CSIR REPORT
EMA-C 8878

Earth, Marine and Atmospheric Science and Technology

Aard-, Mariene en Atmosferiese Wetenskap en Tegnologie

CSIR

WNNR

ST LUCIA DREDGING MONITORING

submitted to
Natal Provincial Administration – Roads Department

August 1988

COUNCIL FOR SCIENTIFIC AND INDUSTRIAL RESEARCH
DIVISION OF EARTH, MARINE, ATMOSPHERIC SCIENCES AND TECHNOLOGY

CSIR CONTRACT REPORT

CONDITIONS OF USE OF THIS REPORT

1. This report is the property of the sponsor who may publish it provided that

   (a) the CSIR is acknowledged in the publication;

   (b) the report is published in full or, where only extracts there from or a summary or an abridgment thereof is published, the CSIR's prior written approval of the extracts, summary or abridged report is obtained;

   (c) the CSIR is indemnified against any claim for damages which may result from publication.

2. The CSIR will not publish this report or the detailed results without the sponsor's prior consent. The CSIR is, however, entitled to use technical information obtained from the investigation but undertakes, in doing so, not to identify the sponsor or the subject of this investigation.

3. The contents of reports may not be used for purposes of sale or publicity or in advertisement without the prior written approval of the CSIR.

DIVISION OF EARTH, MARINE, ATMOSPHERIC SCIENCE AND TECHNOLOGY

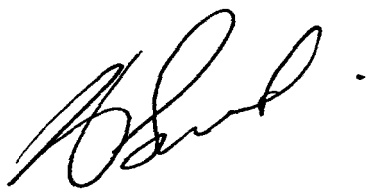
COASTAL PROCESSES AND MANAGEMENT ADVICE PROGRAMME

ST LUCIA DREDGING MONITORING

SCOPE

The Coastal Processes and Management Advice Programme of the CSIR was commissioned in 1987 to monitor the dredging of the St Lucia mouth area. The aim of this dredging is to manipulate the size of the estuary mouth and the monitoring thereof will aid the determination of a unique relationship between the amount of dredging done and the size of the estuary mouth, thereby providing information for the future management of the St Lucia estuary and the lake.

This report is mainly a data report summarising the data from June 1986 to March 1988 and assessing the project with a few preliminary conclusions. The report was compiled by Mr P Badenhorst and was edited for technical content by Dr D H Swart.



D H SWART
PROGRAMME MANAGER

Stellenbosch, South Africa
August 1988

CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF FIGURES (Continued)

LIST OF FIGURES (Continued)

LIST OF FIGURES (Continued)

1. INTRODUCTION

After the Domoina - floods of 1984 Dr's Swart and Van Heerden of the then National Research Institute for Oceanology of the CSIR compiled a report in which management recommendations for the St Lucia mouth area were made. In short it was recommended that the mouth be allowed to shift naturally, with no training walls, provided that it be dredged to ensure a large enough cross-sectional area to allow proper tidal exchange in the Narrows. To evaluate the dredging a monitoring programme was recommended and cross-sectional surveys were started in June 1986.

The aim of this dredging is to dredge in the main channel on the right bank side of the river between Profiles D3 and D4 (Figure 1) in order to create a sand trap in which sand entering the estuary is trapped and then removed. This sand is pumped via a pumpline back to the beach about 2 km north of the mouth. It is therefore important to allow sand banks to be formed in the estuary on the left bank side of the river at this site to "force" the water and transported sediment more to the right bank and the sand trap.

In a letter dated 14 May 1987 the Roads Department of the Natal Provincial Administration contracted the now Coastal Processes and Management Advice (CPMA) Programme of the CSIR to monitor the dredging of the St Lucia mouth area. The monitoring programme includes the following:

1) Cross-sections are taken every 200 m for the first 2 km of the estuary starting at the inner edge of the surf zone every two months (Figure 1). These surveys are done by the Natal Roads Department.

2) Sediment samples are taken at each cross-section at the time of the survey. These samples are analysed by the Geology Department of the University of Natal.

3) Aerial photographs are taken at the time of the survey or as near to this time as practically possible. This is organised by the Natal Roads Department.

4) Dredging times are logged on the dredger.

5) Regular salinity measurements are done by the Natal Parks Board, which are made available for correlation purposes.

Under the contract the CPMA Programme analyses all data (Task 2 was subcontracted to the University of Natal), with the aim of formulating a mouth management policy.

As set out in the above-mentioned letter the contract is to be assessed at the end of the first year. This report therefore summarises the available data with the aim of assessing the progress of the monitoring programme. Chapter 2 contains all available data, with the preliminary conclusions in Chapter 3. Future work is outlined in Chapter 4. Data for Section 2.4 were supplied by Dr T Mason of the Geology Department of the University of Natal since this part of the work was subcontracted to the University when Dr I van Heerden left the CSIR.

It is very important to note that all levels in this report refer to the estuary mean level (EML), which is 0,455 m higher than the mean sea level (MSL).

In an effort to solve any unforeseen problems it was decided to hold a monthly reclamation site meeting at St Lucia, starting from 23 October 1987. The CSIR was represented at the meetings by Dr Mason, with the idea that Mr P Badenhorst was to attend four times a year. These meetings were fairly successful but unfortunately decisions were not always carried out.

2. AVAILABLE DATA

2.1 Cross-sections

Ten surveys from June 1986 to April 1988 are available. The surveys were undertaken by the Natal Roads Department and the plotted profiles were sent to the CSIR. With each survey 19 cross-sections were surveyed. Figure 1 shows the location of Cross-sections D1 to D10. Between D3 and D4 a further nine cross-sections, 20 m apart, were also surveyed to give a better indication of the dredged area. These latter surveys were started in October 1986.

The cross-sections of the 10 surveys for D1 to D10 are shown in Figures 1a-j to 10a-j. A comparison for the surveys of each cross-section for D1 to D10 is shown in Figures 11 to 20. The cross-sections for D3A to D3I are shown in Figures 21a-h to 29a-h with the comparison of cross-sections for the eight surveys shown in Figures 30 to 38.

The cross-sectional area for each cross-section (to the EML + 8 m level) was calculated and the results are shown in Tables 1 (D1 to D10) and 2 (D3A to D3I). These values were then plotted in Figures 39 and 40.

Comparison of the profiles in Figures 11 to 20 clearly shows the dynamic nature of the study area, especially Profiles D1 to D4. Another interesting point is that fairly general sedimentation has taken place for Profiles D6 to D10. This tendency can also clearly be seen in Figure 39, where the biggest decrease in cross-sectional area for Profile 8 is about 15 percent. The decrease for Profile 6 is about 4 percent. Furthermore, the northernmost part of the mouth area (Profiles D1 to D3) has moved northward by about 30 m and except for Profiles D1 and D2 it does not seem as if the floods of the end of September 1987 have had any major scouring effect (Figure 39).

Figures 30 to 38 clearly show that the dredger had moved around considerably from the left to the right bank and had not been stationary in the channel on the right bank side. The deepest depth that the dredger reached was -10 m and the dredged channel was on average less than 100 m wide. Figure 40 shows the changes in cross-sectional area for Profiles D3A to D3I and similarly to Figure 39 there seems to be no increase in the cross-sectional area as a result of the September 1987 floods.

2.2 Dredging Cuts

No dredging volume meter is available on the dredger and it was therefore decided to use a unit dredging rate as a comparison of volume of sand dredged. The dredging cuts registered on the dredger were therefore counted and summarised for monthly periods. These are shown in Table 3 and the values are plotted in Figures 39 and 40.

Figures 39 and 40 show that the amount of dredging varied considerably from month to month and that there is a response in cross-sectional area due to dredging. For Profiles D3A to D3I, the area in which the dredging is taking place, there is a direct response. For Profiles D1 to D10 there is a response for Profiles D1 to D4, with very little response for the other profiles. These responses do not, however, follow a pattern for the different profiles. Owing to the fact that the dredger moved around this variable cannot be ruled out in trying to find the reason for the variable response.

2.3 Aerial Photographs

Nine sets of aerial photographs from 22 May 1986 to 3 February 1988 are available. Features of these photographs were drawn on the same scale in Figures 41a to 41i (see the list of figures for the list of available photographs).

The figures also show the dynamic nature of the mouth area, with the formation of sand banks and the shifting of the mouth channel (area of Profiles D1 to D4). The moving around of the dredger and the introduction of a second dredger (Figure 41g, 11/8/87) can also be seen. When comparing Figures 40f and 41g it can be seen that the sand banks upstream of the pipe are smaller on the photographs of 11 August 1987 (Figure 41g), which is possibly due to the introduction of the second dredger.

The photograph of 6 October 1987 (Figure 41h) taken after the September 1987 floods shows even fewer sand banks and a wide open mouth, which is again narrower on the aerial photograph of 3 February 1988 (Figure 41i).

2.4 Sediment Samples

Since the start of the monitoring programme in 1986 sand samples have been taken on each profile line. When Dr Mason started to look into this data at the end of 1987, it was decided to start collecting samples in a specific way, since samples had been taken at random with no fixed position on the profile. From February 1988 six samples were taken on each profile line and the position of each was surveyed. These data have since been analysed by Dr Mason's department.

Analysis of these sand samples indicates that in the lower estuary (from the mouth upstream for about 800 m) the sand is marine- derived and this wedge is moving upstream. Upstream of this section to Honeymoon Bend the sand is estuarine-derived, which means that these sediments are being transported from the Narrows and possibly from the Mfolozi.

The sedimentation taking place from Profiles D6 to D10 is therefore mainly estuarine-derived but the situation is being dramatically aggravated by the marine sand wedge, already at Profile D5, now moving further upstream.

2.5 Discussion

From the previous data description it is clear that the monitoring programme is successful in providing information on the changes taking place in the mouth area due to natural processes and dredging. Monitoring of the profiles and the sand samples will with time be able to describe the process of sedimentation in the lower estuary area. It is therefore important to continue with the programme until such time as the processes are clearly understood.

The aim of this contract, however, is to study the effect of the dredging on processes in the mouth area. Thus far the data show that the dredging has an effect on cross-sectional area, although mainly in Profiles D1 to D4. Figures 39 and 40 show the response in cross-sectional area and it seems that there is some delay in response for Profiles D1 and D2, with a direct response for Profiles D3 and D4 and very little response for Profiles D5 to D10. There is no clear pattern from these two figures, however, of the effect of the dredging on the cross-sectional area. Comparing Figures 41a to 41i (aerial photographs) with Figures 39 and 40, the scouring of the mouth area during the September 1987 floods is clearly reflected on Profiles D1 and D2 in Figure 39. The use of a second dredger during July/August 1987 (Figure 41g) is possibly also the reason for the increase in cross-sectional area for Profiles D4 and D5 in Figure 39. Furthermore Figures 21a-h to 29a-h clearly show the dredged area and the fact that the dredger moved over the total width of the river.

It was the aim of the dredging operation to create a sand trap on the right bank side of the river and the profile data as well as the aerial photographs clearly show that this condition was not met. During the site meetings this point was repeatedly stressed and although practical problems do exist with the pipeline a serious effort should be made to solve these problems in order to allow the sand bank on the left bank to build up so that maximum amounts of incoming marine sediment can be trapped in the sand

trap dredged by the dredger on the right bank. It is very important to keep this variable constant in order to study the effect of the dredging on cross-sectional area. Another important reason is that the sand analysis shows that a marine sand wedge is moving upstream and the effect of the dredging on this process is not clear. It is possible that marine sand is bypassing the sand trap because there is never a clearly defined trap.

Figures 42a and 42b show the dredging cuts as a ratio of the cross-sectional area for Profiles D1 to D10 and the ratios for Profiles D3A to D3I are shown in Figures 43a and 43b. Figures 42a and 42b show a good correlation in the ratio change for every profile between different surveys. It can therefore be concluded that a specific variable change between surveys (a change in the dredging rate, river flow and, sediment input from the sea or a combination of these) affects all cross-sections in the same relative way.

Figures 42c and 42d, where the effect of dredging is removed, clearly illustrate this point because all the lines fall within a narrow band (note that values for October 1987 and February 1988 are about zero, the reason being that before October 1987 the September floods were experienced, dramatically increasing some of the cross-sectional areas while at the same time little dredging was done).

There is, no correlation however, in change of cross-sectional area when compared with amount of dredging. Possible reasons for this are that the dredger moved around without dredging a proper sand trap, changes in river flow and changes in sediment input through the mouth from the sea due to wave action. Figures 43a and 43b show that there is not a good correlation between the different surveys, possibly because of dredging not having been done consistently or because the dredger moved around and in this way dredged without really affecting the cross-sectional area.

For this study to quantify the effect of the dredging the dredger needs to dredge a sand trap on the right bank side of the river, the sand bank on the left bank side must be allowed to form naturally and furthermore the changes in river flow and sediment input from the sea need to be quantified. It is therefore recommended that the dredger dredge between Profiles D3 and D4 for a width of about 100 m with the centre line about 60 m from Beacon EM4. This area is only a guideline because the mouth area is very dynamic but as a rule the dredger should never move to the left of the centre line of the estuary. Furthermore the dredging cuts used as a dredging volume are considered to be fairly crude and an effort should be made to improve on the amount of sand dredged.

3. PRELIMINARY CONCLUSIONS

From the above the following conclusions can be drawn:

1) The mouth stays open, although the mouth area, especially Profiles D1 and D2, is very dynamic in that sand banks are formed and the mouth channel moves around over a distance of about 300 m.

2) A marine-derived sand wedge is already at Profile 5 and it is moving upstream.

3) Sedimentation at Profiles 6 to 10 is taking place and at this stage the sand is mainly estuarine-derived.

4) The dredger is moving around over the full width of the estuary between Profiles D3 and D4 and for a period a second dredger was also operative.

5) There is a response in cross-sectional area, especially Profiles D1 to D5, as an effect of dredging. For these profiles the effect is delayed and for Profiles D3A to D3I it is direct.

6) Although the ratio of dredging cuts and cross-sectional area is affected in the same way for all profiles, there is no pattern for the amount of dredging relative to the cross-sectional area. This and the intrusion of marine-derived sand are possibly due to the fact that the dredger is moving around and the sand bank on the left bank of the river is not allowed to form naturally. Other possible reasons are changes in river flow and changes in sediment input through the mouth from the sea.

7) It will not be possible to quantify the relationship between dredging and cross-sectional area if the dredger is not working in one specific area and the other variables mentioned in (6) are not quantified.

8) The use of dredging cuts as an indication of the dredging volume is fairly crude.

4. RECOMMENDATIONS

In order to quantify the effect of the dredging on the mouth area and the relationship between dredging and cross-sectional area the following are recommended:

(1) The dredger needs to work in one area in order to create a proper sand trap in the main channel on the right bank side of the estuary. It is therefore recommended that the dredger work in an area about 100 m wide between Profiles D3 and D4. The centre line of this area should be about 60 m from Beacon EM4. This is a guideline area but as a rule the dredger should never move to the left of the centre line of the estuary. In an effort to monitor this, daily position fixes of the dredger should be taken.

(2) The effects of changes in river flow and sediment input from the sea must be investigated to combine their effects with the dredging quantities when calculating cross-sectional area ratios.

(3) The practical problems experienced with the pumpline should be investigated as well as the measurement of the dredged volume.

(4) All the other aspects of the monitoring programme (survey of profiles, sediment samples and analyzing and aerial photographs) should continue.

TABLE 1: Cross-sectional areas (m^2) for Profiles D1 to D10

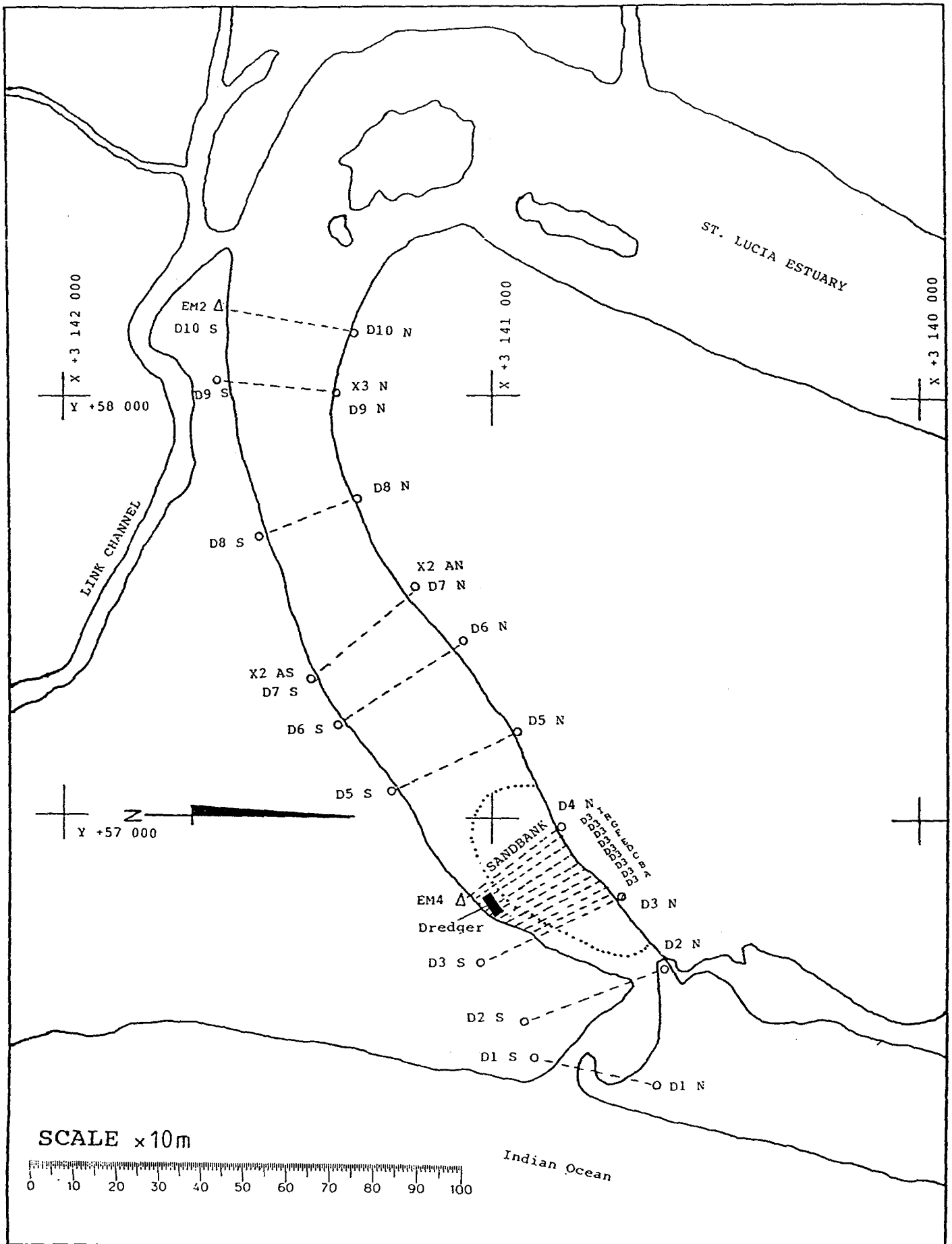
DATE	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10
JUN 86	2969	2996	2835	2983	3484	3760	3402	2958	2782	2970
AUG 86	2946	2824	2779	2970	3519	3726	3430	3014	2830	3058
OCT 86	3074	2966	2959	2865	3454	3751	3478	2918	2761	2973
FEB 87	2878	2861	2590	2869	3532	3755	3455	2988	2841	2980
APR 87	2957	3315	2819	2886	3371	3727	3461	2888	2774	2968
JUN 87	2841	3343	2811	2757	3335	3657	3419	2890	2706	2961
SEP 87	2955	3103	3133	2708	3393	3663	3393	2821	2735	2965
OCT 87	3544	3601	3127	2885	3427	3694	3356	2818	2744	2967
FEB 88	3057	3561	3115	2936	3296	3632	3305	2722	2573	2868
APR 88	3163,3	3220	2924,6	2916,1	3323,1	3567,8	3262,2	2552,9	2692,9	2947,9

TABLE 2: Cross-sectional areas (m^2) for Profiles D3A to D3I

DATE	D3A	D3B	D3C	D3D	D3E	D3F	D3G	D3H	D3I
OCT 86	2039	2662	2561	2887	3159	3239	3136	2835	2557
FEB 87	2131	2537	2499	2719	3272	3260	3126	3029	2965
APR 87	2072	2449	2508	2832	2138	3144	3220	3061	2947
JUN 87	2487	2681	3241	3052	3380	3320	3080	2902	2763
SEP 87	3090	3183	3103	3193	3237	3174	3154	2961	2755
OCT 87	2784	2879	3010	2865	2846	2849	2945	3094	2887
FEB 88	2886	3053	3114	3120	3266	3173	3119	3123	2980
APR 88	2035,5	2859,6	3170,5	3175,3	3193,0	3008,4	3098,1	3054,6	3059,1

TABLE 3: Number of monthly dredger cuts

SEP 86	540
OCT 86	1250
NOV 86	300
DEC 86	590
JAN 87	1610
FEB 87	1880
MAR 87	1770
APR 87	510
MAY 87	1050
JUN 87	1470
JUL 87	2020
AUG 87	421
SEP 86	720
OCT 87	265
NOV 87	501
JAN 88	234
FEB 88	516

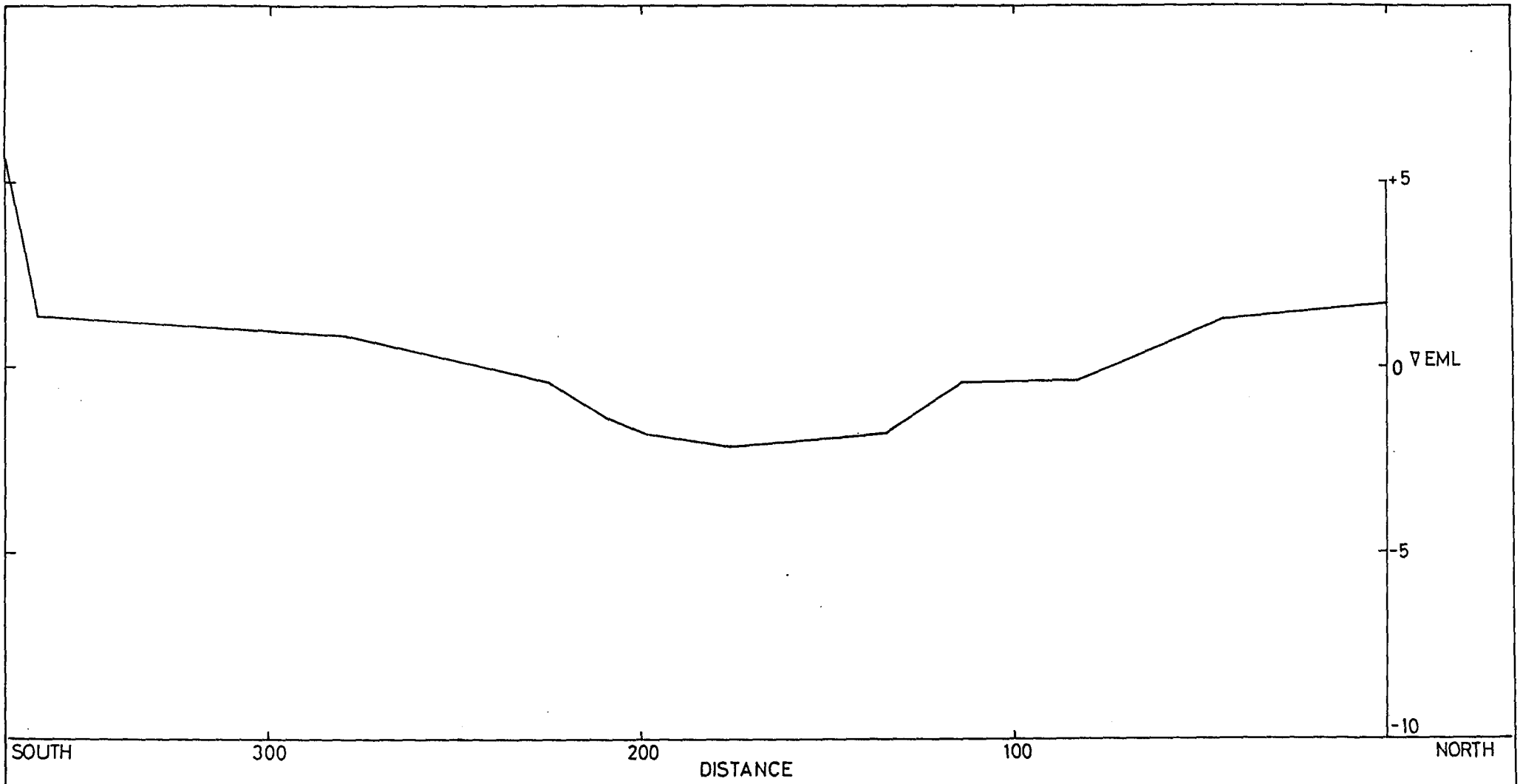


ST.LUCIA ESTUARY

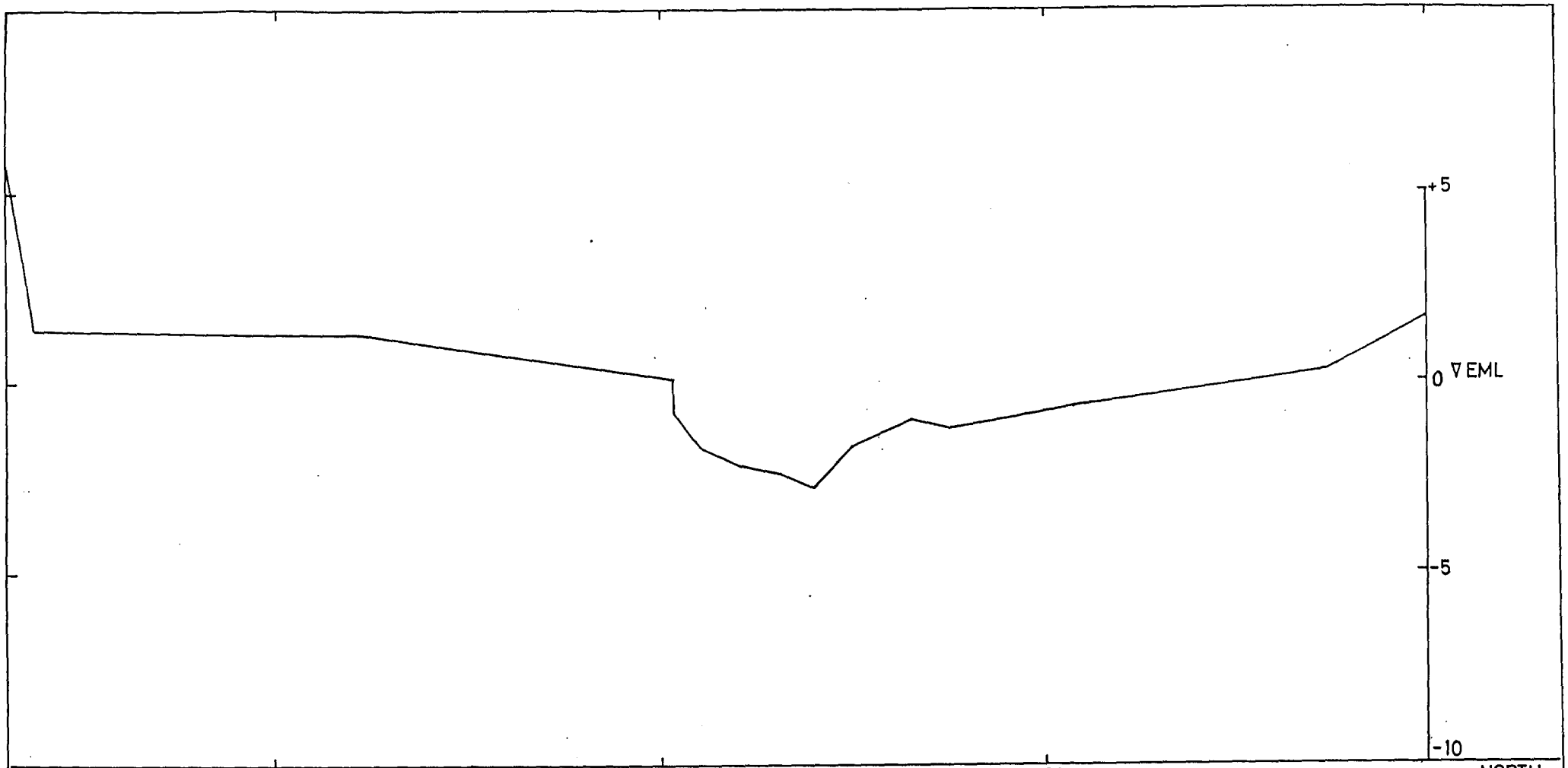
Positions of Cross Sections

FIGURE A

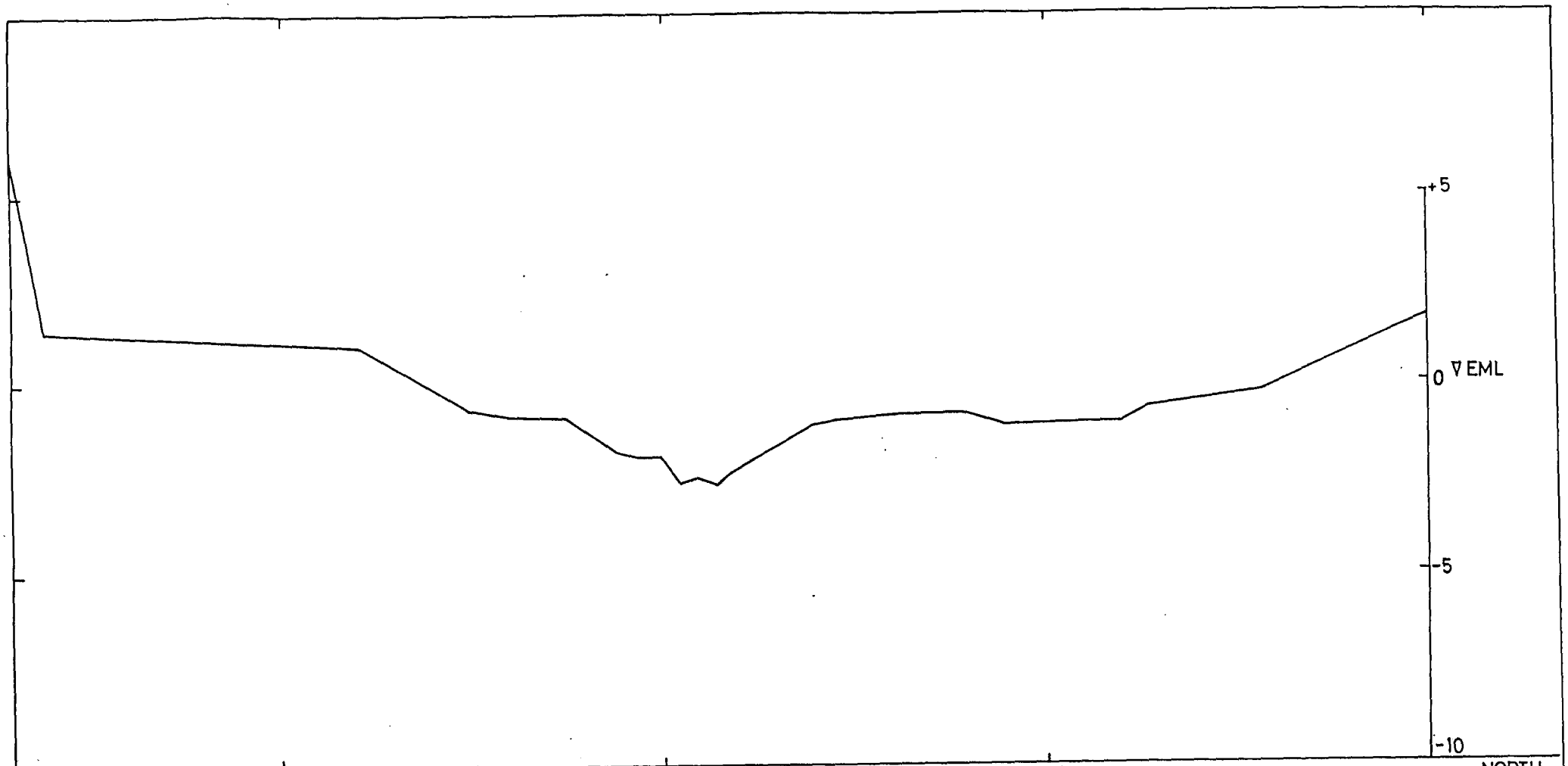
CSIR - EMA



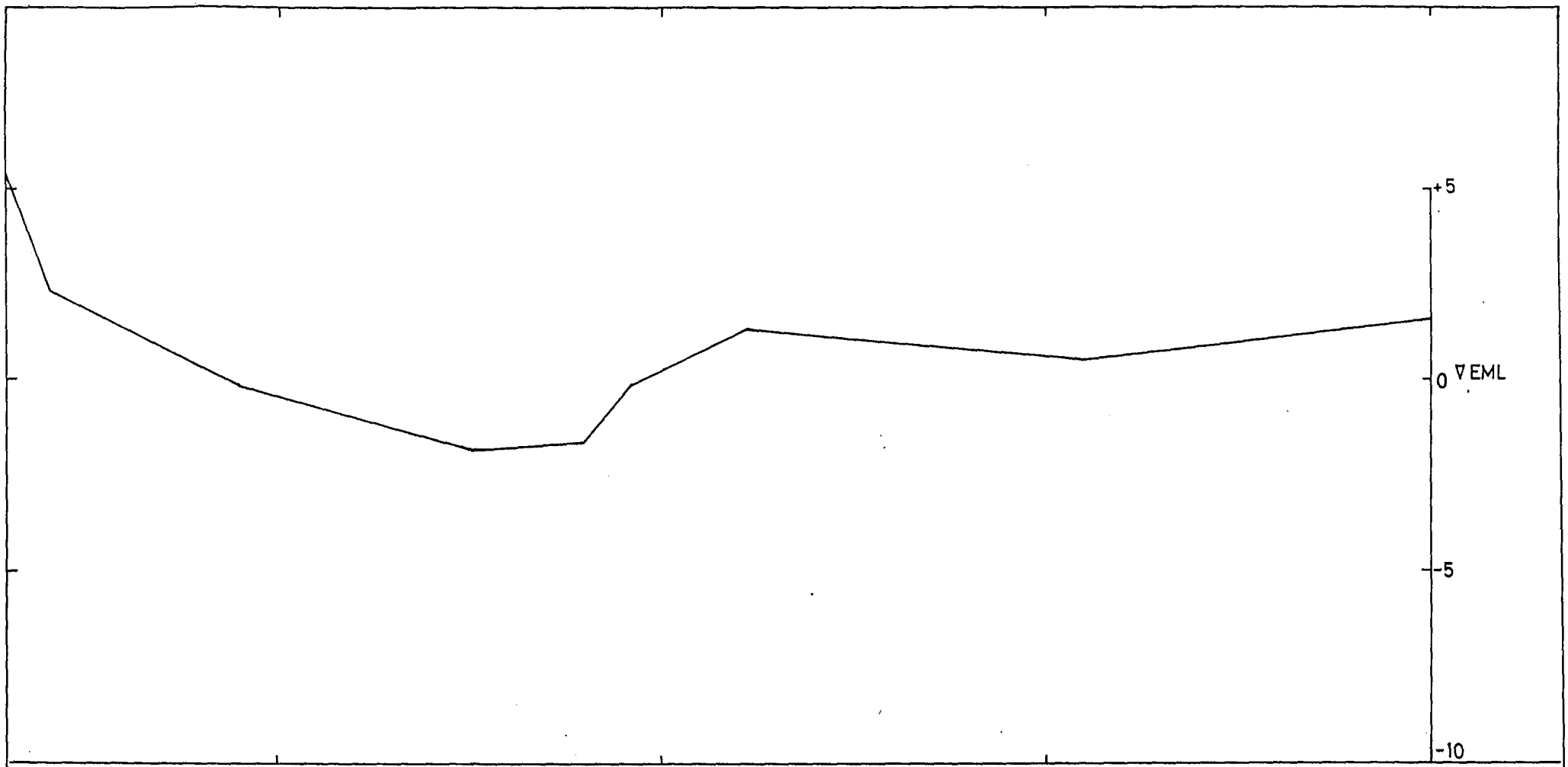
TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS-SECTION D1 - JUNE 1986	FIGURE 1 A
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		



