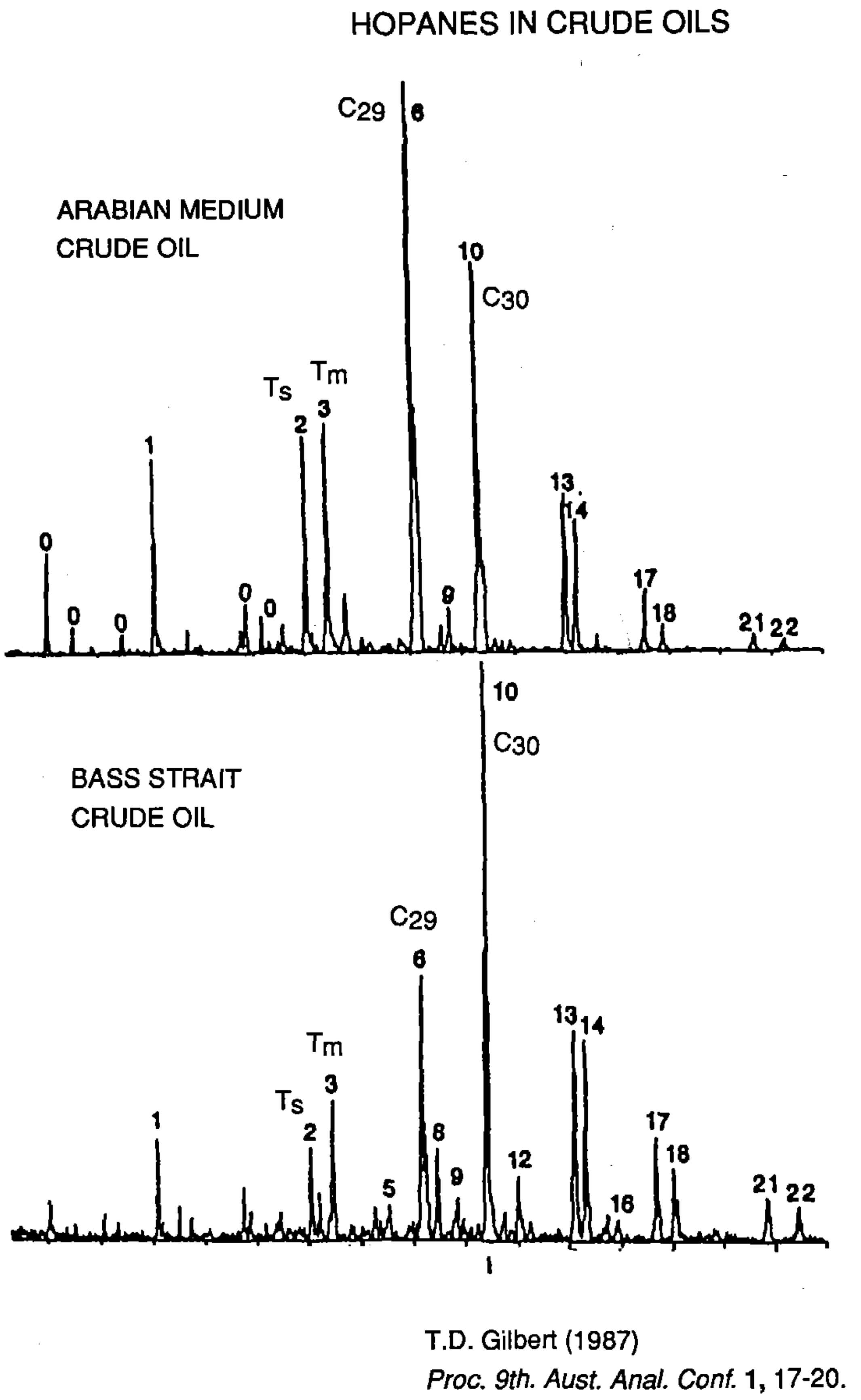


Figure 11. Mass fragmentograms for m/z 191 showing distributions of C_{27} - C_{33} hopanes in Middle East and Gippsland Basin crude oils.

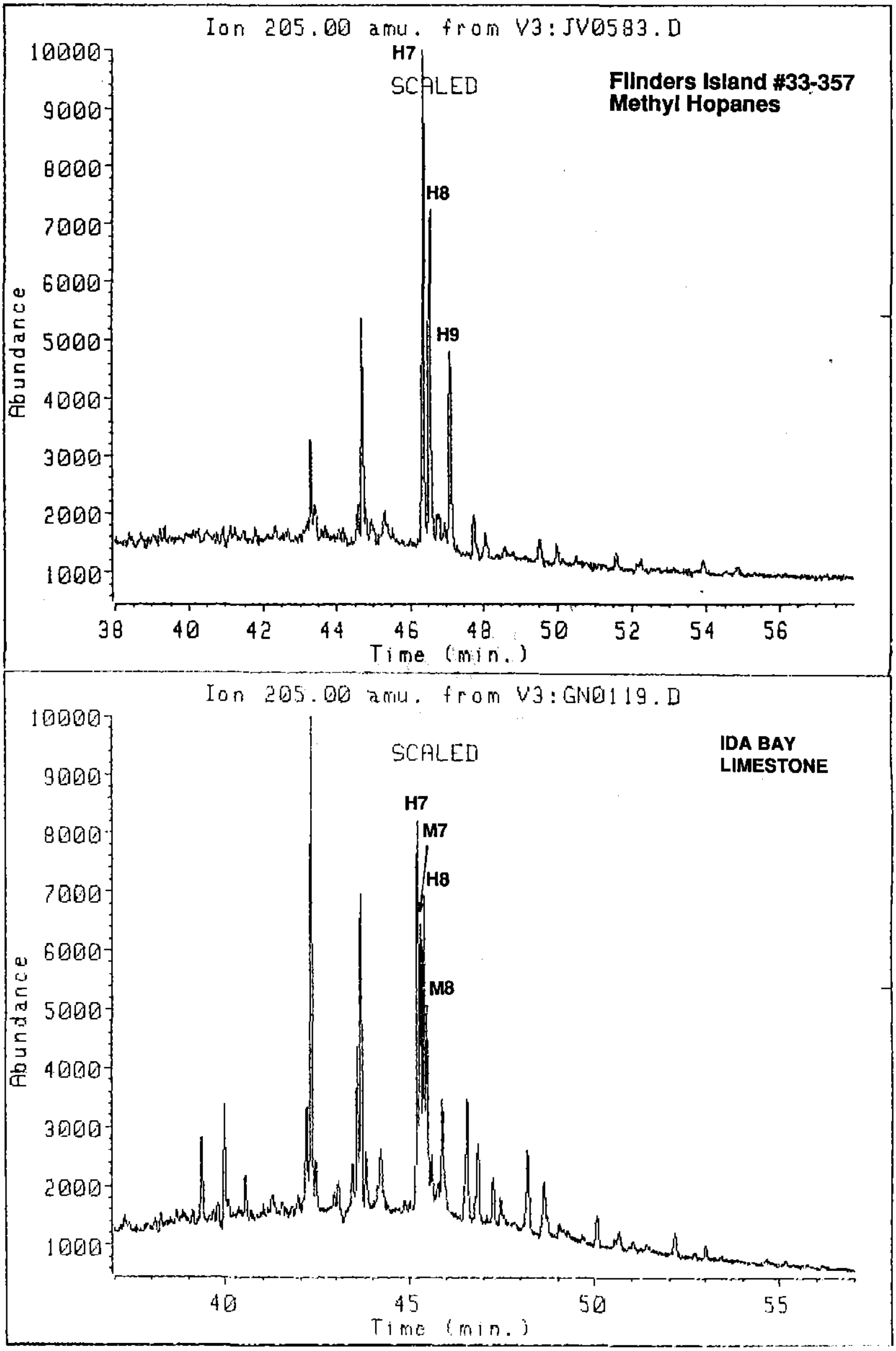


Figure 12. Mass fragmentograms for m/z 205 showing distribution of methyl hopanes in (a) Flinders Island bitumen #33-357 and (b) Ida Bay Ordovician limestone. The m/z 205 mass fragmentogram for Flinders Island only shows the presence of C_{29} - C_{31} hopanes and absence of methyl hopanes.

the limestones contain much more of the C_{29} hopane, as well as methyl hopanes that are not present in detectable amounts in the bitumens (see below). One possible explanation for this is that similar types of source organic matter are involved (as shown by steranes), but the depositional environment is different (as shown by different hopanoid distributions implying different bacterial populations in the sedimentary depositional environment). The bitumen hopane distributions are more typical of those found in shales.

(f) Methyl hopanes

The bitumens do not contain detectable amounts of 2-methyl hopanes as shown by the m/z 205 mass fragmentogram, whereas these are abundant in the Ordovician limestones (Fig. 12 and Volkman, 1988). High abundances are commonly associated with carbonate source rocks although they are not restricted to this source facies.

(g) Demethylated hopanes

M/z 177 mass fragmentograms (Appendix) indicate that demethylated hopanes are not present in the bitumens. These are commonly associated with highly biodegraded residues of crude oil (Volkman *et al.*, 1983), implying that the bitumens are less likely to be tar residues from an exposed reservoir.

Aromatic Hydrocarbons

At this stage, only a preliminary investigation has been carried out on the aromatic hydrocarbon fractions. The bitumens have a distinctly "aromatic" smell, not unlike naphthalene. The total aromatic hydrocarbon fractions were analysed on the non-polar capillary column using cold on-column injection. These extracts are still being analysed and full details will be provided in the final report.

A capillary gas chromatogram of the total aromatic hydrocarbon fraction in the Flinders Island bitumen is shown in Fig. 13. The chromatogram is dominated by a broad hump representing an unresolved complex mixture of components, although discrete peaks are also observed. This is typical of weathered bitumens. Had the sample been extensively water washed, we would not have expected to see so many resolvable compounds. GC-

MS fingerprinting confirmed the presence of methylated naphthalenes and phenanthrenes; these compounds are readily removed by water washing. Aromatic steroids were also detected which will be useful for future fingerprinting studies.

Mass fragmentograms for m/z 178 (phenanthrene) and 192 (methylphenanthrenes) are shown in Fig. 14. The methylphenanthrene distribution is unusual. In mature oils, the 2- and 3-methylphenanthrene isomers usually predominate over the 1- and 9-methylphenanthrene isomers (Radke and Welte, 1983), but the reverse is found in the bitumens. The equivalent vitrinite reflectance calculated from the methylphenanthrene index (MPI) according to Radke and Welte (1983) is about 0.6 (i.e. early oil window) which is in good agreement with the biomarker maturity parameters. If the alternative equation proposed by Boreham *et al.* (1988) is used, the equivalent vitrinite reflectance is calculated to be about 0.47. Note that this equation refers strictly to coals and carbonaceous shales, and so may not be appropriate here. The abundance of the 1-methylphenanthrene is quite low which argues against a source containing coniferous higher plant organic matter (Alexander *et al.*, 1988).

$$\mathrm{MPI} = \frac{1.5\,(2\text{-MP} + 3\text{-MP})}{\mathrm{P} + 1\text{-MP} + 9\text{-MP}}$$

$R_{calc} = 0.6\ \mathrm{MPI} + 0.4$ (Radke and Welte, 1983)

$R_{calc} = 0.7\ \mathrm{MPI} + 0.22$ (Boreham *et al.*, 1988).

Methylphenanthrene distributions have been determined for hydrocarbons isolated from several Tasmanian limestones (AMDEL, 1987). Mass fragmentograms are shown in Fig. 15. None of these distributions match very well with the bitumen profiles. The Ordovician limestones from Surprise Bay and Ida Bay appear to much more mature, but those from the Kamburg and Chicken Island limestones are only slightly more mature.

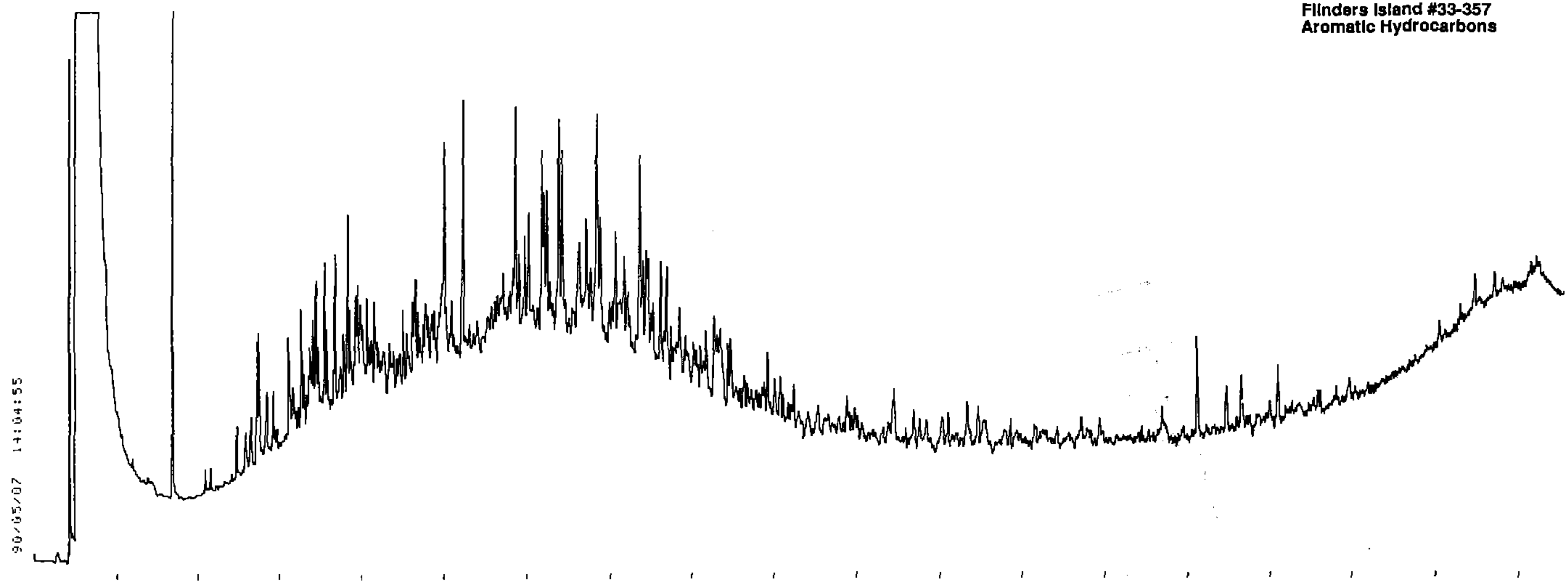


Figure 13. Capillary gas chromatogram showing the distribution of total aromatic hydrocarbons in the Flinders Island bitumen.

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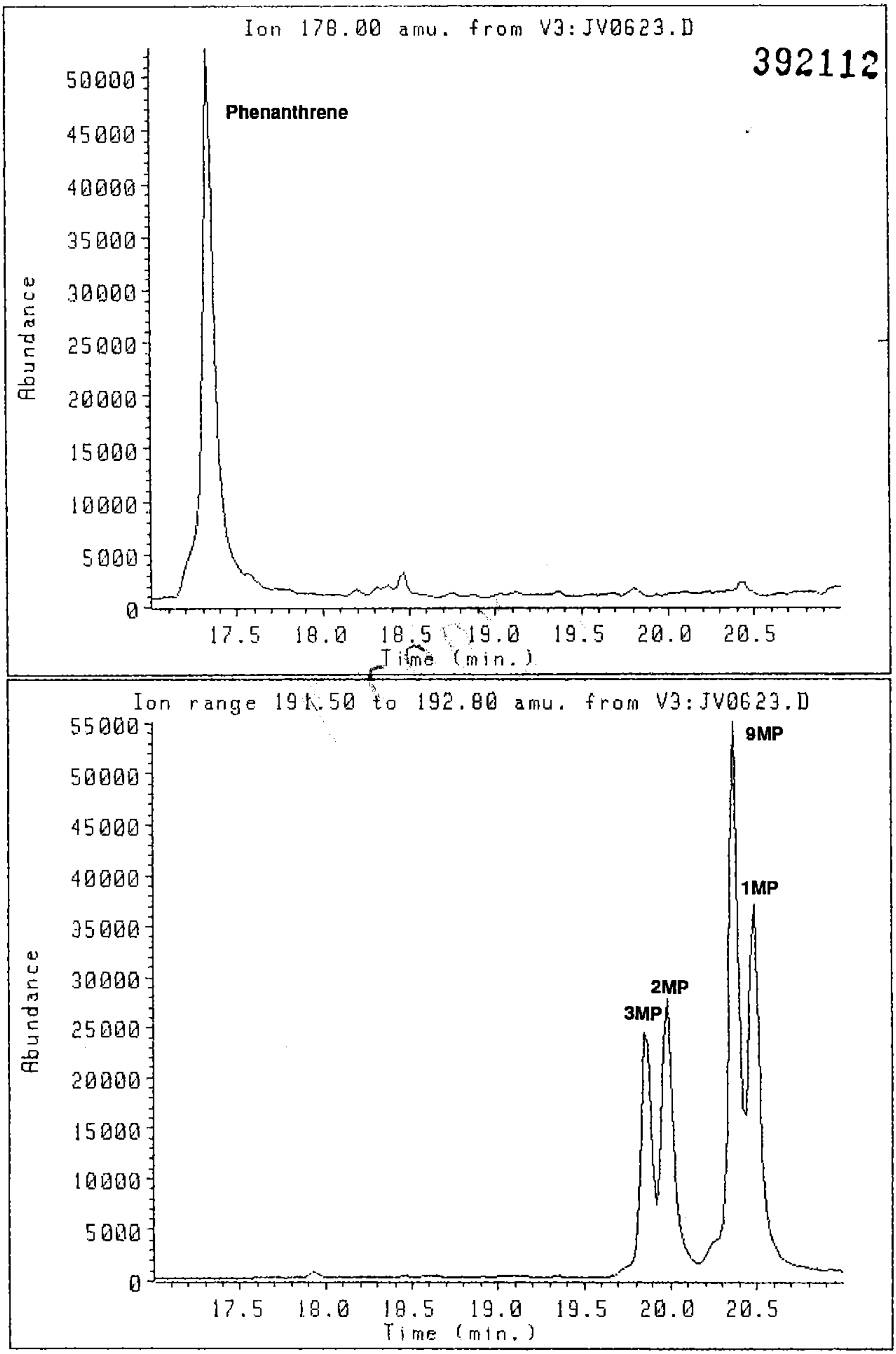

Figure 14. Mass fragmentograms for m/z 178 and 192 showing the presence of phenanthrene and distribution of methylphenanthrenes respectively in the Flinders Island bitumen.

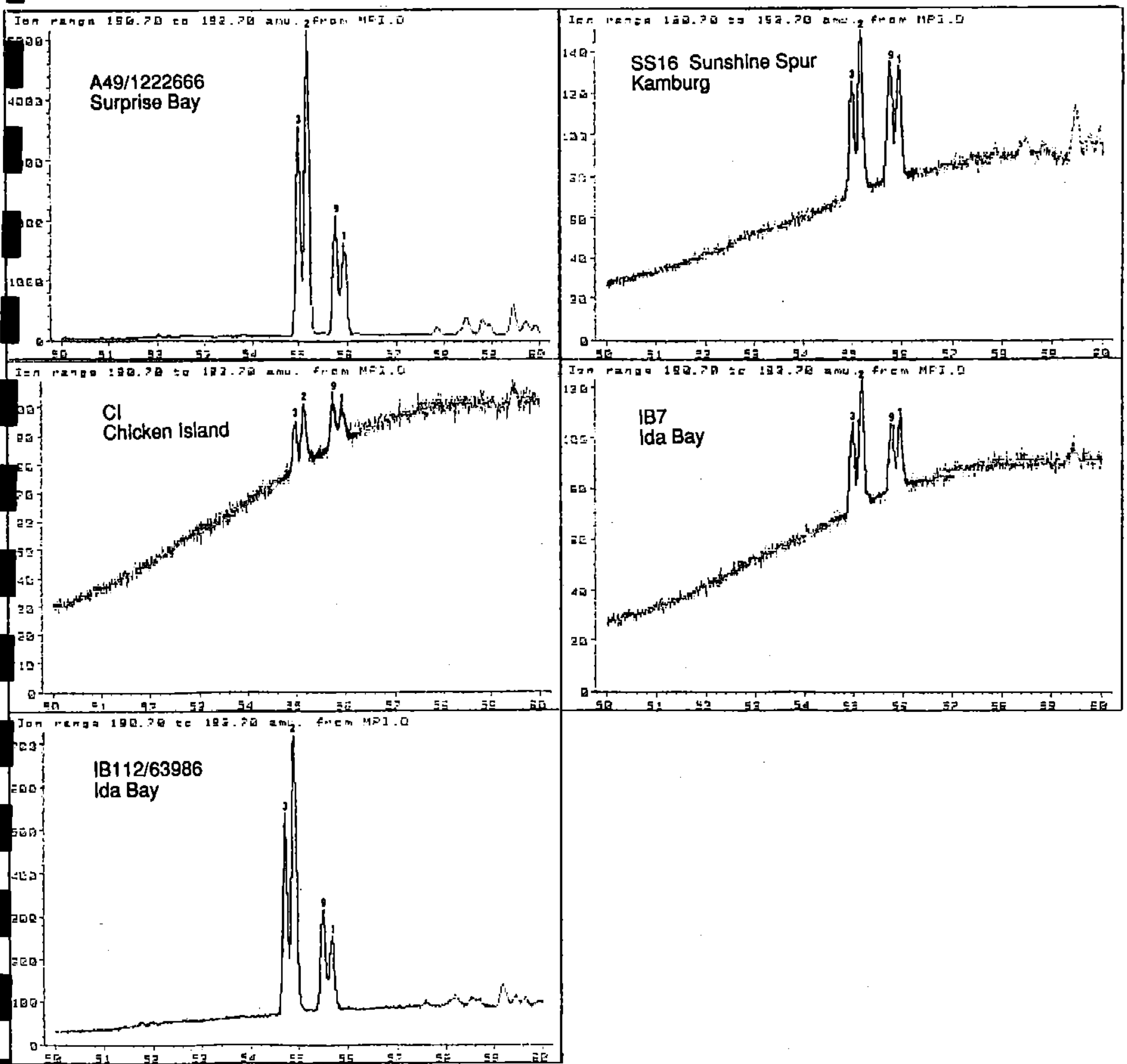

Figure 15. Mass fragmentograms for m/z 191 + 192 showing the distribution of methylphenanthrenes in some Tasmanian limestones (AMDEL, 1987).

PRELIMINARY CONCLUSIONS

The bitumens contain appreciable amounts of hydrocarbons having the characteristic distributions found in low to moderately mature crude oils. The lack of shorter chain n-alkanes and low molecular weight aromatic hydrocarbons is typical of weathered bitumens, but there is no evidence for significant biodegradation indicating that the bitumens could not have been at sea for more than a few days. Indeed, there is little evidence from their physical appearance or chemical composition that they have been exposed to the sea at all. Some laboratory studies to ascertain how readily these compounds are removed by exposure to salt-water would be useful here.

It seems likely that the bitumens were derived from a heavy non-waxy crude oil having a high content of asphaltenes. The biomarker distributions are all remarkably similar and indicate a common source and generation at the same level of thermal maturity. Some biomarker parameters are similar to those found in hydrocarbons from Ordovician limestones from Ida Bay and Queenstown except for the absence of methyl hopanes and 29-norhopanes. The remarkable similarity between the sterane distributions implies that the hydrocarbons in both are probably derived from the same type of organic matter. The predominance of C_{27} steranes is not typical of oils generated from higher plants or coaly organic matter, but is more typical of algal organic matter.

The very low abundance of tricylic alkanes indicates that *Tasmanites* is not the source of the hydrocarbons, and the maturity is clearly greater than found in the Permian oil shales exposed at Oonah and Latrobe. Sterane parameters rule out higher plants as the major contributors of organic matter in the source rocks. The bitumens appear to be unrelated to oils presently recovered from the Bass and Gippsland Basins.

The presence of abundant diasteranes implies a depositional environment in which the sediments contain a high content of silt or clay. The absence of methyl hopanes argues against a shallow carbonate depositional environment represented by the limestones previously analysed from Ida Bay and Queenstown. One possibility is that the hydrocarbons in some of the limestones might actually be migrated oil from another source. The Queenstown limestones have very much higher maturities than the Ida Bay limestones based on the conodont alteration index (CAI) and yet the hydrocarbons show the same maturity. This anomaly could be reconciled if the hydrocarbons there have migrated into the rock. Clearly, we need to know much more about the hydrocarbon distributions in possible source rocks, and more about the factors that control the abundance of the compounds such as methyl hopanes in different carbonate environments.

Aliphatic biomarker parameters suggest a similar level of maturity which is within the early stages of the oil window. These imply an equivalent vitrinite reflectance of about 0.6, which is consistent with methyl phenanthrene measurements.

A major study of bitumens stranded on South Australian beaches has been underway for some years. Most of these contain significant amounts of the unusual isoprenoid botryococcane which was not detectable in the Tasmanian samples. Pristane/phytane ratios were also generally significantly greater. The exception is bitumen sample #34 (Family 4) collected from Beachport, South Australia (McKirdy *et al.*, 1986). This has the same physical description and very similar biomarker characteristics including pristane/phytane ratio, absence of botryococcane, and sterane ratios. This bitumen has a high content of sulphur (3.3 %), whereas the Tasmanian bitumens do not appear to have high sulphur levels based on the low abundance of sulphur in the hydrocarbon extracts. This needs to be confirmed by direct analysis. A sample of the South Australian bitumen should be obtained for comparative study. In particular, it will be of great interest to see whether the n-alkanes show a greater degree of removal consistent with exposure to transport through seawater.

In summary, the data imply that:

(i) all of the bitumens are derived from the same source rock,
(ii) they were all generated at the same level of maturity, and
(iii) the seeps are located near to the bitumen collection sites.

This implies the existence of a source rock and reservoirs extending over much of present-day Tasmania and adjacent near-shore areas. This is not readily accommodated by previous models of Tasmanian geology, but does lend weight to revised models incorporating concepts of thin-skin tectonics and Precambrian thrust belts. Detailed geochemical studies of possible source rocks are now required to test these hypotheses.

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REPORT 90-HC1

APPENDIX TO

PRELIMINARY REPORT ON THE ORGANIC GEOCHEMISTRY OF SOME TASMANIAN BITUMENS

May 7, 1990

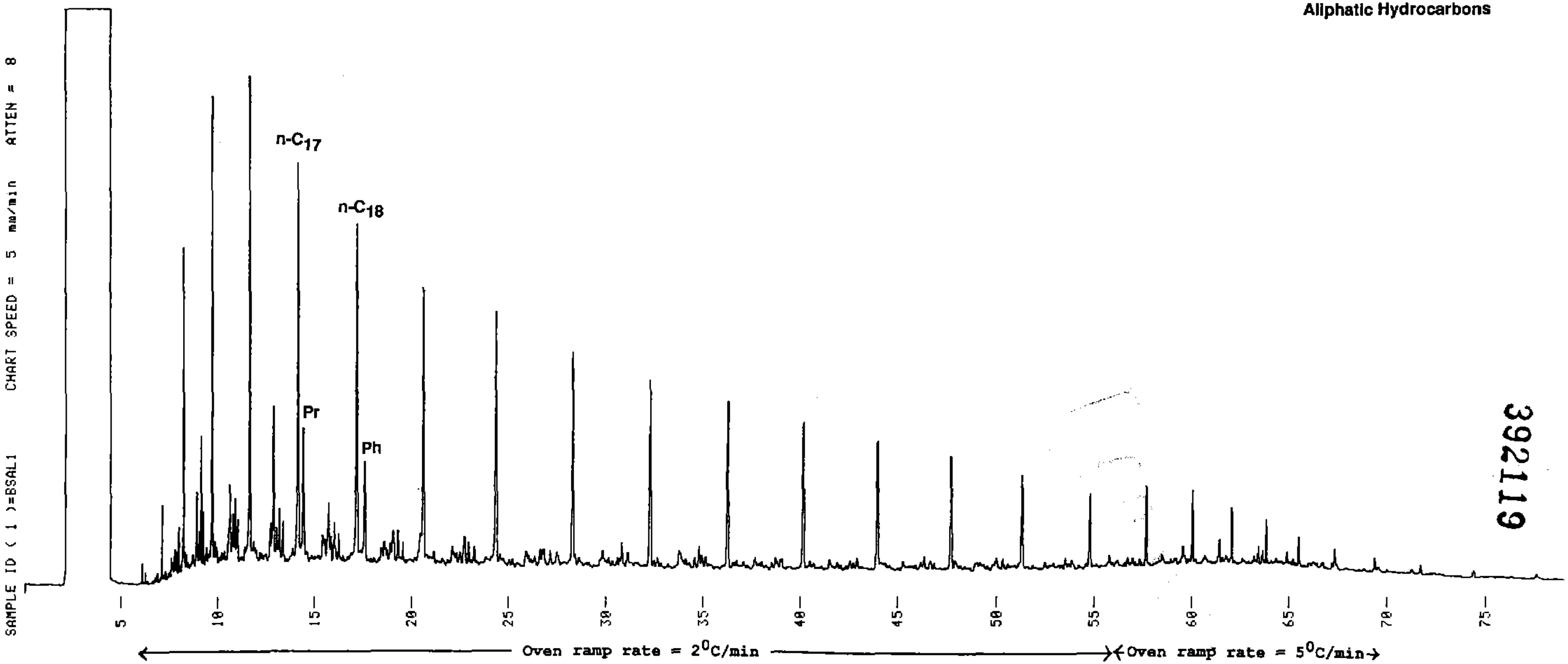
Key 1. Identifications of peaks in sterane and diasterane (m/z 217 and 218) mass fragmentograms.

PEAK	COMPOUND
S1	C_{27} (20S)-5α(H),14α(H),17α(H)-cholestane
S2	C_{27} (20R)-5α(H),14β(H),17β(H)-cholestane
S3	C_{27} (20S)-5α(H),14β(H),17β(H)-cholestane
S4	C_{27} (20R)-5α(H),14α(H),17α(H)-cholestane
S5	C_{28} (20S)-5α(H),14α(H),17α(H)-24-methylcholestane
S6	C_{28} (20R)-5α(H),14β(H),17β(H)-24-methylcholestane
S7	C_{28} (20S)-5α(H),14β(H),17β(H)-24-methylcholestane
S8	C_{28} (20R)-5α(H),14α(H),17α(H)-24-methylcholestane
S9	C_{29} (20S)-5α(H),14α(H),17α(H)-24-ethylcholestane
S10	C_{29} (20R)-5α(H),14β(H),17β(H)-24-ethylcholestane
S11	C_{29} (20S)-5α(H),14β(H),17β(H)-24-ethylcholestane
S12	C_{29} (20R)-5α(H),14α(H),17α(H)-24-ethylcholestane
D1	C_{27} (20S)-13β(H),17α(H)-diasterane
D2	C_{27} (20R)-13β(H),17α(H)-diasterane
D3	C_{28} (20S)-13β(H),17α(H)-diasterane
D4	C_{28} (20R)-13β(H),17α(H)-diasterane
D5	C_{29} (20S)-13β(H),17α(H)-diasterane
D6	C_{29} (20R)-13β(H),17α(H)-diasterane

Key 2. Identifications of peaks in hopane (m/z 191) and methyl hopane (m/z 205) mass fragmentograms

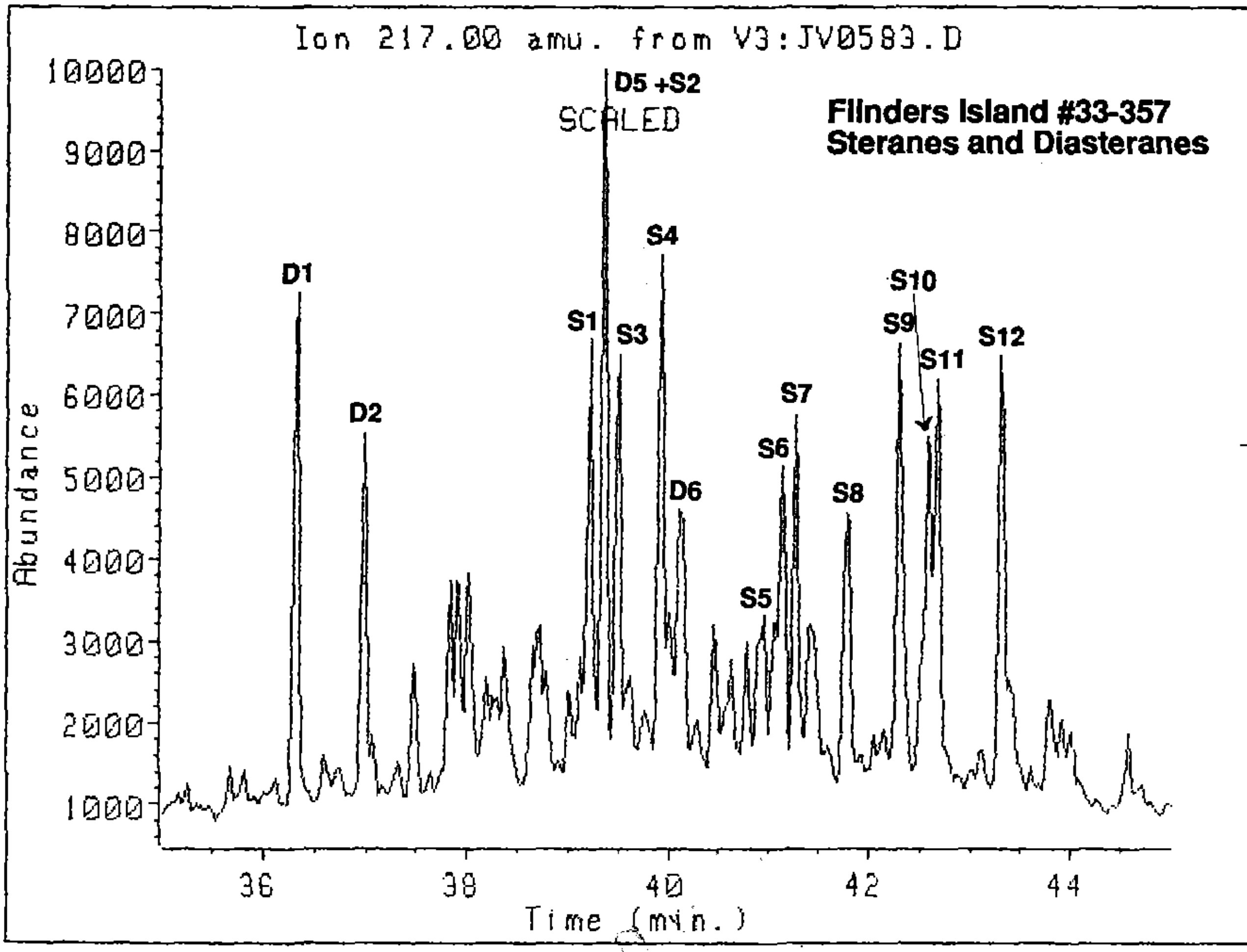
PEAK	COMPOUND
H1	C_{27} 18α(H)-22,29,30-trisnorneohopane (Ts)
H2	C_{27} 17α(H)-22,29,30-trisnorhopane (Tm)
H3	C_{29} 17α(H),21β(H)-30-norhopane
H4	C_{29} 17β(H),21α(H)-30-normoretane
H5	C_{30} 17α(H),21β(H)-hopane
H6	C_{30} 17β(H),21α(H)-moretane
H7	C_{31} (22S)-17α(H),21β(H)-homohopane
H8	C_{31} (22R)-17α(H),21β(H)-homohopane
H9	C_{31} (22S)-17β(H),21α(H)-bishomohopane
H10	C_{32} (22S)-17α(H),21β(H)-bishomohopane
H11	C_{32} (22R)-17α(H),21β(H)-bishomohopane
H12	C_{33} (22S)-17α(H),21β(H)-trishomohopane
H13	C_{33} (22R)-17α(H),21β(H)-trishomohopane
H14	C_{34} (22S)-17α(H),21β(H)-tetrakishomohopane
H15	C_{34} (22R)-17α(H),21β(H)-tetrakishomohopane
H16	C_{35} (22S)-17α(H),21β(H)-pentakishomohopane
H17	C_{35} (22R)-17α(H),21β(H)-pentakishomohopane
M7	C_{32} (22S)-17α(H),21β(H)-2-methylhomohopane
M8	C_{32} (22R)-17α(H),21β(H)-2-methylhomohopane

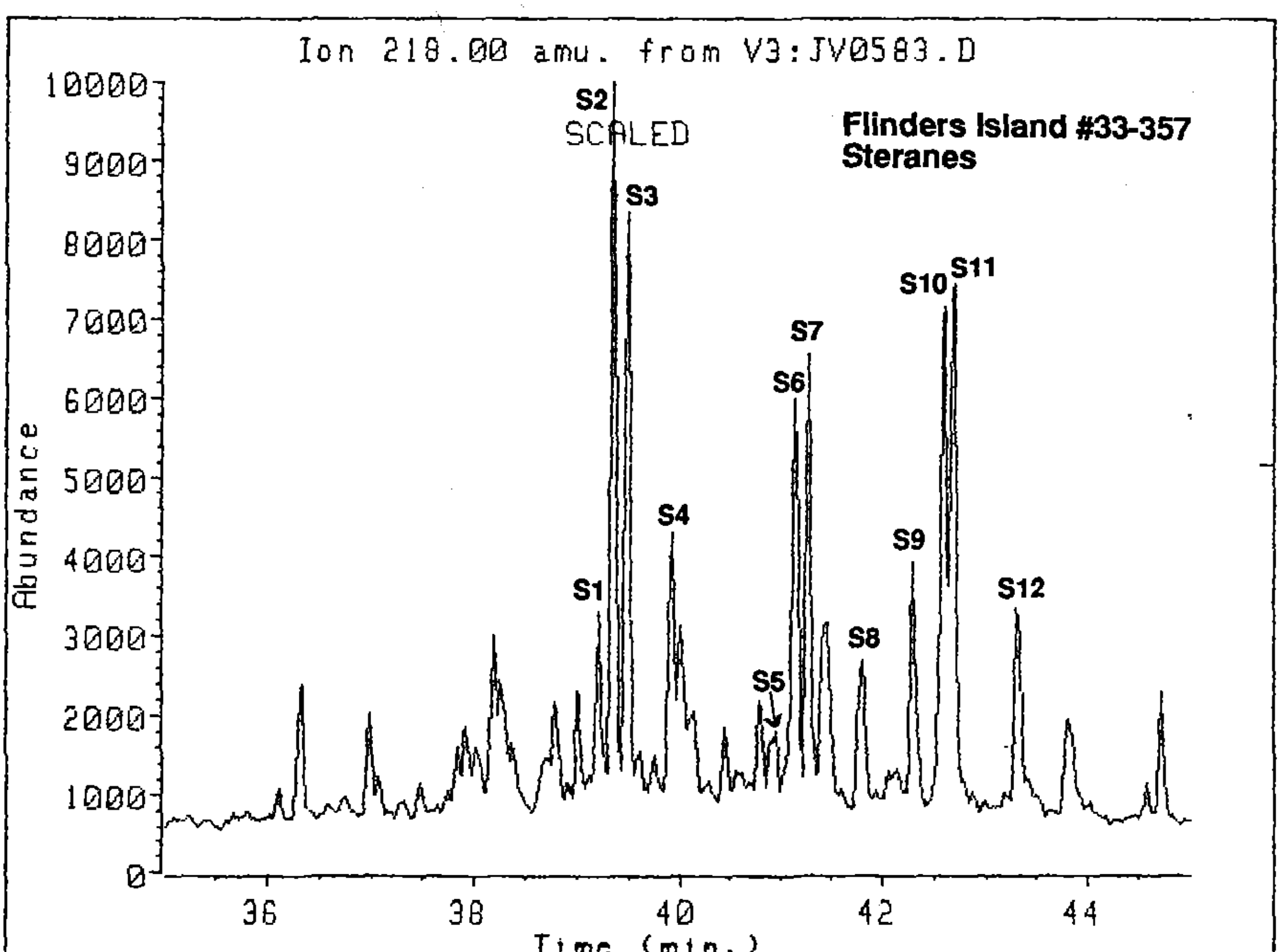
Flinders Island #33-357
Aliphatic Hydrocarbons

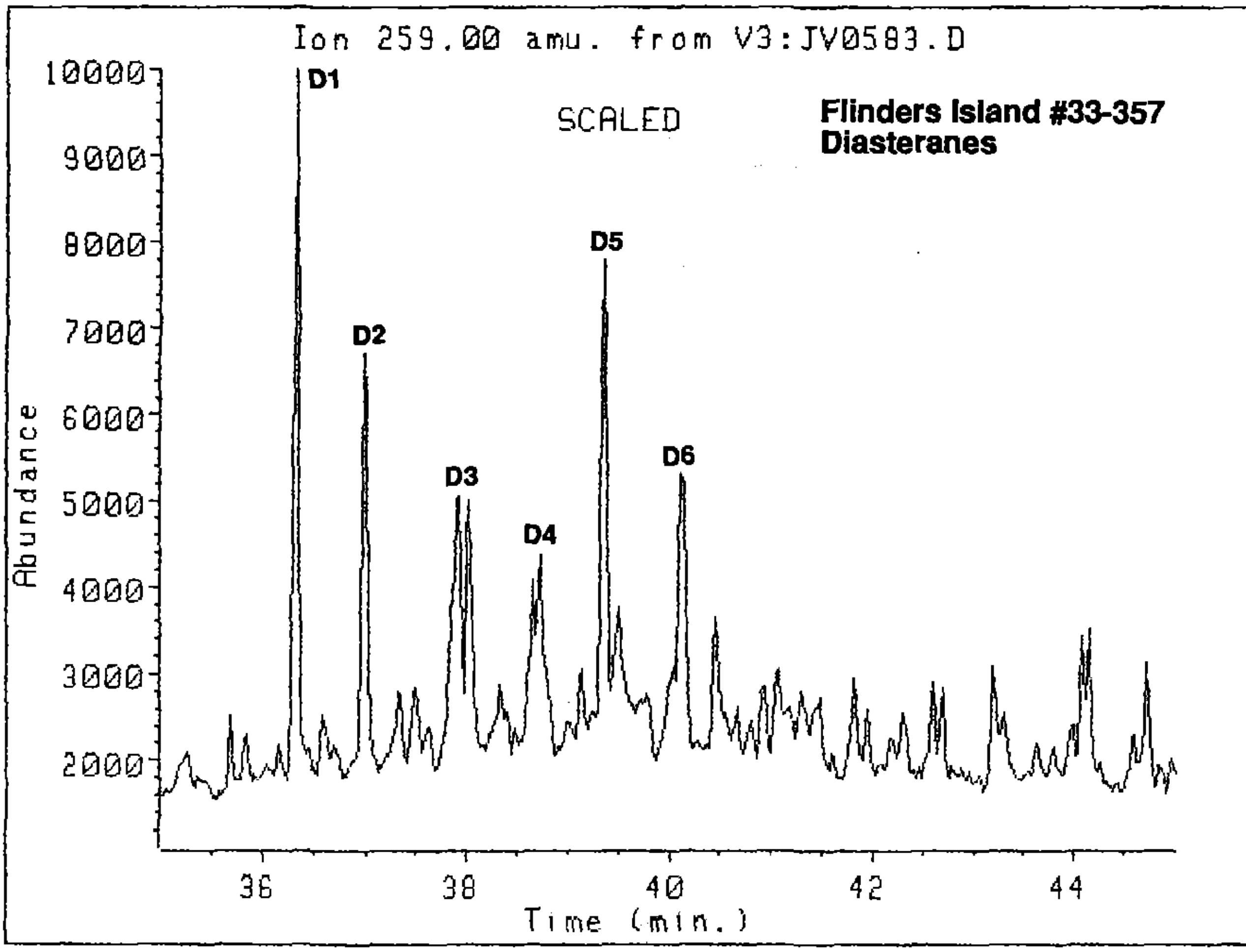


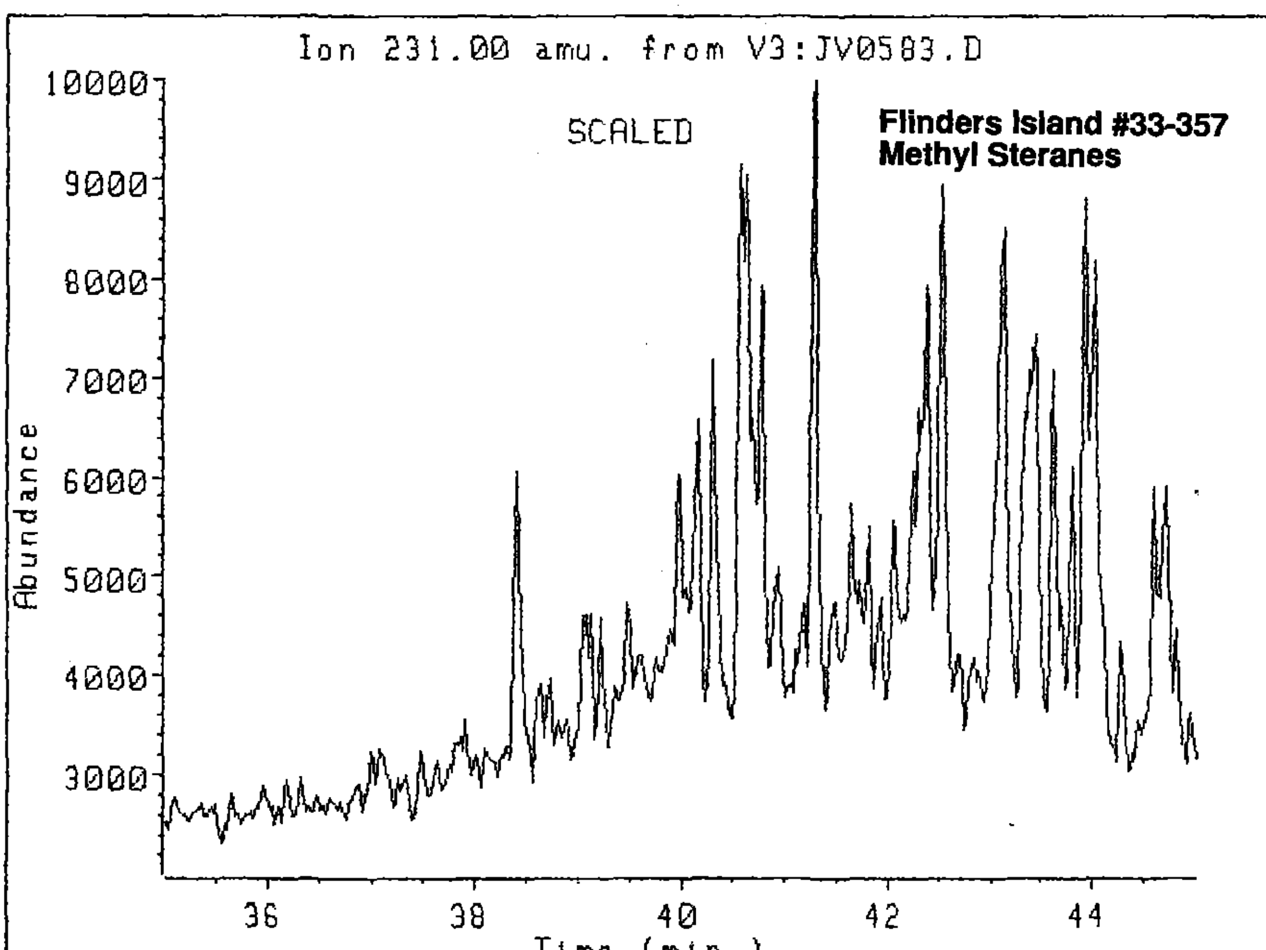
392119

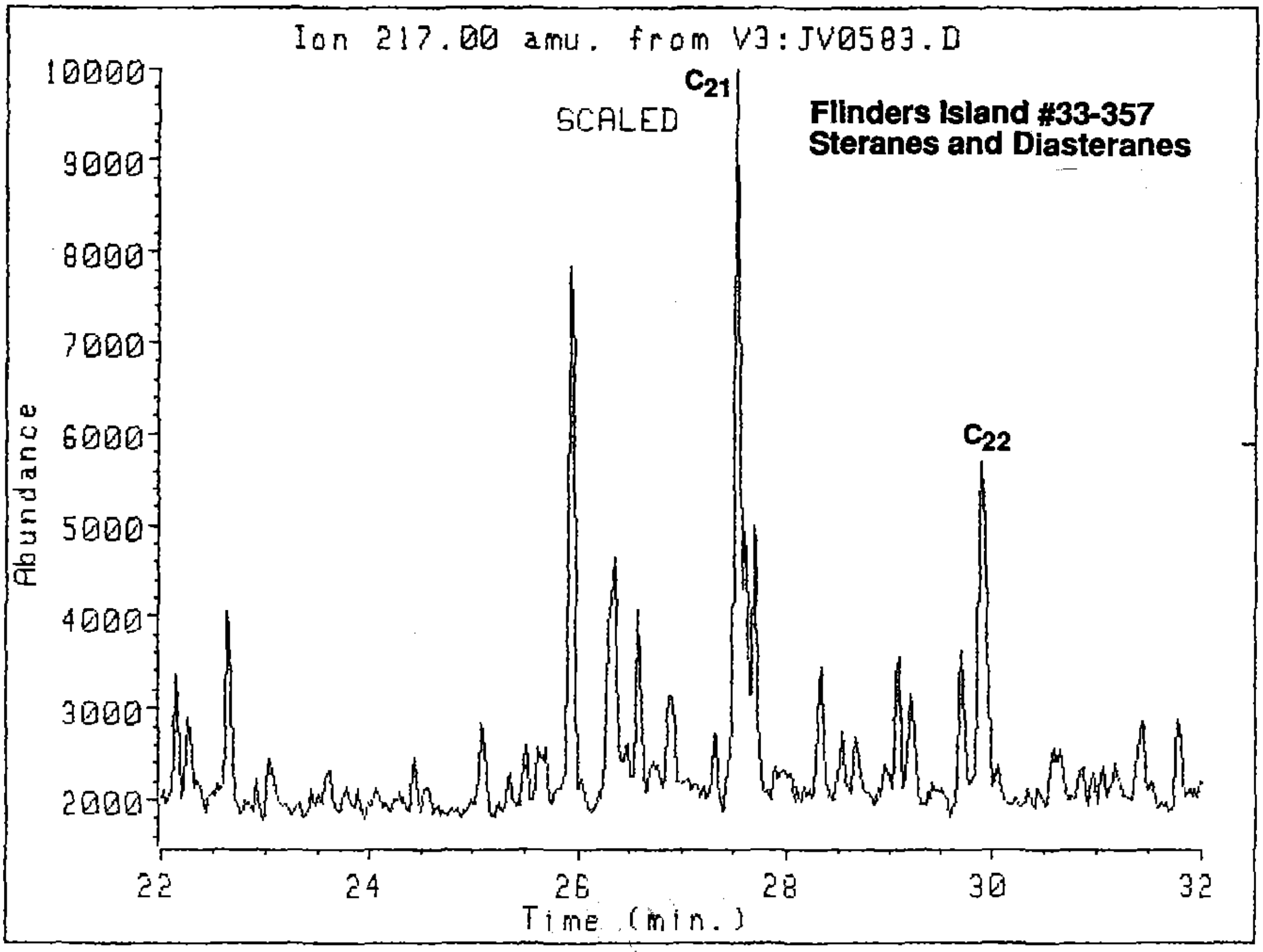
119

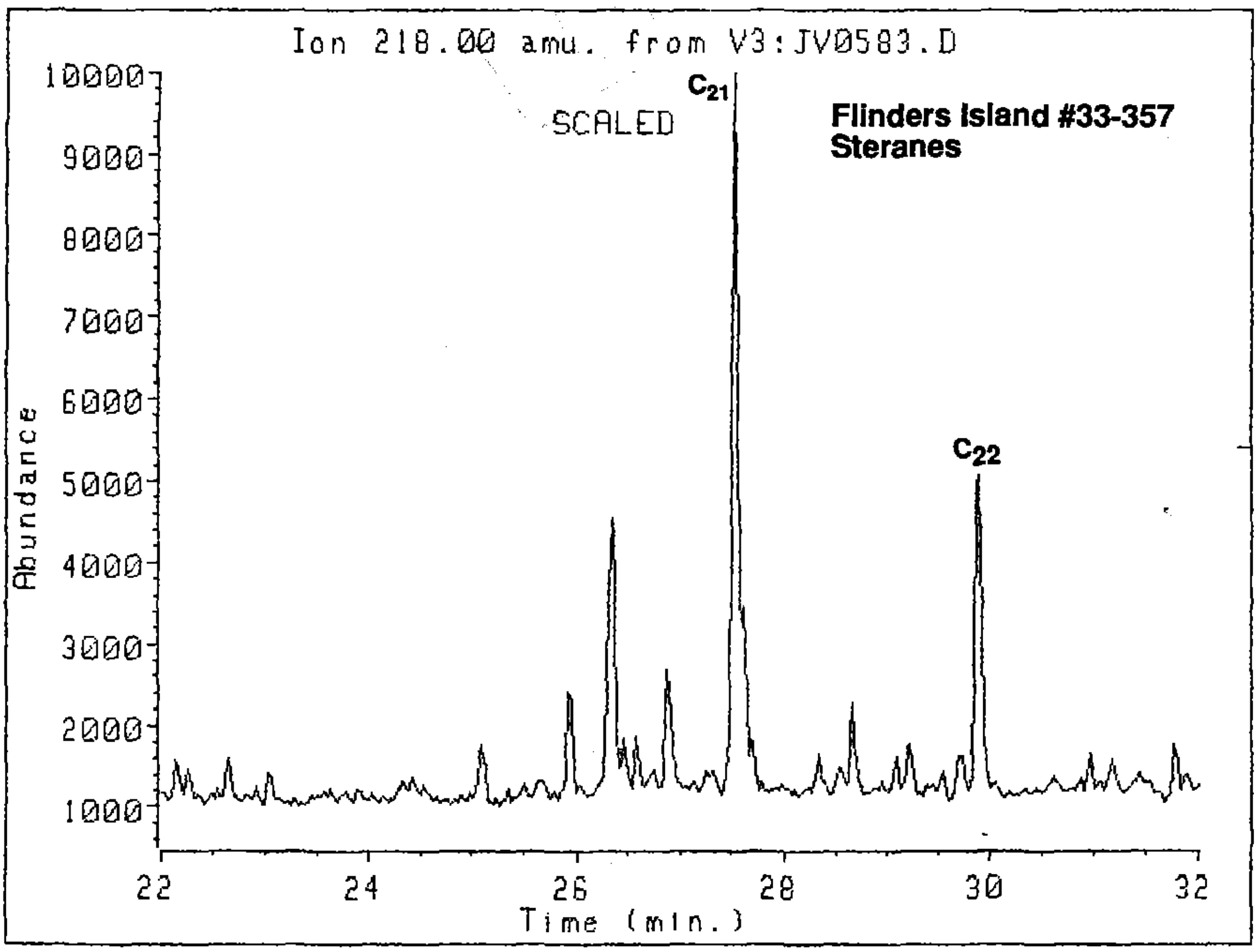

Ion 217.00 amu. from V3:JV0583.D
SCALED
Flinders Island #33-357
Steranes and Diasteranes
D1
D2
S1
D5 +S2
S3
S4
D6
S5
S6
S7
S8
S9
S10
S11
S12
Abundance
Time (min.)

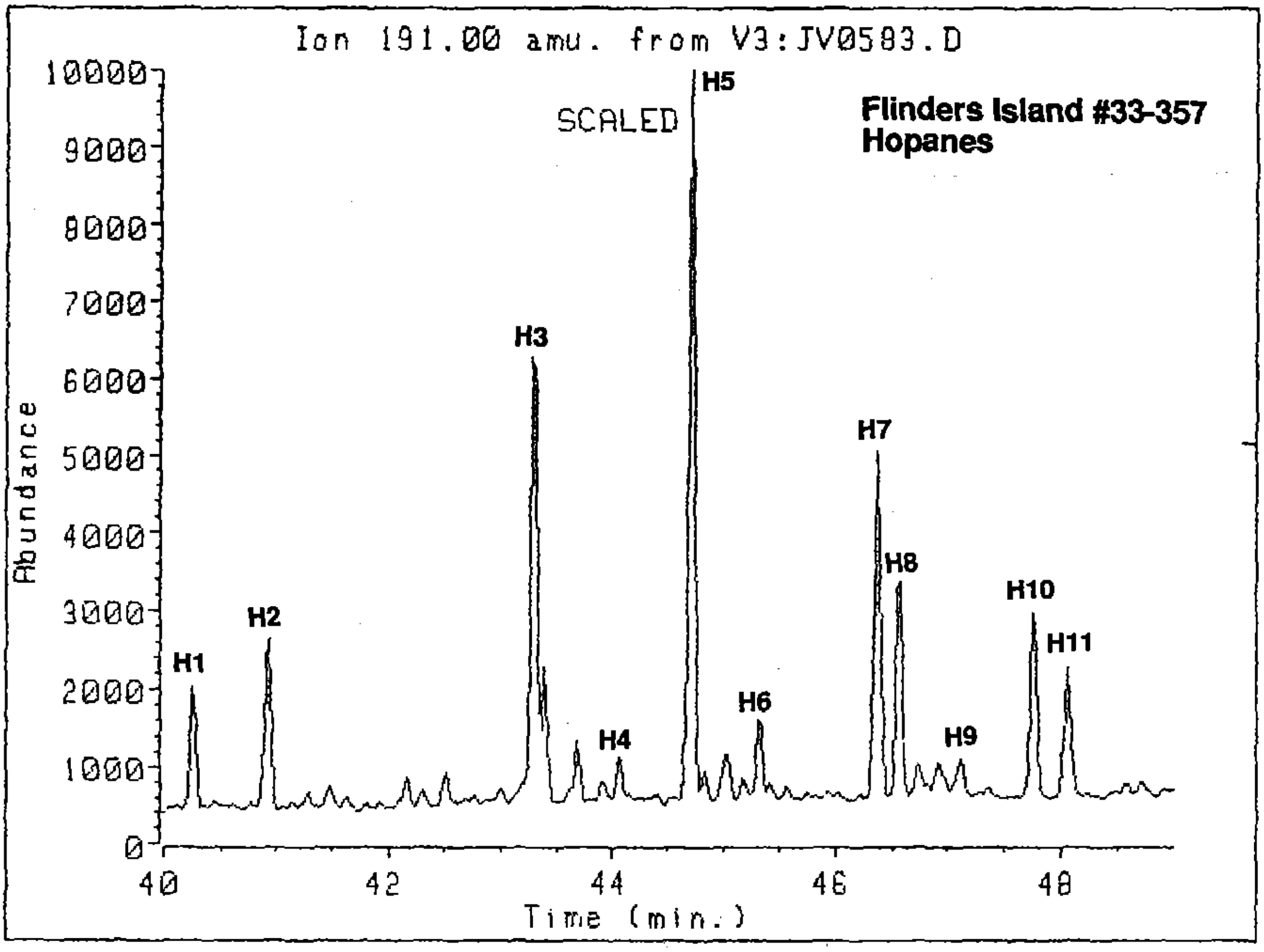

Ion 218.00 amu. from V3:JV0583.D
SCALED
Flinders Island #33-357
Steranes
S1
S2
S3
S4
S5
S6
S7
S8
S9
S10
S11
S12
Abundance
Time (min.)

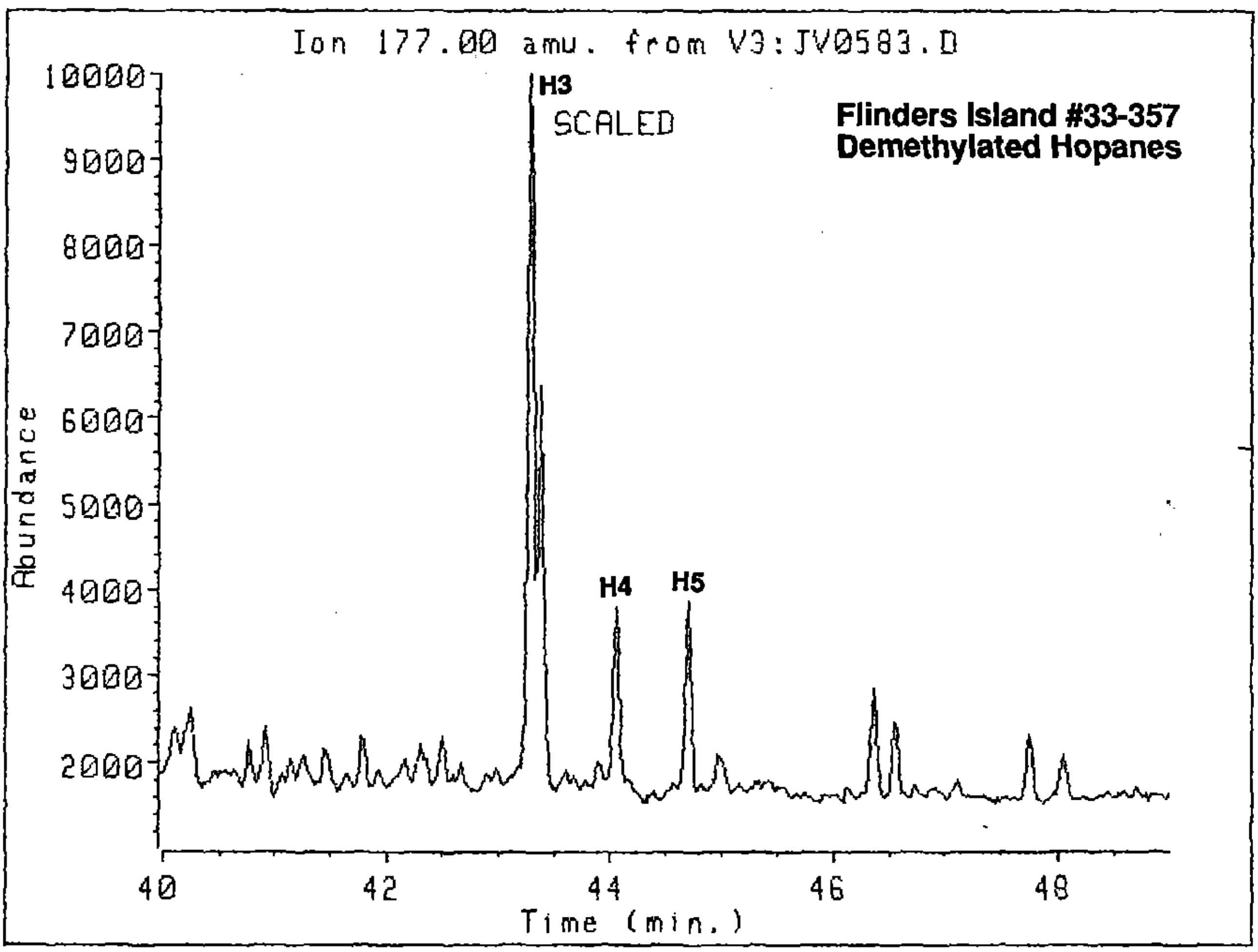

Ion 259.00 amu. from V3:JV0583.D
SCALED
Flinders Island #33-357
Diasteranes
D1
D2
D3
D4
D5
D6
Abundance
10000
9000
8000
7000
6000
5000
4000
3000
2000
36
38
40
42
44
Time (min.)

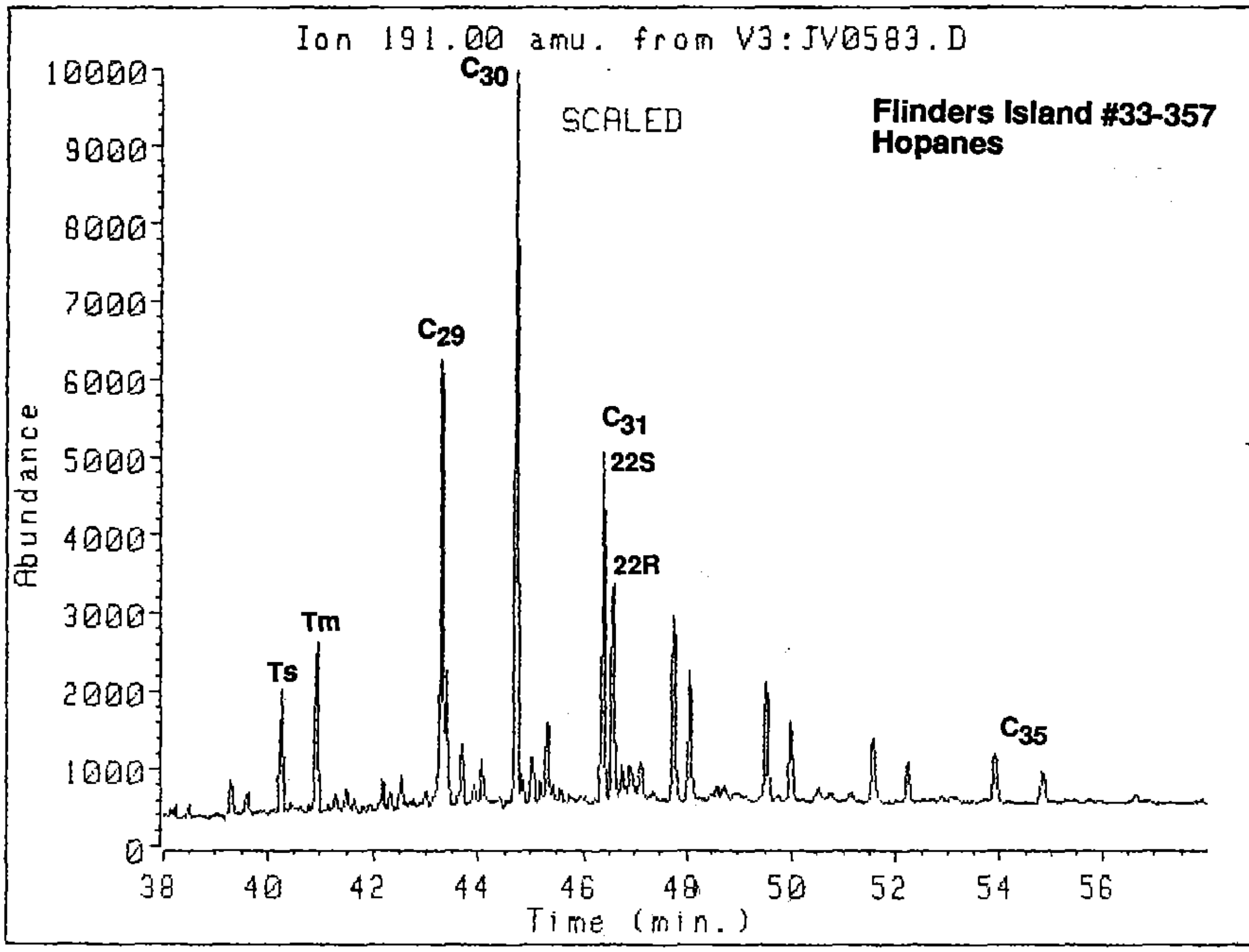

Ion 231.00 amu. from V3:JV0583.D
SCALED
Flinders Island #33-357
Methyl Steranes
Abundance
10000
9000
8000
7000
6000
5000
4000
3000
36
38
40
42
44
Time (min.)

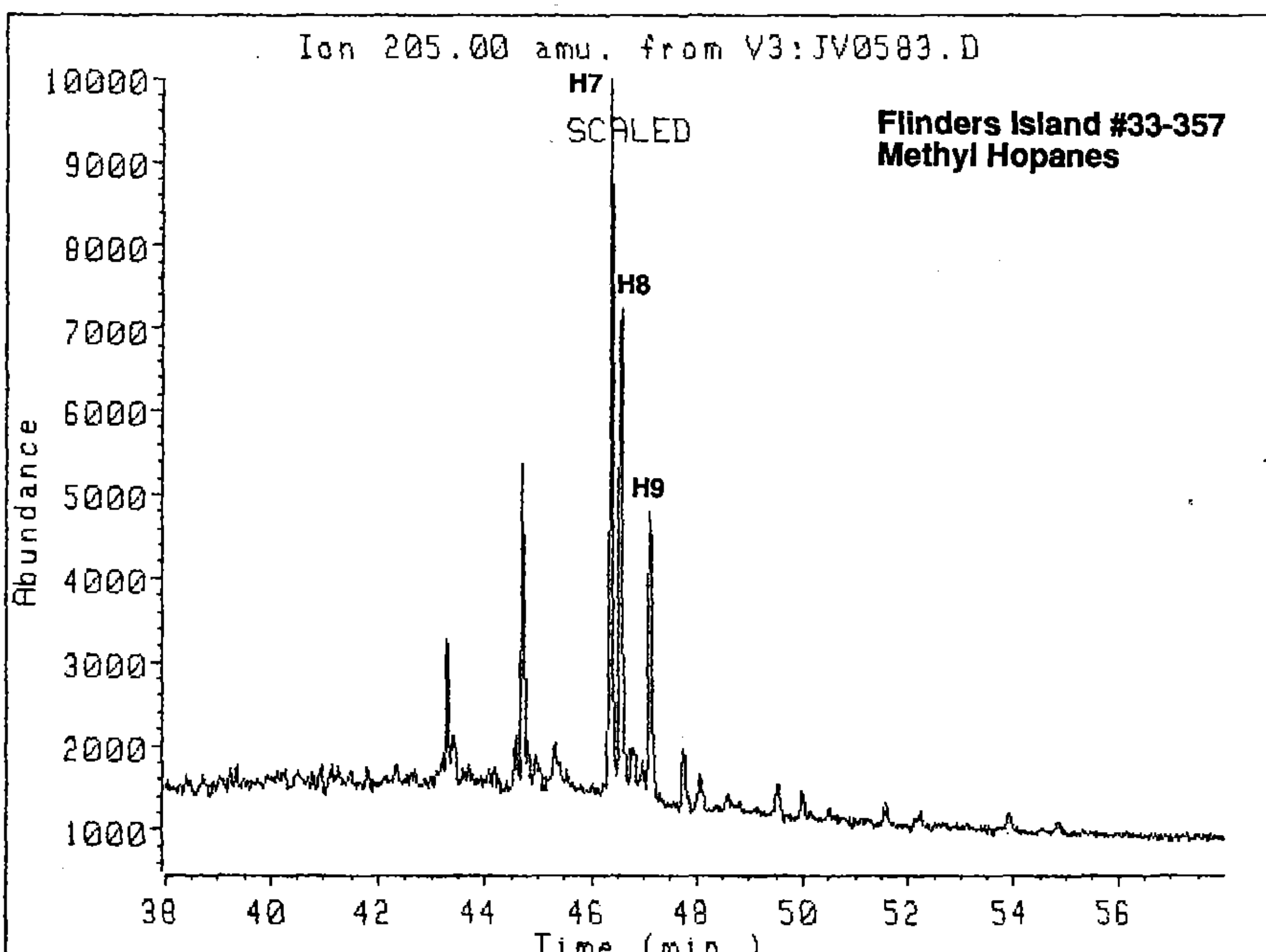

Ion 217.00 amu. from V3:JV0583.D
SCALED
C21
C22
Flinders Island #33-357
Steranes and Diasteranes
Abundance
10000
9000
8000
7000
6000
5000
4000
3000
2000
22
24
26
28
30
32
Time (min.)

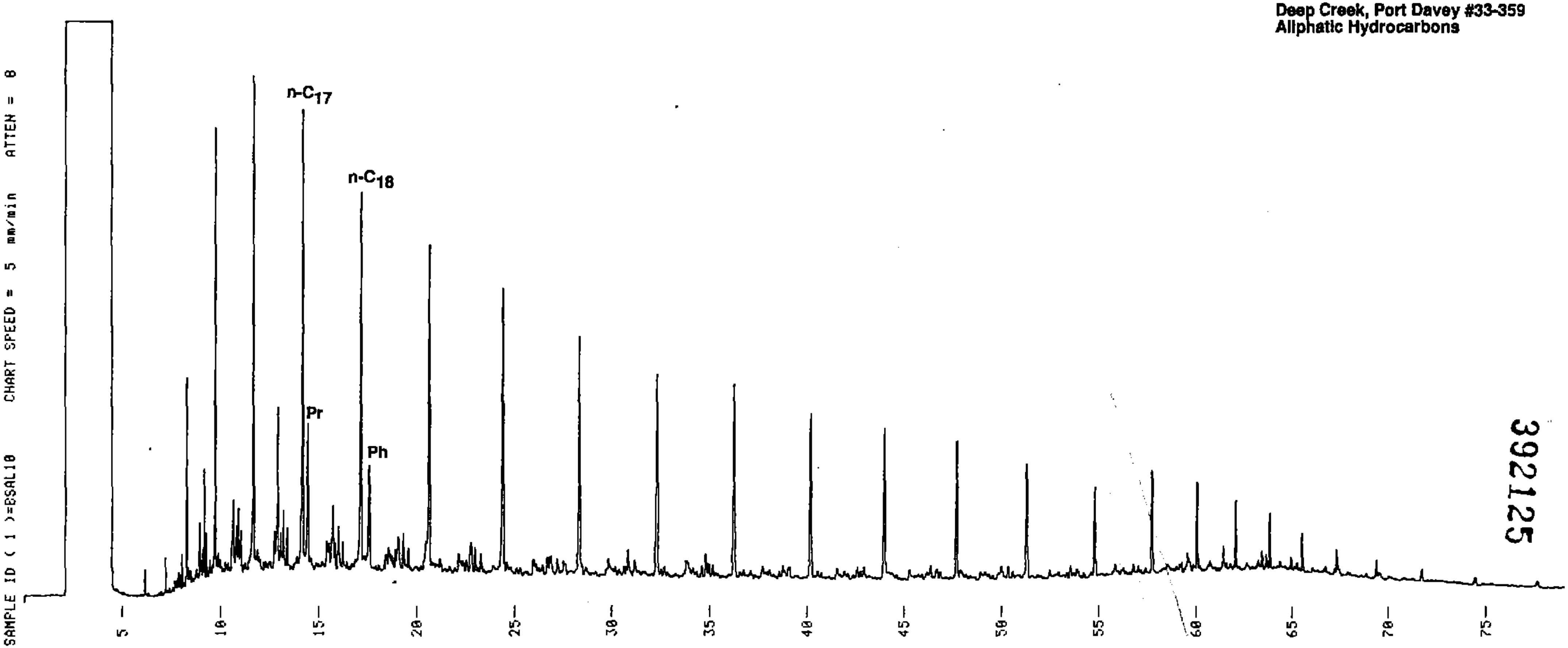

Ion 218.00 amu. from V3:JV0583.D
SCALED
C21
C22
Flinders Island #33-357
Steranes
Abundance
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
22
24
26
28
30
32
Time (min.)


Ion 191.00 amu. from V3:JV0583.D
SCALED
Flinders Island #33-357
Hopanes
H1
H2
H3
H4
H5
H6
H7
H8
H9
H10
H11
Abundance
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
40
42
44
46
48
Time (min.)


Ion 177.00 amu. from V3:JV0583.D
SCALED
Flinders Island #33-357
Demethylated Hopanes
H3
H4
H5
Abundance
10000
9000
8000
7000
6000
5000
4000
3000
2000
40
42
44
46
48
Time (min.)

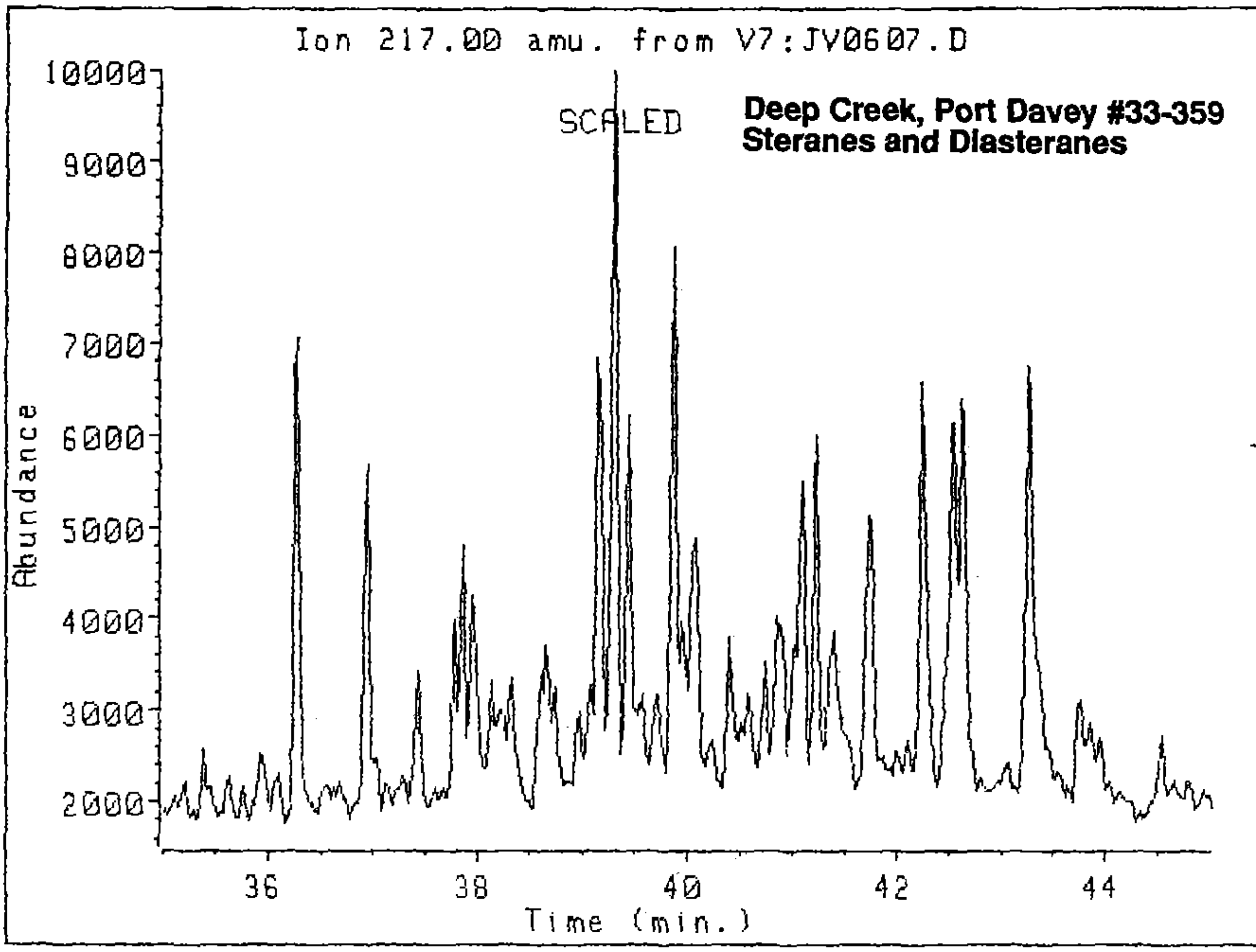

Ion 191.00 amu. from V3:JV0583.D
SCALED
Flinders Island #33-357
Hopanes
Abundance
Time (min.)
Ts
Tm
C29
C30
C31
22S
22R
C35

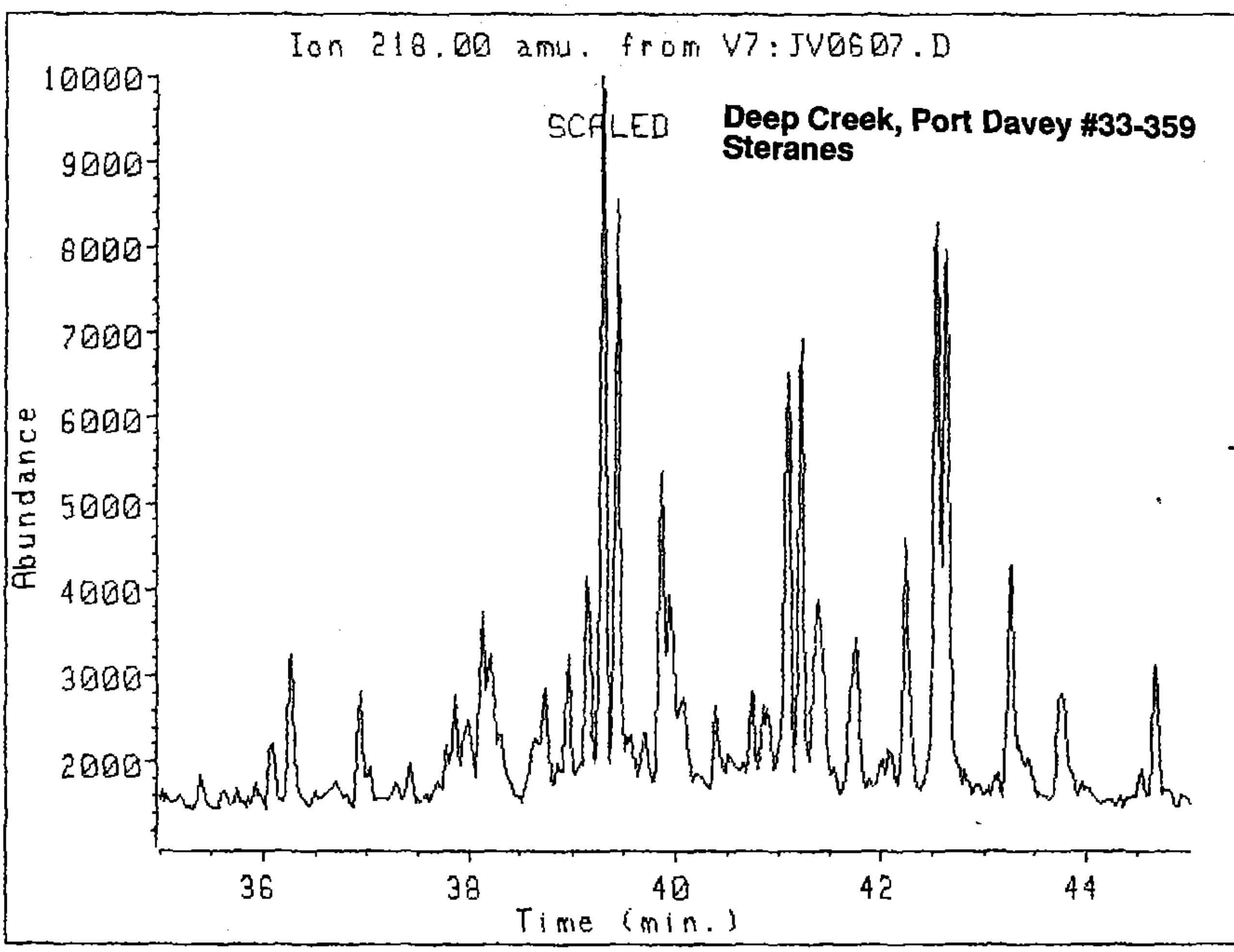

Ion 205.00 amu. from V3:JV0583.D
SCALED
Flinders Island #33-357
Methyl Hopanes
Abundance
Time (min.)
H7
H8
H9



Deep Creek, Port Davey #33-359
Aliphatic Hydrocarbons

392125


Ion 217.00 amu. from V7:JV0607.D
SCALED
Deep Creek, Port Davey #33-359
Steranes and Diasteranes
Abundance
10000
9000
8000
7000
6000
5000
4000
3000
2000
36
38
40
42
44
Time (min.)


Ion 218.00 amu. from V7:JV0607.D
SCALED
Deep Creek, Port Davey #33-359
Steranes
Abundance
10000
9000
8000
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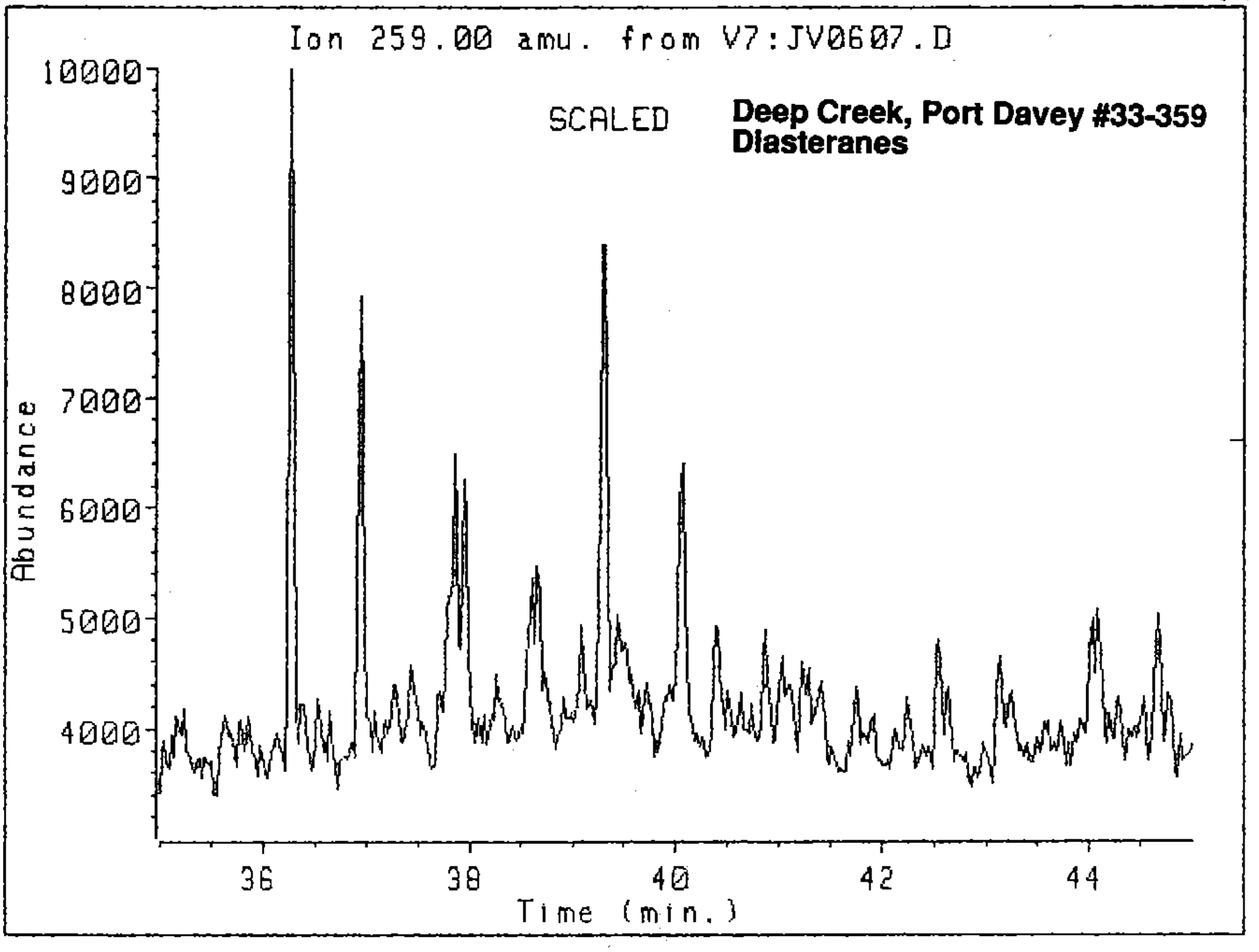
40
42
44
Time (min.)


Ion 259.00 amu. from V7:JV0607.D
SCALED
Deep Creek, Port Davey #33-359
Diasteranes
Abundance
10000
9000
8000
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36
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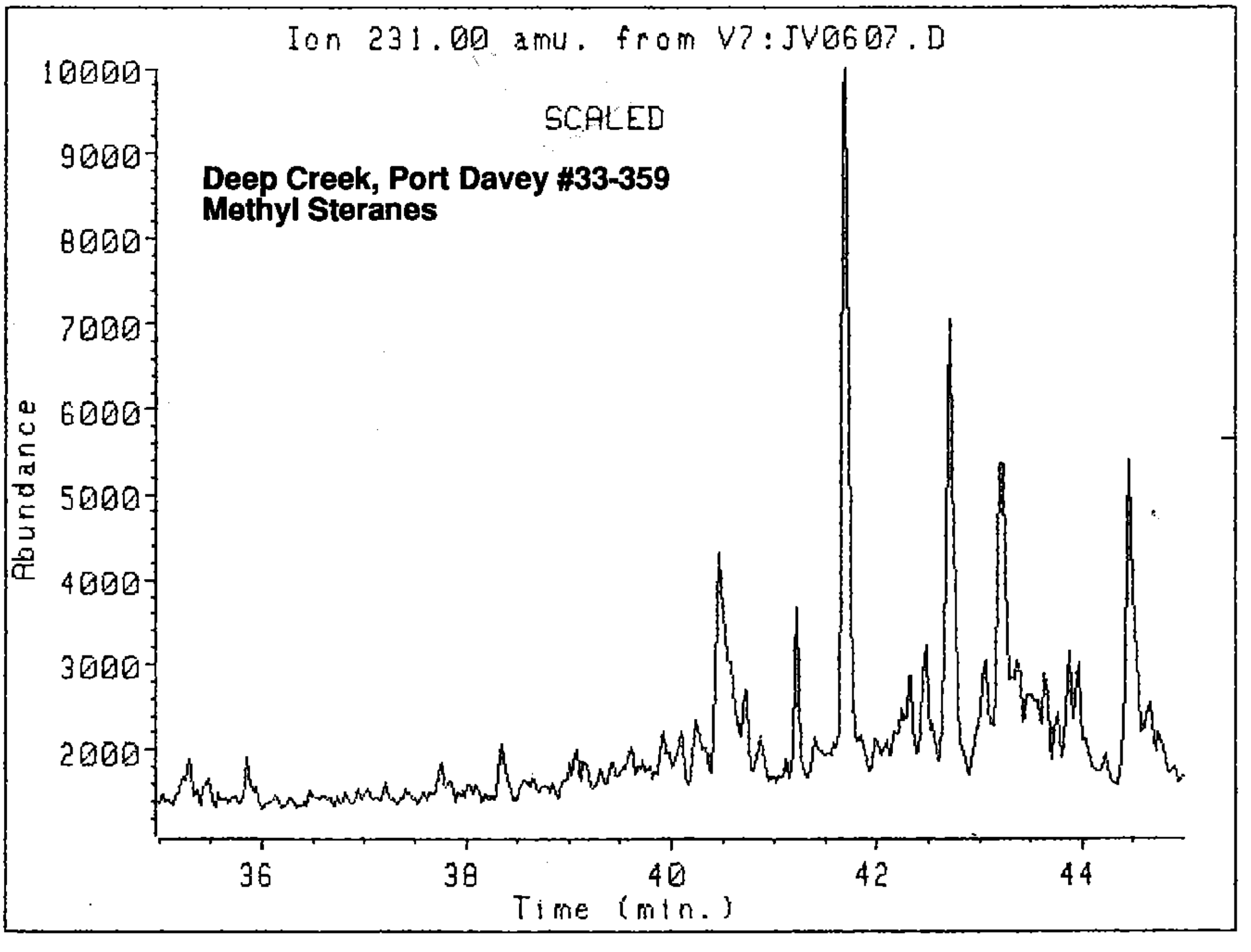
40
42
44
Time (min.)


Ion 231.00 amu. from V7:JV0607.D
SCALED
Deep Creek, Port Davey #33-359
Methyl Steranes
Abundance
10000
9000
8000
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6000
5000
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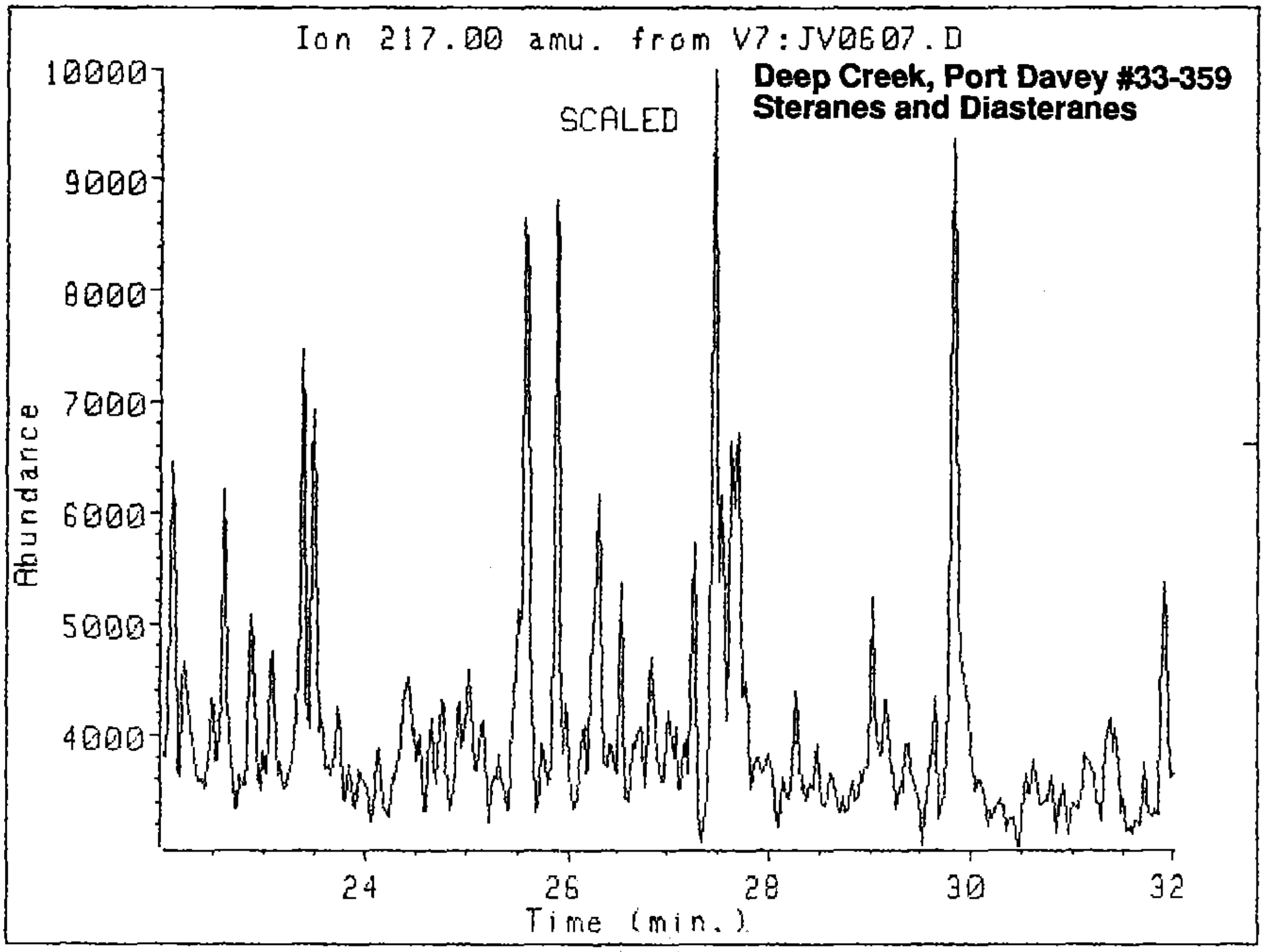
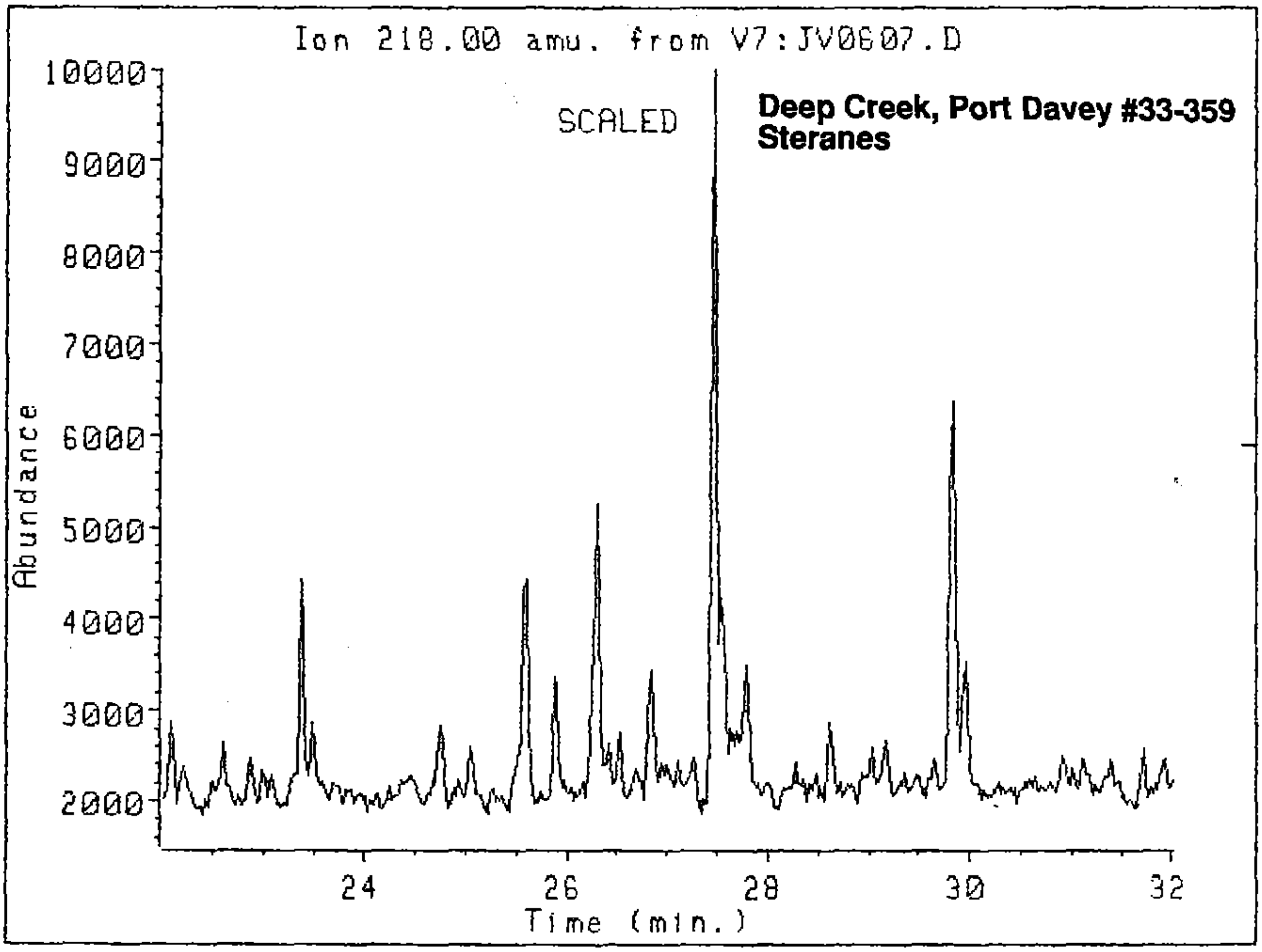
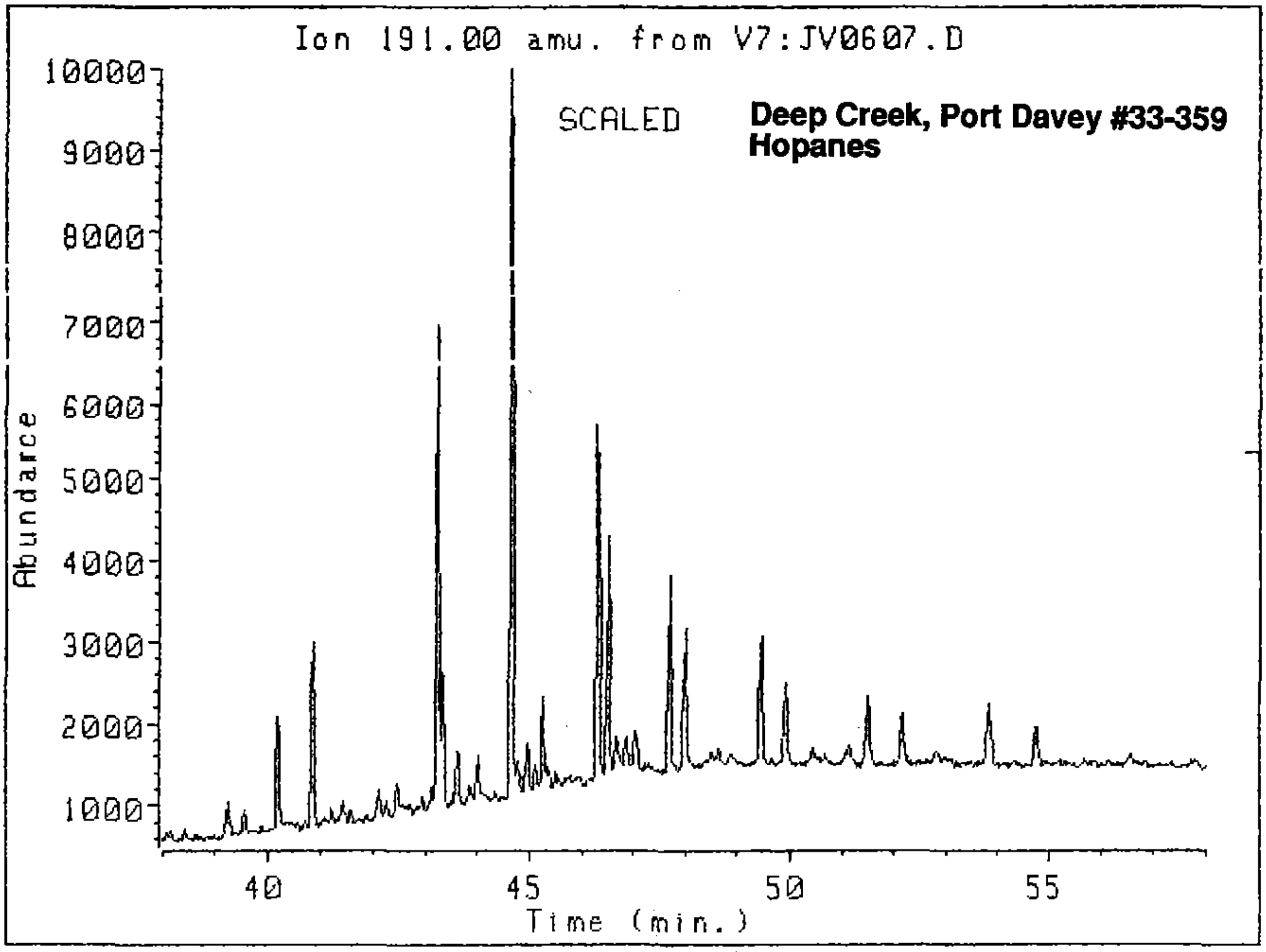
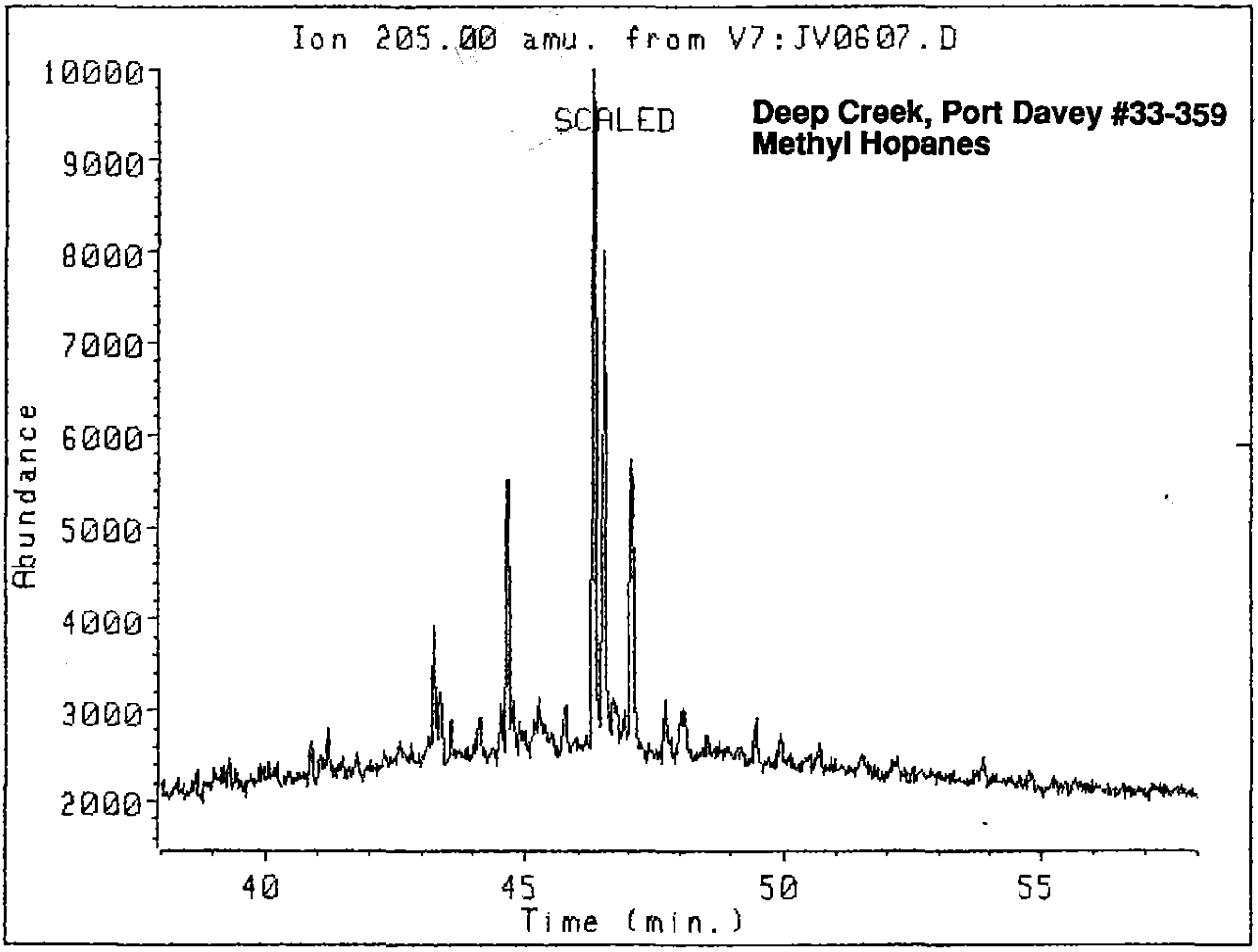
3000
2000
36
38
40
42
44
Time (min.)


Ion 217.00 amu. from V7:JV0607.D
Deep Creek, Port Davey #33-359
Steranes and Diasteranes
SCALED
Abundance
10000
9000
8000
7000
6000
5000
4000
Time (min.)
24
26
28
30
32

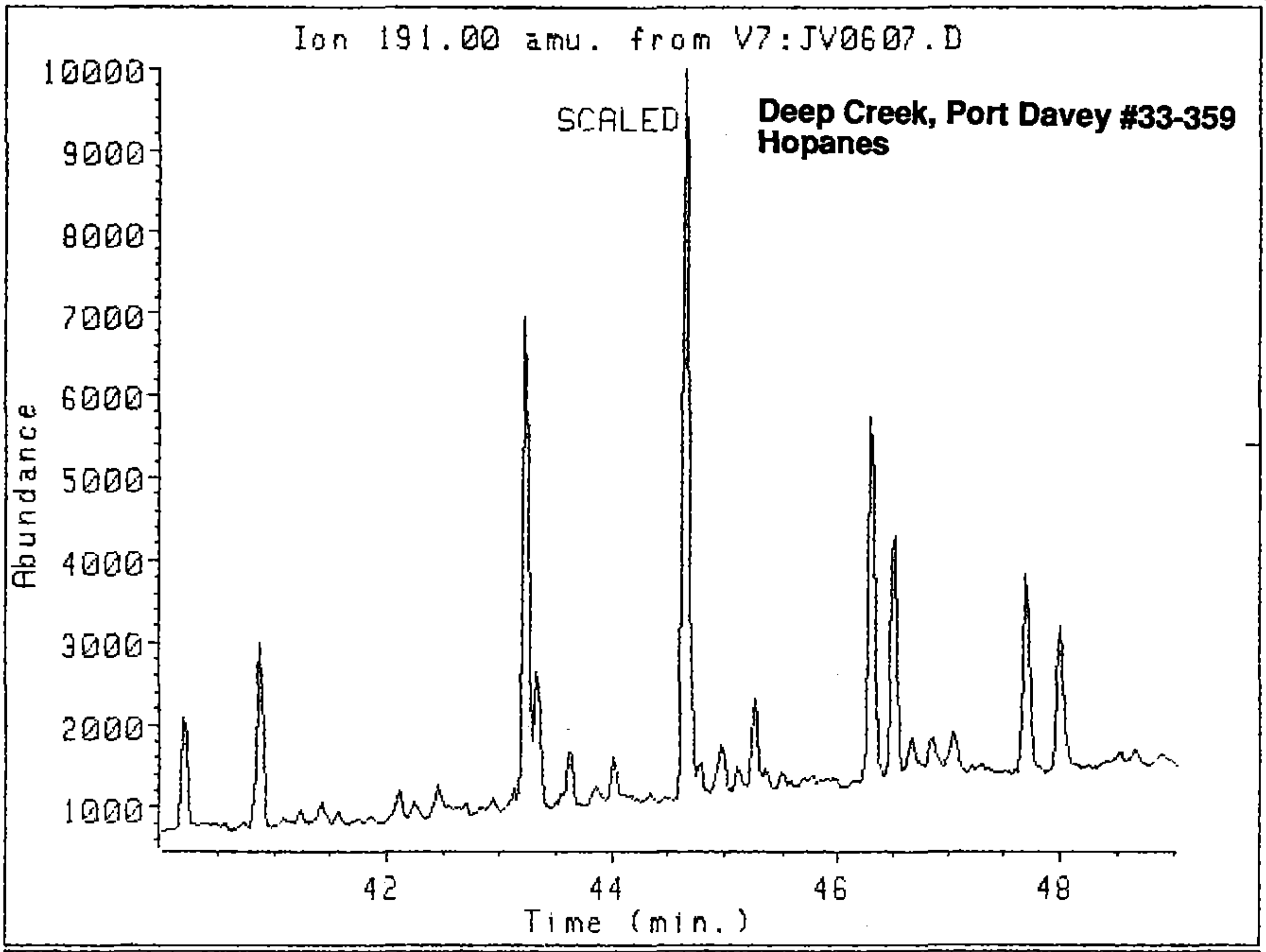

Ion 218.00 amu. from V7:JV0607.D
Deep Creek, Port Davey #33-359
Steranes
SCALED
Abundance
10000
9000
8000
7000
6000
5000
4000
3000
2000
Time (min.)
24
26
28
30
32

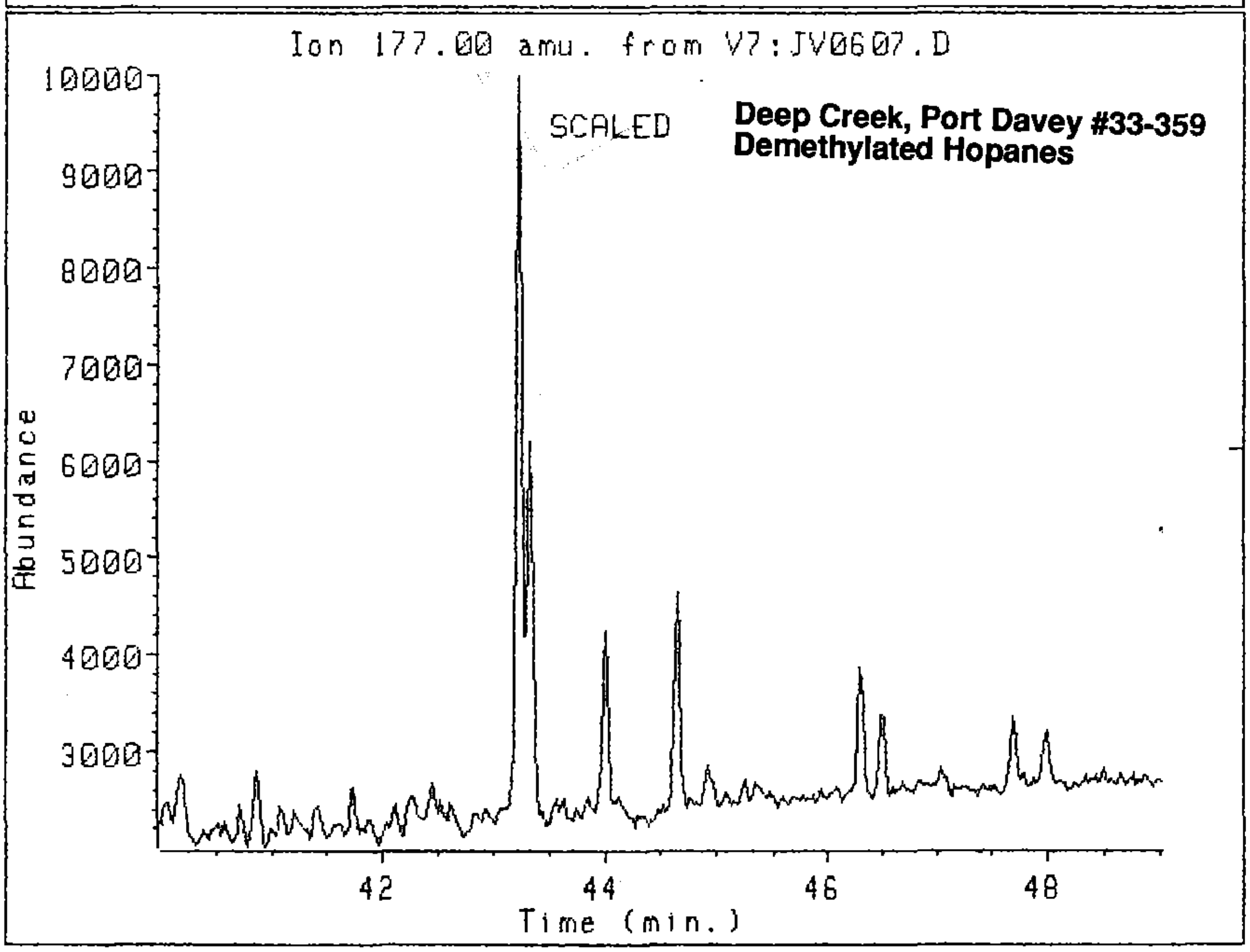


Ion 191.00 amu. from V7:JV0607.D
SCALED
Deep Creek, Port Davey #33-359
Hopanes
Abundance
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
40
45
50
55
Time (min.)

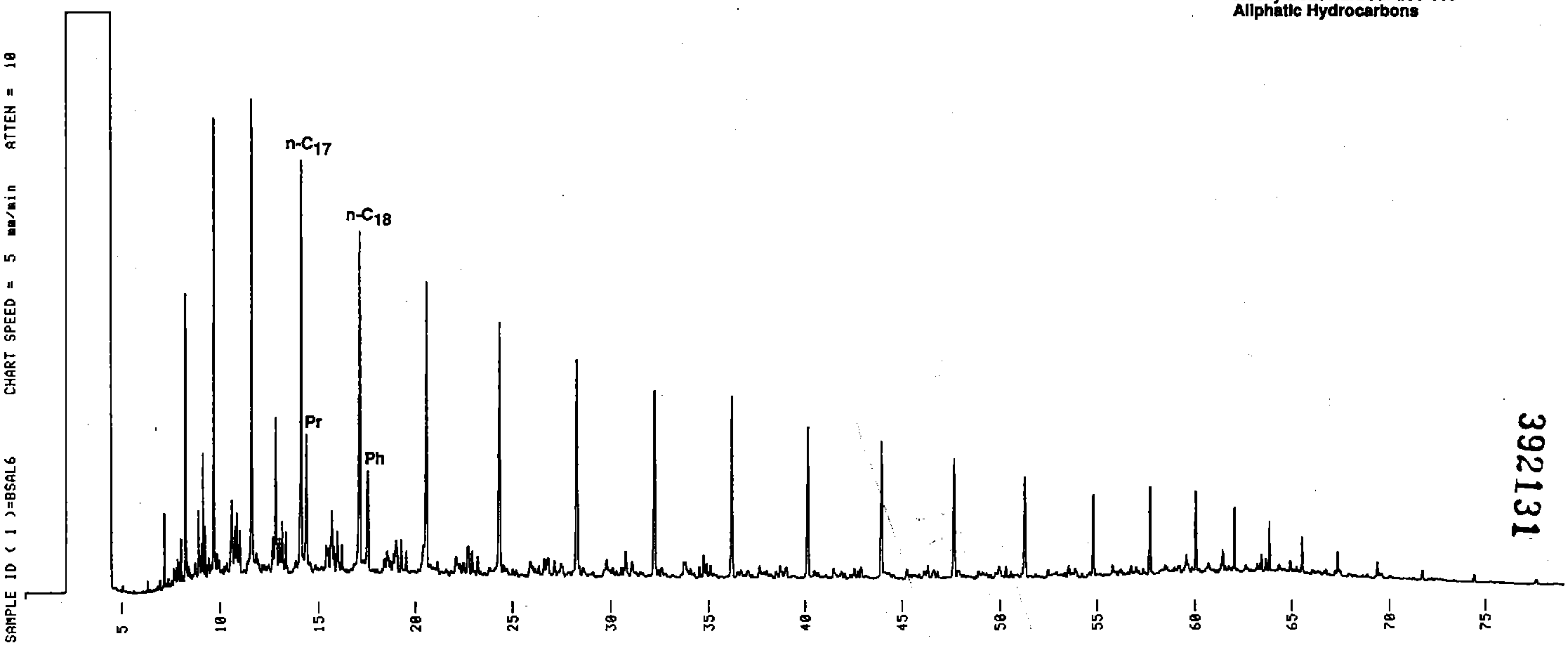


Ion 205.00 amu. from V7:JV0607.D
SCALED
Deep Creek, Port Davey #33-359
Methyl Hopanes
Abundance
10000
9000
8000
7000
6000
5000
4000
3000
2000
40
45
50
55
Time (min.)

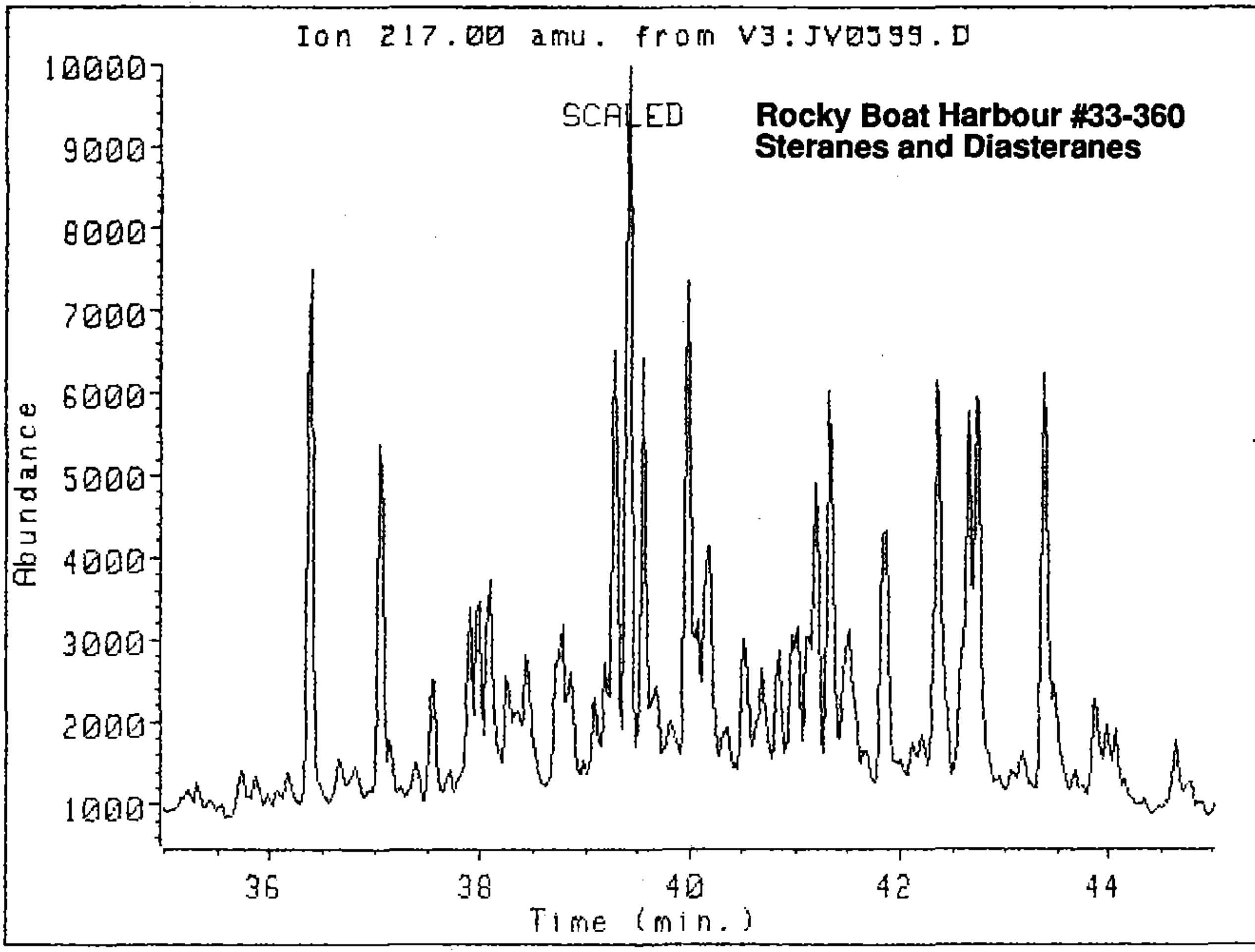

Ion 191.00 amu. from V7:JV0607.D
SCALED
Deep Creek, Port Davey #33-359
Hopanes
Abundance
Time (min.)

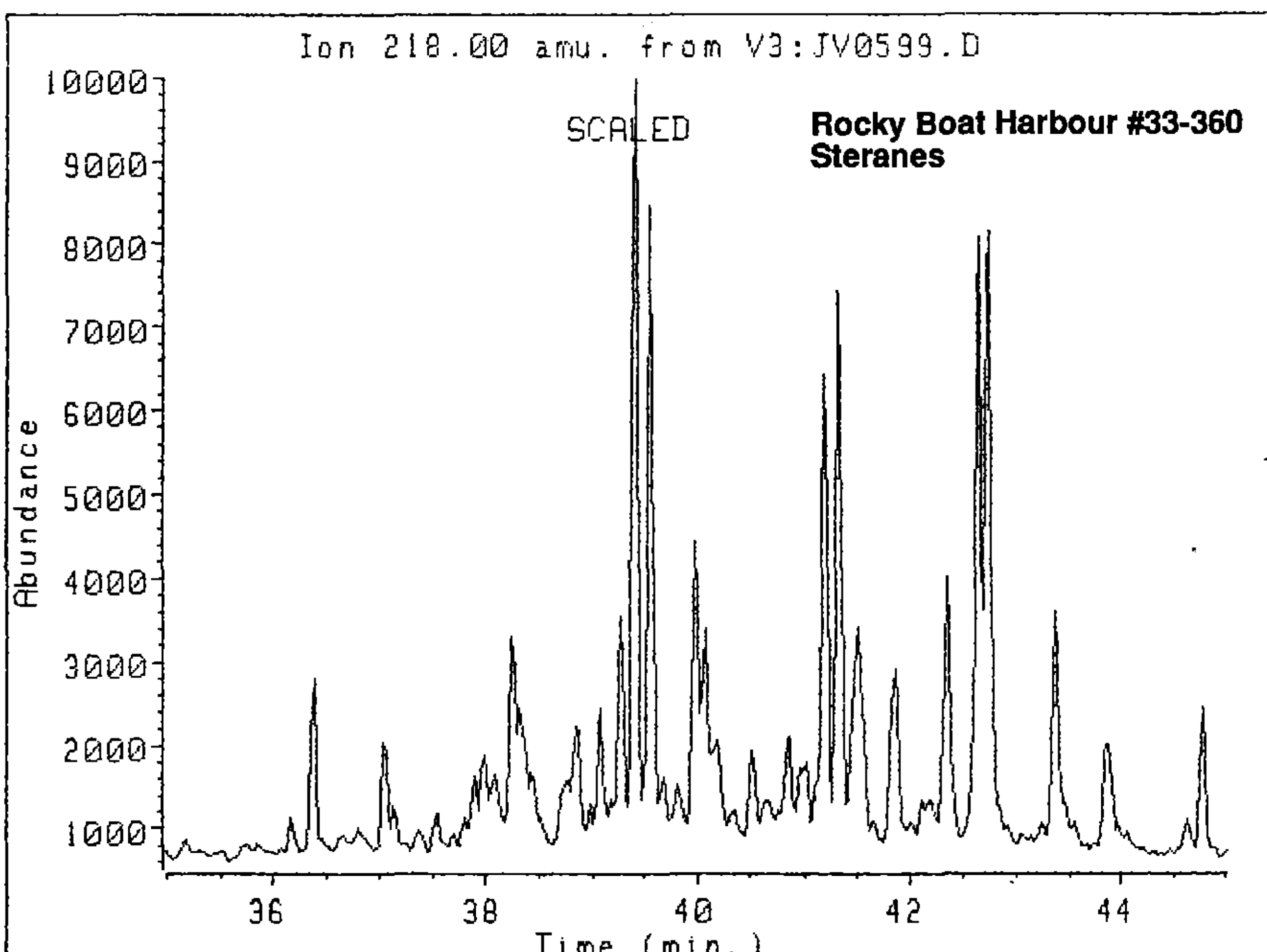

Ion 177.00 amu. from V7:JV0607.D
SCALED
Deep Creek, Port Davey #33-359
Demethylated Hopanes
Abundance
Time (min.)

Rocky Boat Harbour #33-360
Aliphatic Hydrocarbons



392131


Ion 217.00 amu. from V3:JV0599.D
SCALED
Rocky Boat Harbour #33-360
Steranes and Diasteranes
Abundance
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
36
38
40
42
44
Time (min.)


Ion 218.00 amu. from V3:JV0599.D
SCALED
Rocky Boat Harbour #33-360
Steranes
Abundance
10000
9000
8000
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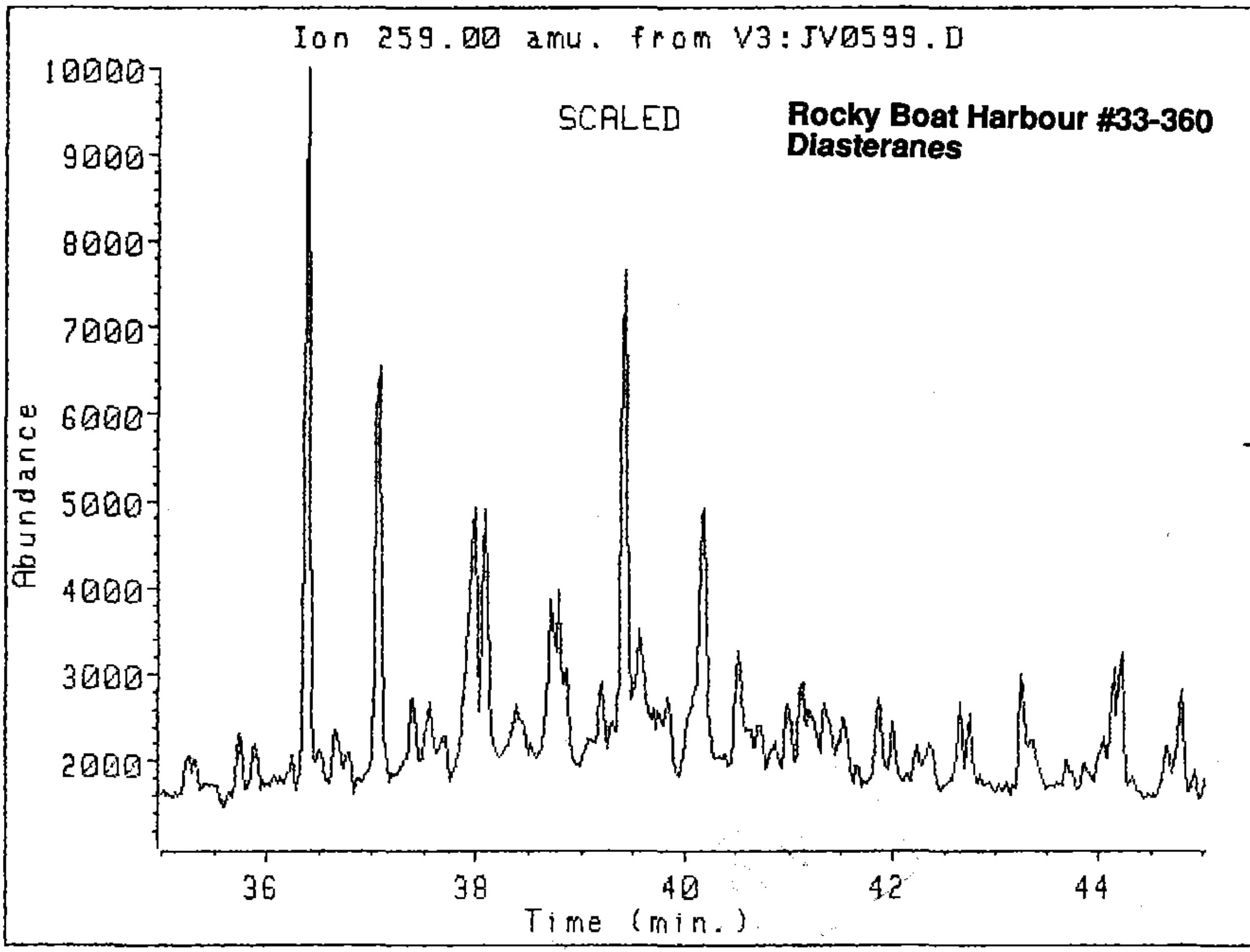
6000
5000
4000
3000
2000
1000
36
38
40
42
44
Time (min.)


Ion 259.00 amu. from V3:JV0599.D
SCALED
Rocky Boat Harbour #33-360
Diasteranes
Abundance
10000
9000
8000
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5000
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3000
2000
36
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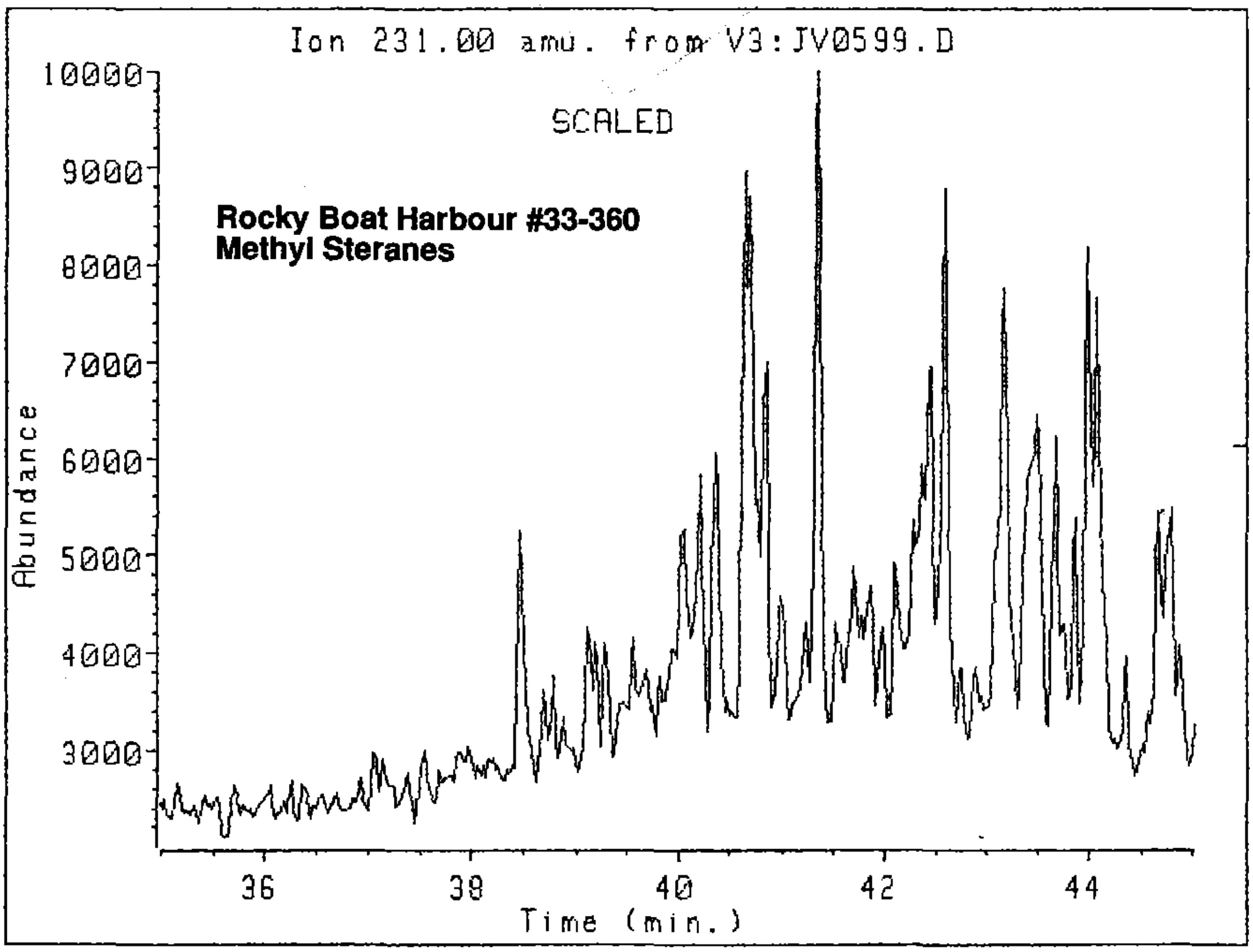
40
42
44
Time (min.)


Ion 231.00 amu. from V3:JV0599.D
SCALED
Rocky Boat Harbour #33-360
Methyl Steranes
Abundance
10000
9000
8000
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3000
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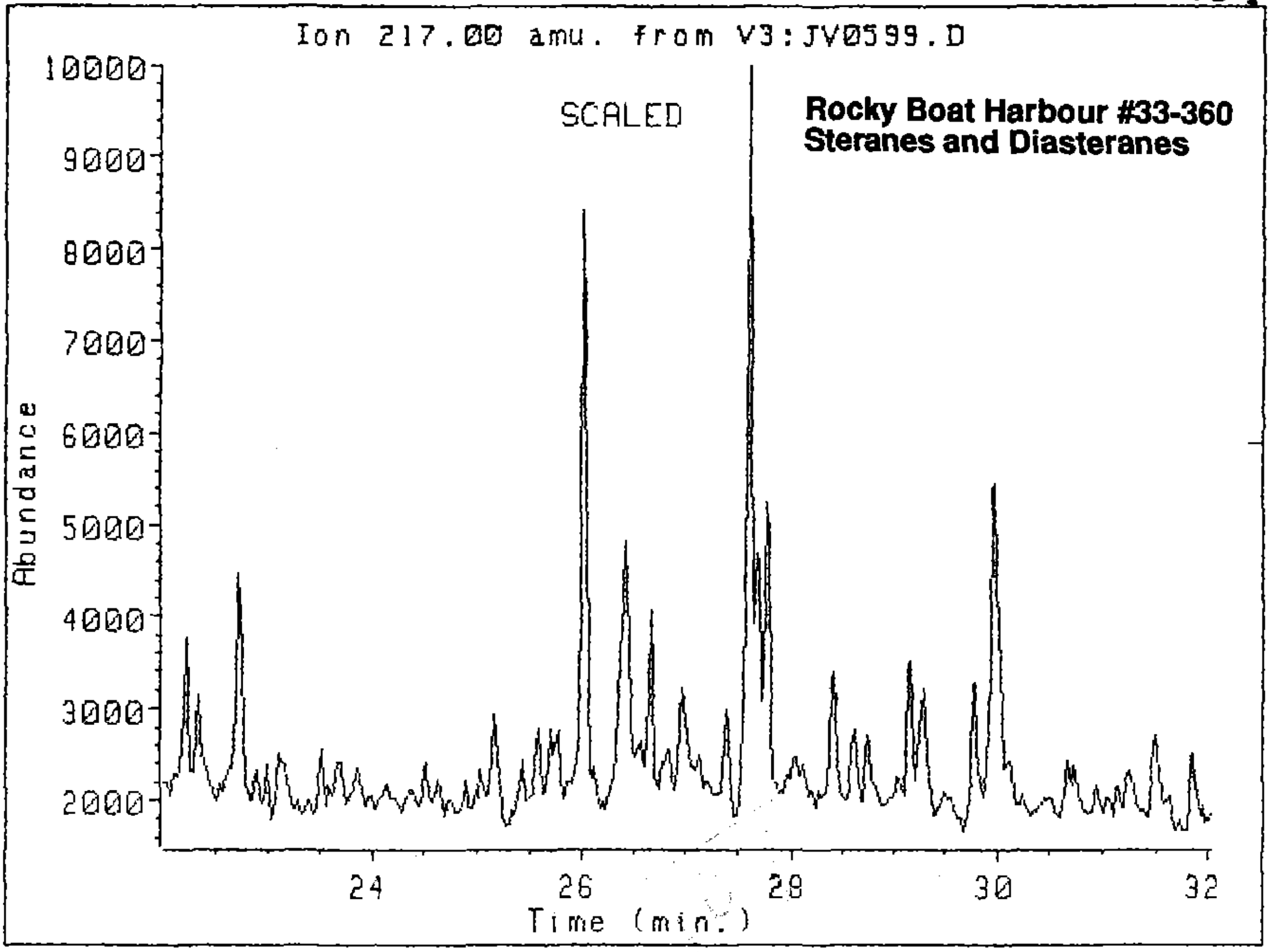
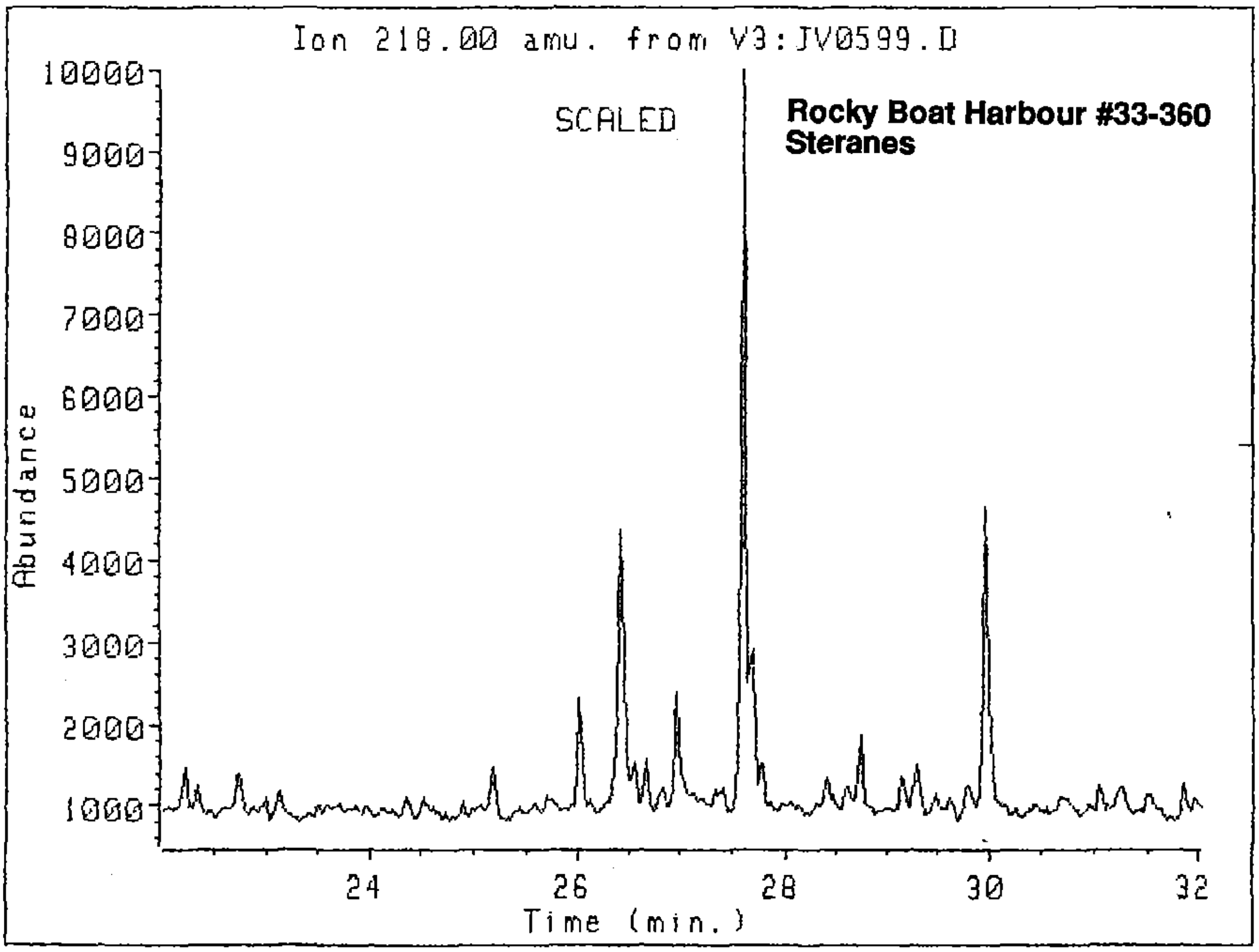
38
40
42
44
Time (min.)


Ion 217.00 amu. from V3:JV0599.D
SCALED
Rocky Boat Harbour #33-360
Steranes and Diasteranes
Abundance
10000
9000
8000
7000
6000
5000
4000
3000
2000
24
26
28
30
32
Time (min.)


Ion 218.00 amu. from V3:JV0599.D
SCALED
Rocky Boat Harbour #33-360
Steranes
Abundance
10000
9000
8000
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6000
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4000
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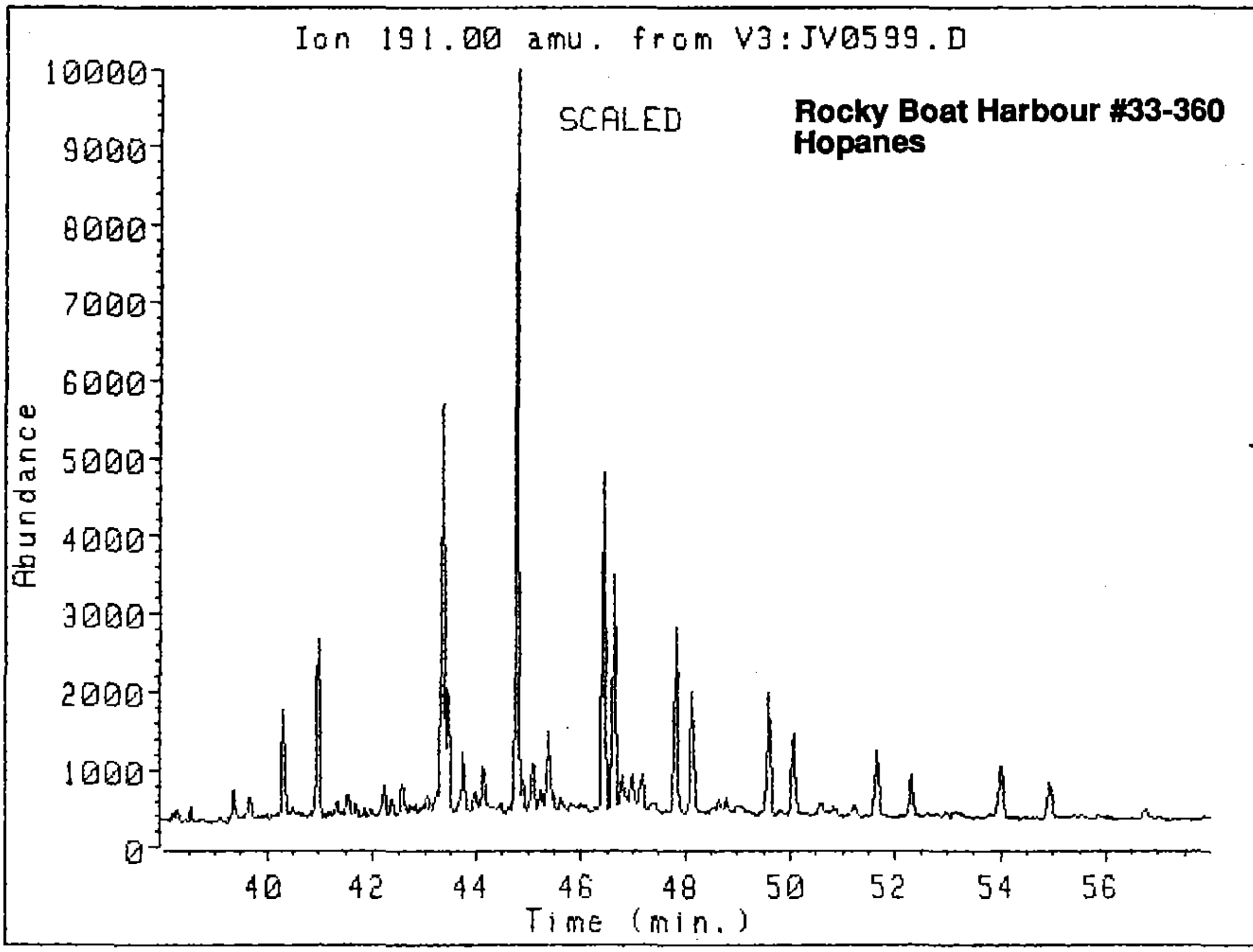
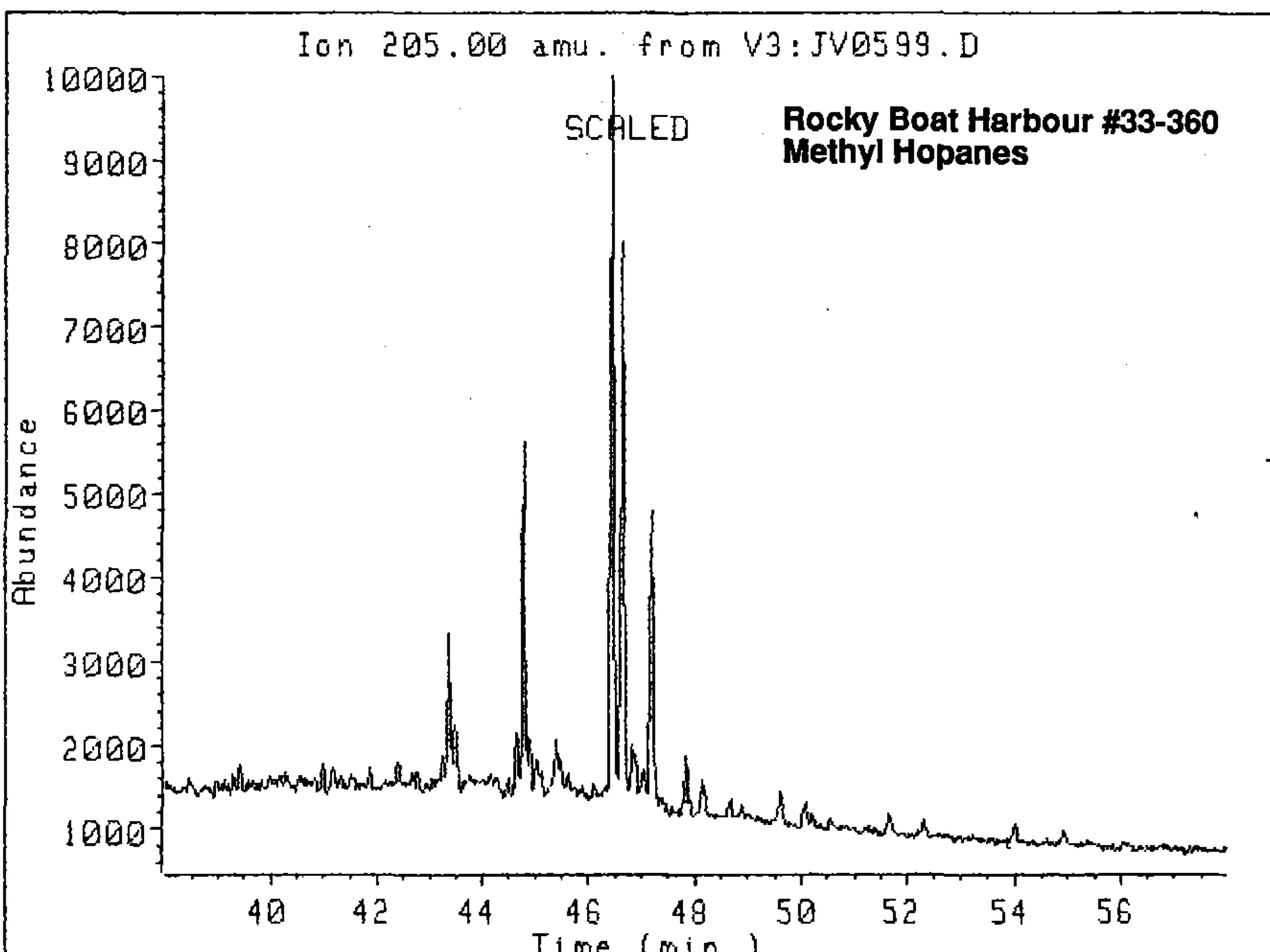
2000
1000
24
26
28
30
32
Time (min.)