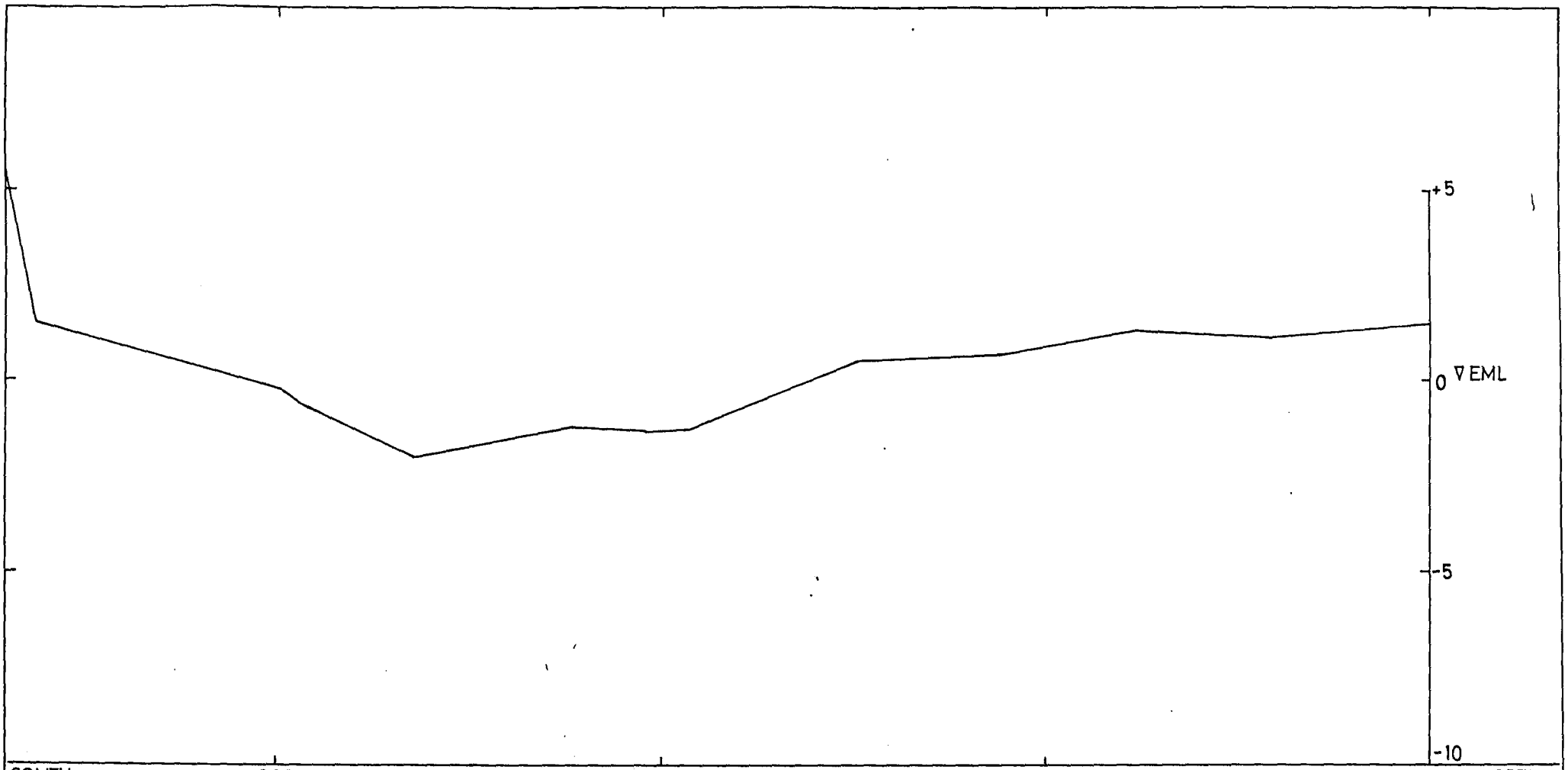
TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS-SECTION D 1 - AUGUST 1986	FIGURE 1B
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		



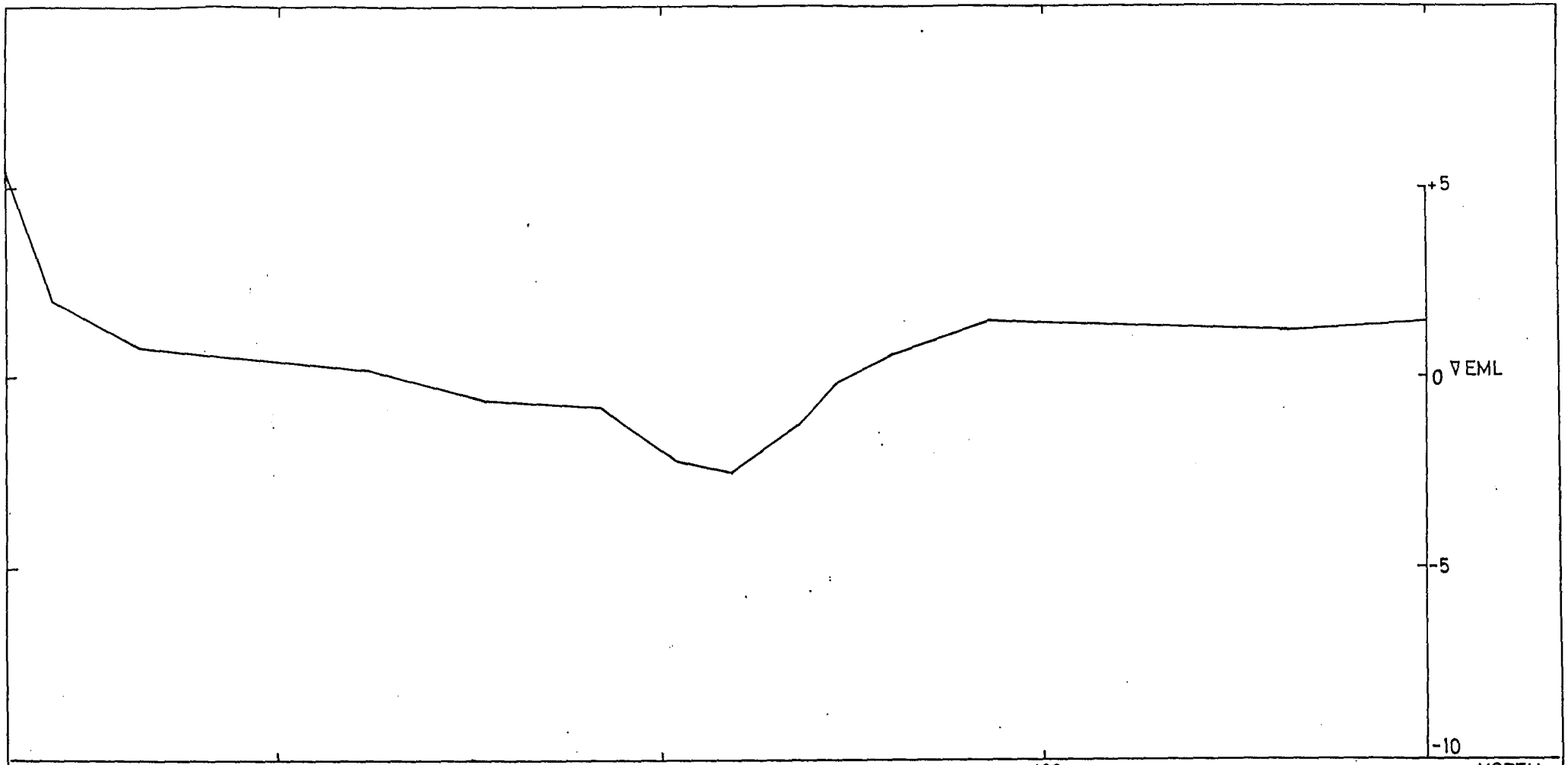
TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS-SECTION D1 - OCTOBER 1986	FIGURE 1C
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		



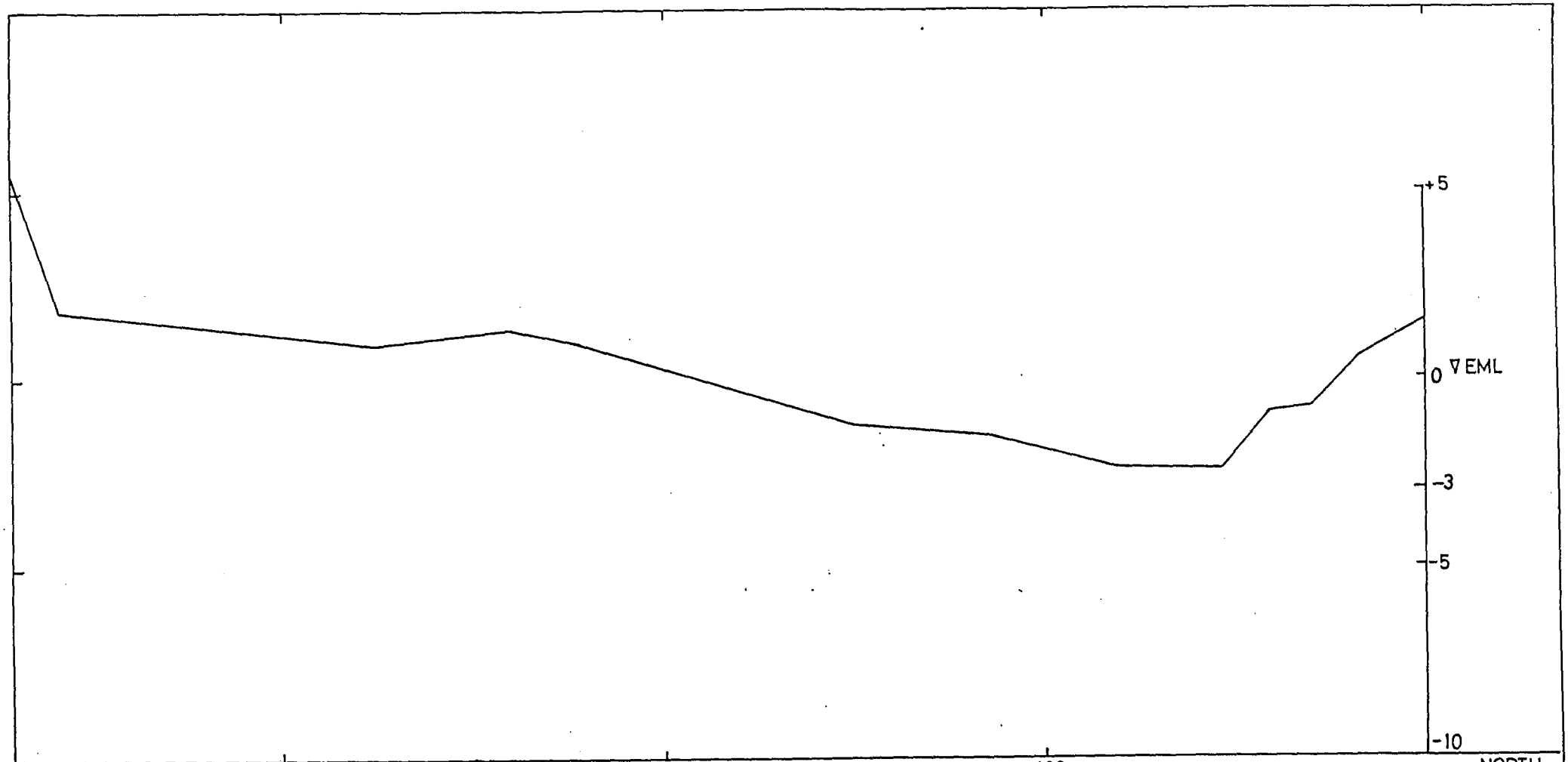
TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS-SECTION D1 - FEBRUARY 1987	FIGURE 10
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		



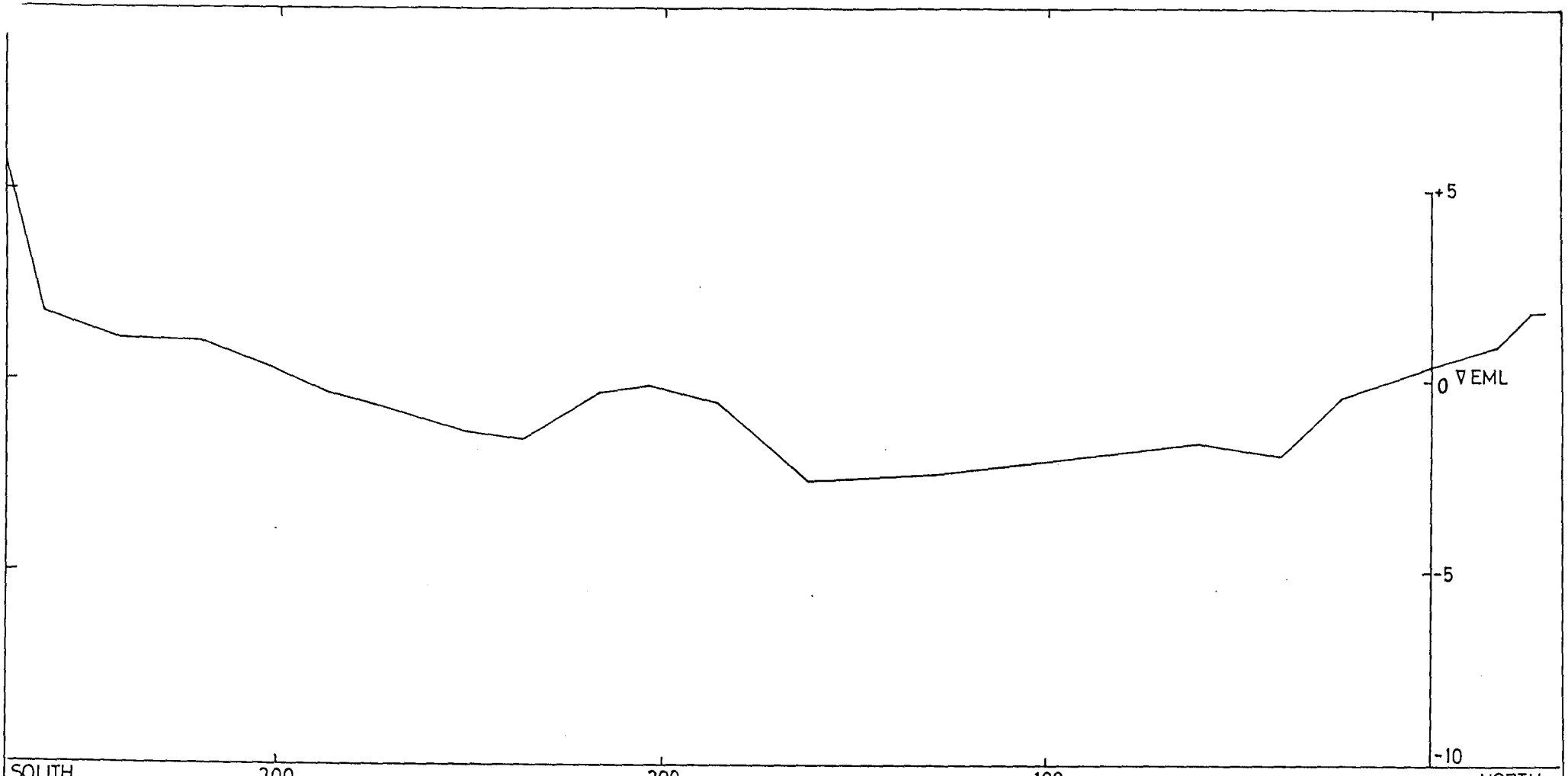
TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS-SECTION D1 - APRIL 1987	FIGURE 1E
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		



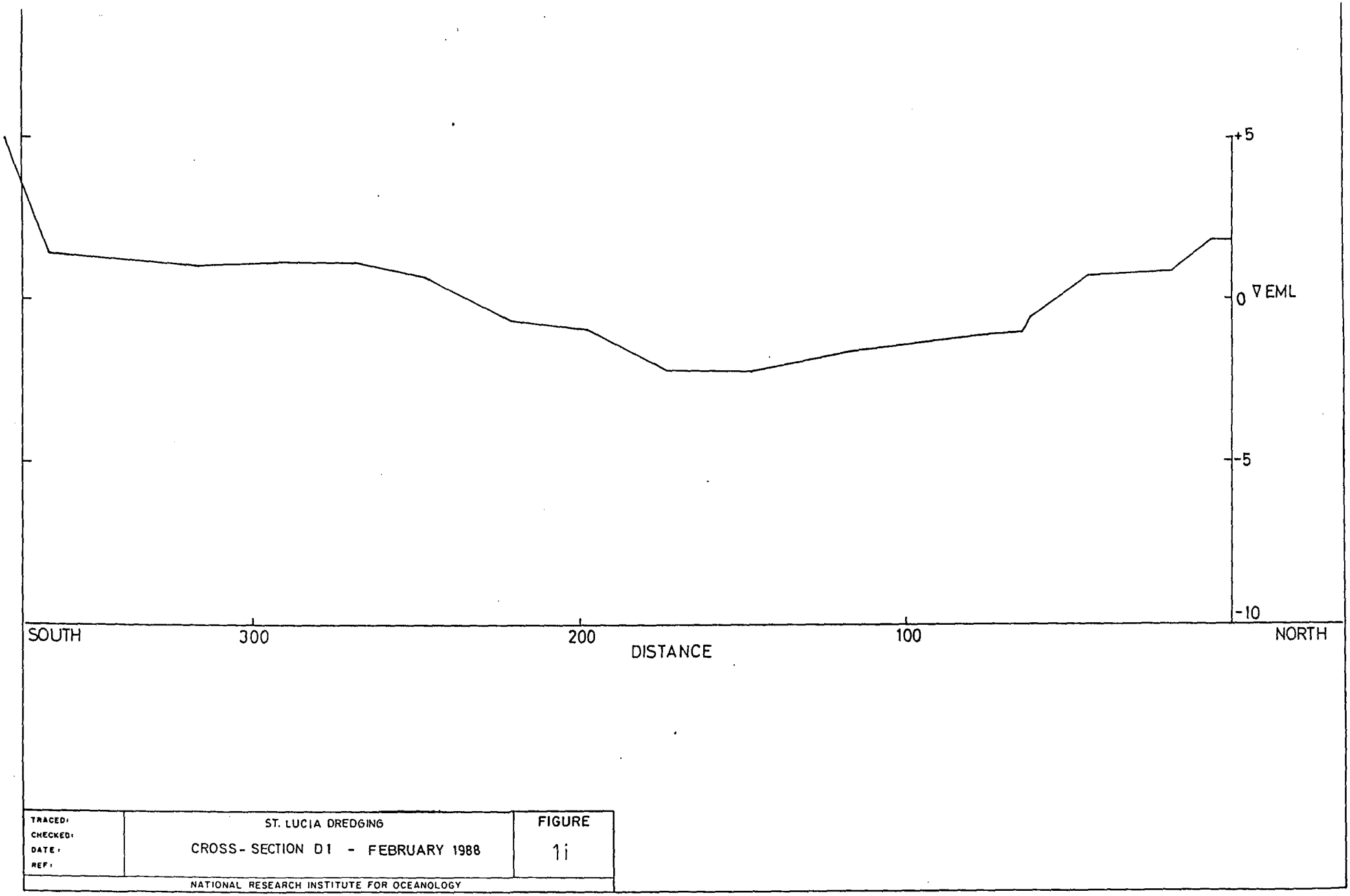
TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS-SECTION D1 - JUNE 1987	FIGURE 1F
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		



TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS-SECTION D1 - SEPTEMBER 1987	FIGURE 16
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		

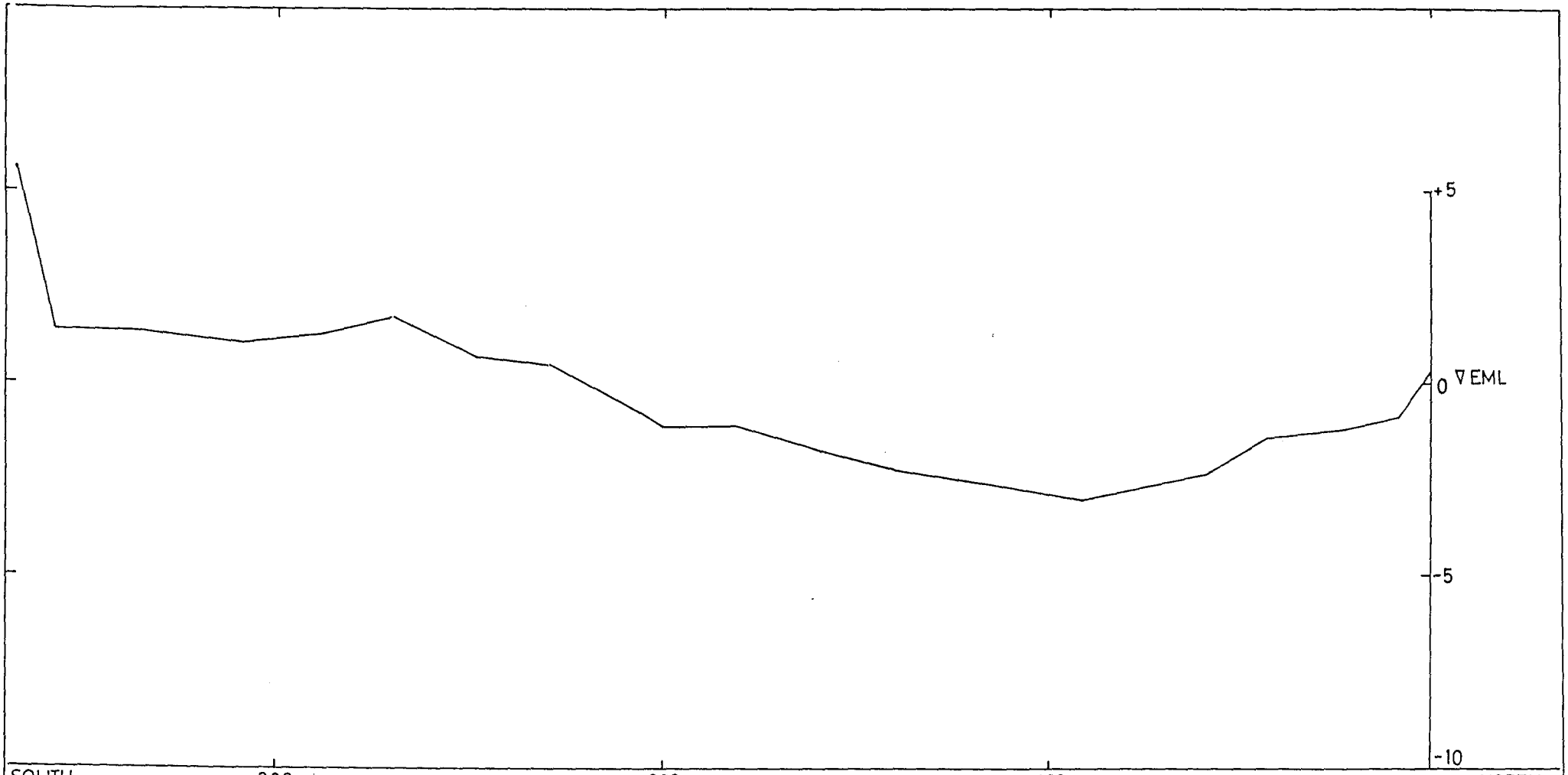


TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS- SECTION D I - OCTOBER 1987	FIGURE 1h
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		

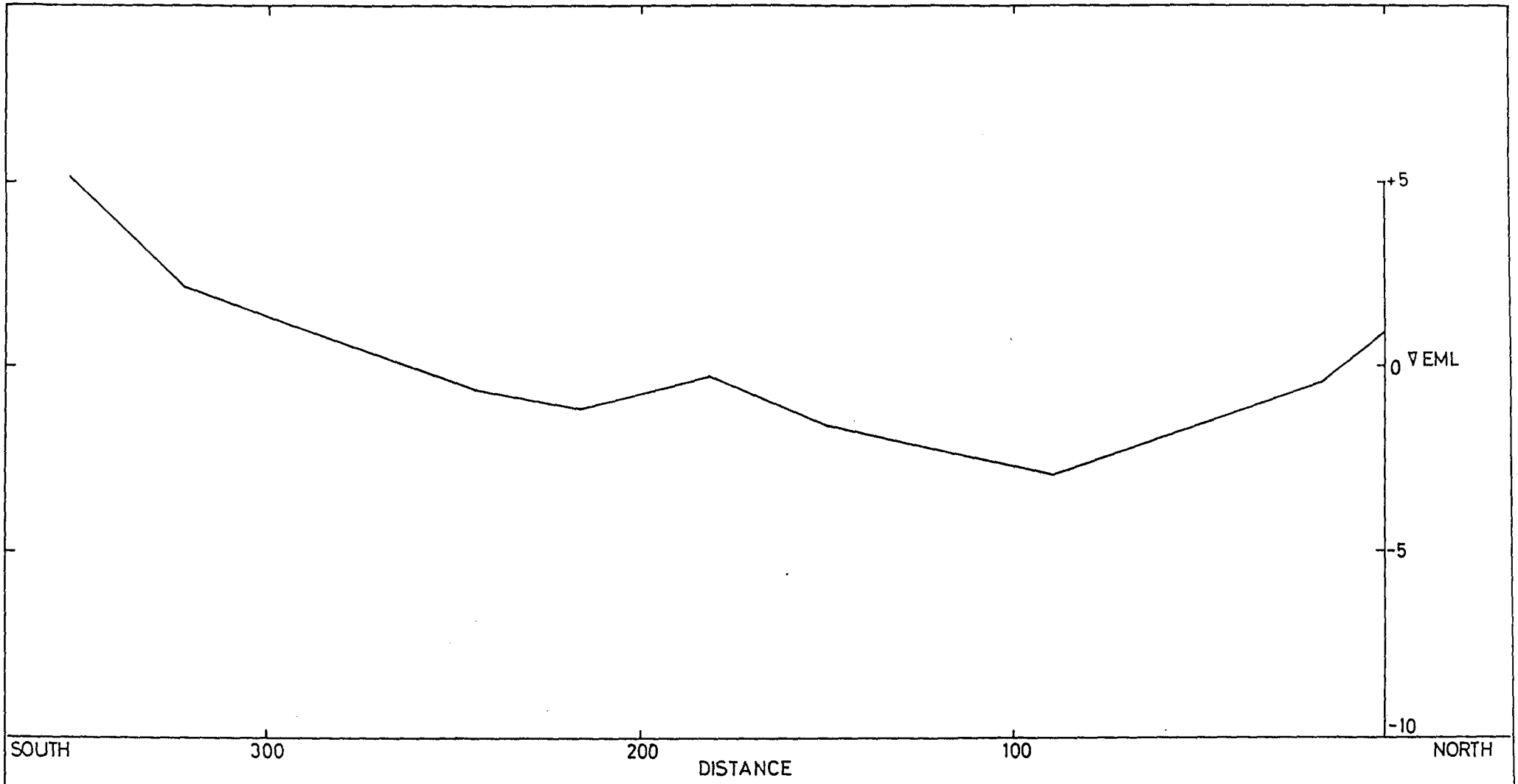


TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS-SECTION D1 - FEBRUARY 1988	FIGURE 1j

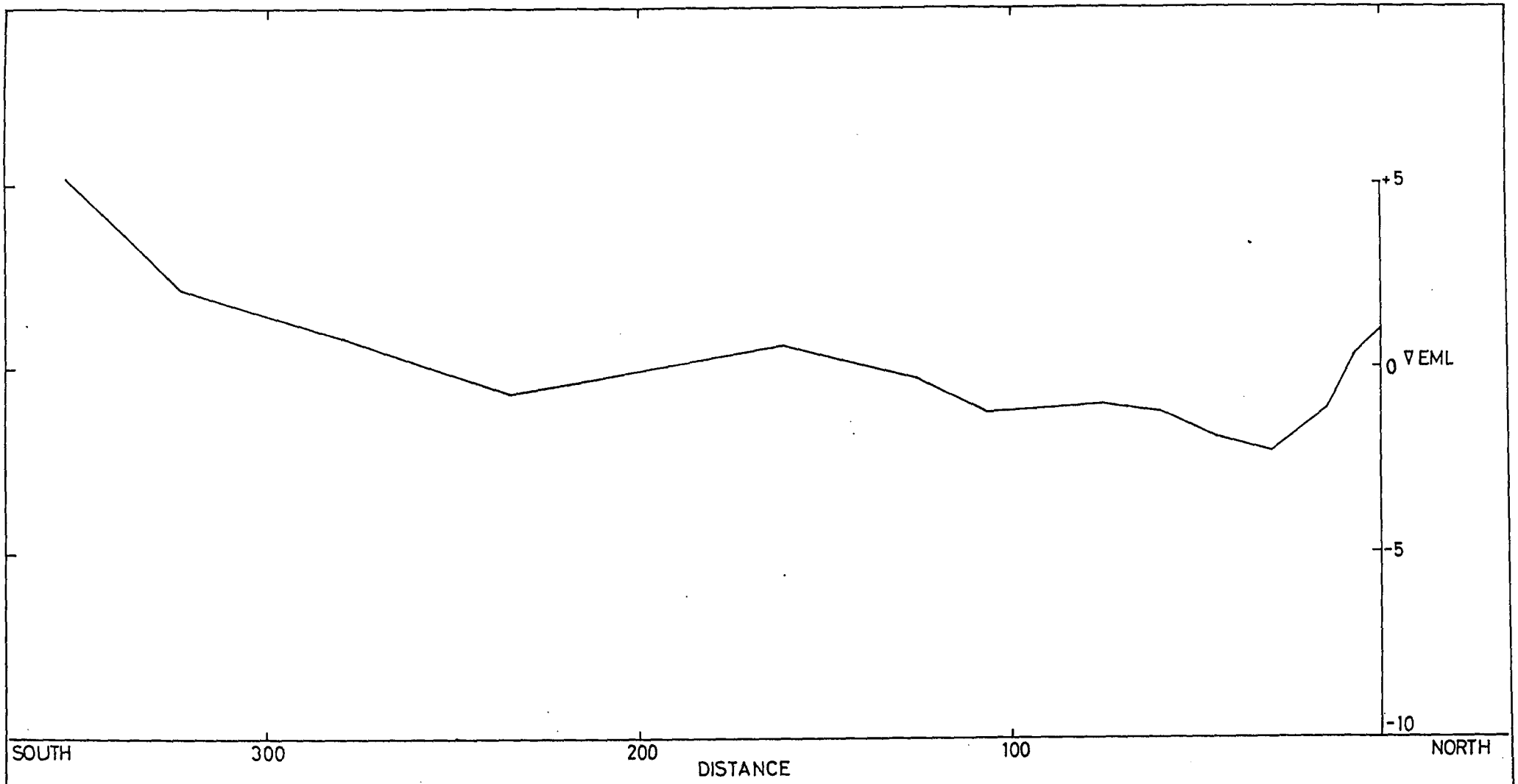
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY



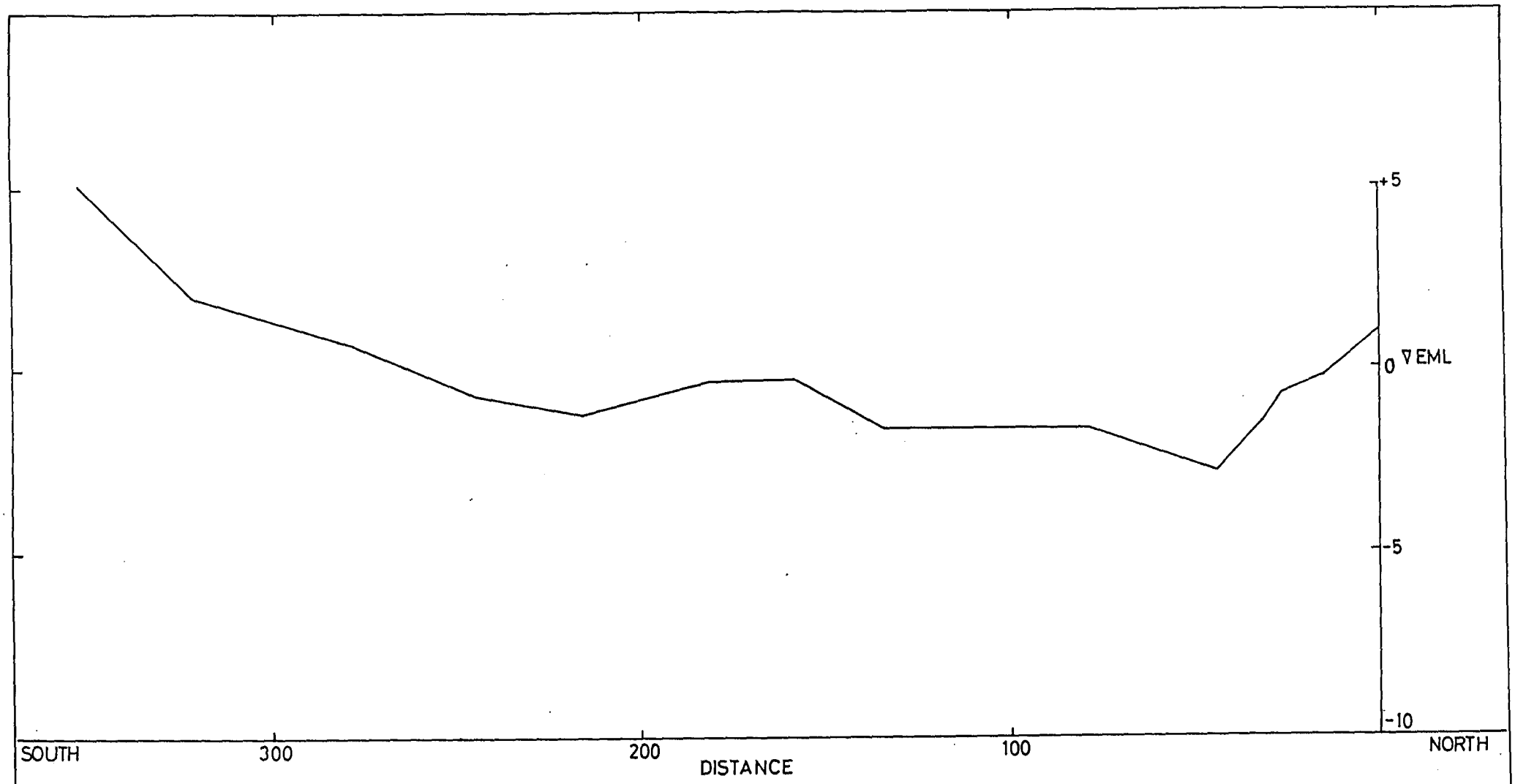
TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS - SECTION DI - APRIL 1988	FIGURE 1j
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		



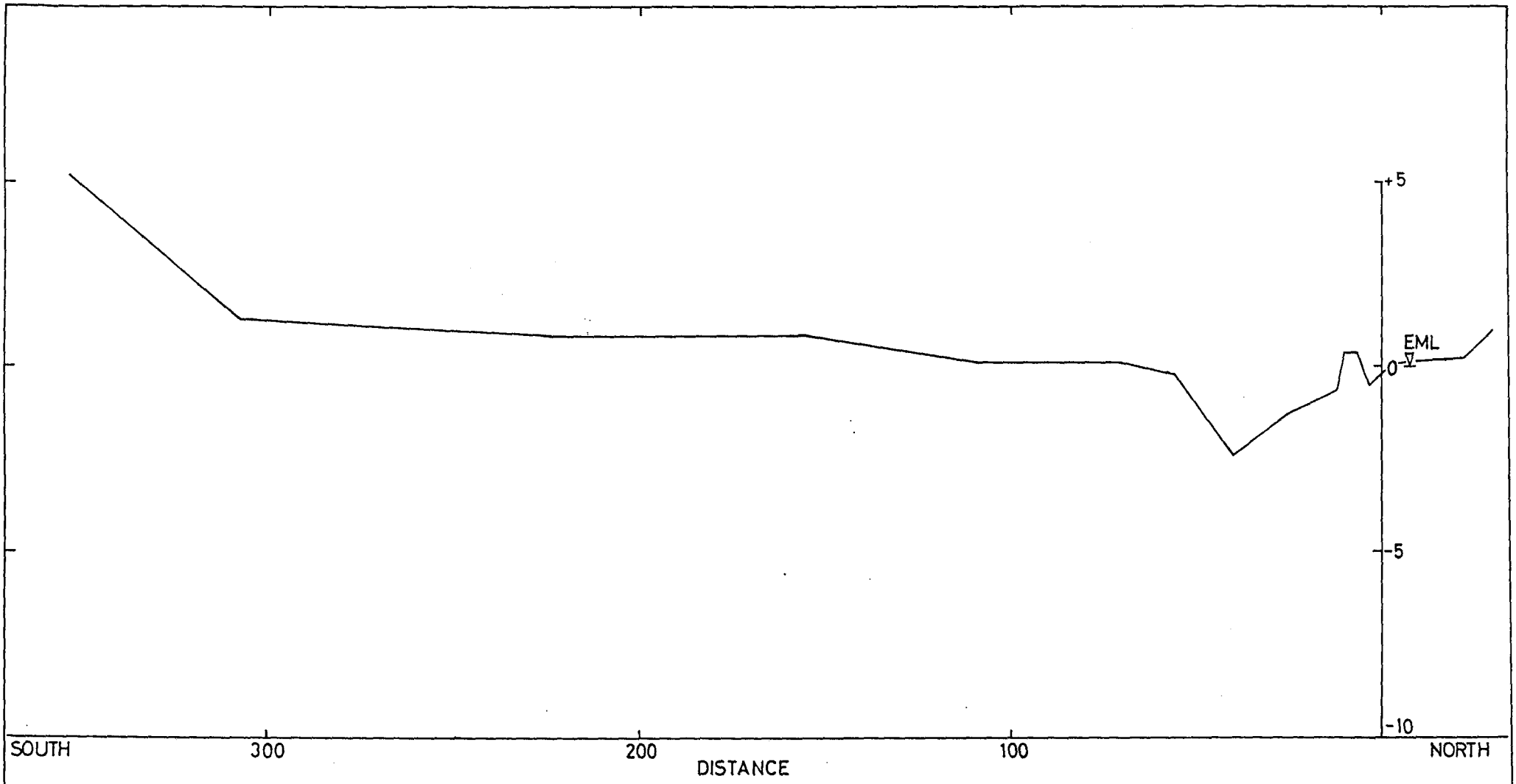
TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS-SECTION D2 - JUNE 1986	FIGURE 2A
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		