Ion 191.00 amu. from V3:JV0599.D
SCALED
Rocky Boat Harbour #33-360
Hopanes
Abundance
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
40
42
44
46
48
50
52
54
56
Time (min.)


Ion 205.00 amu. from V3:JV0599.D
SCALED
Rocky Boat Harbour #33-360
Methyl Hopanes
Abundance
10000
9000
8000
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46
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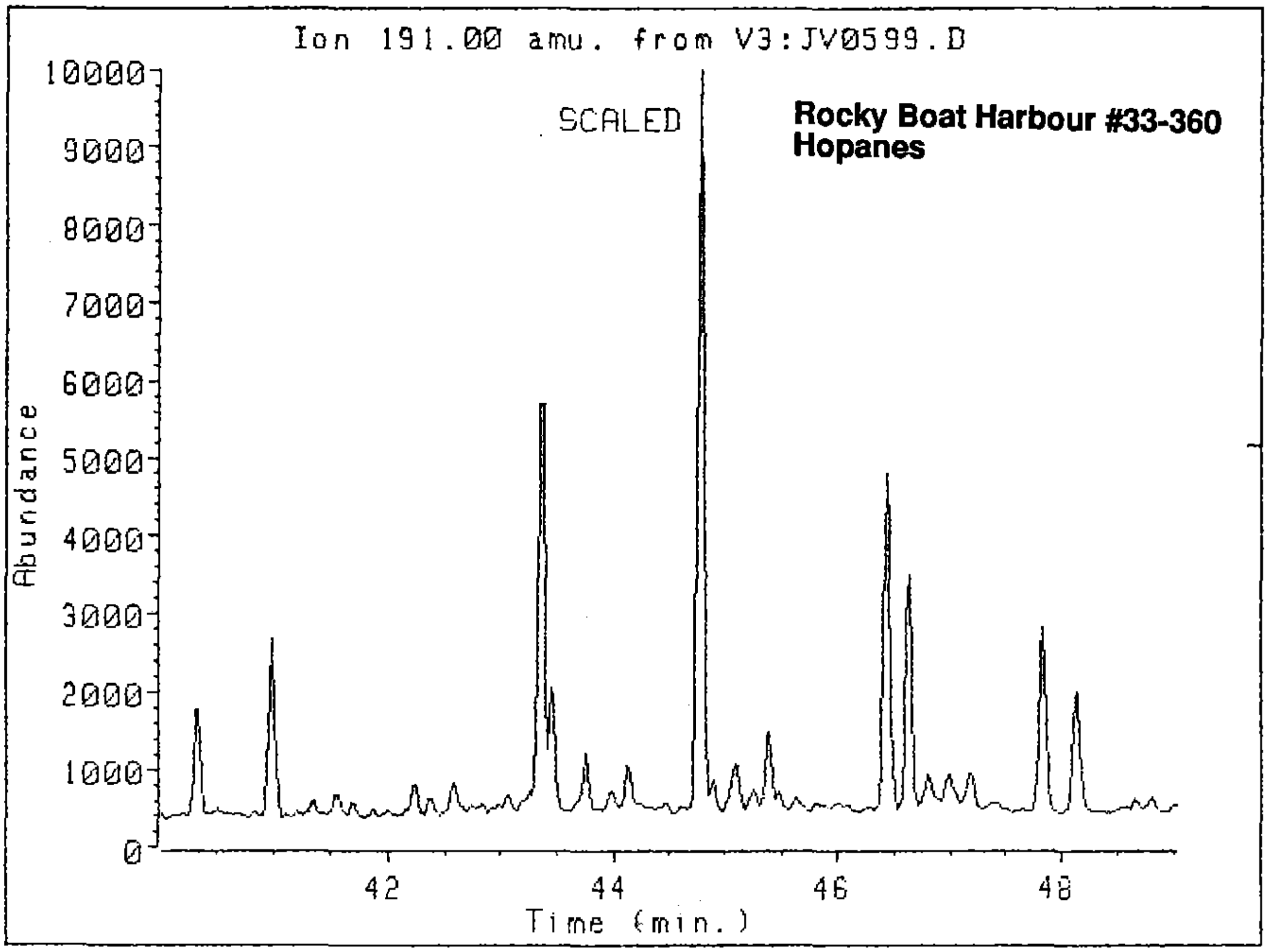
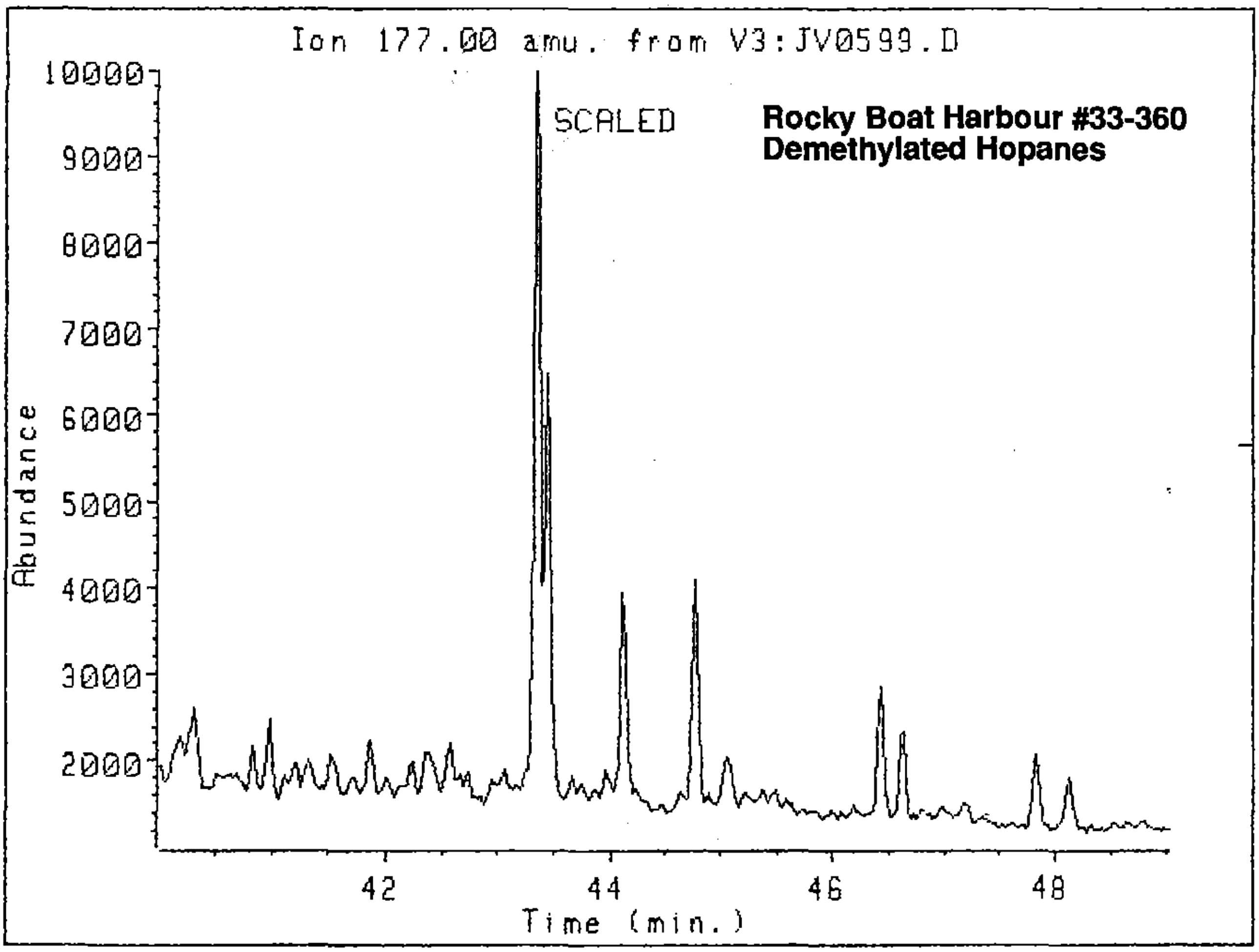
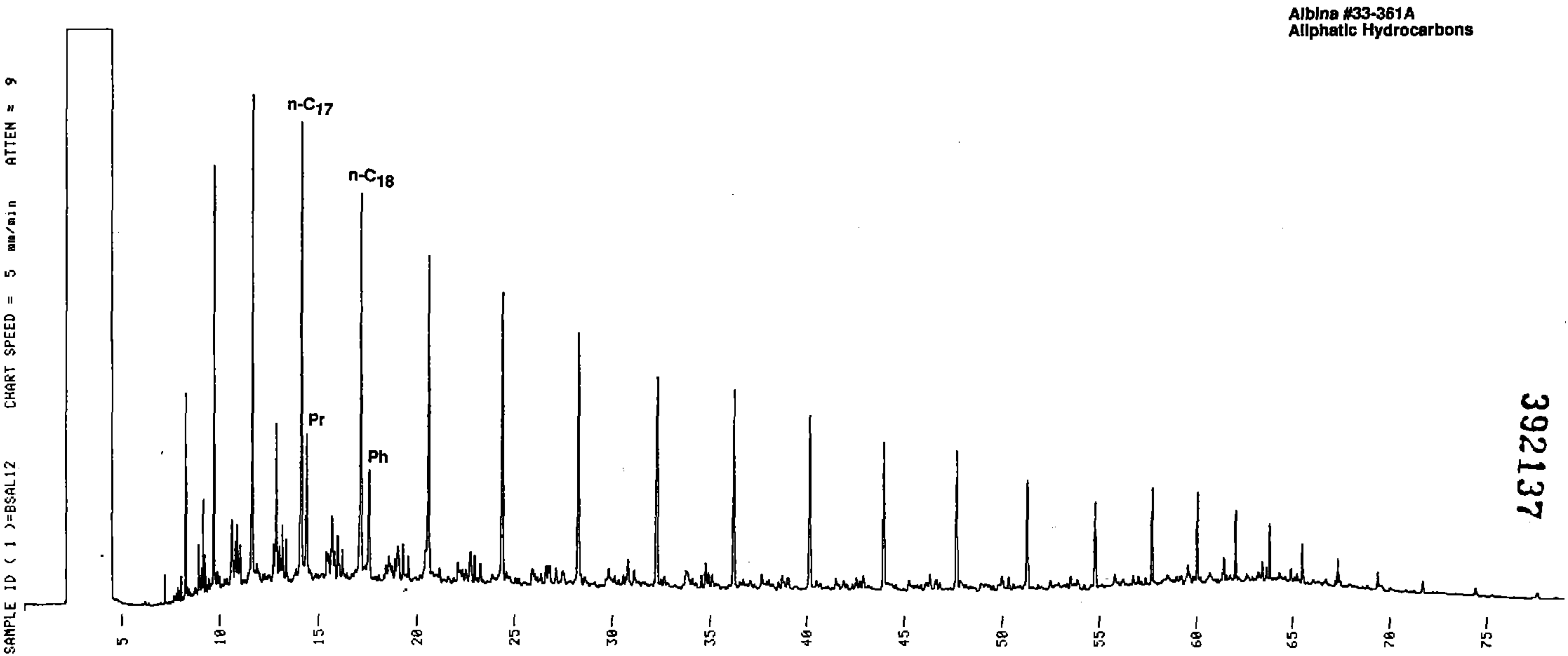
52
54
56
Time (min.)

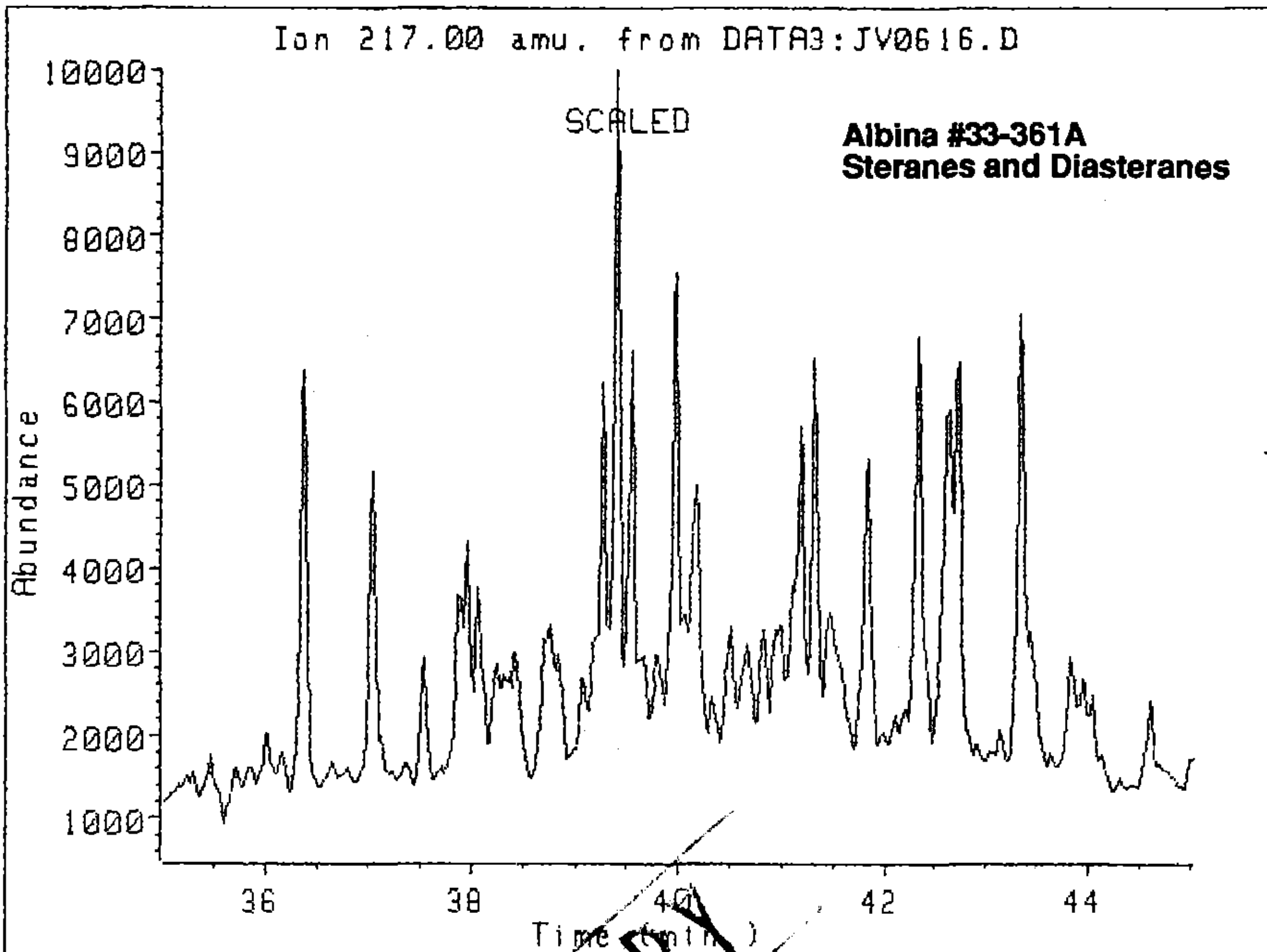

Ion 191.00 amu. from V3:JV0599.D
SCALED
Rocky Boat Harbour #33-360
Hopanes
Abundance
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
42
44
46
48
Time (min.)

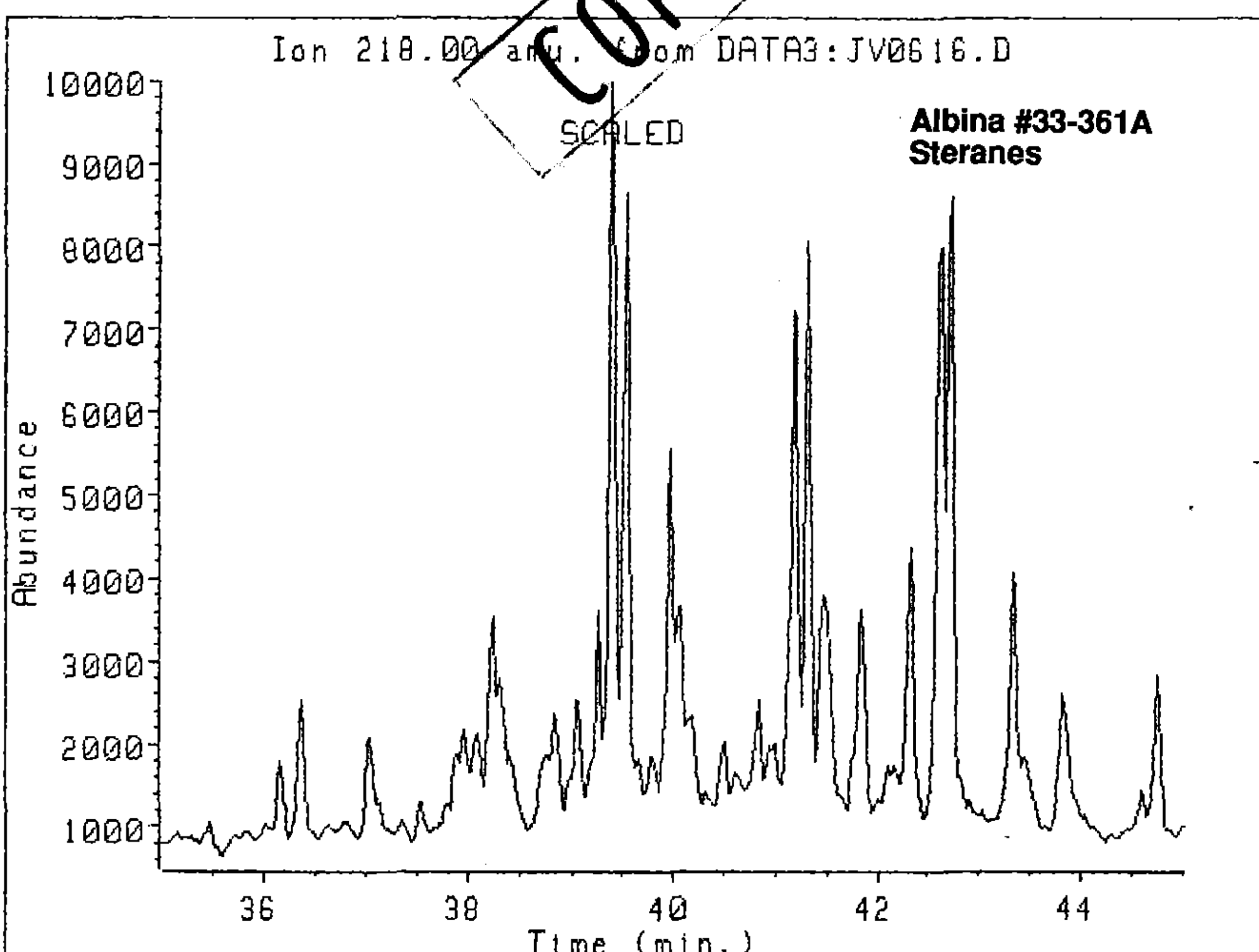

Ion 177.00 amu. from V3:JV0599.D
SCALED
Rocky Boat Harbour #33-360
Demethylated Hopanes
Abundance
10000
9000
8000
7000
6000
5000
4000
3000
2000
42
44
46
48
Time (min.)



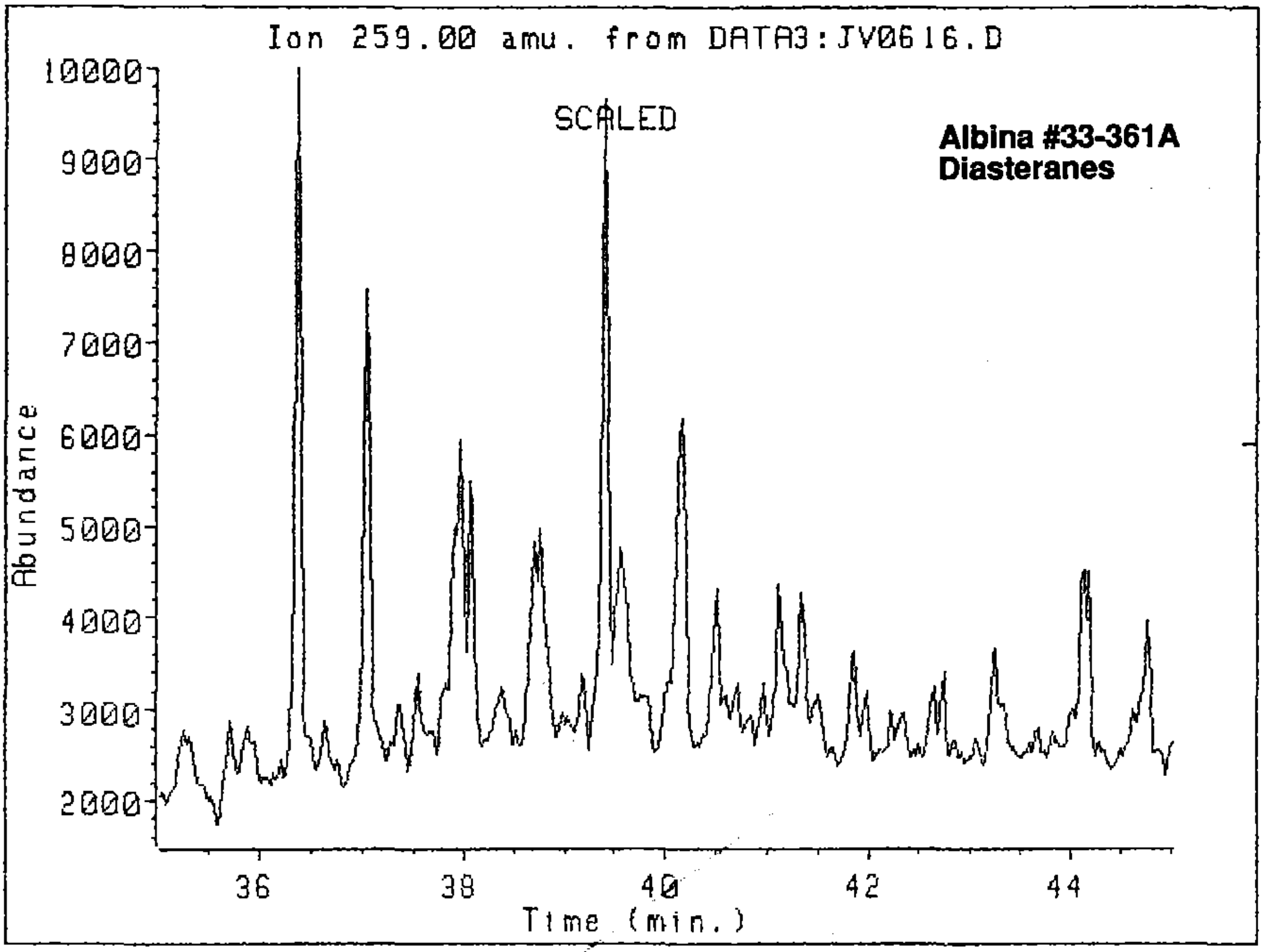
Albina #33-361A
Aliphatic Hydrocarbons
n-C17
n-C18
Pr
Ph
SAMPLE ID (1)=BSAL12 CHART SPEED = 5 mm/min ATTEN = 9
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75

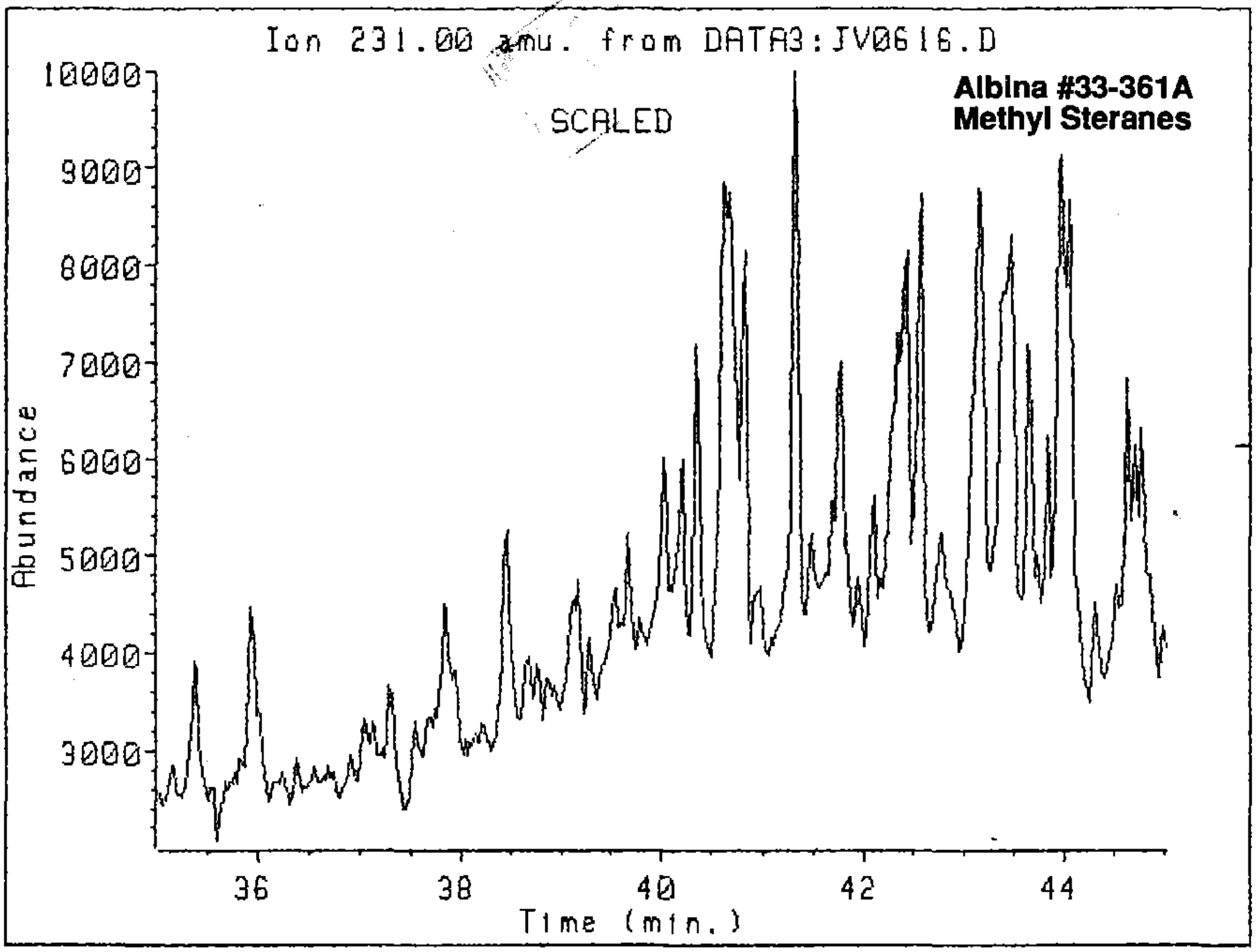
392137

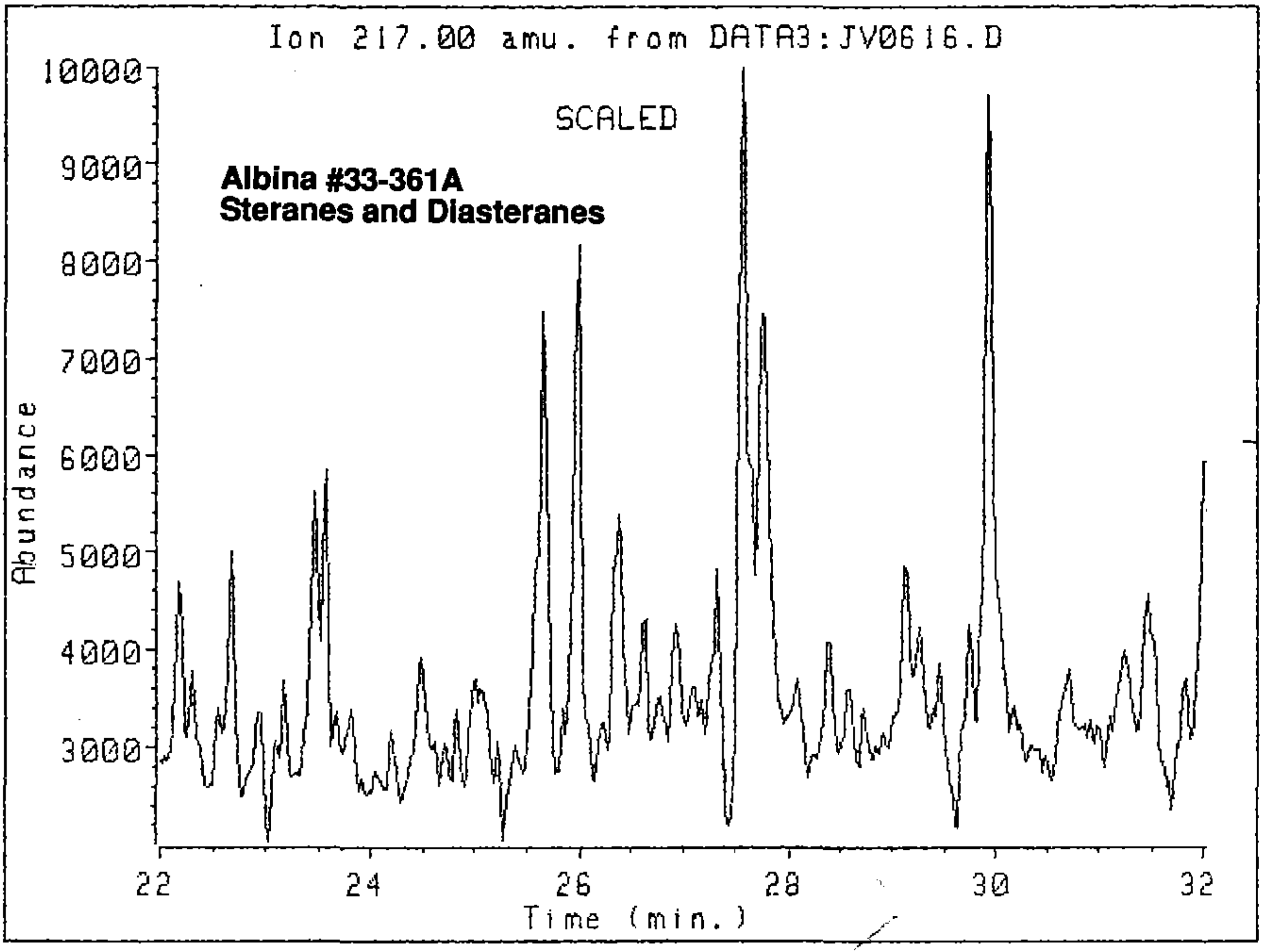

Ion 217.00 amu. from DATA3:JV0616.D
SCALED
Albina #33-361A
Steranes and Diasteranes
Abundance
Time (min.)

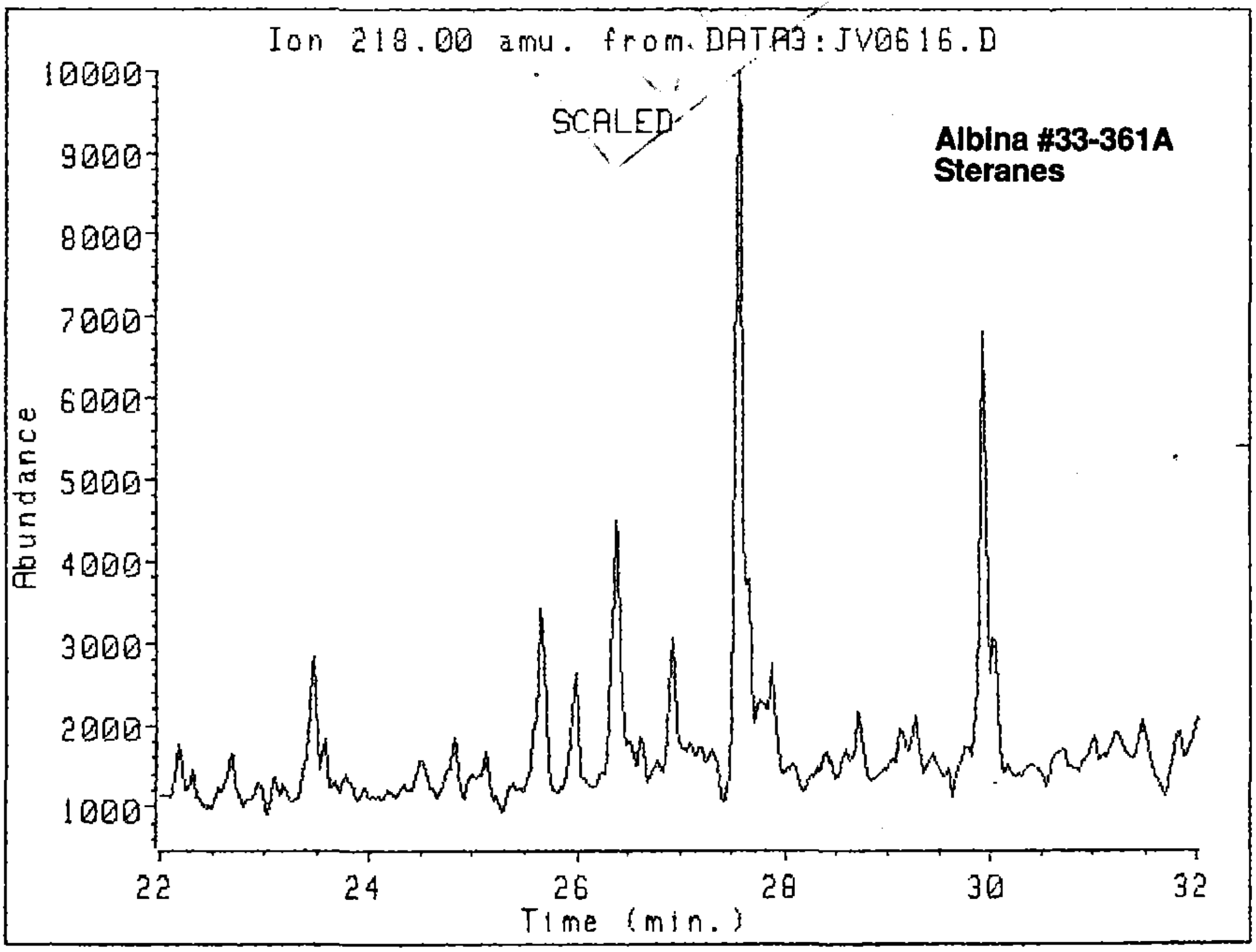

Ion 218.00 amu. from DATA3:JV0616.D
SCALED
Albina #33-361A
Steranes
Abundance
Time (min.)

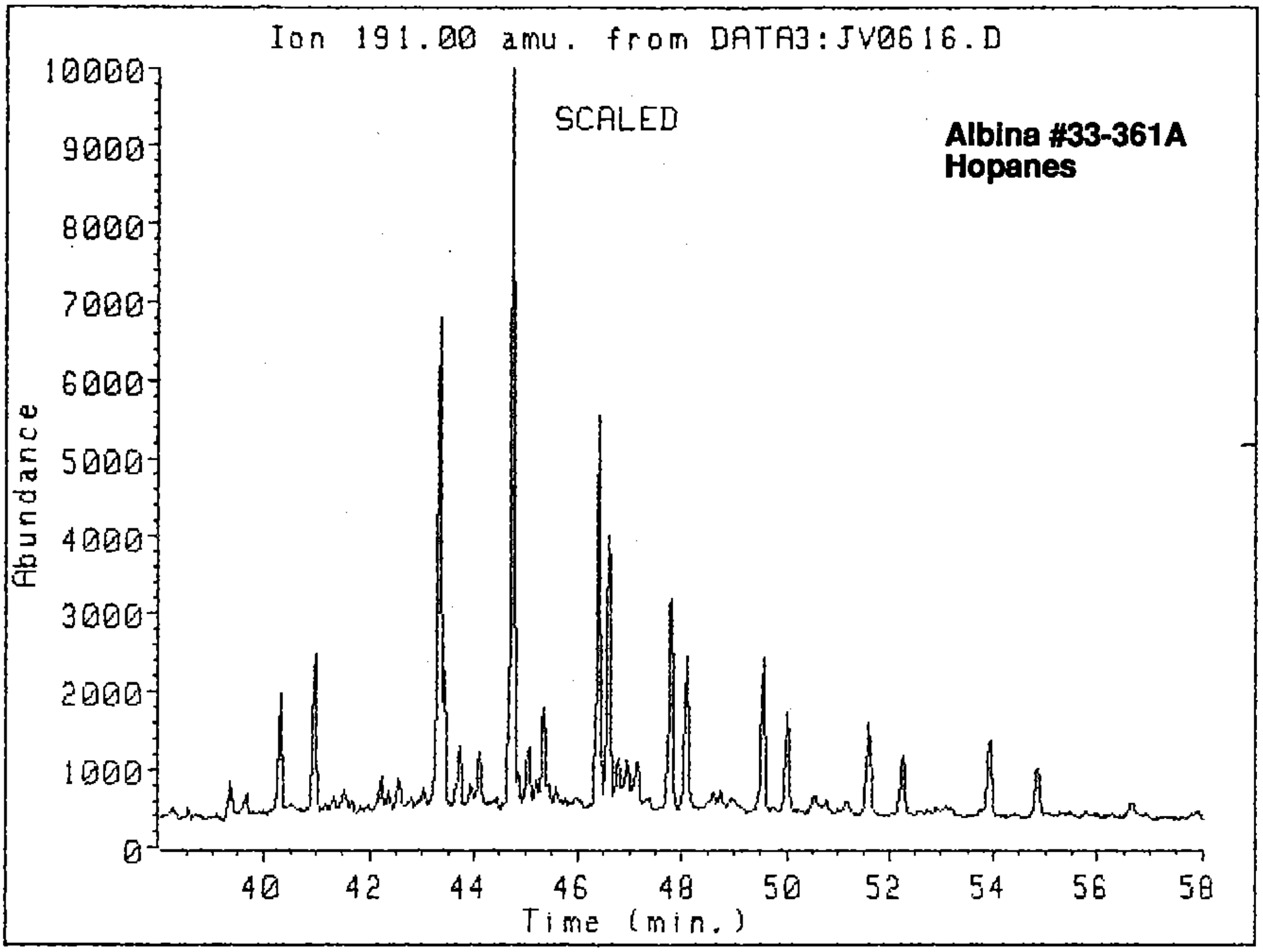
COPY


Ion 259.00 amu. from DATA3:JV0616.D
SCALED
Albina #33-361A
Diasteranes
Abundance
10000
9000
8000
7000
6000
5000
4000
3000
2000
36
38
40
42
44
Time (min.)


Ion 231.00 amu. from DATA3:JV0616.D
SCALED
Albina #33-361A
Methyl Steranes
Abundance
10000
9000
8000
7000
6000
5000
4000
3000
36
38
40
42
44
Time (min.)


Ion 217.00 amu. from DATA3:JV0616.D
SCALED
Albina #33-361A
Steranes and Diasteranes
Abundance
10000
9000
8000
7000
6000
5000
4000
3000
22
24
26
28
30
32
Time (min.)


Ion 218.00 amu. from DATA3:JV0616.D
SCALED
Albina #33-361A
Steranes
Abundance
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
22
24
26
28
30
32
Time (min.)


Ion 191.00 amu. from DATA3:JV0616.D
SCALED
Albina #33-361A
Hopanes
Abundance
0
1000
2000
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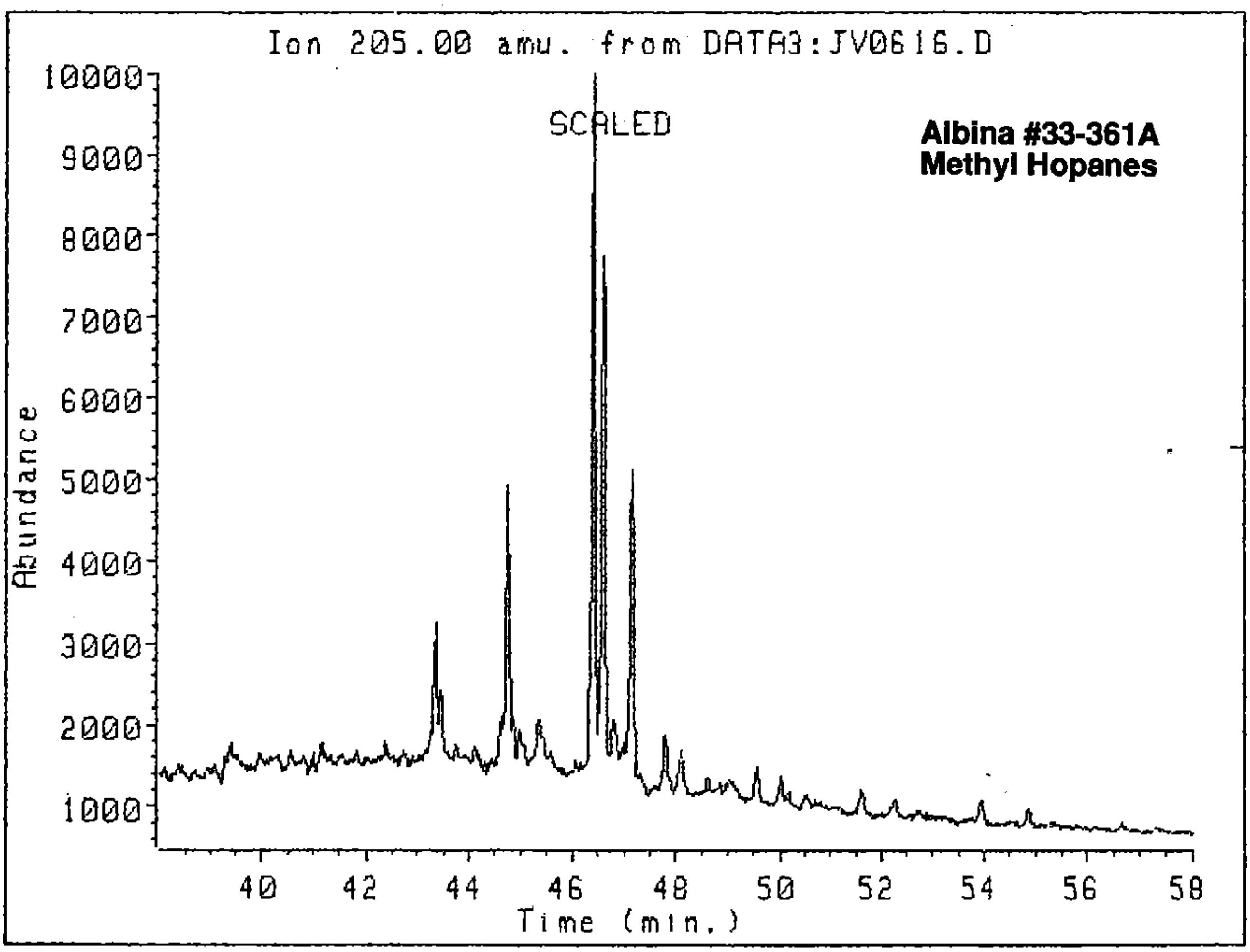
4000
5000
6000
7000
8000
9000
10000
40
42
44
46
48
50
52
54
56
58
Time (min.)


Ion 205.00 amu. from DATA3:JV0616.D
SCALED
Albina #33-361A
Methyl Hopanes
Abundance
1000
2000
3000
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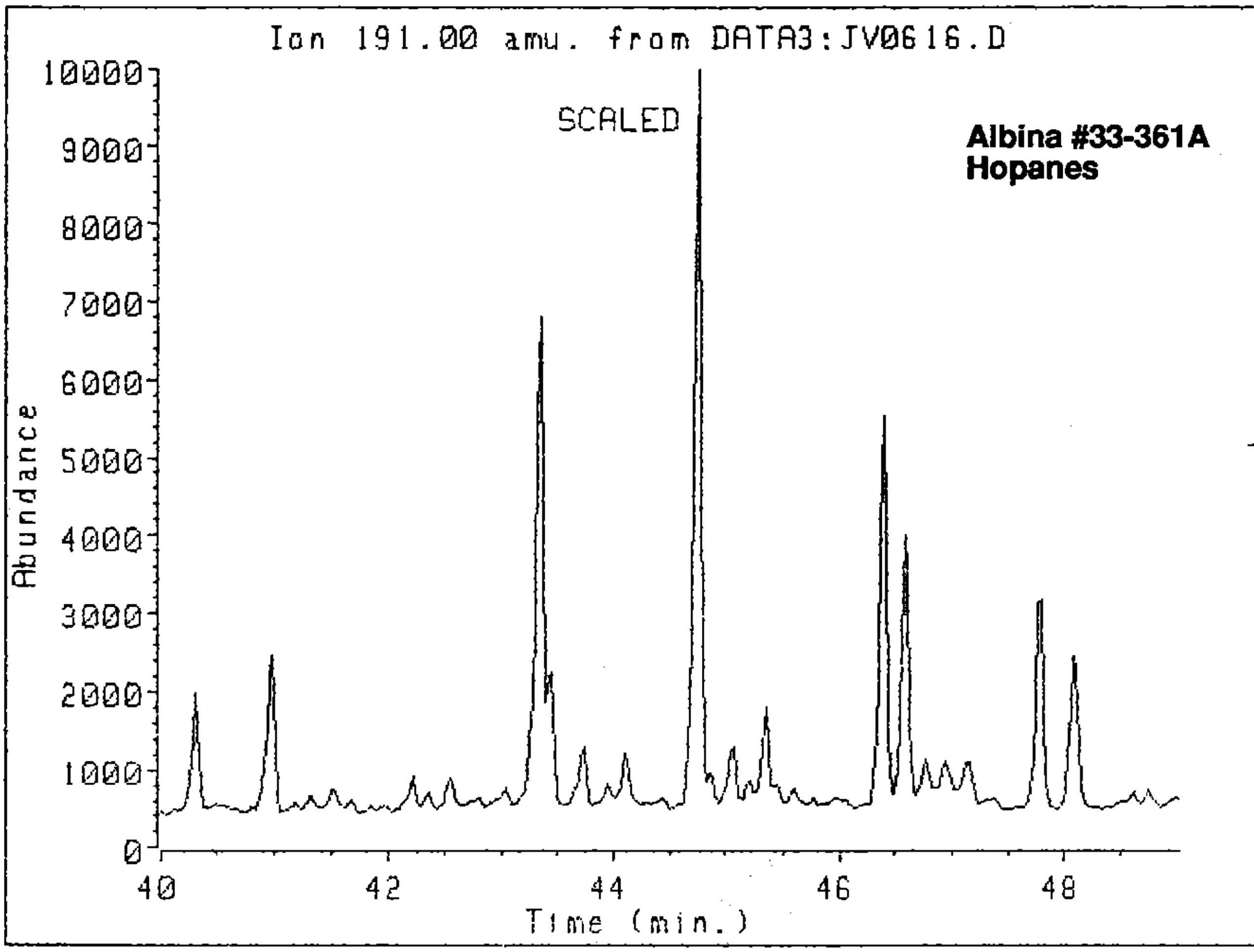
5000
6000
7000
8000
9000
10000
40
42
44
46
48
50
52
54
56
58
Time (min.)


Ion 191.00 amu. from DATA3:JV0616.D
SCALED
Albina #33-361A
Hopanes
Abundance
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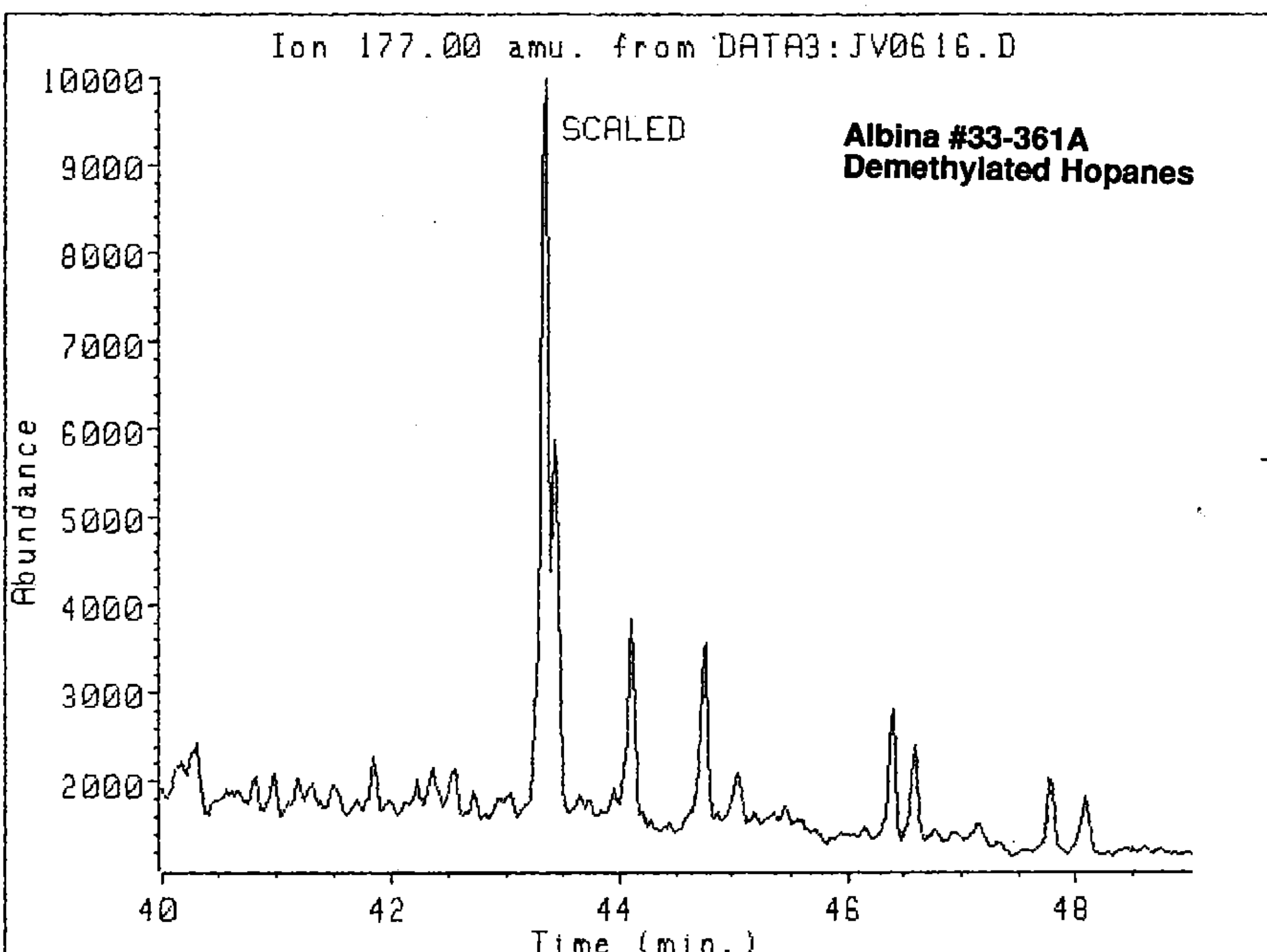
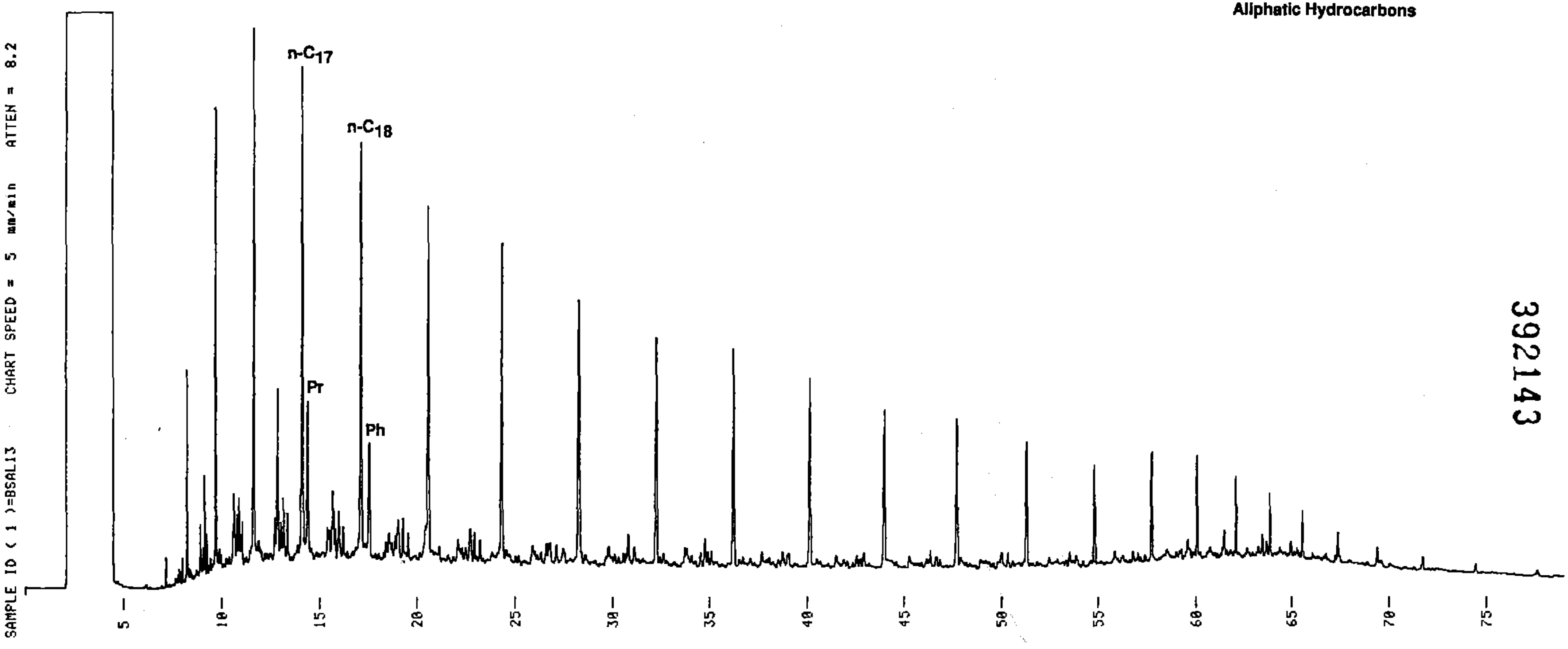
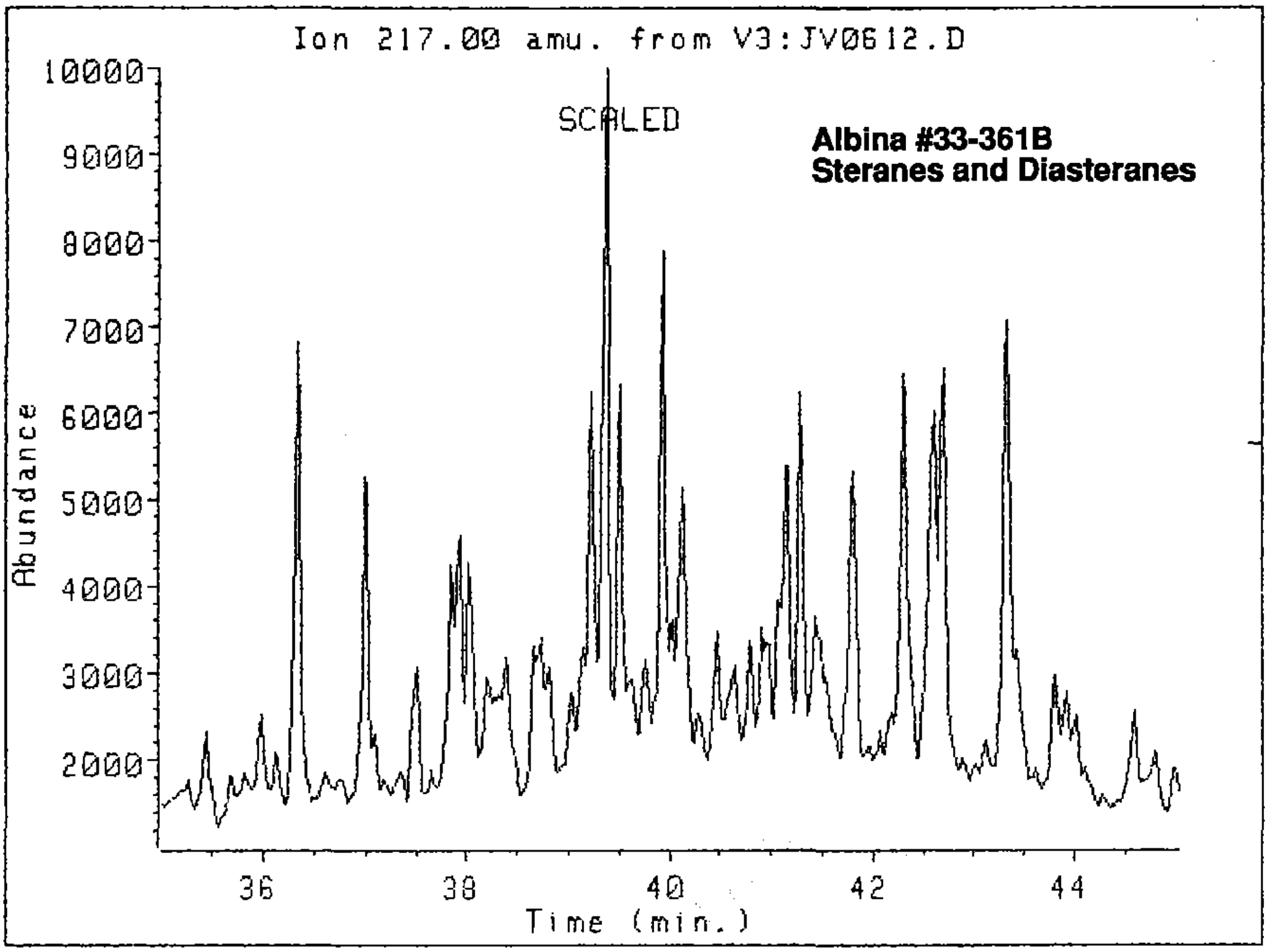
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
40
42
44
46
48
Time (min.)

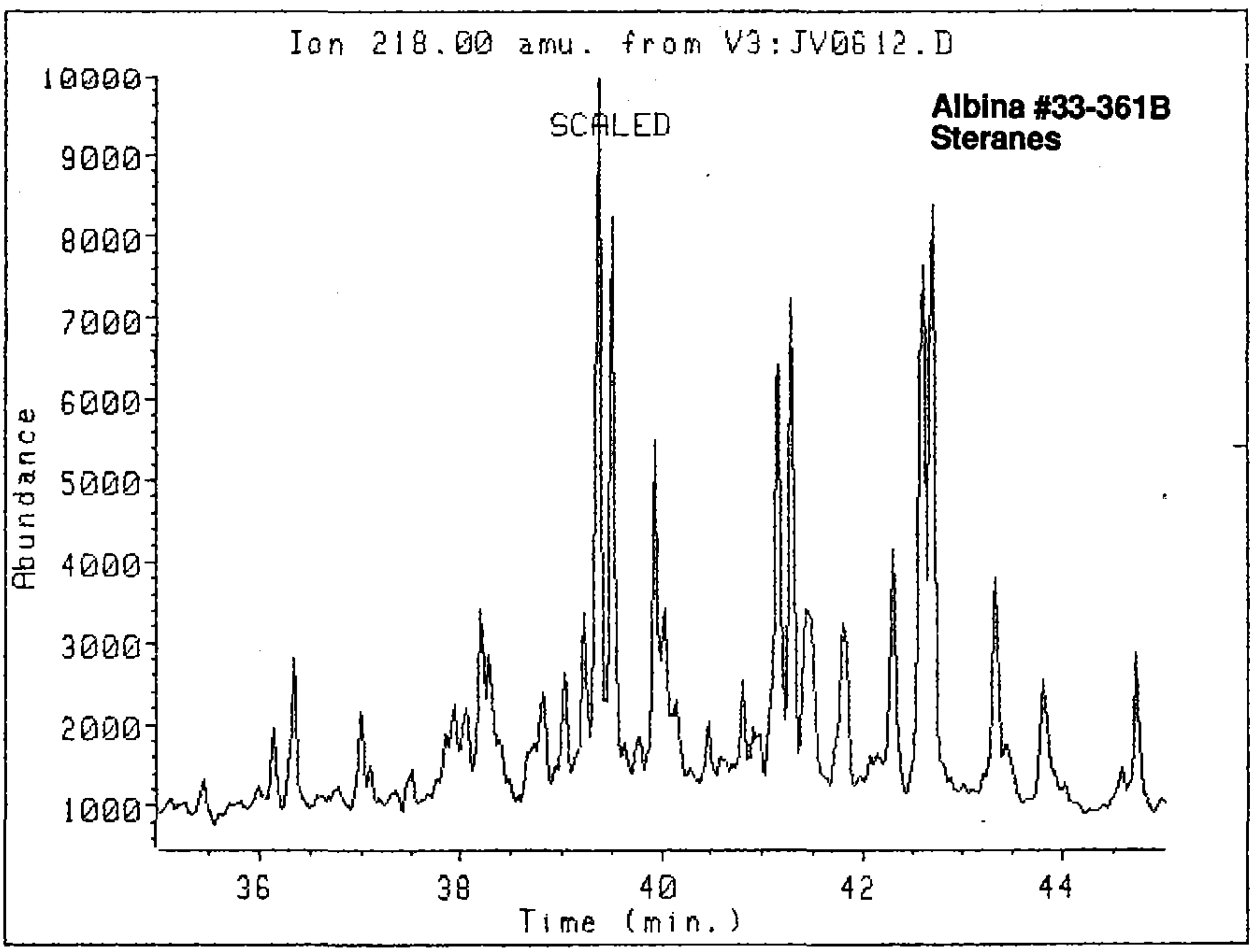

Ion 177.00 amu. from DATA3:JV0616.D
SCALED
Albina #33-361A
Demethylated Hopanes
Abundance
10000
9000
8000
7000
6000
5000
4000
3000
2000
40
42
44
46
48
Time (min.)

Albina #33-361B
Aliphatic Hydrocarbons



392143


Ion 217.00 amu. from V3:JV0612.D
SCALED
Albina #33-361B
Steranes and Diasteranes
Abundance
10000
9000
8000
7000
6000
5000
4000
3000
2000
36
38
40
42
44
Time (min.)


Ion 218.00 amu. from V3:JV0612.D
SCALED
Albina #33-361B
Steranes
Abundance
10000
9000
8000
7000
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4000
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1000
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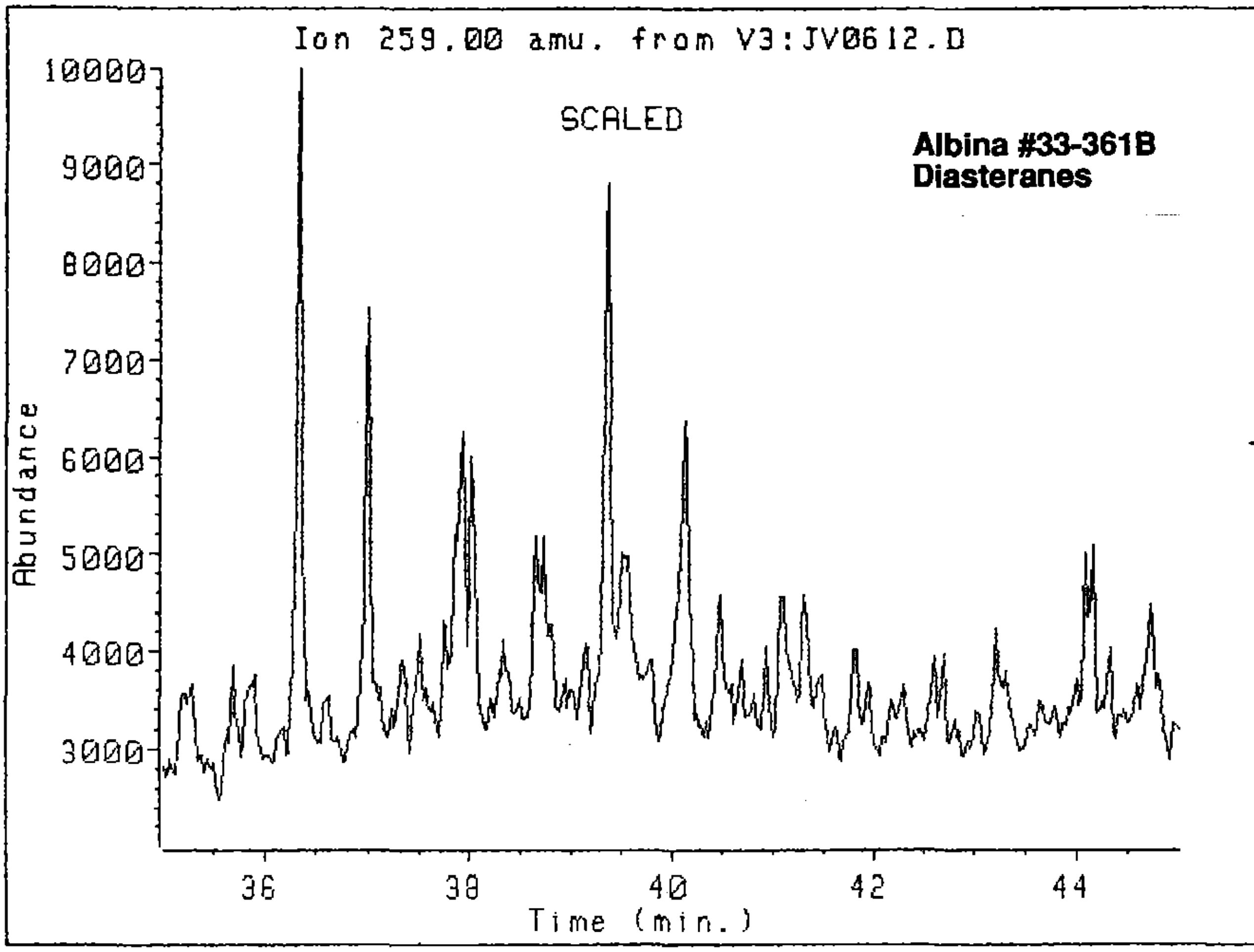
38
40
42
44
Time (min.)



Ion 259.00 amu. from V3:JV0612.D
SCALED
Albina #33-361B
Diasteranes
Abundance
10000
9000
8000
7000
6000
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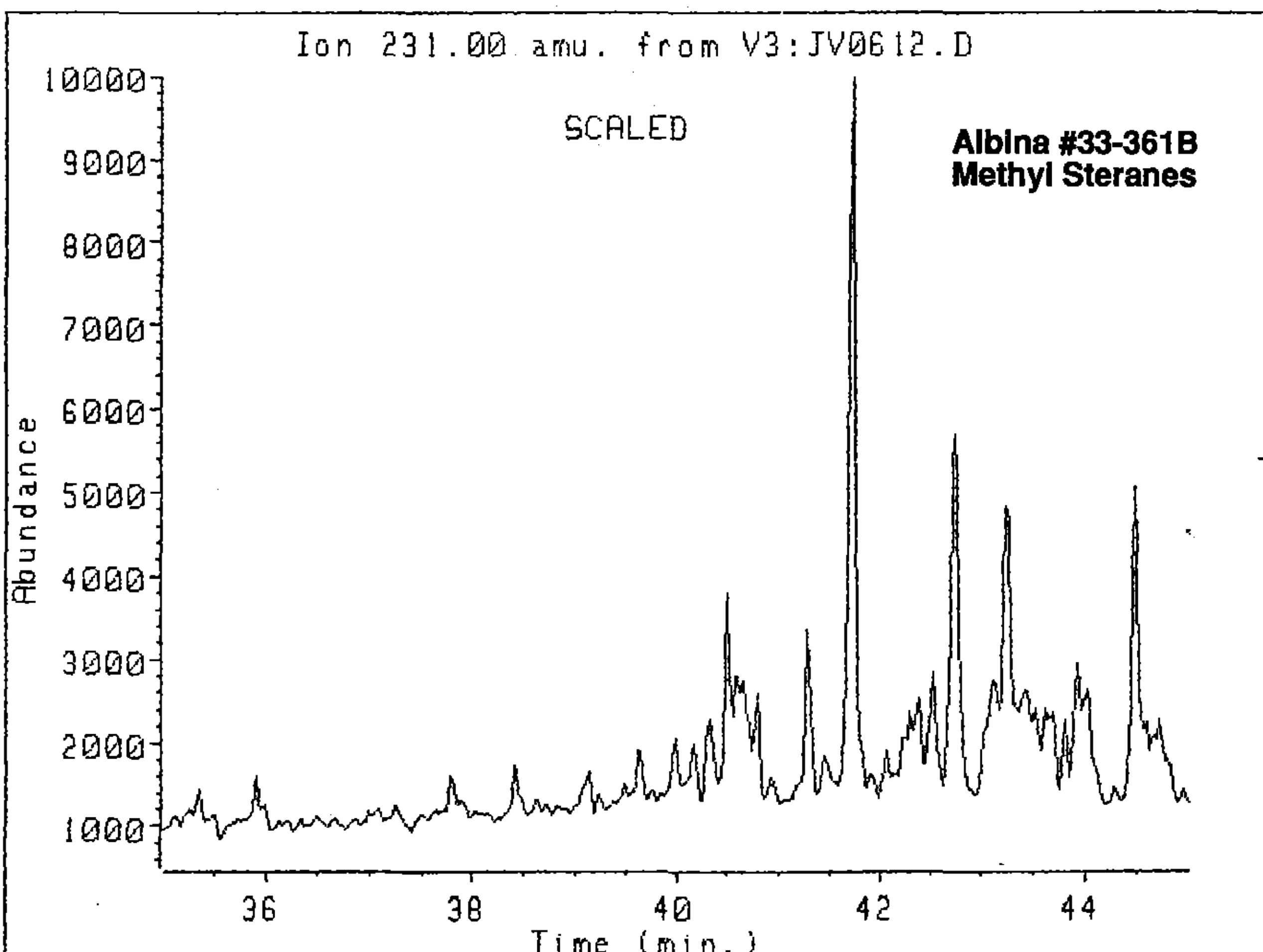
4000
3000
36
38
40
42
44
Time (min.)