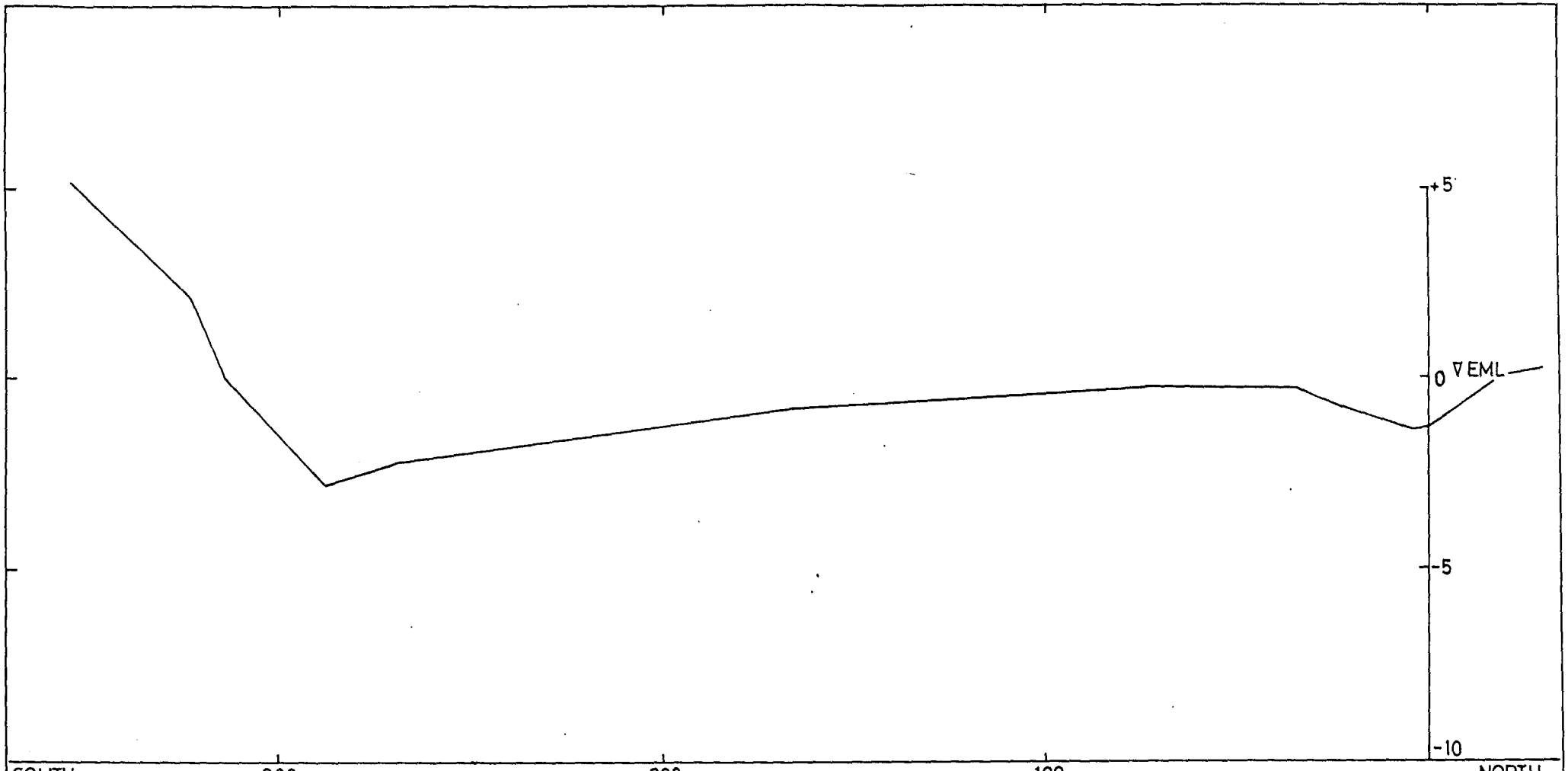
TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS-SECTION D2 - AUGUST 1986	FIGURE 2B
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		



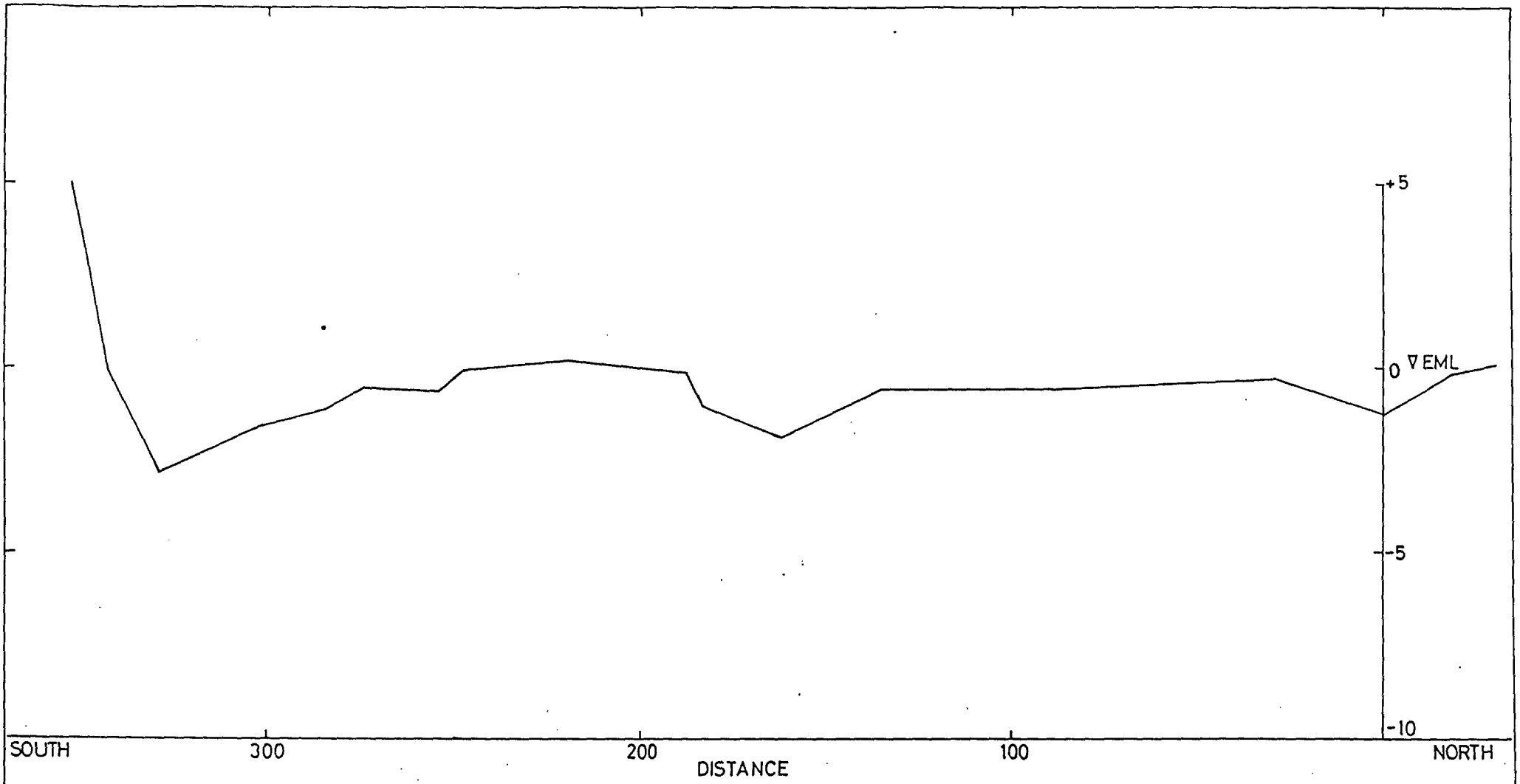
TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS - SECTION D 2 - OCTOBER 1986	FIGURE 2 C
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		



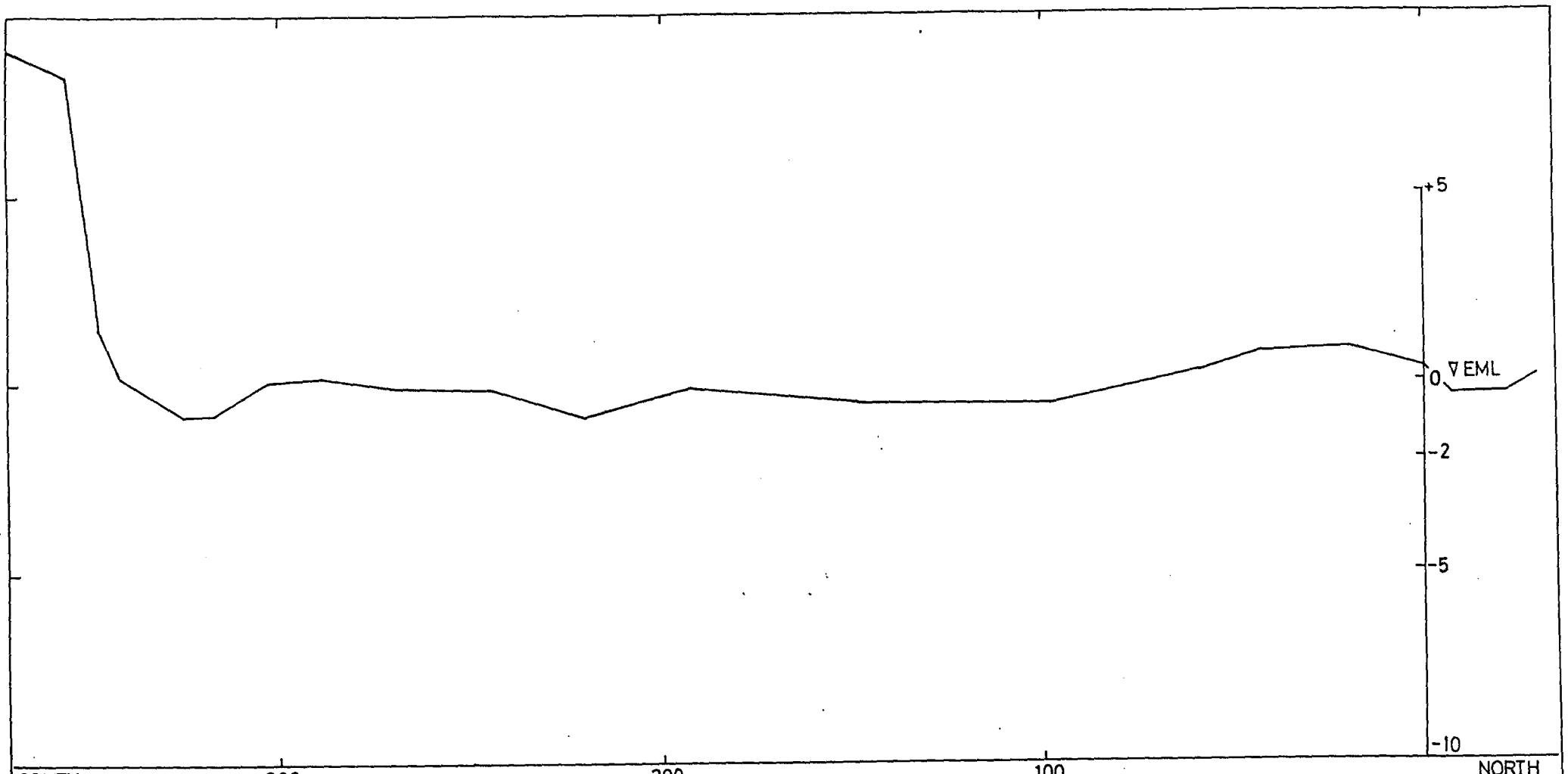
TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS-SECTION D2 - FEBRUARY 1987	FIGURE 2 D
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		



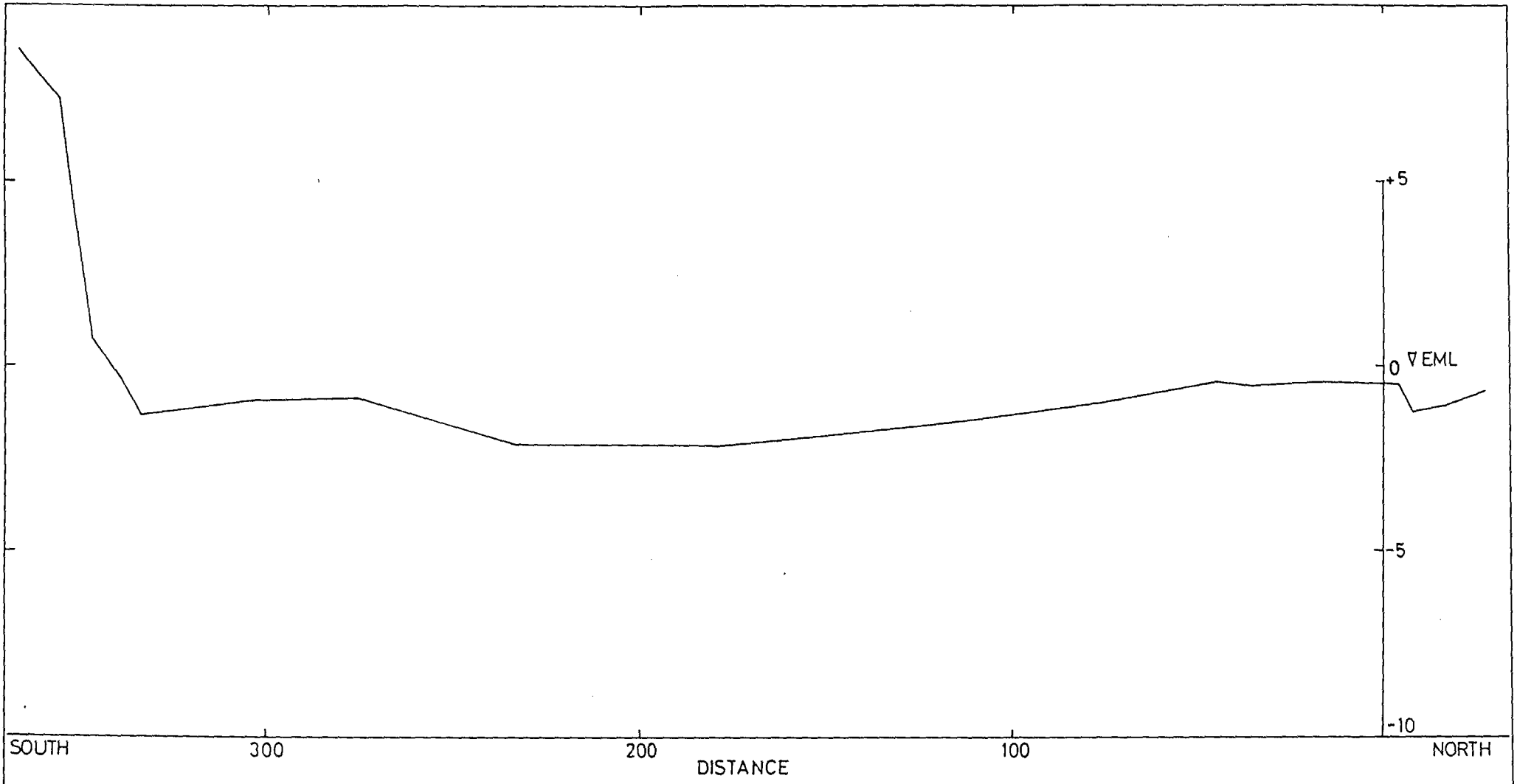
TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS-SECTION D2 - APRIL 1987	FIGURE 2E
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		



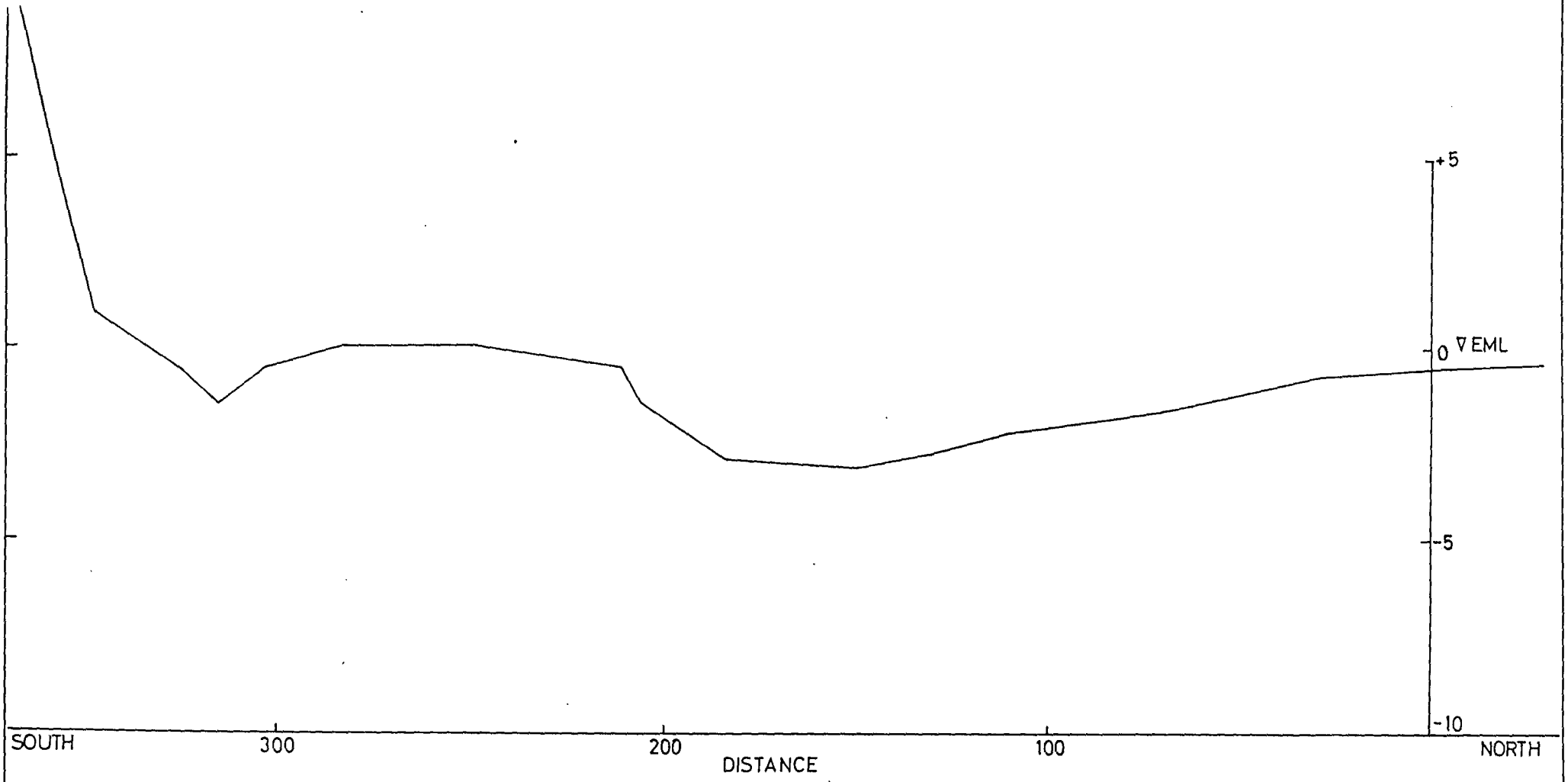
TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS-SECTION D2 - JUNE 1987	FIGURE 2 F
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		



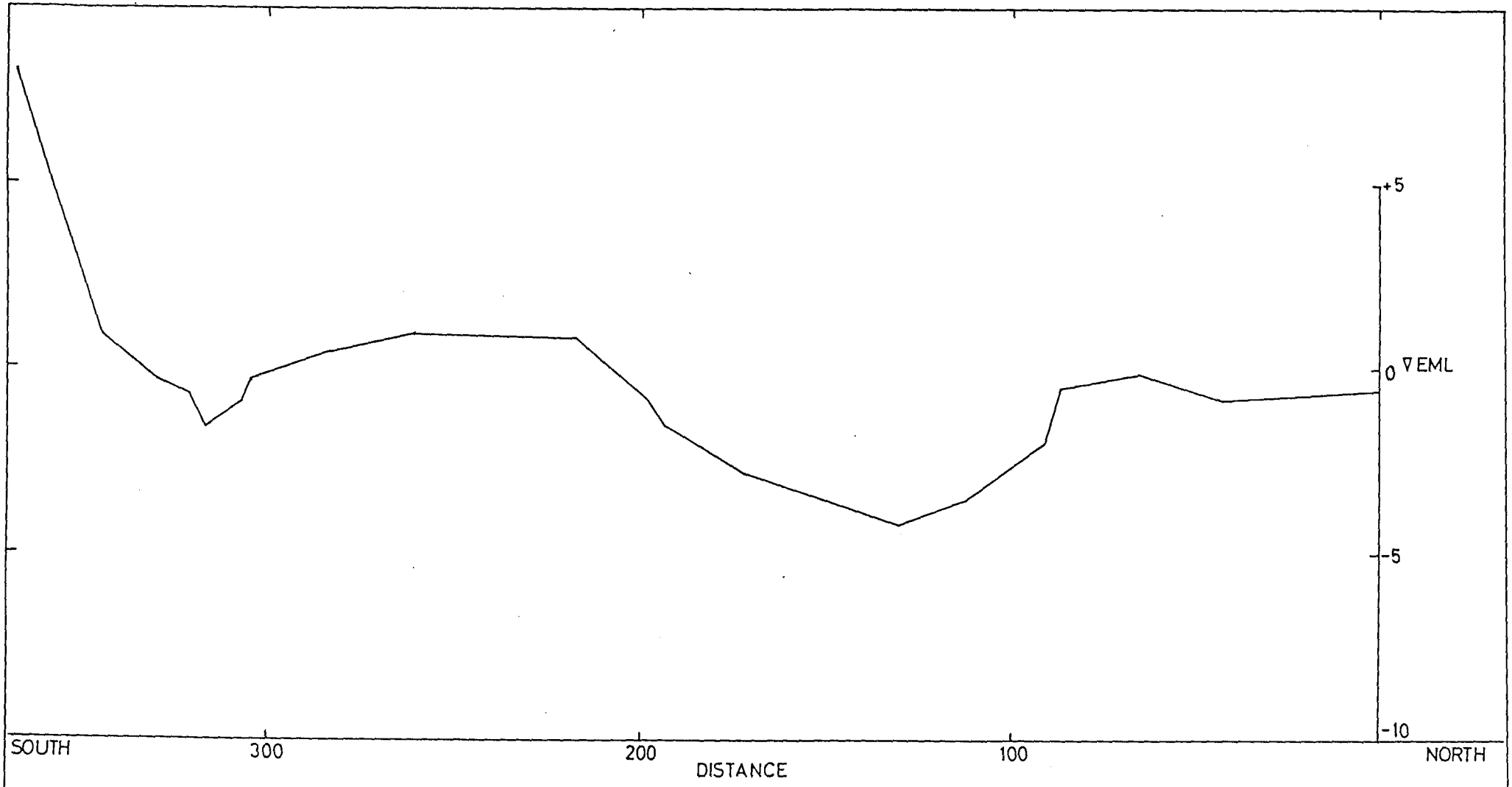
TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS-SECTION D2 - SEPTEMBER 1987	FIGURE 2G
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		



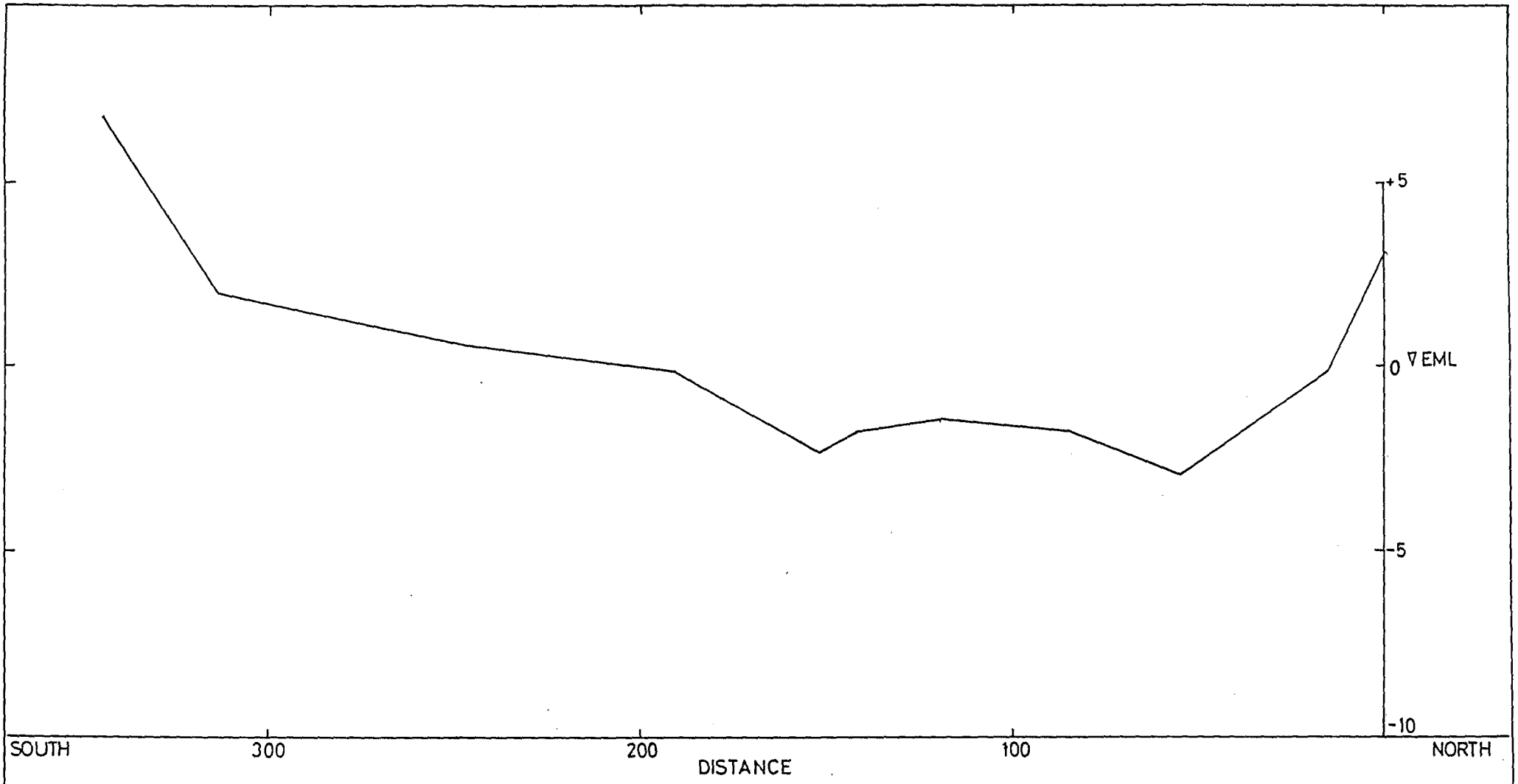
TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS-SECTION D 2 - OCTOBER 1987	FIGURE 2h
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		



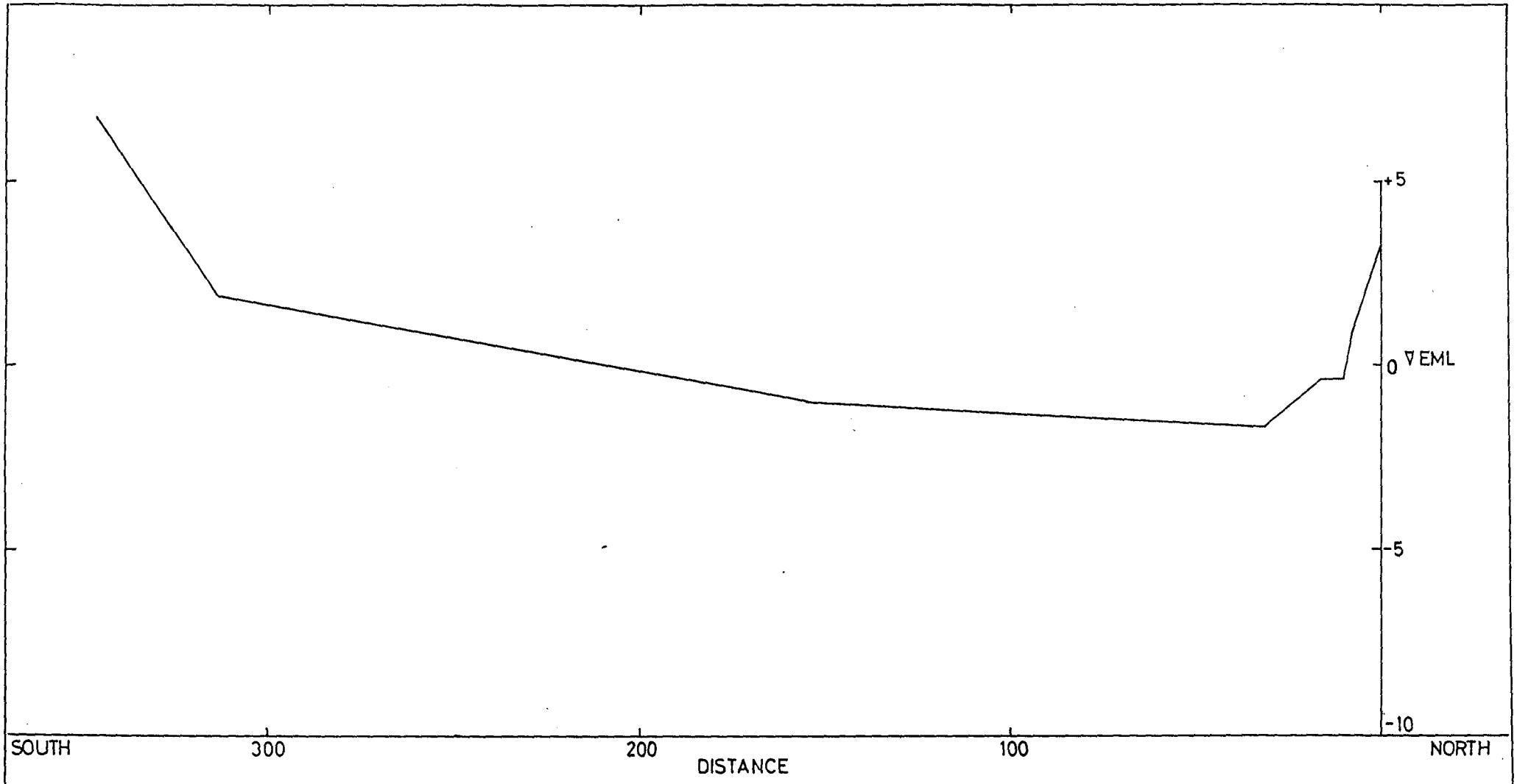
TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS-SECTION D2 - FEBRUARY 1988	FIGURE 2i
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		



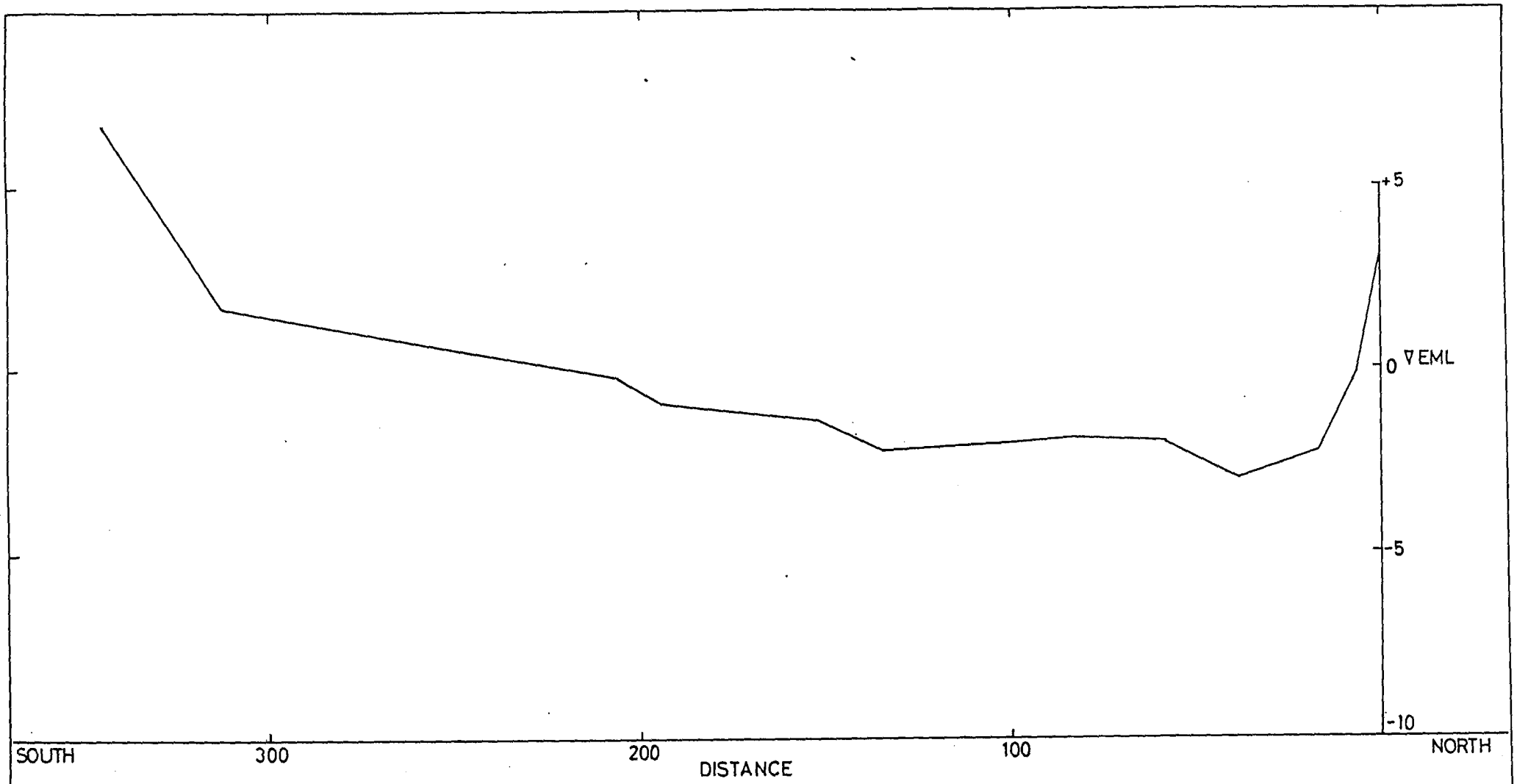
TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS-SECTION D2 - APRIL 1988	FIGURE 2j
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		



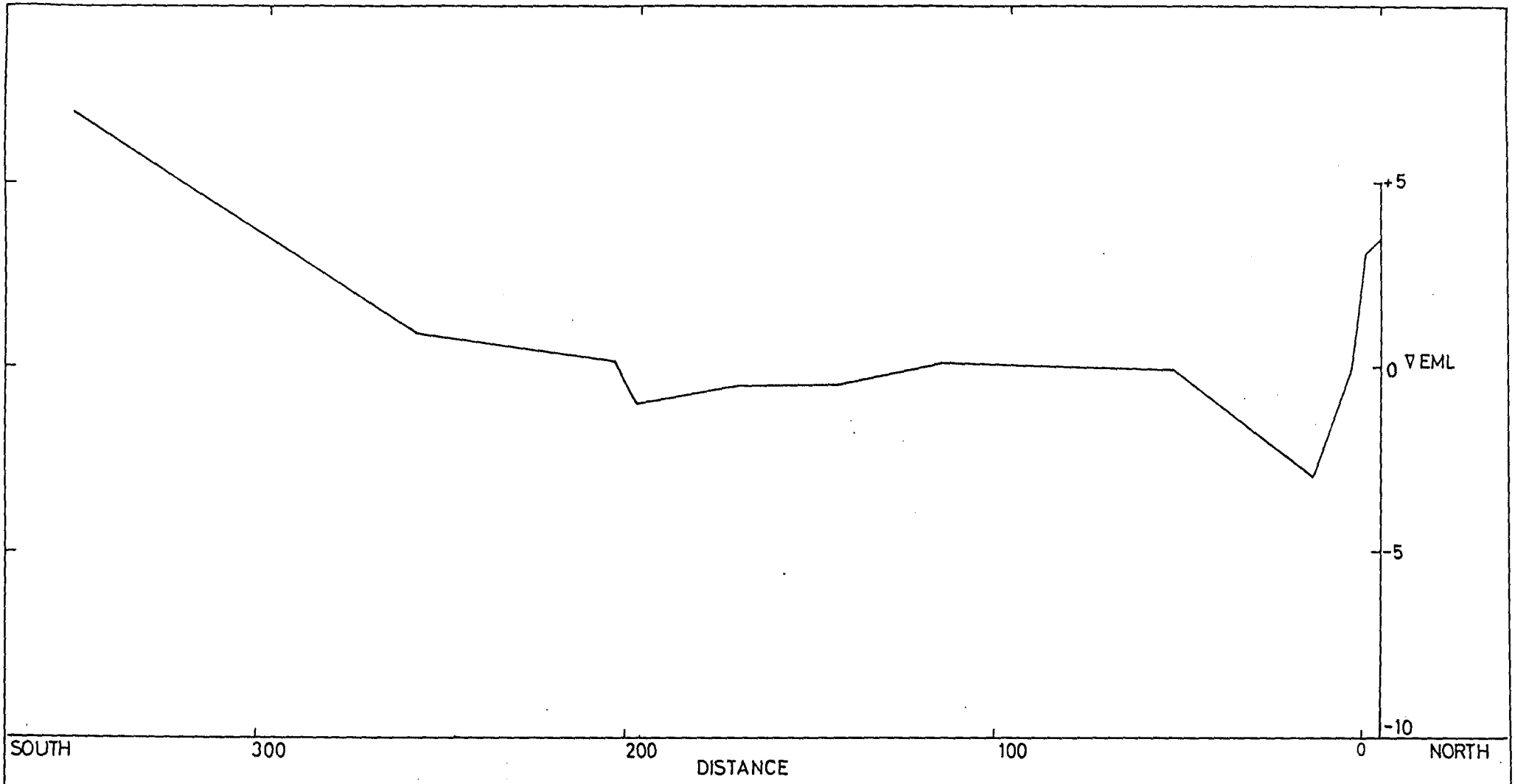
TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS- SECTION D3 - JUNE 1986	FIGURE 3A
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		