Ion 231.00 amu. from V3:JV0612.D
SCALED
Albina #33-361B
Methyl Steranes
Abundance
10000
9000
8000
7000
6000
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1000
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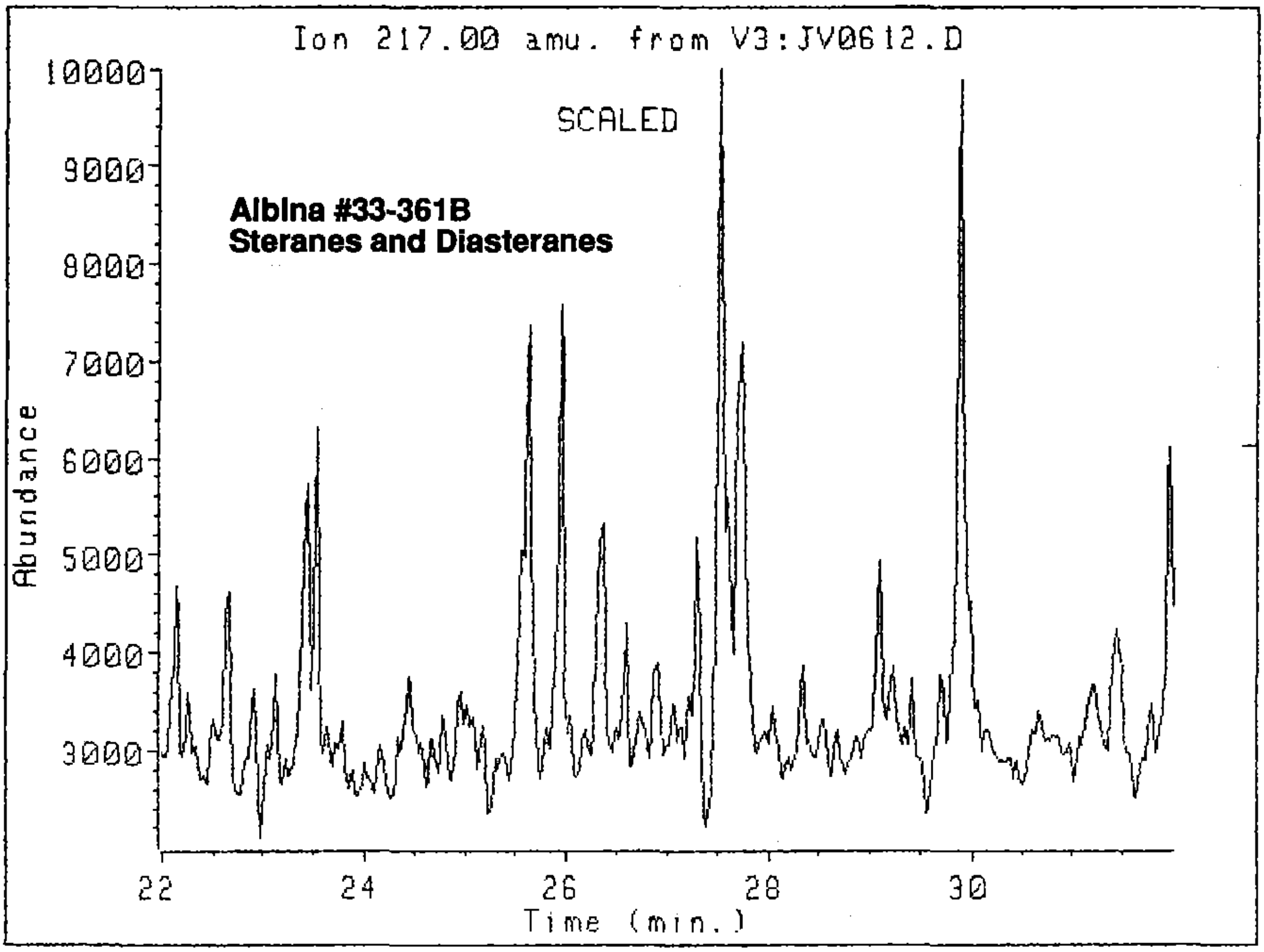
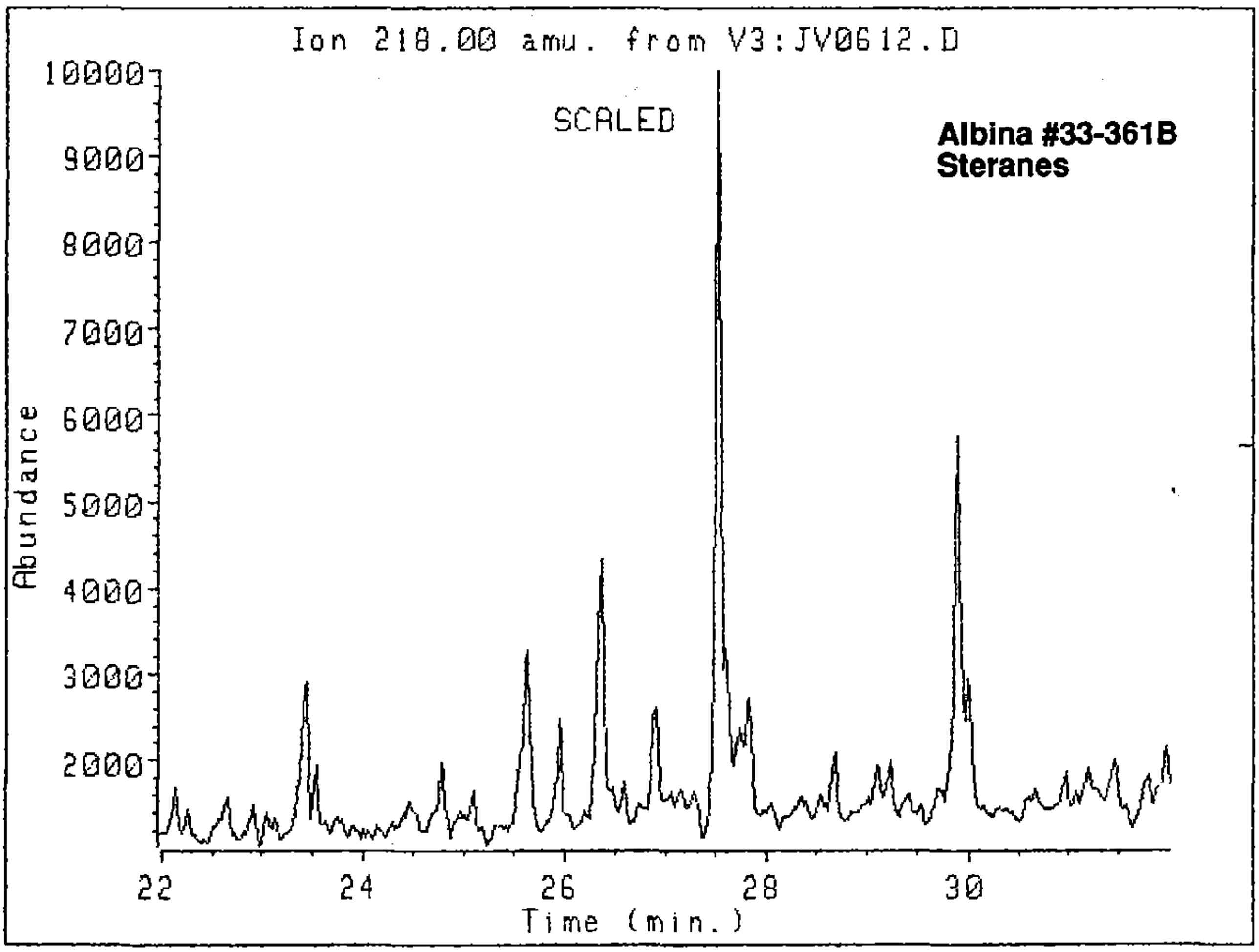
40
42
44
Time (min.)


Ion 217.00 amu. from V3:JV0612.D
SCALED
Albina #33-361B
Steranes and Diasteranes
Abundance
10000
9000
8000
7000
6000
5000
4000
3000
22
24
26
28
30
Time (min.)


Ion 218.00 amu. from V3:JV0612.D
SCALED
Albina #33-361B
Steranes
Abundance
10000
9000
8000
7000
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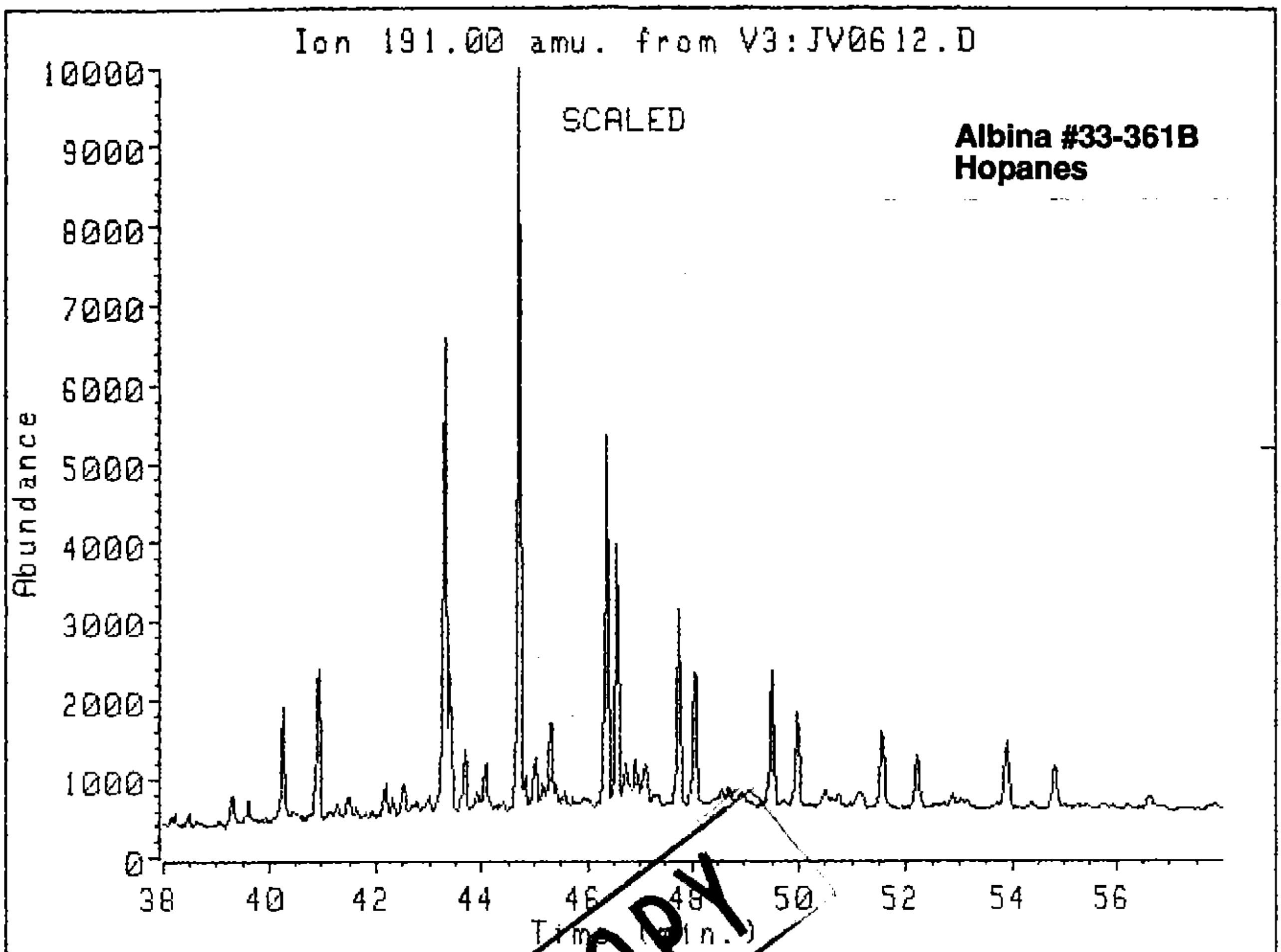
26
28
30
Time (min.)


Ion 191.00 amu. from V3:JV0612.D
SCALED
Albina #33-361B
Hopanes
Abundance
Time (min.)
10000
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8000
7000
6000
5000
4000
3000
2000
1000
0
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42
44
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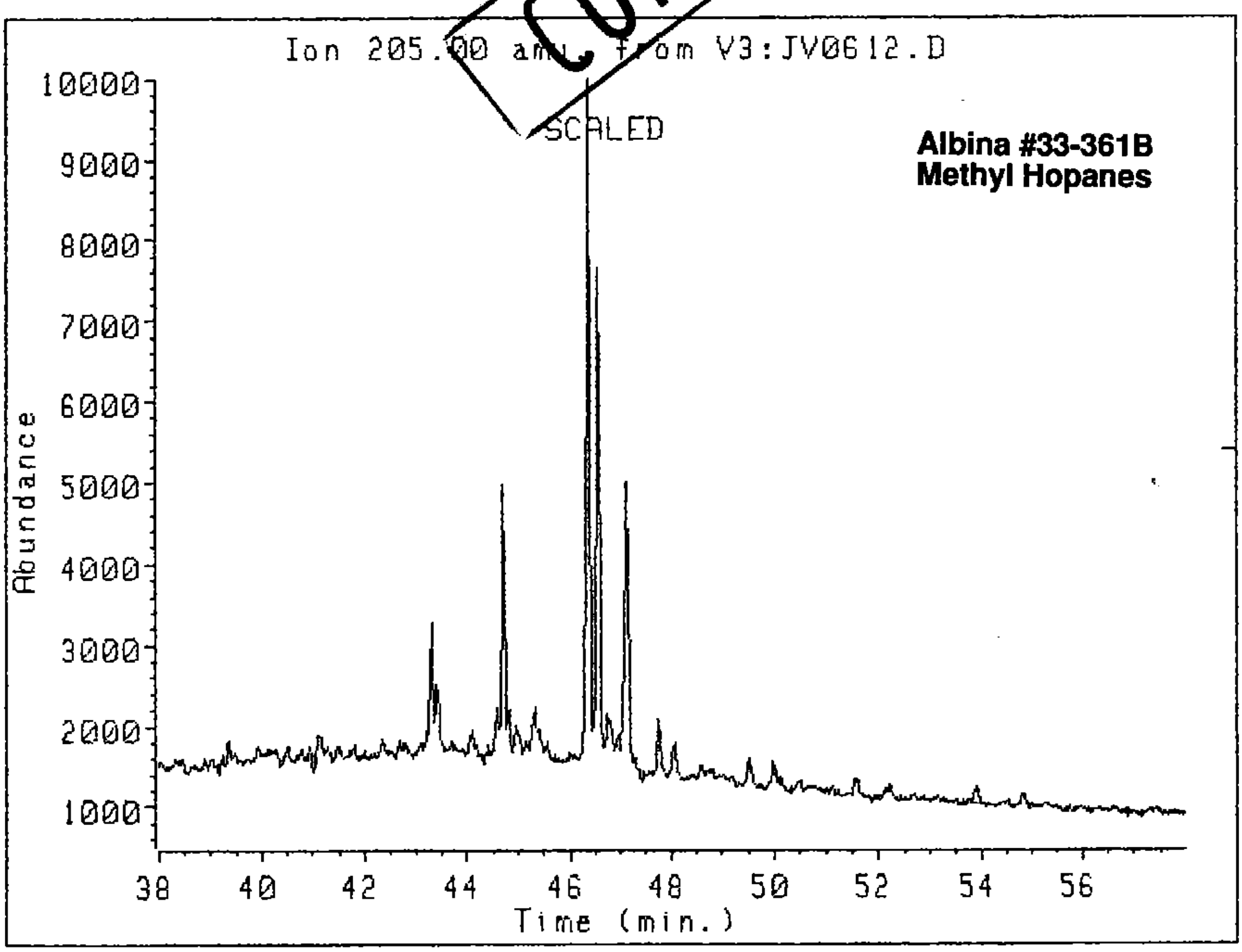
Ion 205.00 amu. from V3:JV0612.D
SCALED
Albina #33-361B
Methyl Hopanes
Abundance
Time (min.)
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7000
6000
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4000
3000
2000
1000
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42
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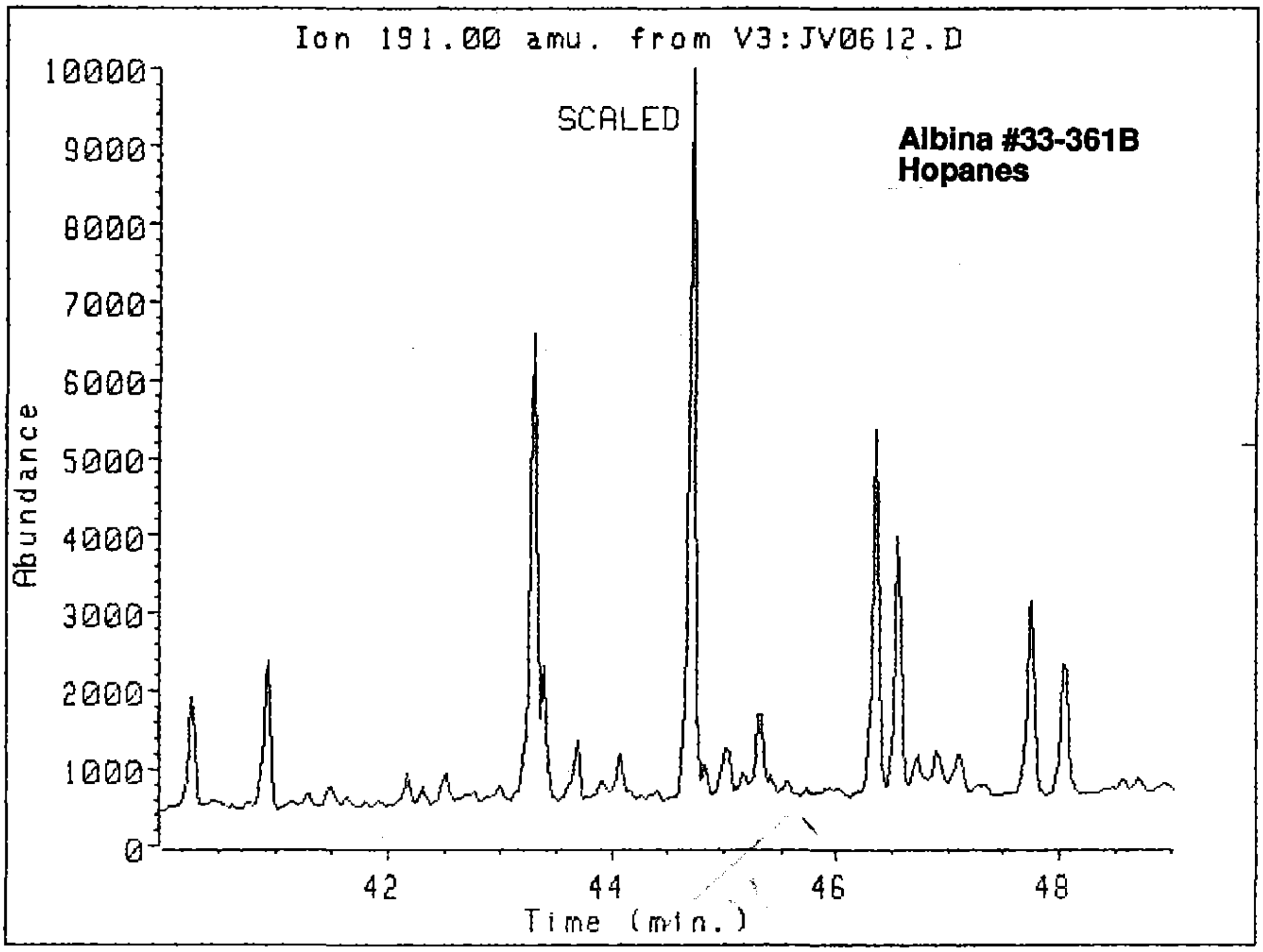
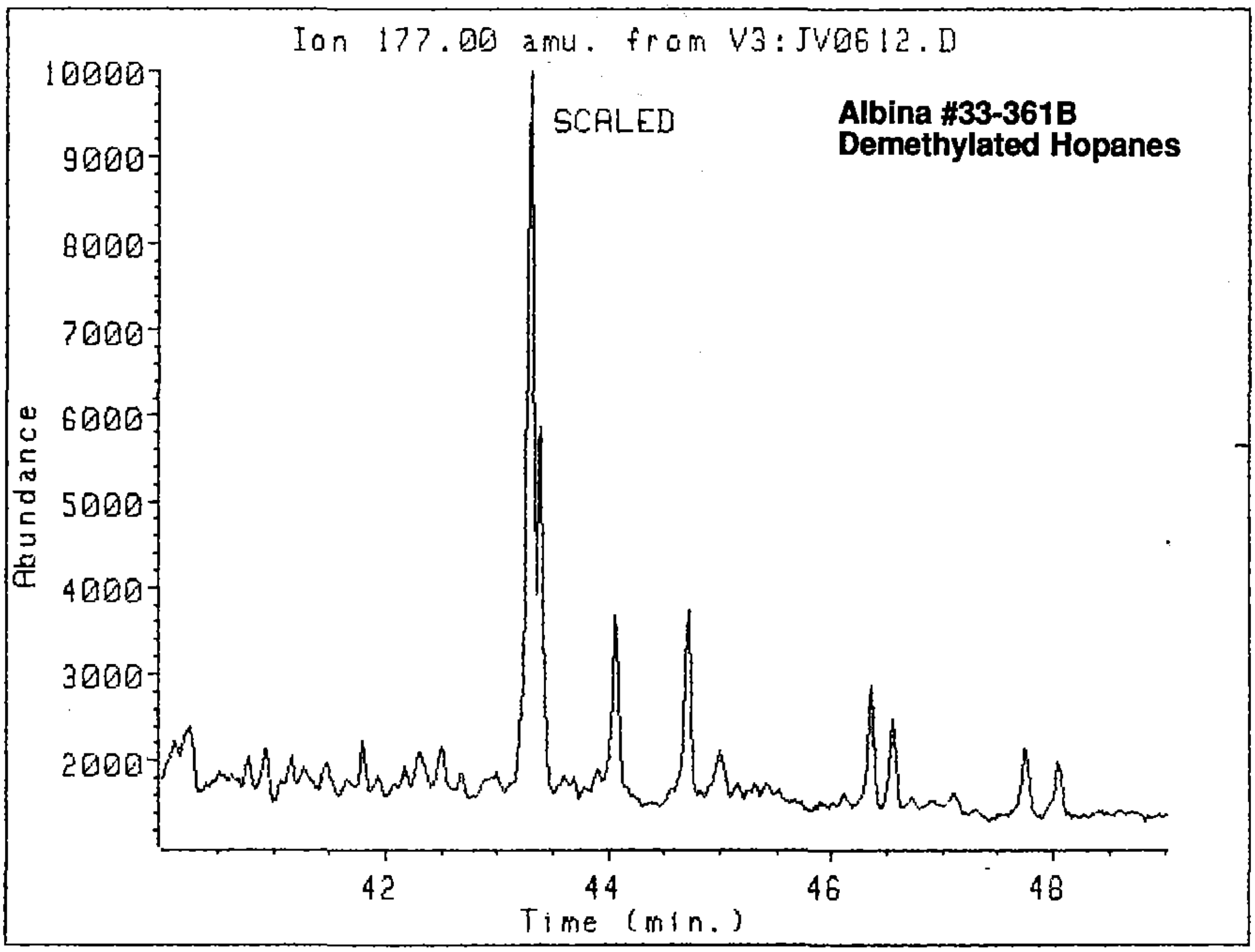
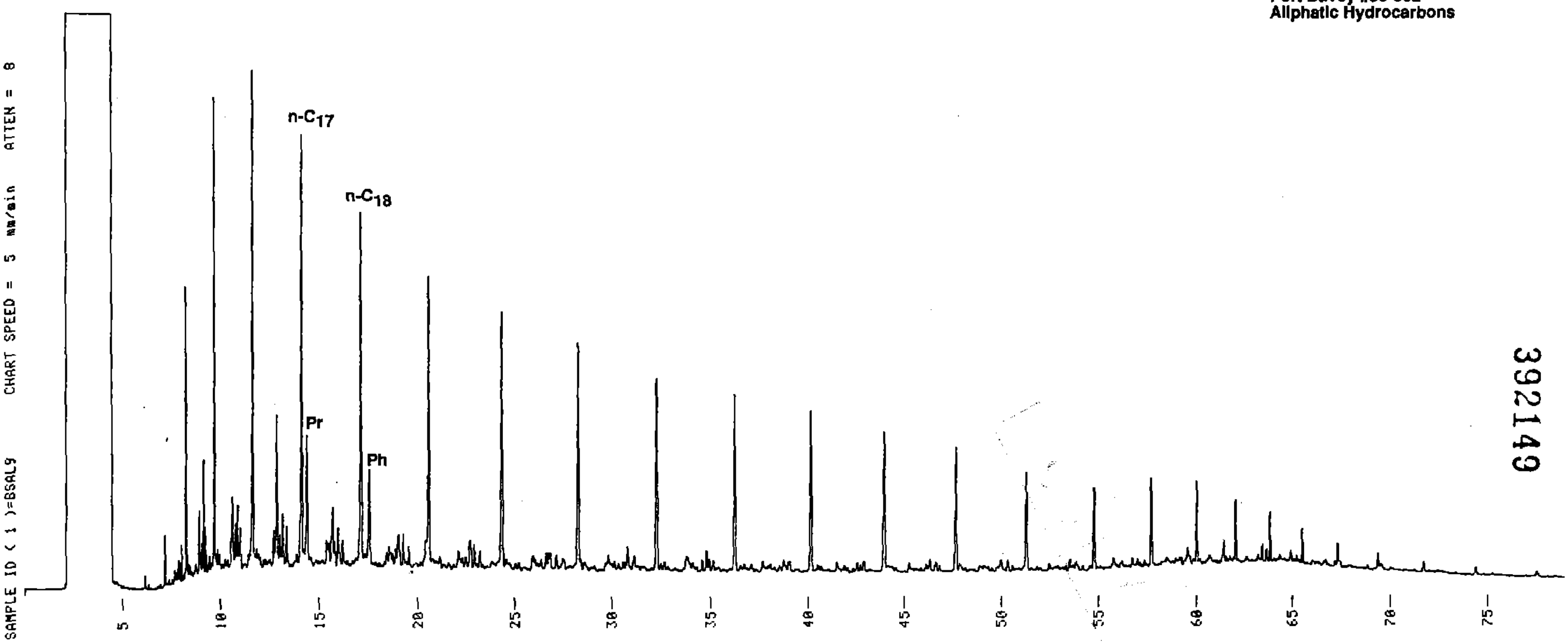
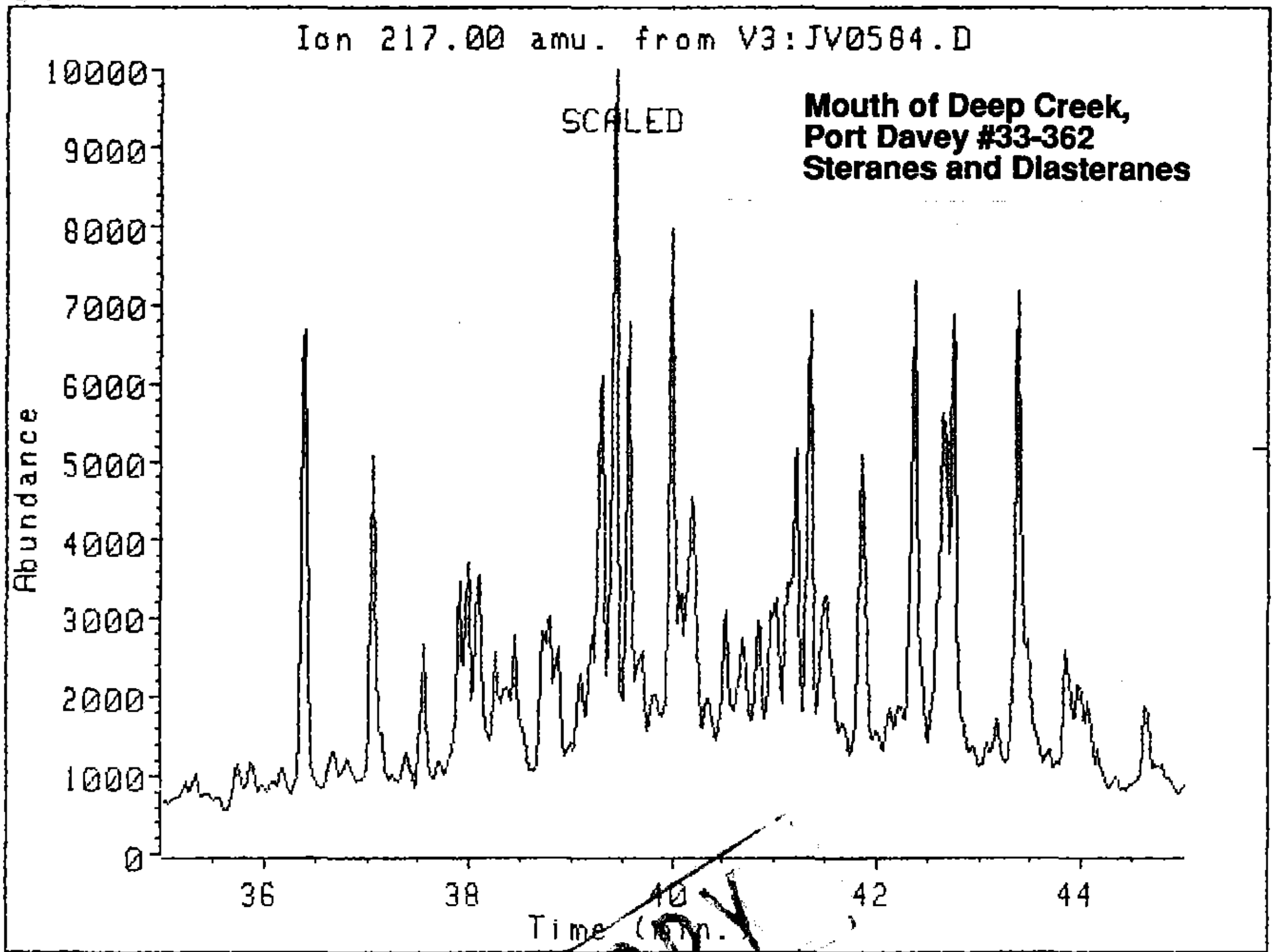

Ion 191.00 amu. from V3:JV0612.D
SCALED
Albina #33-361B
Hopanes
Abundance
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
42
44
46
48
Time (min.)


Ion 177.00 amu. from V3:JV0612.D
SCALED
Albina #33-361B
Demethylated Hopanes
Abundance
10000
9000
8000
7000
6000
5000
4000
3000
2000
42
44
46
48
Time (min.)

Mouth of Deep Creek,
Port Davey #33-362
Aliphatic Hydrocarbons



392149


Ion 217.00 amu. from V3:JV0584.D
SCALED
Mouth of Deep Creek,
Port Davey #33-362
Steranes and Diasteranes
Abundance
10000
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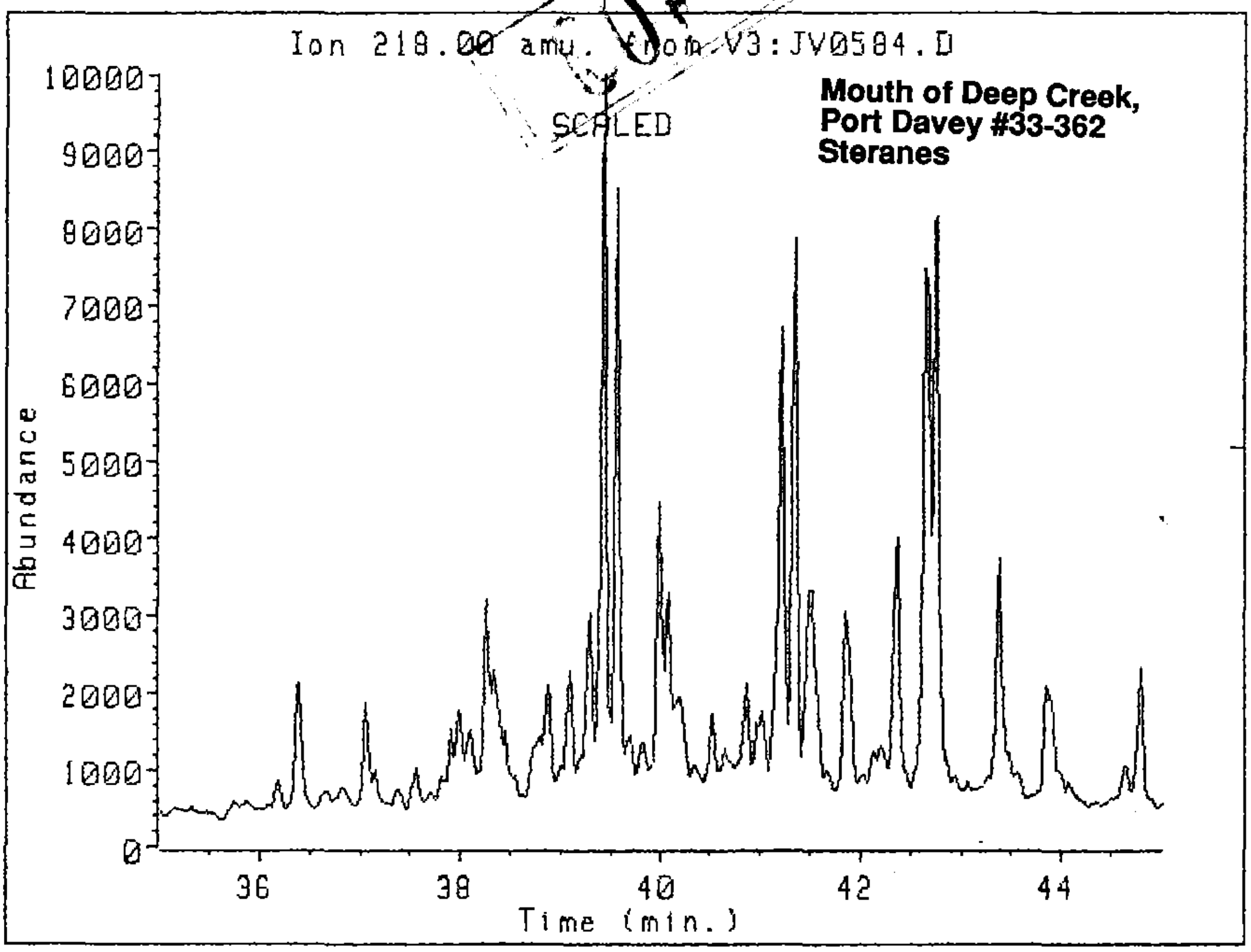
8000
7000
6000
5000
4000
3000
2000
1000
0
36
38
40
42
44
Time (min.)


Ion 218.00 amu. from V3:JV0584.D
SCALED
Mouth of Deep Creek,
Port Davey #33-362
Steranes
Abundance
10000
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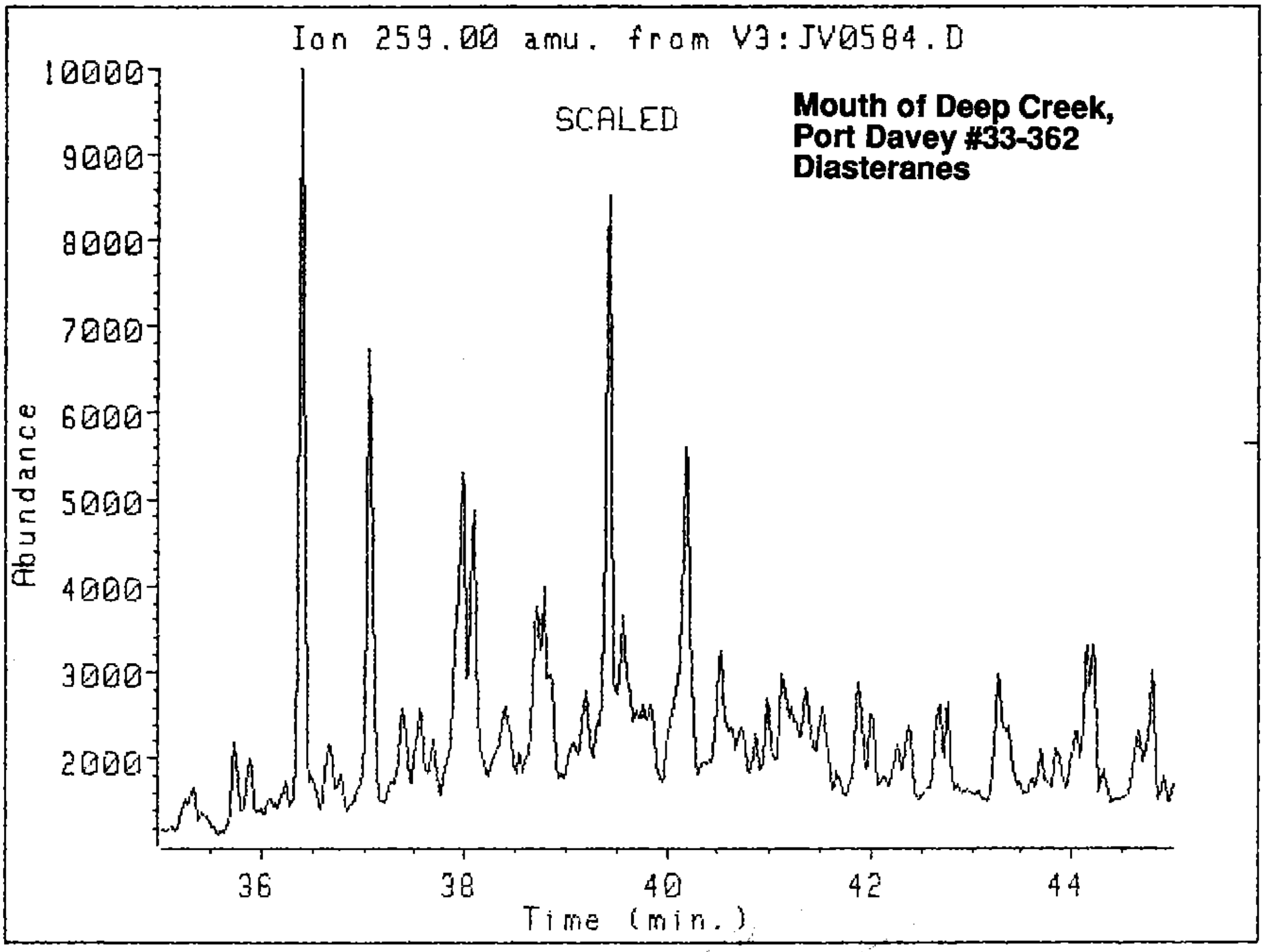
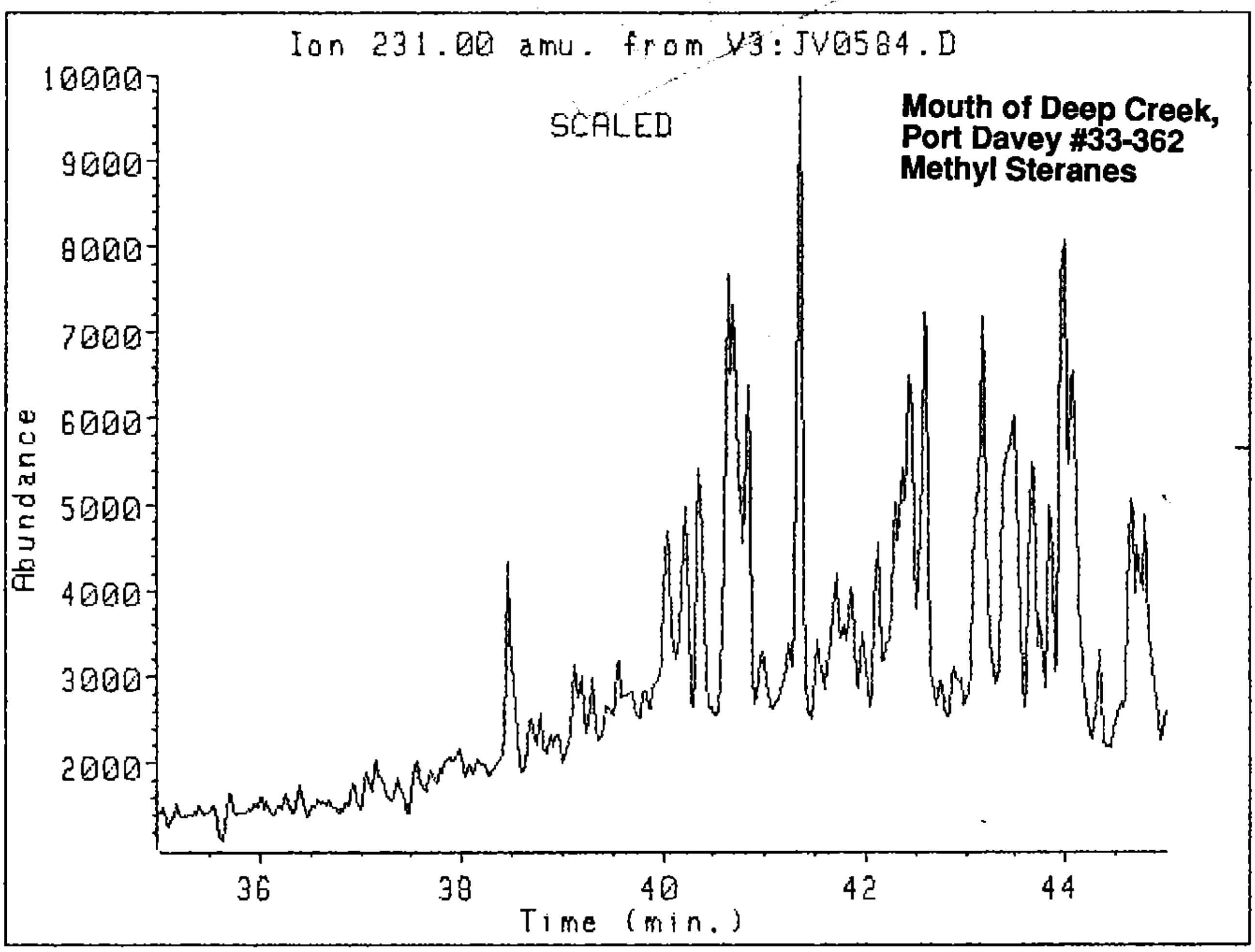
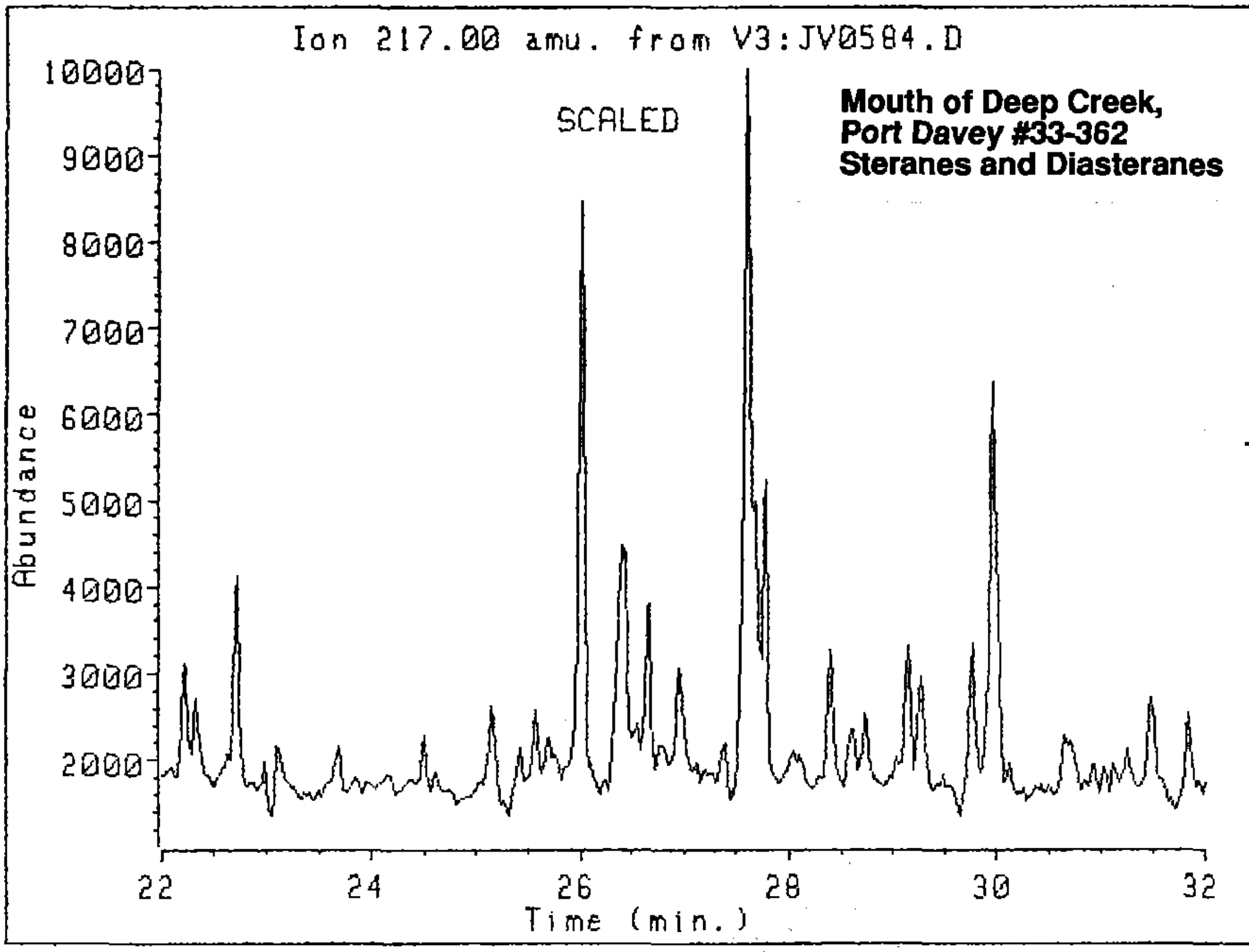
8000
7000
6000
5000
4000
3000
2000
1000
0
36
38
40
42
44
Time (min.)


Ion 259.00 amu. from V3:JV0584.D
SCALED
Mouth of Deep Creek,
Port Davey #33-362
Diasteranes
Abundance
10000
9000
8000
7000
6000
5000
4000
3000
2000
36
38
40
42
44
Time (min.)


Ion 231.00 amu. from V3:JV0584.D
SCALED
Mouth of Deep Creek,
Port Davey #33-362
Methyl Steranes
Abundance
10000
9000
8000
7000
6000
5000
4000
3000
2000
36
38
40
42
44
Time (min.)


Ion 217.00 amu. from V3:JV0584.D
SCALED
Mouth of Deep Creek,
Port Davey #33-362
Steranes and Diasteranes
Abundance
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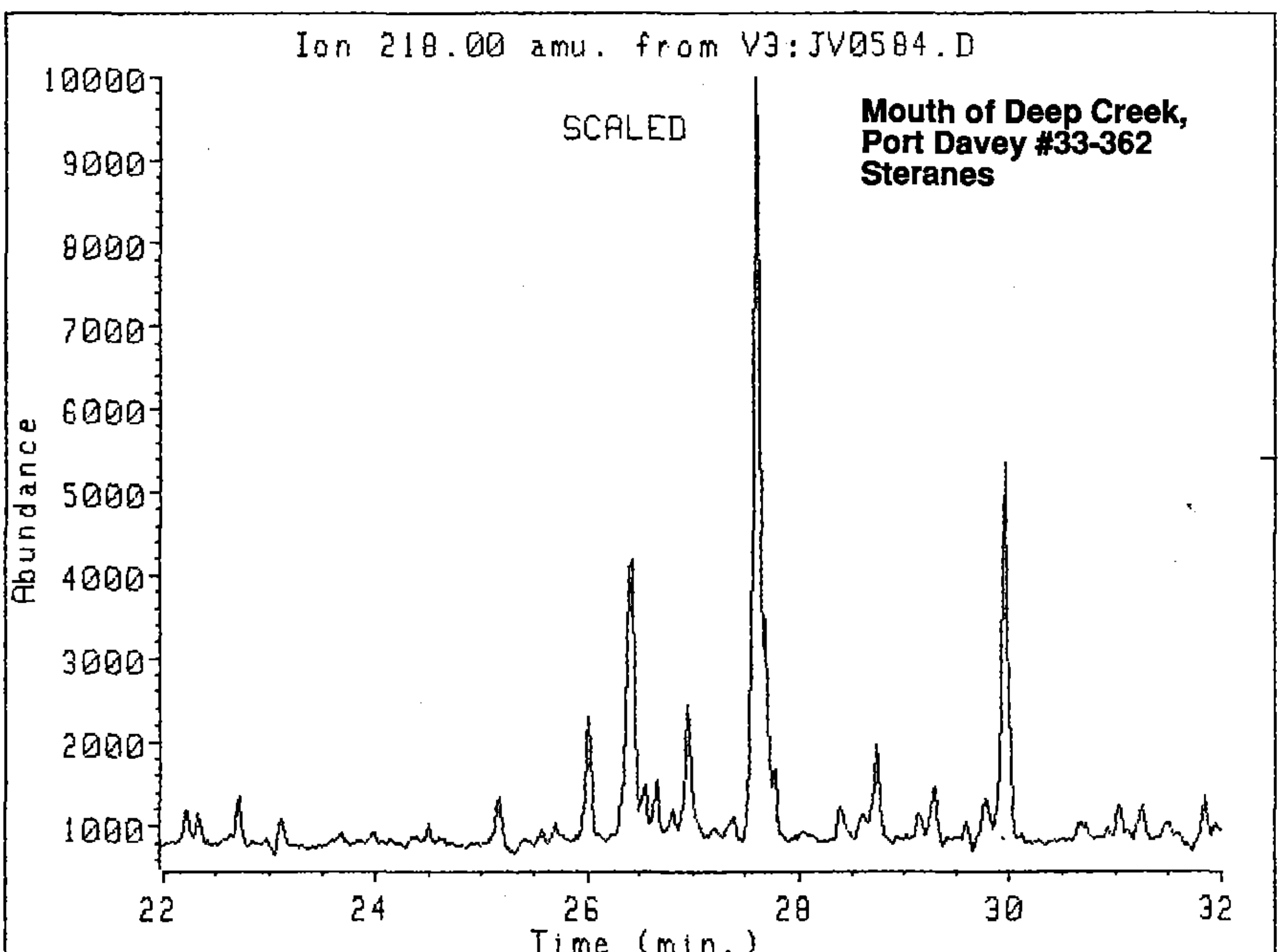
28
30
32
Time (min.)


Ion 218.00 amu. from V3:JV0584.D
SCALED
Mouth of Deep Creek,
Port Davey #33-362
Steranes
Abundance
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7000
6000
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4000
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2000
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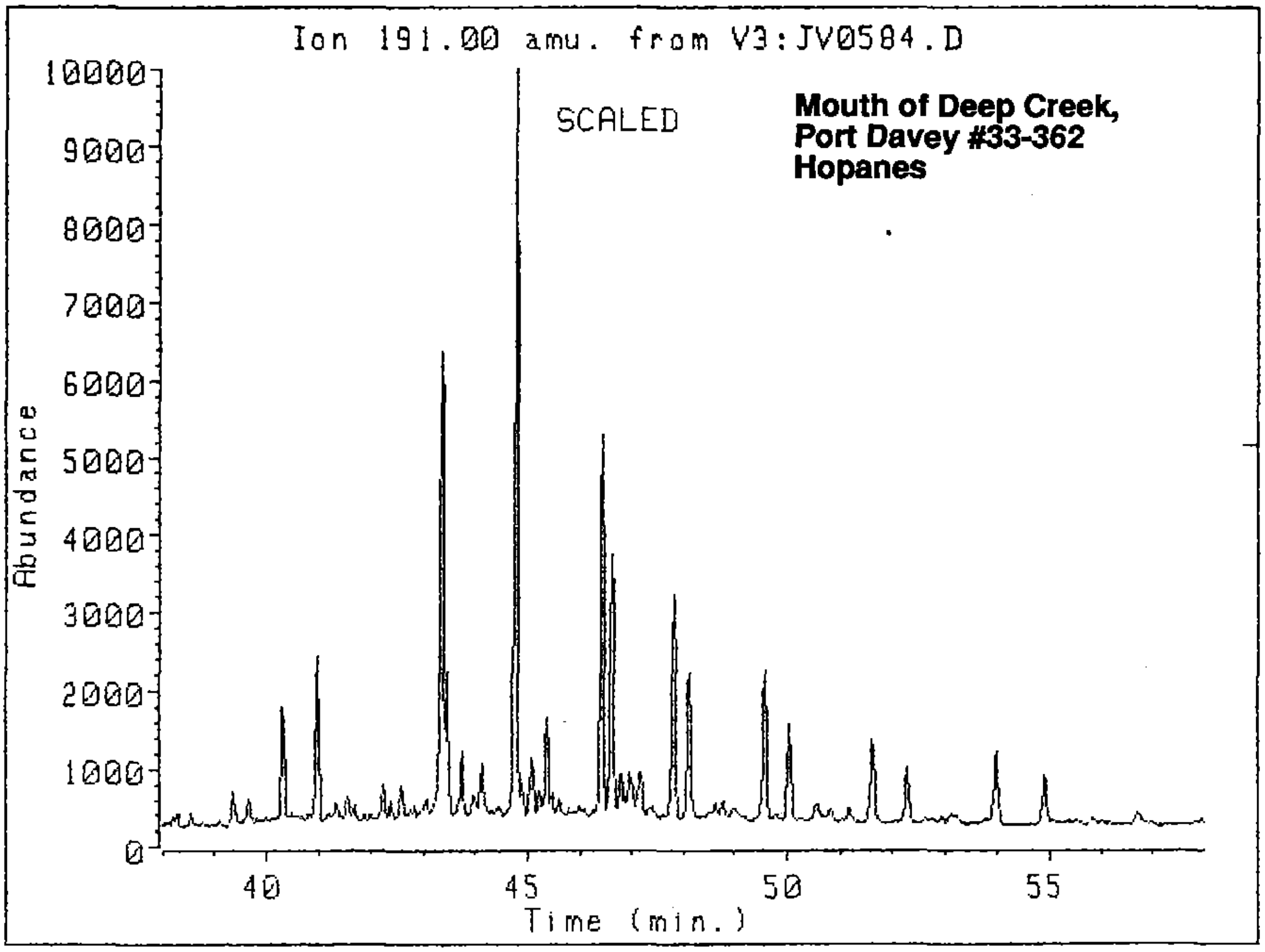
22
24
26
28
30
32
Time (min.)


Ion 191.00 amu. from V3:JV0584.D
SCALED
Mouth of Deep Creek,
Port Davey #33-362
Hopanes
Abundance
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7000
6000
5000
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1000
0
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45
50
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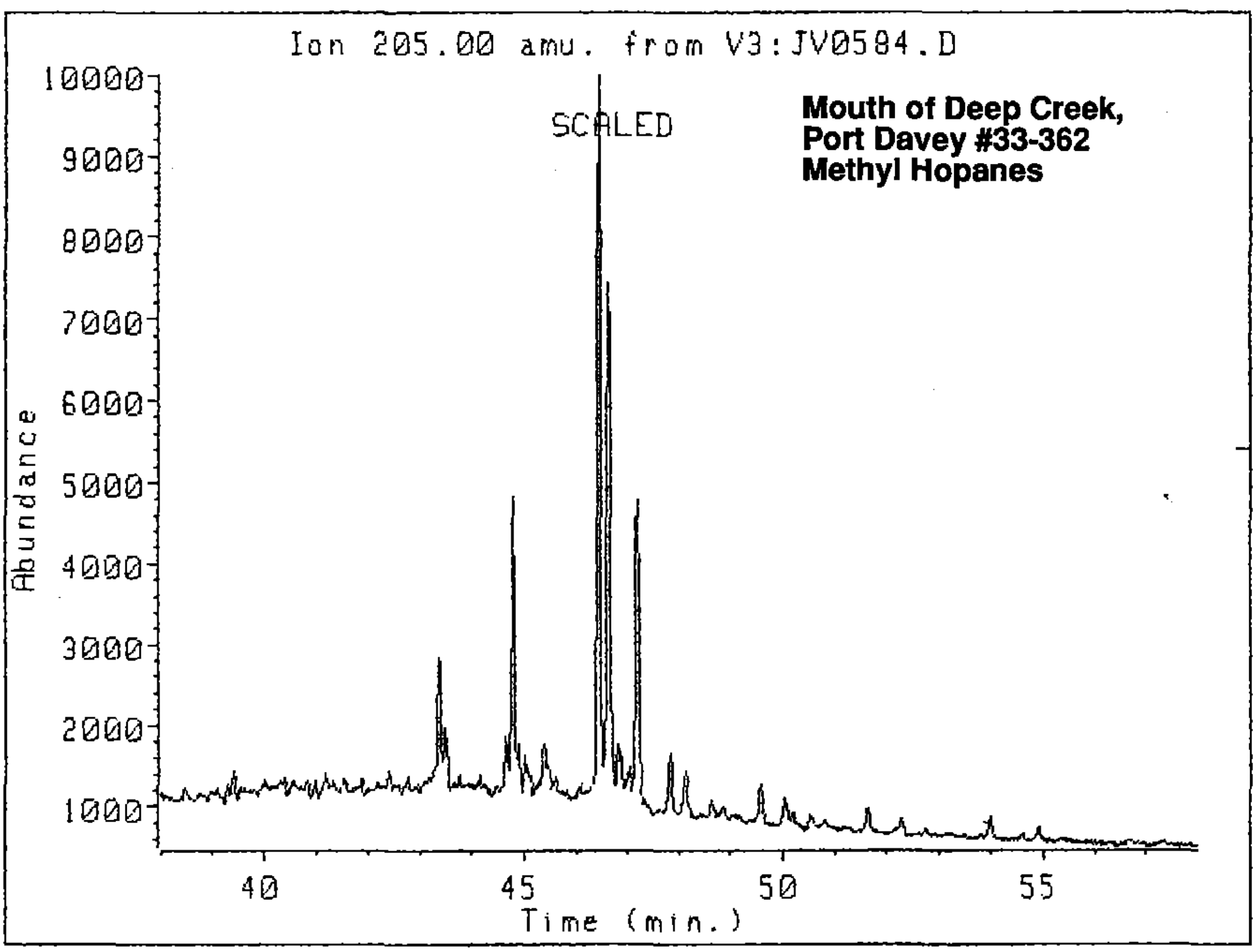
Time (min.)


Ion 205.00 amu. from V3:JV0584.D
SCALED
Mouth of Deep Creek,
Port Davey #33-362
Methyl Hopanes
Abundance
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6000
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2000
1000
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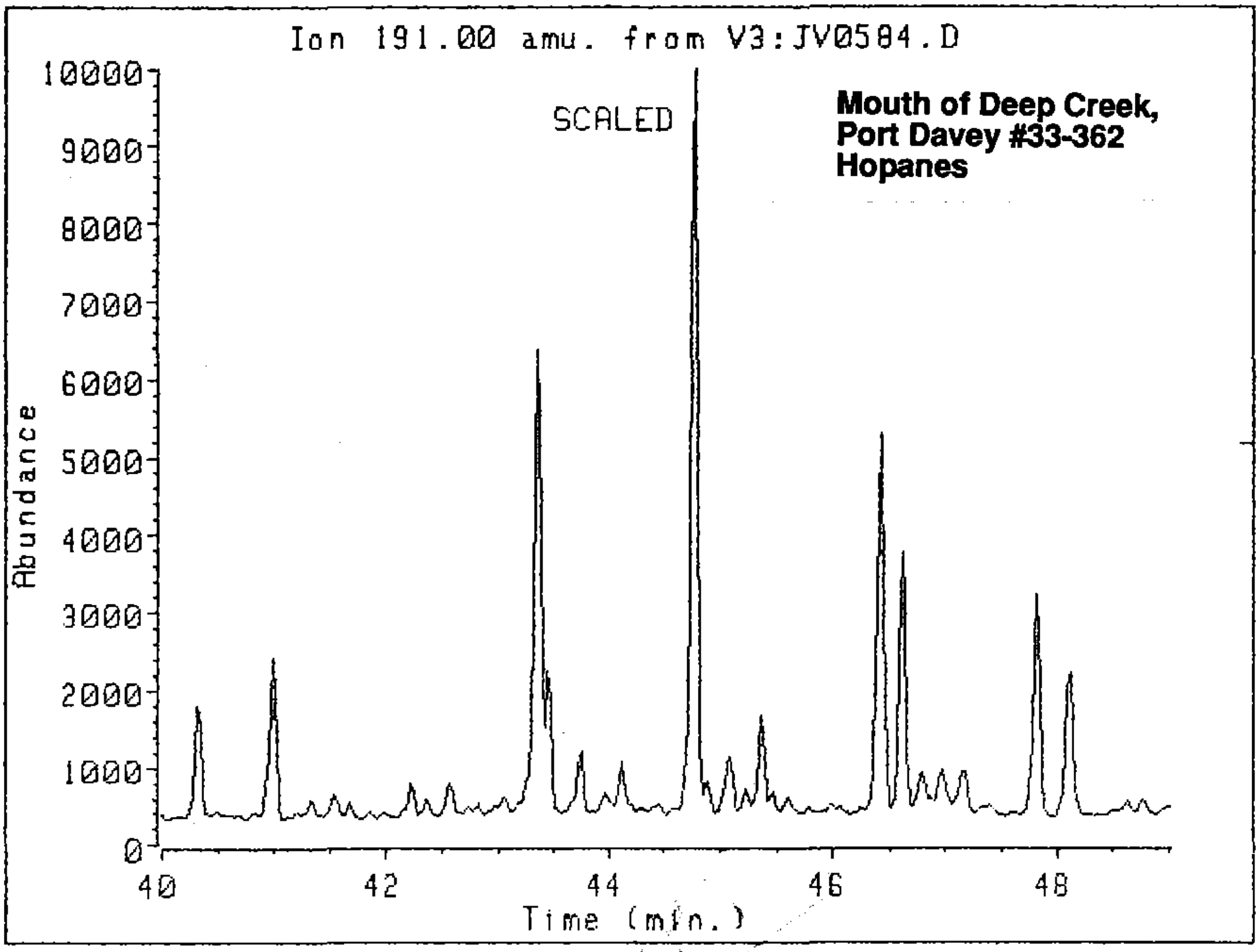
50
55
Time (min.)


Ion 191.00 amu. from V3:JV0584.D
SCALED
Mouth of Deep Creek,
Port Davey #33-362
Hopanes
Abundance
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8000
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6000
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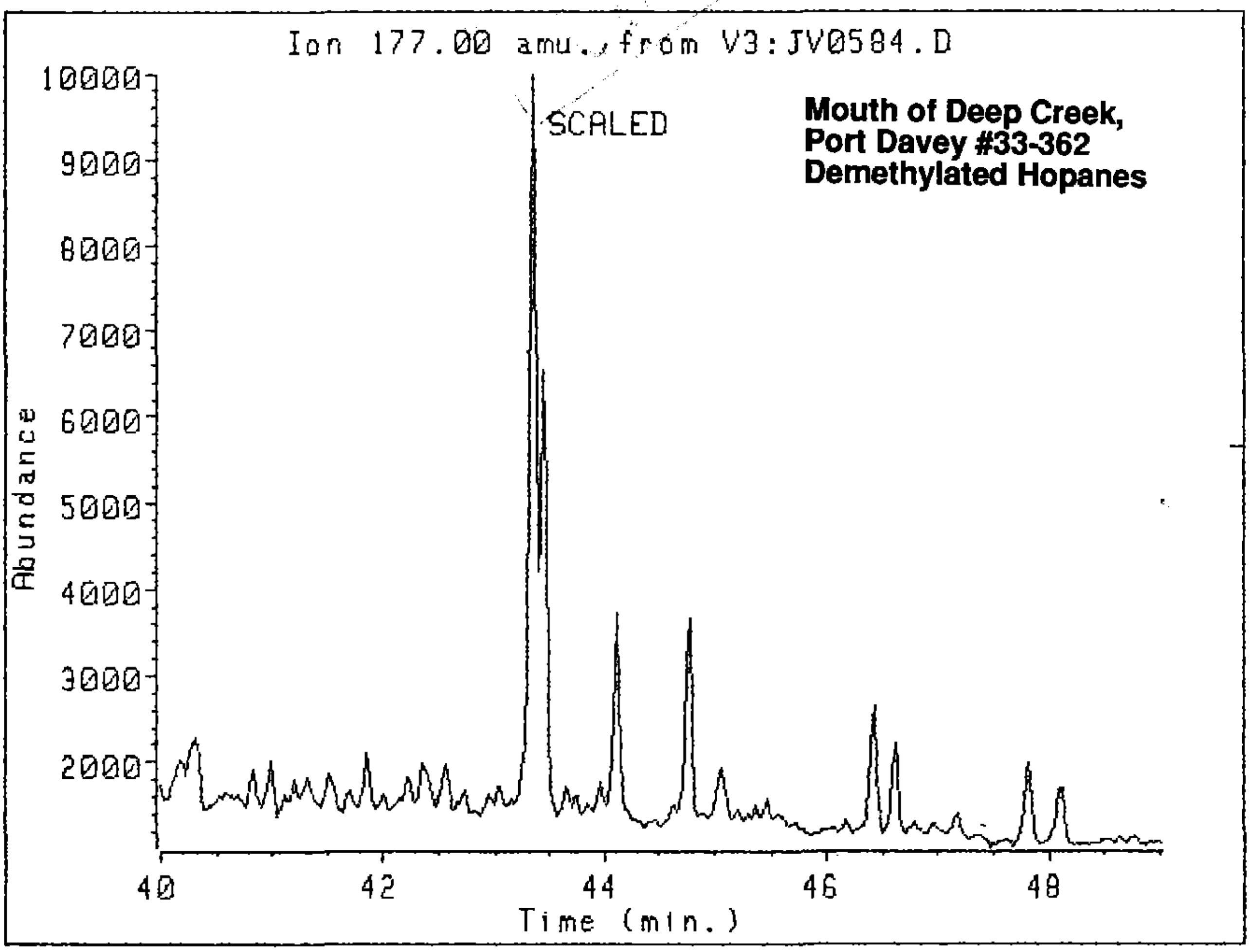
4000
3000
2000
1000
0
40
42
44
46
48
Time (min.)


Ion 177.00 amu. from V3:JV0584.D
SCALED
Mouth of Deep Creek,
Port Davey #33-362
Demethylated Hopanes
Abundance
10000
9000
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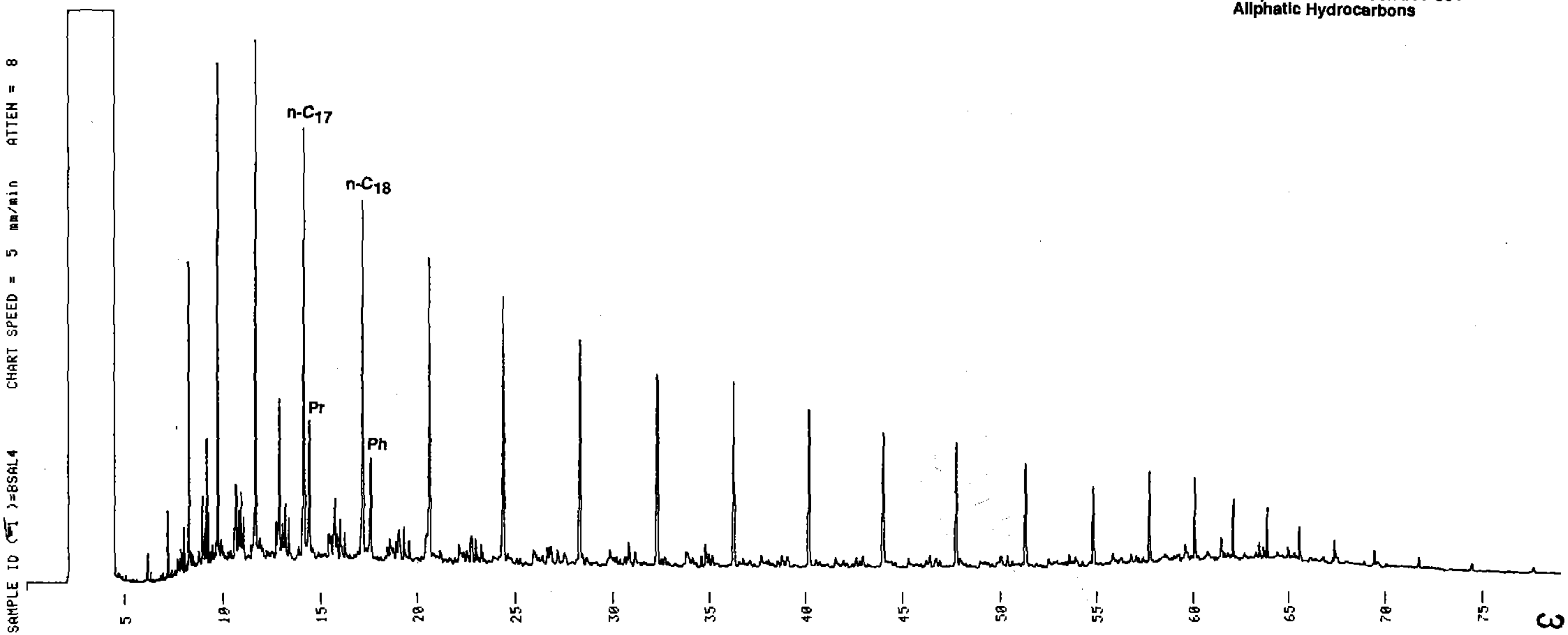
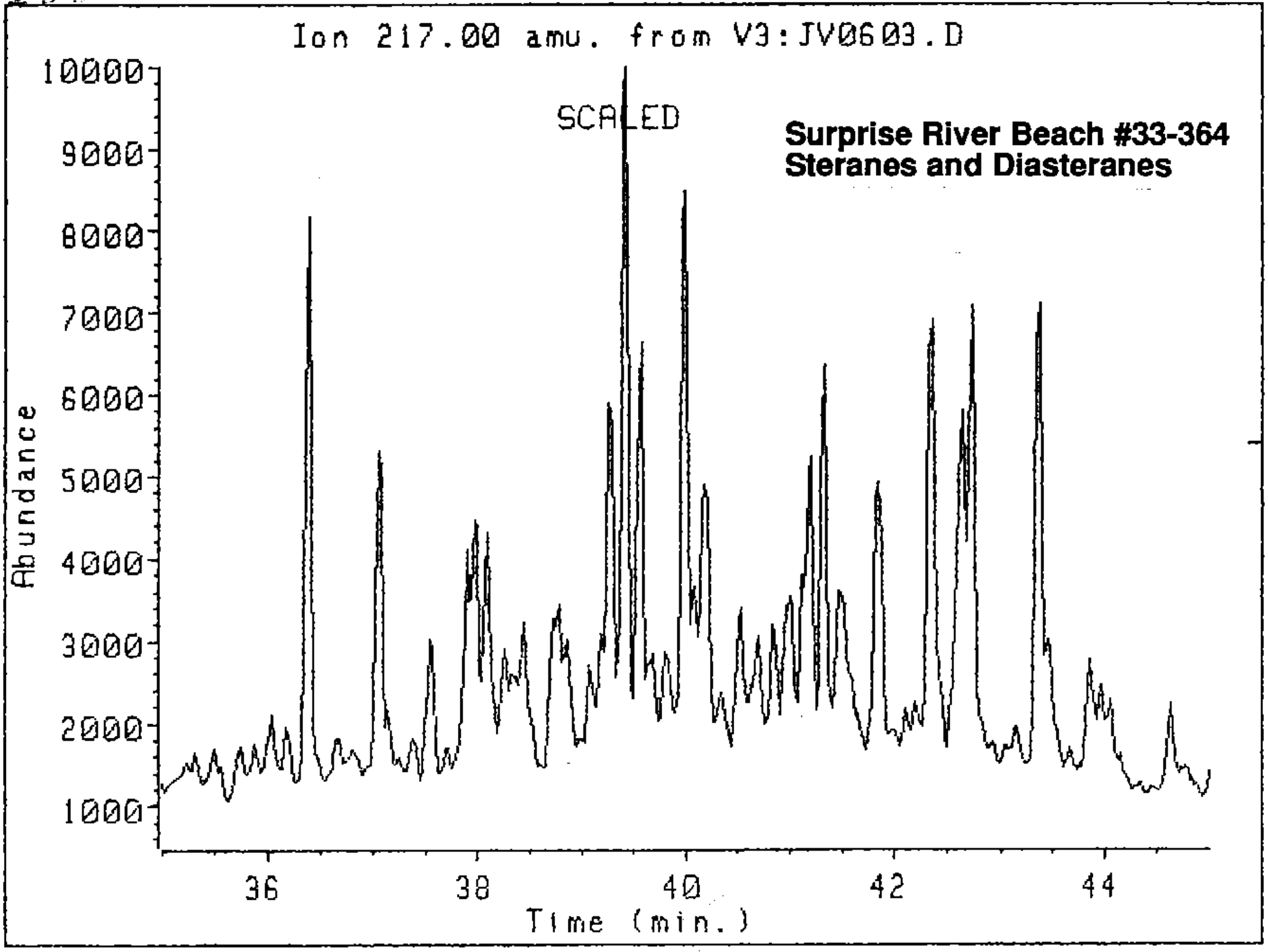
7000
6000
5000
4000
3000
2000
40
42
44
46
48
Time (min.)

Surprise River Beach #33-364
Aliphatic Hydrocarbons




Ion 217.00 amu. from V3:JV0603.D
SCALED
Surprise River Beach #33-364
Steranes and Diasteranes
Abundance
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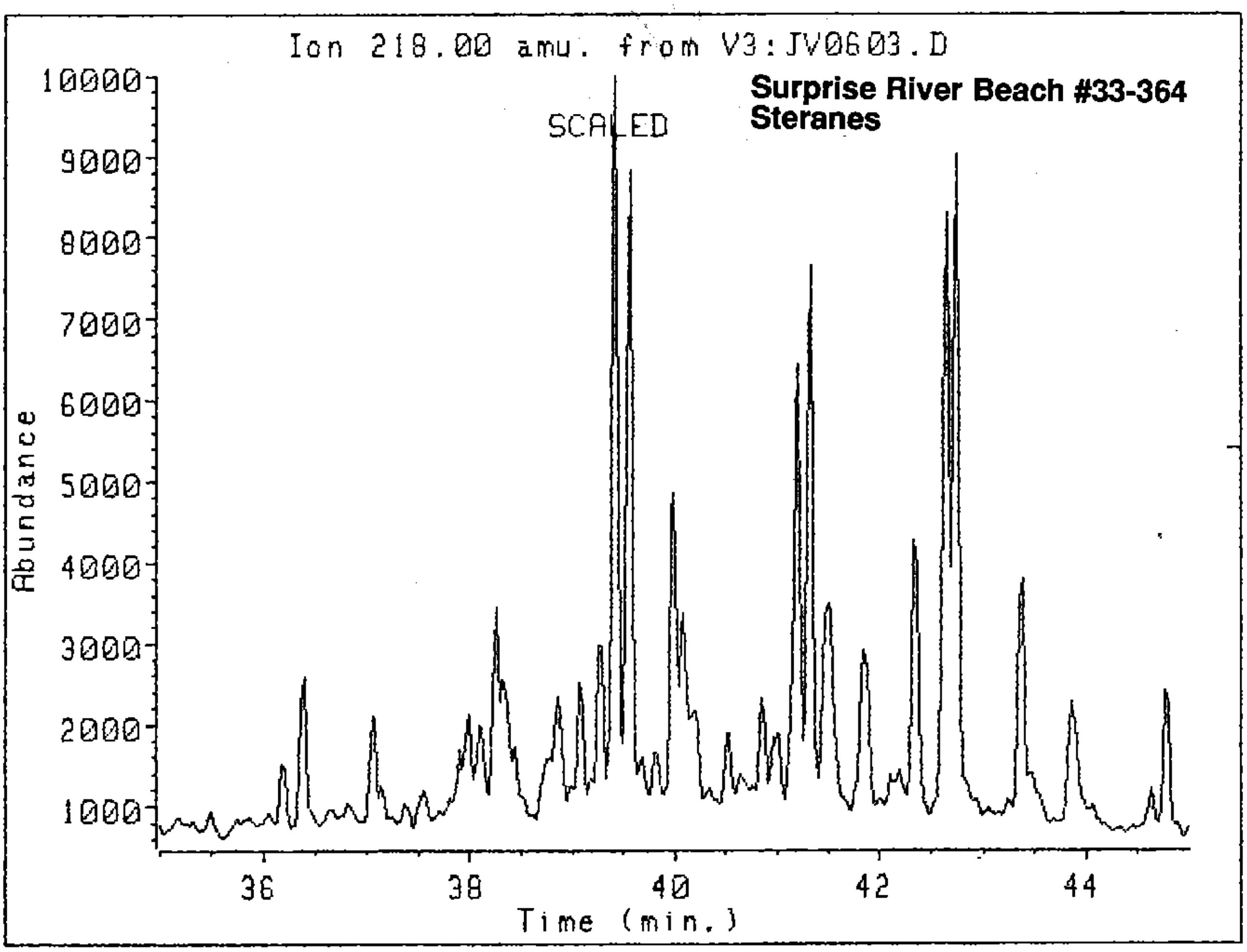
40
42
44
Time (min.)


Ion 218.00 amu. from V3:JV0603.D
SCALED
Surprise River Beach #33-364
Steranes
Abundance
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9000
8000
7000
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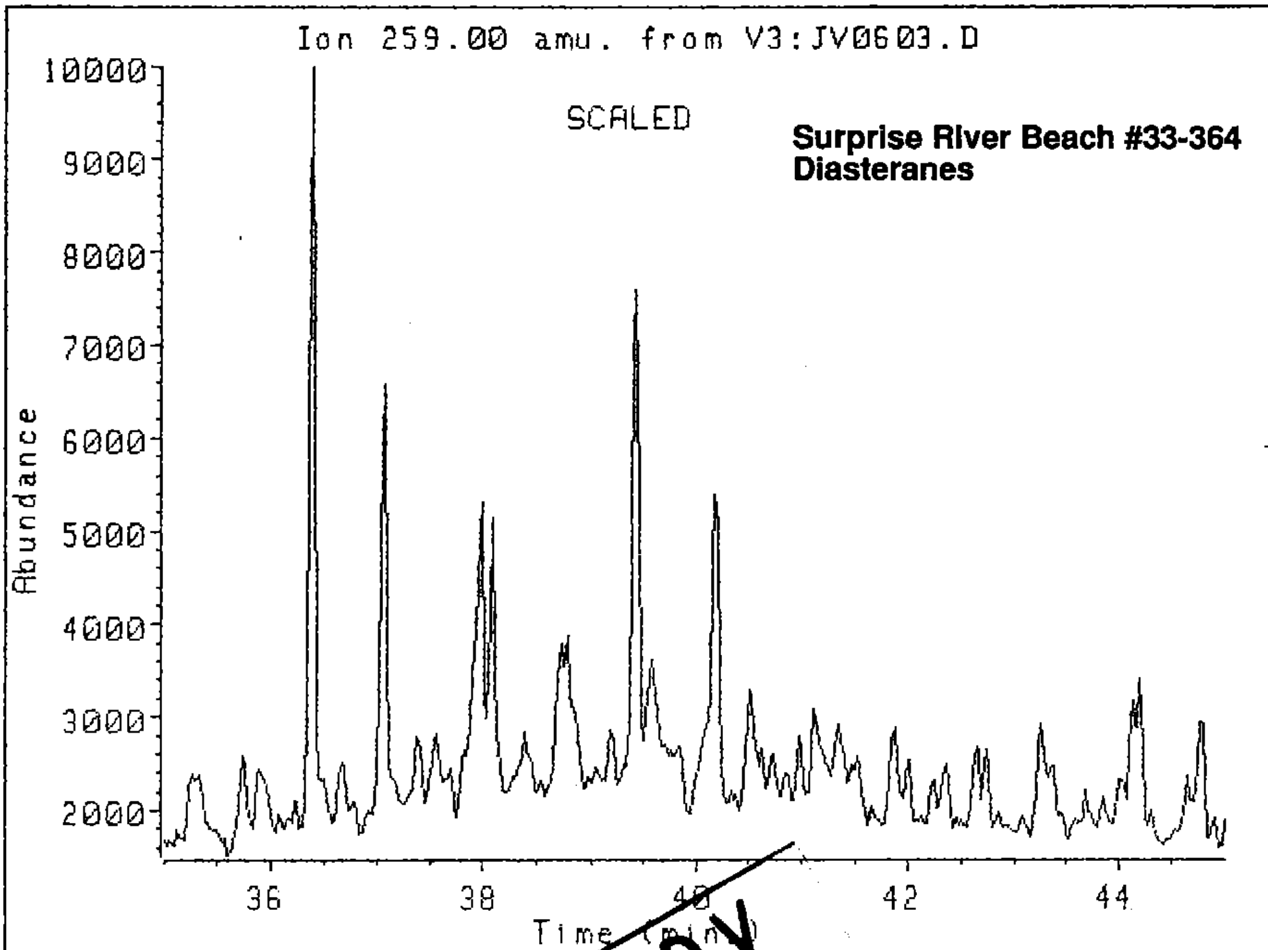
40
42
44
Time (min.)


Ion 259.00 amu. from V3:JV0603.D
SCALED
Surprise River Beach #33-364
Diasteranes
Abundance
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9000
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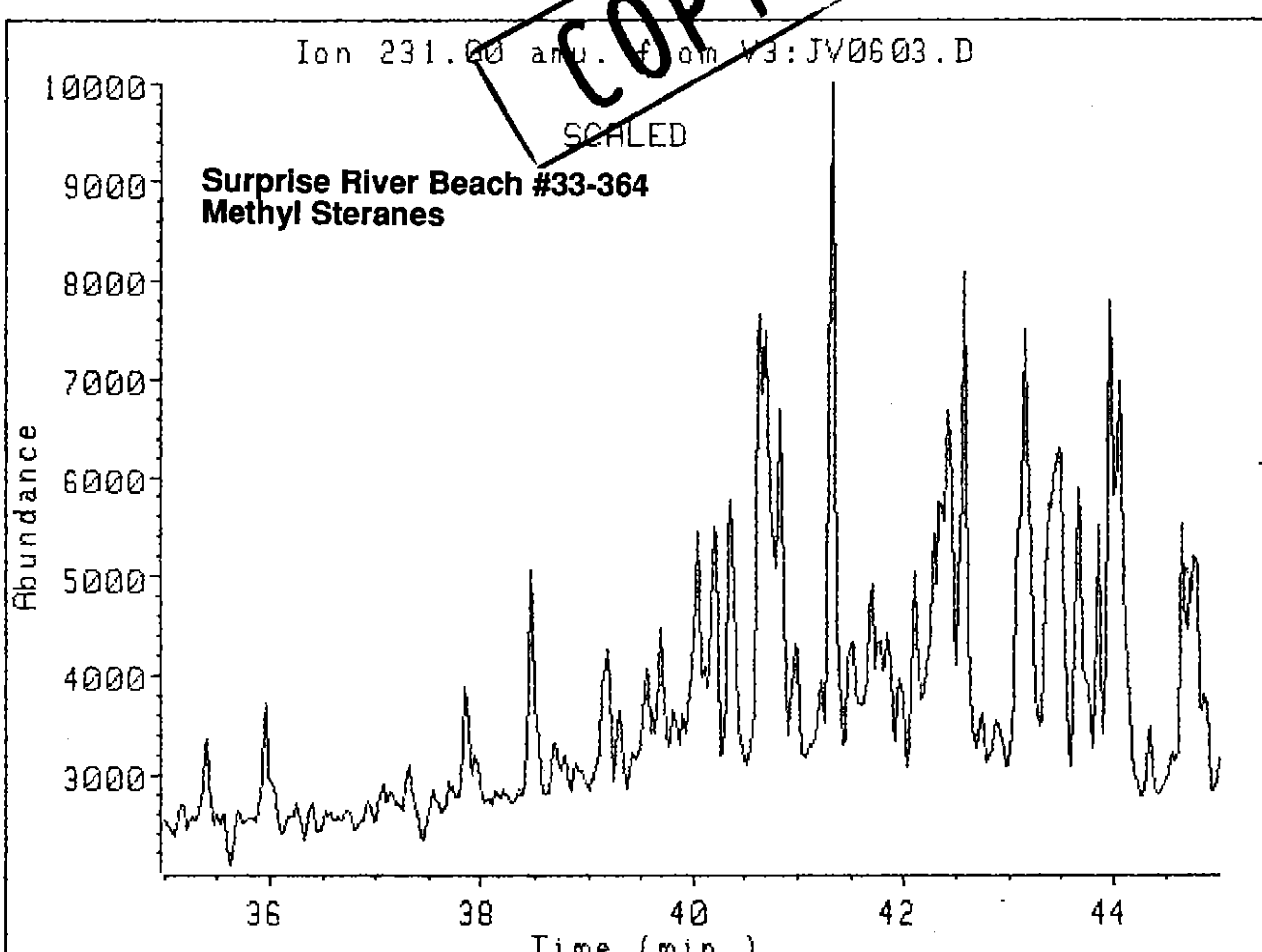
7000
6000
5000
4000
3000
2000
36
38
40
42
44
Time (min.)


Ion 231.00 amu. from V3:JV0603.D
SCALED
Surprise River Beach #33-364
Methyl Steranes
Abundance
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9000
8000
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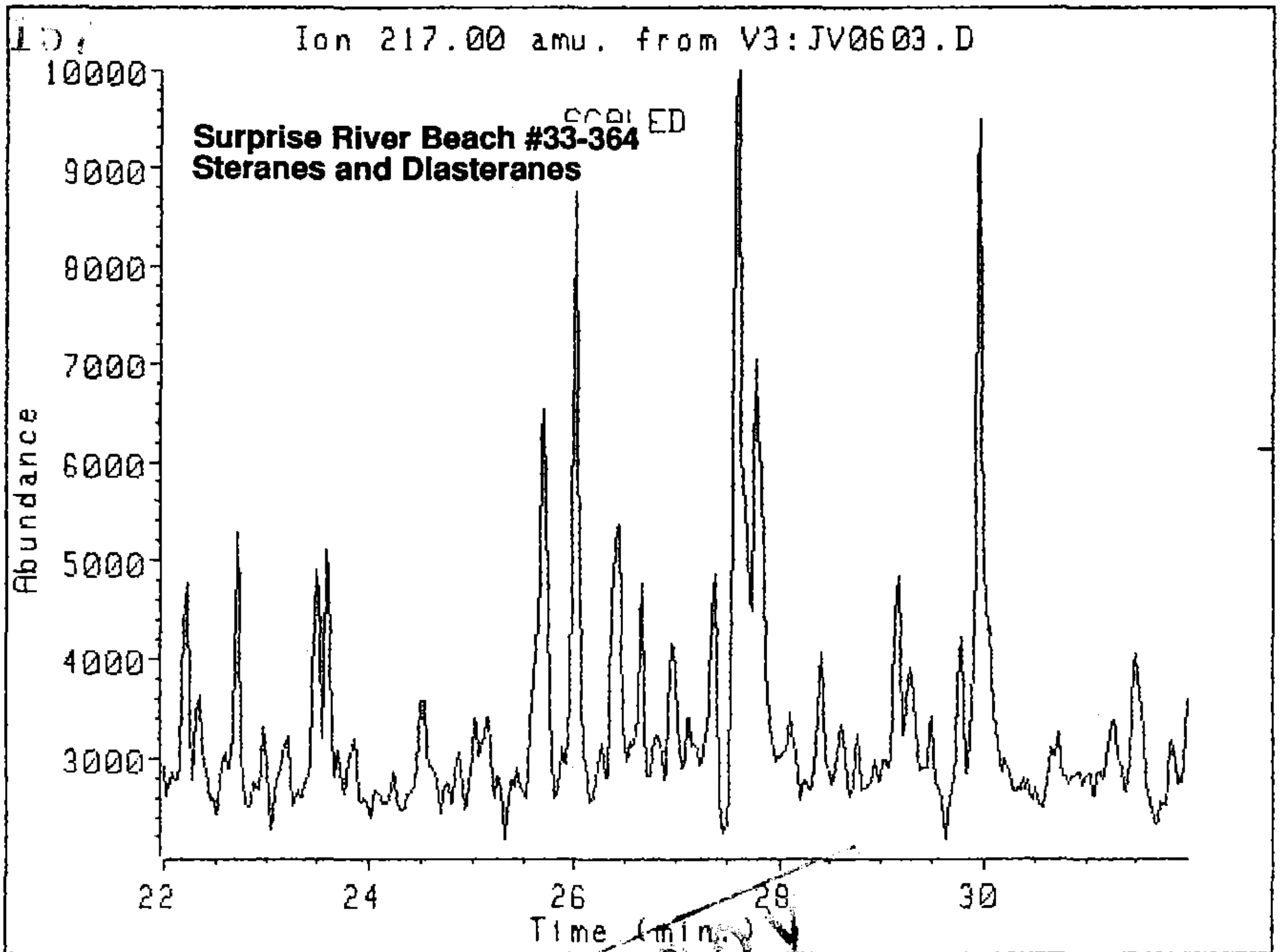
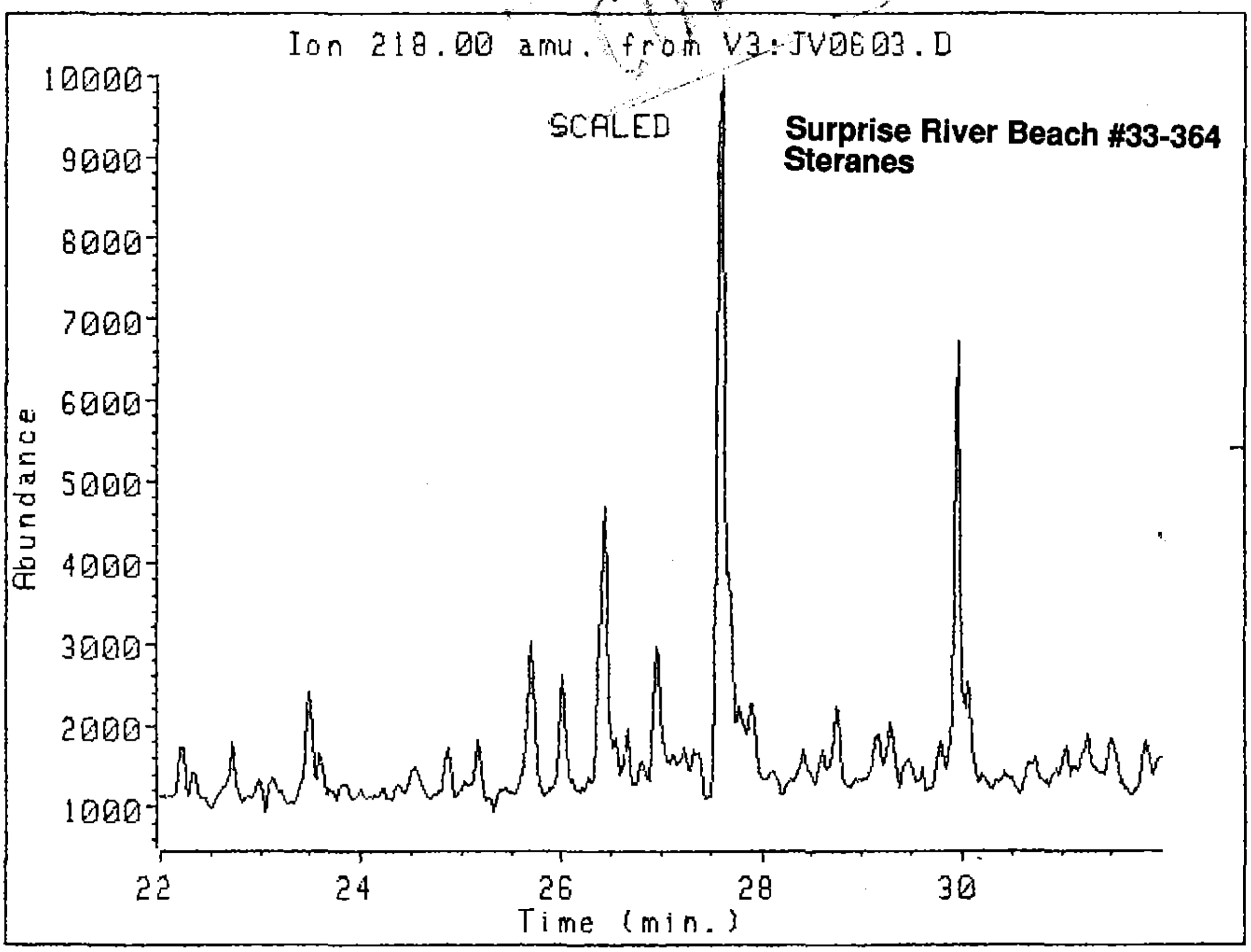
40
42
44
Time (min.)


Ion 217.00 amu. from V3:JV0603.D
SCALED
Surprise River Beach #33-364
Steranes and Diasteranes
Abundance
10000
9000
8000
7000
6000
5000
4000
3000
22
24
26
28
30
Time (min.)


Ion 218.00 amu. from V3:JV0603.D
SCALED
Surprise River Beach #33-364
Steranes
Abundance
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8000
7000
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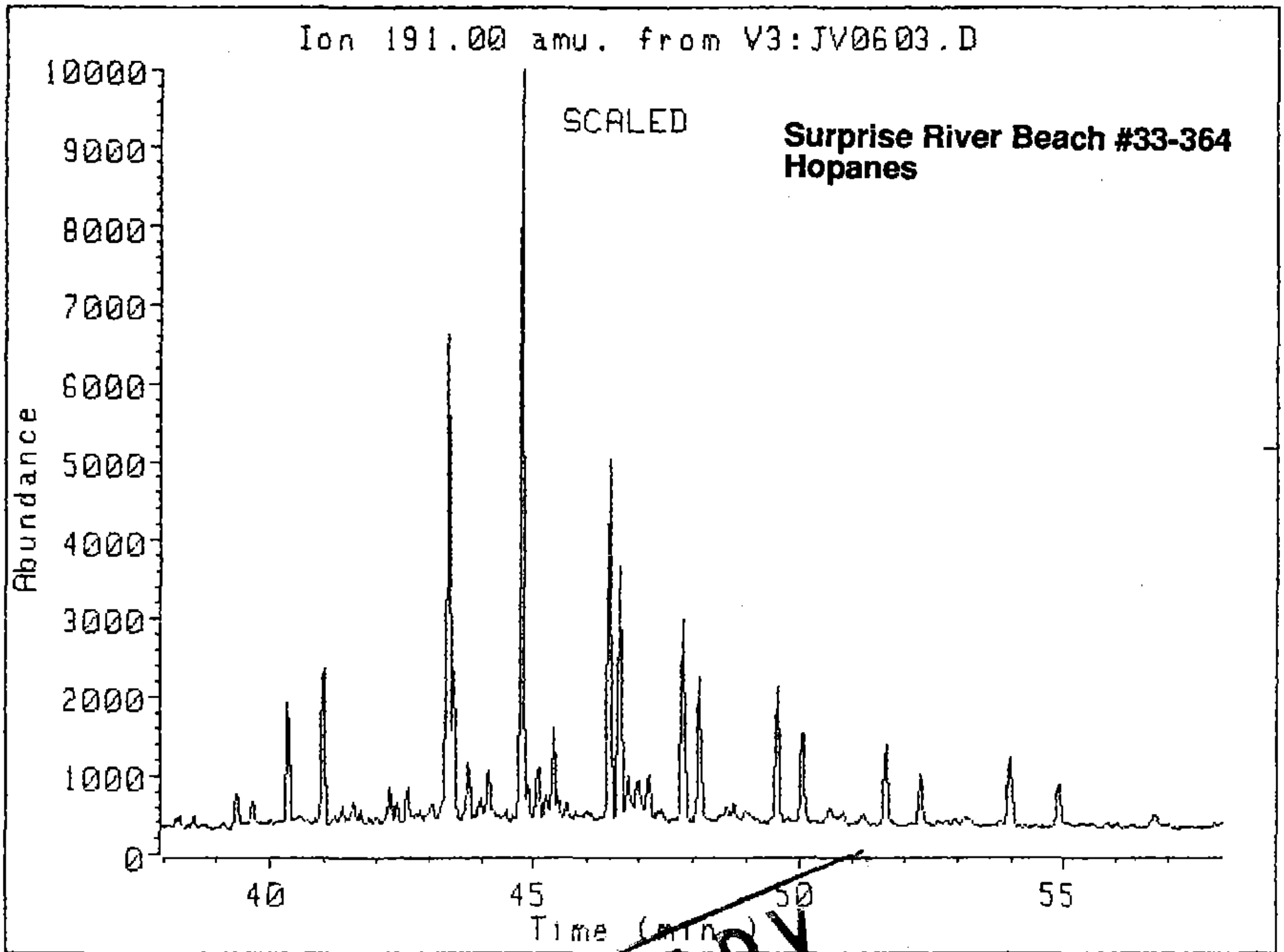
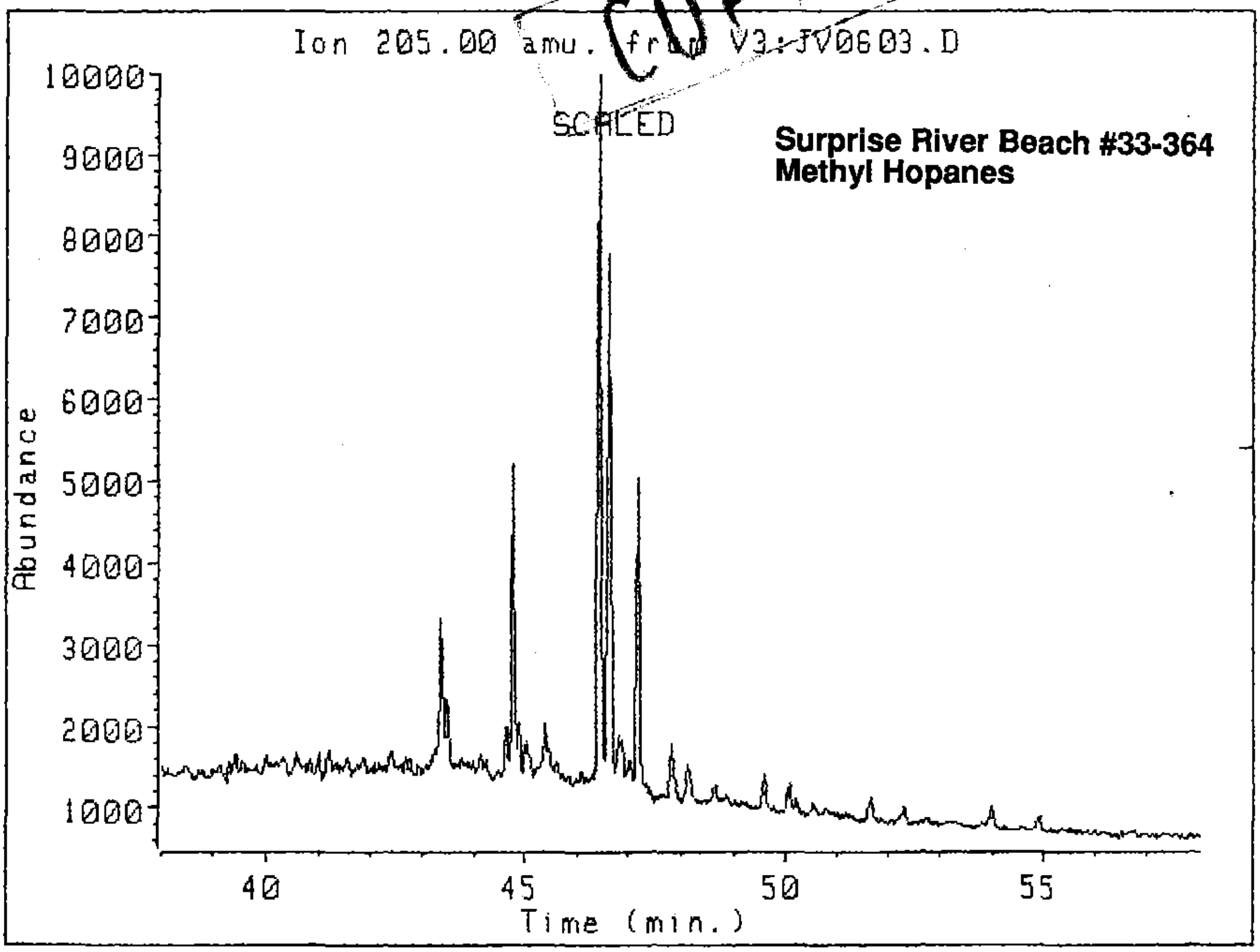
26
28
30
Time (min.)


Ion 191.00 amu. from V3:JV0603.D
SCALED
Surprise River Beach #33-364
Hopanes
Abundance
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
40
45
50
55
Time (min.)


Ion 205.00 amu. from V3:JV0603.D
SCALED
Surprise River Beach #33-364
Methyl Hopanes
Abundance
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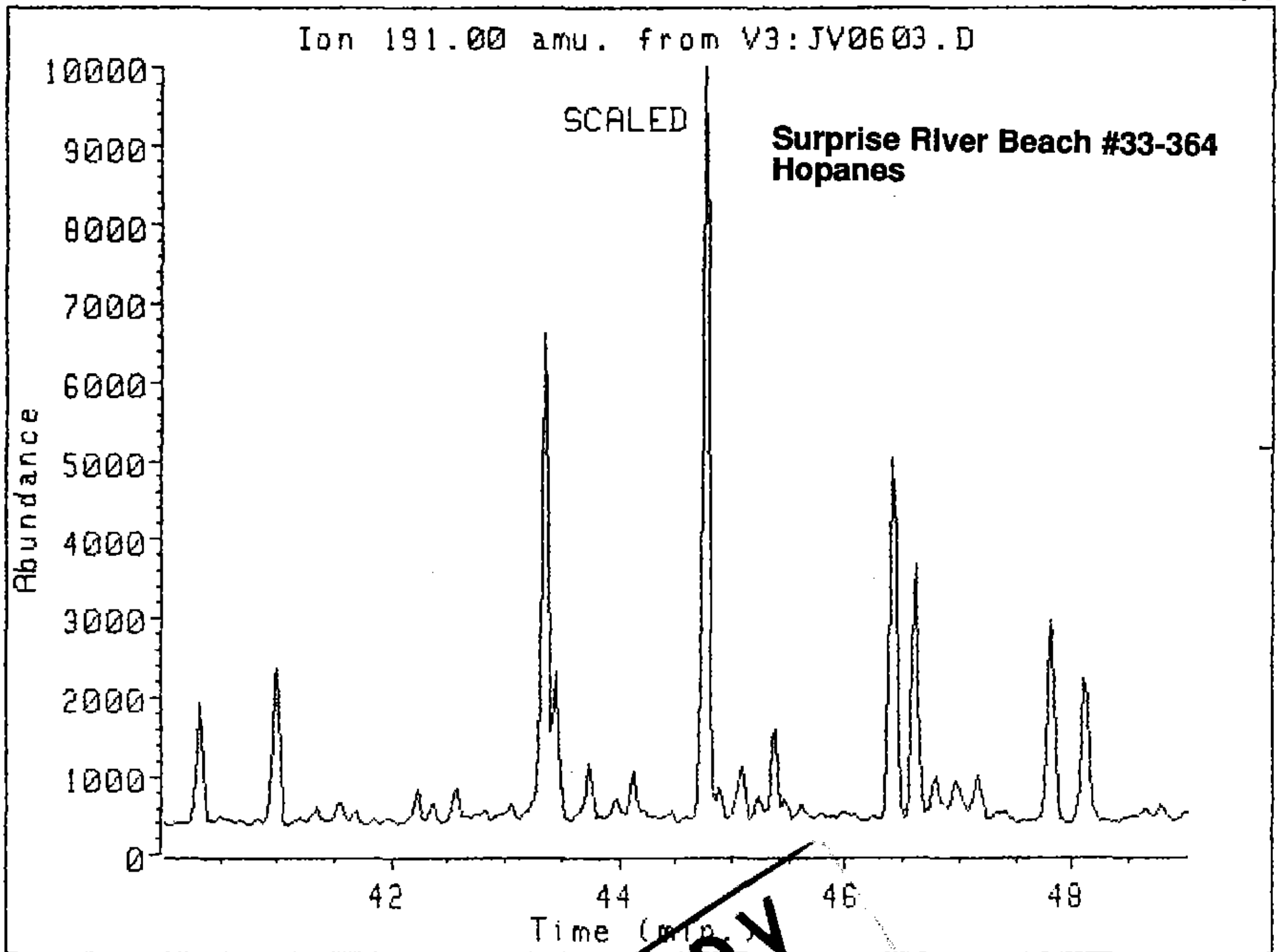
8000
7000
6000
5000
4000
3000
2000
1000
40
45
50
55
Time (min.)


Ion 191.00 amu. from V3:JV0603.D
SCALED
Surprise River Beach #33-364
Hopanes
Abundance
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7000
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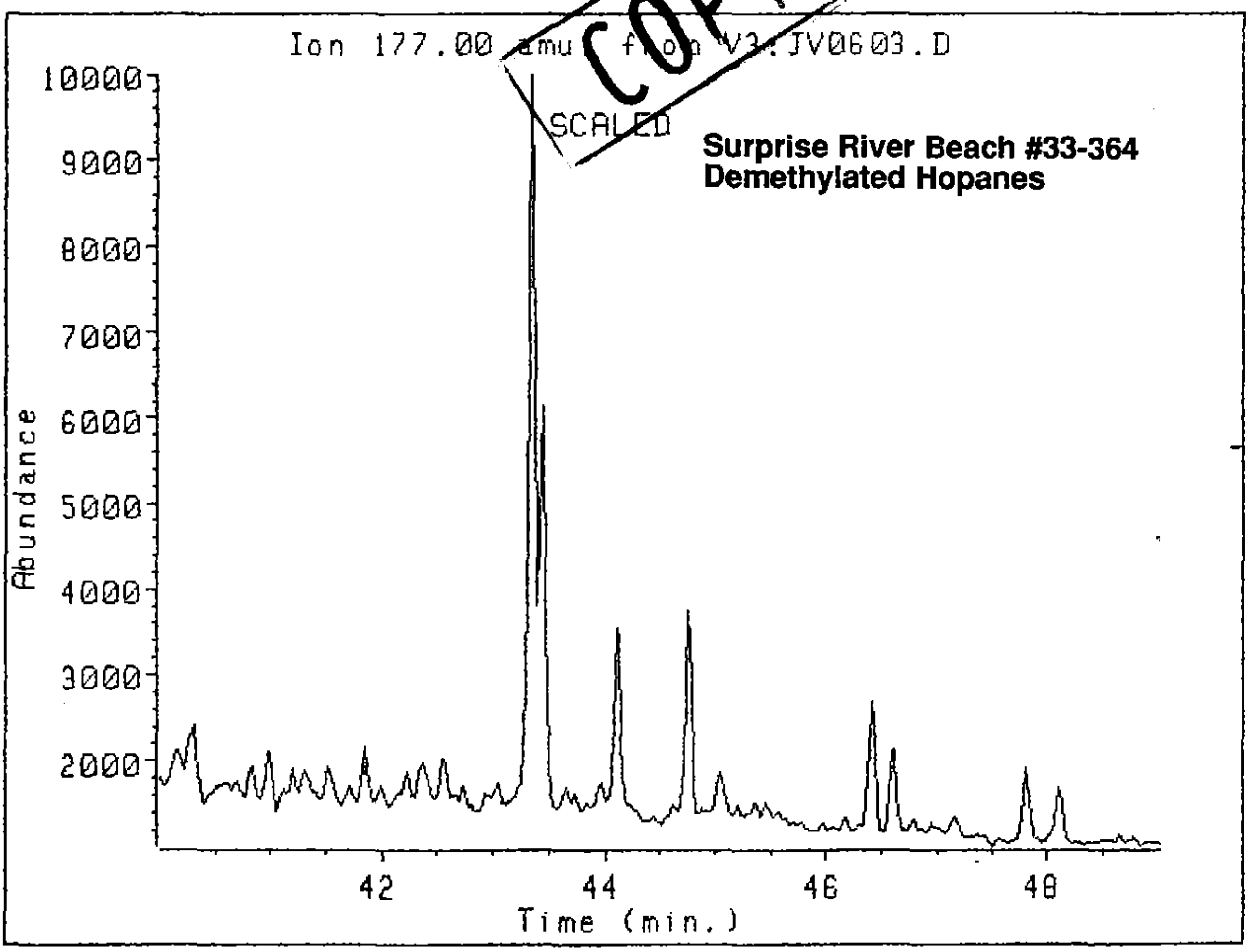
5000
4000
3000
2000
1000
0
42
44
46
48
Time (min.)


Ion 177.00 amu. from V3:JV0603.D
SCALED
Surprise River Beach #33-364
Demethylated Hopanes
Abundance
10000
9000
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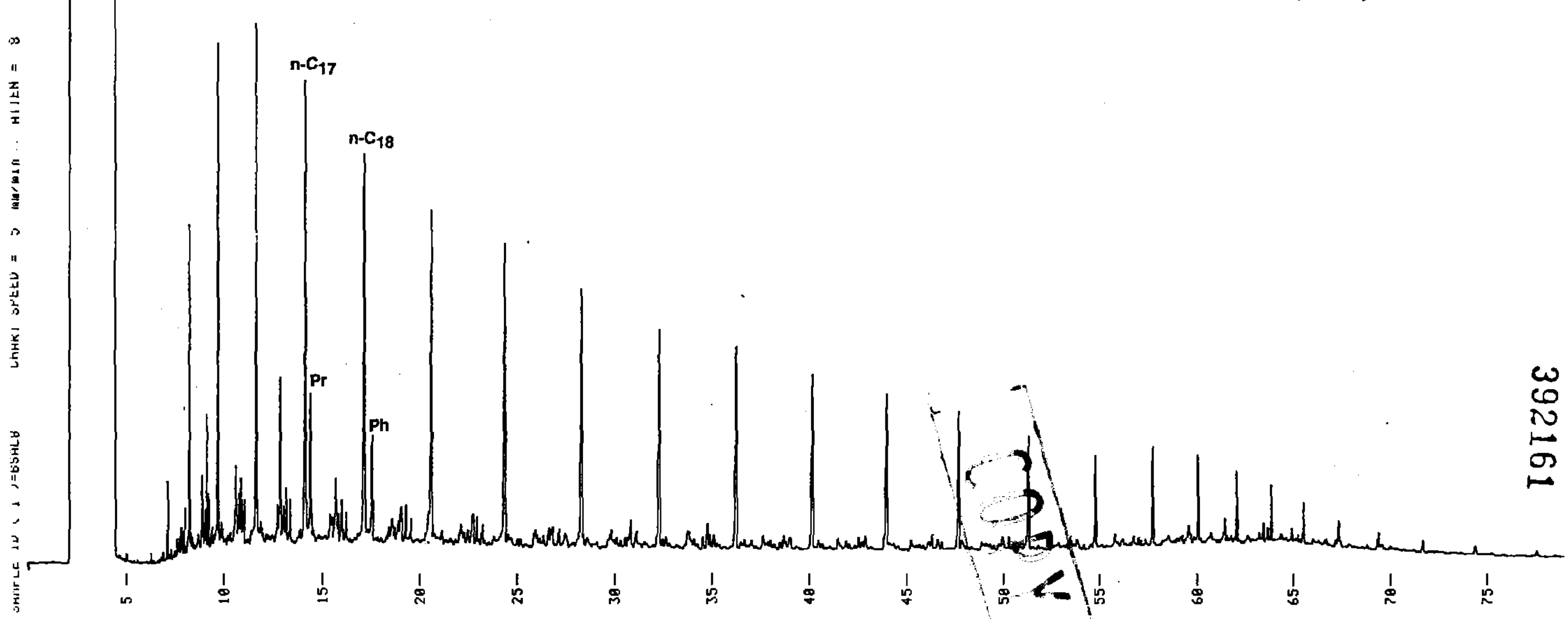
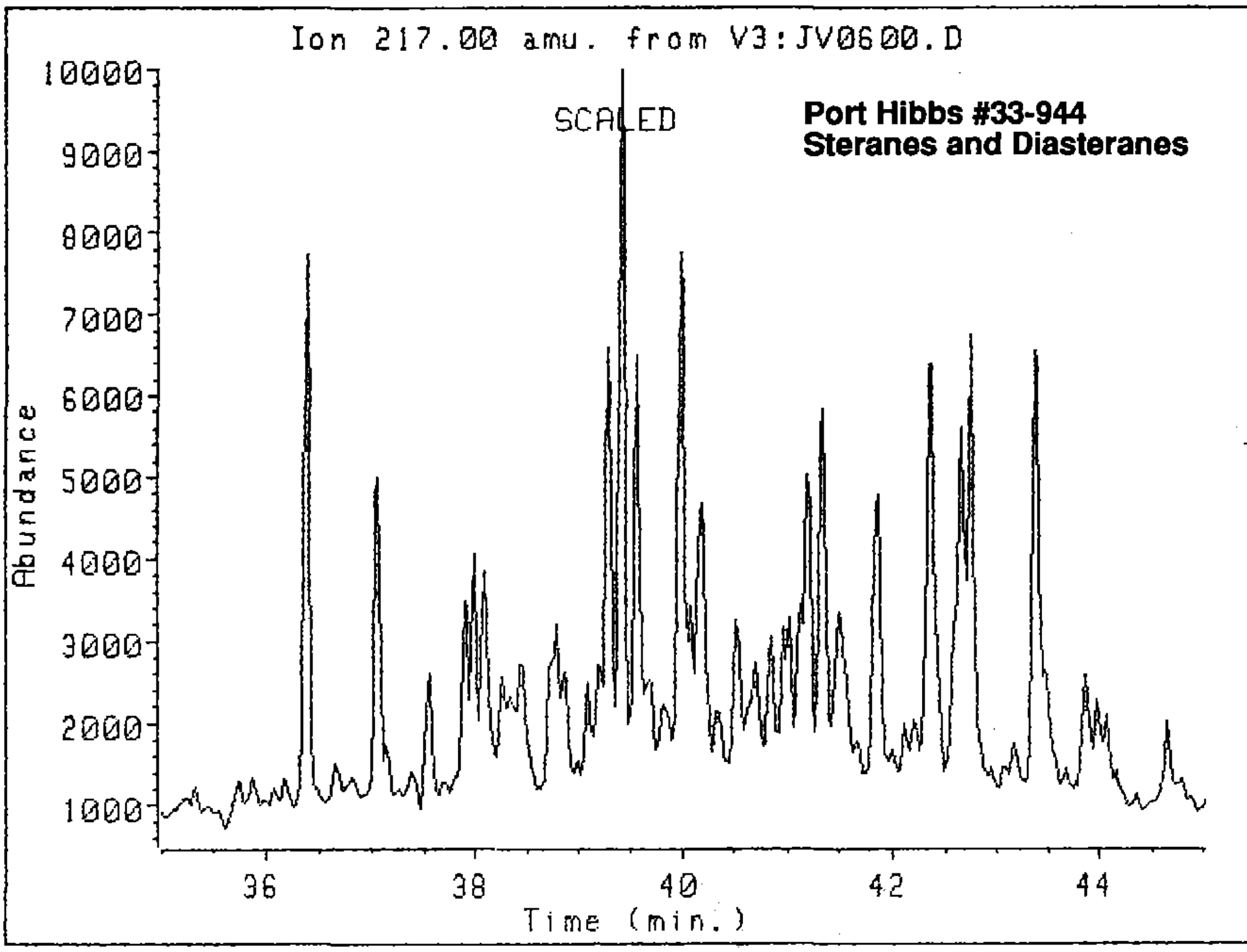
7000
6000
5000
4000
3000
2000
42
44
46
48
Time (min.)
COPY

Port Hibbs #33-944
Aliphatic Hydrocarbons



392161


Ion 217.00 amu. from V3:JV0600.D
SCALED
Port Hibbs #33-944
Steranes and Diasteranes
Abundance
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
36
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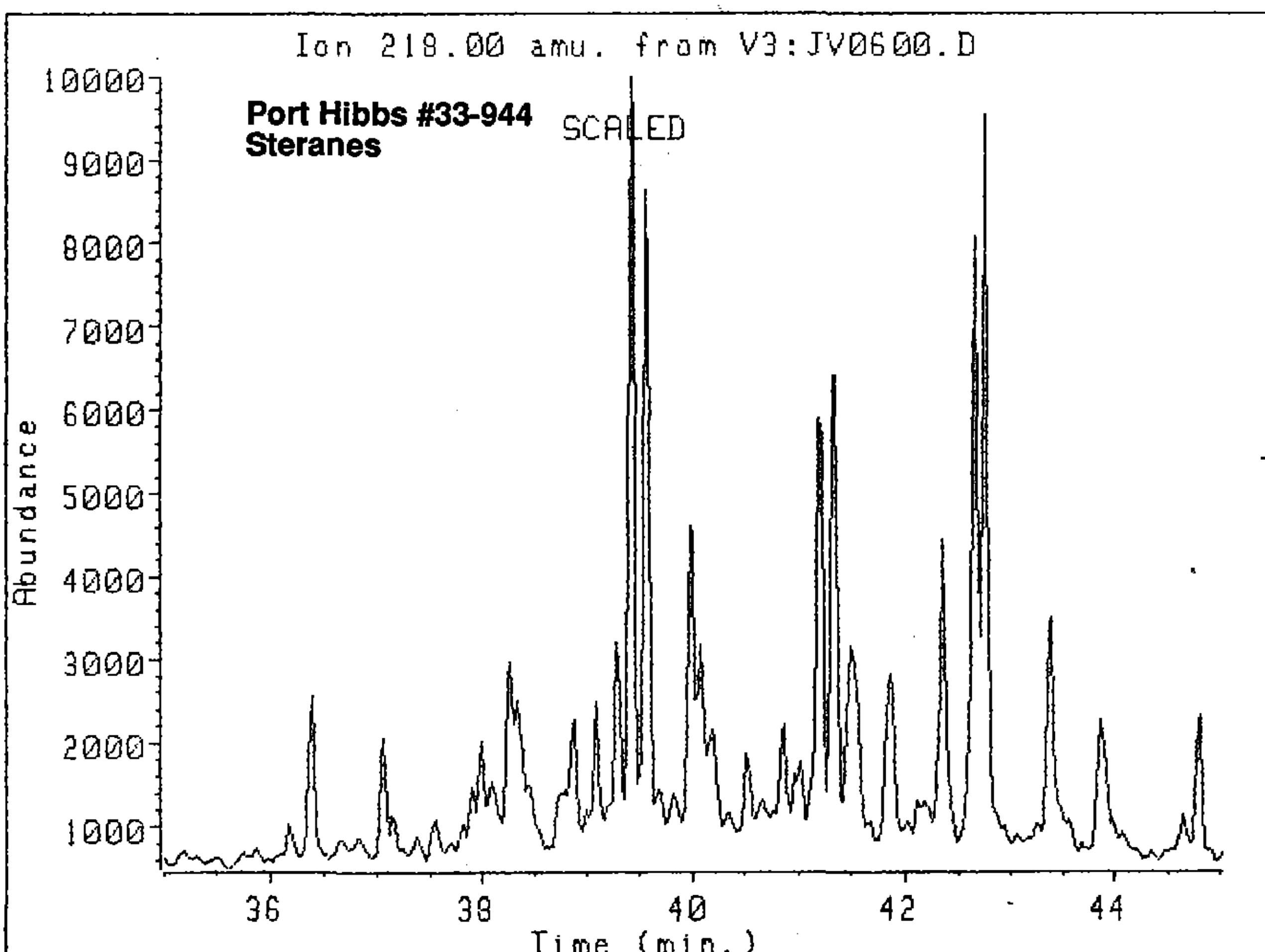
40
42
44
Time (min.)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Port Hibbs #33-944
Steranes
SCALED
Abundance
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3000
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36
38
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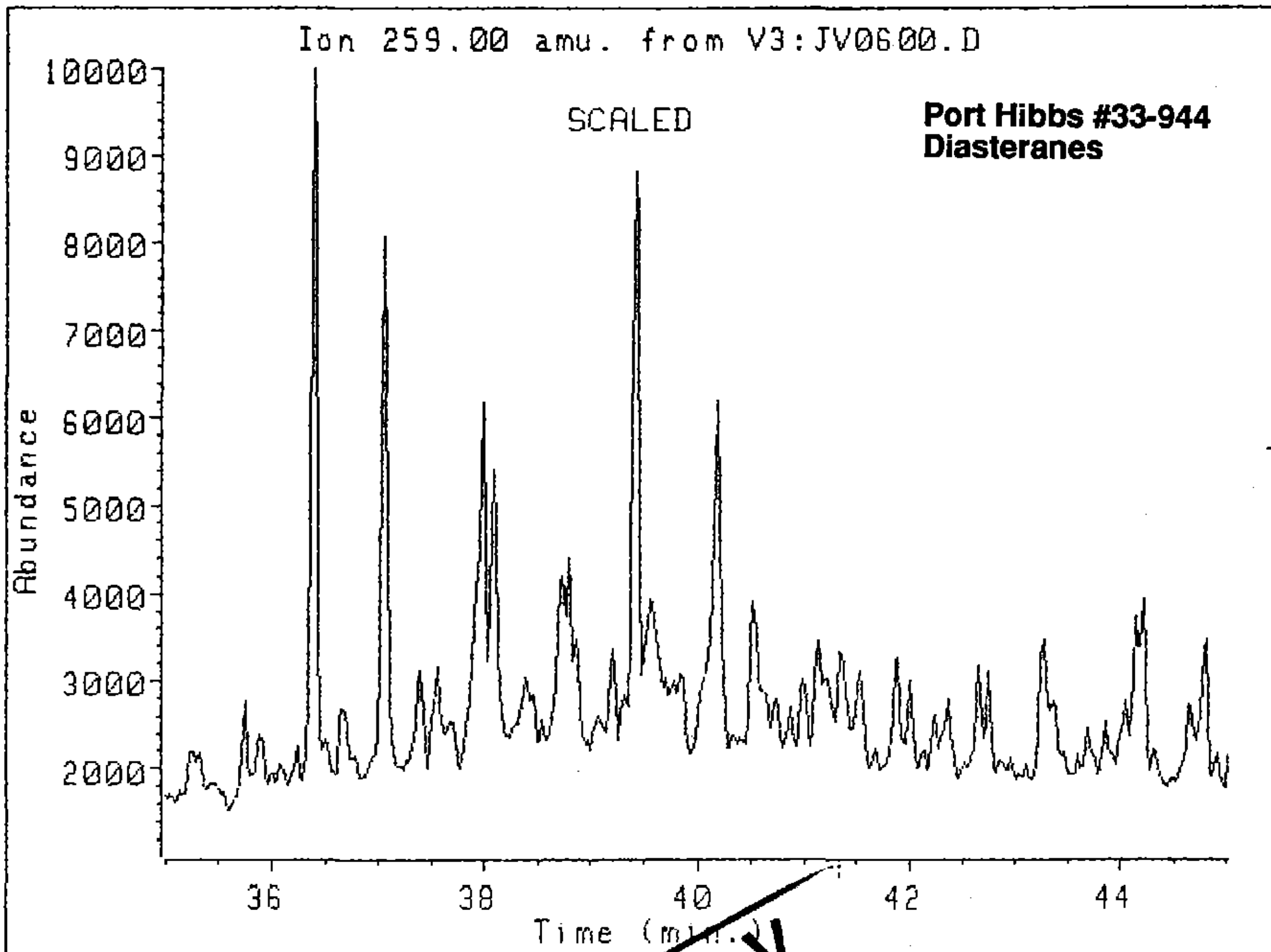
42
44
Time (min.)



Ion 259.00 amu. from V3:JV0600.D
SCALED
Port Hibbs #33-944
Diasteranes
Abundance
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9000
8000
7000
6000
5000
4000
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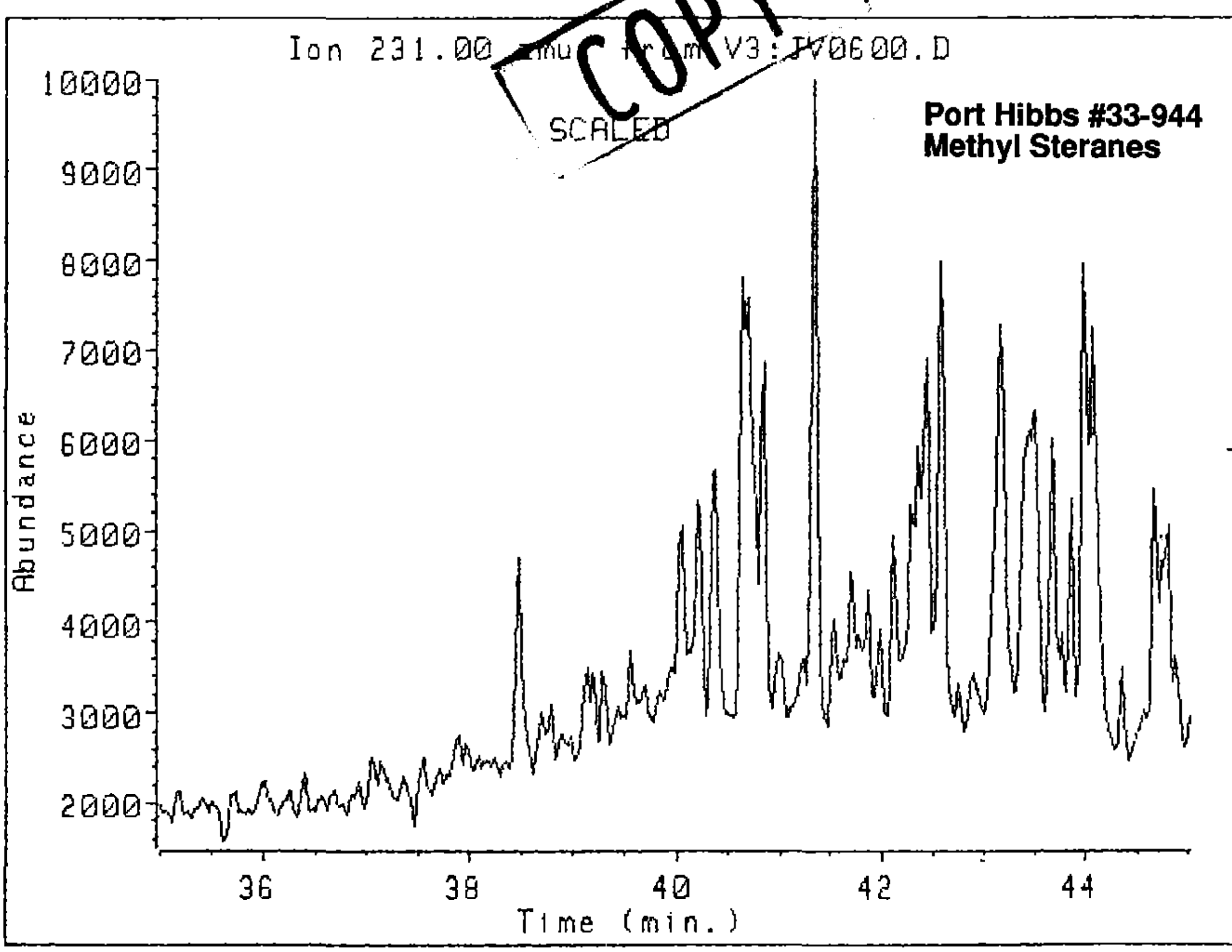
2000
36
38
40
42
44
Time (min.)



Ion 231.00 amu. from V3:JV0600.D
SCALED
Port Hibbs #33-944
Methyl Steranes
Abundance
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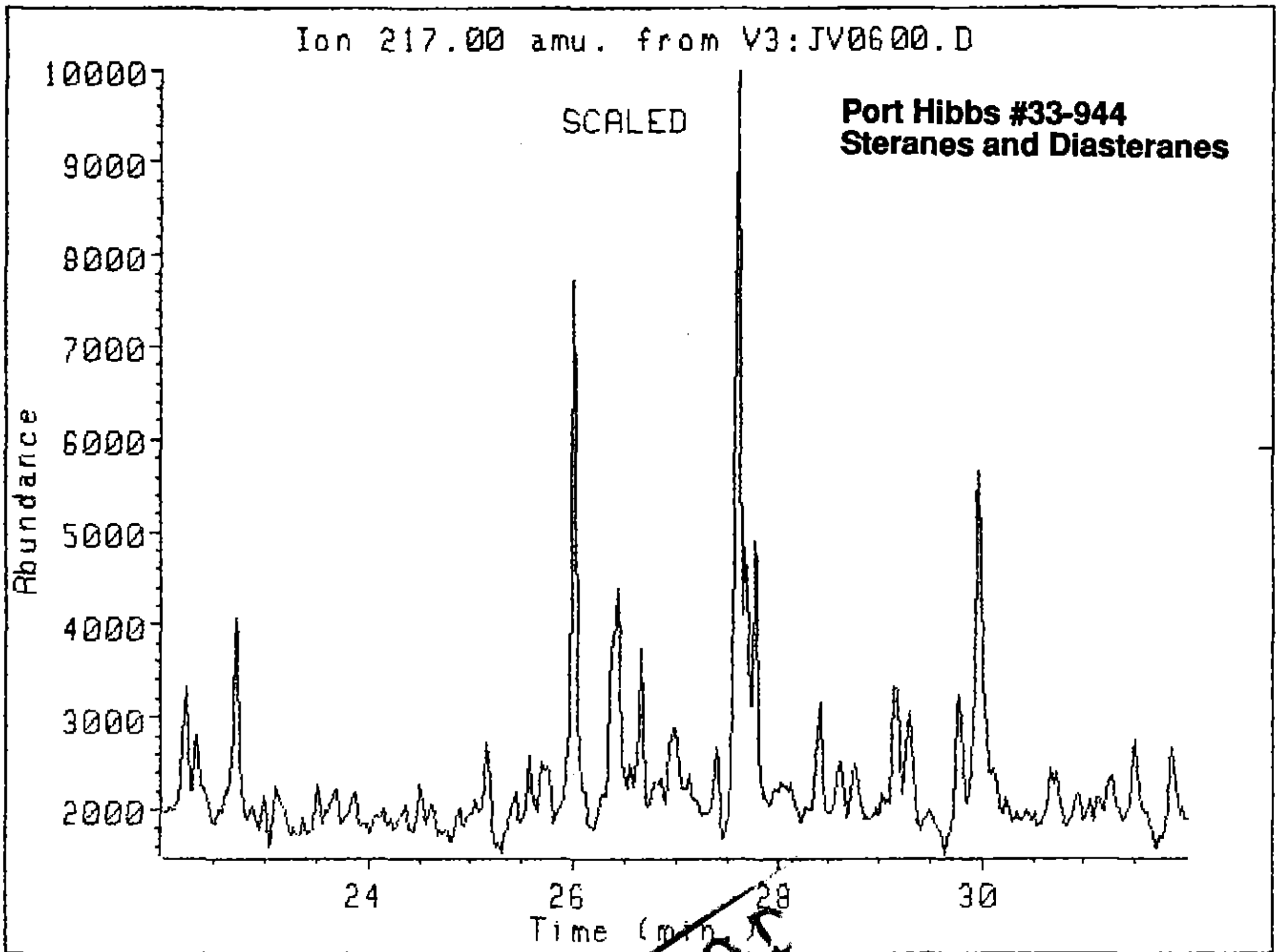
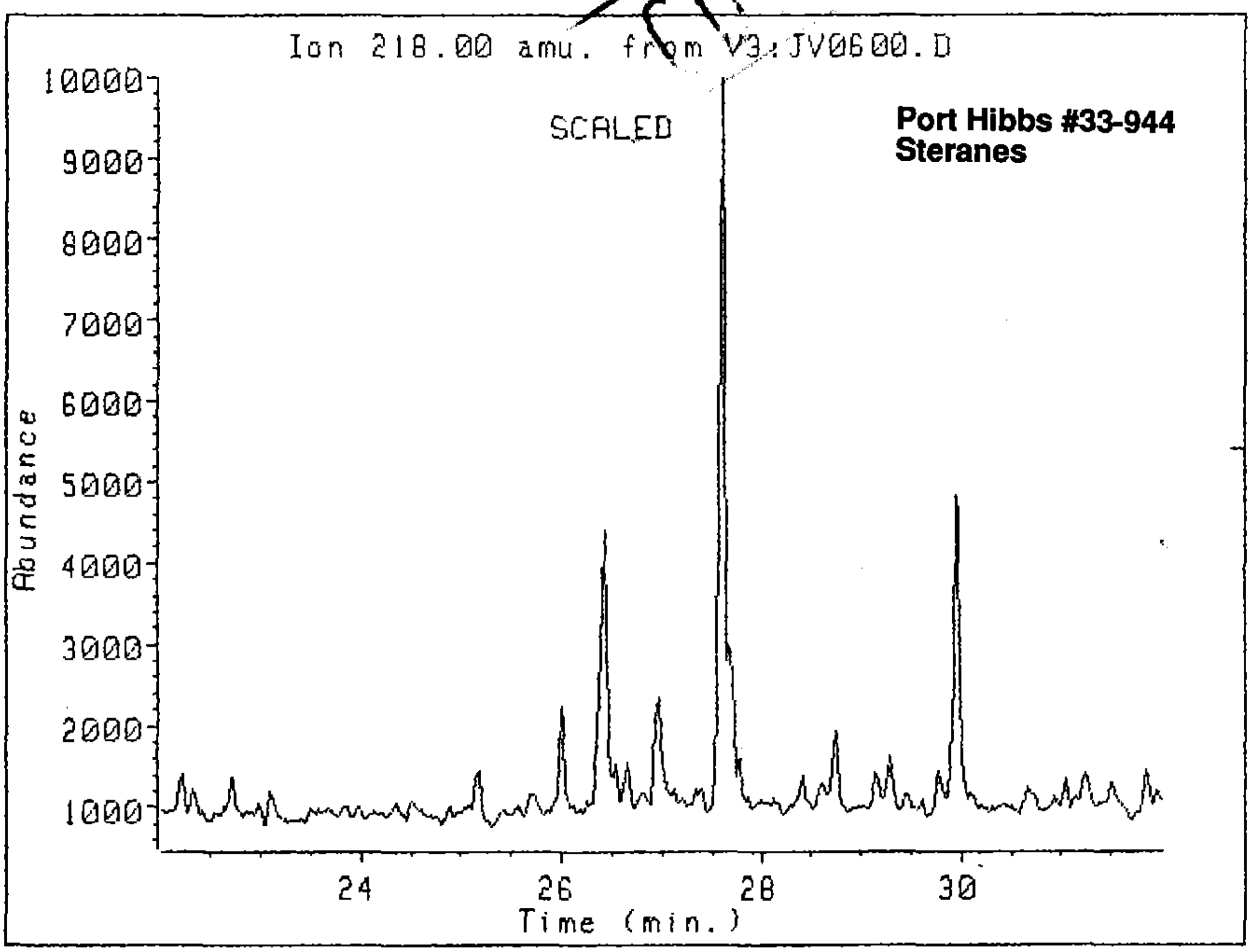
9000
8000
7000
6000
5000
4000
3000
2000
36
38
40
42
44
Time (min.)


Ion 217.00 amu. from V3:JV0600.D
SCALED
Port Hibbs #33-944
Steranes and Diasteranes
Abundance
10000
9000
8000
7000
6000
5000
4000
3000
2000
24
26
28
30
Time (min.)


Ion 218.00 amu. from V3:JV0600.D
SCALED
Port Hibbs #33-944
Steranes
Abundance
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8000
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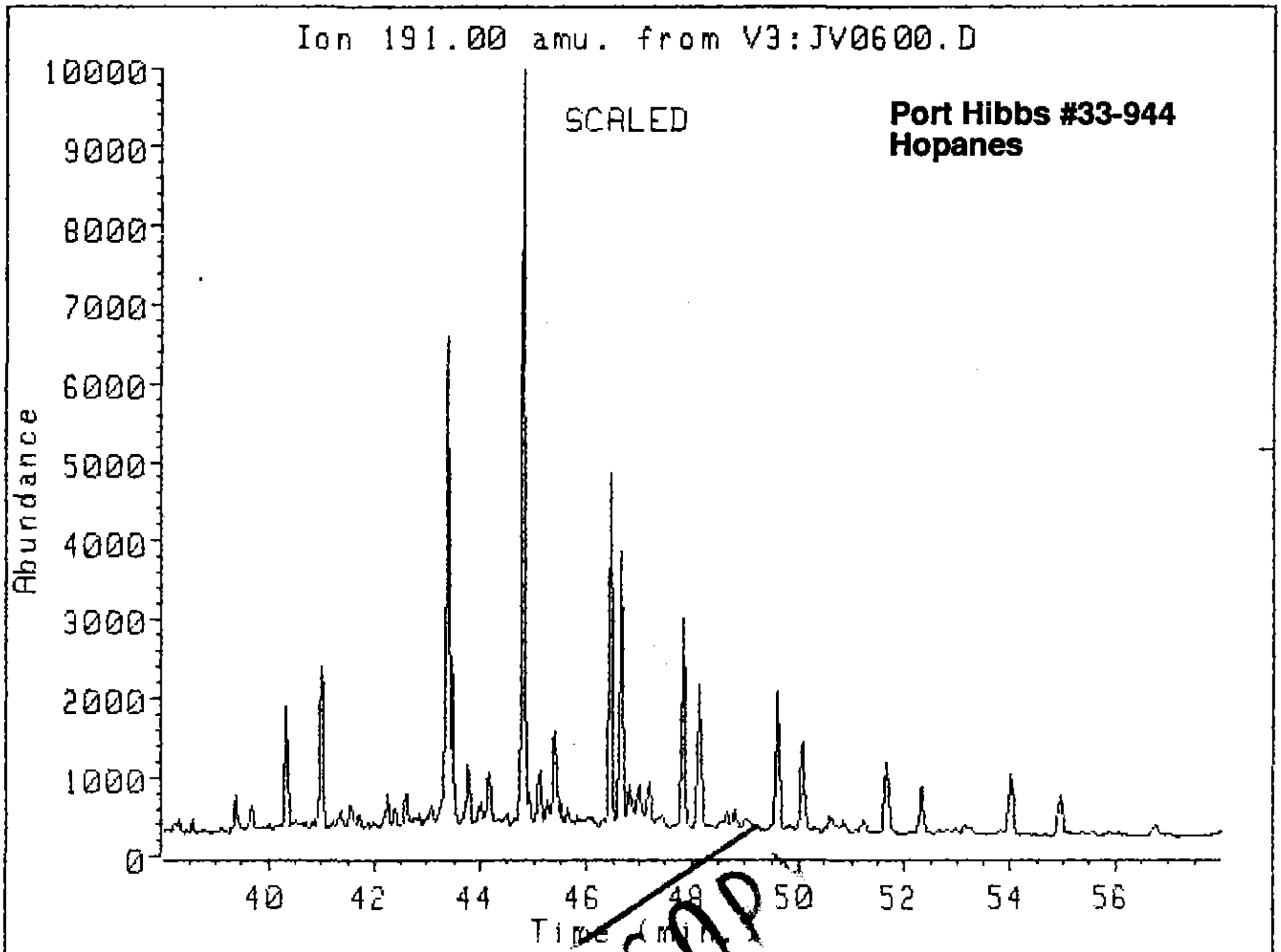
26
28
30
Time (min.)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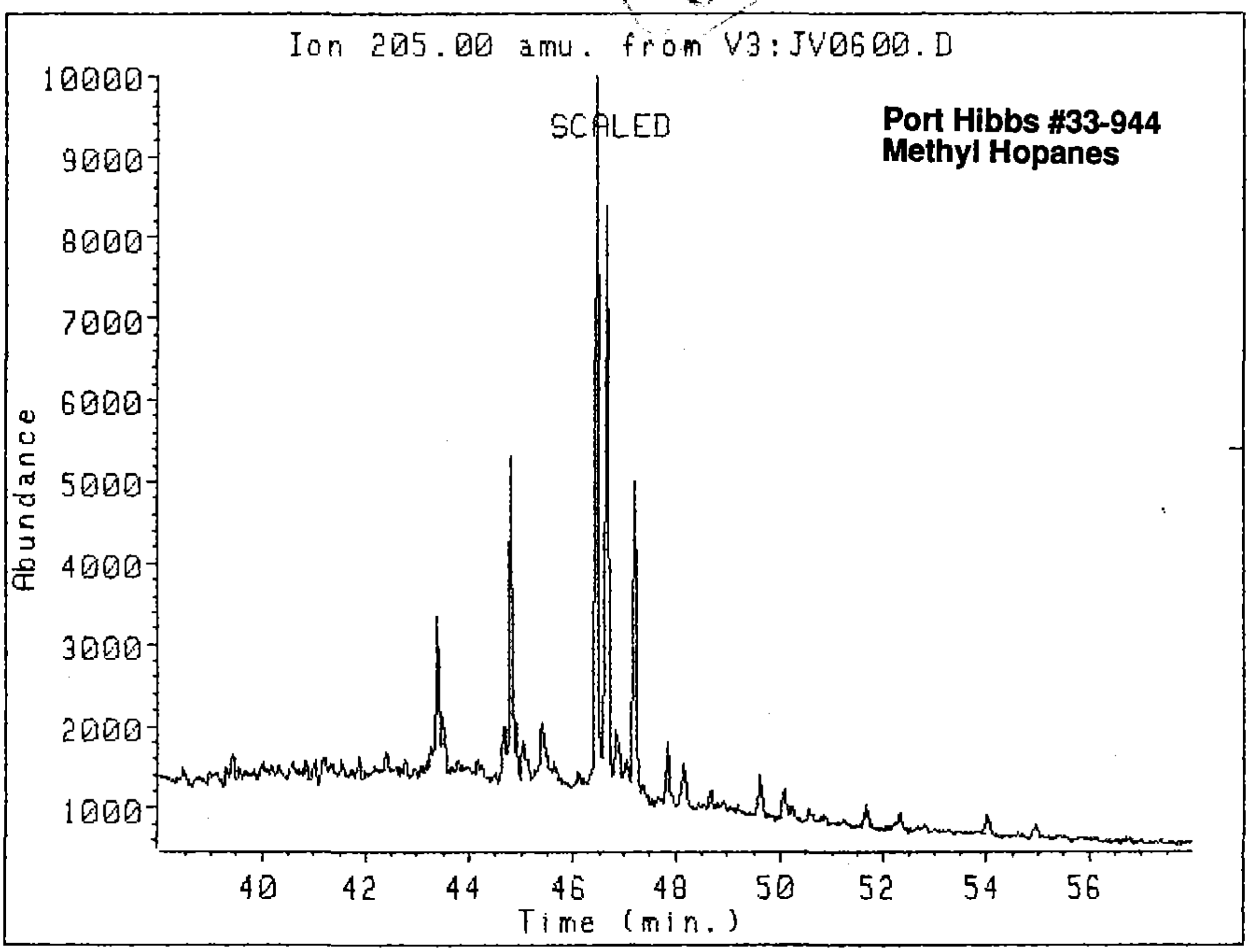
SCALED
Port Hibbs #33-944
Hopanes
Abundance
Time (min.)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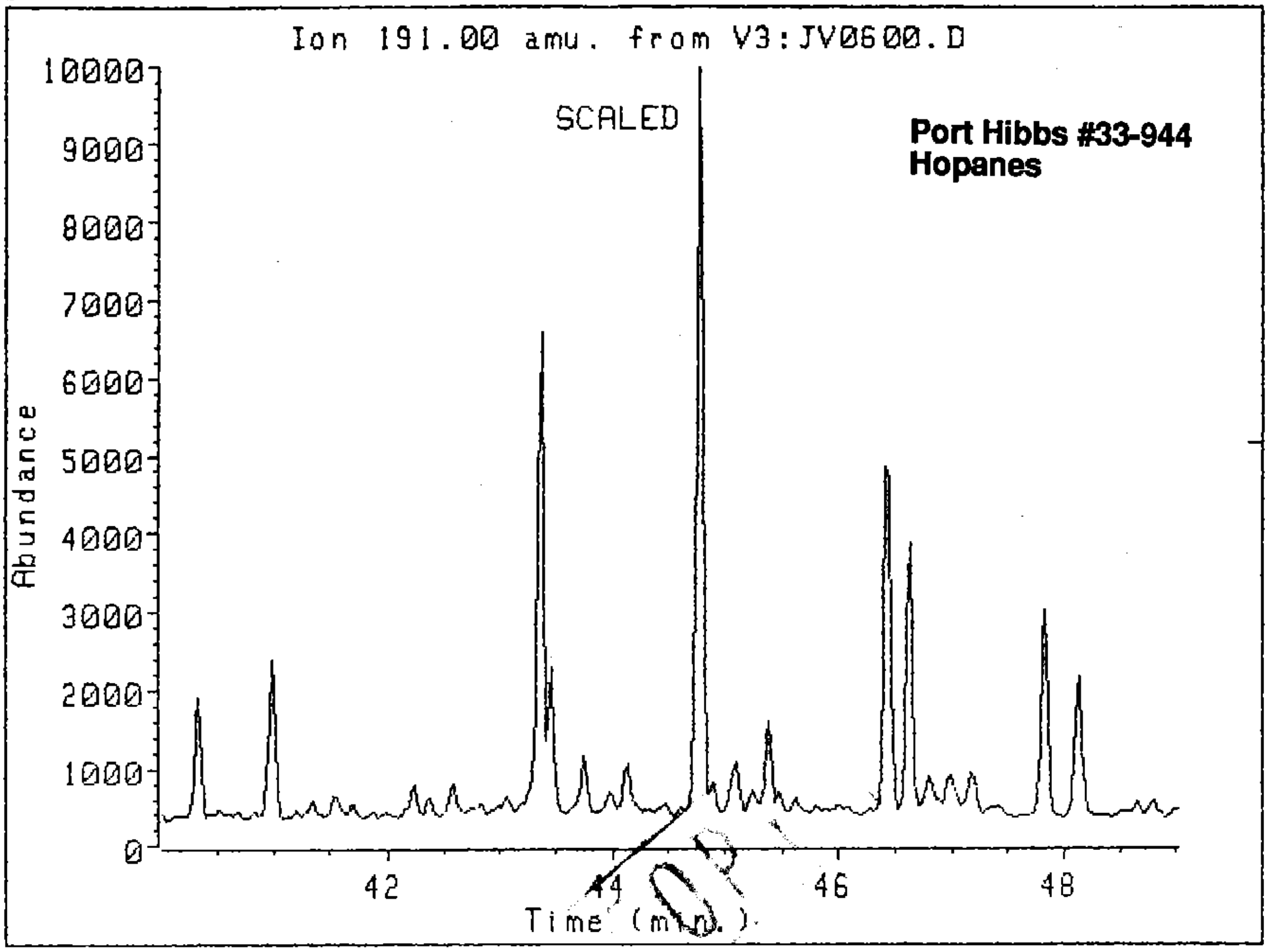
SCALED
Port Hibbs #33-944
Methyl Hopanes
Abundance
Time (min.)