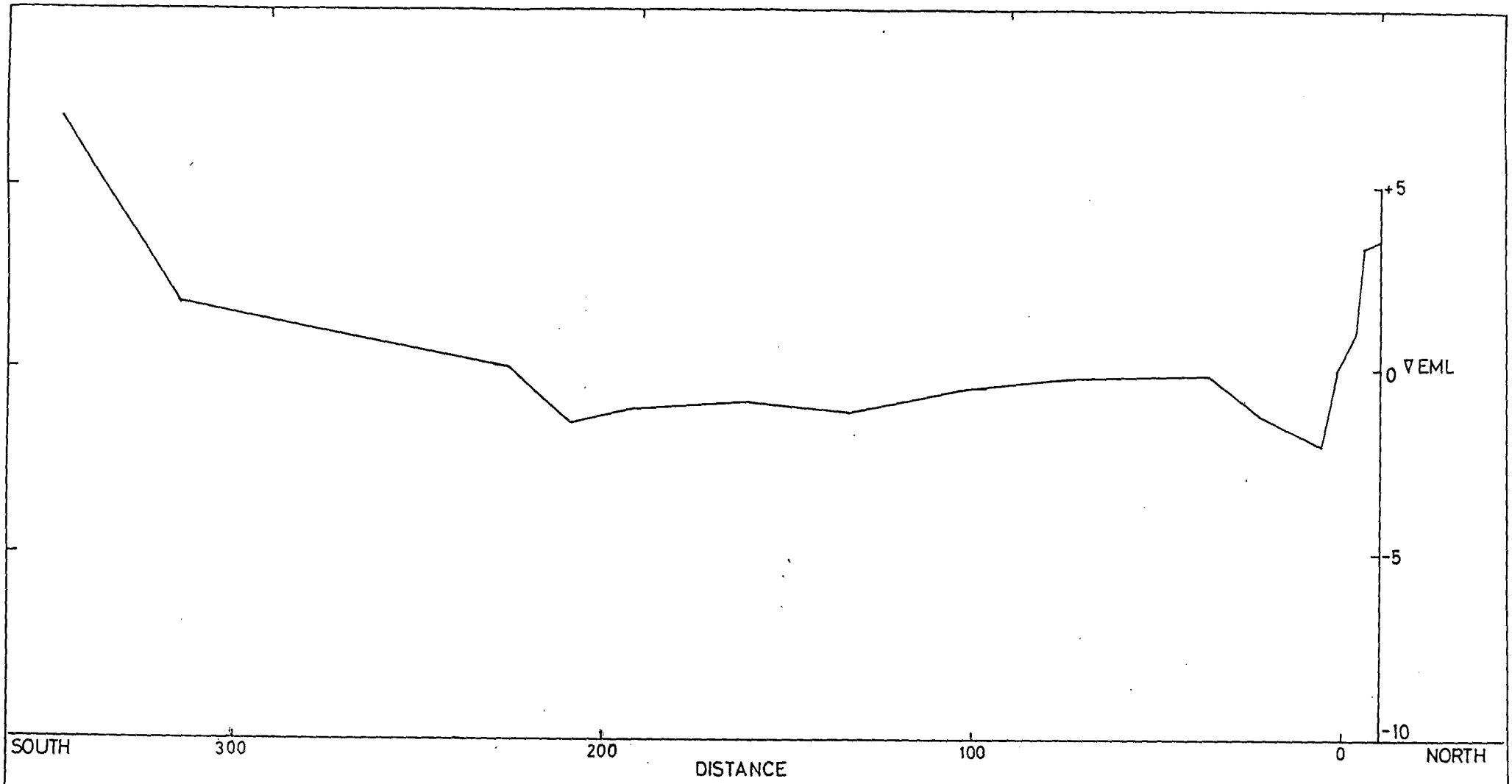
TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS-SECTION D 3 - AUGUST 1986	FIGURE 3 B
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		



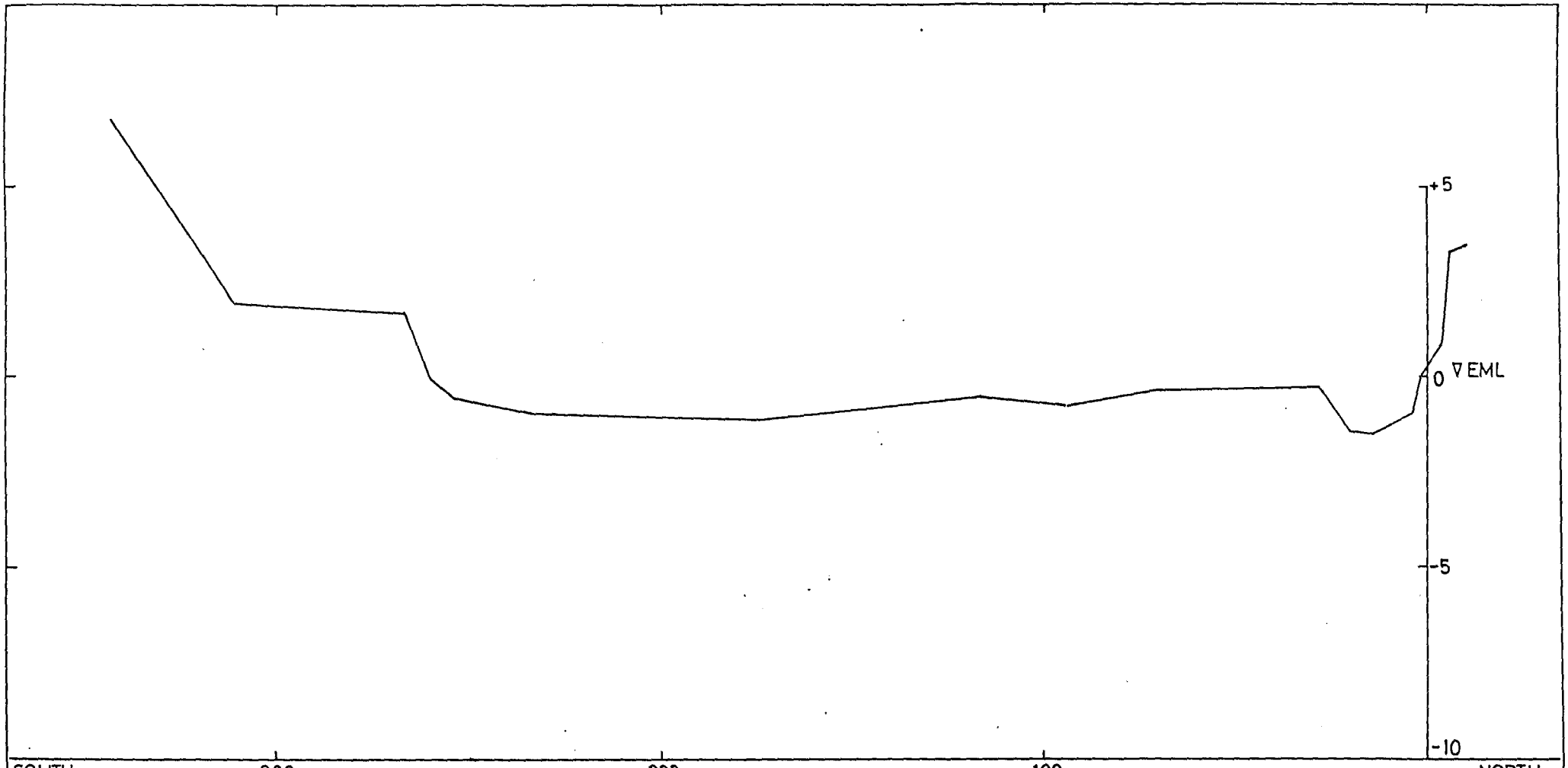
TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS- SECTION D 3 - OCTOBER 1986	FIGURE 3 C
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		



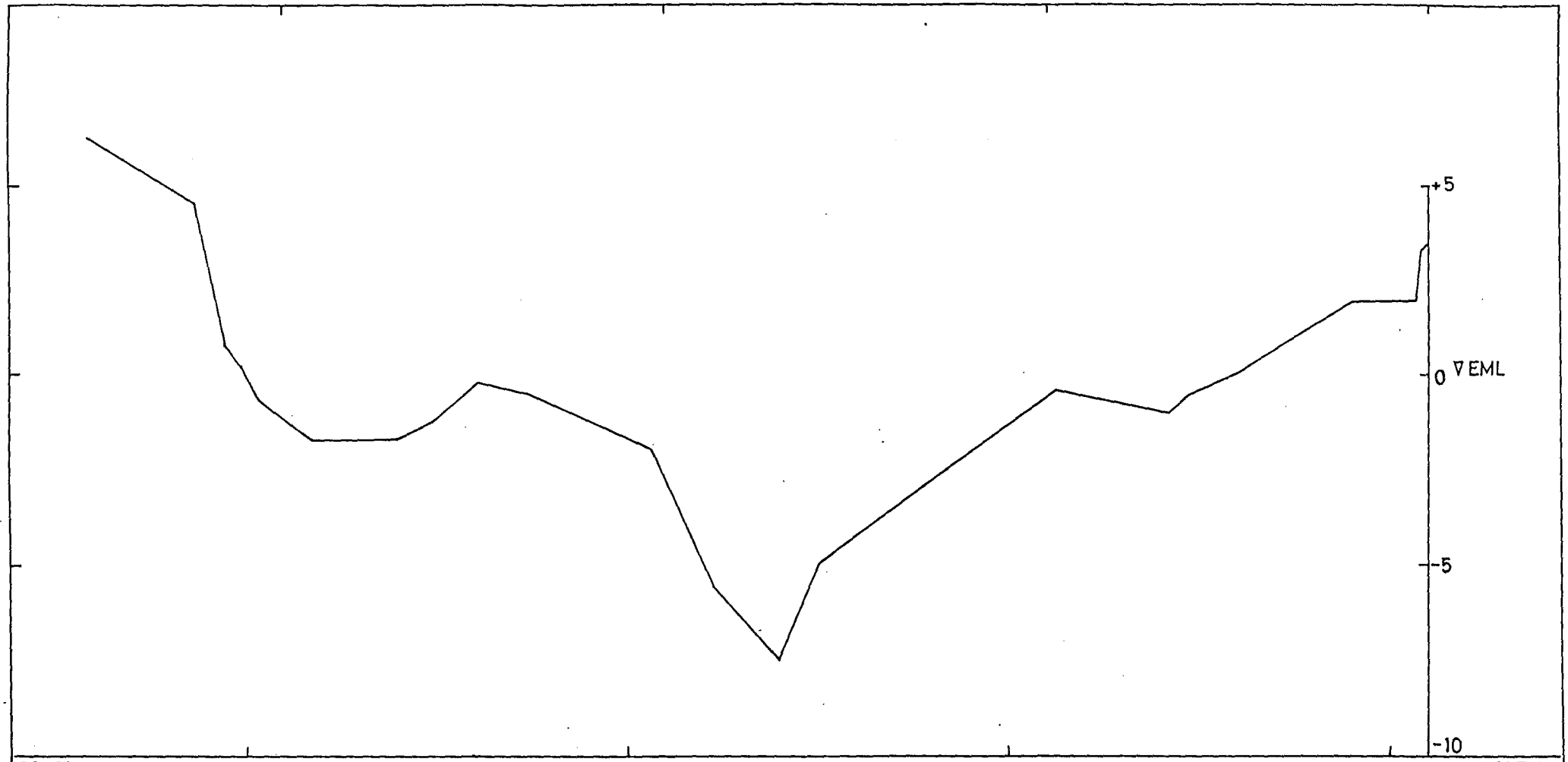
TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS-SECTION D3 - FEBRUARY 1987	FIGURE 3 d
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		



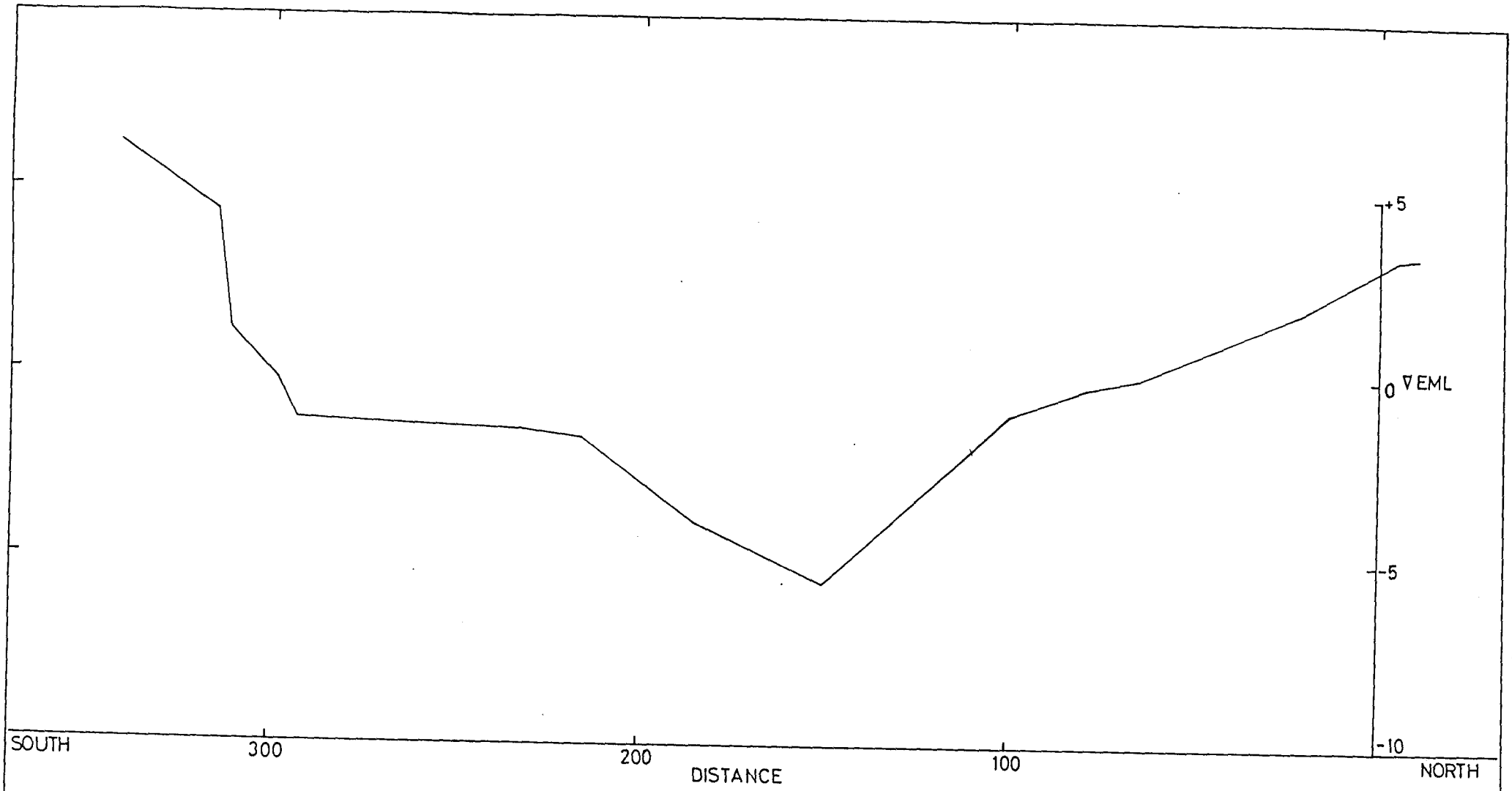
TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS- SECTION D3 - APRIL 1987	FIGURE 3 e
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		



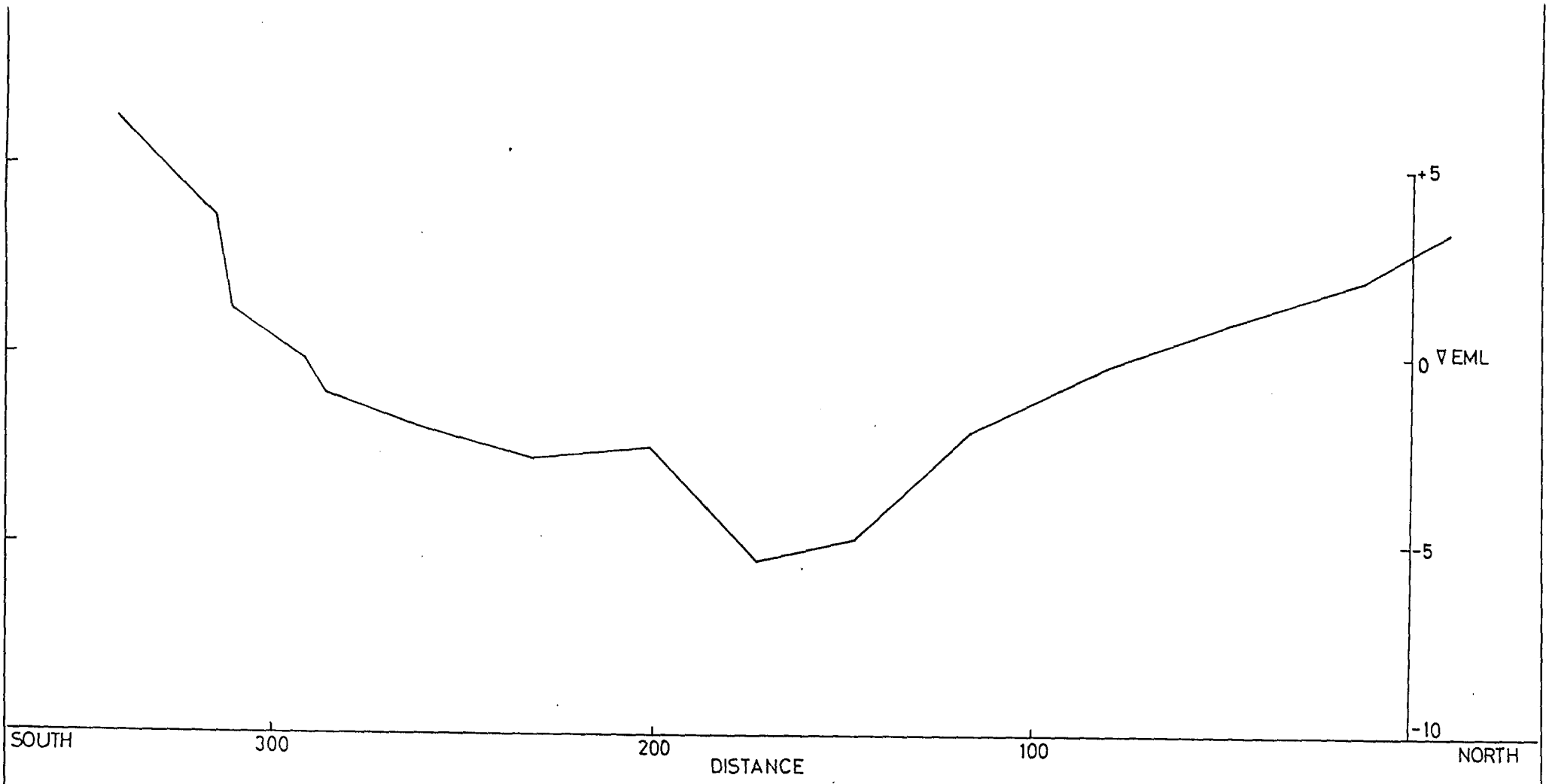
TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS-SECTION D3 - JUNE 1987	FIGURE 3 F
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		



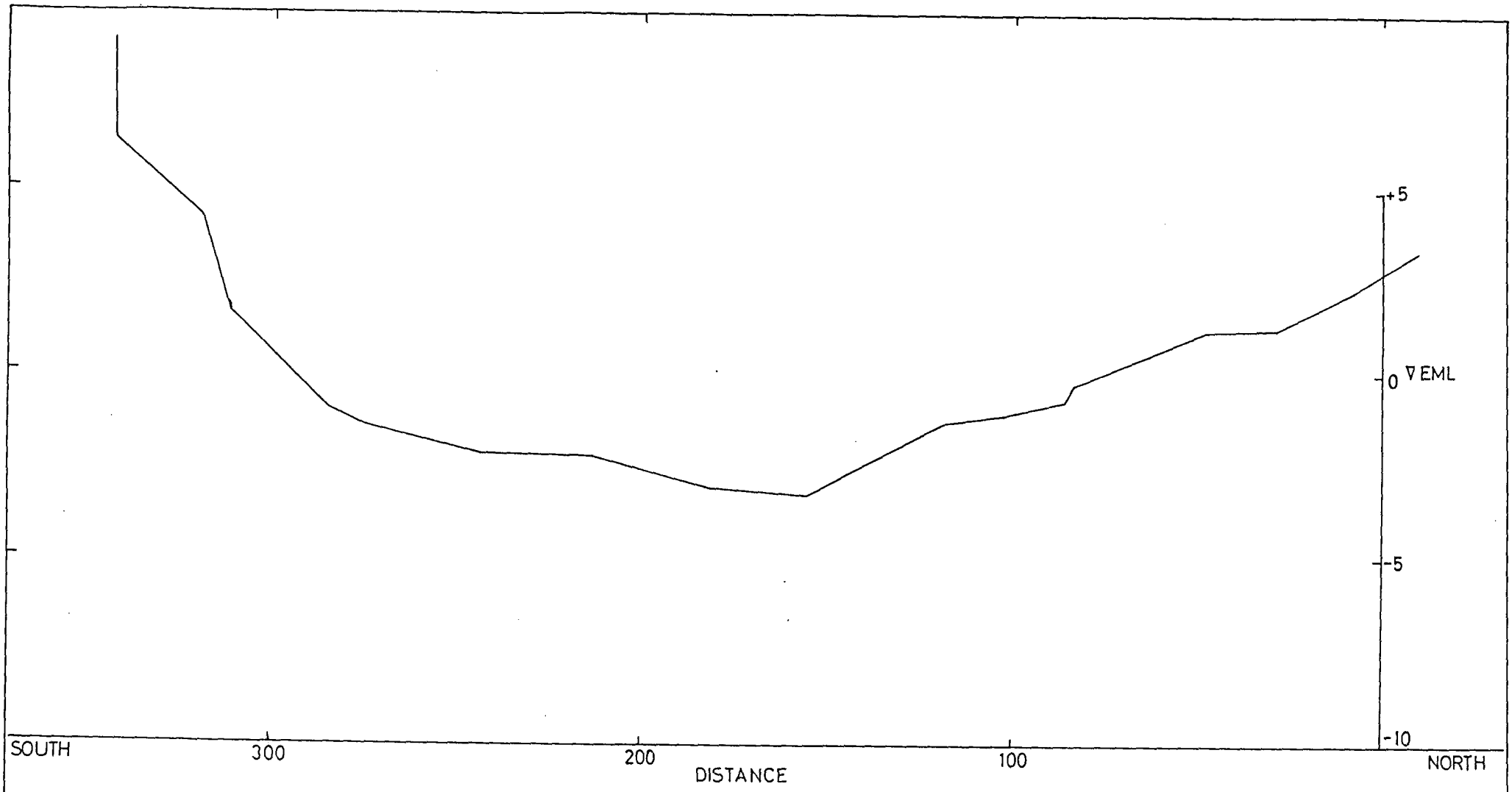
TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS-SECTION D3 - SEPTEMBER 1987	FIGURE 3g
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		



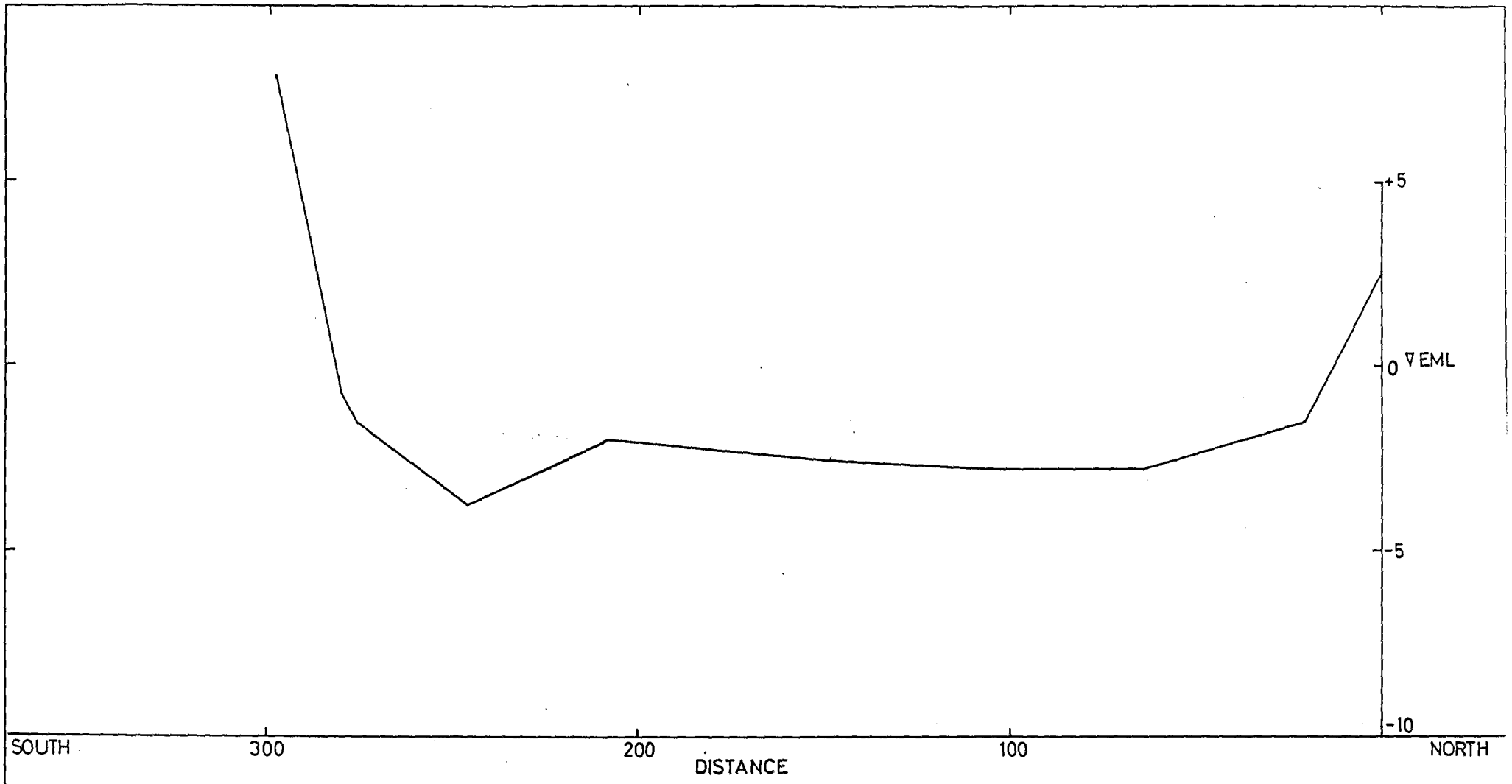
TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS-SECTION D 3 - OCTOBER 1987	FIGURE 3h
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		



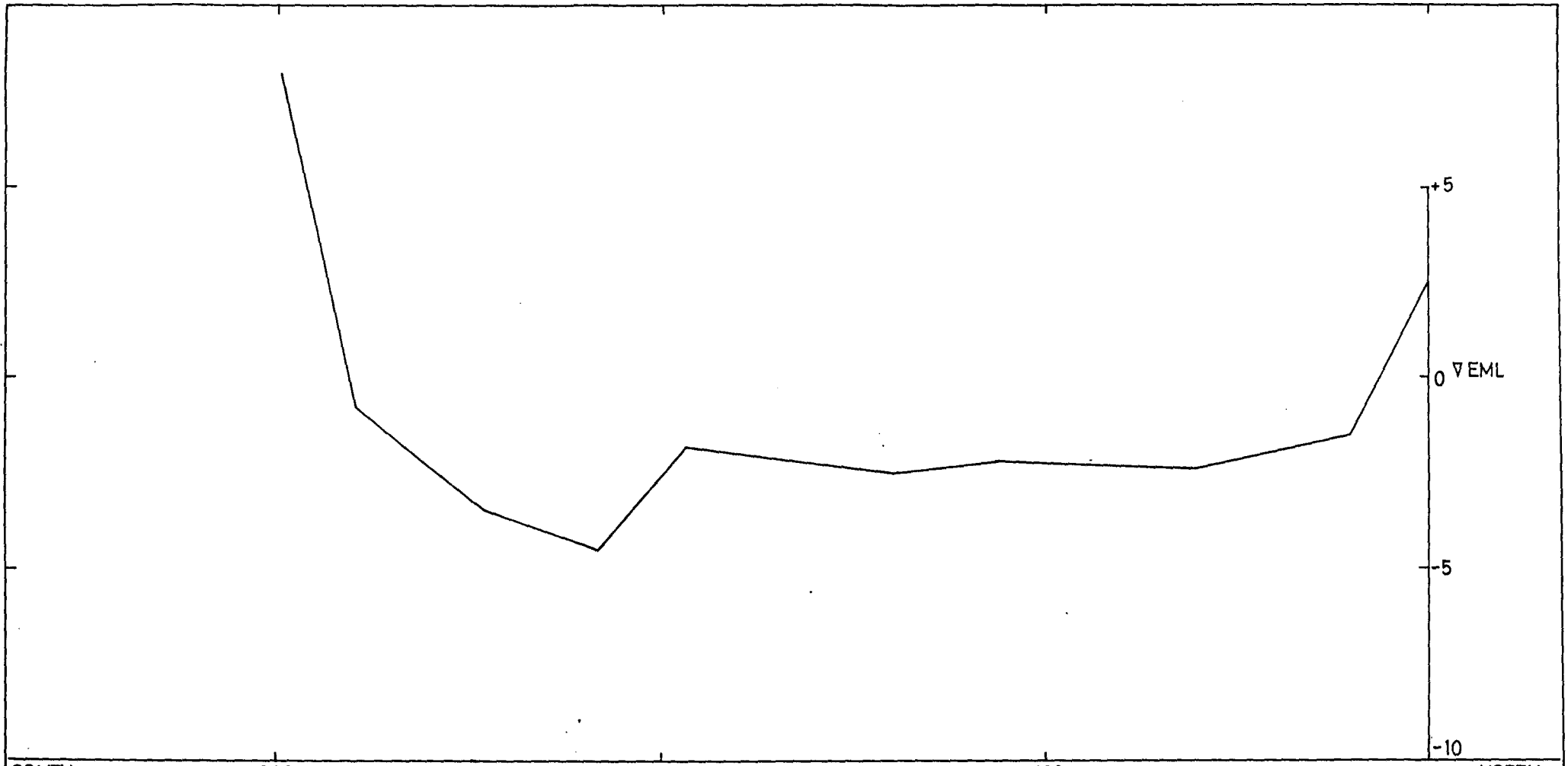
TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS-SECTION D 3 - FEBRUARY 1988	FIGURE 3i
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		



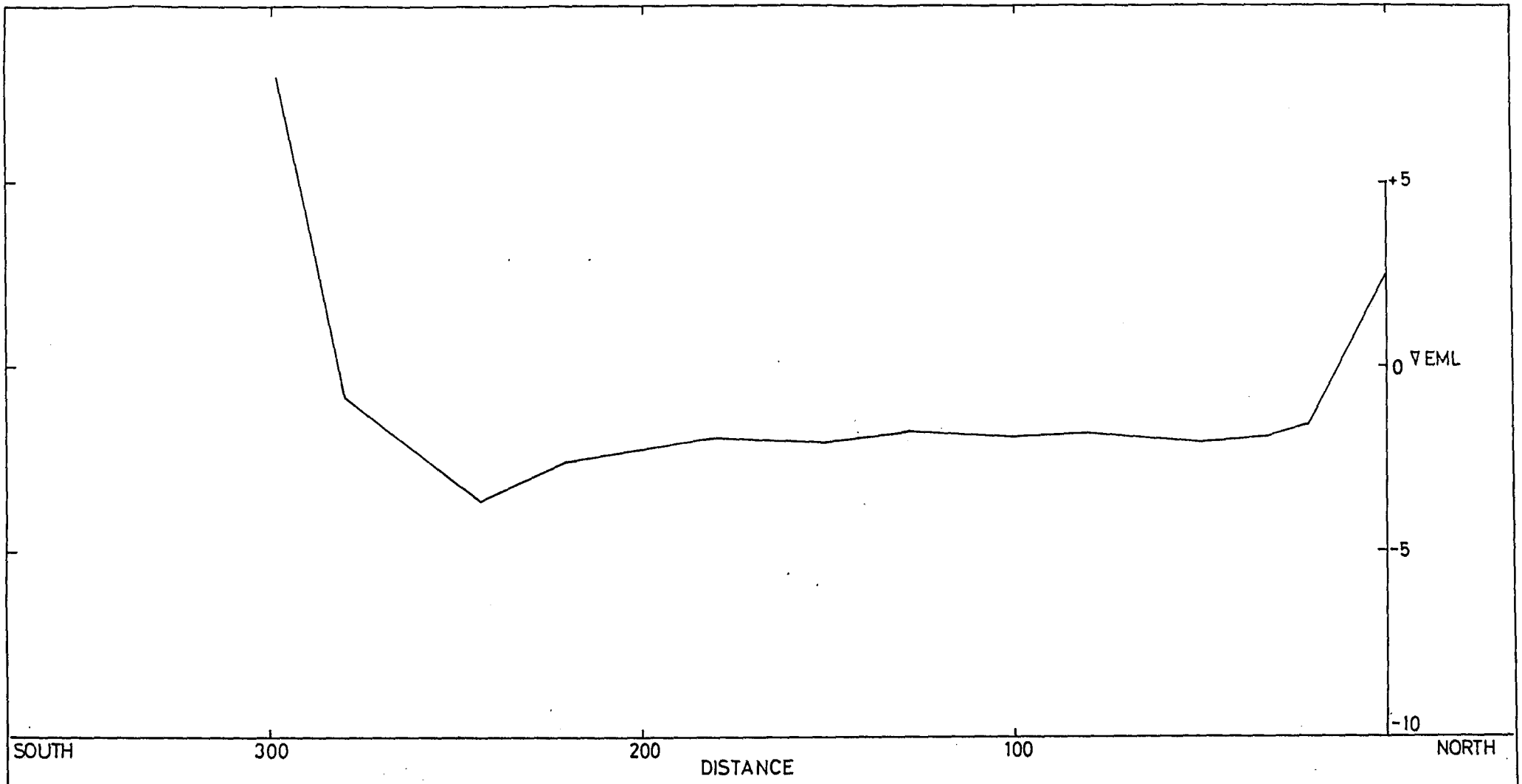
TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS-SECTION D3 - APRIL 1988	FIGURE 3j
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		



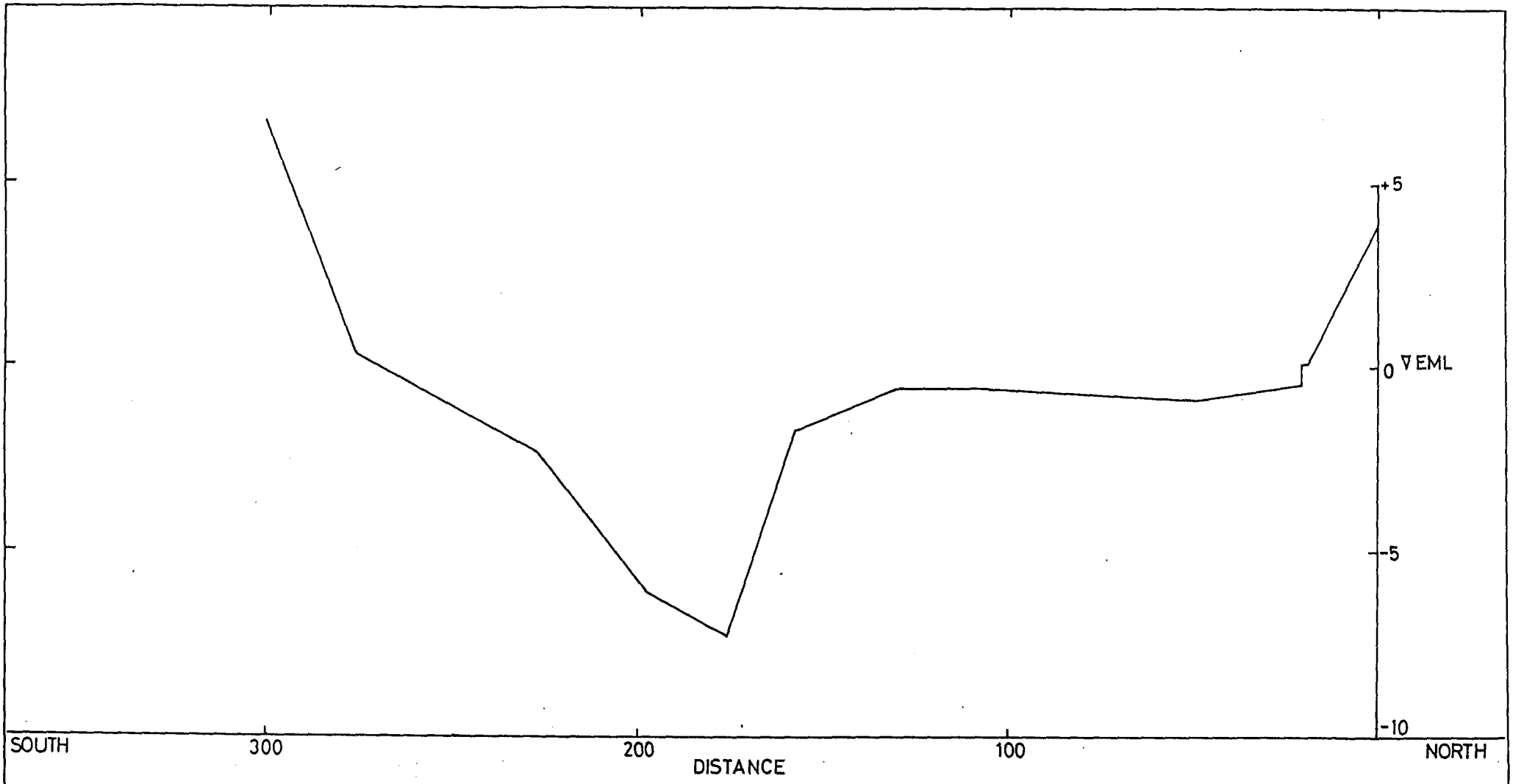
TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS-SECTION D4 - JUNE 1986	FIGURE 4A
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		



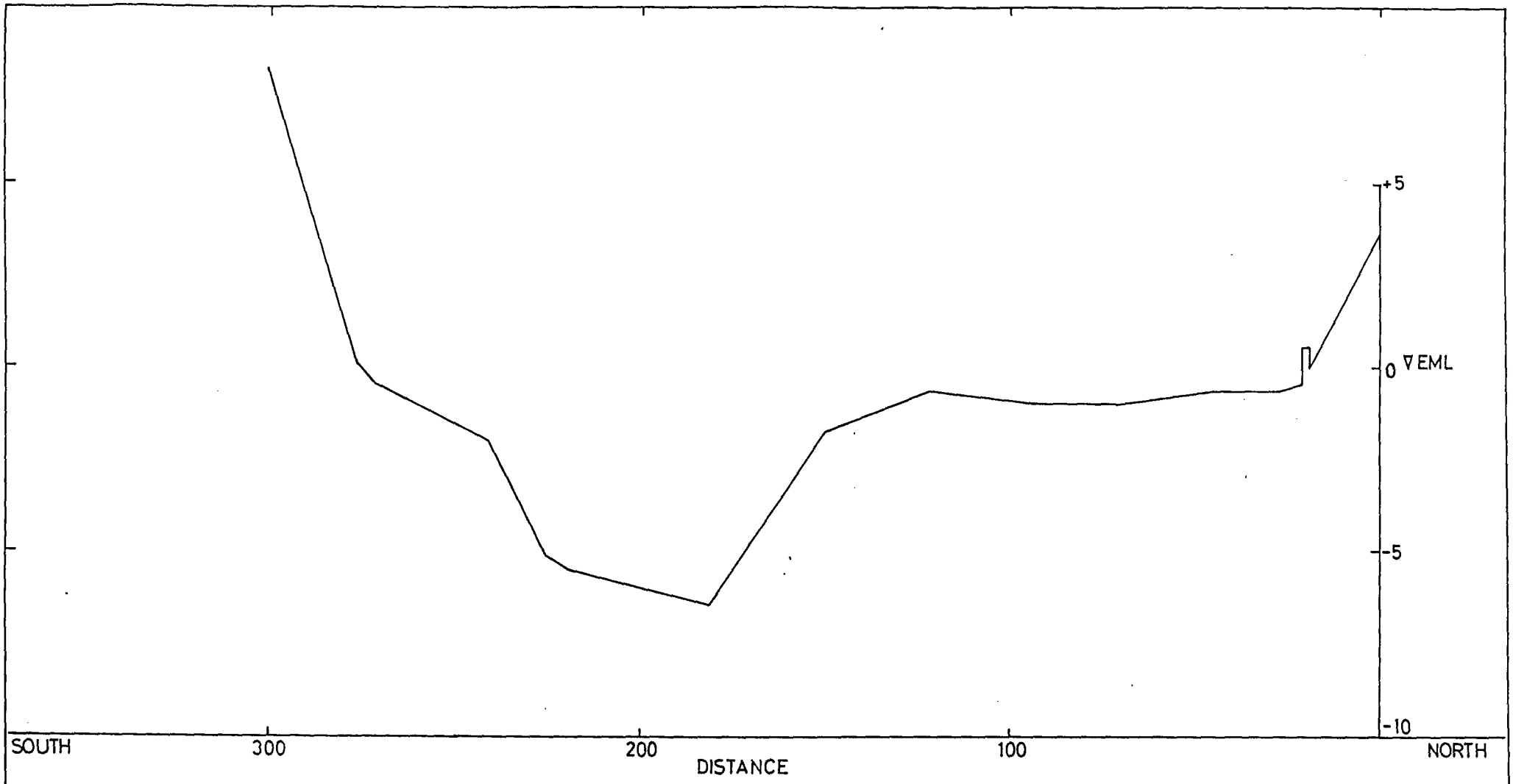
TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS-SECTION D4 - AUGUST 1986	FIGURE 4B
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		



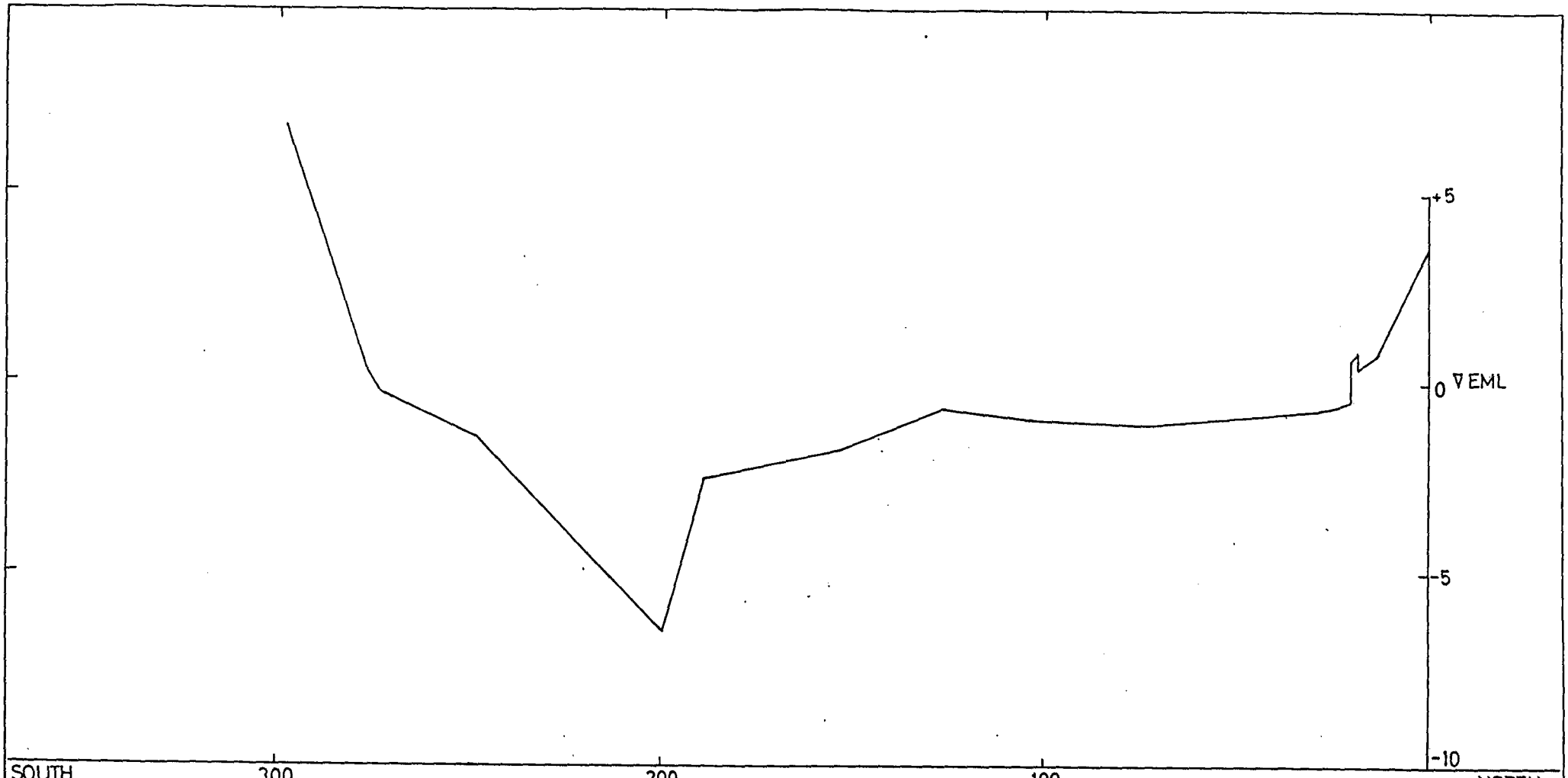
TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS- SECTION D4 - OCTOBER 1986	FIGURE 4C
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		



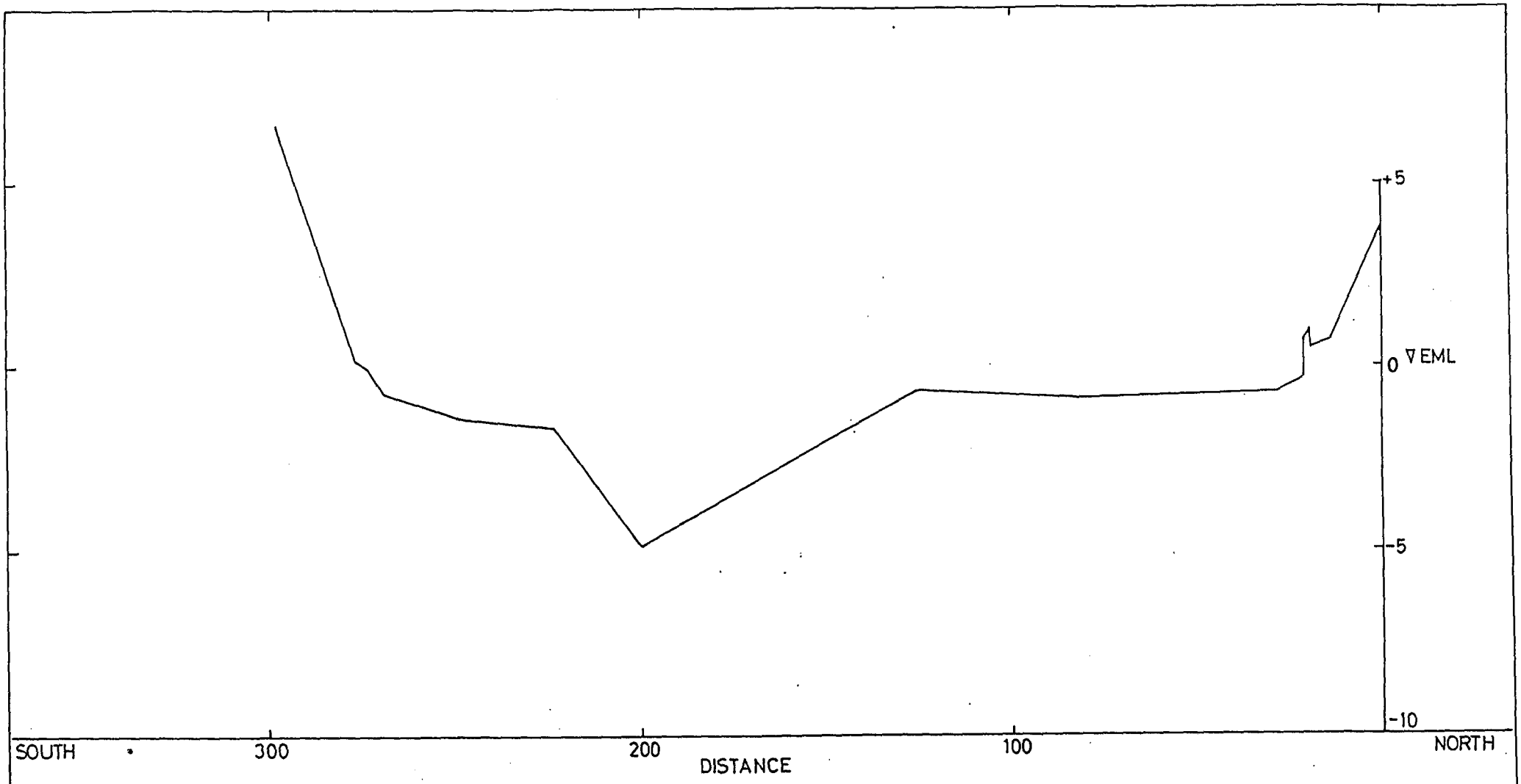
TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS-SECTION D4 - FEBRUARY 1987	FIGURE 40
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		



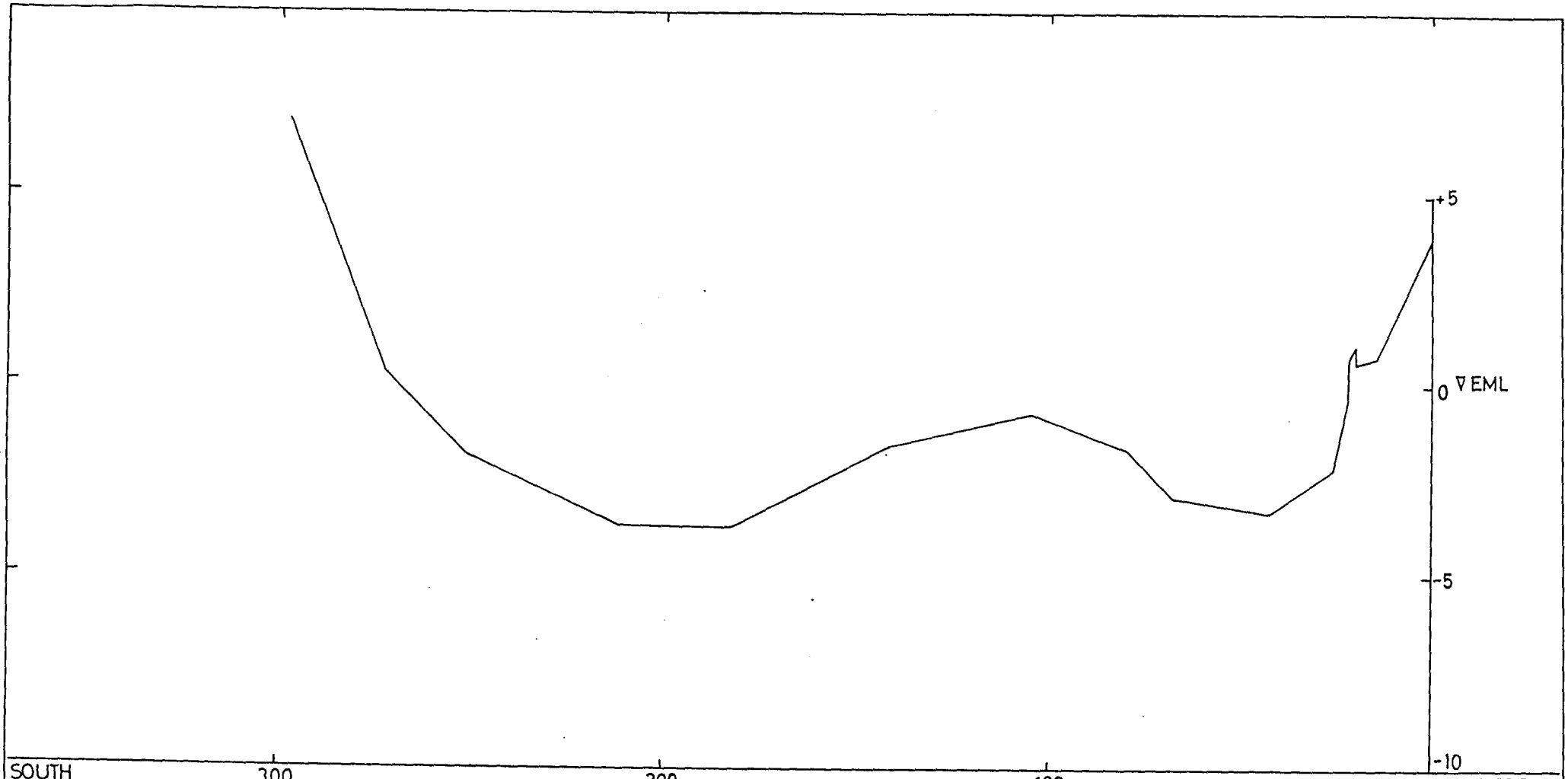
TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS - SECTION D 4 - APRIL 1987	FIGURE 4 E
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		



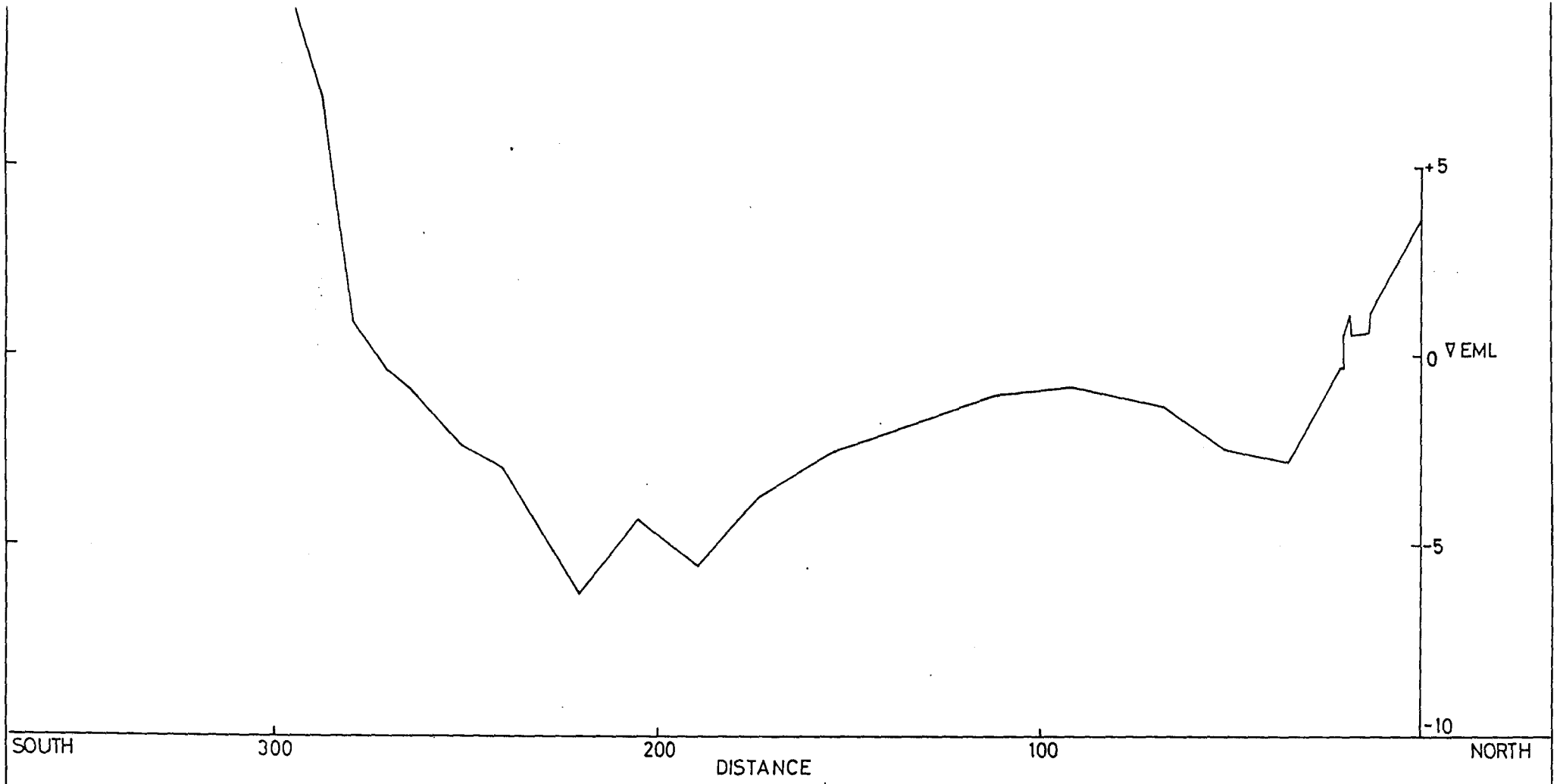
TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS-SECTION D4 - JUNE 1987	FIGURE 4 F
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		



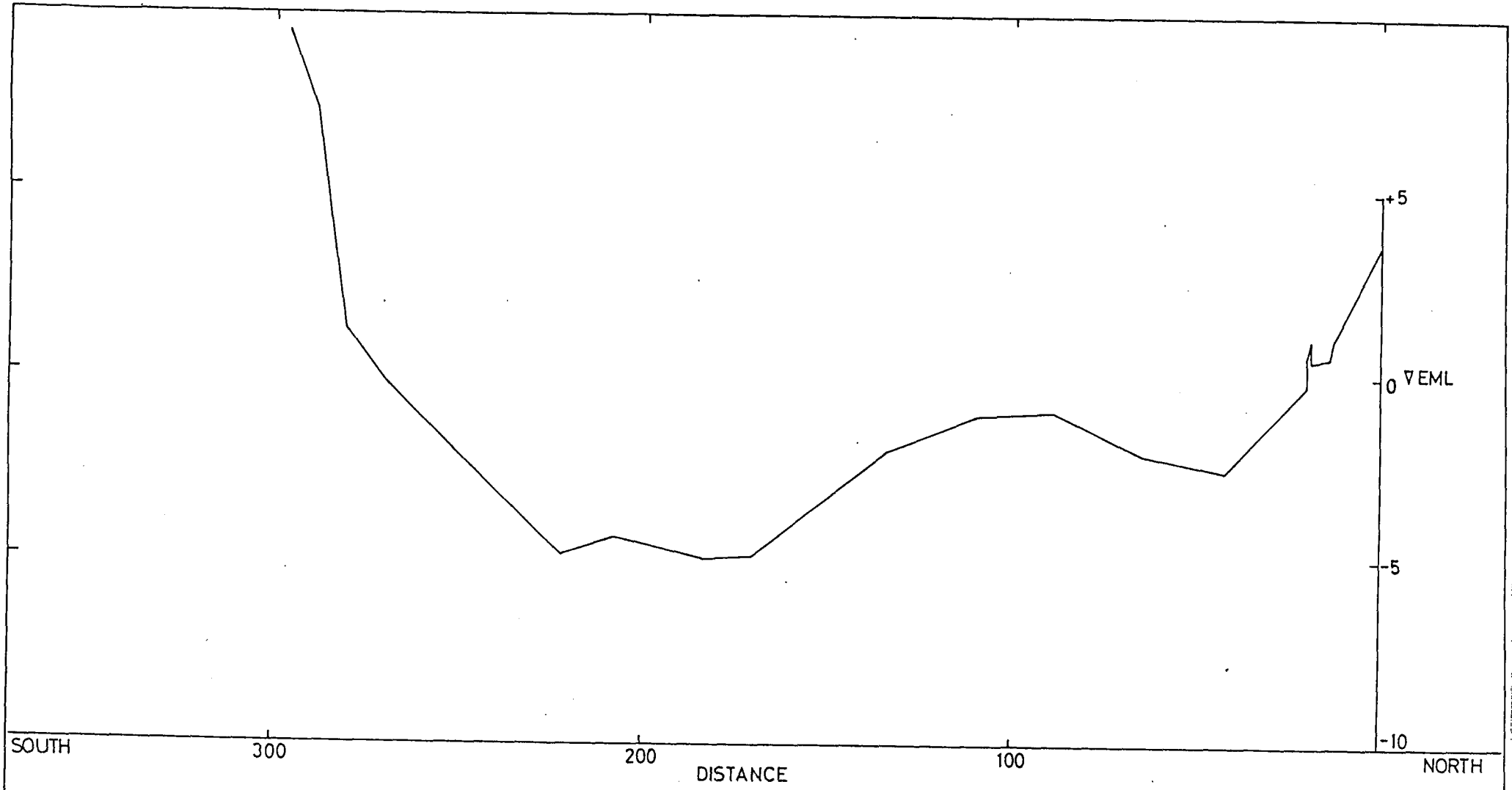
TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS-SECTION D4 - SEPTEMBER 1987	FIGURE 4G
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		



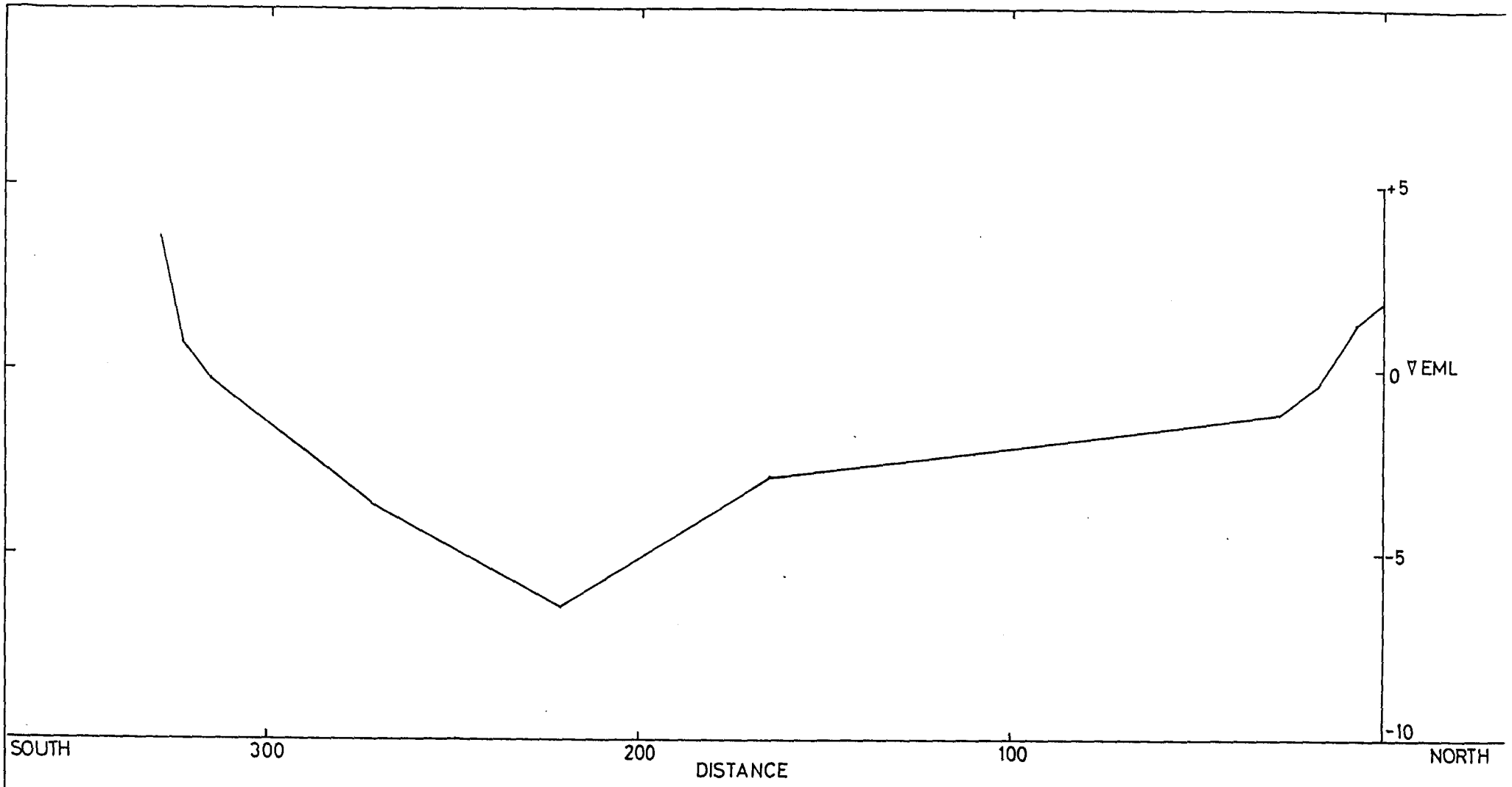
TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS - SECTION D 4 - OCTOBER 1987	FIGURE 4h
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		



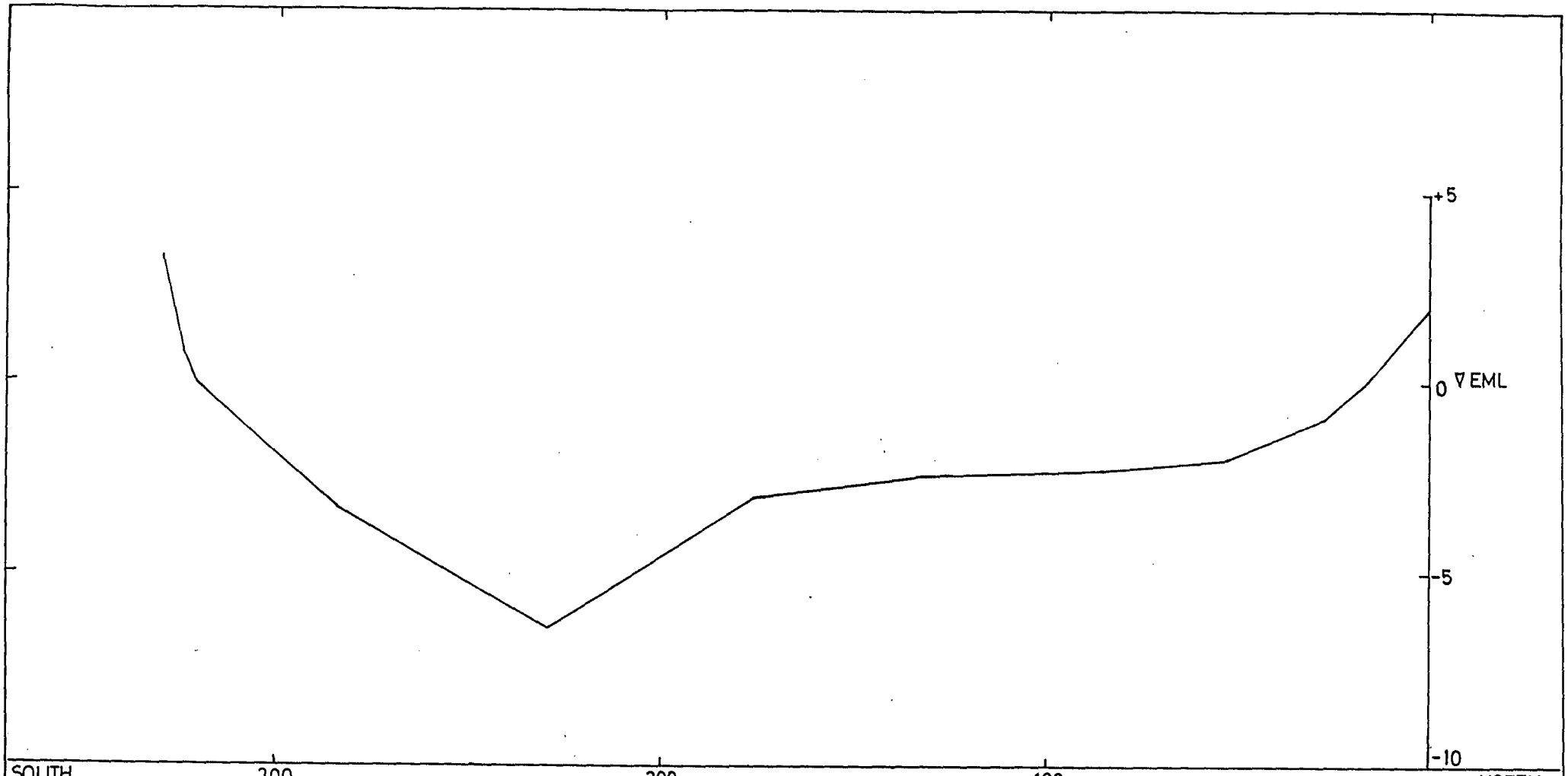
TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS- SECTION D4 - FEBRUARY 1988	FIGURE 4i
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		



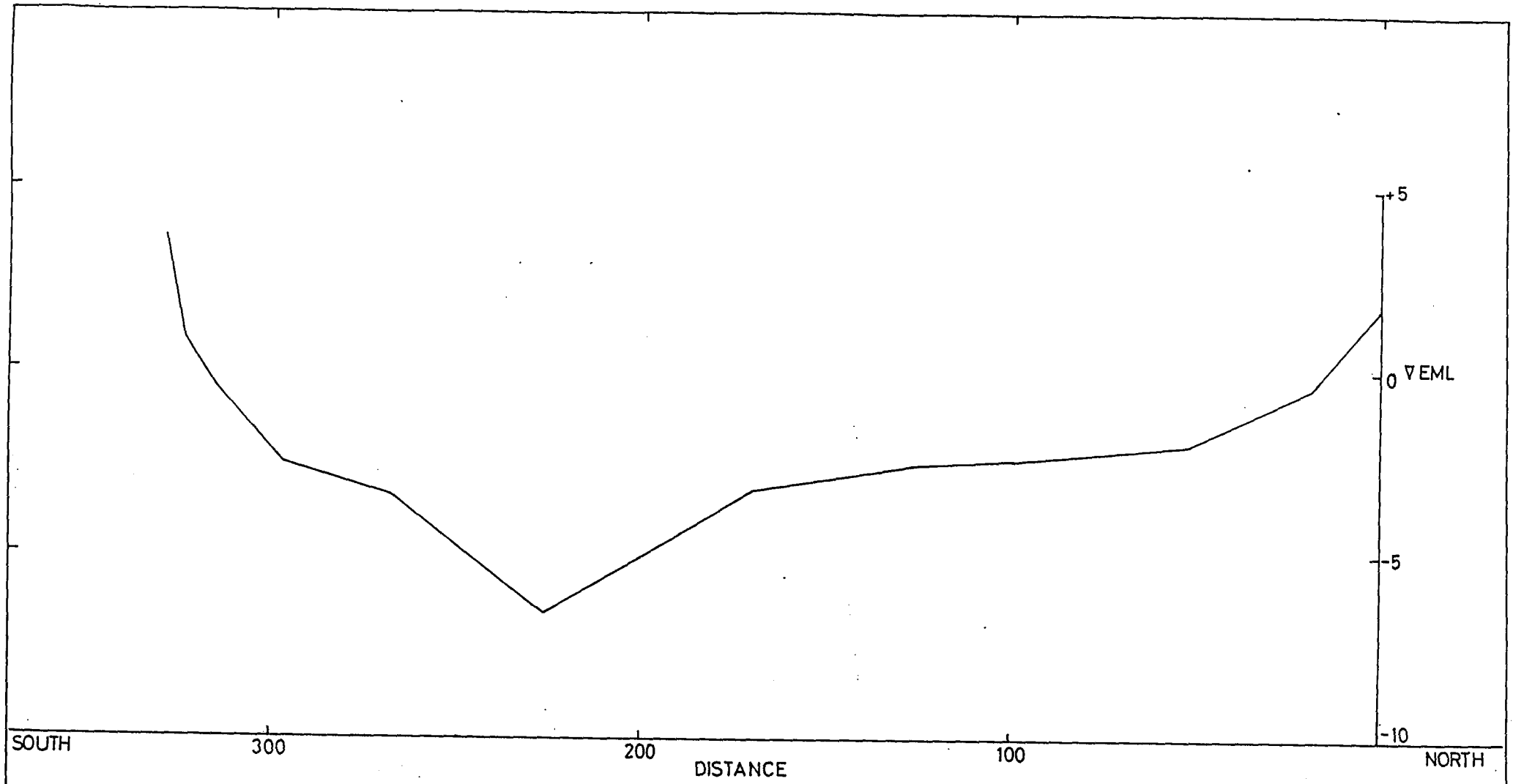
TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS - SECTION D4 - APRIL 1988	FIGURE 4j
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		



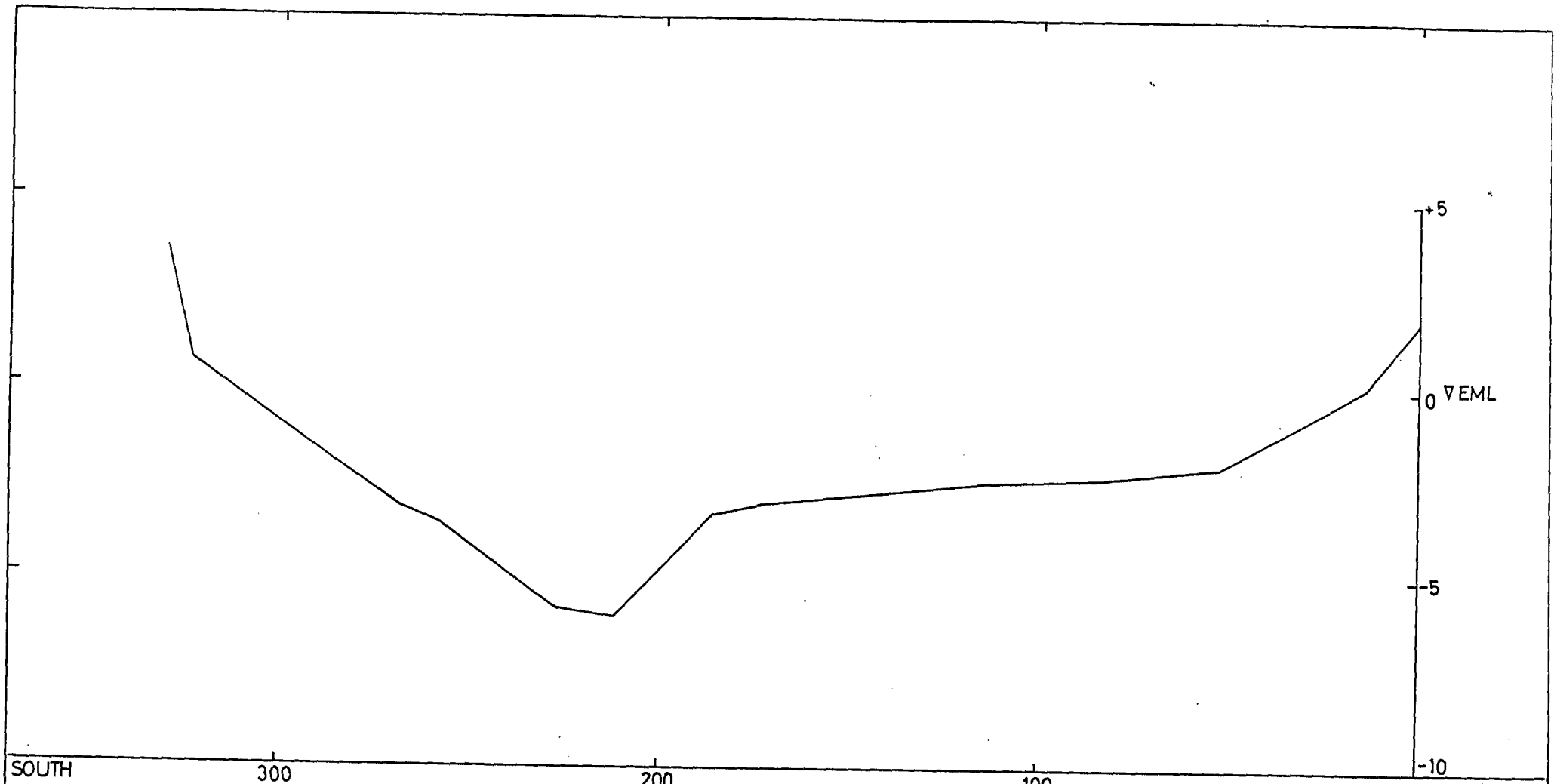
TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS- SECTION D 5 - JUNE 1986	FIGURE 5A
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		