Ion 191.00 amu. from V3:JV0600.D
SCALED
Port Hibbs #33-944
Hopanes
Abundance
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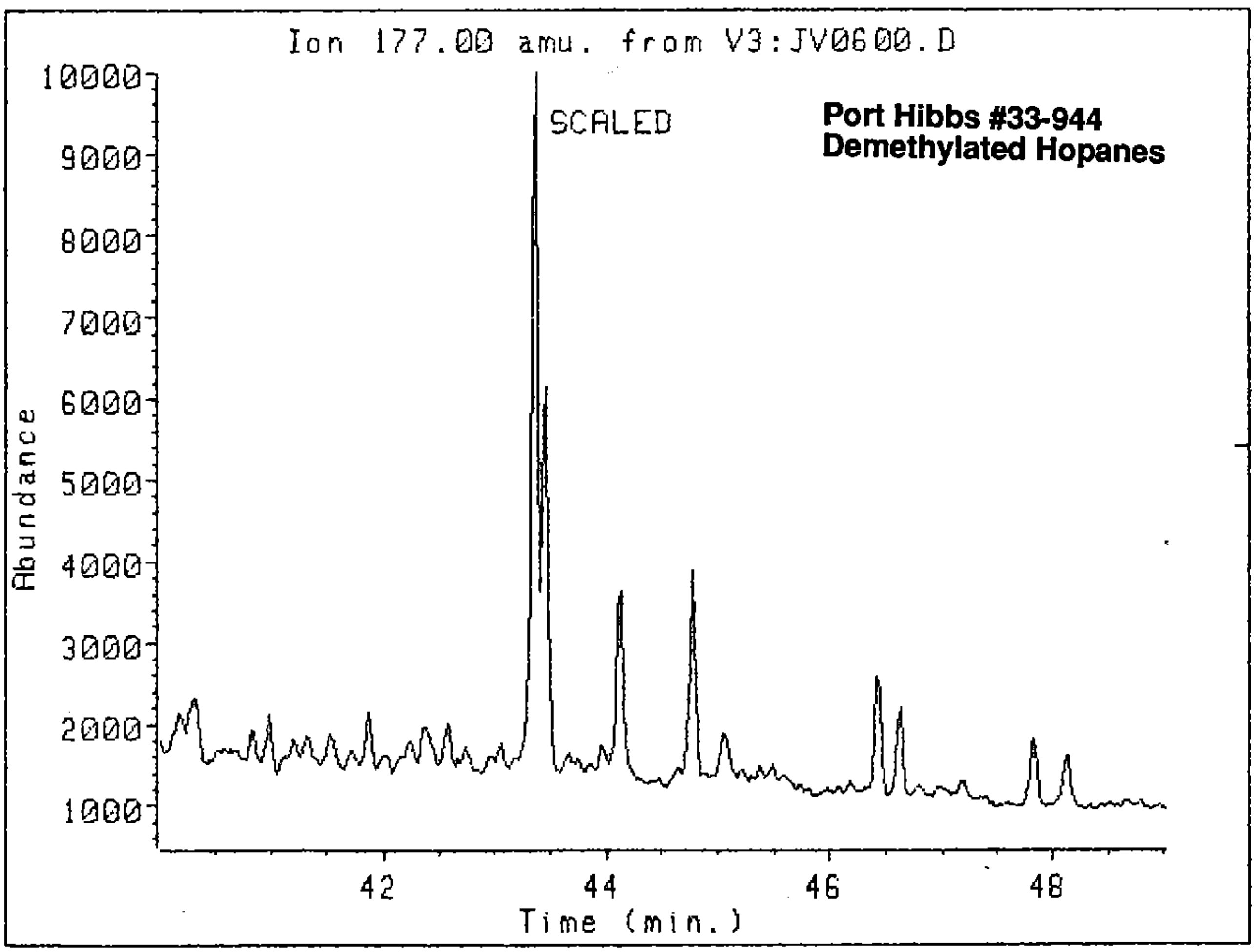
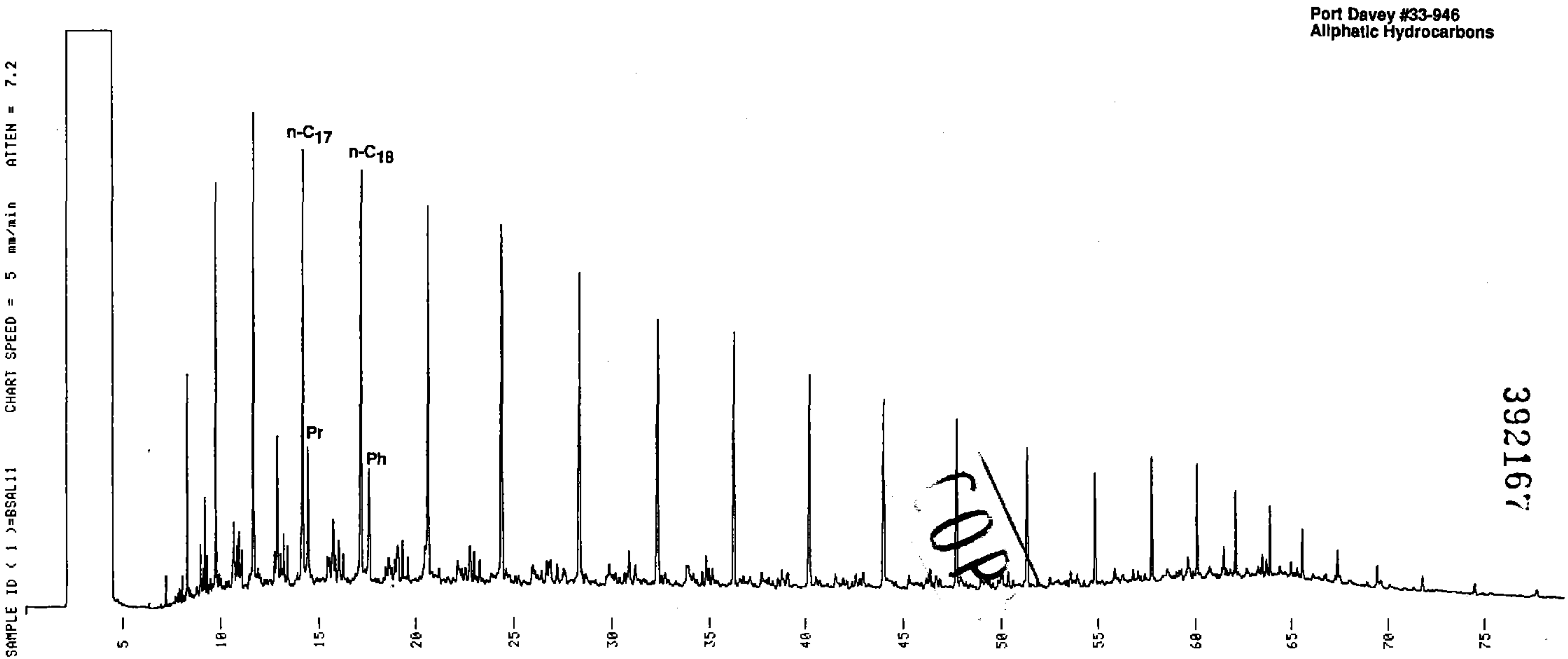
7000
6000
5000
4000
3000
2000
1000
0
42
44
46
48
Time (min.)


Ion 177.00 amu. from V3:JV0600.D
SCALED
Port Hibbs #33-944
Demethylated Hopanes
Abundance
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
42
44
46
48
Time (min.)


Port Davey #33-946
Aliphatic Hydrocarbons
SAMPLE ID (1)=BSAL11 CHART SPEED = 5 mm/min ATTEN = 7.2
n-C_{17}
n-C_{18}
Pr
Ph
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10
15
20
25
30
35
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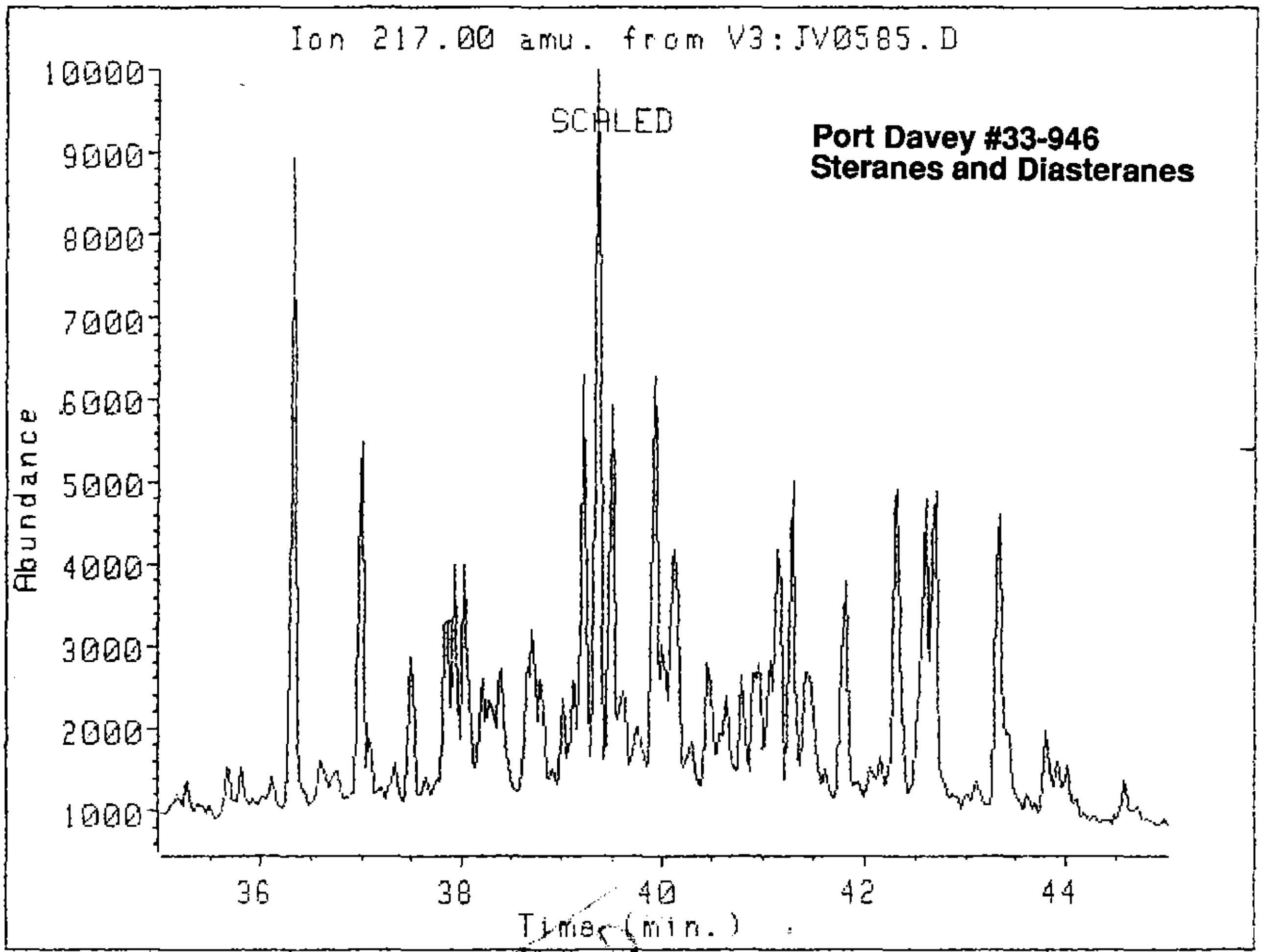
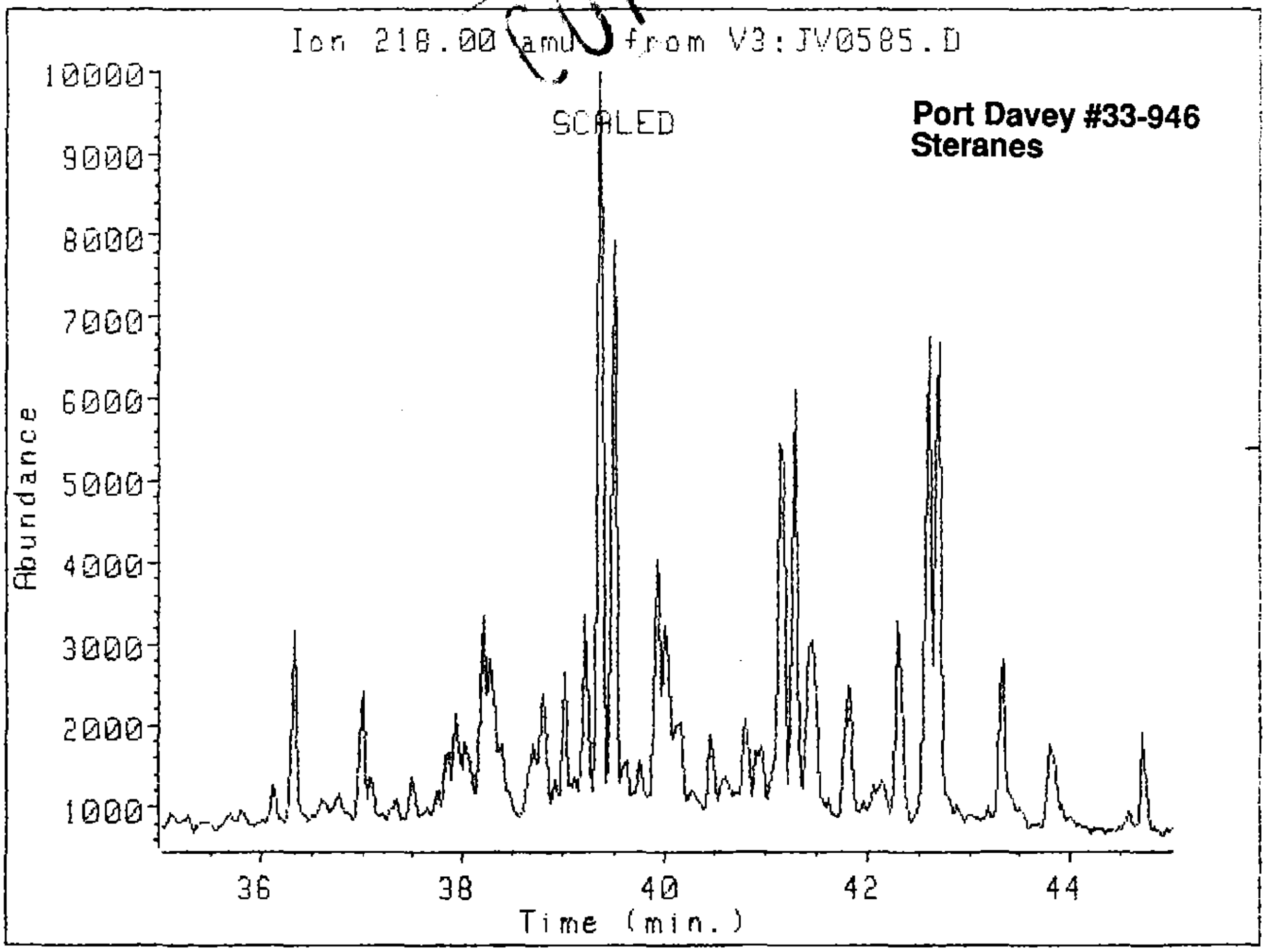
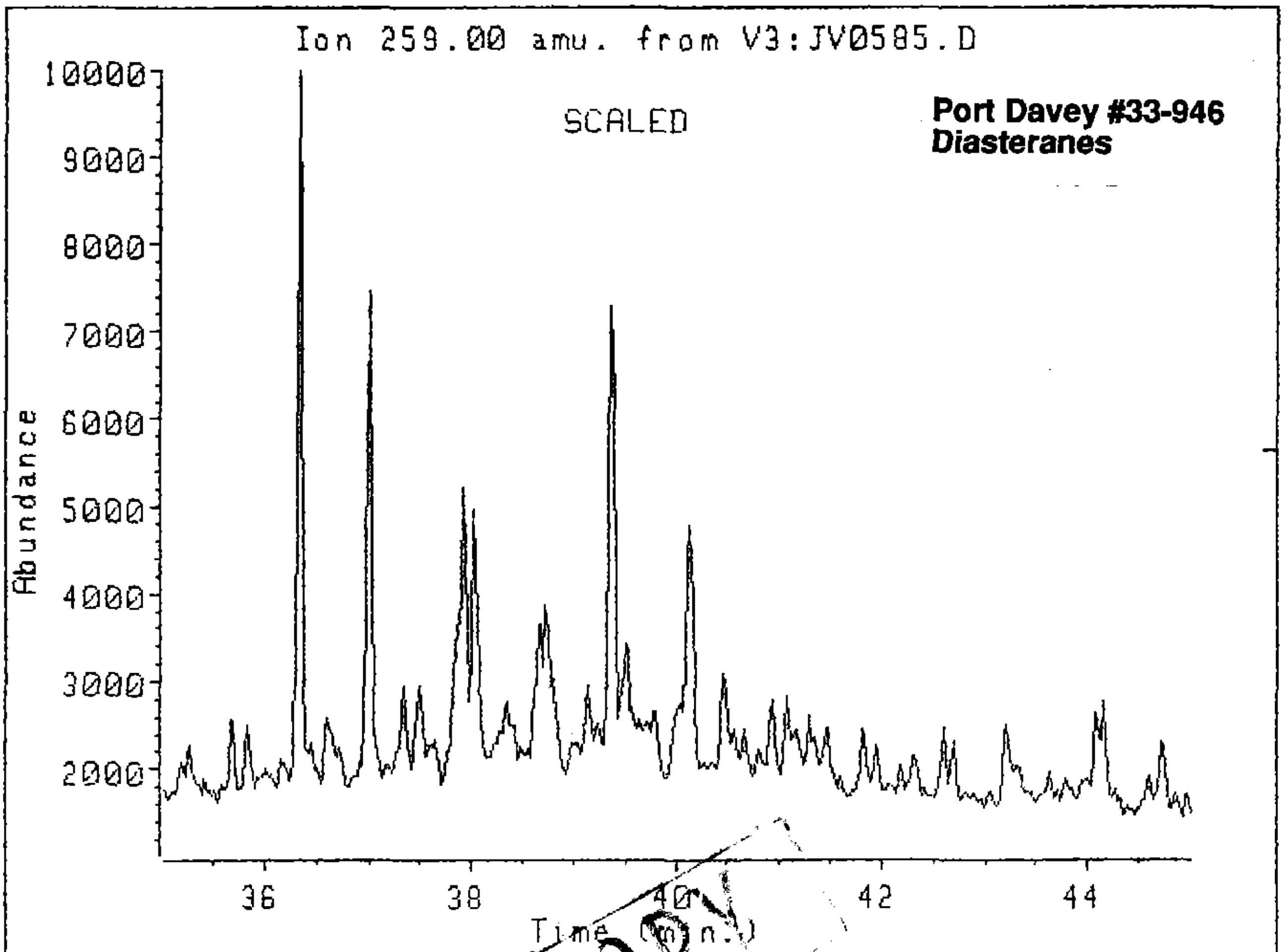
45
50
55
60
65
70
75

392167


Ion 217.00 amu. from V3:JV0585.D
SCALED
Port Davey #33-946
Steranes and Diasteranes
Abundance
Time (min.)


Ion 218.00 amu. from V3:JV0585.D
SCALED
Port Davey #33-946
Steranes
Abundance
Time (min.)


Ion 259.00 amu. from V3:JV0585.D
SCALED
Port Davey #33-946
Diasteranes
Abundance
10000
9000
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7000
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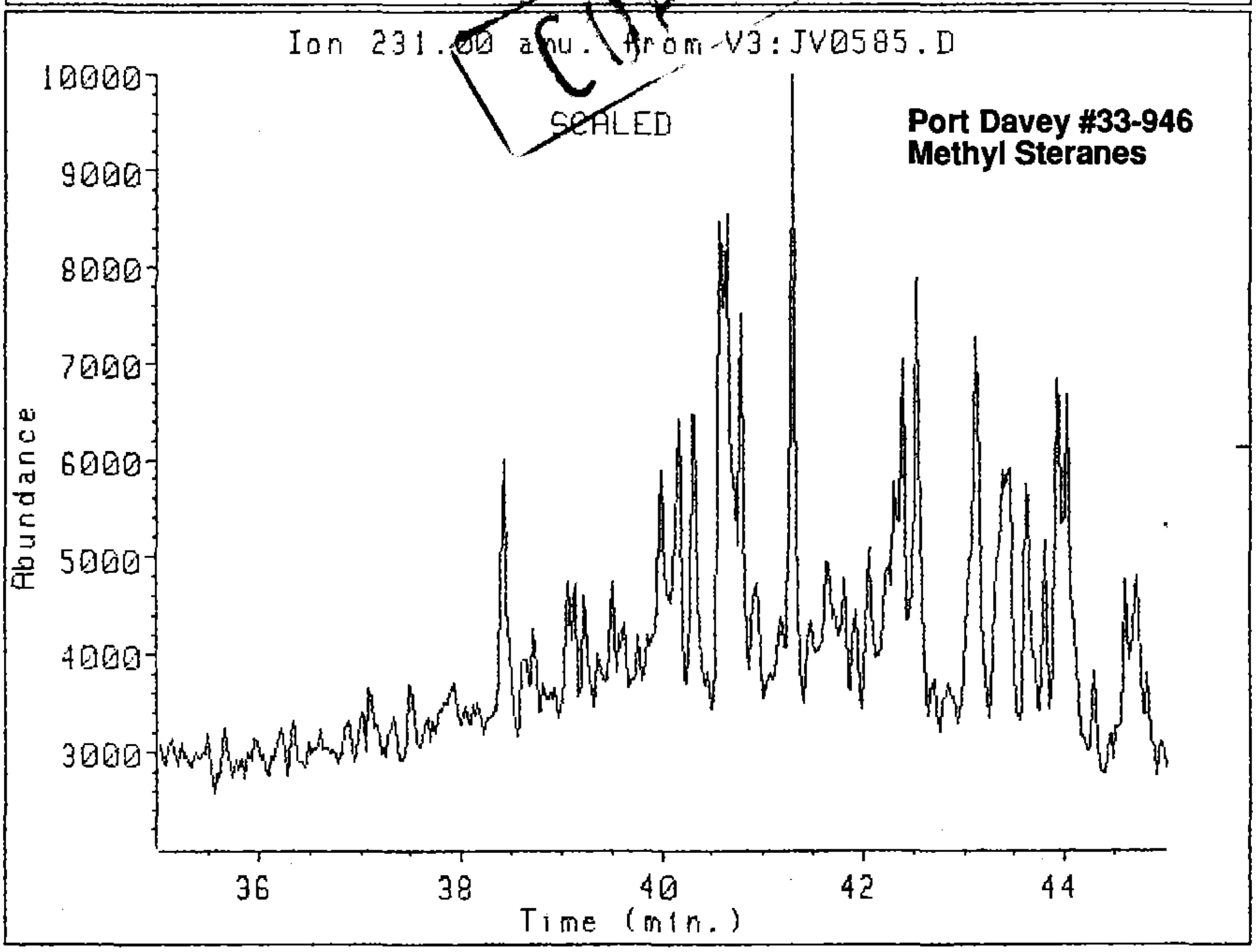
40
42
44
Time (min.)


Ion 231.00 amu. from V3:JV0585.D
SCALED
Port Davey #33-946
Methyl Steranes
Abundance
10000
9000
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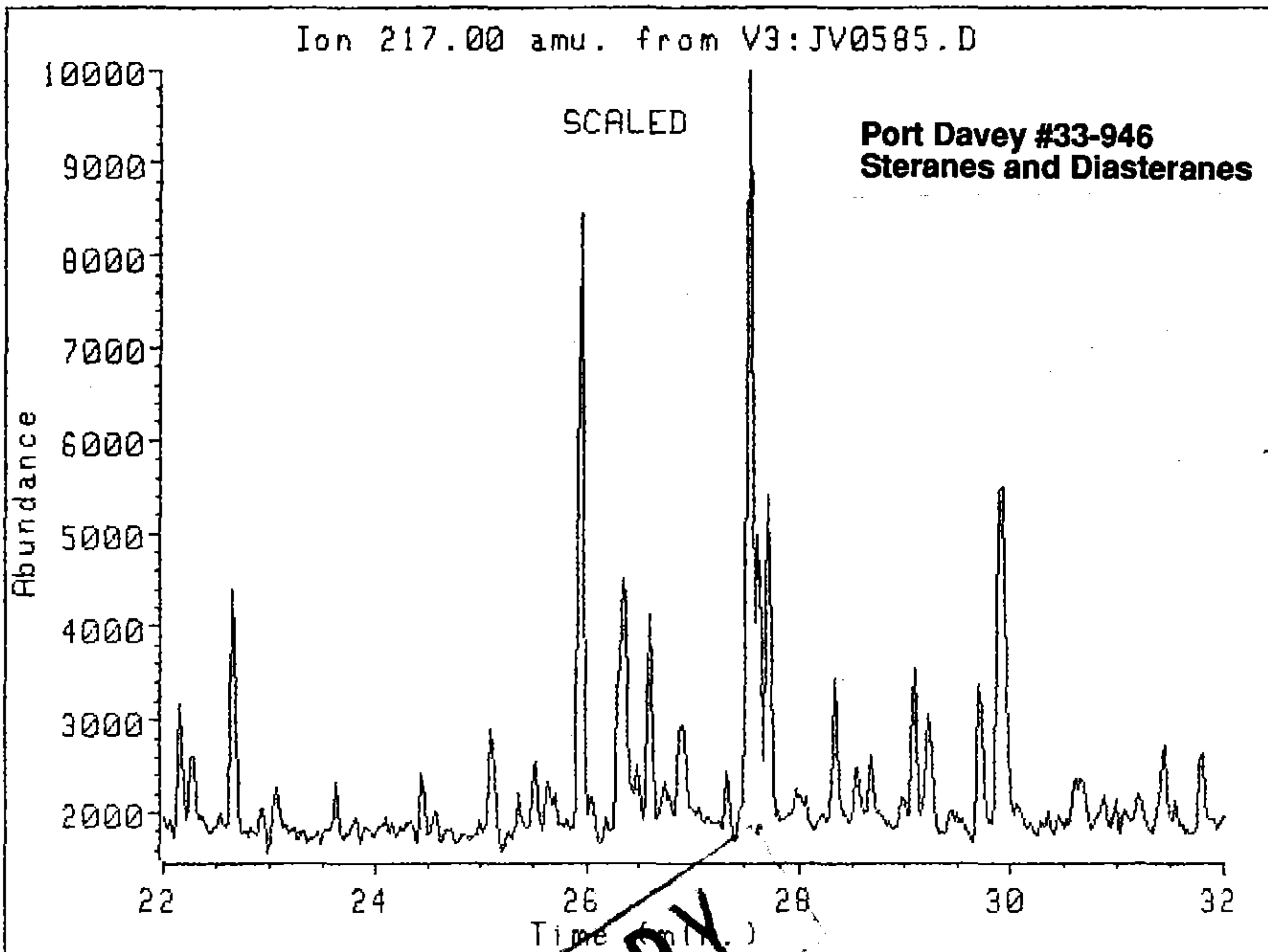
40
42
44
Time (min.)


Ion 217.00 amu. from V3:JV0585.D
SCALED
Port Davey #33-946
Steranes and Diasteranes
Abundance
10000
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24
26
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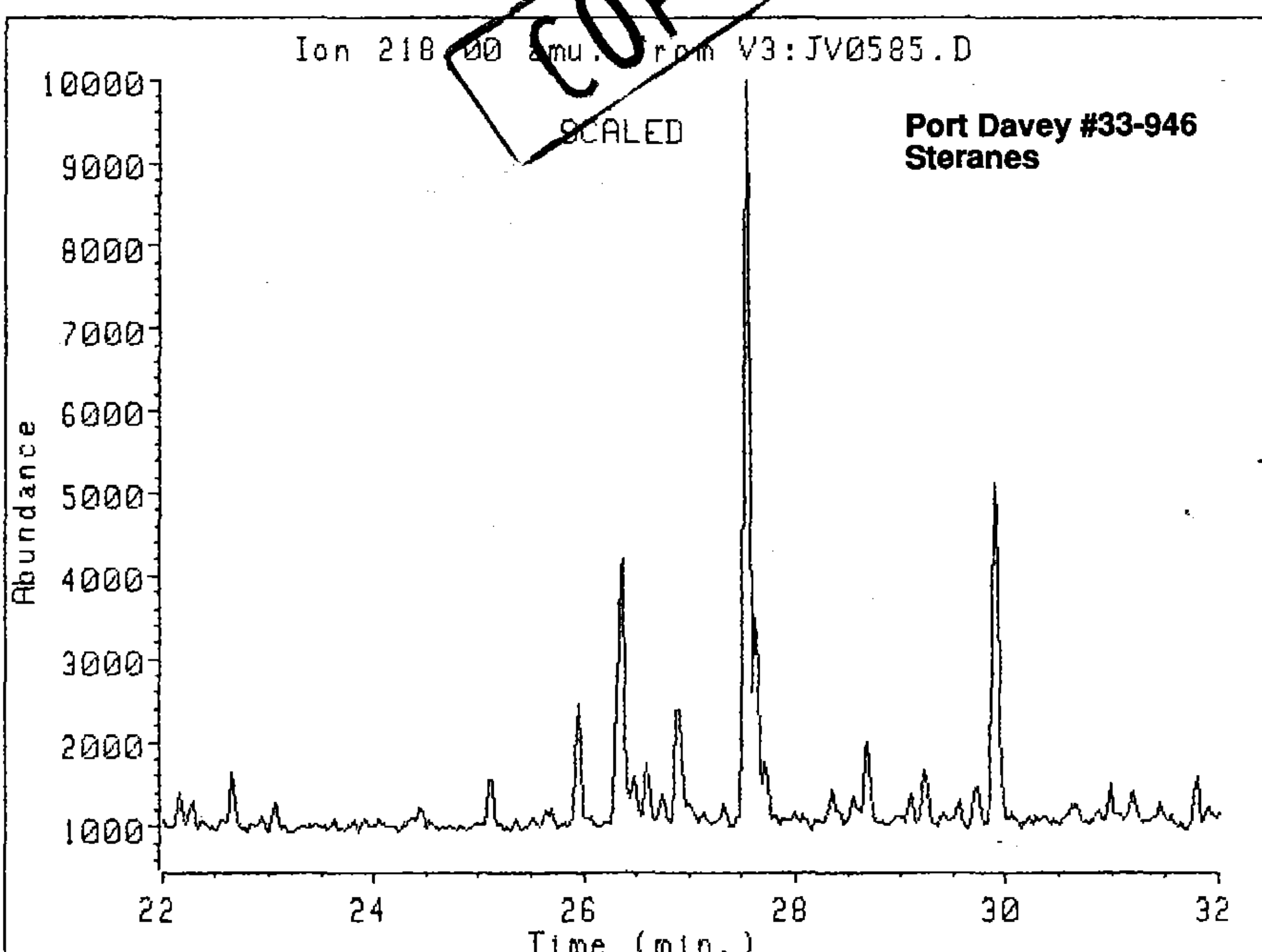
32
Time (min.)


Ion 218.00 amu. from V3:JV0585.D
SCALED
Port Davey #33-946
Steranes
Abundance
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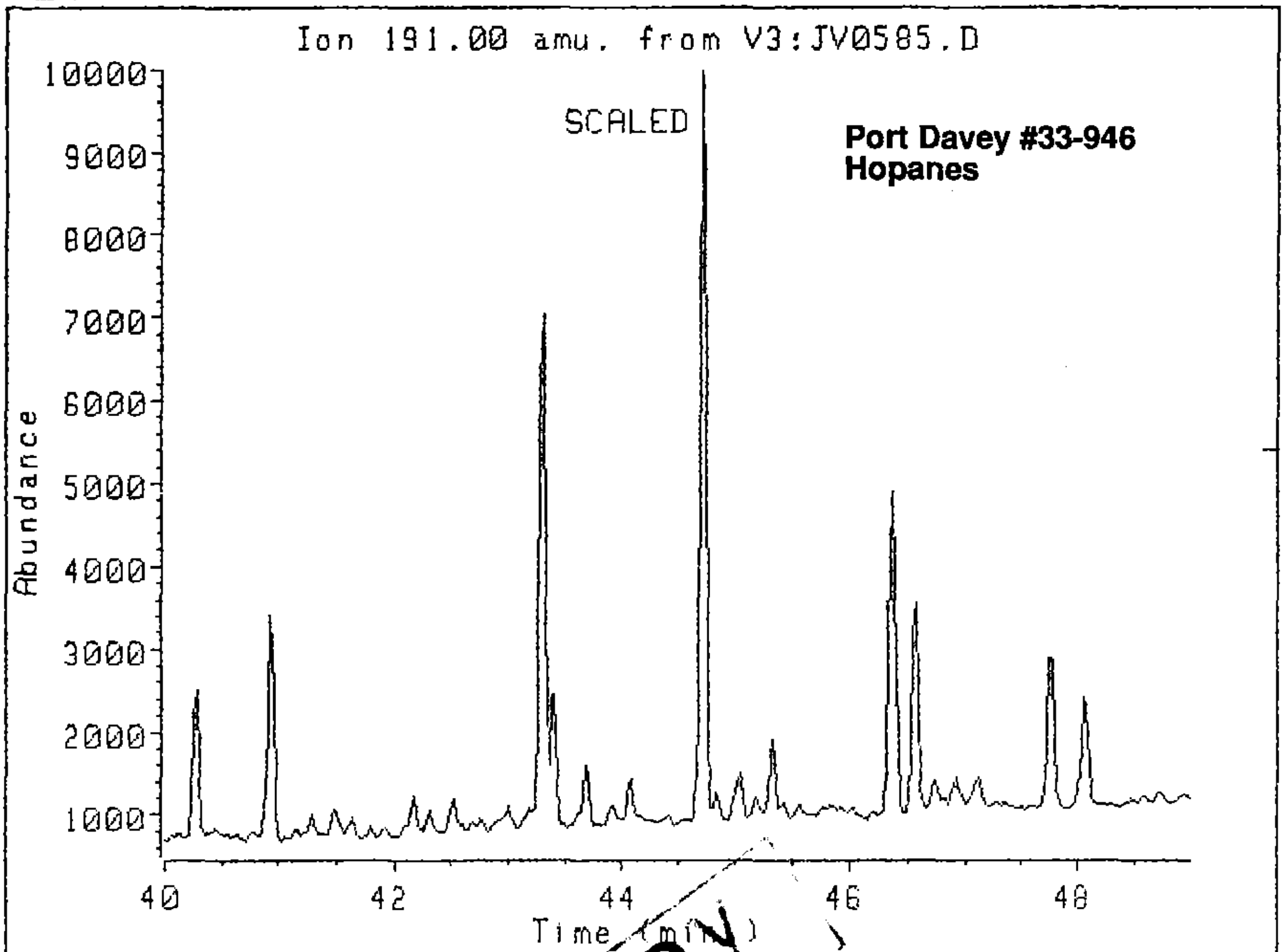
28
30
32
Time (min.)

170


Ion 191.00 amu. from V3:JV0585.D
SCALED
Port Davey #33-946
Hopanes
Abundance
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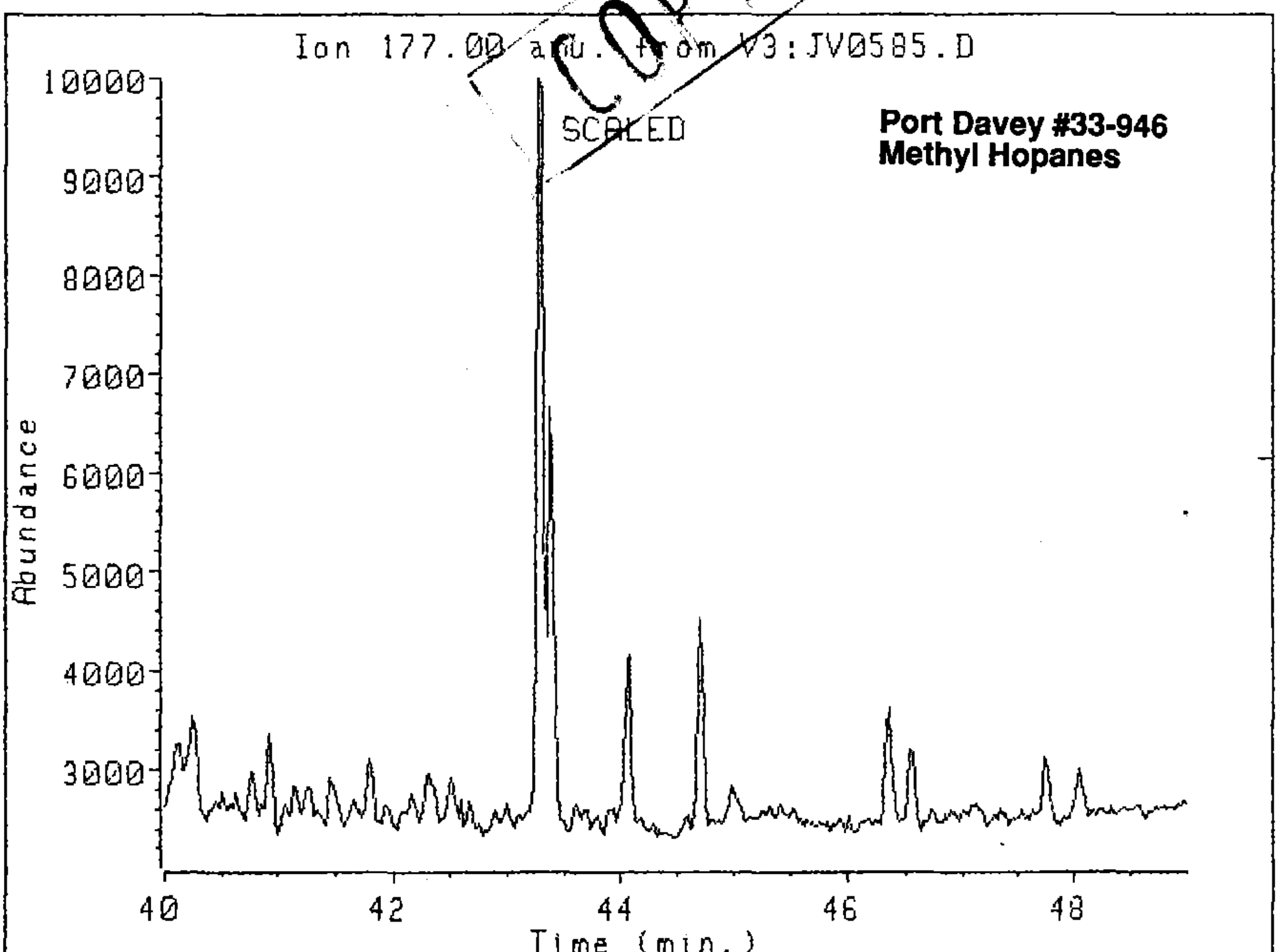
46
48
Time (min.)


Ion 177.00 amu. from V3:JV0585.D
SCALED
Port Davey #33-946
Methyl Hopanes
Abundance
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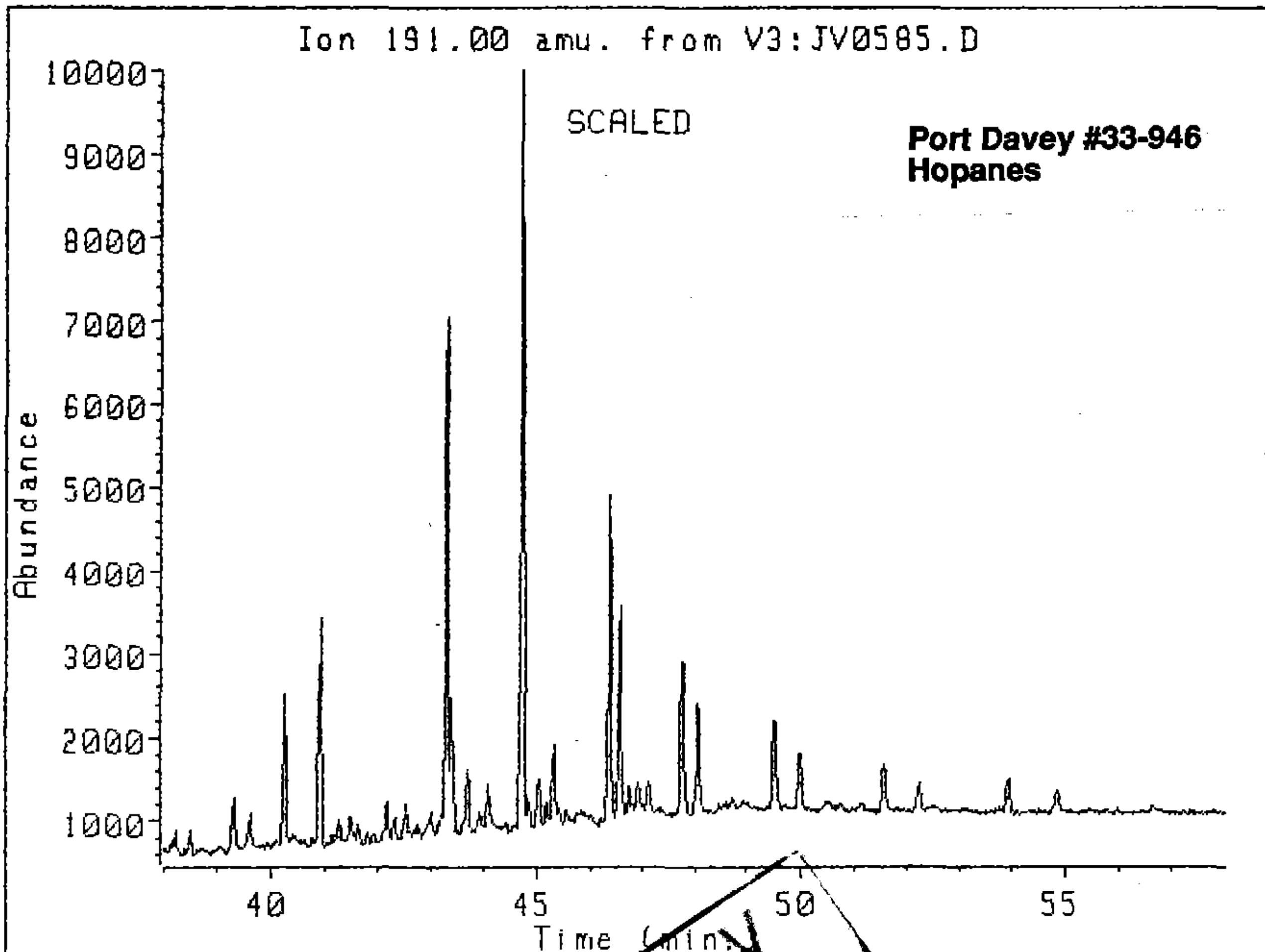
Time (min.)

COPY


Ion 191.00 amu. from V3:JV0585.D
SCALED
Port Davey #33-946
Hopanes
Abundance
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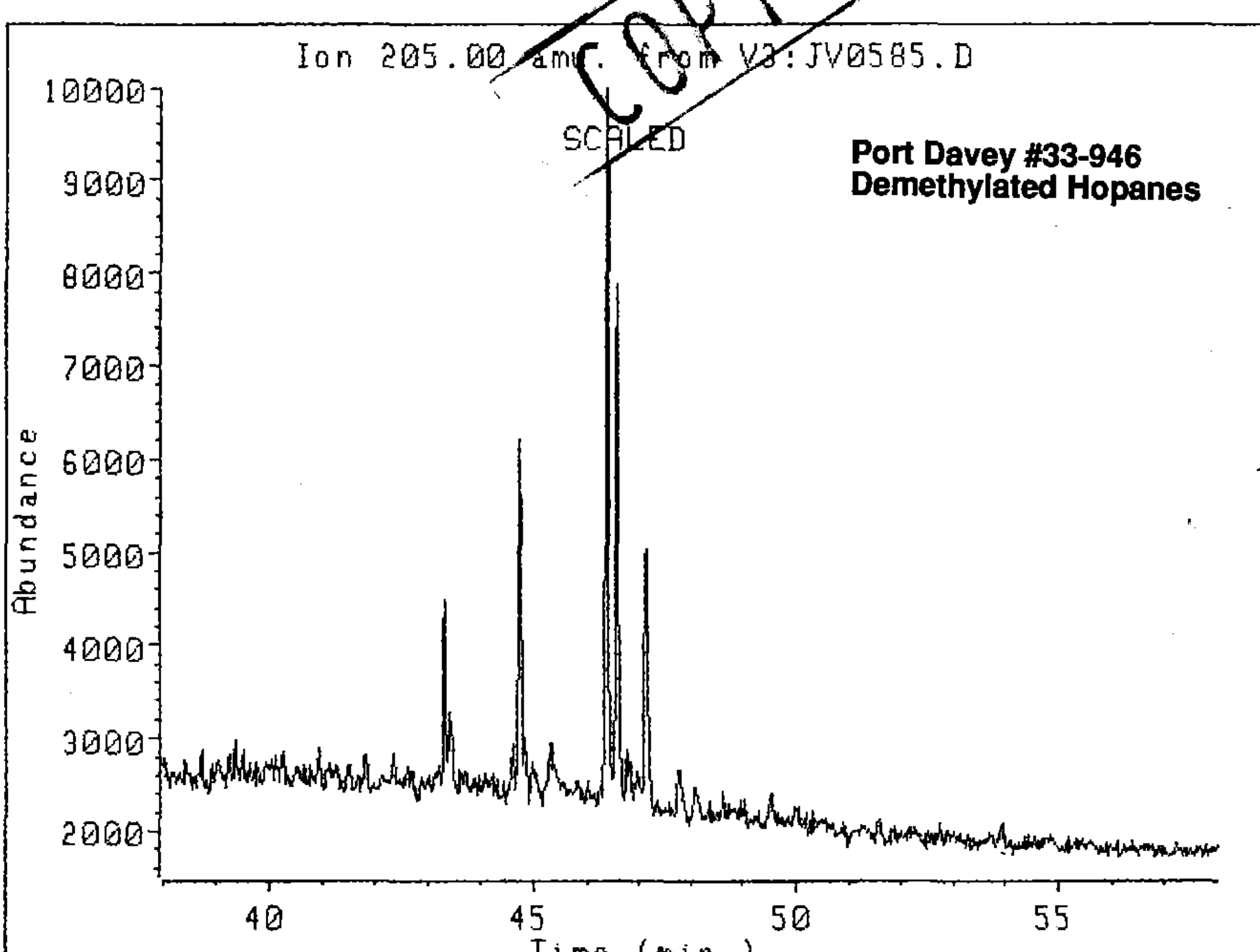
Time (min.)


Ion 205.00 amu. from V3:JV0585.D
SCALED
Port Davey #33-946
Demethylated Hopanes
Abundance
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9000
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6000
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2000
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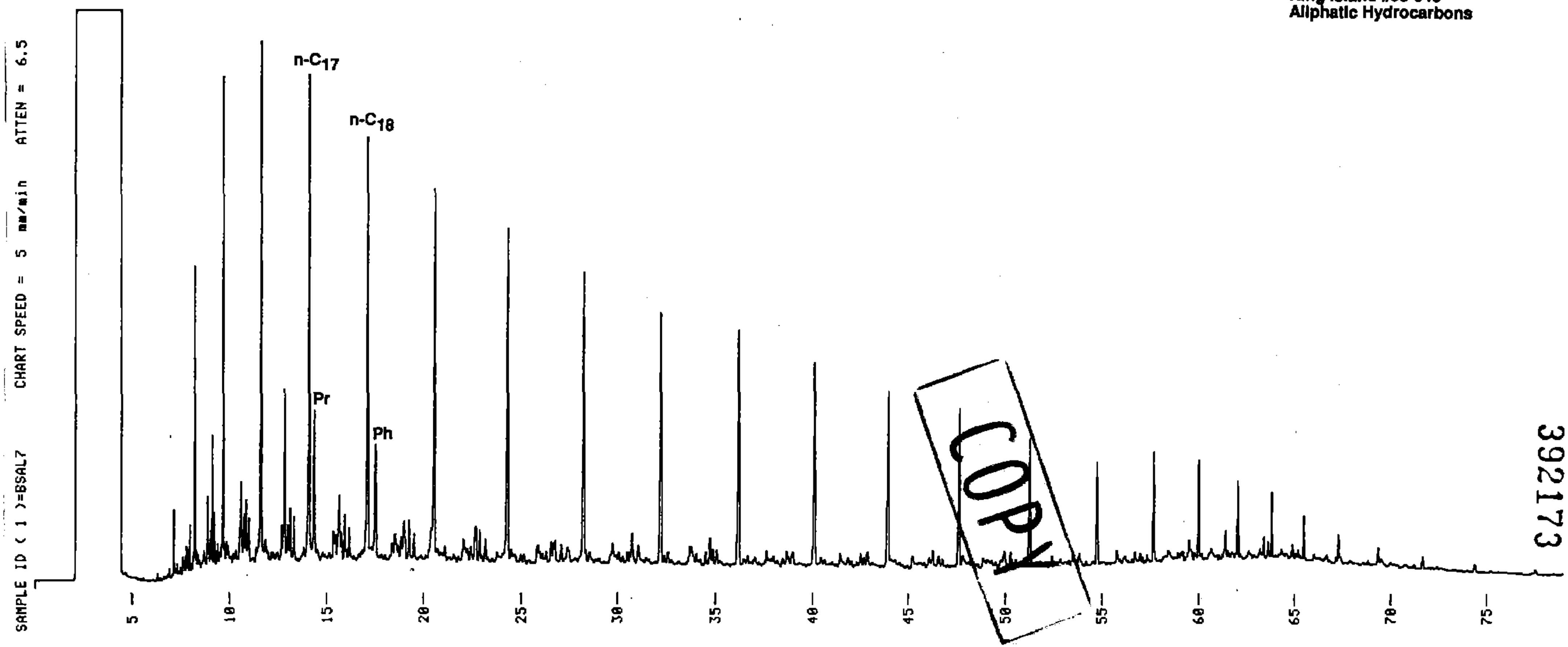
45
50
55
Time (min.)

King Island #33-948
Aliphatic Hydrocarbons



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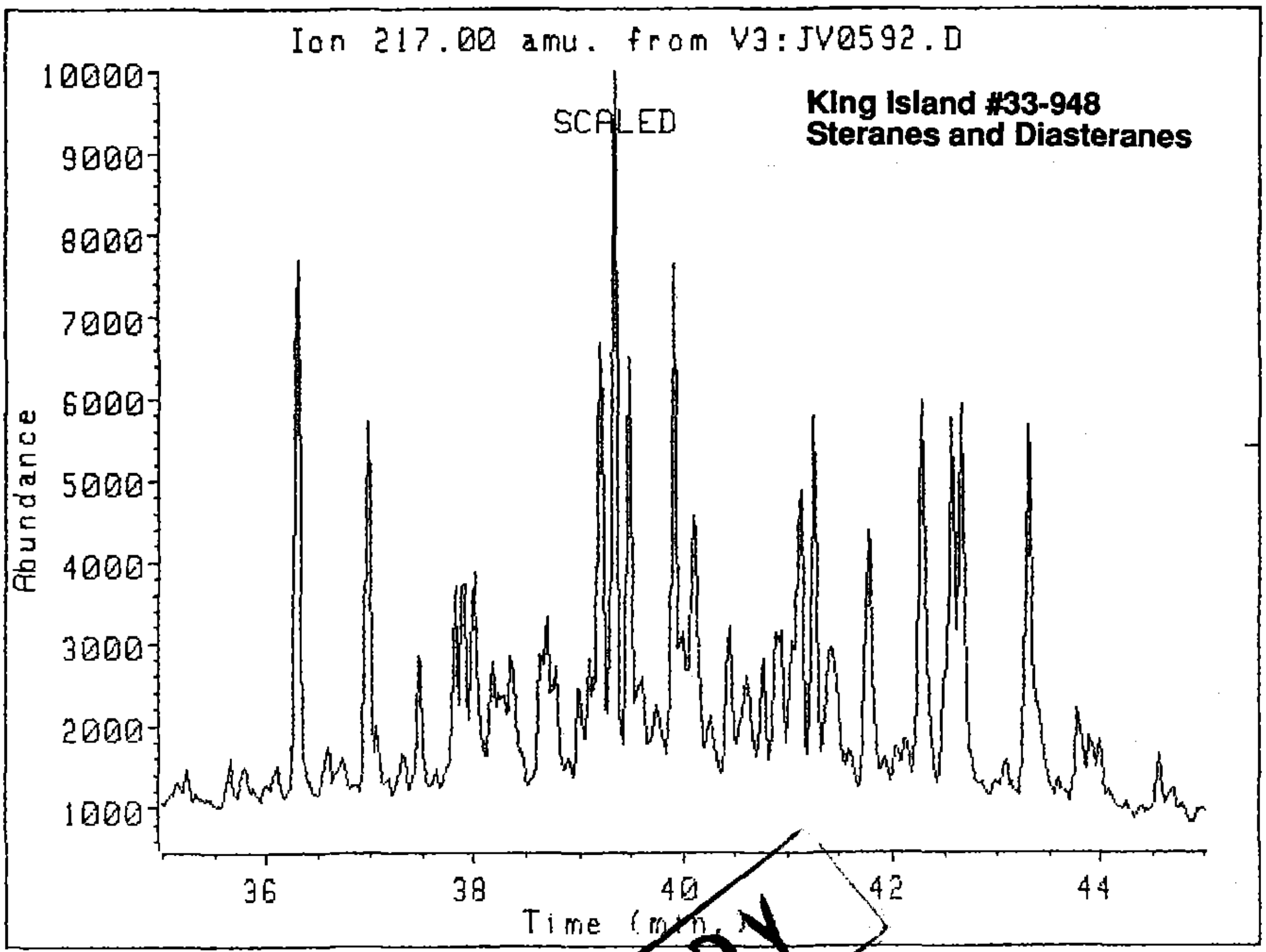
Ion 217.00 amu. from V3:JV0592.D
SCALED
King Island #33-948
Steranes and Diasteranes
Abundance
10000
9000
8000
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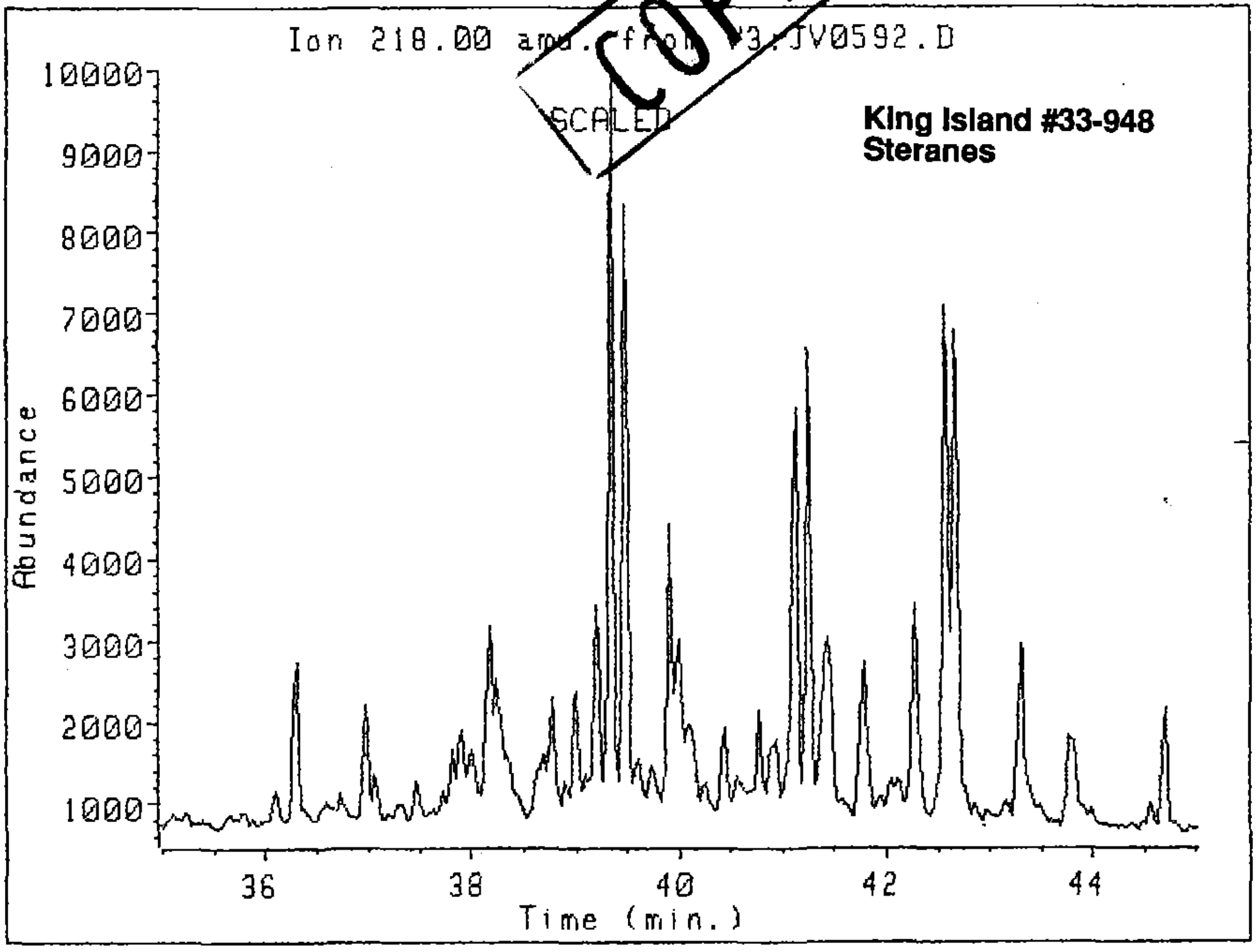
40
42
44
Time (min.)


Ion 218.00 amu. from V3:JV0592.D
SCALED
King Island #33-948
Steranes
Abundance
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7000
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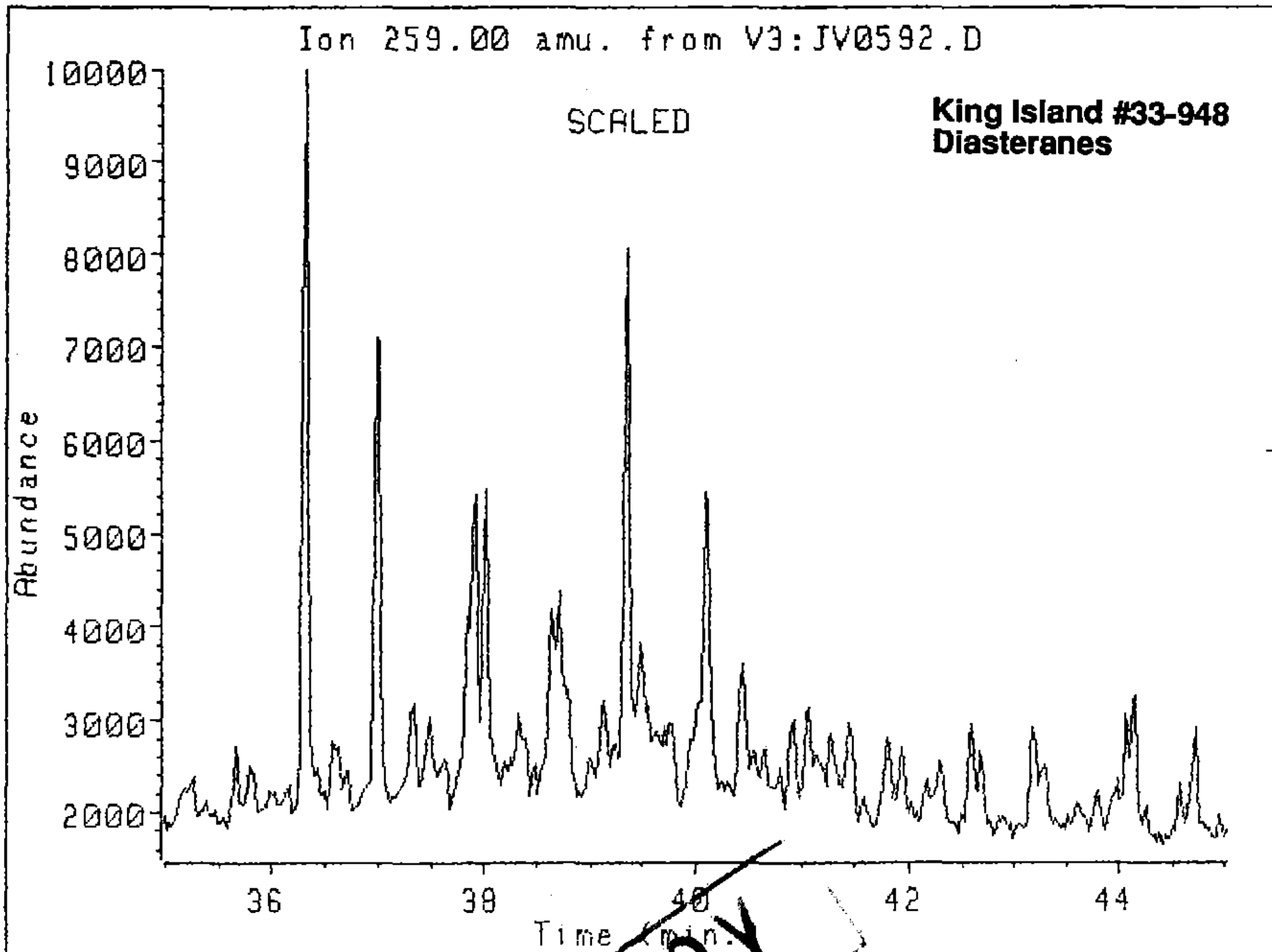
40
42
44
Time (min.)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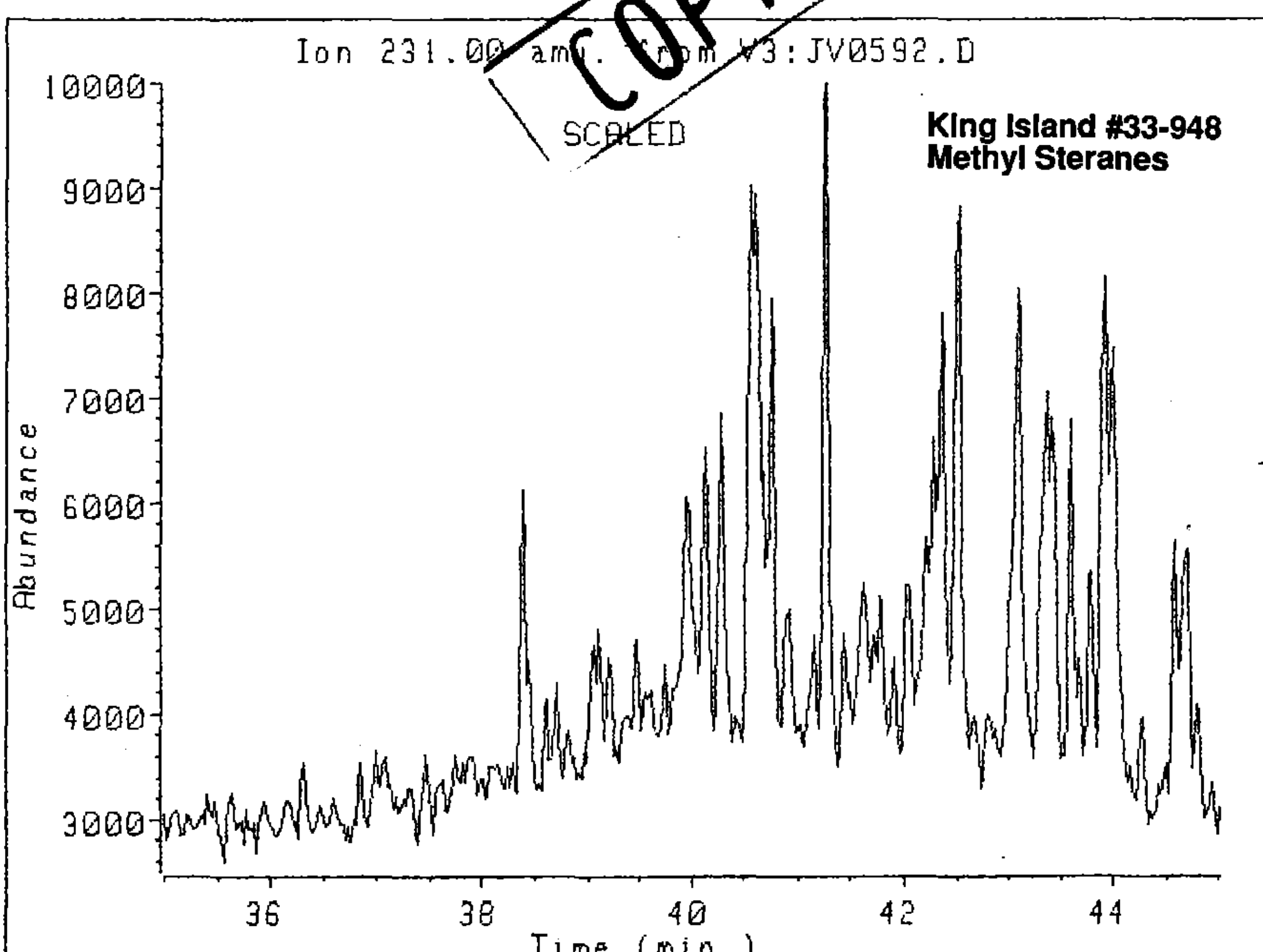
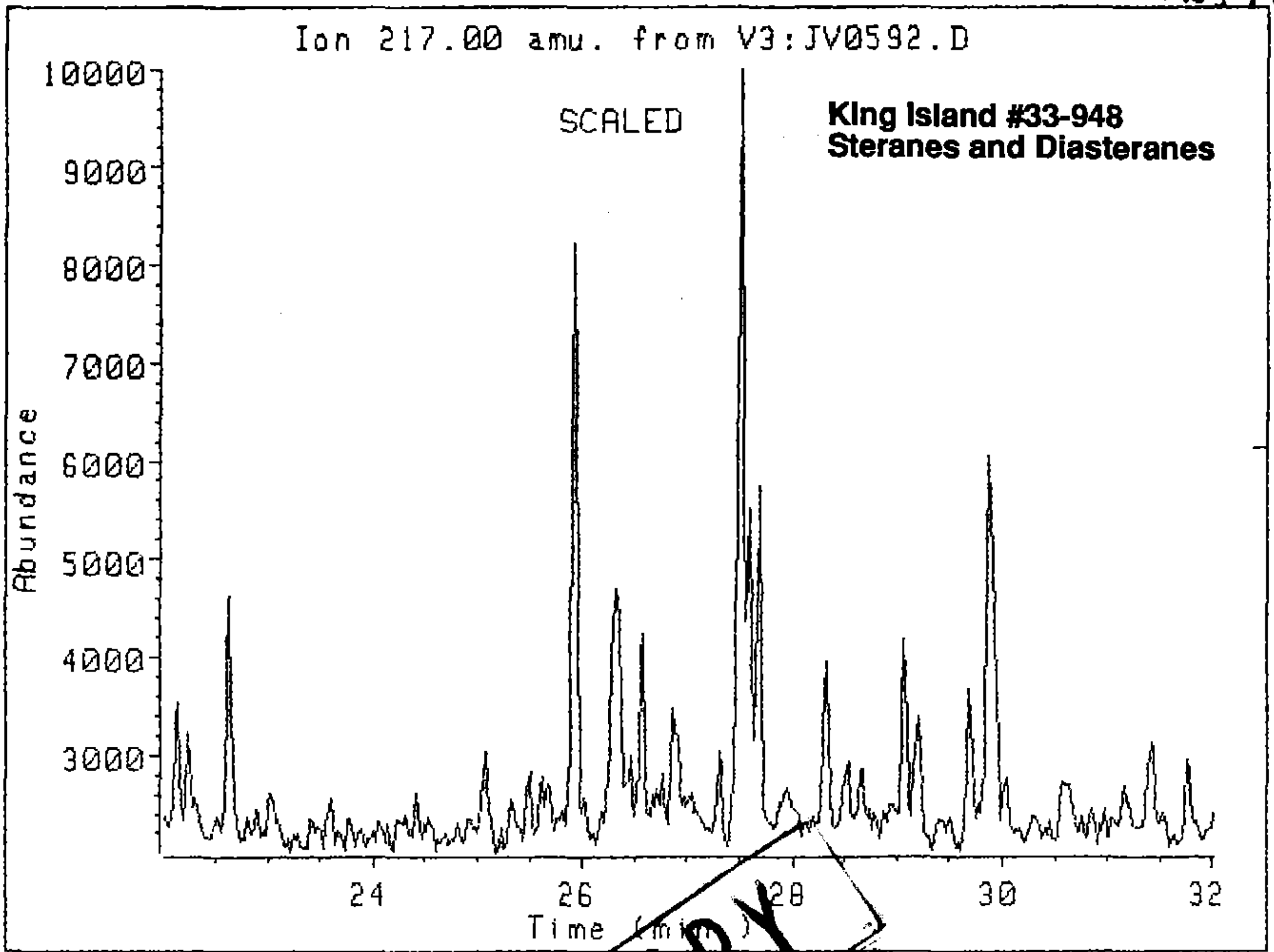
SCALED
King Island #33-948
Diasteranes
Abundance
Time (min.)


Ion 231.00 amu. from V3:JV0592.D
SCALED
King Island #33-948
Methyl Steranes
Abundance
Time (min.)


Ion 217.00 amu. from V3:JV0592.D
SCALED
King Island #33-948
Steranes and Diasteranes
Abundance
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9000
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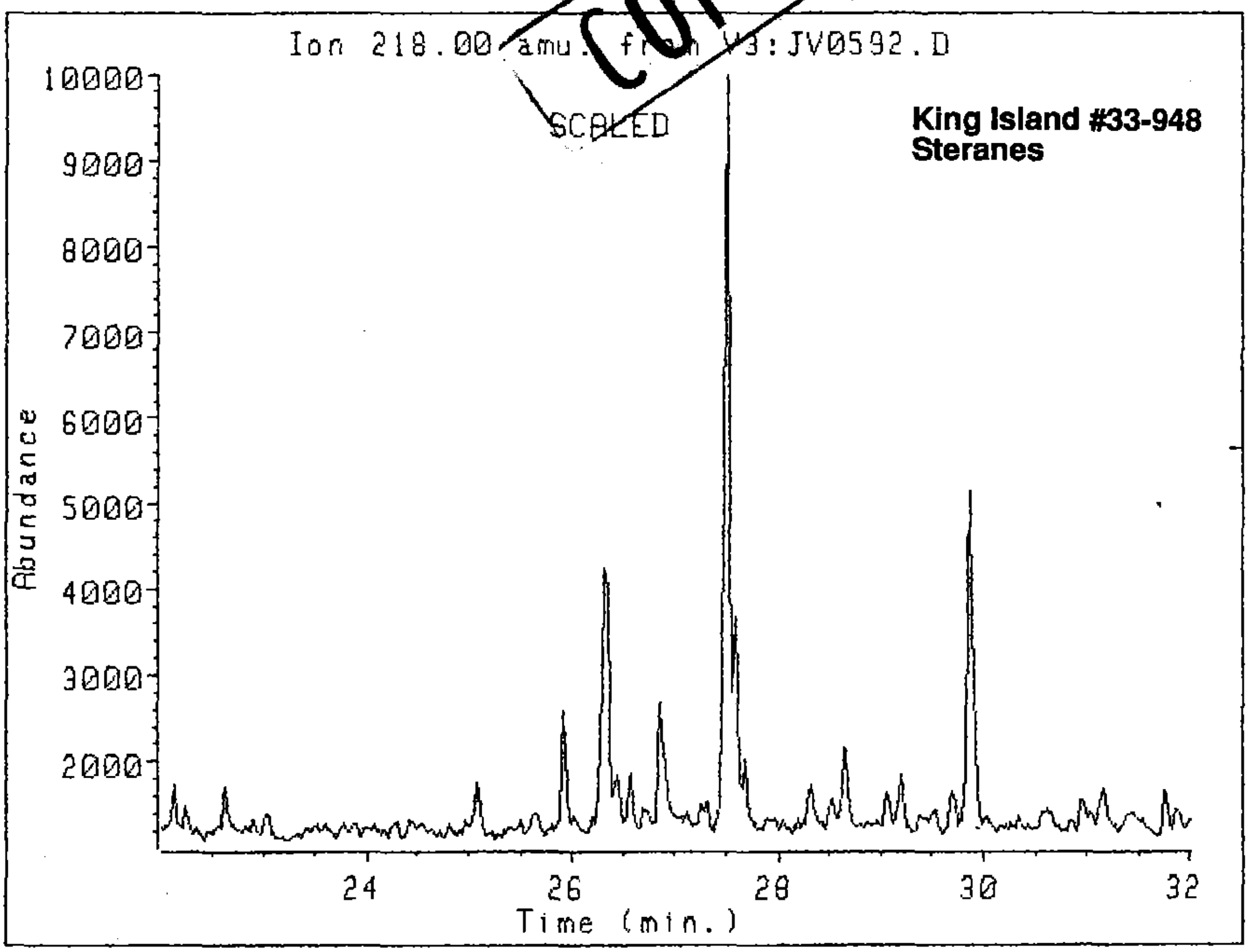
30
32
Time (min.)


Ion 218.00 amu. from V3:JV0592.D
SCALED
King Island #33-948
Steranes
Abundance
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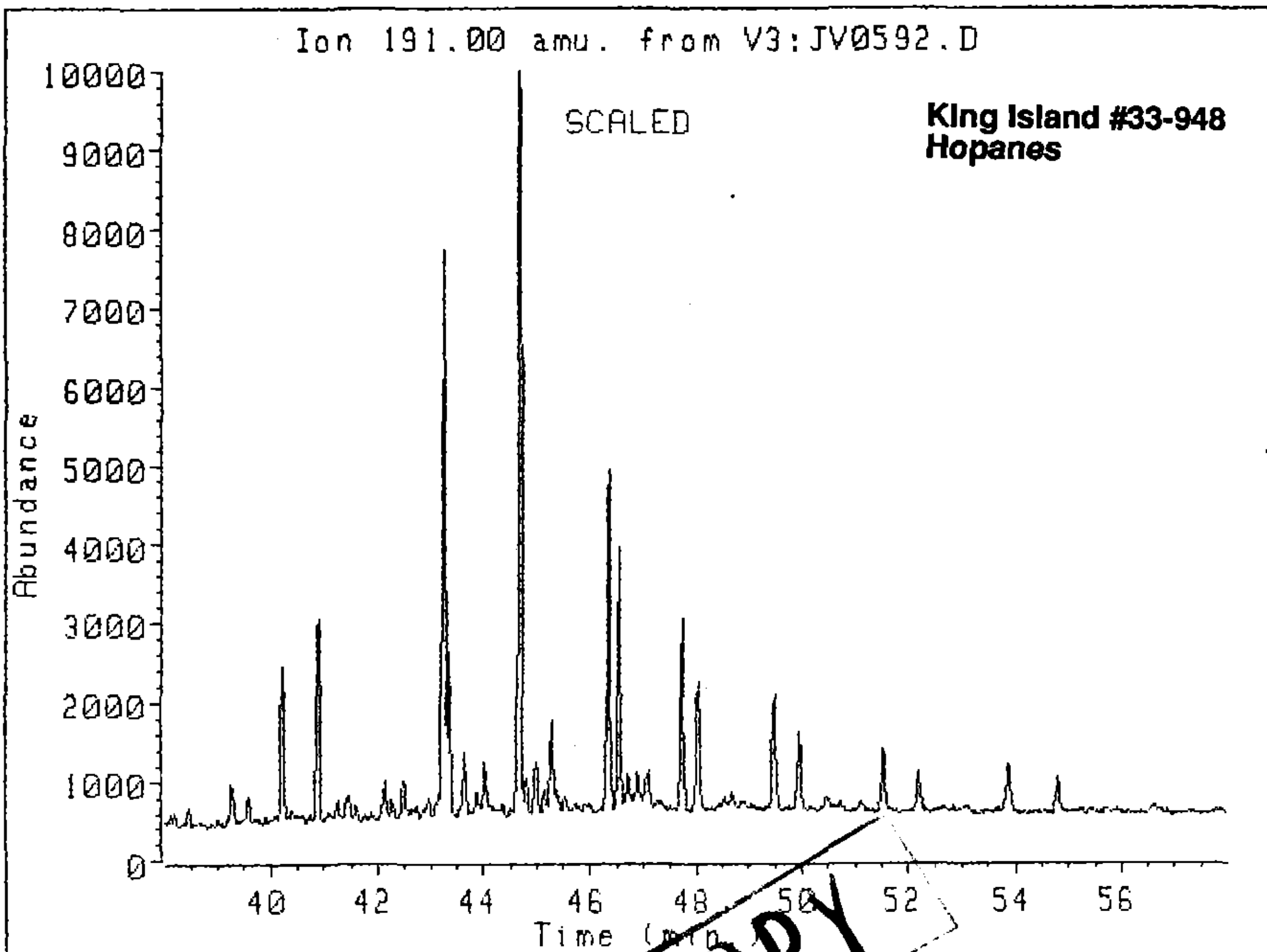
Time (min.)


Ion 191.00 amu. from V3:JV0592.D
SCALED
King Island #33-948
Hopanes
Abundance
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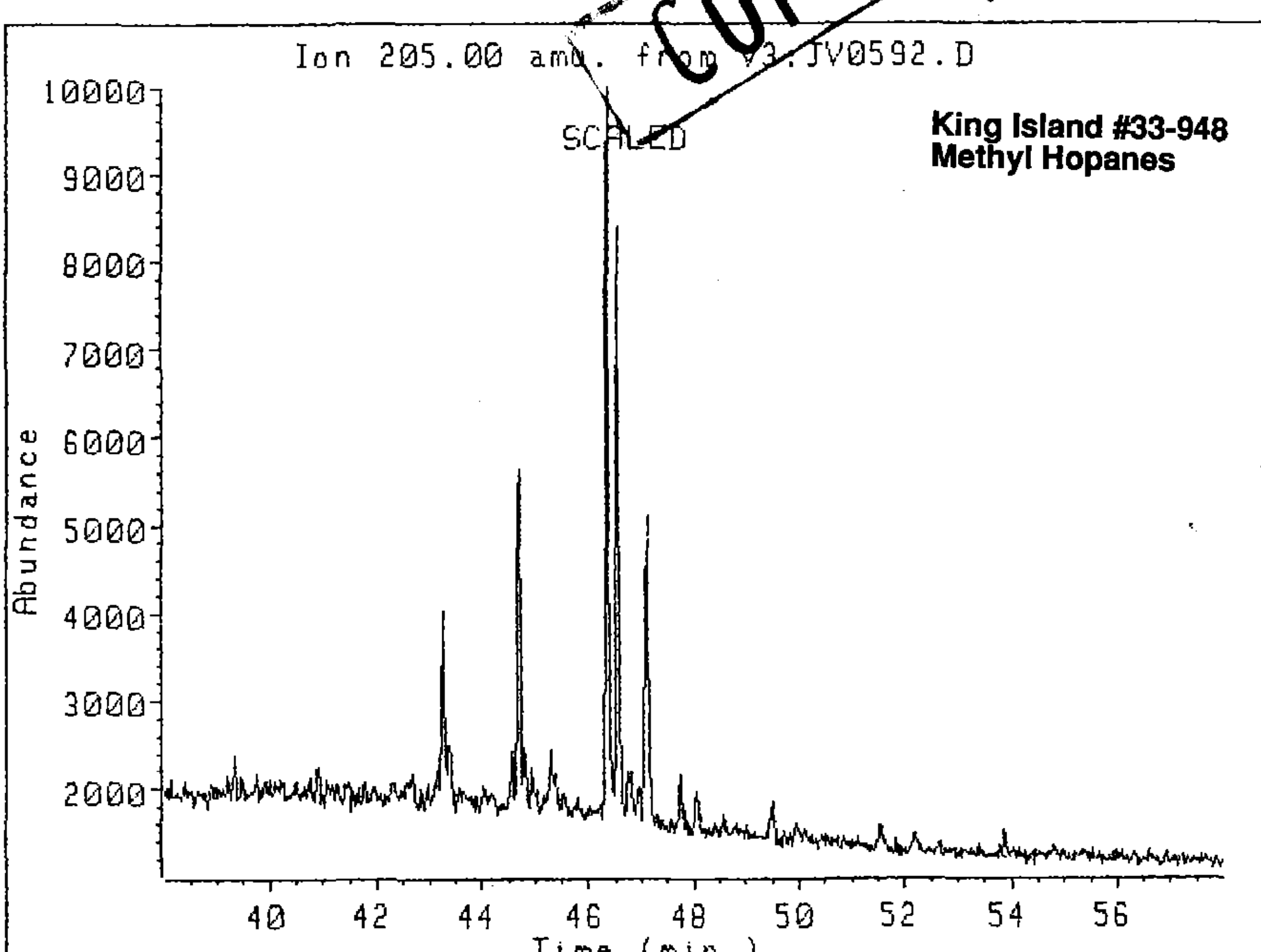
52
54
56
Time (min.)


Ion 205.00 amu. from V3:JV0592.D
SCALED
King Island #33-948
Methyl Hopanes
Abundance
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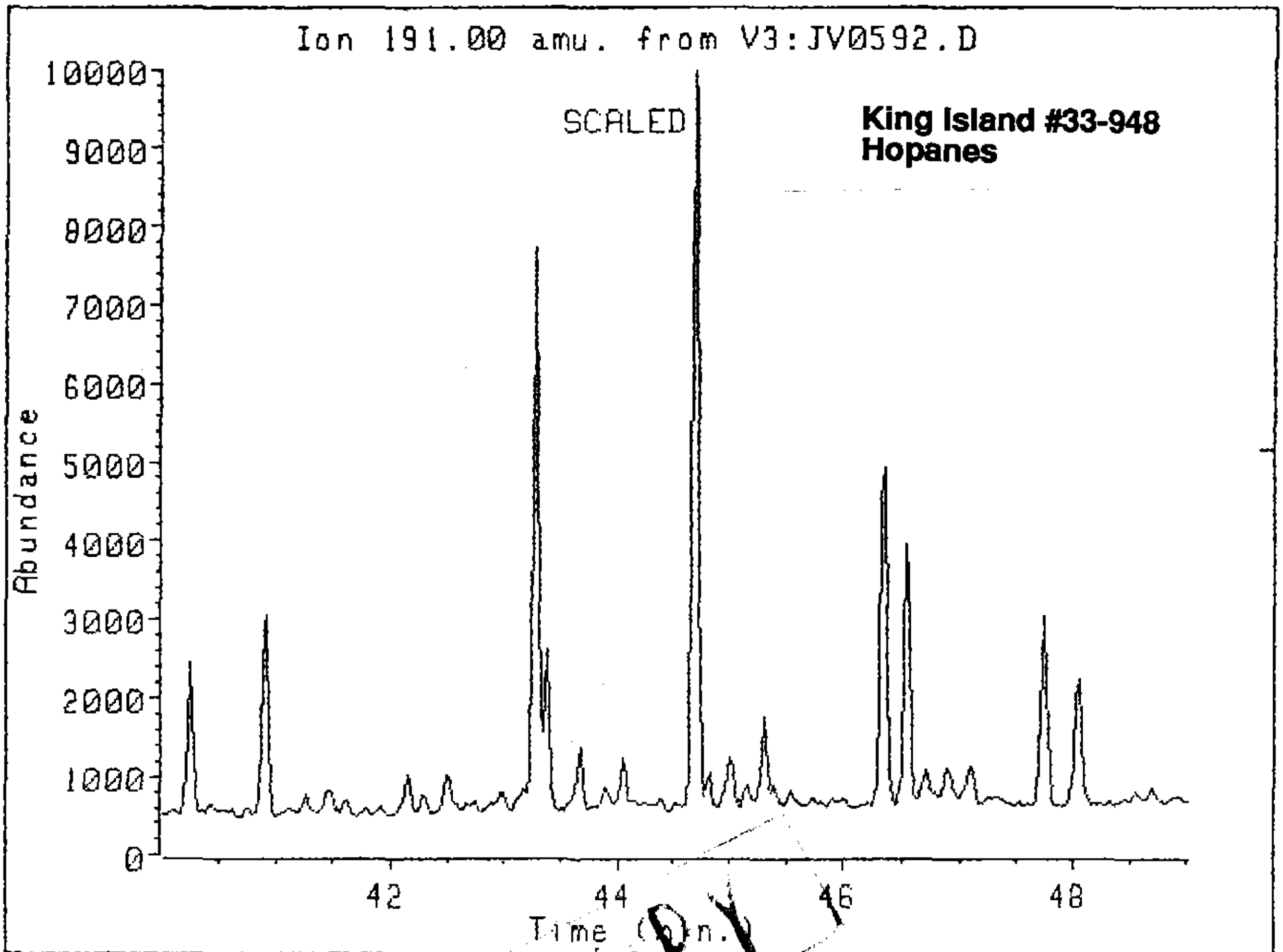
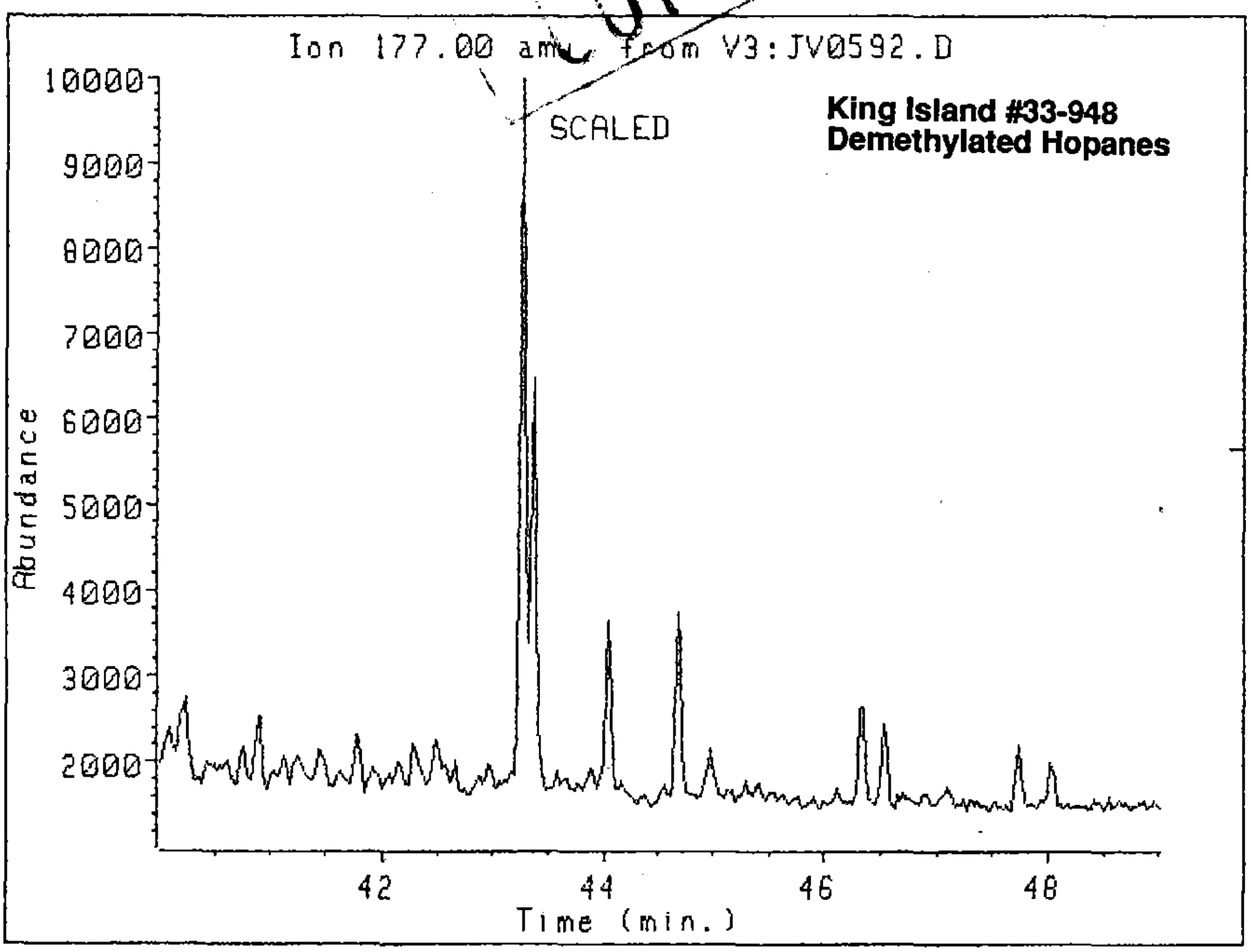
54
56
Time (min.)

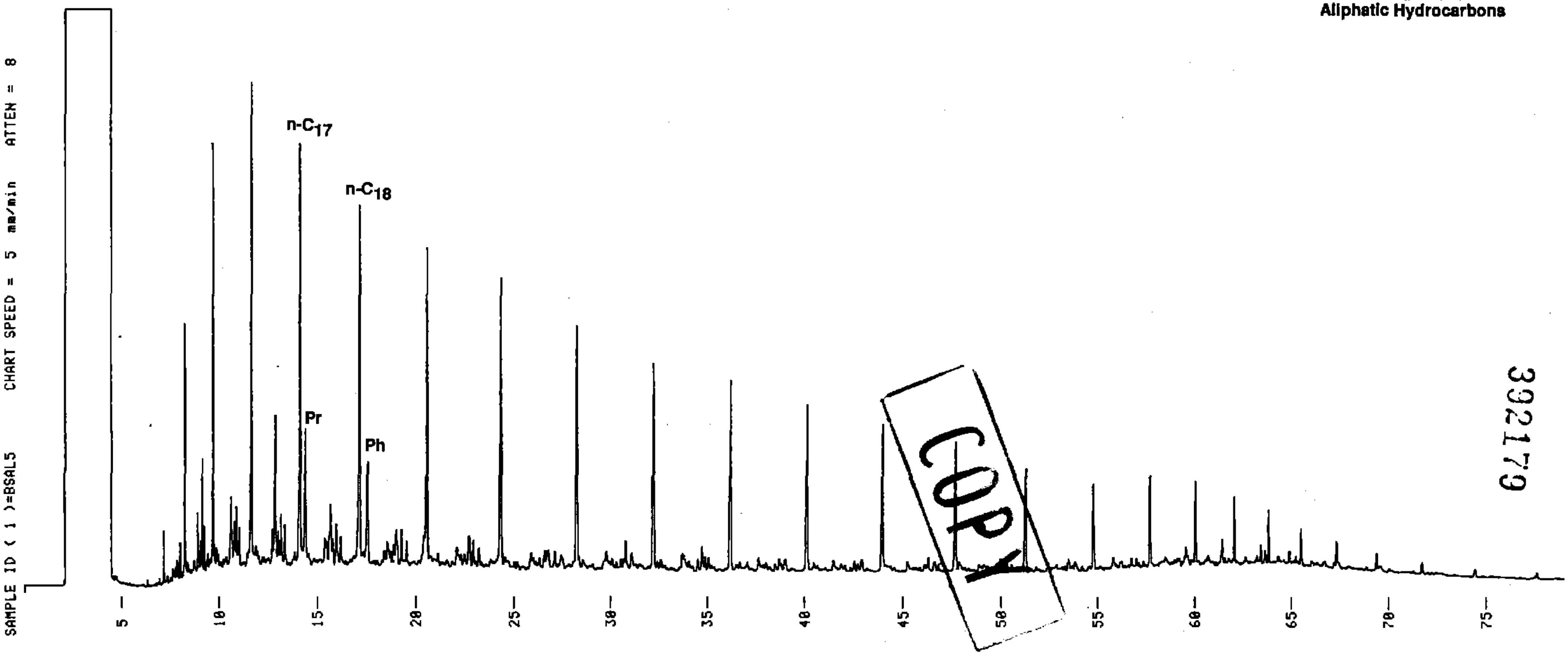


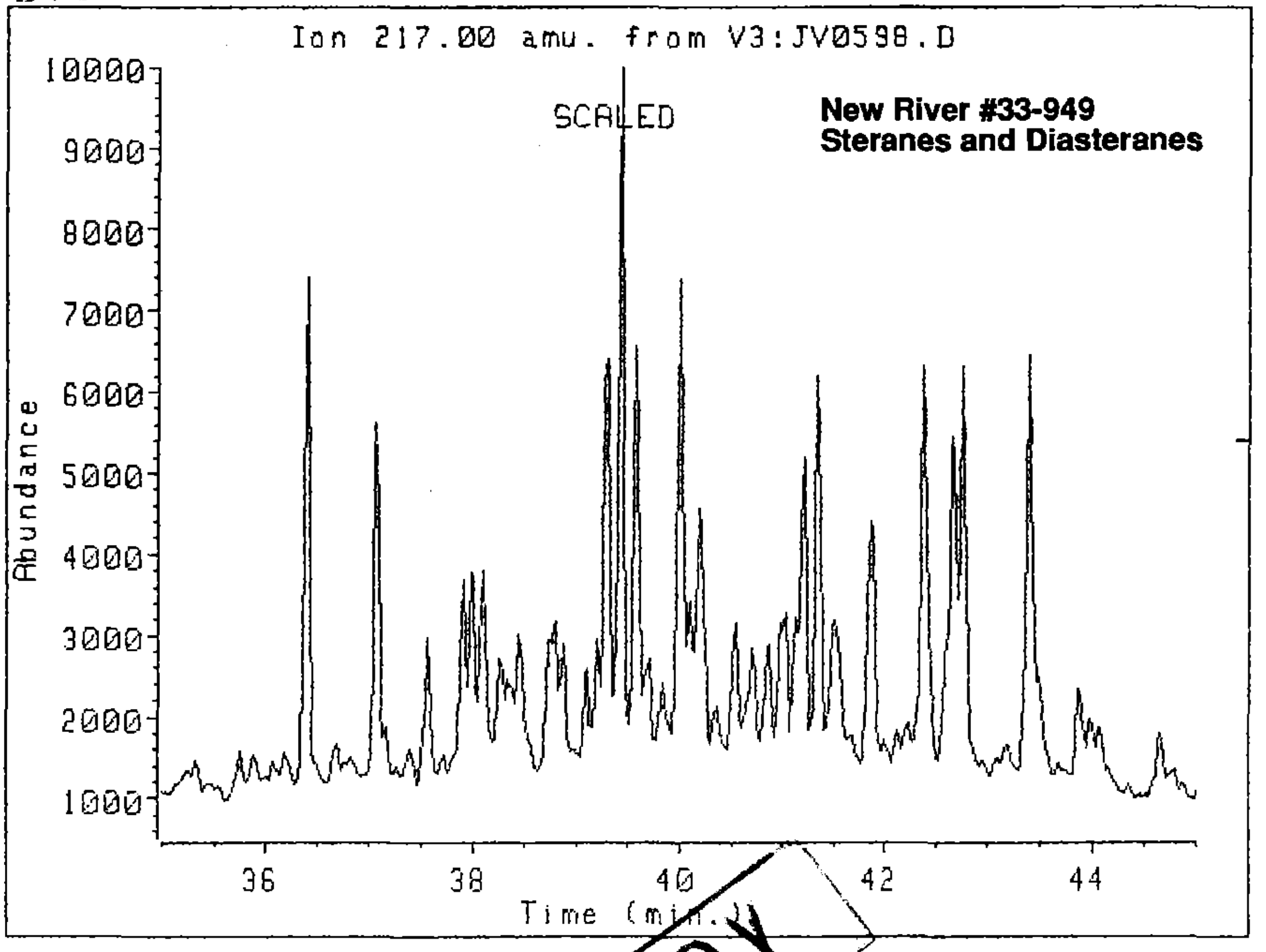
Ion 191.00 amu. from V3:JV0592.D
SCALED
King Island #33-948
Hopanes
Abundance
Time (min.)



Ion 177.00 amu. from V3:JV0592.D
SCALED
King Island #33-948
Demethylated Hopanes
Abundance
Time (min.)

New River #33-949
Aliphatic Hydrocarbons

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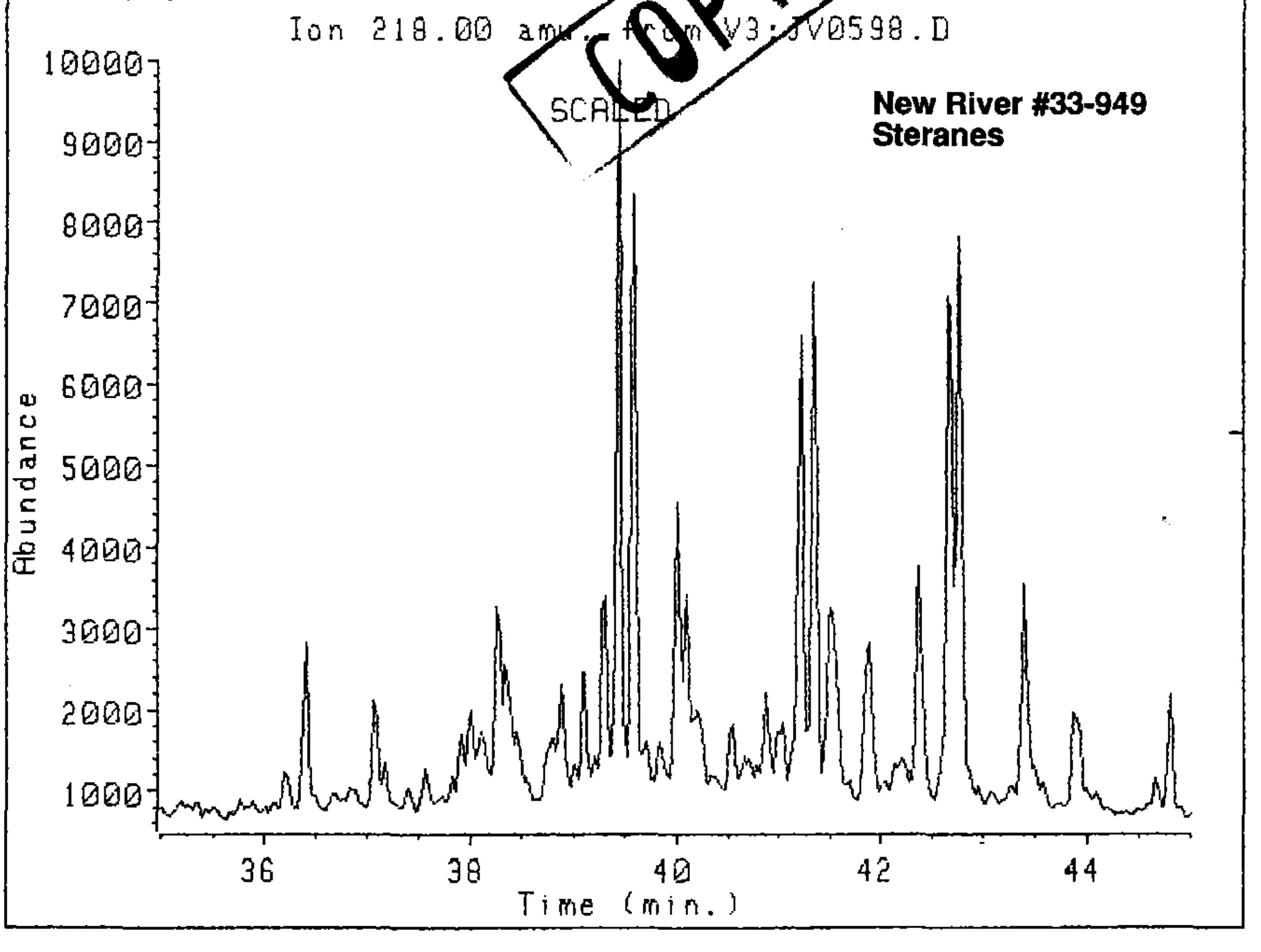
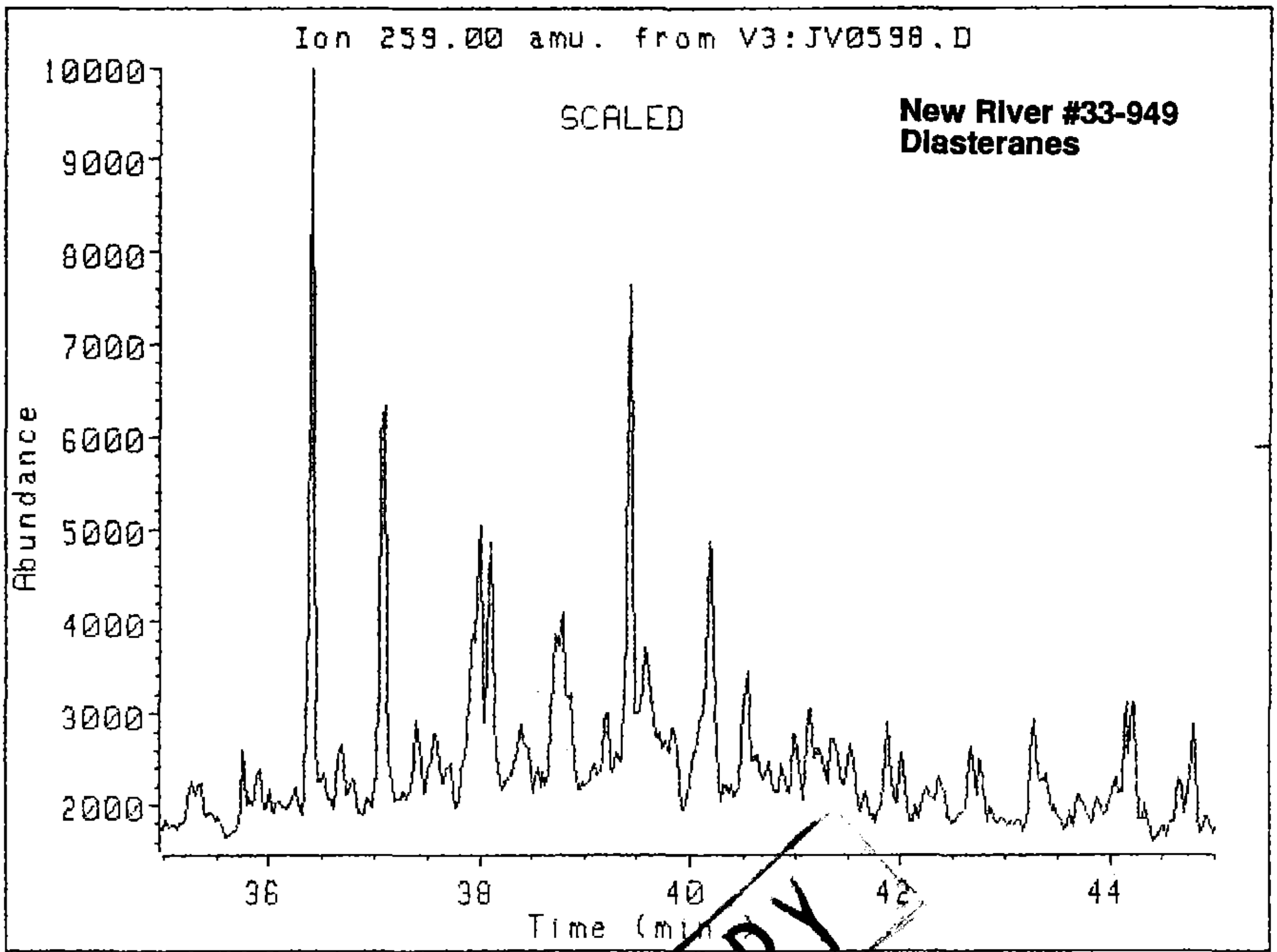
SCALED
New River #33-949
Steranes and Diasteranes
Abundance
Time (min.)


Ion 218.00 amu. from V3:JV0598.D
SCALED
New River #33-949
Steranes
Abundance
Time (min.)


Ion 259.00 amu. from V3:JV0598.D
SCALED
New River #33-949
Diasteranes
Abundance
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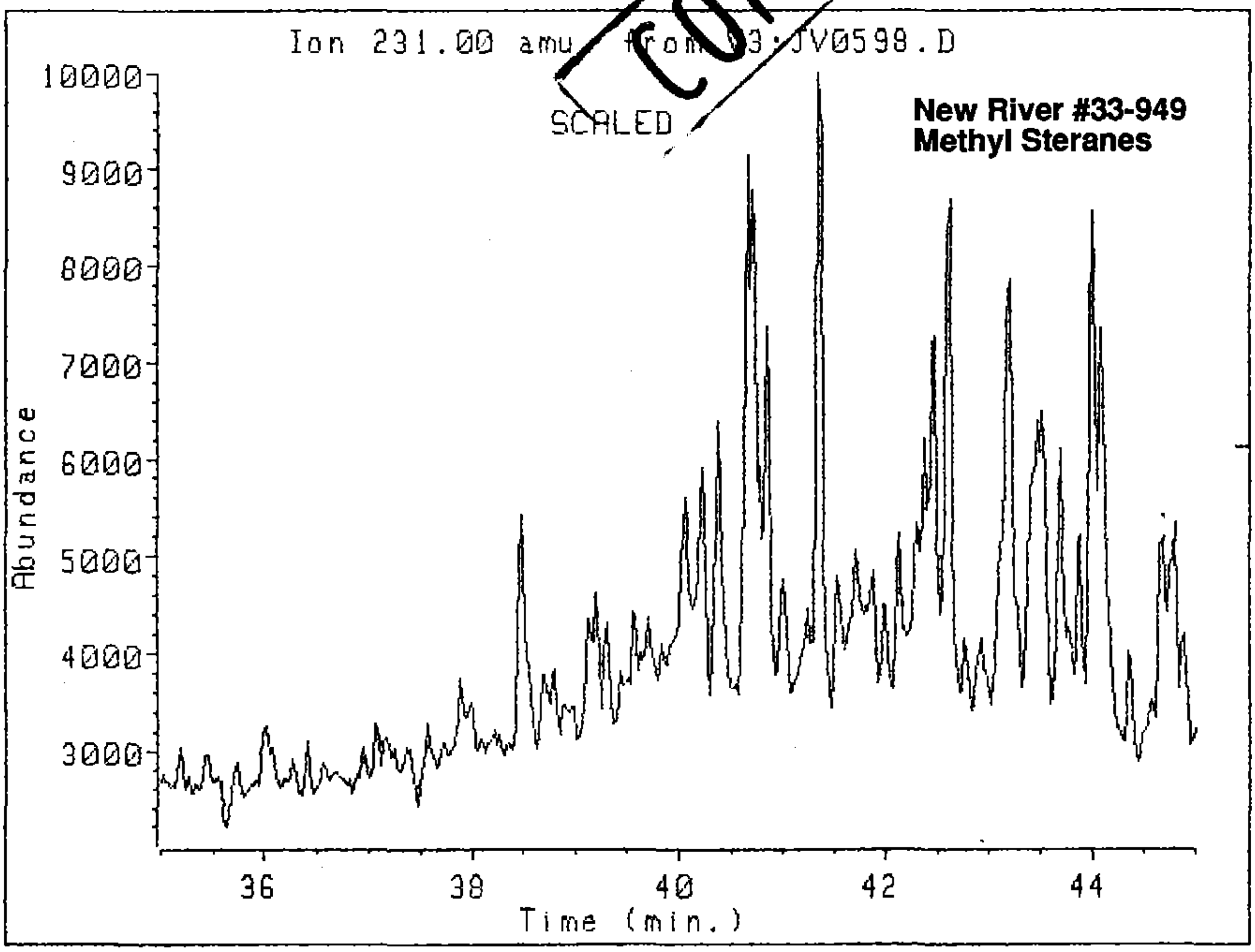
40
42
44
Time (min.)


Ion 231.00 amu. from V3:JV0598.D
SCALED
New River #33-949
Methyl Steranes
Abundance
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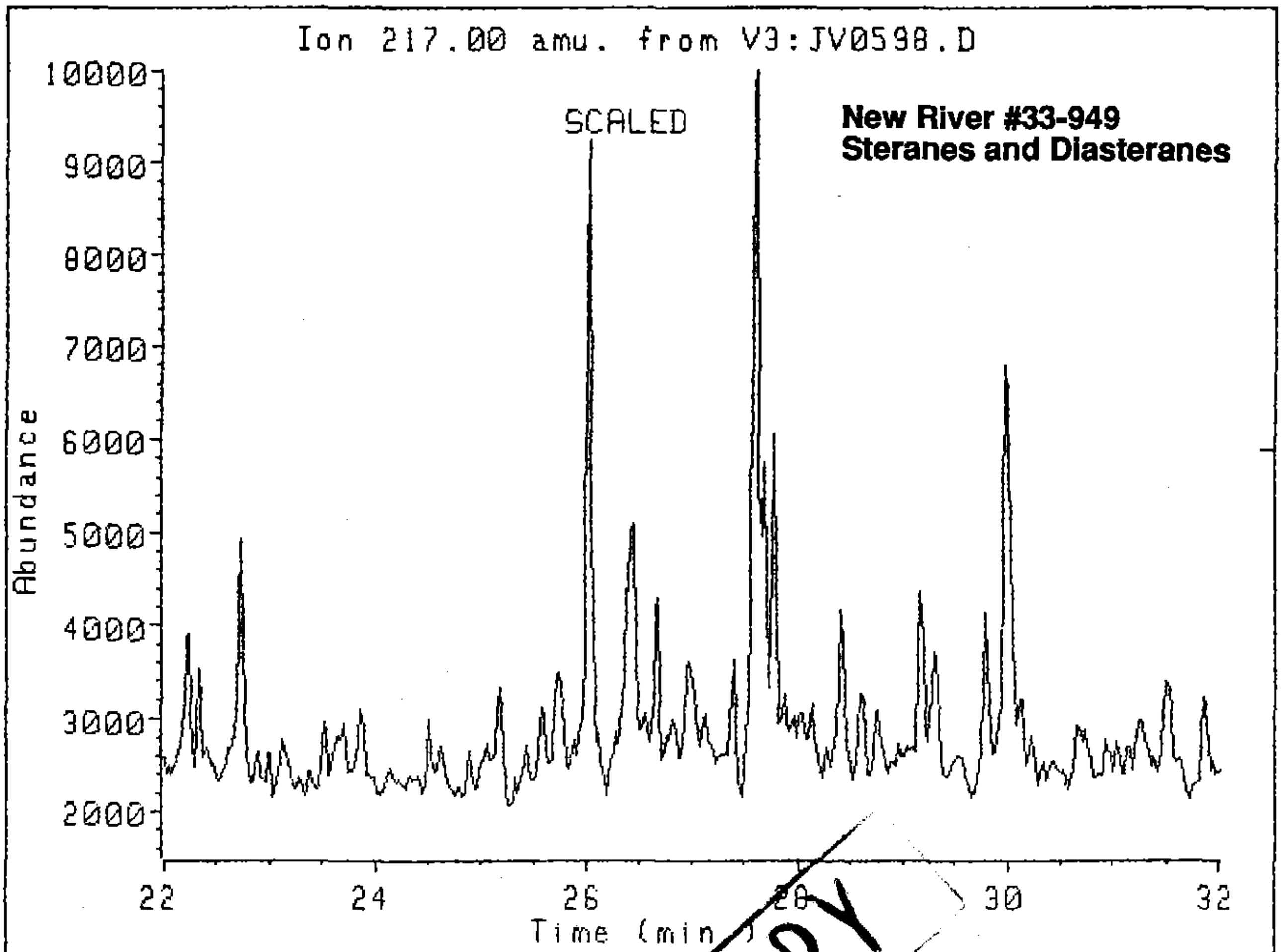
42
44
Time (min.)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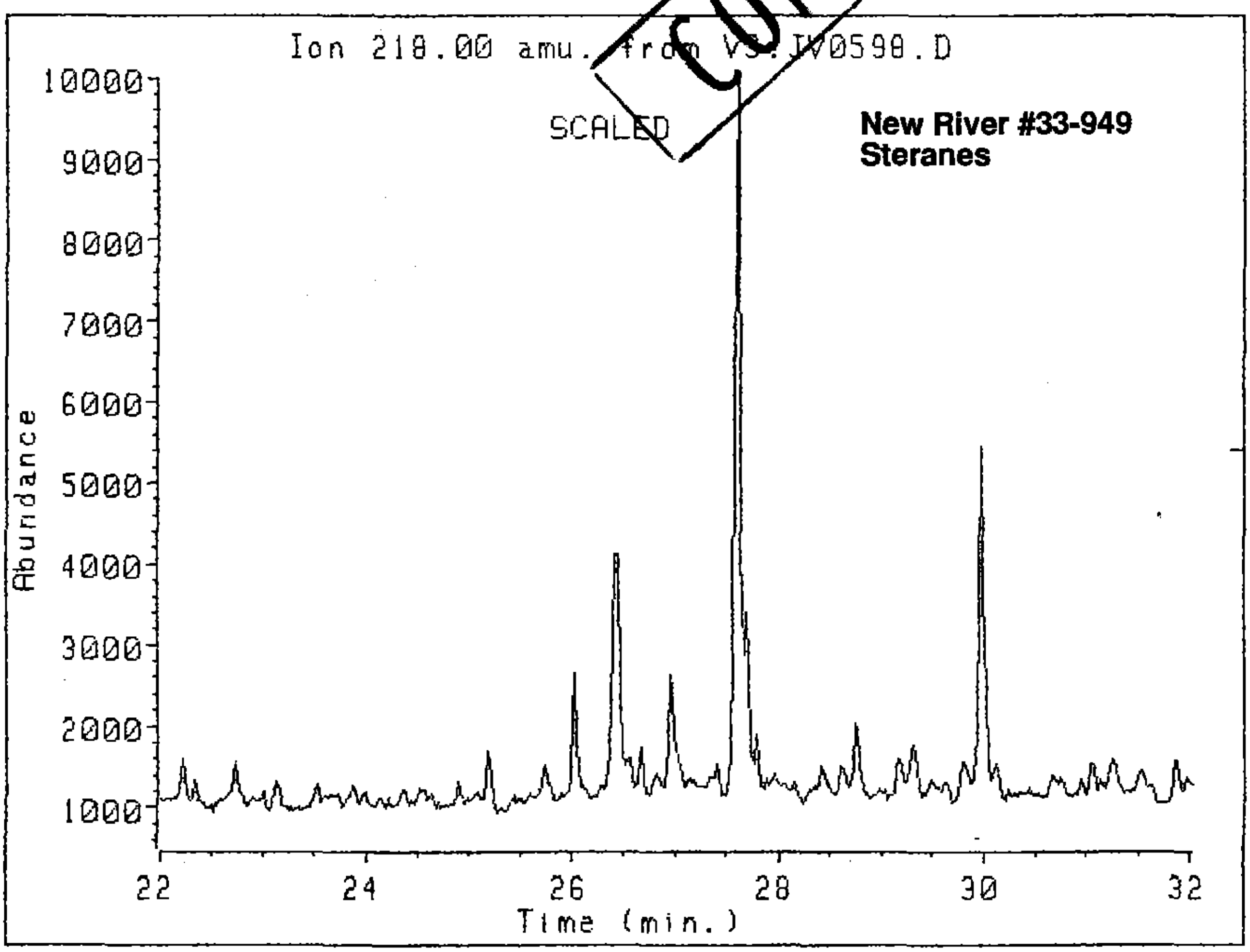
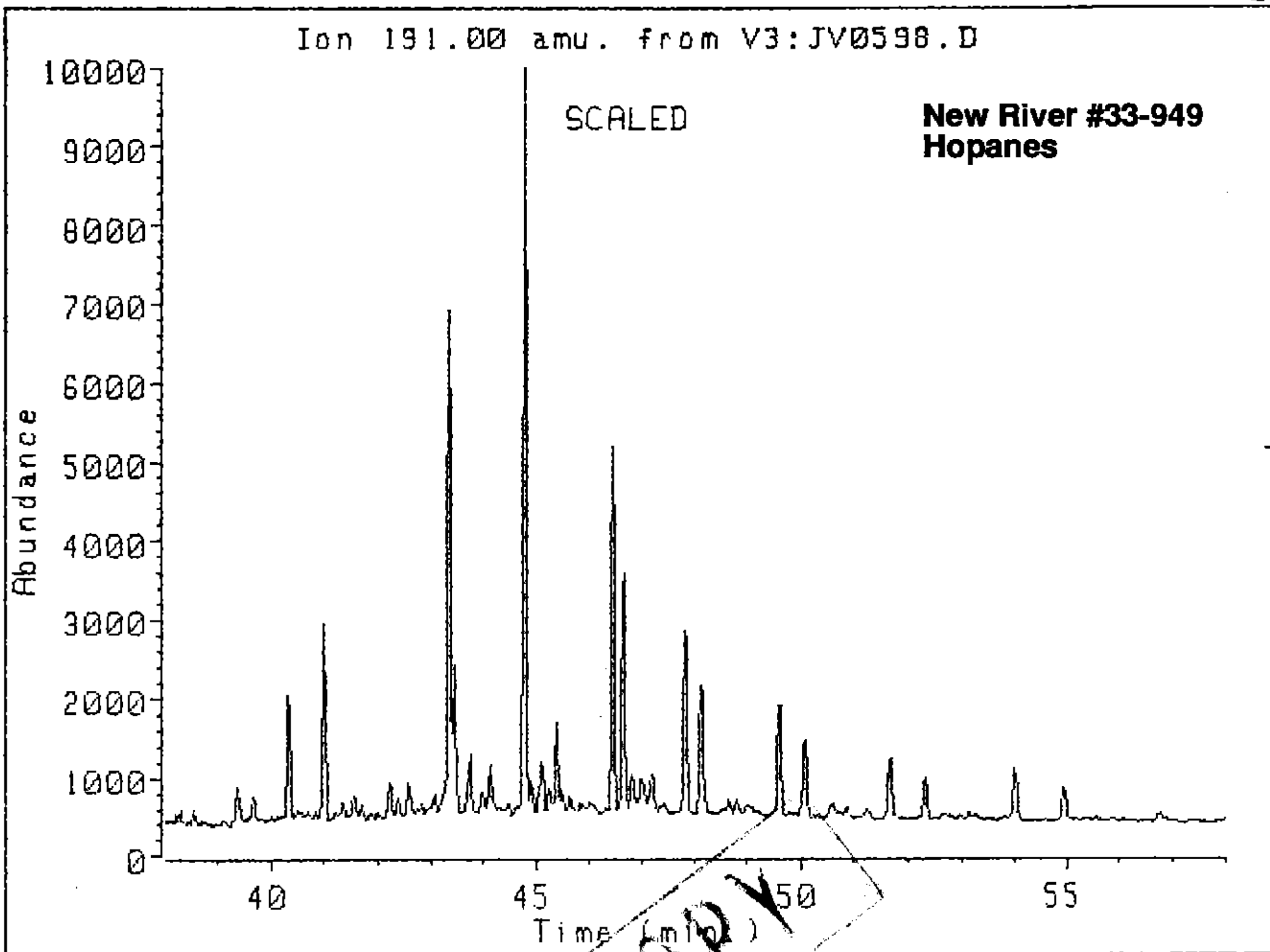
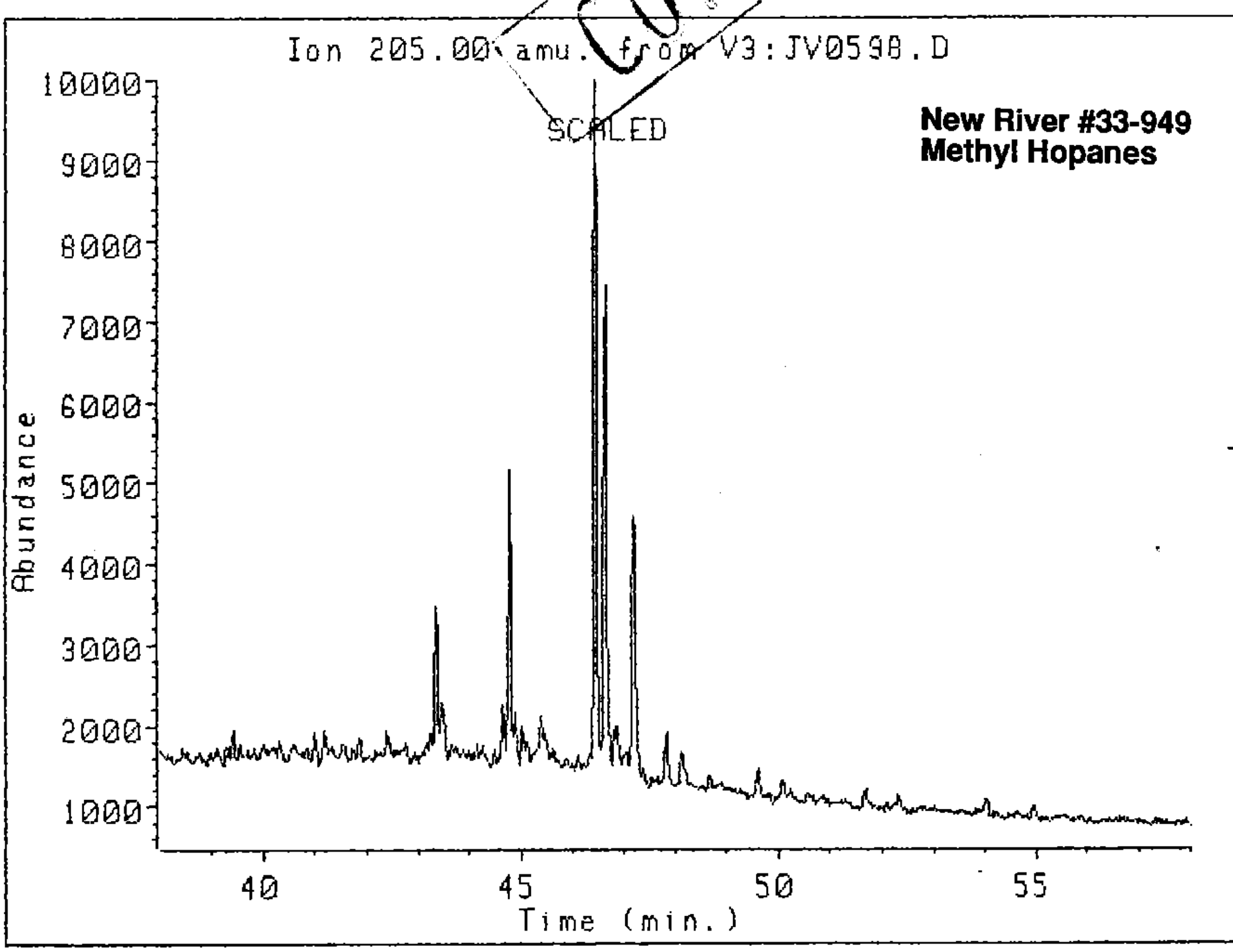
SCALED
New River #33-949
Steranes and Diasteranes
Abundance
Time (min.)


Ion 218.00 amu. from V3:JV0598.D
SCALED
New River #33-949
Steranes
Abundance
Time (min.)


Ion 191.00 amu. from V3:JV0598.D
SCALED
New River #33-949
Hopanes
Abundance
Time (min.)
COPY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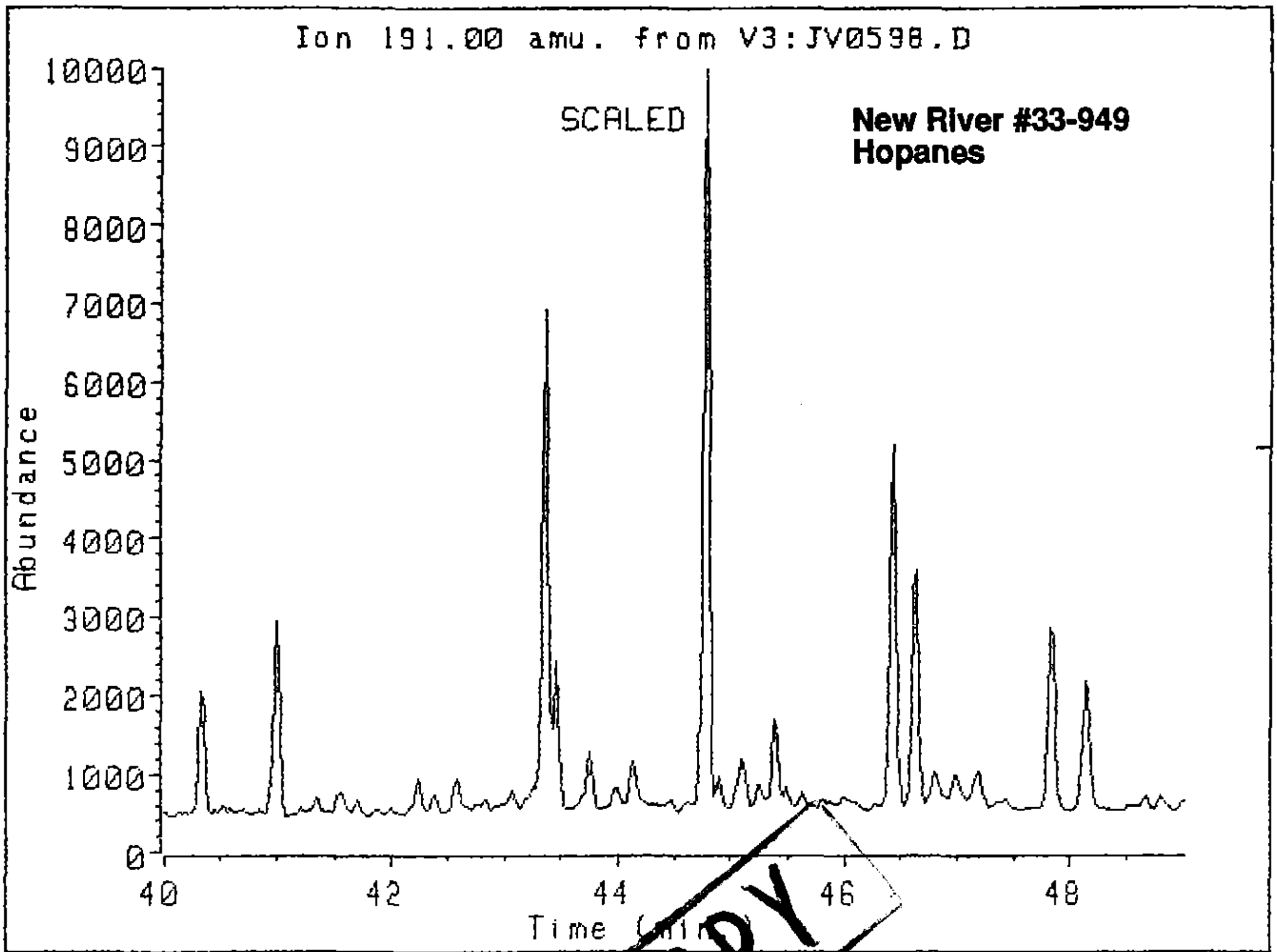
SCALED
New River #33-949
Methyl Hopanes
Abundance
Time (min.)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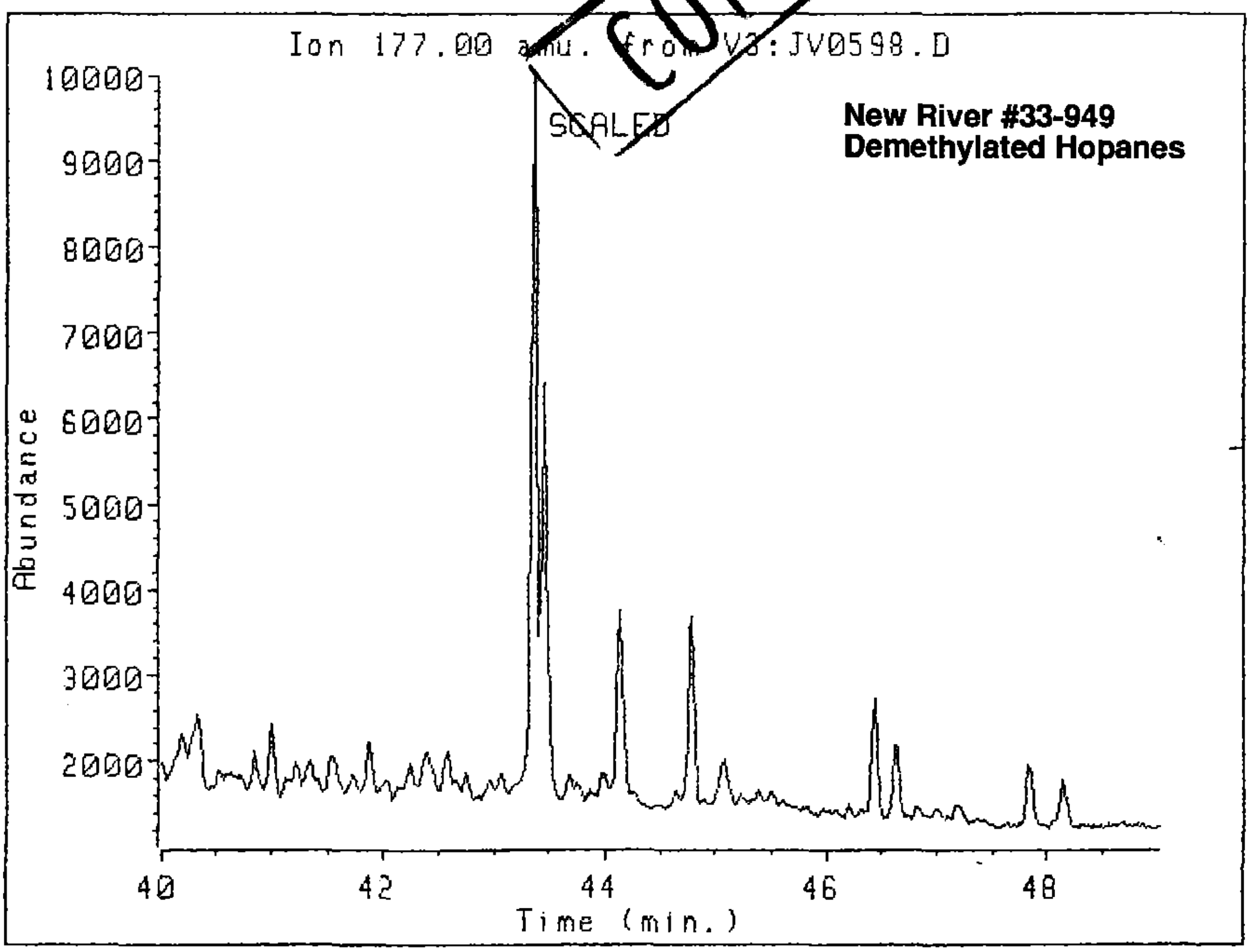
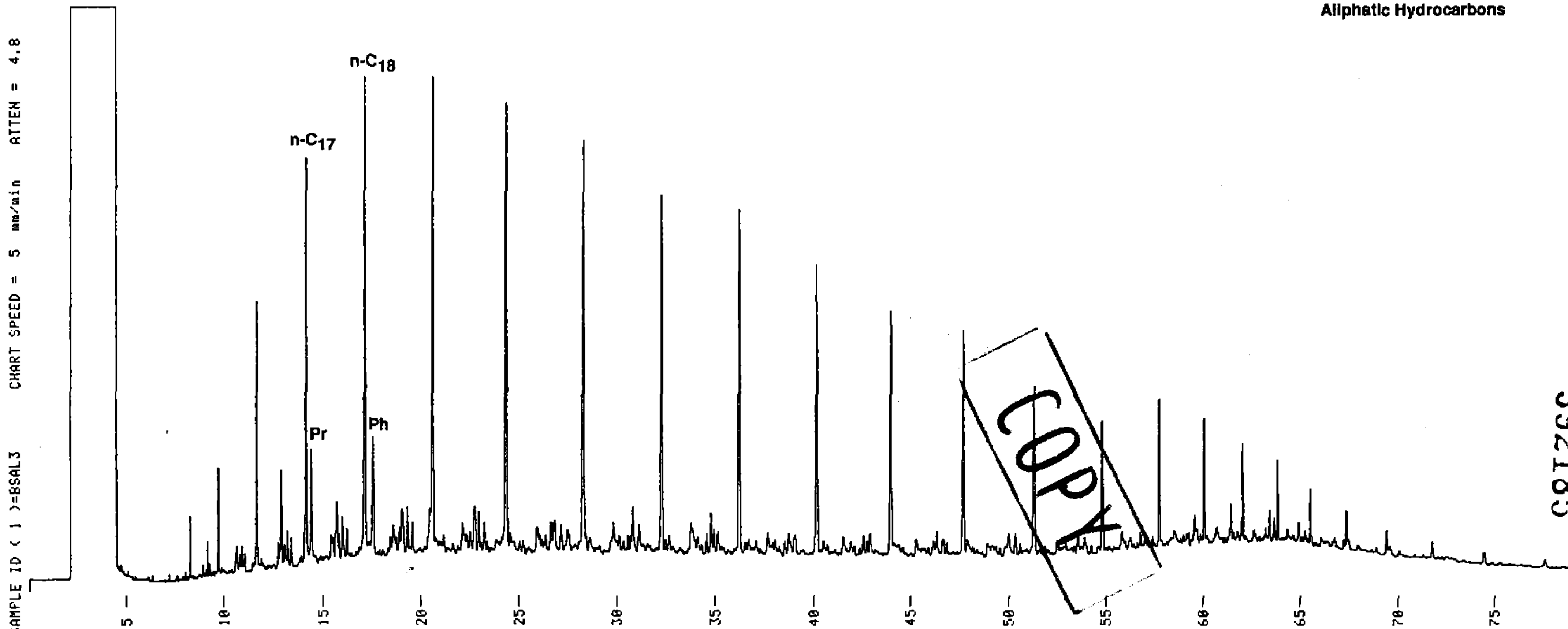
SCALED
New River #33-949
Hopanes
Abundance
Time (min.)
COPY


Ion 177.00 amu. from V3:JV0598.D
SCALED
New River #33-949
Demethylated Hopanes
Abundance
Time (min.)

Marrawah #X2283
Aliphatic Hydrocarbons



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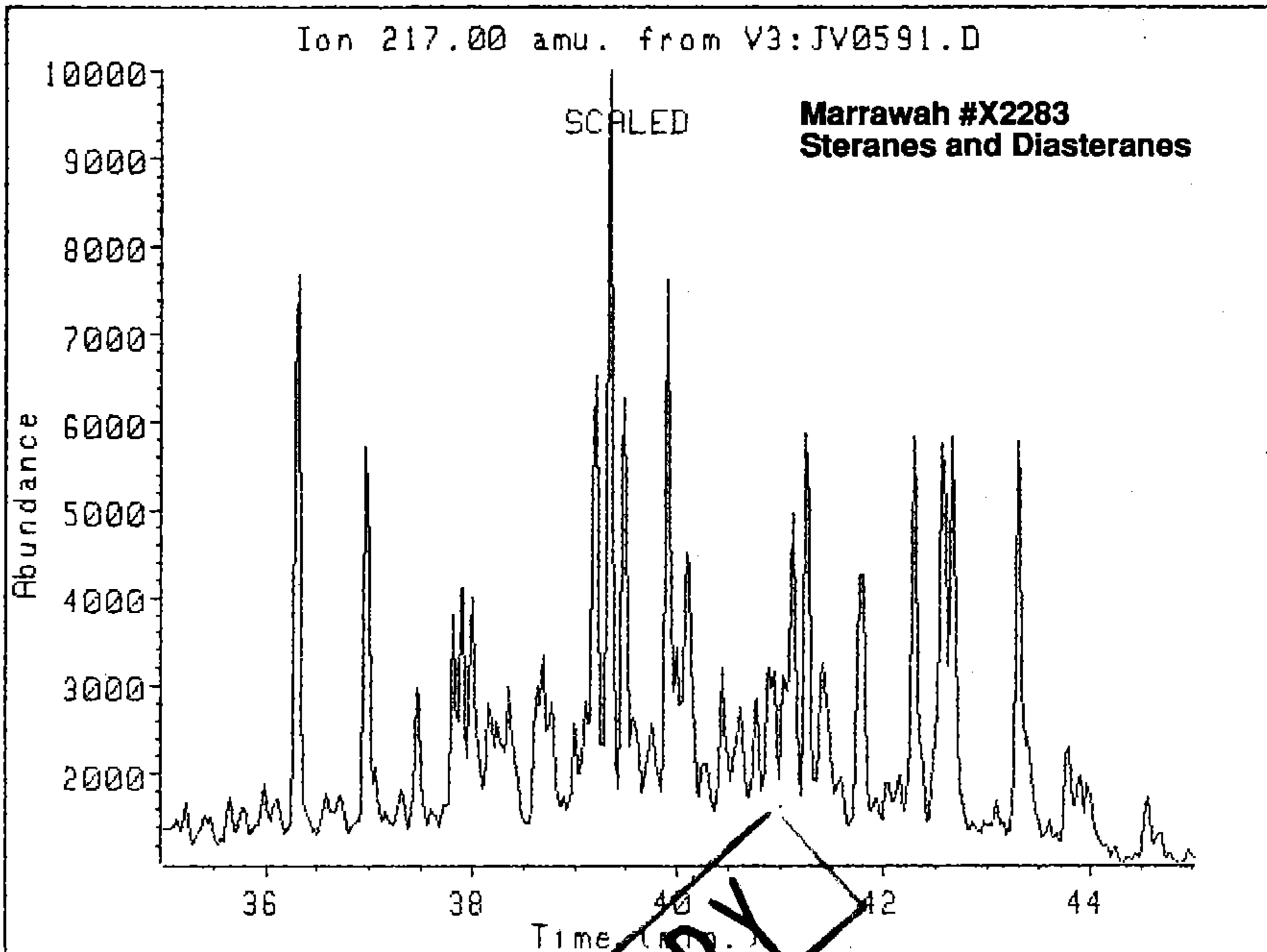
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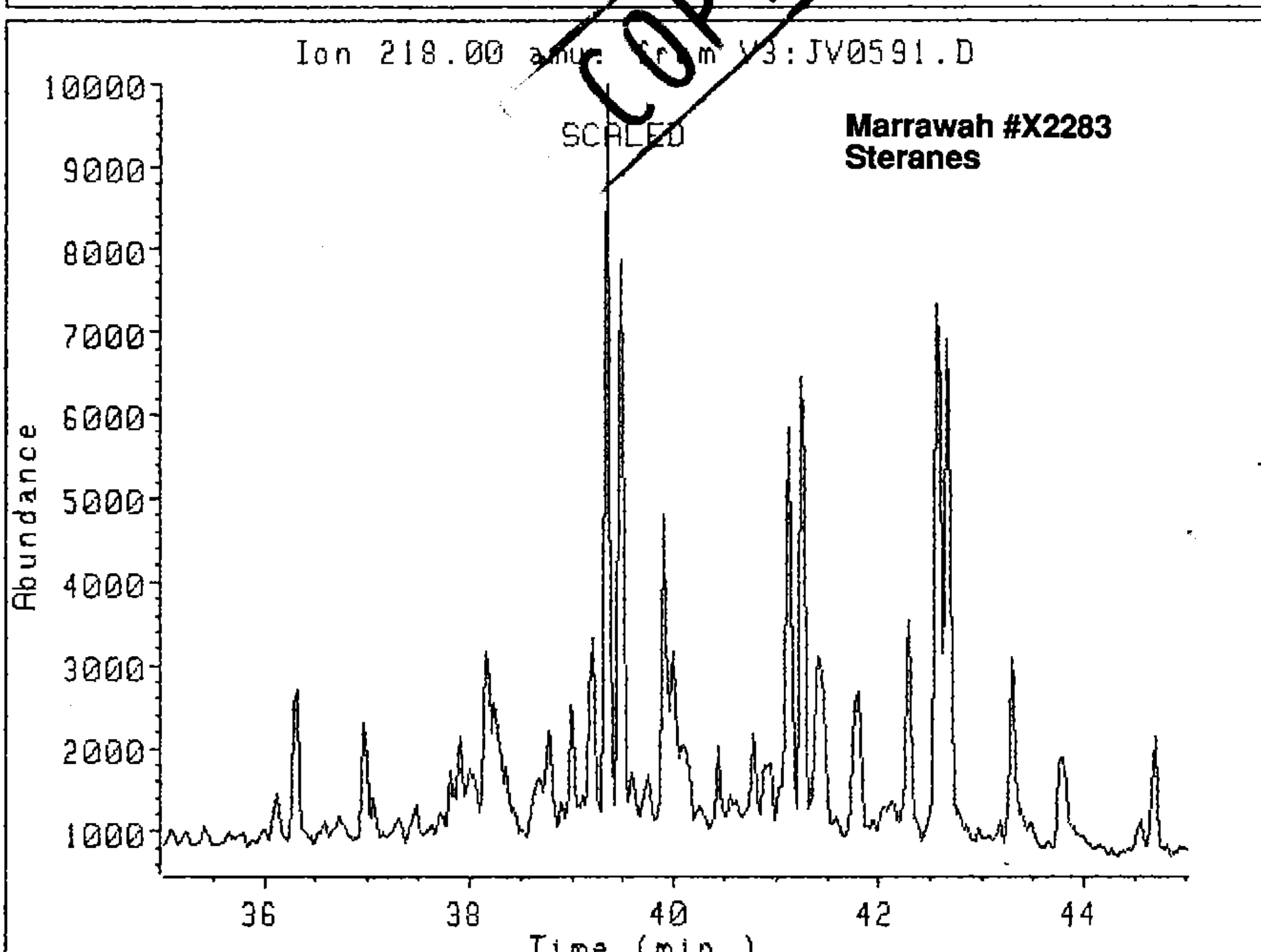
SCALED
Marrawah #X2283
Steranes and Diasteranes
Abundance
10000
9000
8000
7000
6000
5000
4000
3000
2000
36
38
40
42
44
Time (min.)