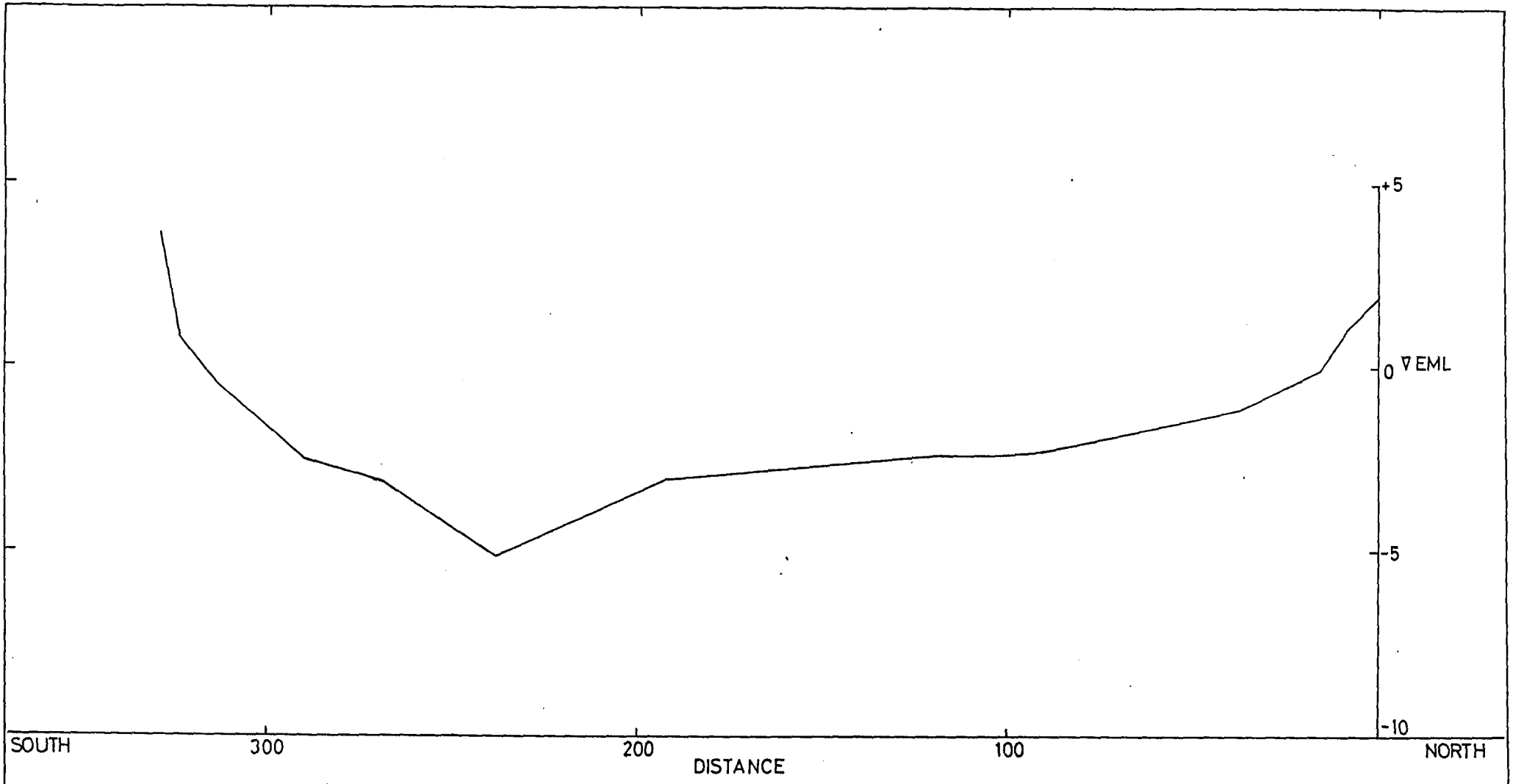
TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS- SECTION D 5 - AUGUST 1986	FIGURE 5 B
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		



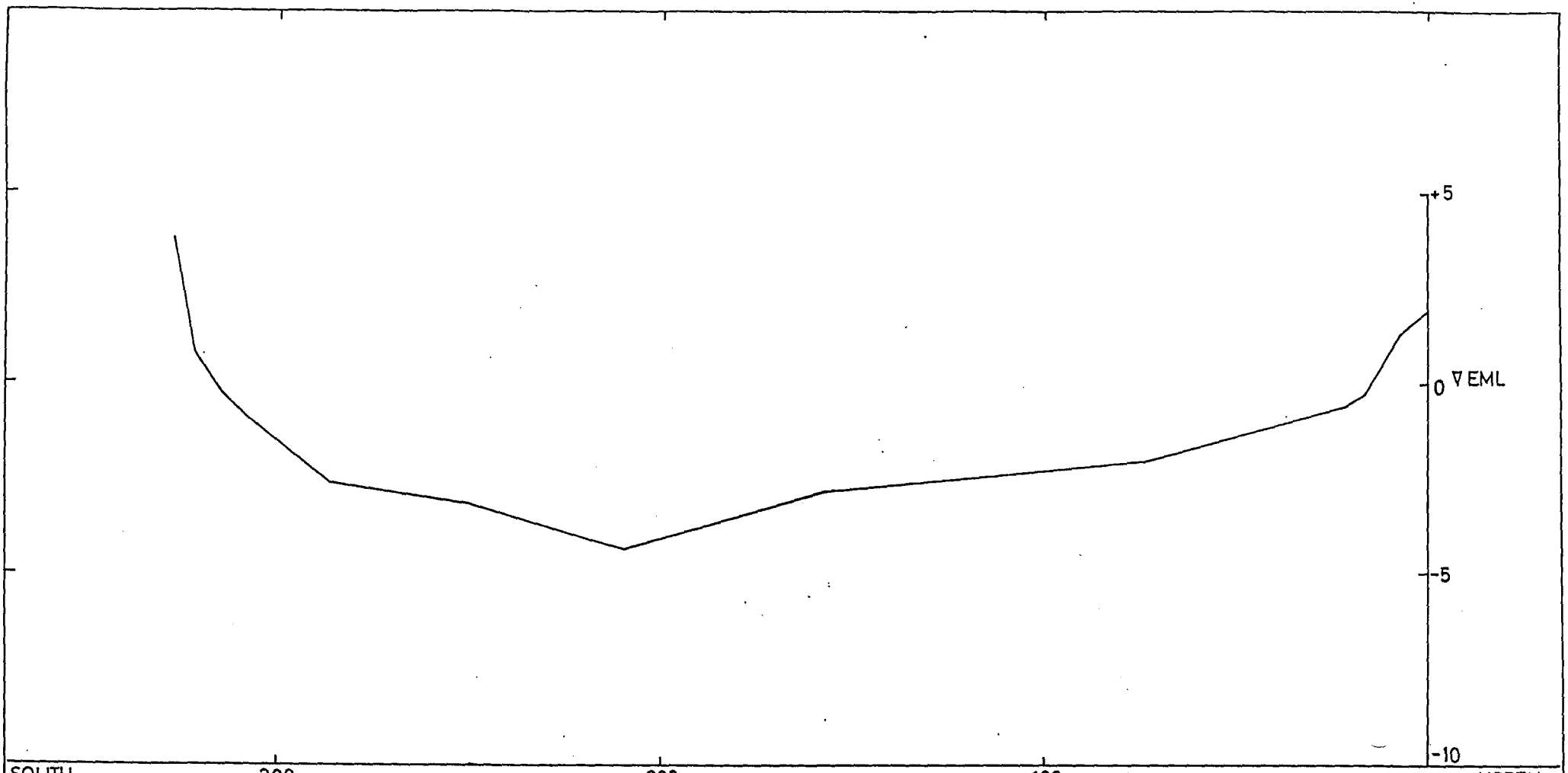
TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS-SECTION D5 - OCTOBER 1986	FIGURE 5C
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		



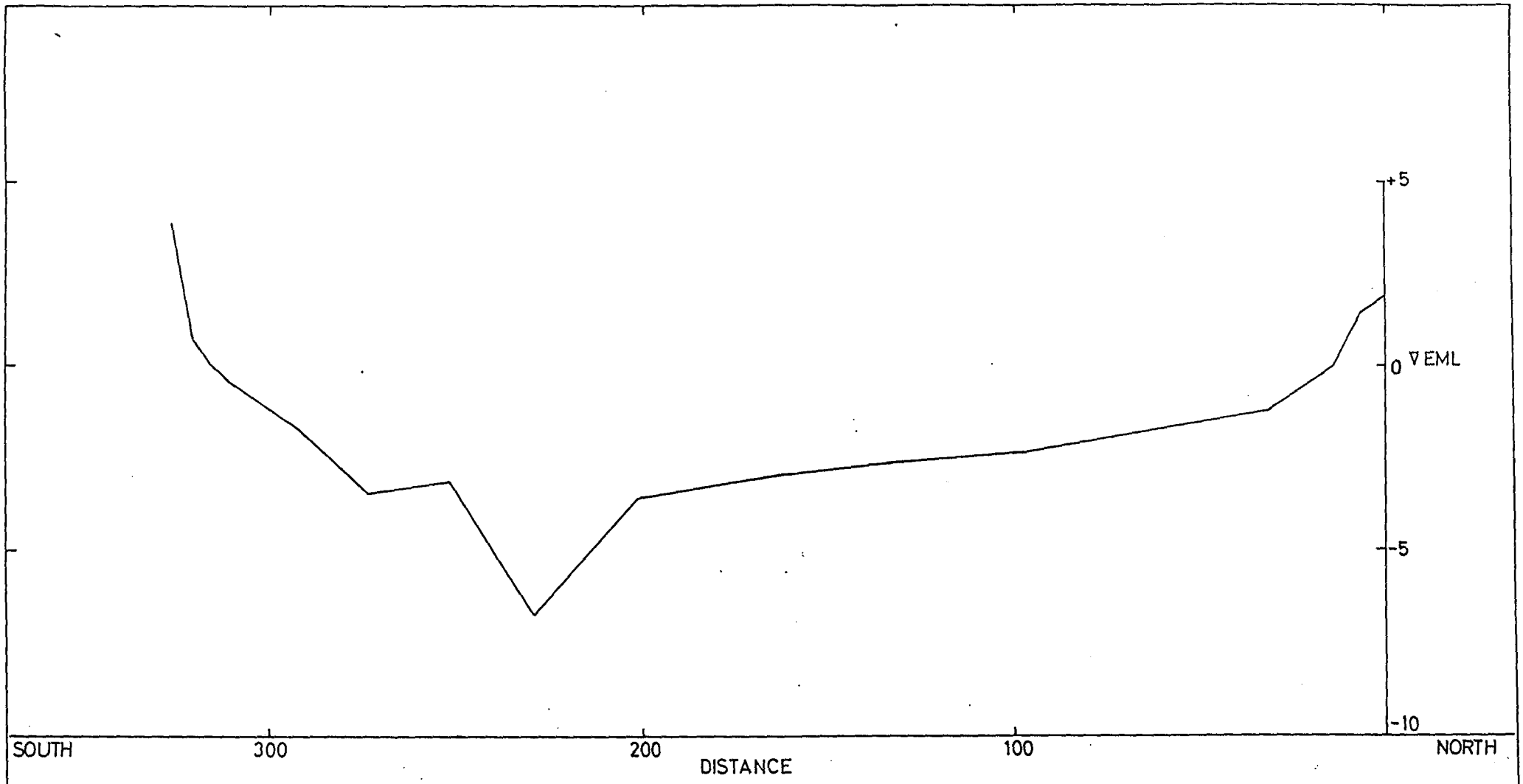
TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS-SECTION D5 - FEBRUARY 1987	FIGURE 5 D
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		



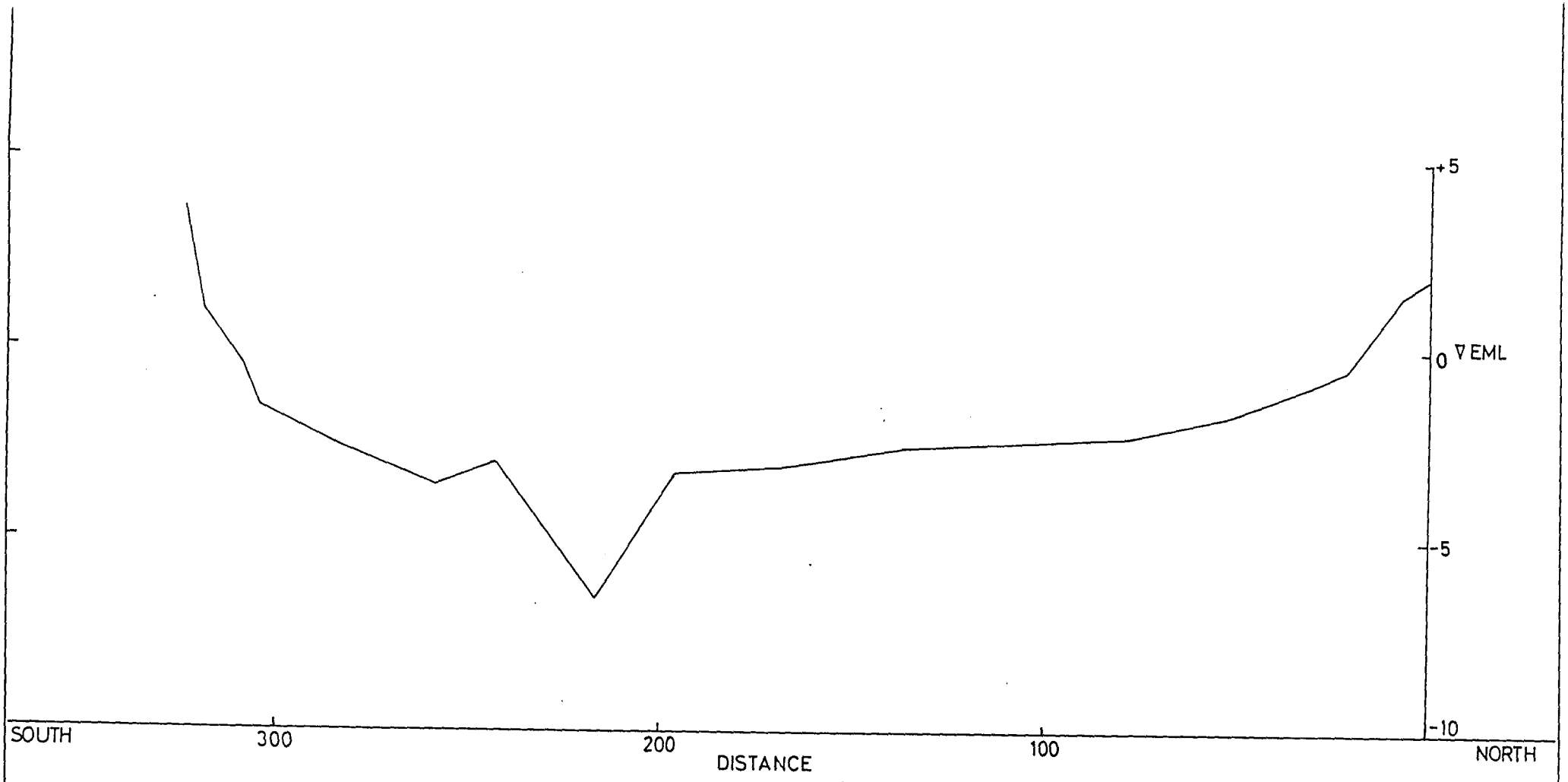
TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS- SECTION D5 - APRIL 1987	FIGURE 5 E
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		



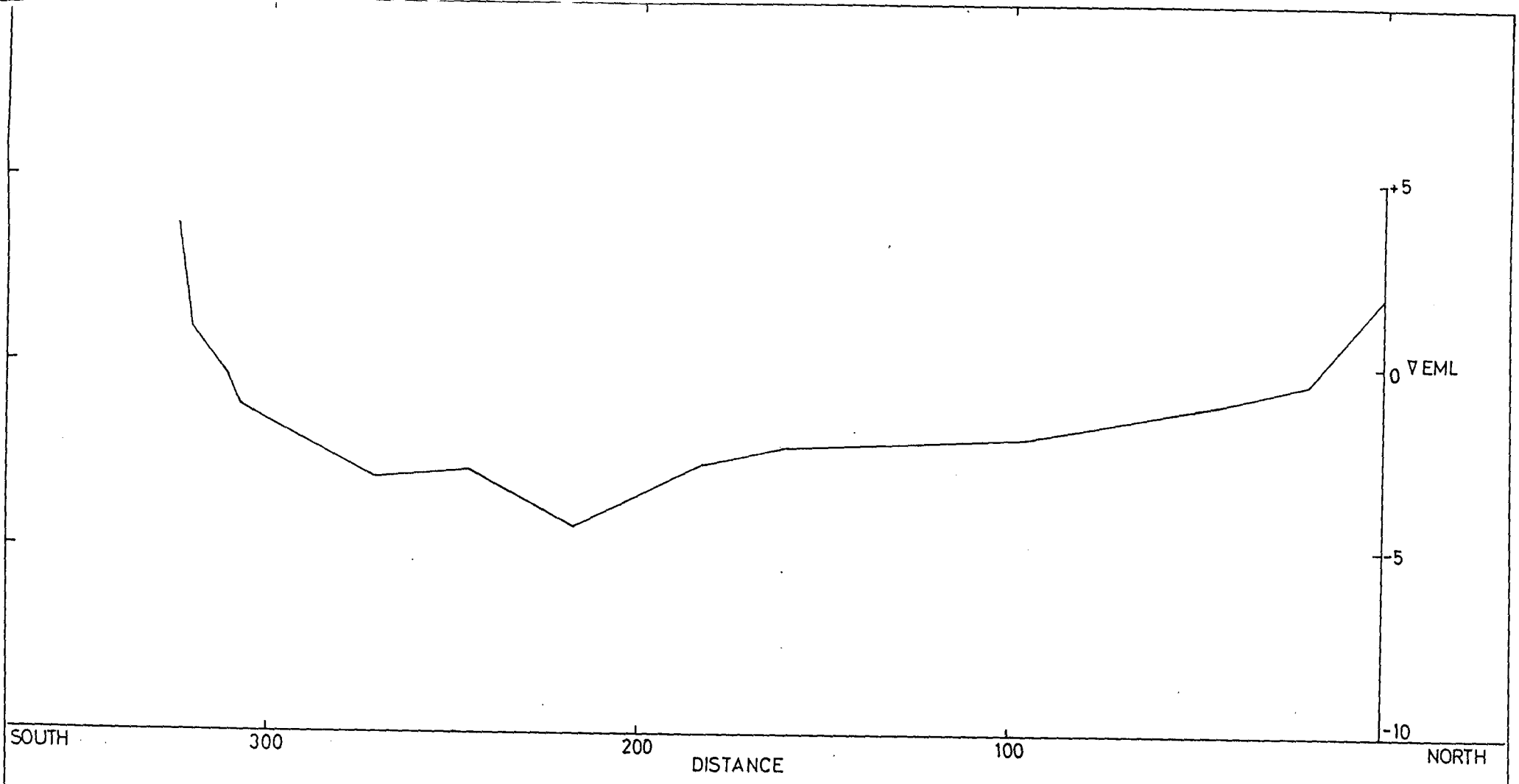
TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS-SECTION D5 - JUNE 1987	FIGURE 5F
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		



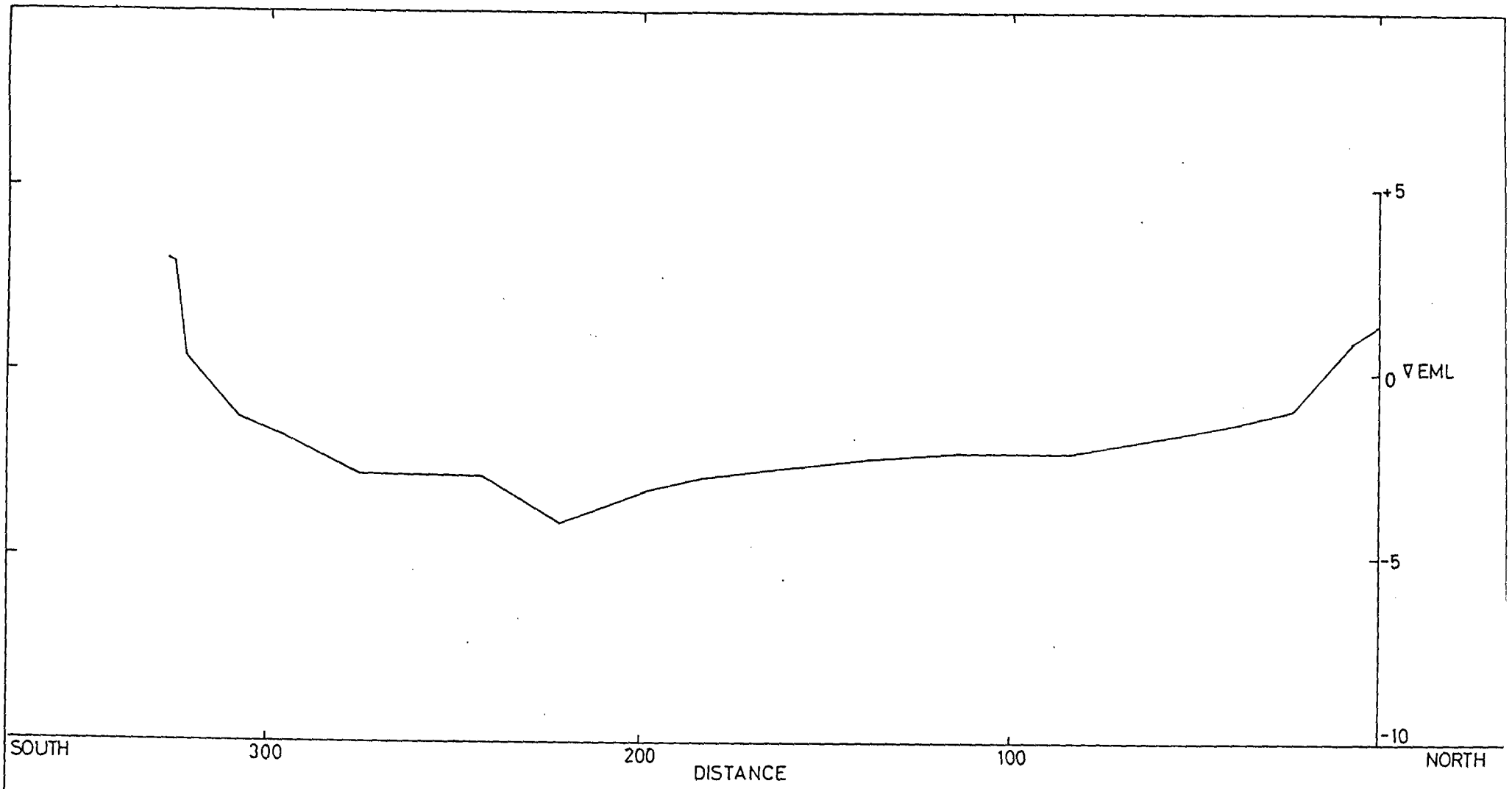
TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS-SECTION D5 - SEPTEMBER 1987	FIGURE 5G
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		



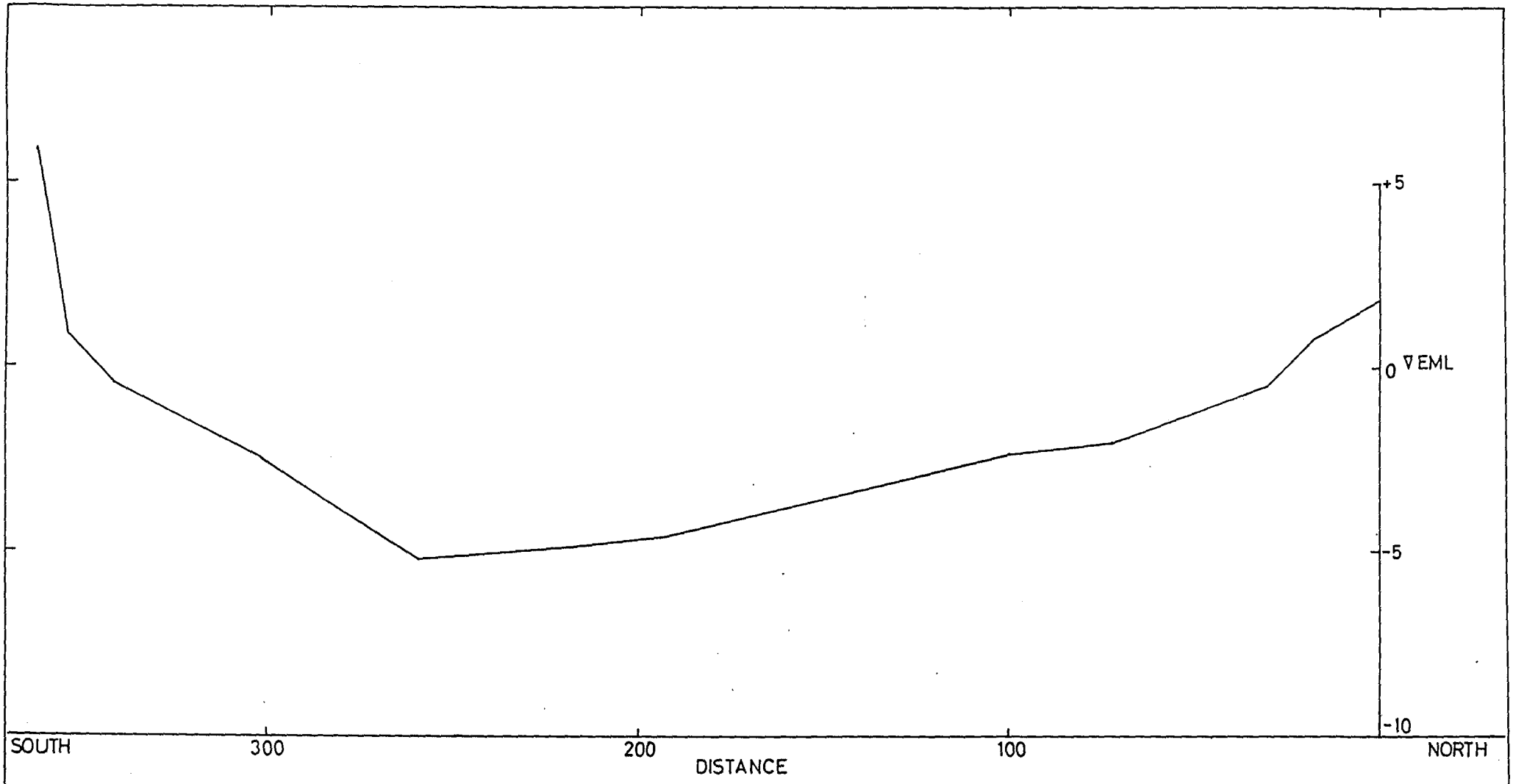
TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS-SECTION D5 - OCTOBER 1987	FIGURE 5h
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		



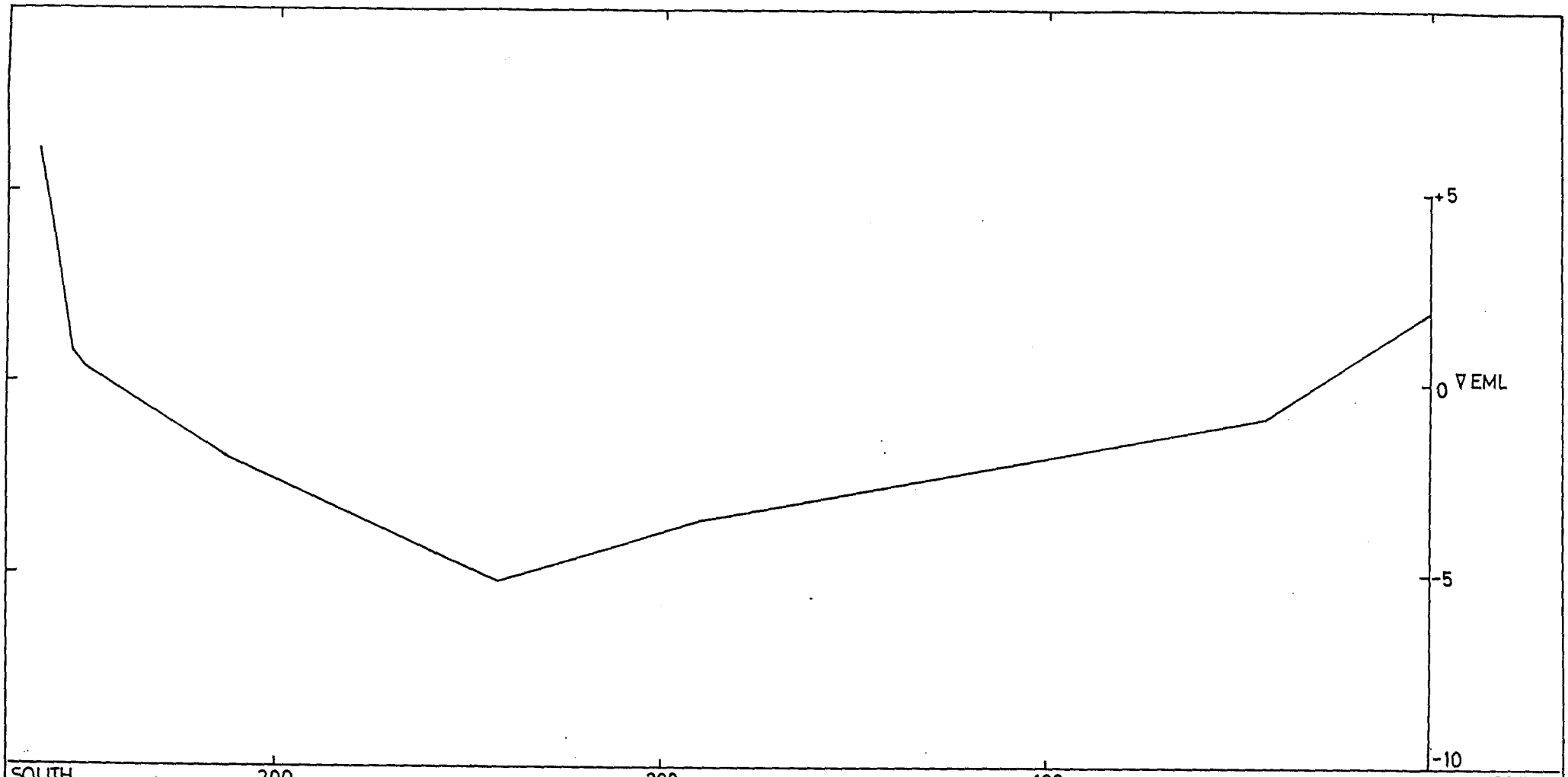
TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS-SECTION D5 - FEBRUARY 1988	FIGURE 5i
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		



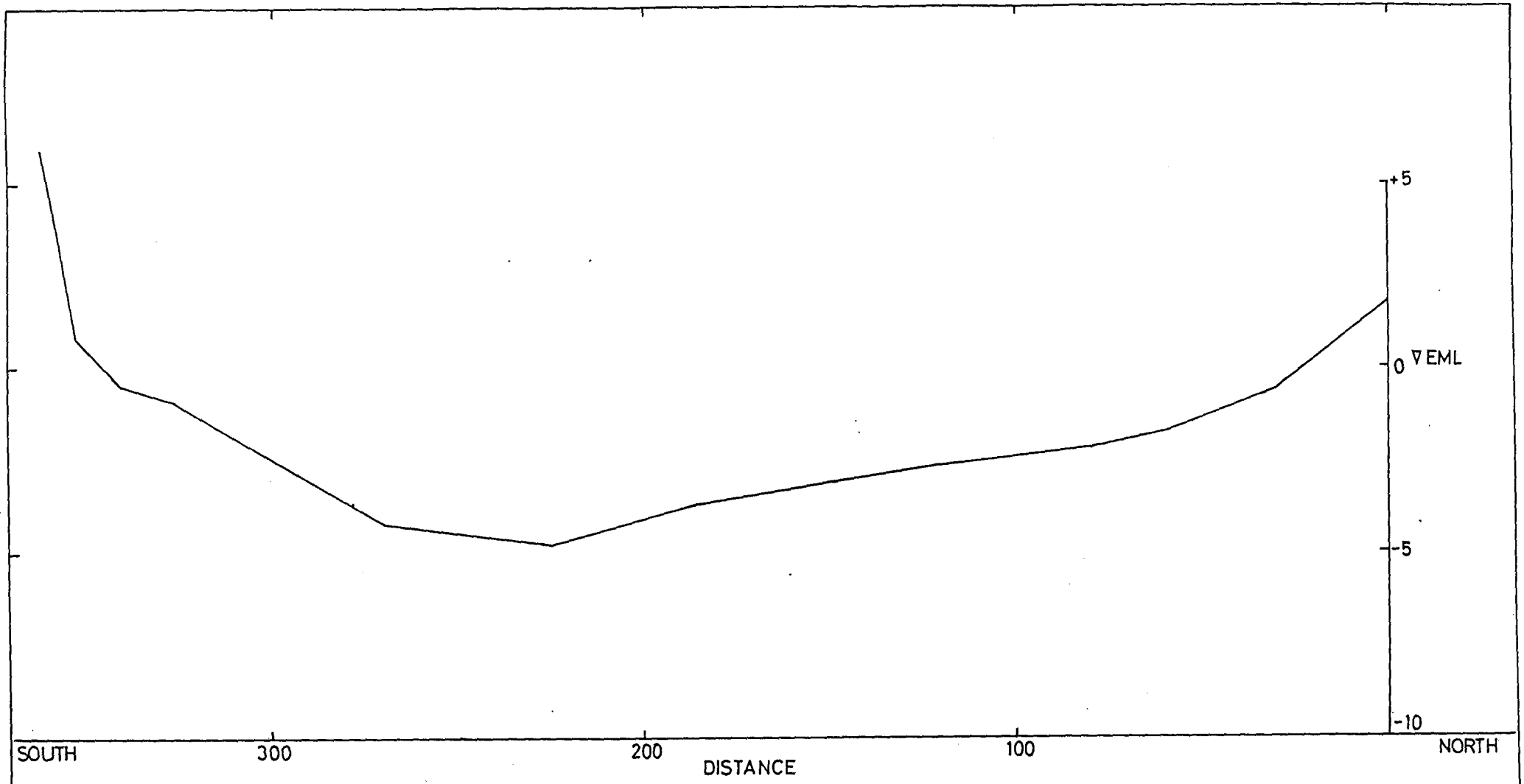
TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS-SECTION 05 - APRIL 1988	FIGURE 5j
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		



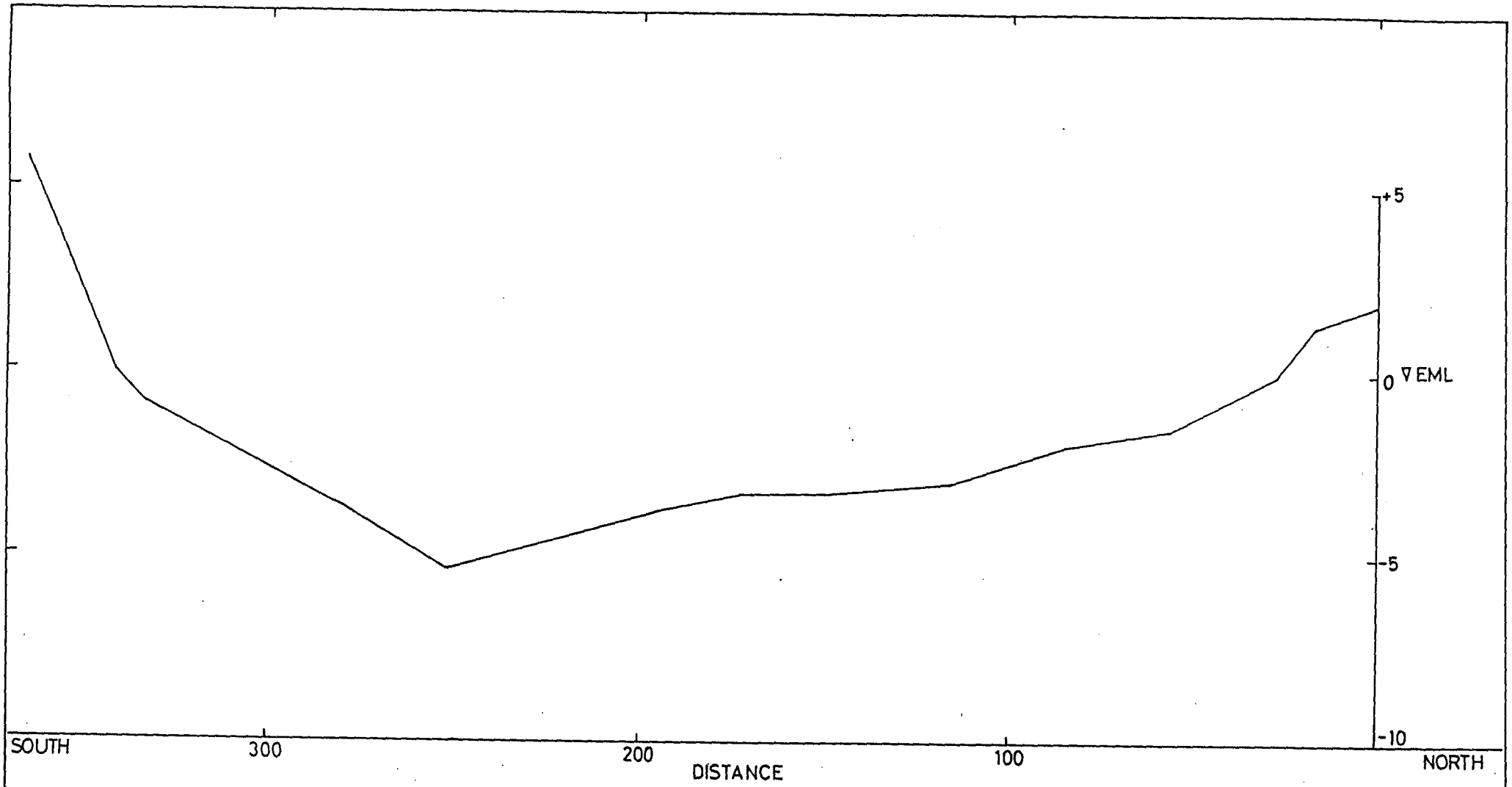
TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS-SECTION D 6 - JUNE 1986	FIGURE 6 a
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		



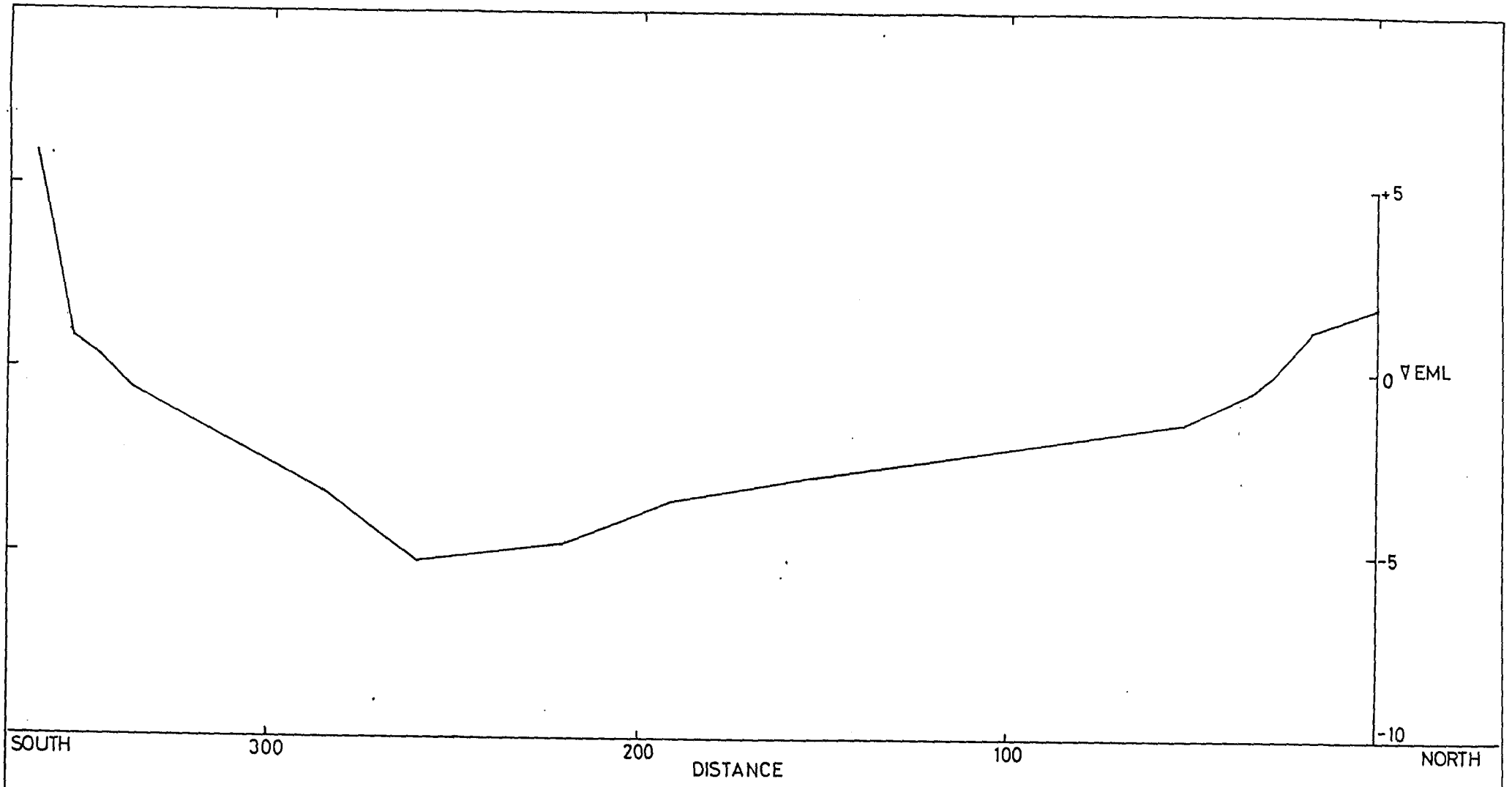
TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS-SECTION D 6 - AUGUST 1986	FIGURE 6b
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		



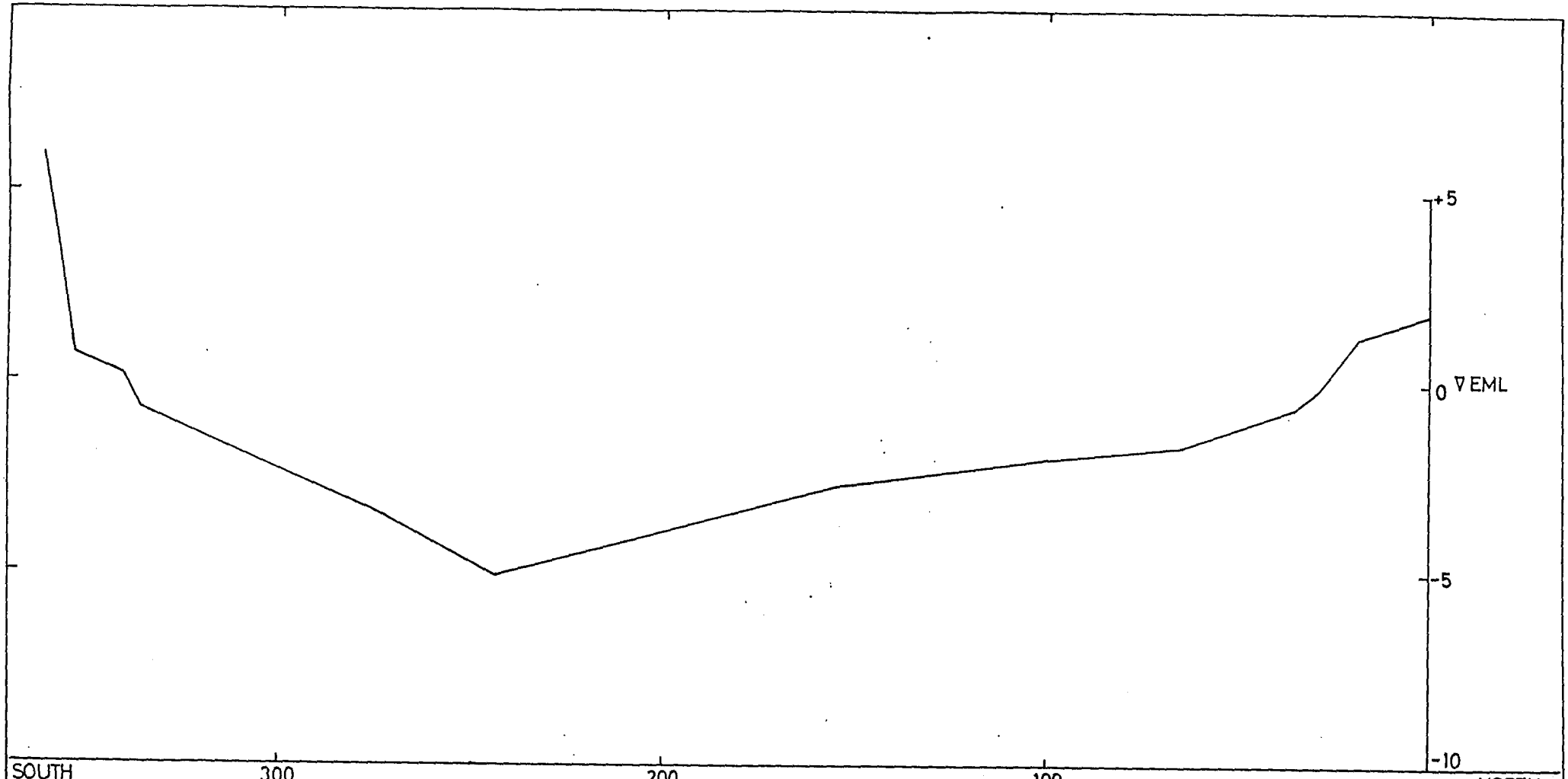
TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS - SECTION D 6 - OCTOBER 1986	FIGURE 6 c
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		



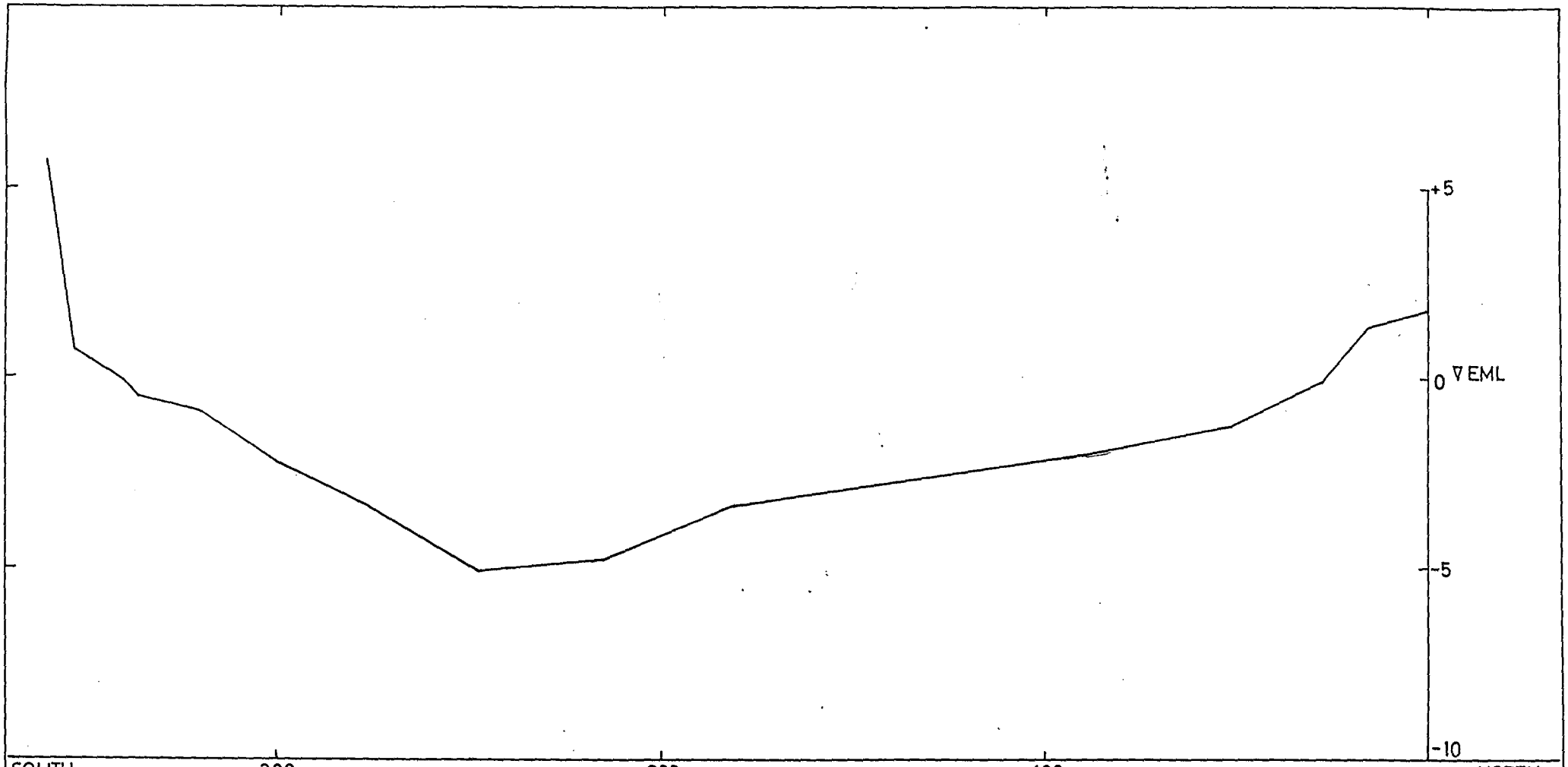
TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS-SECTION D 6 - FEBRUARY 1987	FIGURE 6d
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		



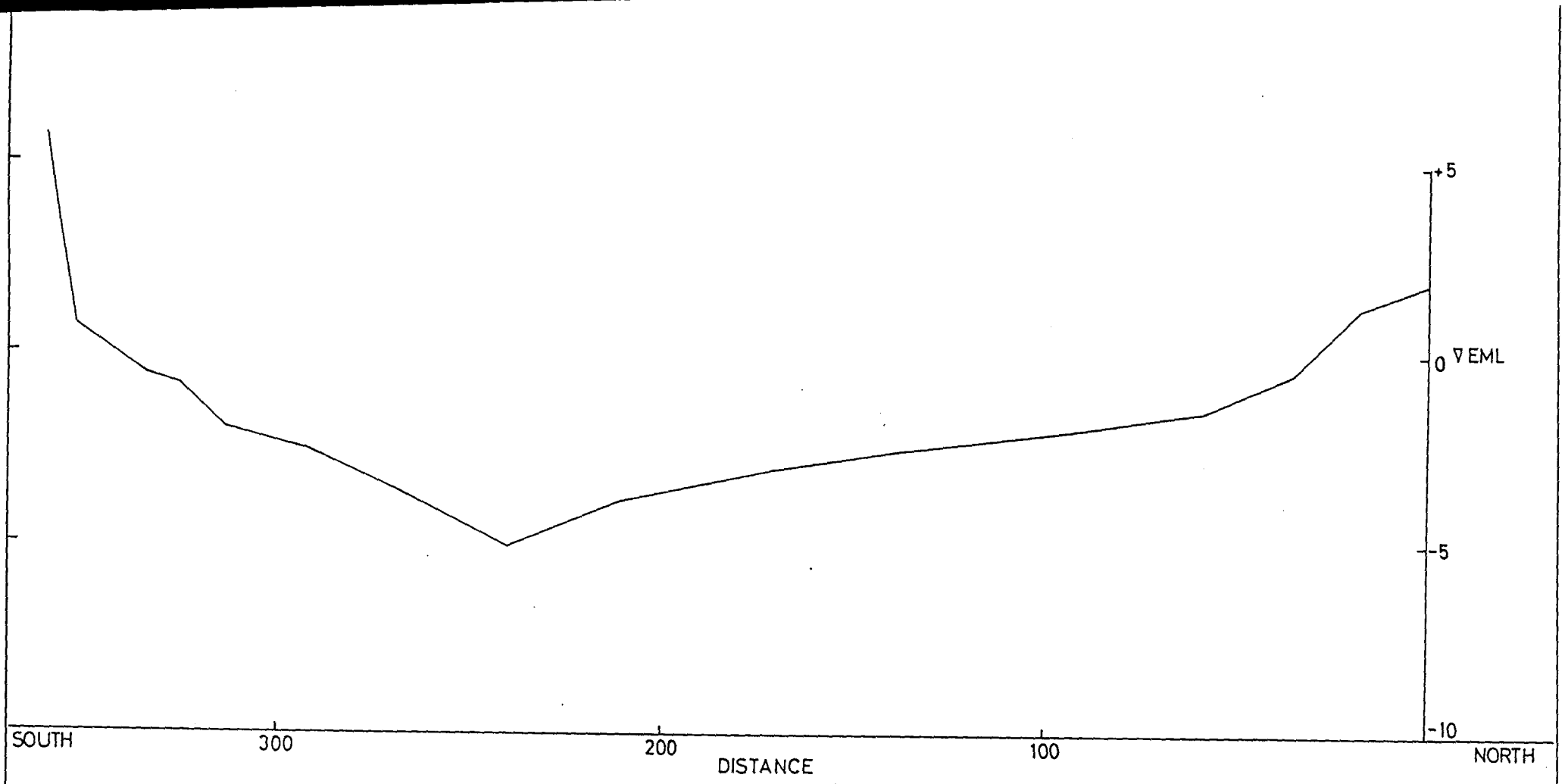
TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS-SECTION D6 - APRIL 1987	FIGURE 6e
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		



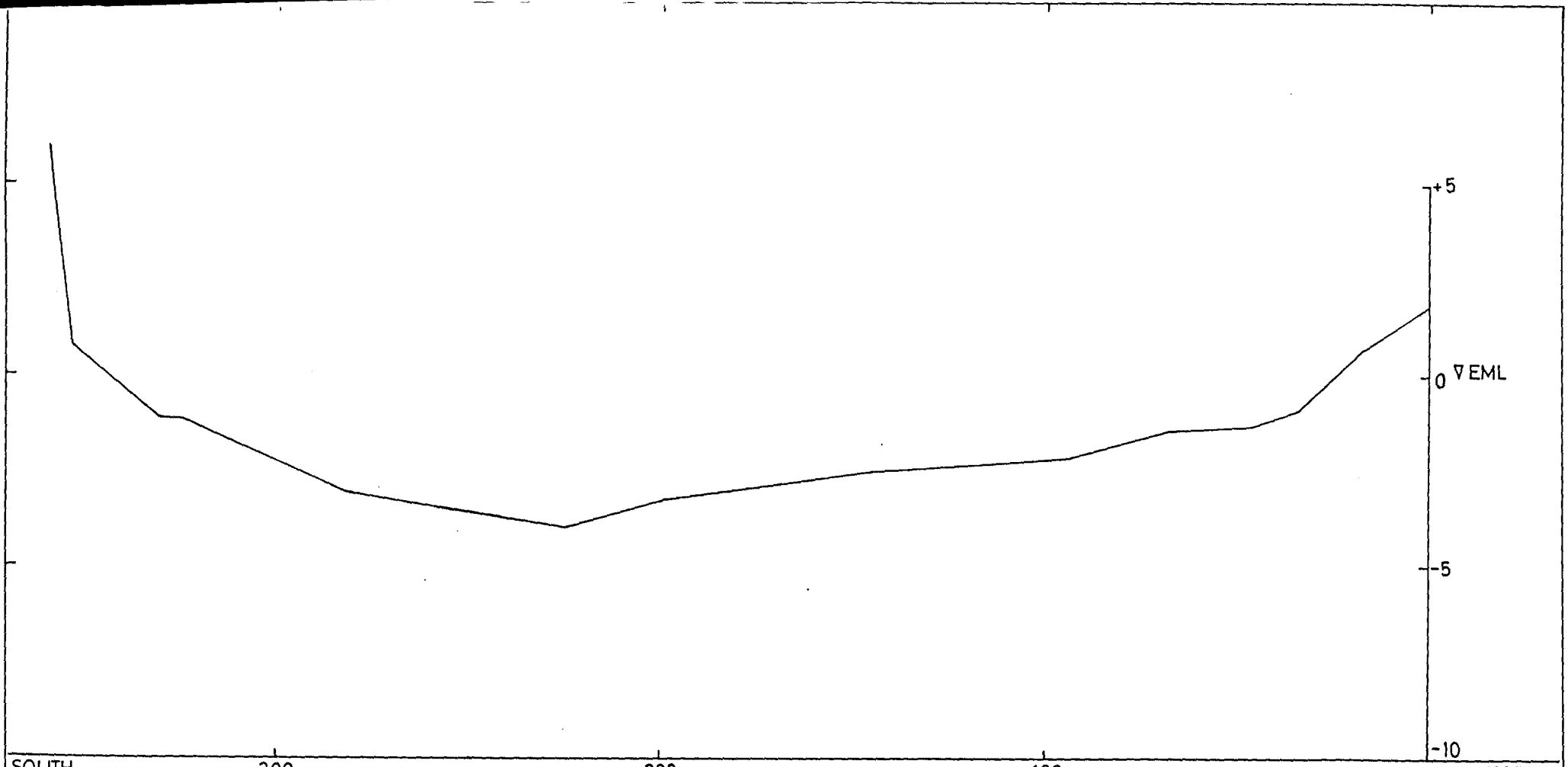
TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS-SECTION D6 - JUNE 1987	FIGURE 6f
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		



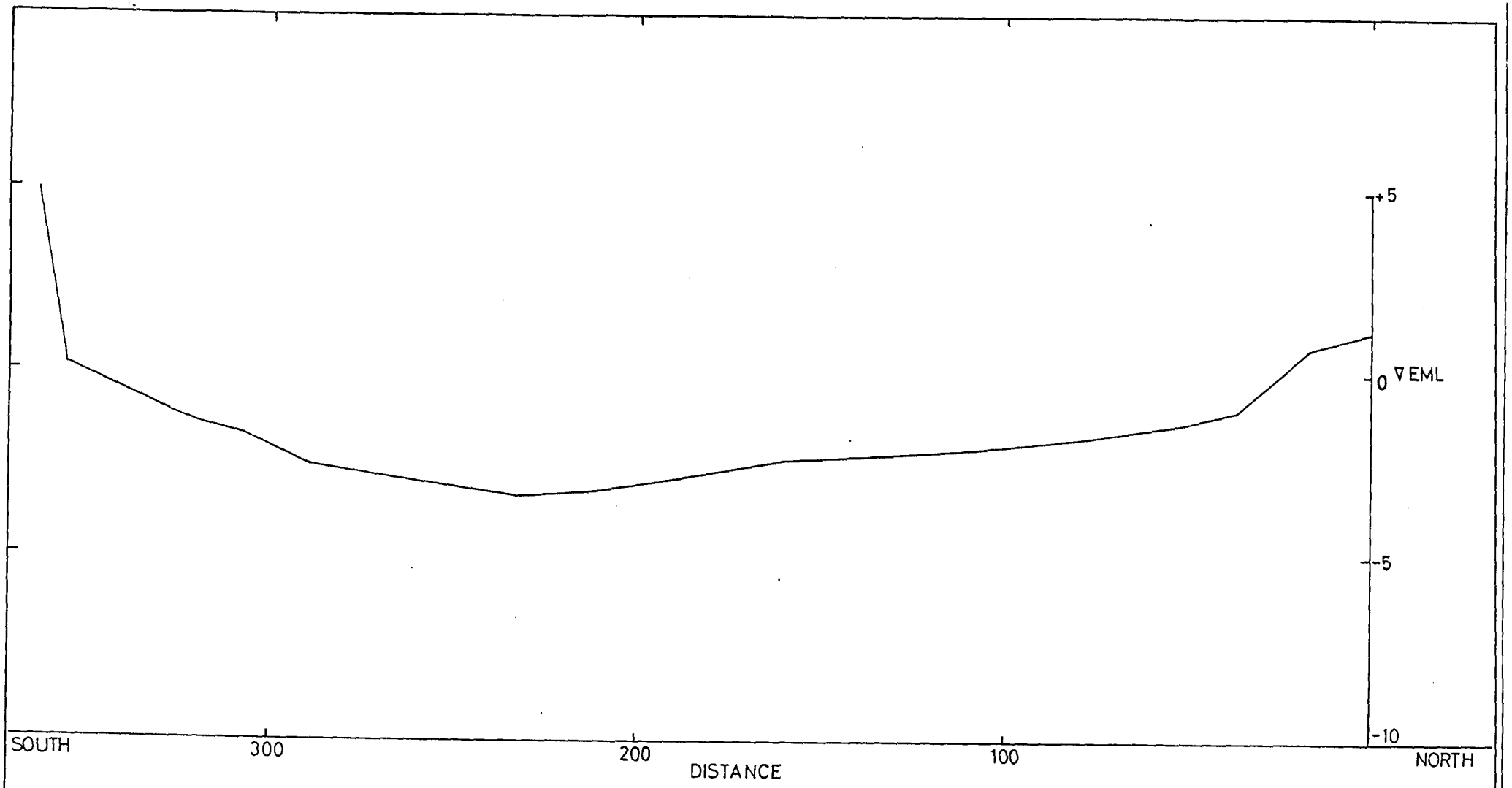
TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS- SECTION D6 - SEPTEMBER 1987	FIGURE 6g
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		



TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS-SECTION D 6 - OCTOBER 1987	FIGURE 6h
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		

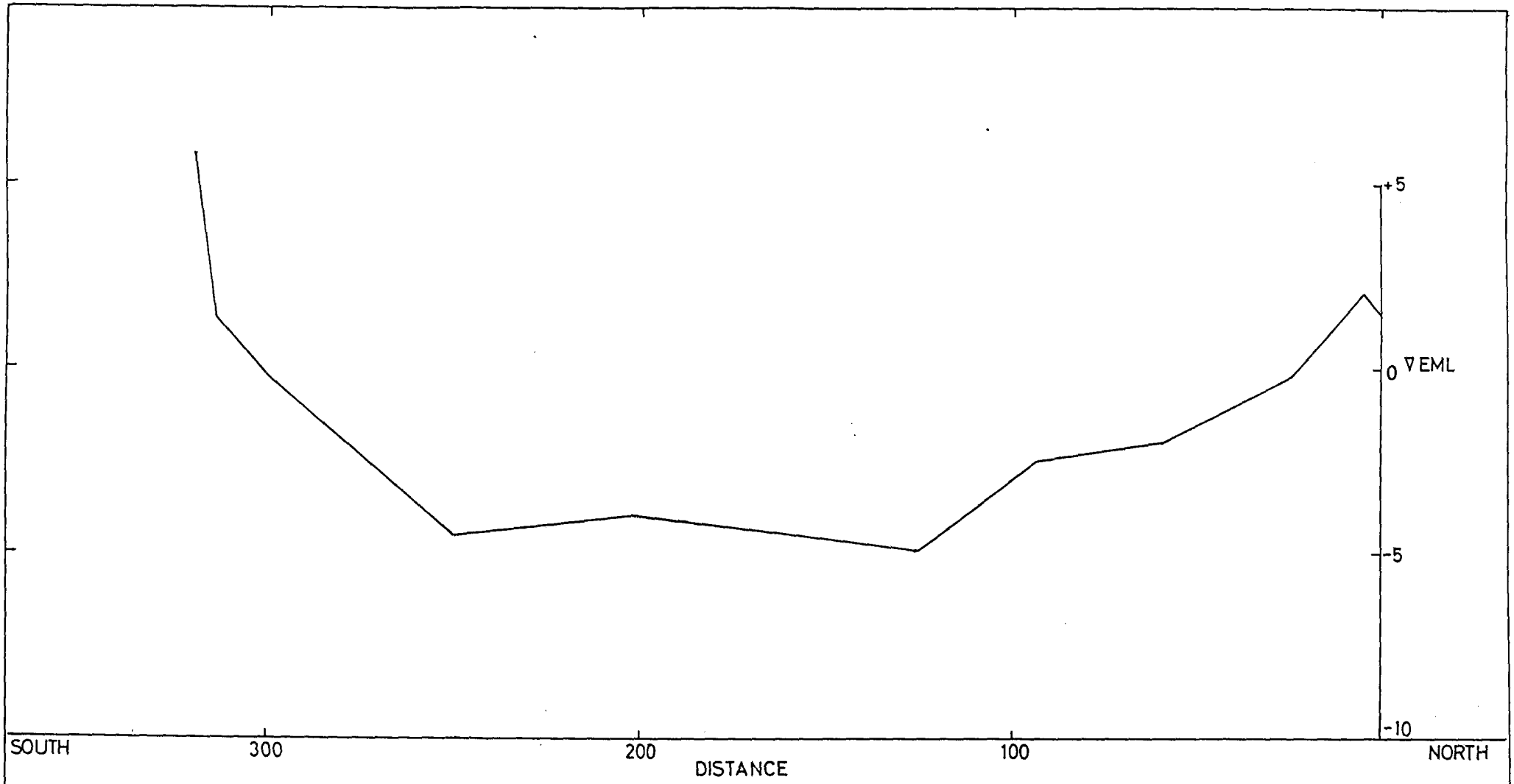


TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS-SECTION D6 - FEBRUARY 1988	FIGURE 6i
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		

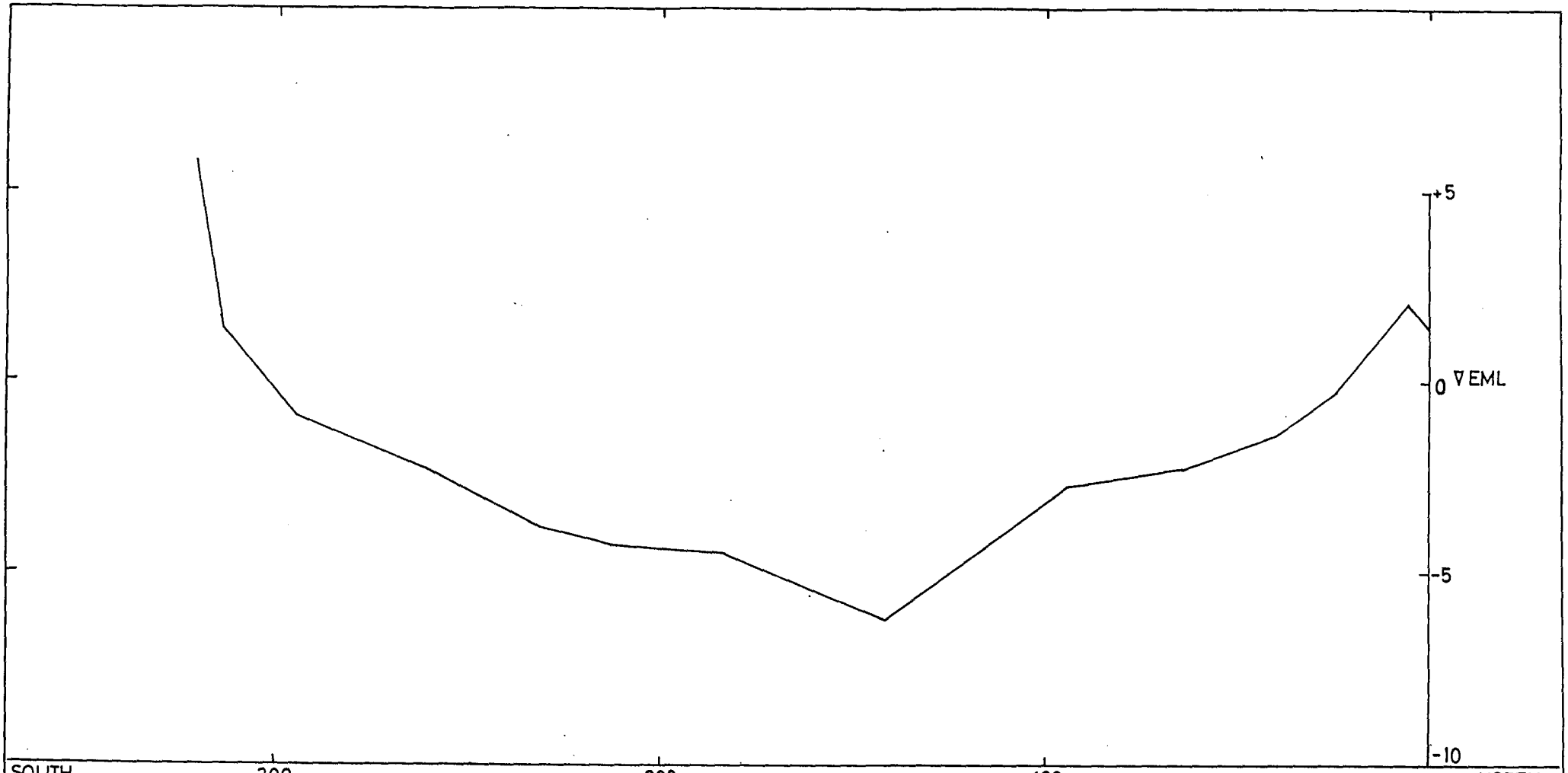


TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS-SECTION D6 - APRIL 1988	FIGURE 6j

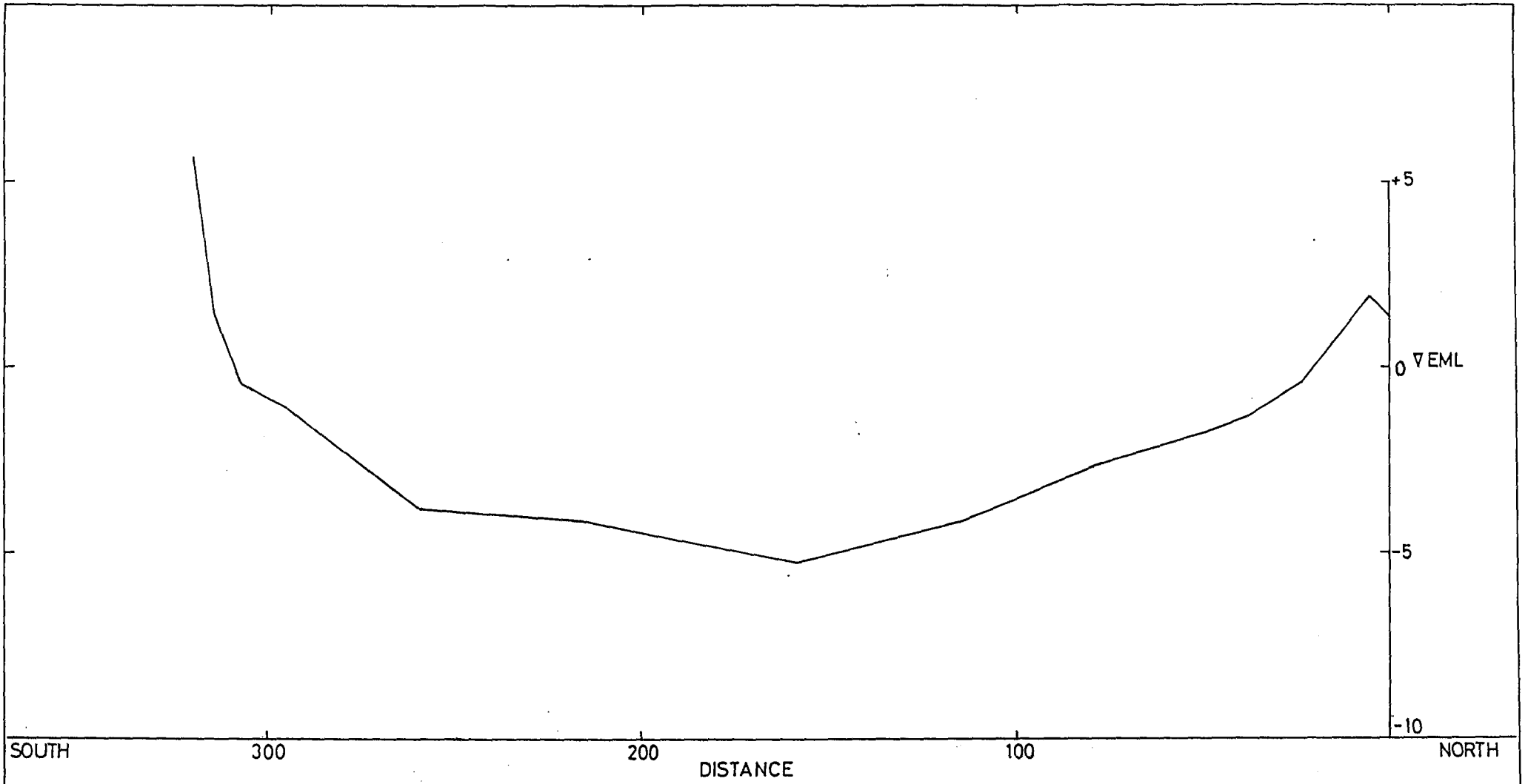
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY



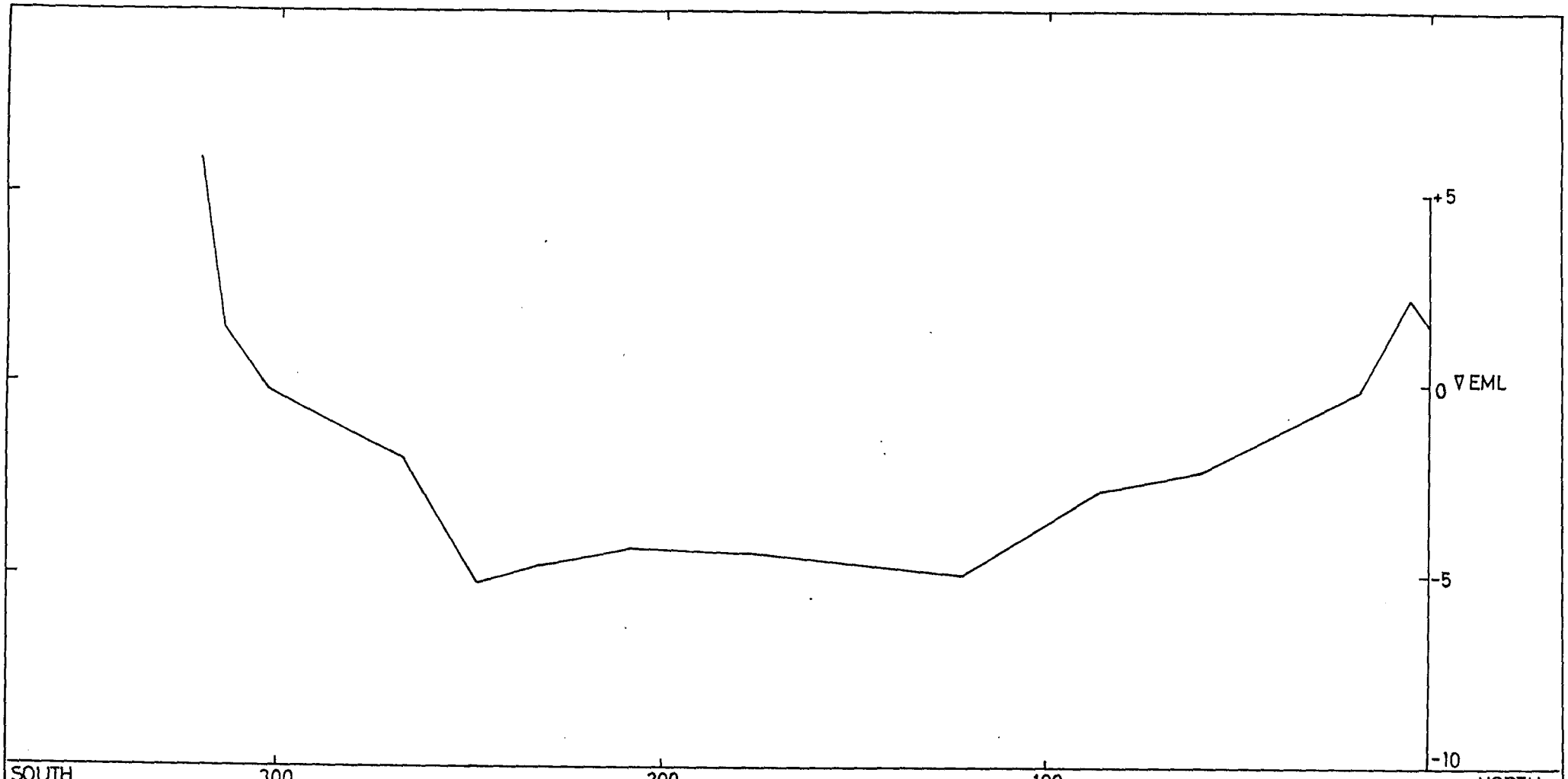
TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS-SECTION D7 - JUNE 1986	FIGURE 7a
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		