Ion 218.00 amu. from V3:JV0591.D
SCALED
Marrawah #X2283
Steranes
Abundance
10000
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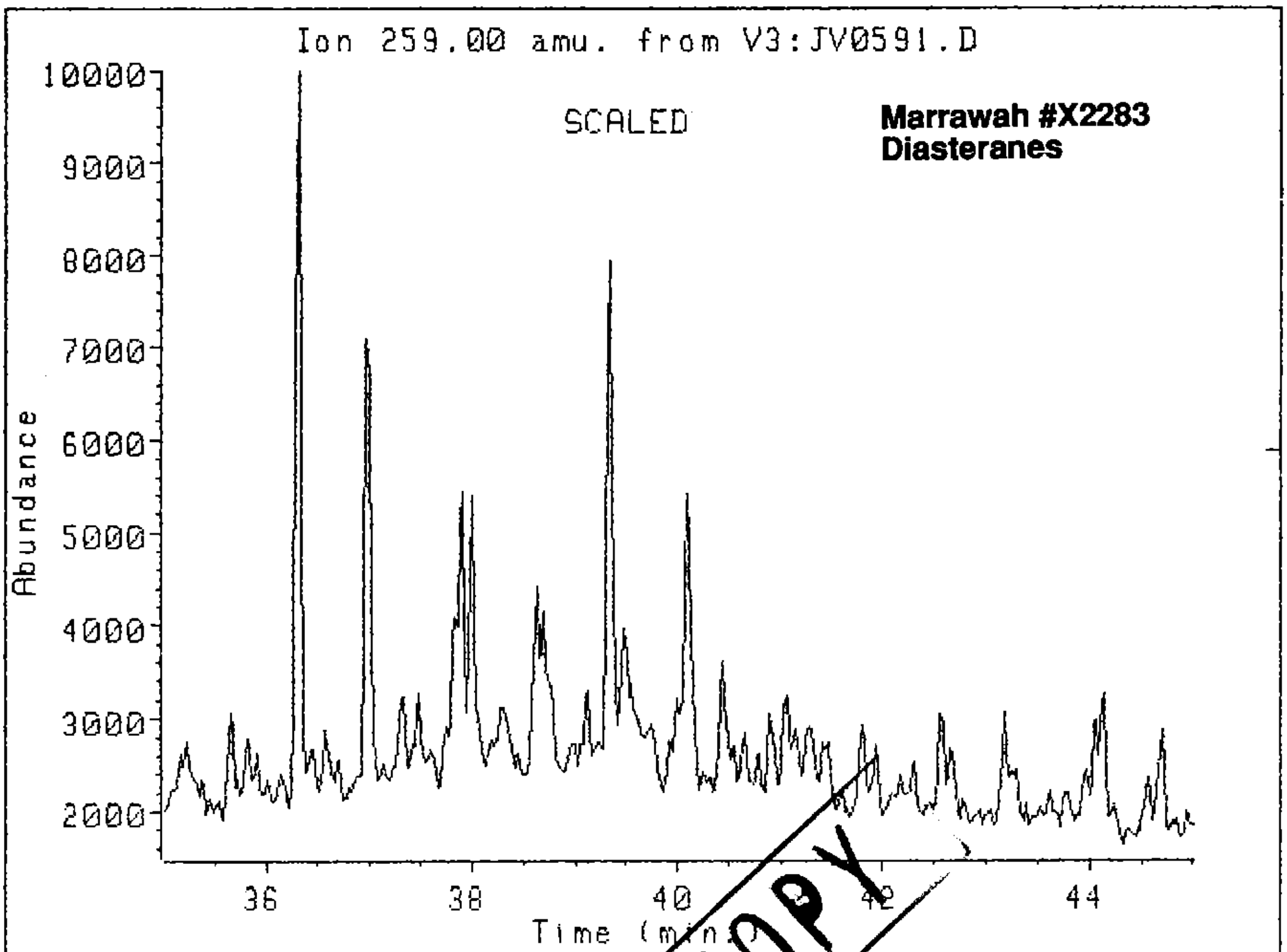
7000
6000
5000
4000
3000
2000
1000
36
38
40
42
44
Time (min.)
COPY


Ion 259.00 amu. from V3:JV0591.D
SCALED
Marrawah #X2283
Diasteranes
Abundance
10000
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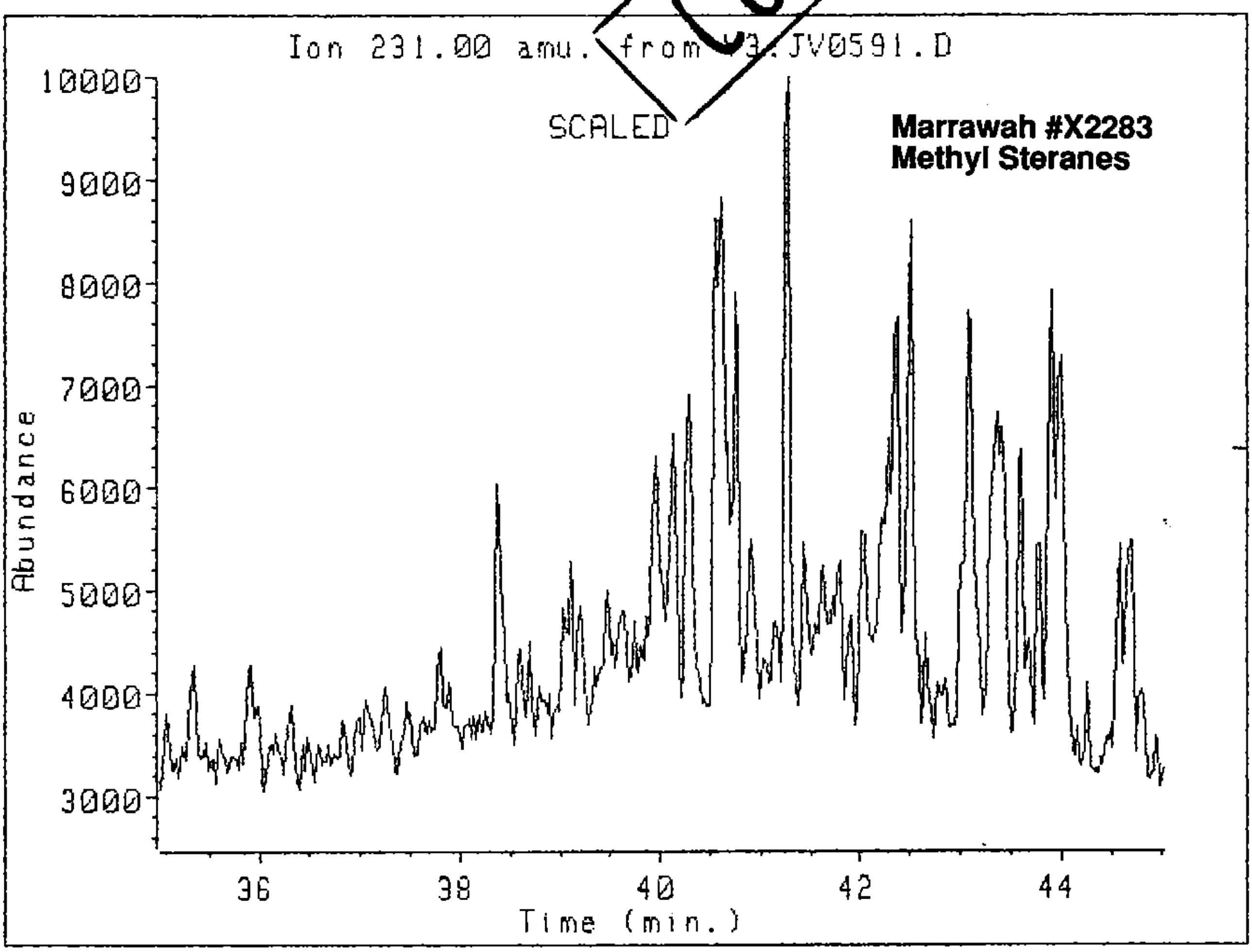
8000
7000
6000
5000
4000
3000
2000
36
38
40
42
44
Time (min.)


Ion 231.00 amu. from V3:JV0591.D
SCALED
Marrawah #X2283
Methyl Steranes
Abundance
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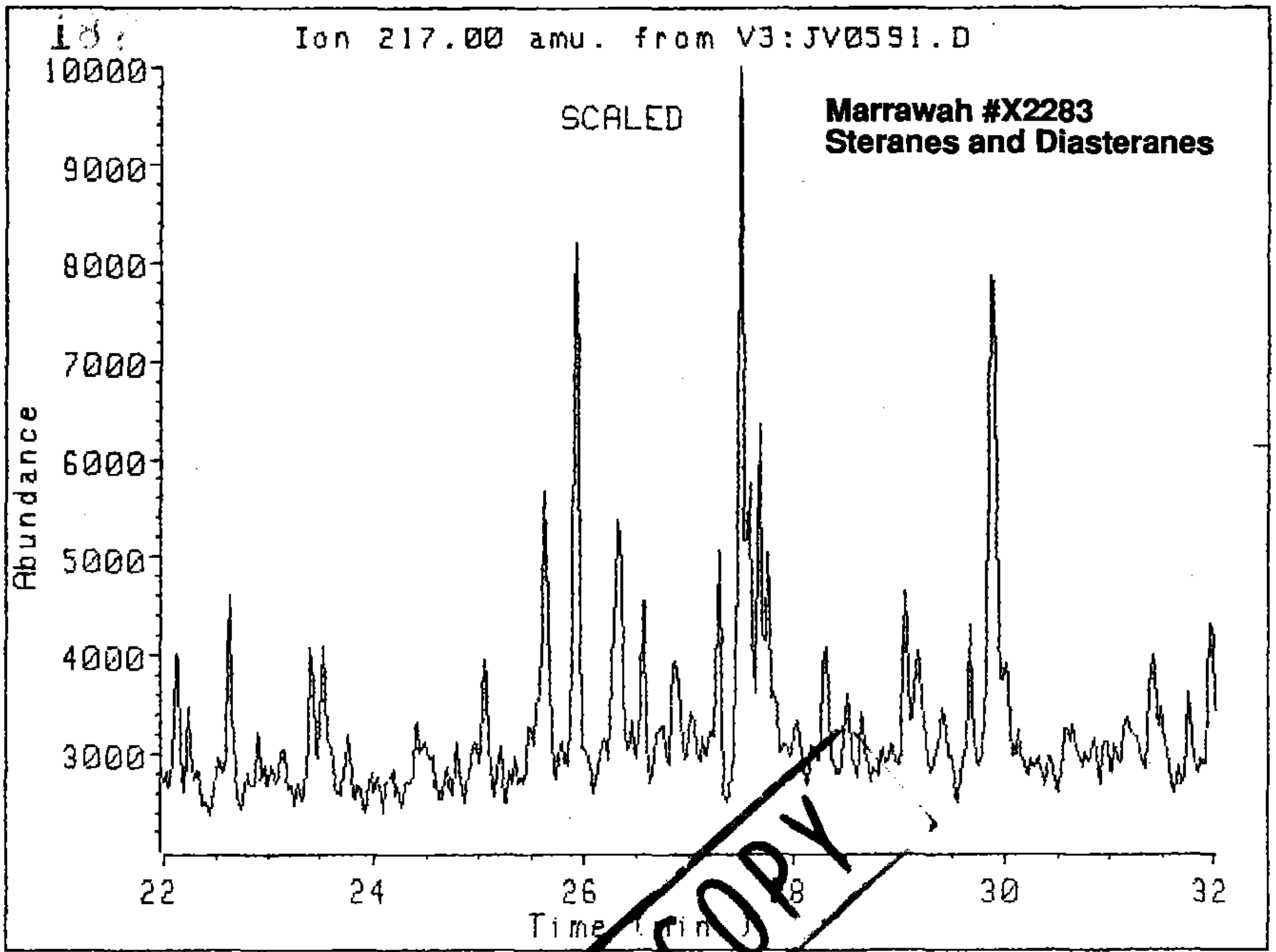
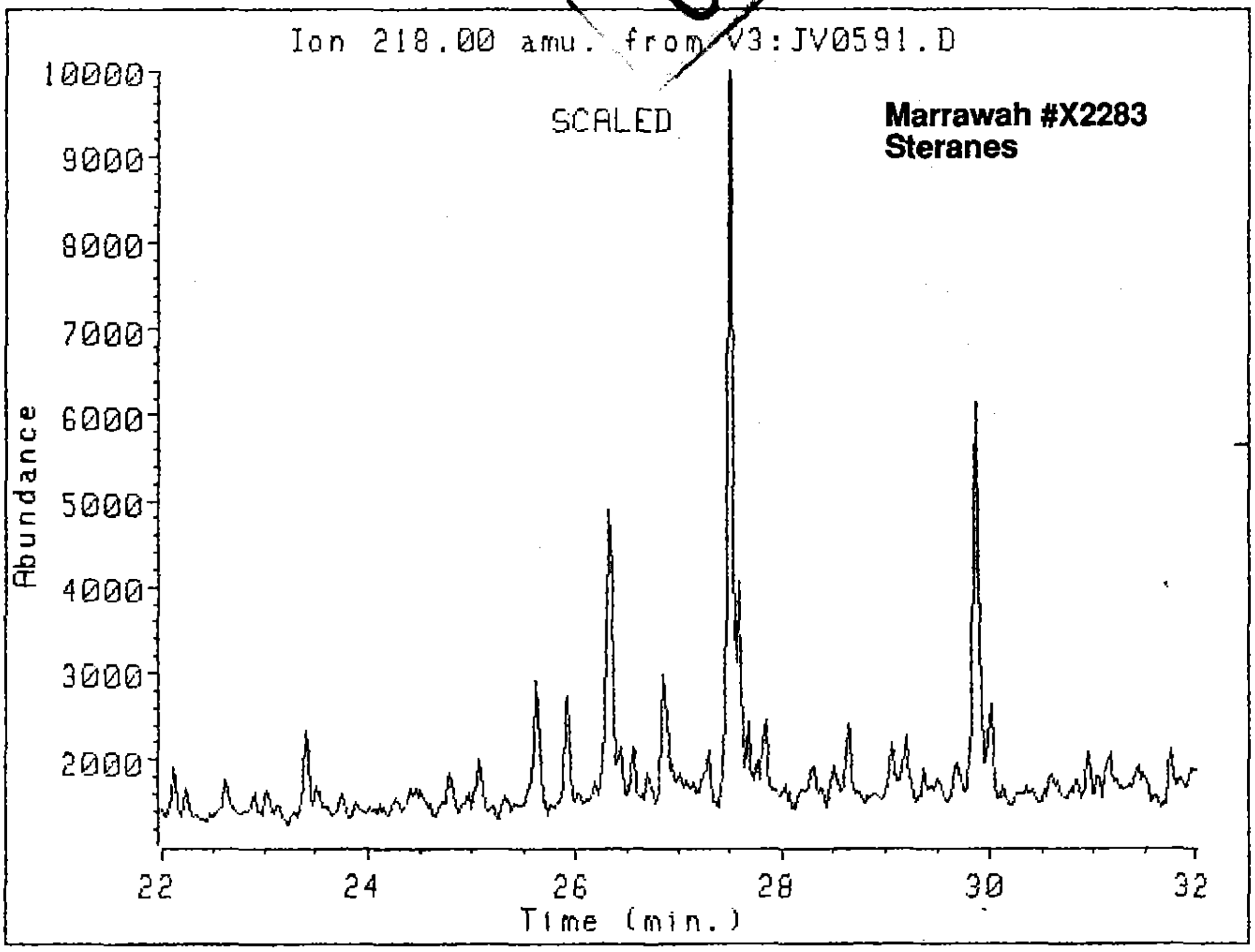
9000
8000
7000
6000
5000
4000
3000
36
38
40
42
44
Time (min.)

392188

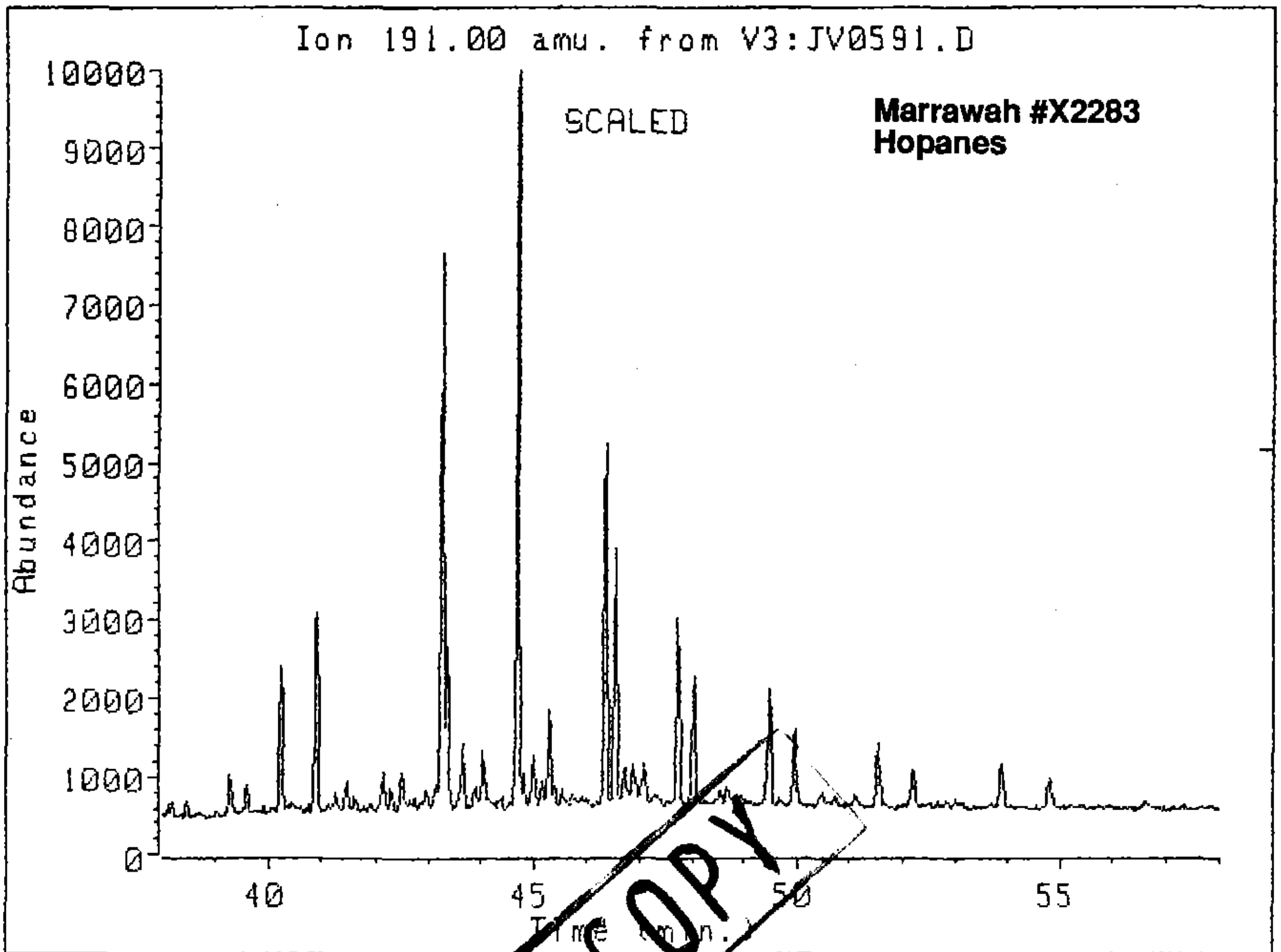


Ion 217.00 amu. from V3:JV0591.D
SCALED
Marrawah #X2283
Steranes and Diasteranes
10000
9000
8000
7000
6000
5000
4000
3000
Abundance
22
24
26
28
30
32
Time (min.)
COPY



Ion 218.00 amu. from V3:JV0591.D
SCALED
Marrawah #X2283
Steranes
10000
9000
8000
7000
6000
5000
4000
3000
2000
Abundance
22
24
26
28
30
32
Time (min.)

392189


Ion 191.00 amu. from V3:JV0591.D
SCALED
Marrawah #X2283
Hopanes
Abundance
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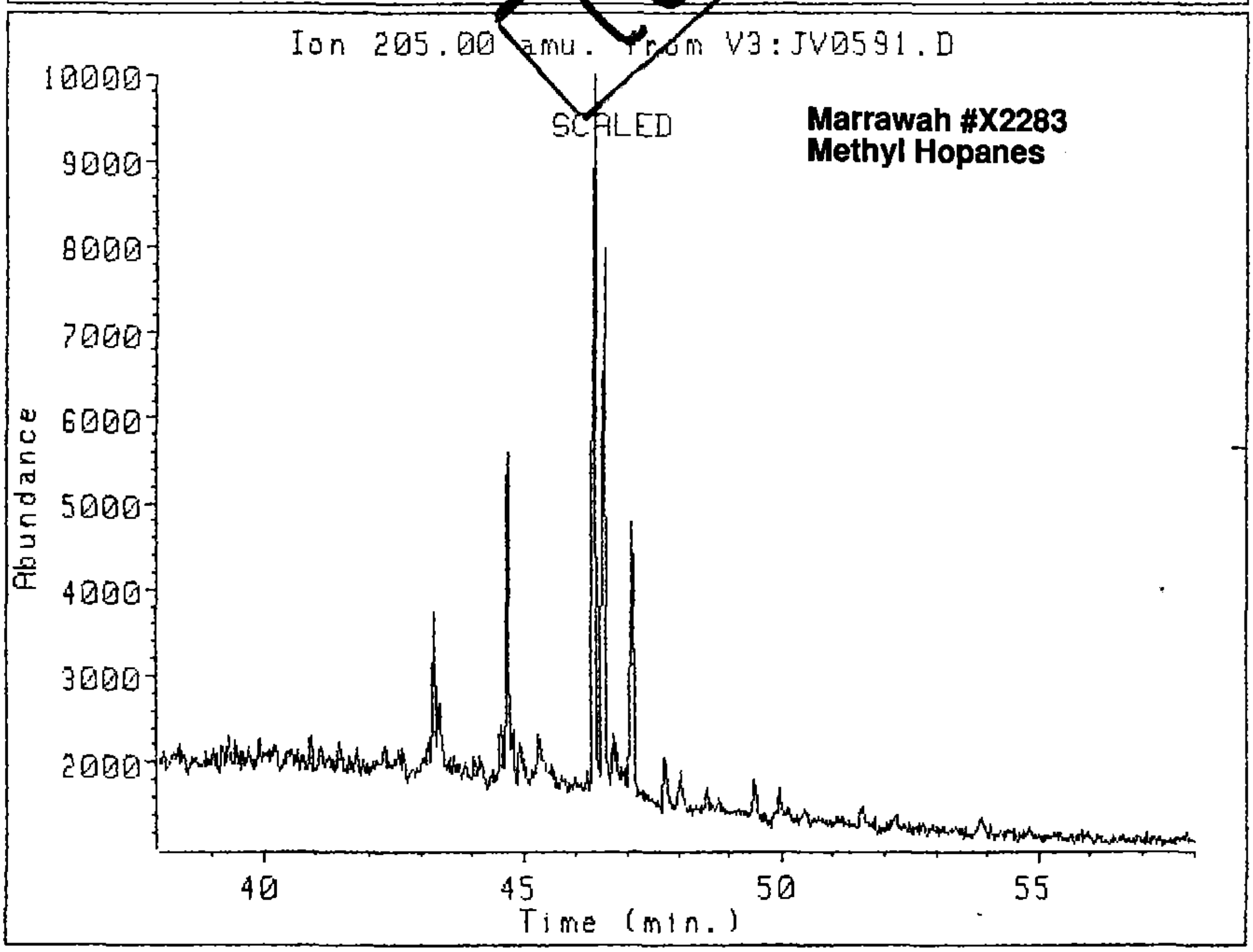
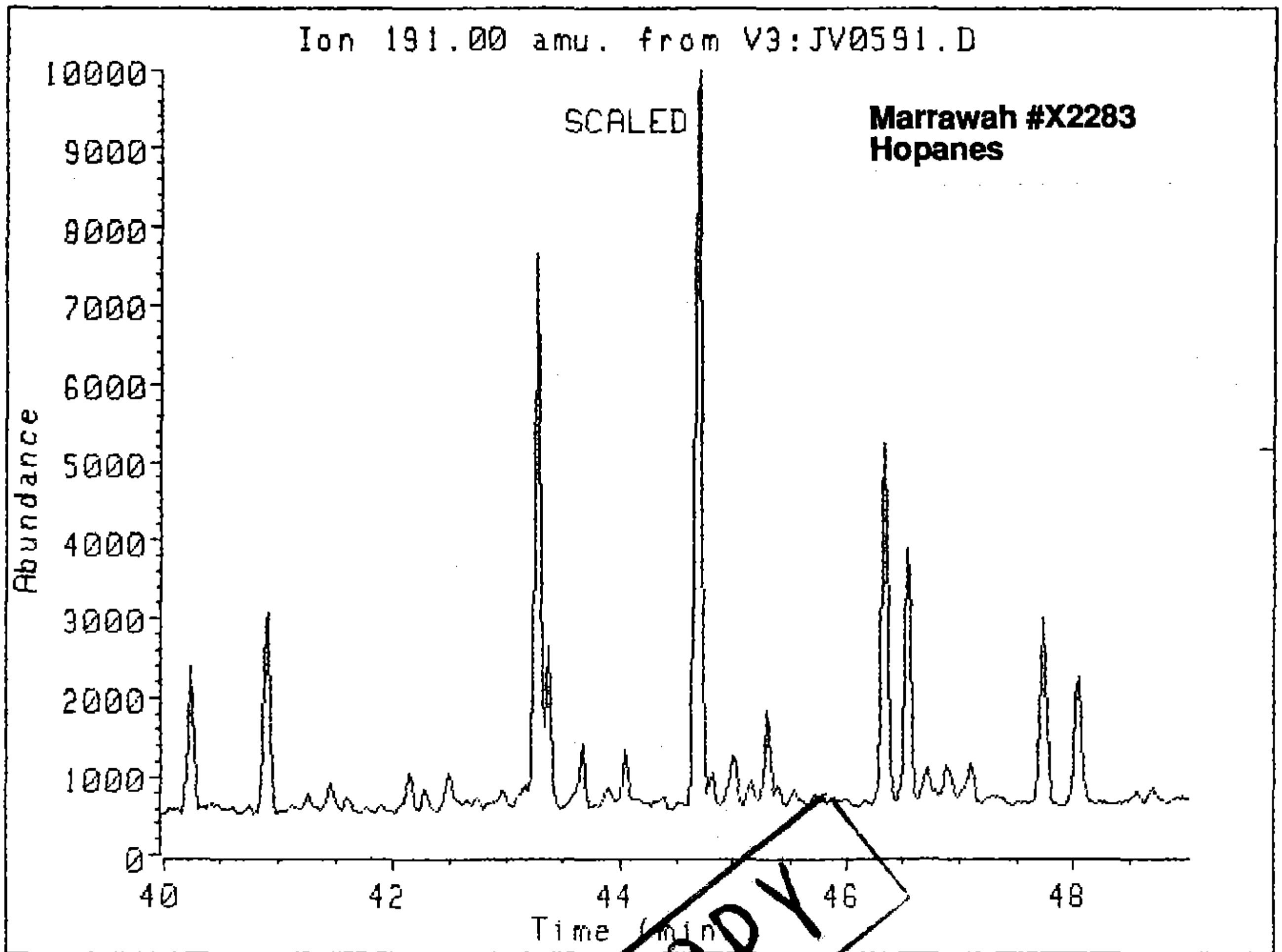
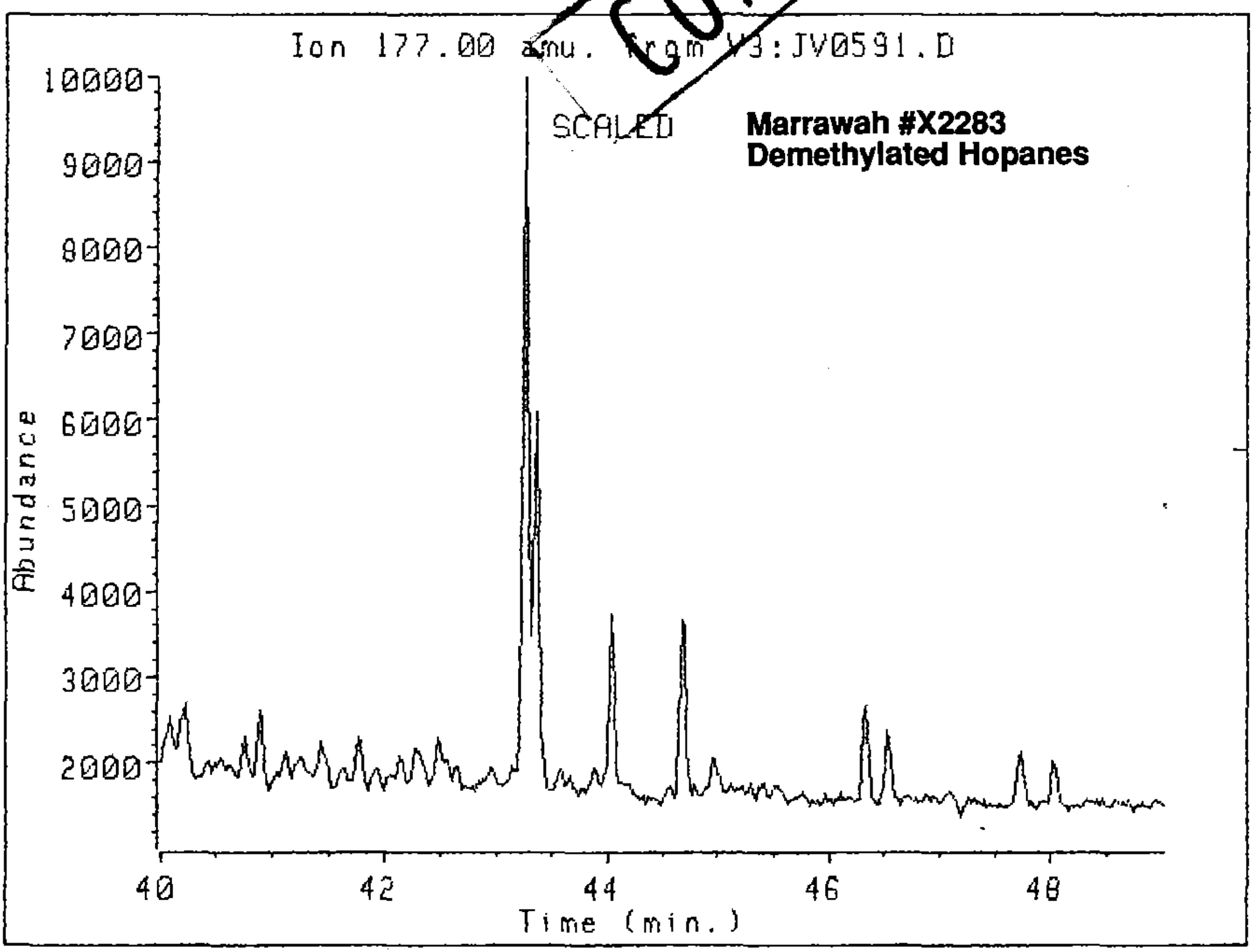
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
40
45
50
55
Time (min.)

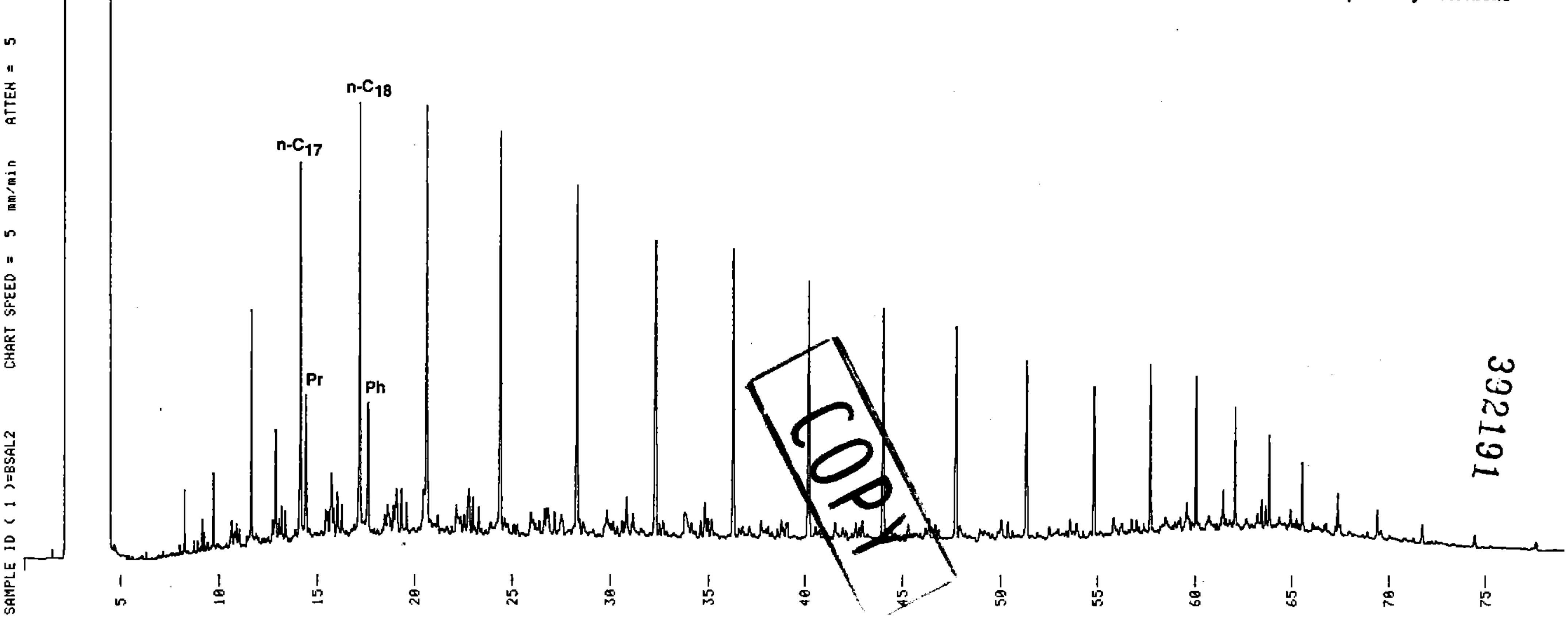

Ion 205.00 amu. from V3:JV0591.D
SCALED
Marrawah #X2283
Methyl Hopanes
Abundance
10000
9000
8000
7000
6000
5000
4000
3000
2000
40
45
50
55
Time (min.)

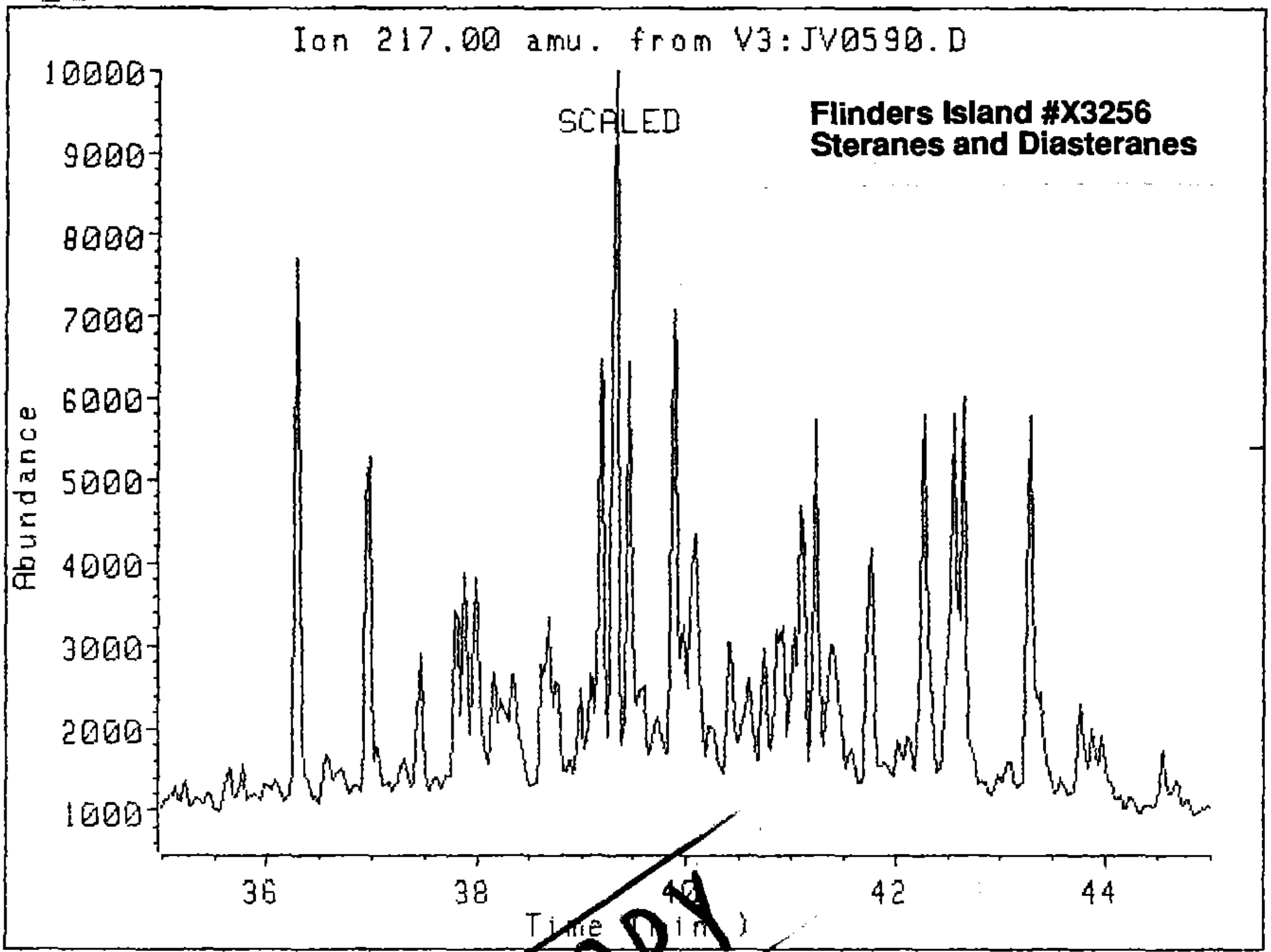
392190

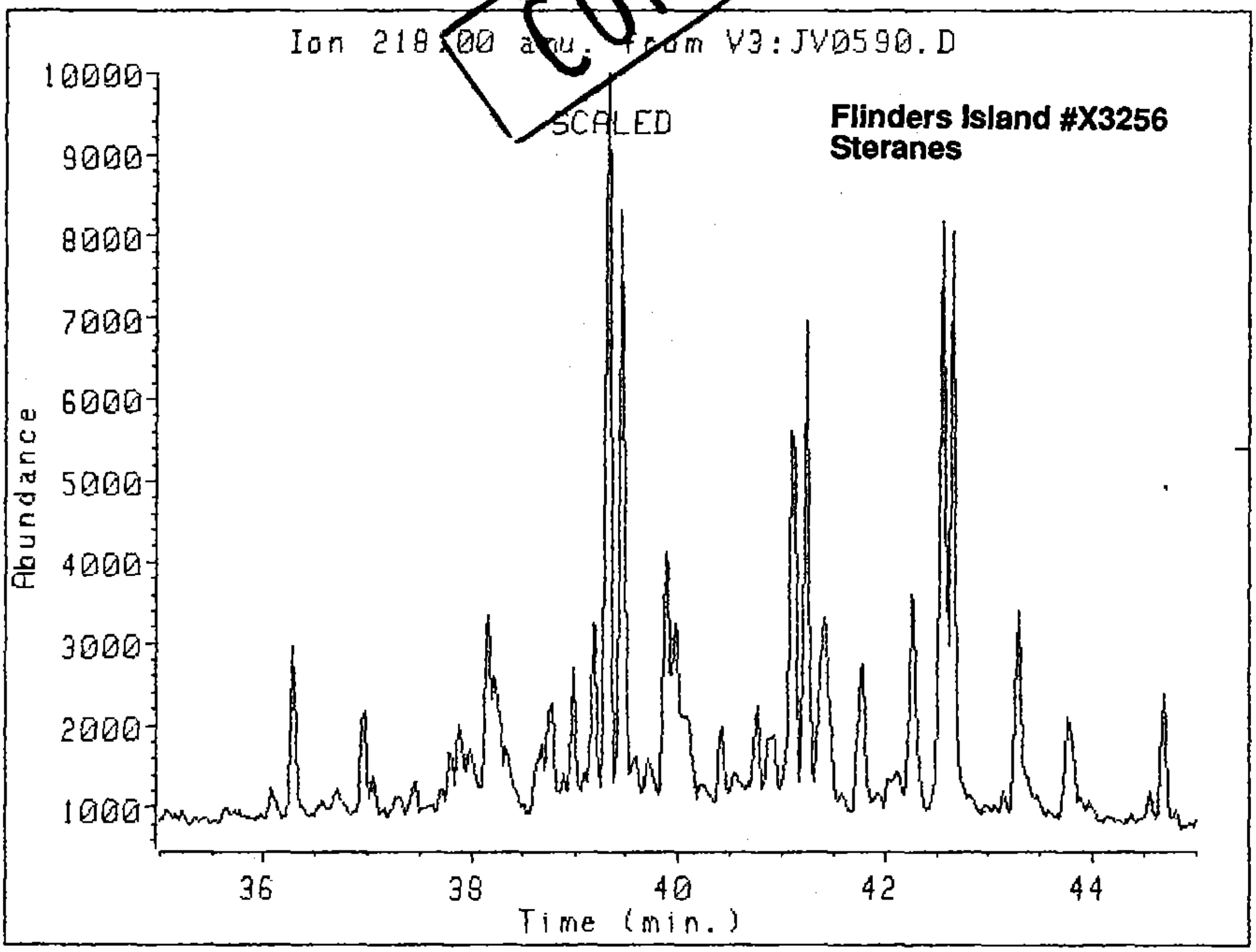

Ion 191.00 amu. from V3:JV0591.D
SCALED
Marrawah #X2283
Hopanes
Abundance
Time (min.)
COPY


Ion 177.00 amu. from V3:JV0591.D
SCALED
Marrawah #X2283
Demethylated Hopanes
Abundance
Time (min.)

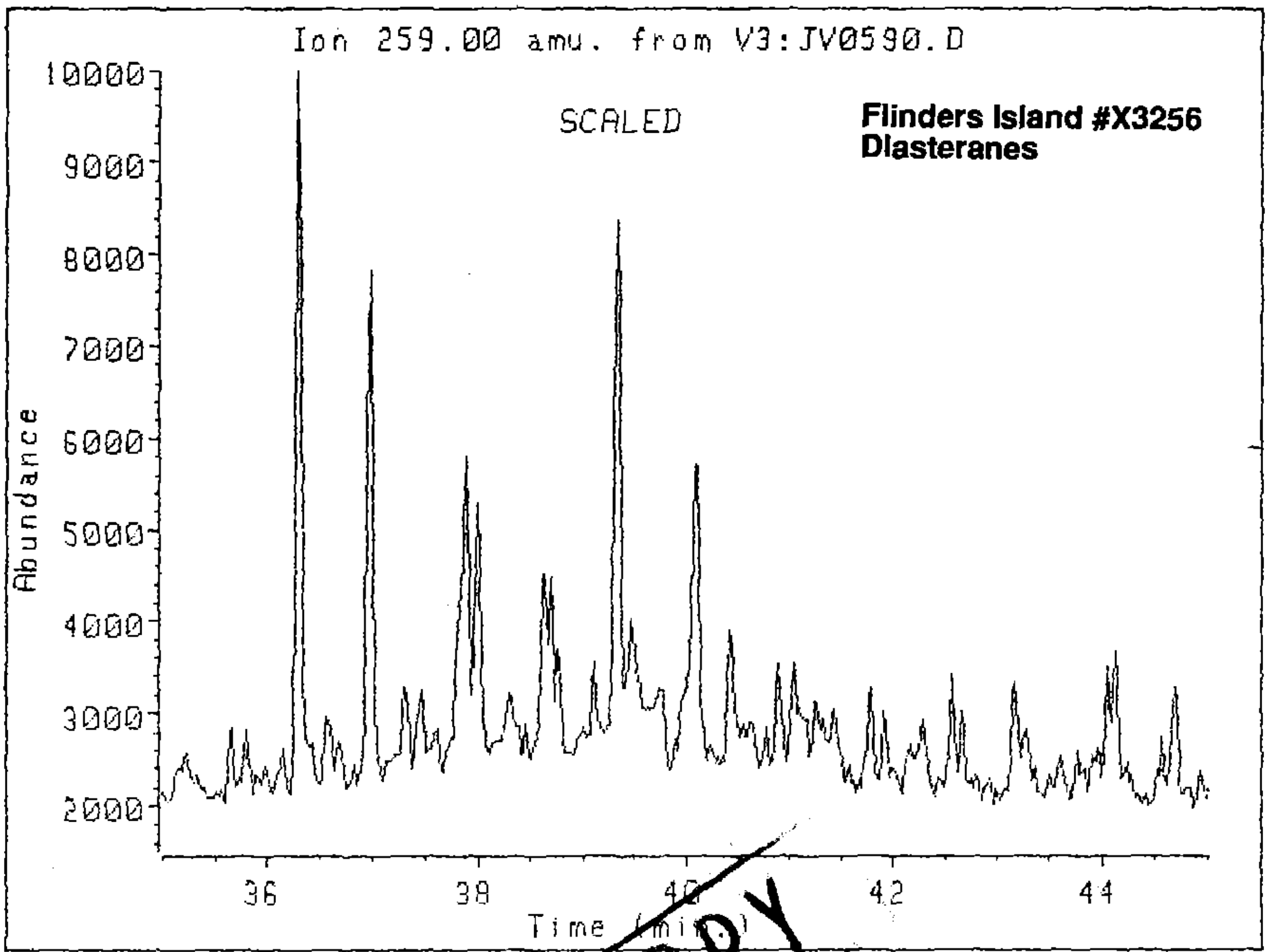
Flinders Island #X3256
Aliphatic Hydrocarbons




Ion 217.00 amu. from V3:JV0590.D
SCALED
Flinders Island #X3256
Steranes and Diasteranes
Abundance
Time (min.)


Ion 218.00 amu. from V3:JV0590.D
SCALED
Flinders Island #X3256
Steranes
Abundance
Time (min.)

193


Ion 259.00 amu. from V3:JV0590.D
SCALED
Flinders Island #X3256
Diasteranes
Abundance
10000
9000
8000
7000
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5000
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3000
2000
36
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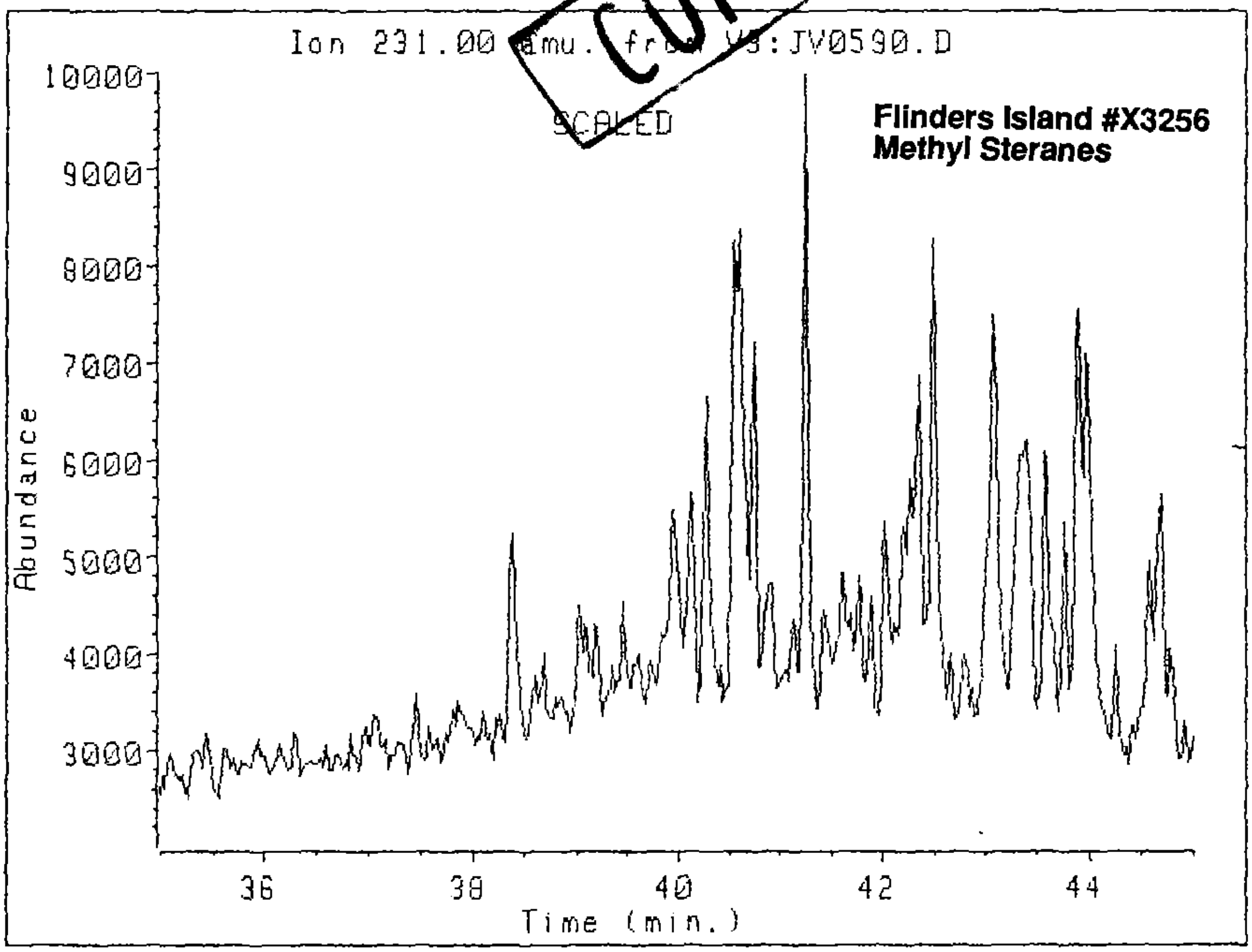
40
42
44
Time (min.)


Ion 231.00 amu. from V3:JV0590.D
SCALED
Flinders Island #X3256
Methyl Steranes
Abundance
10000
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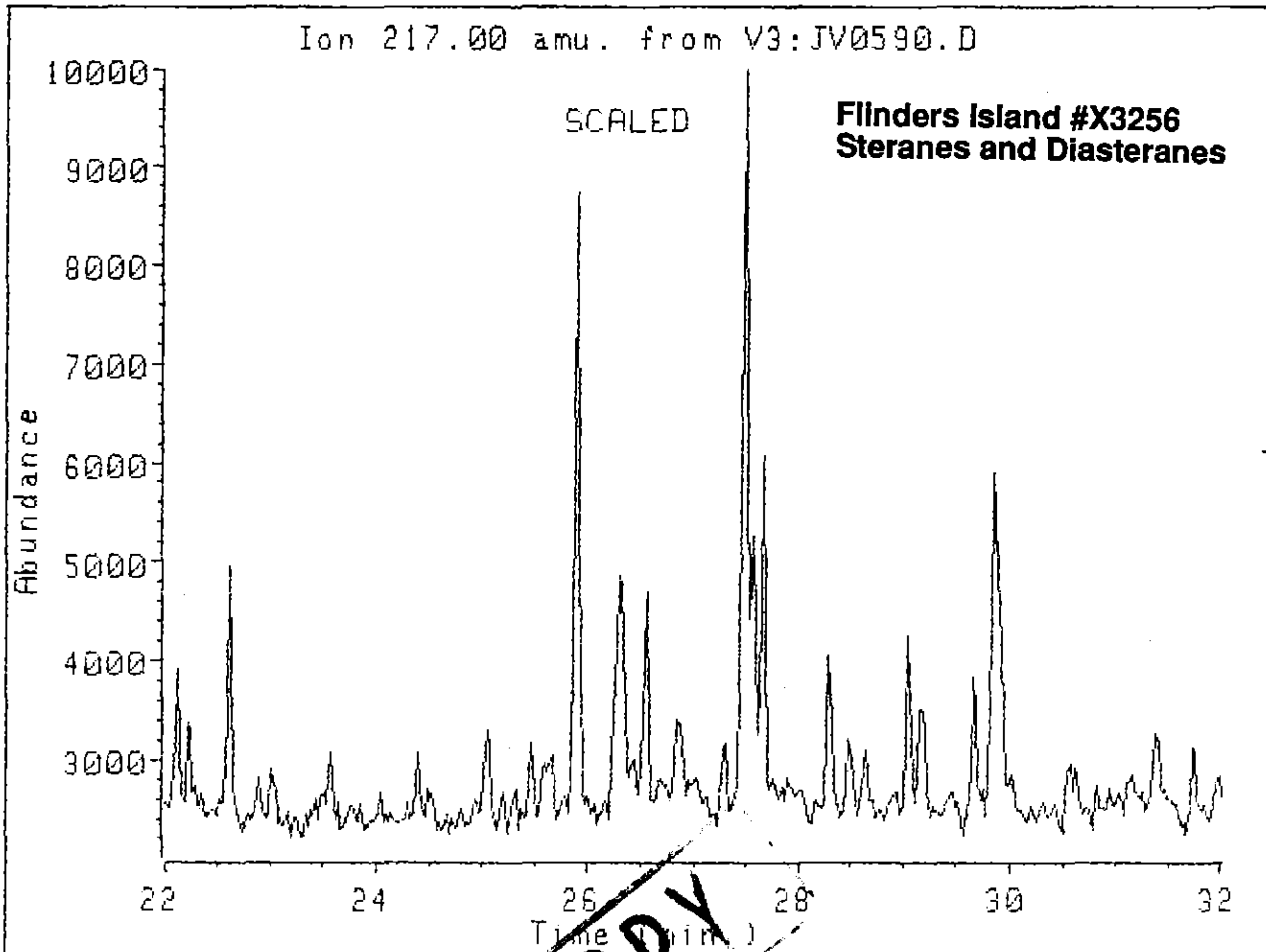
42
44
Time (min.)


Ion 217.00 amu. from V3:JV0590.D
SCALED
Flinders Island #X3256
Steranes and Diasteranes
Abundance
10000
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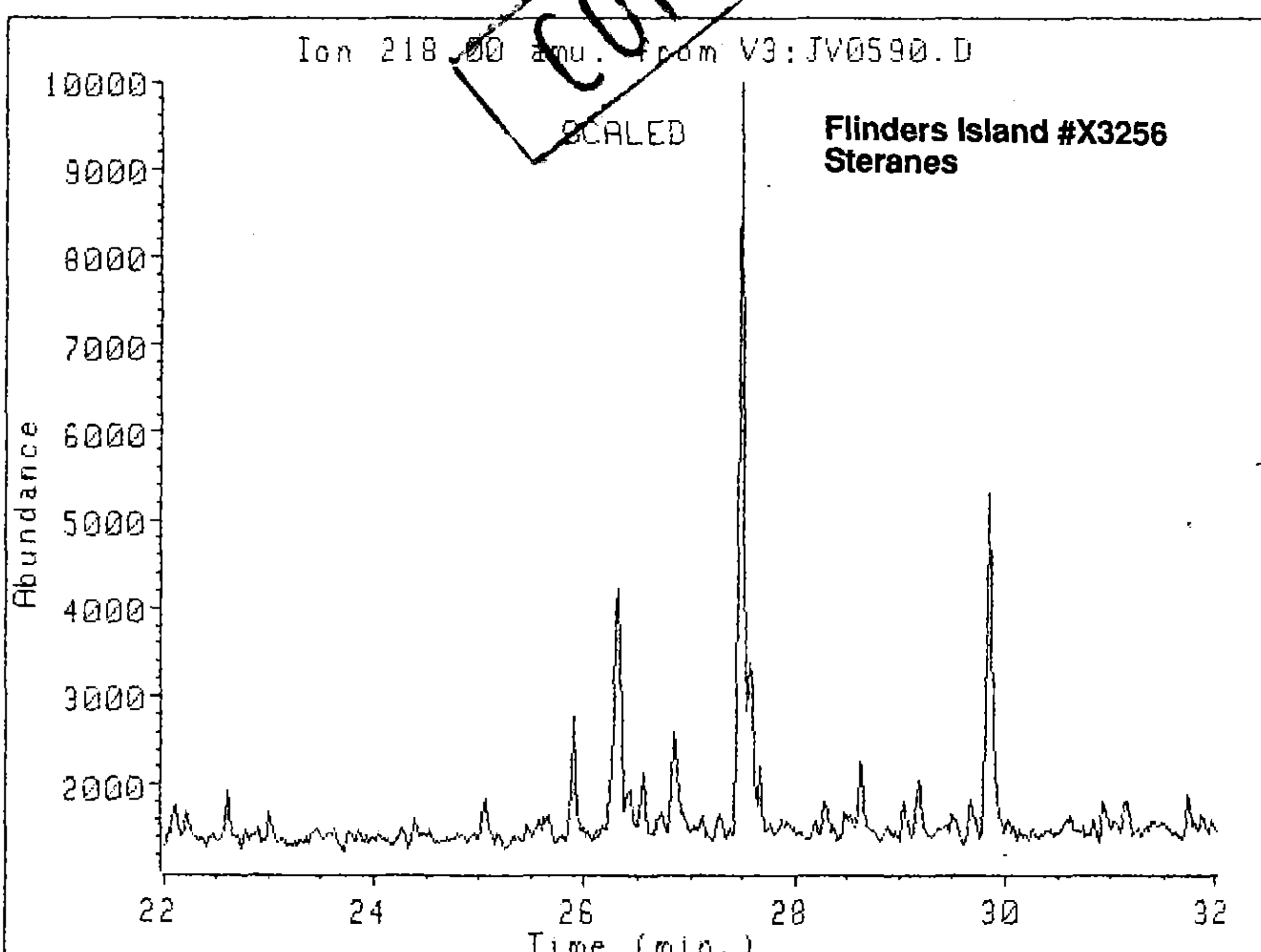
32
Time (min.)


Ion 218.00 amu. from V3:JV0590.D
SCALED
Flinders Island #X3256
Steranes
Abundance
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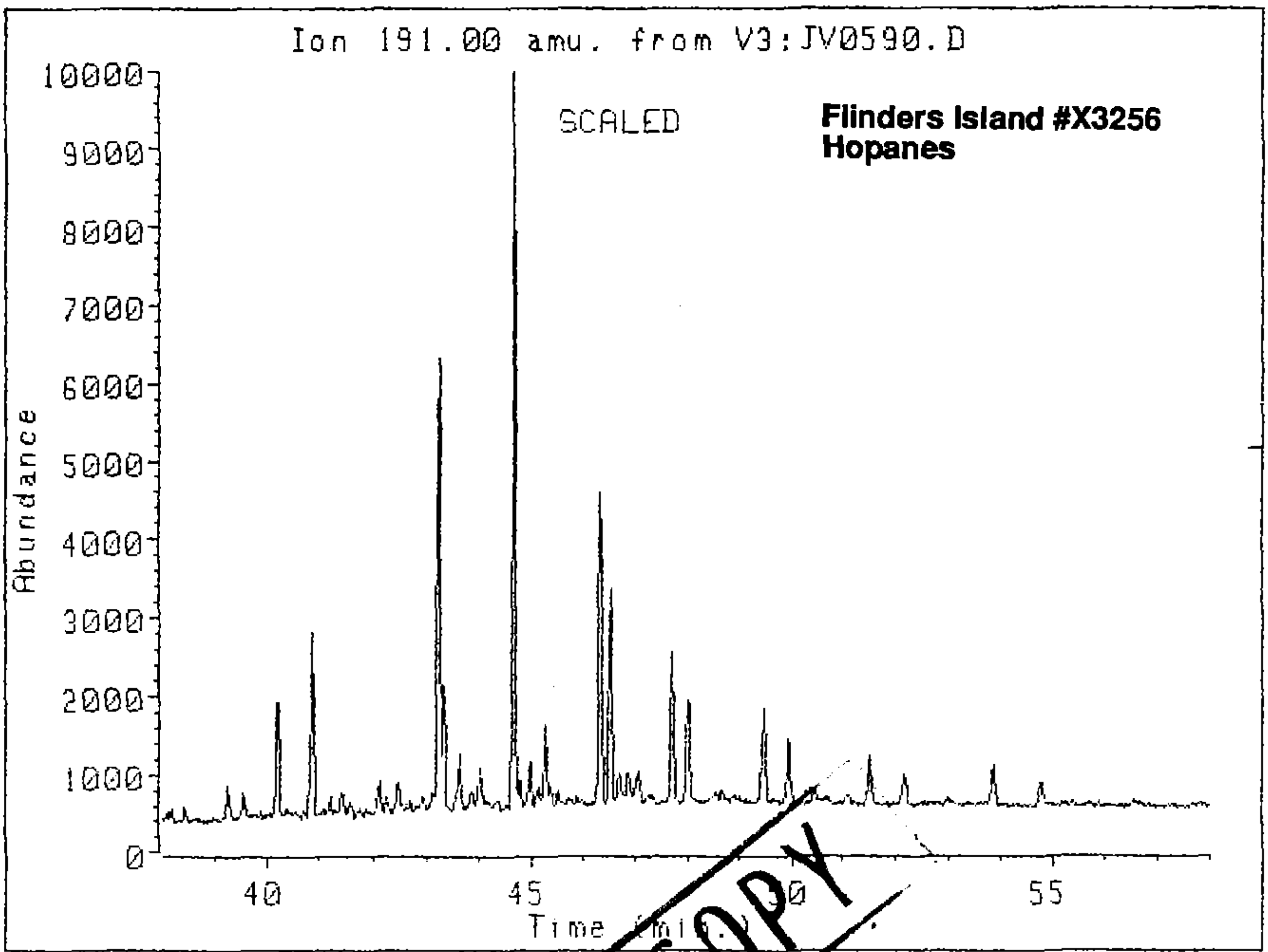
Time (min.)


Ion 191.00 amu. from V3:JV0590.D
SCALED
Flinders Island #X3256
Hopanes
Abundance
10000
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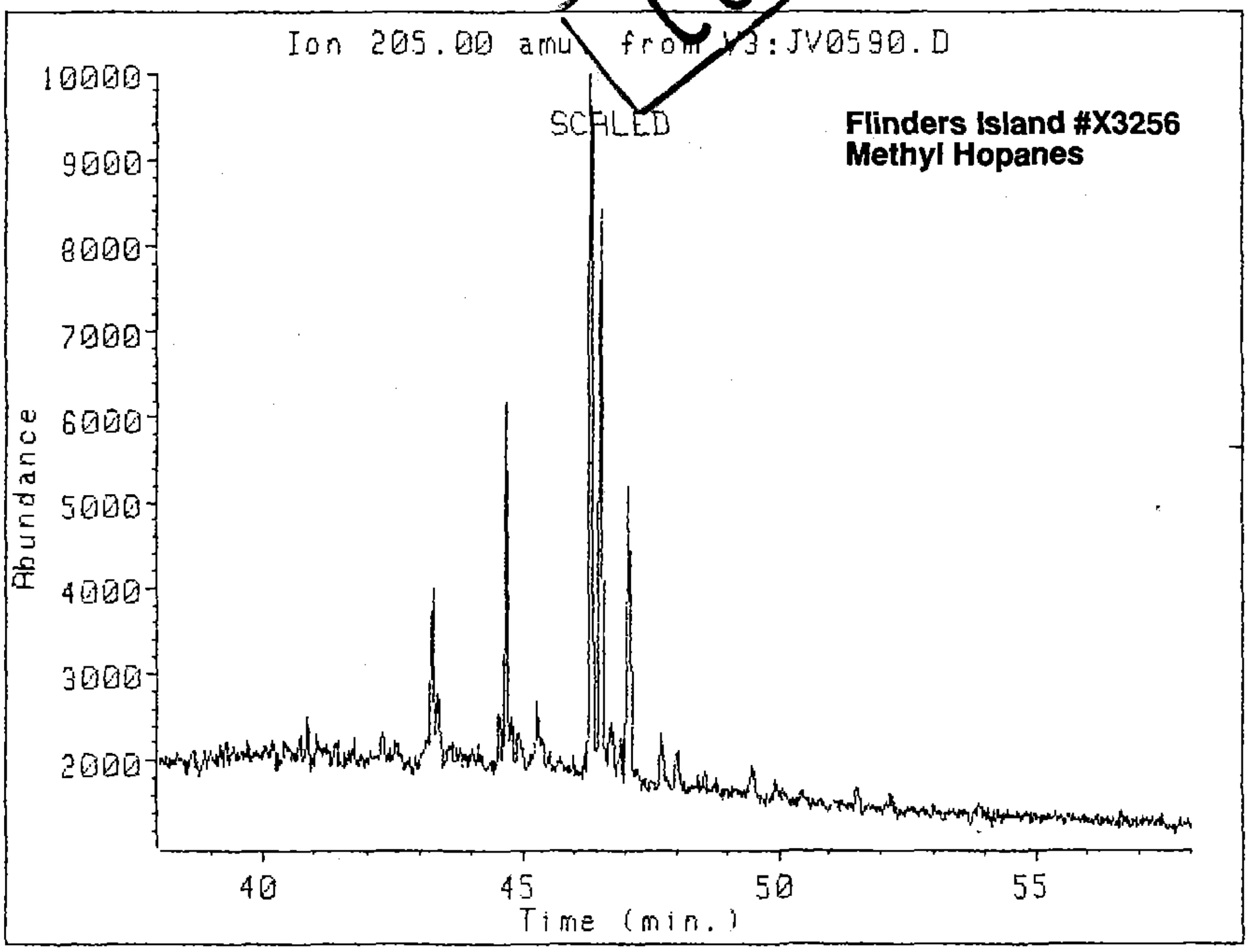
0
40
45
55
Time (min.)
COPY


Ion 205.00 amu. from V3:JV0590.D
SCALED
Flinders Island #X3256
Methyl Hopanes
Abundance
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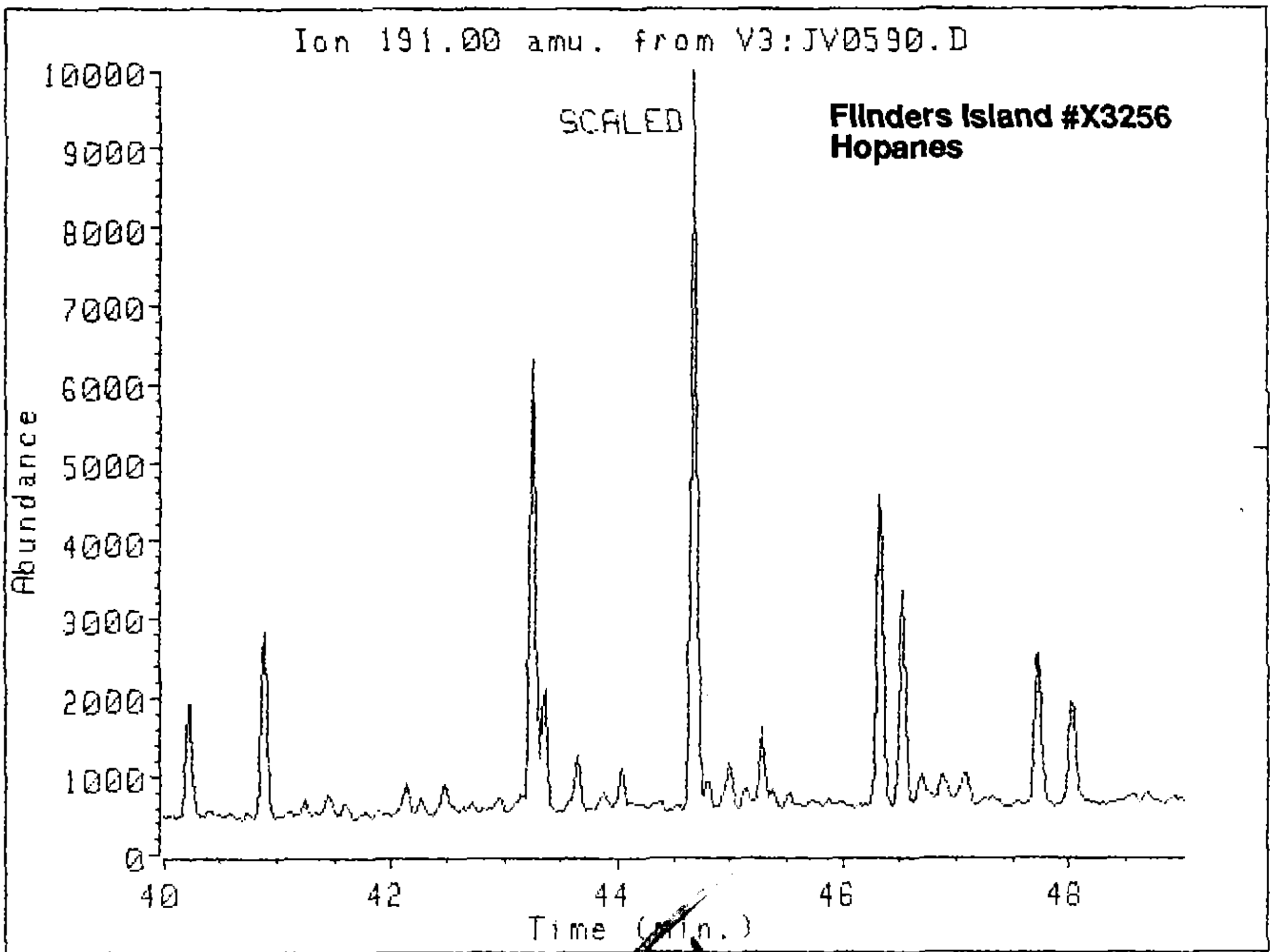
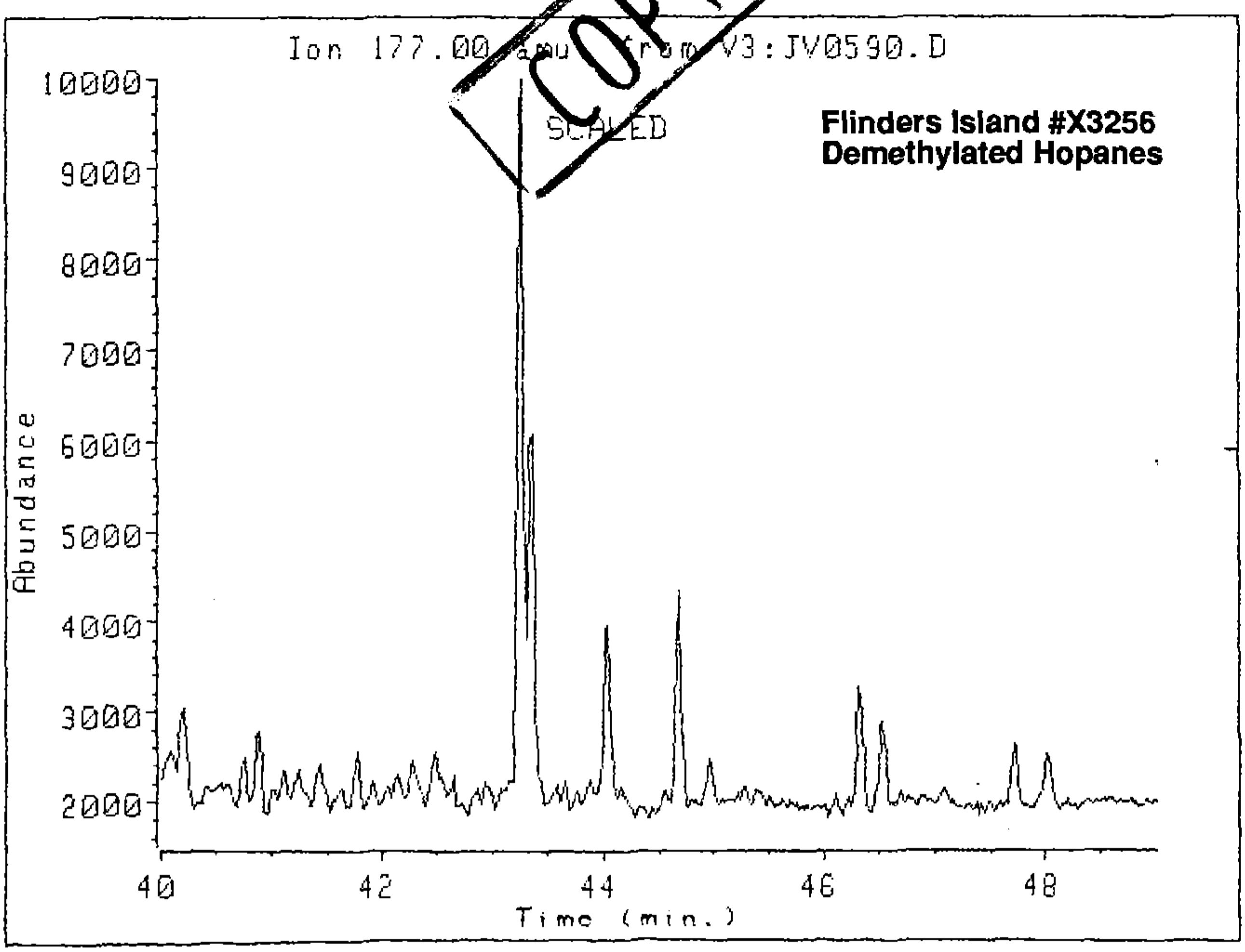
Time (min.)


Ion 191.00 amu. from V3:JV0590.D
SCALED
Flinders Island #X3256
Hopanes
Abundance
Time (min.)


Ion 177.00 amu. from V3:JV0590.D
SCALED
Flinders Island #X3256
Demethylated Hopanes
Abundance
Time (min.)