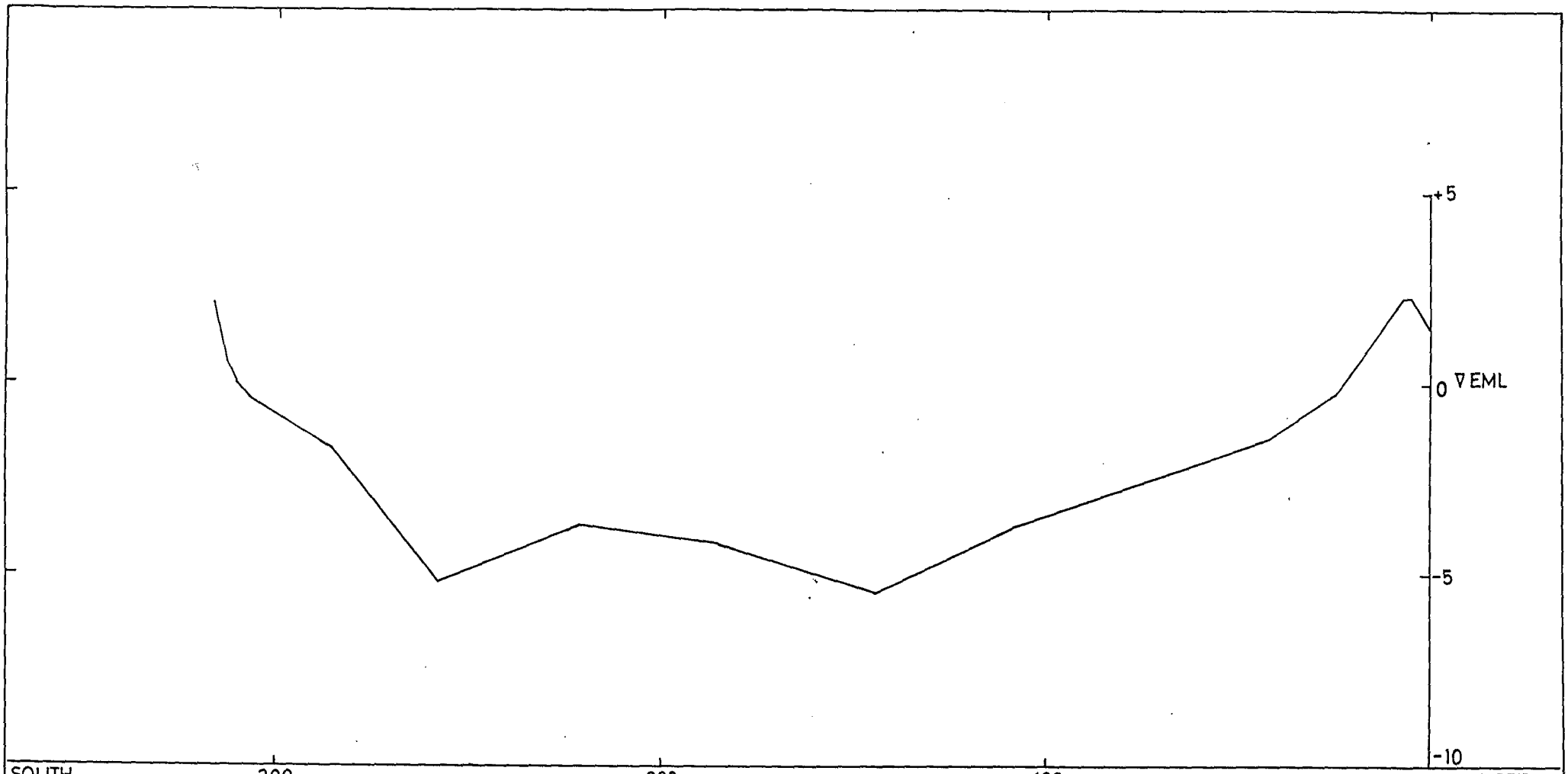
TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS- SECTION D7 - AUGUST 1986	FIGURE 7b
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		



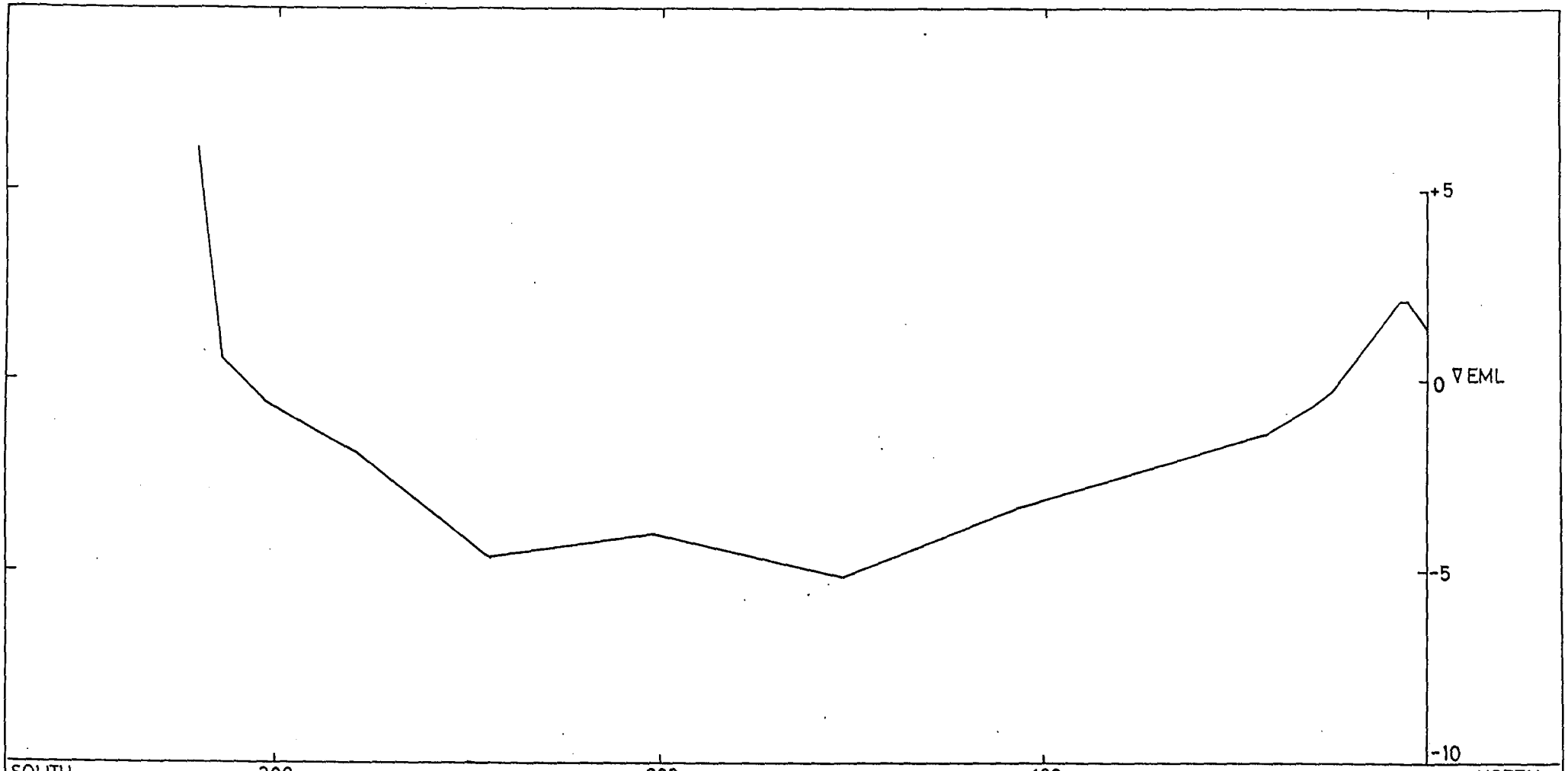
TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS-SECTION D7 - OCTOBER 1986	FIGURE 7c
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		



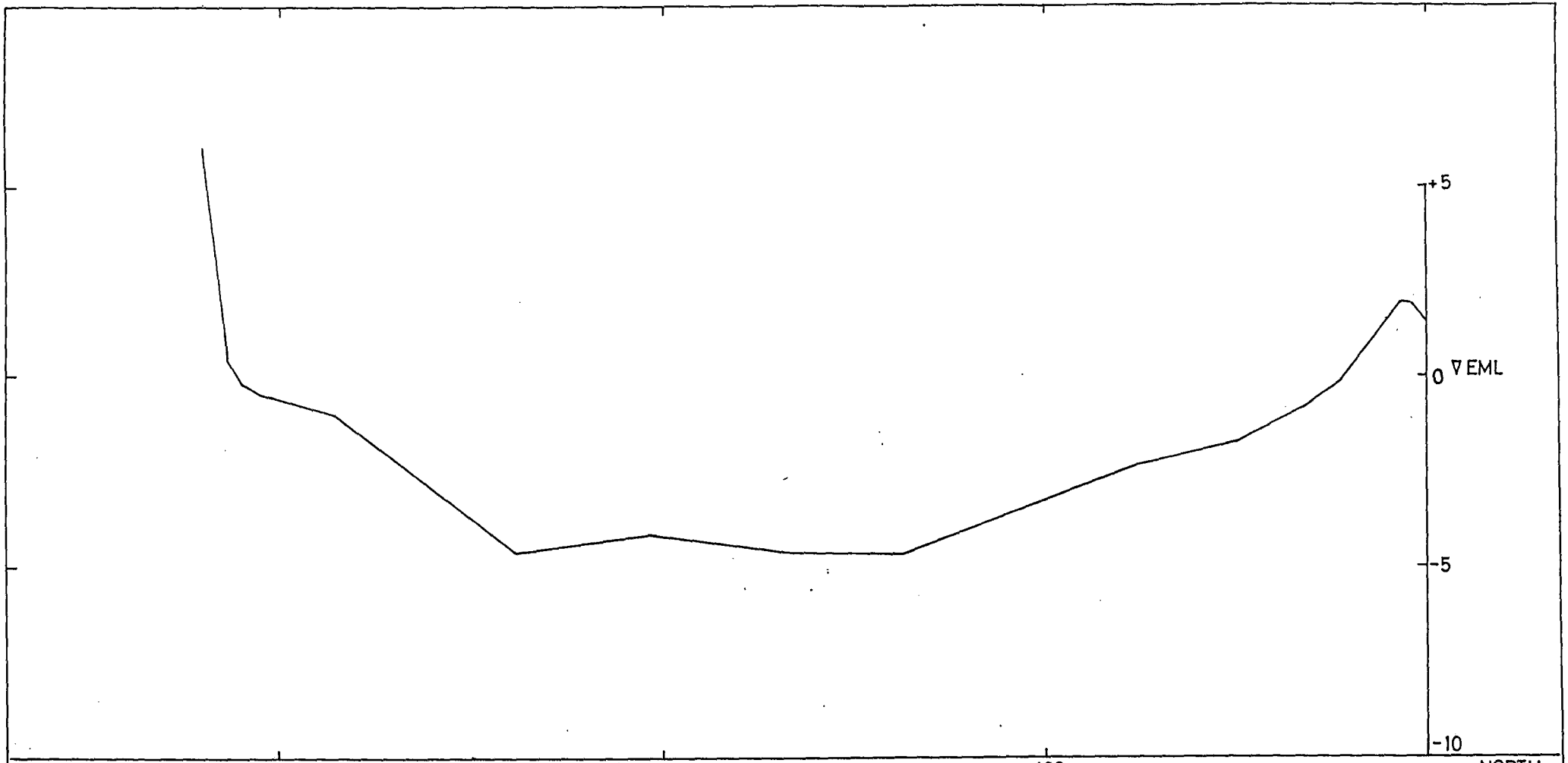
TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS-SECTION D7 - FEBRUARY 1987	FIGURE 7d
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		



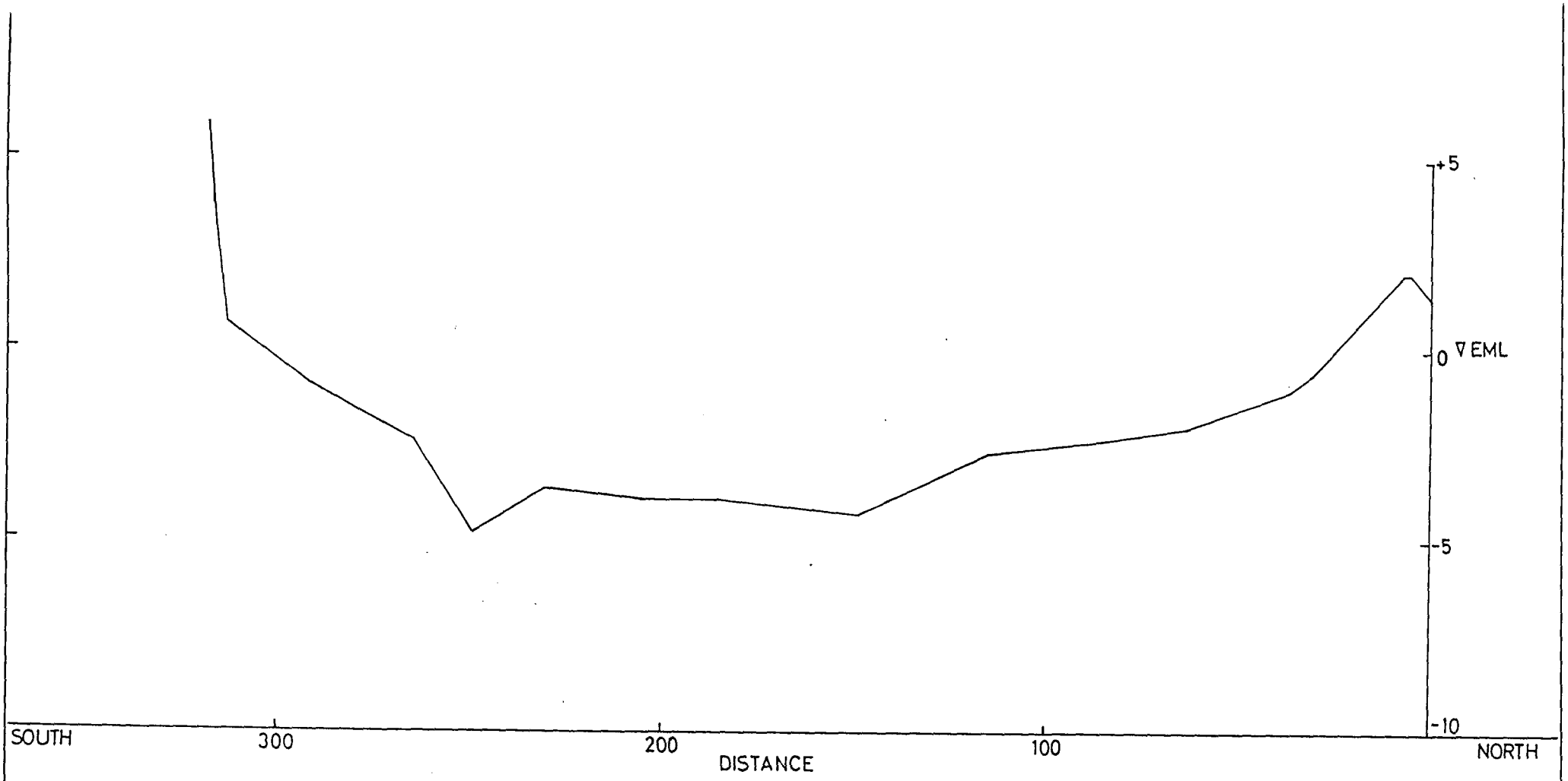
TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS- SECTION D7 - APRIL 1987	FIGURE 7e
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		



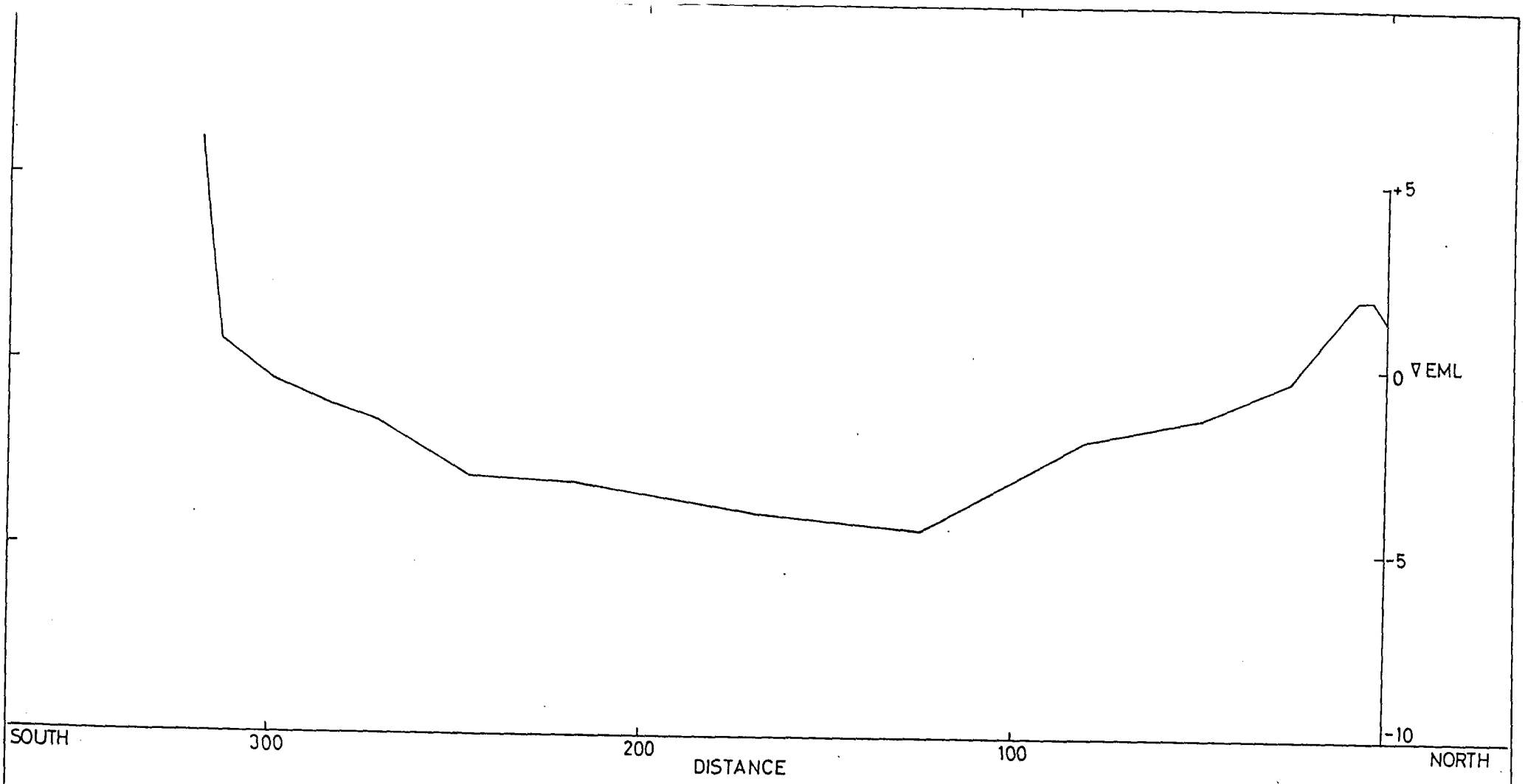
TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS- SECTION D7 - JUNE 1987	FIGURE 7f
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		



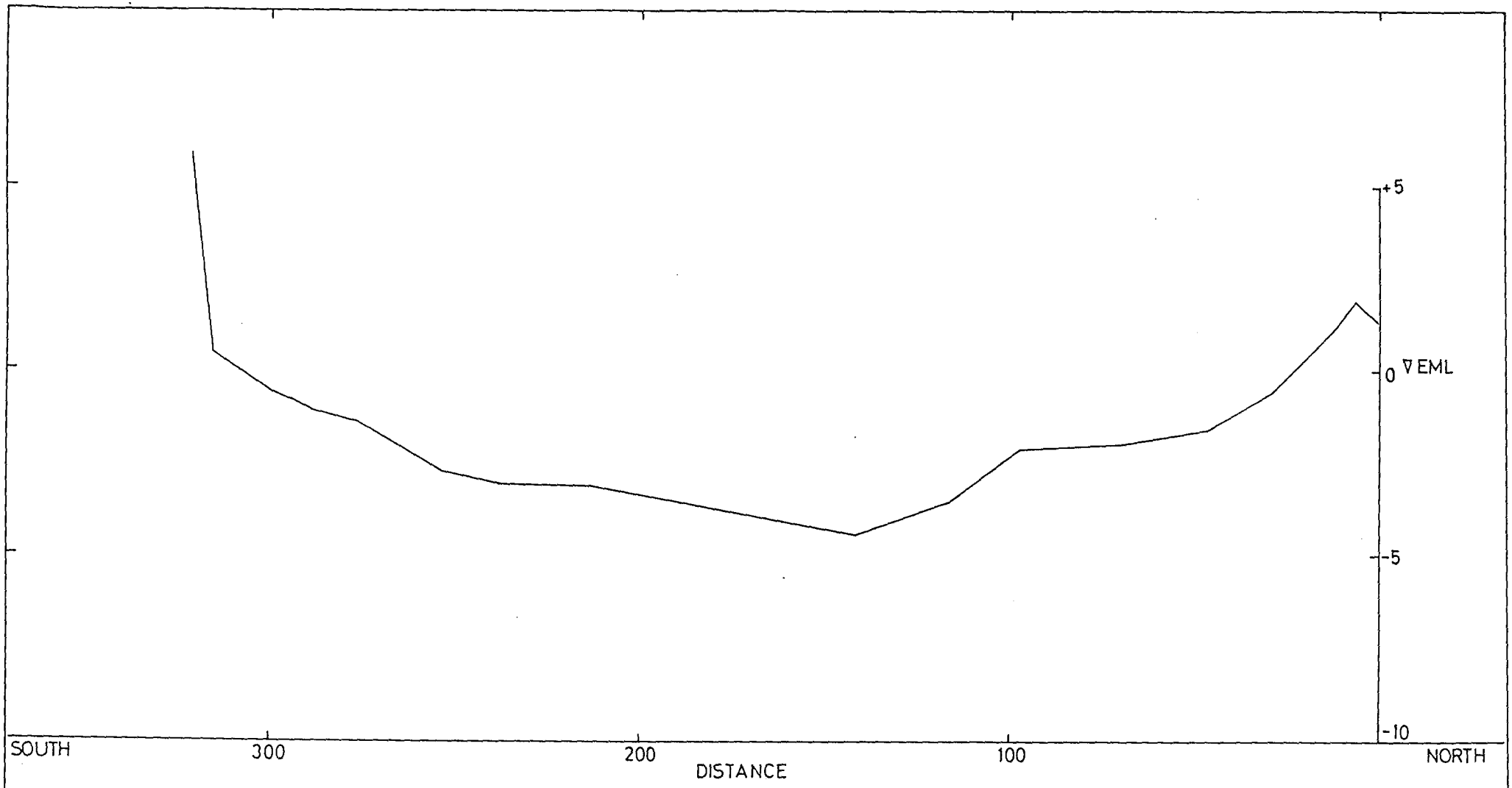
TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS- SECTION D7 - SEPTEMBER 1987	FIGURE 7g
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		



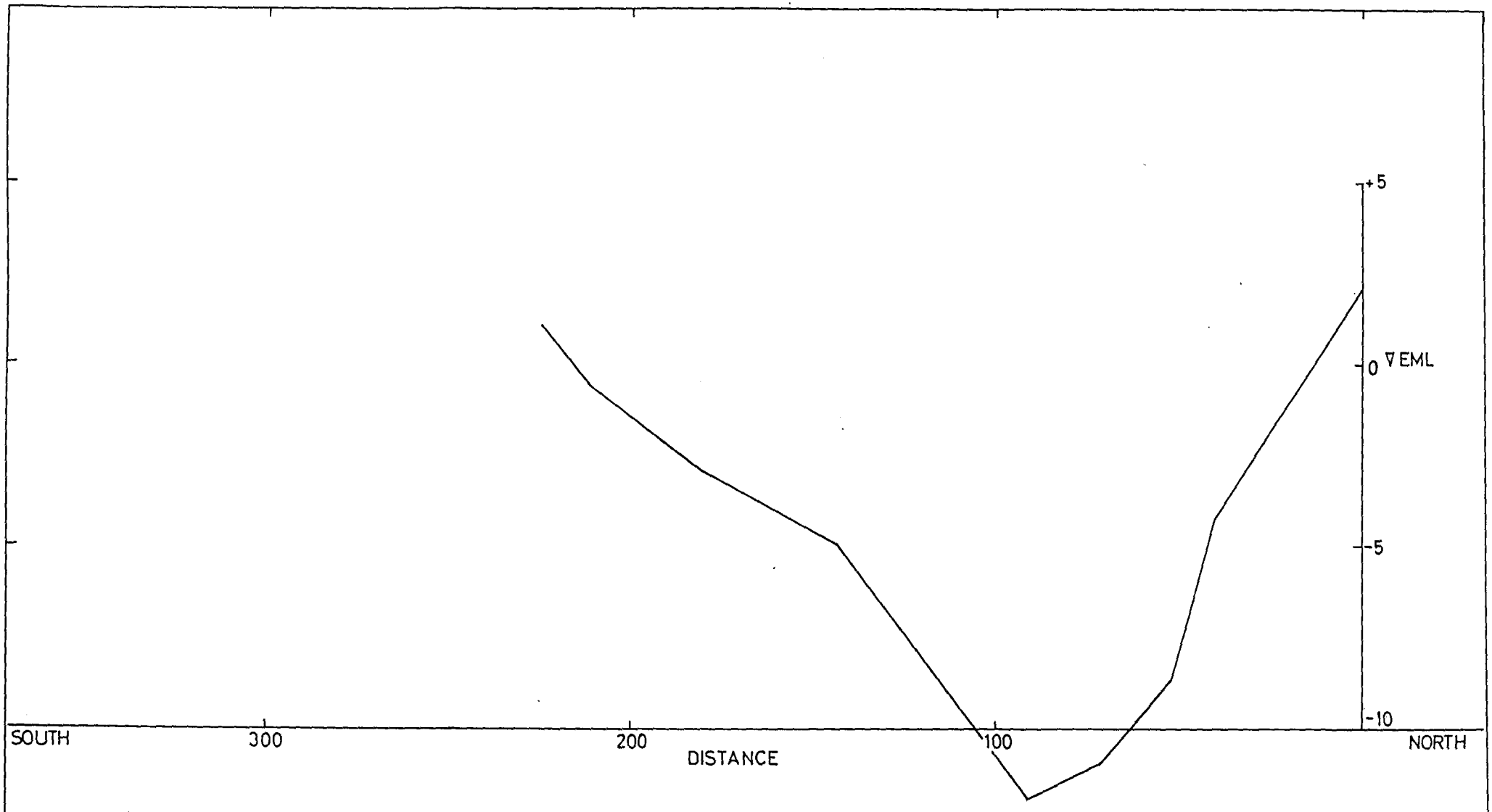
TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS- SECTION D 7 - OCTOBER 1987	FIGURE 7h
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		



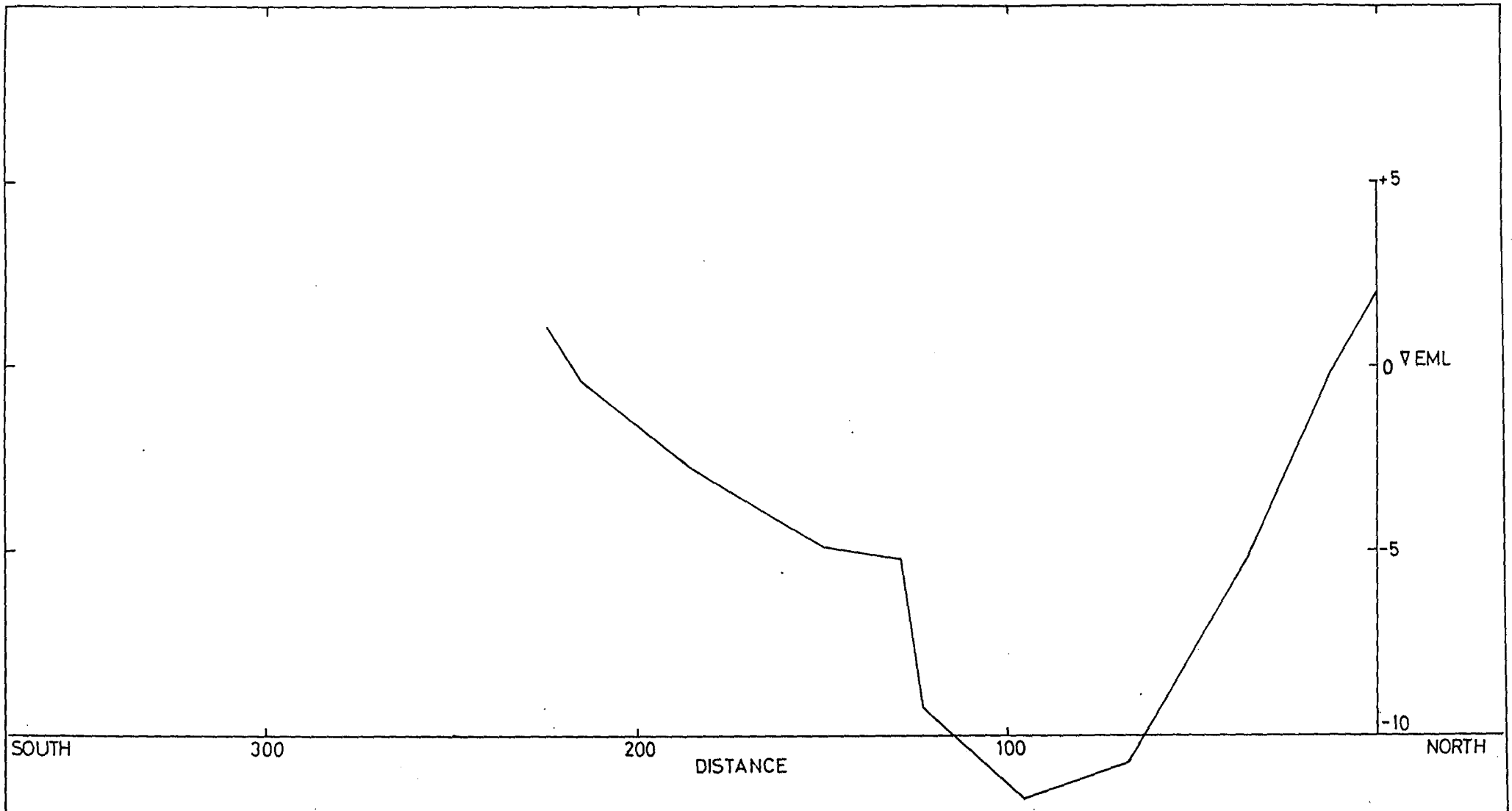
TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS-SECTION D7 - FEBRUARY 1988	FIGURE 7i
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		



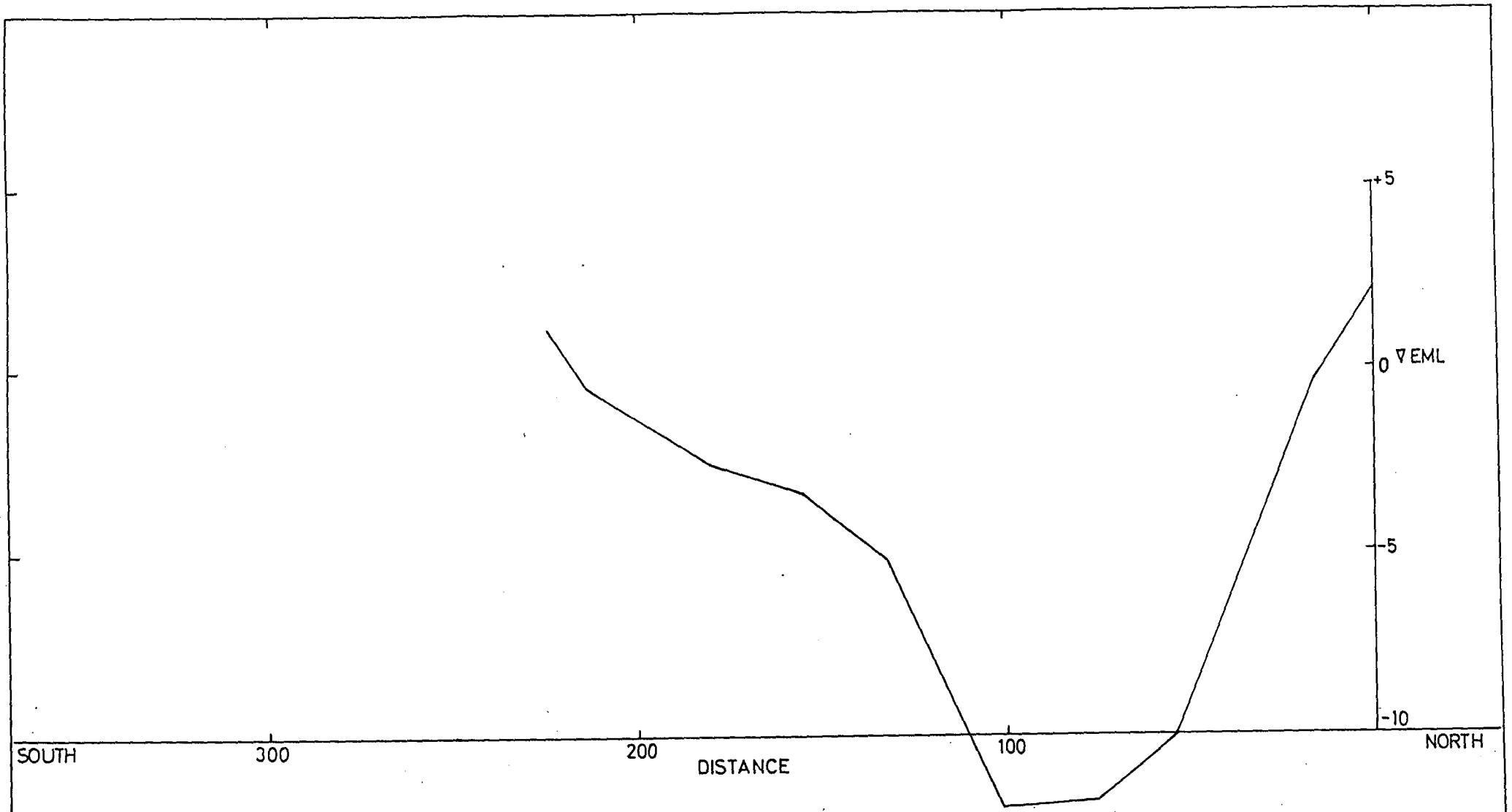
TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS- SECTION D7 - APRIL 1988	FIGURE 7j
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		



TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS-SECTION D8 - JUNE 1986	FIGURE 8 a
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		

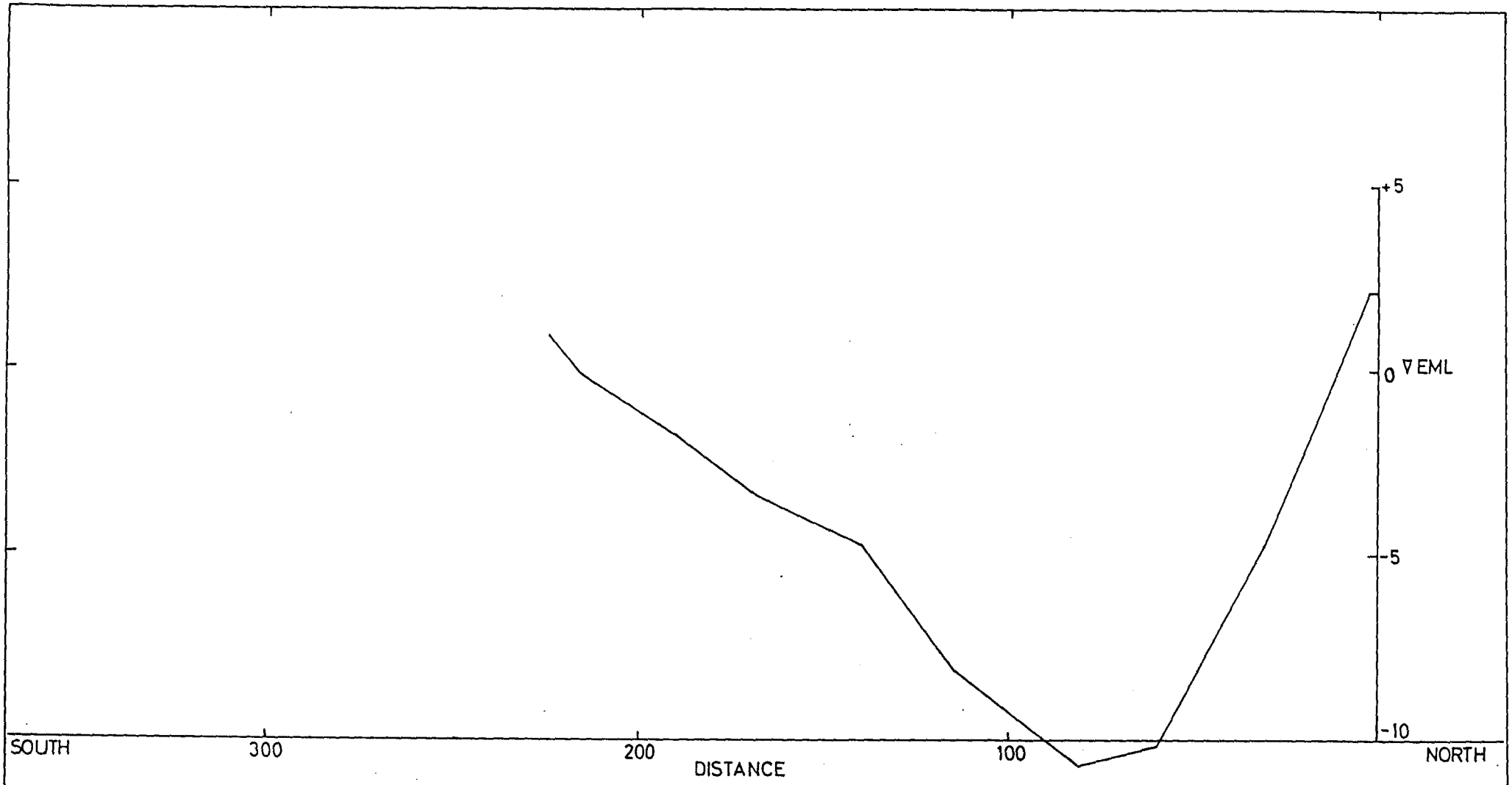


TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS- SECTION D 8 - AUGUST 1986	FIGURE 8 b
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		

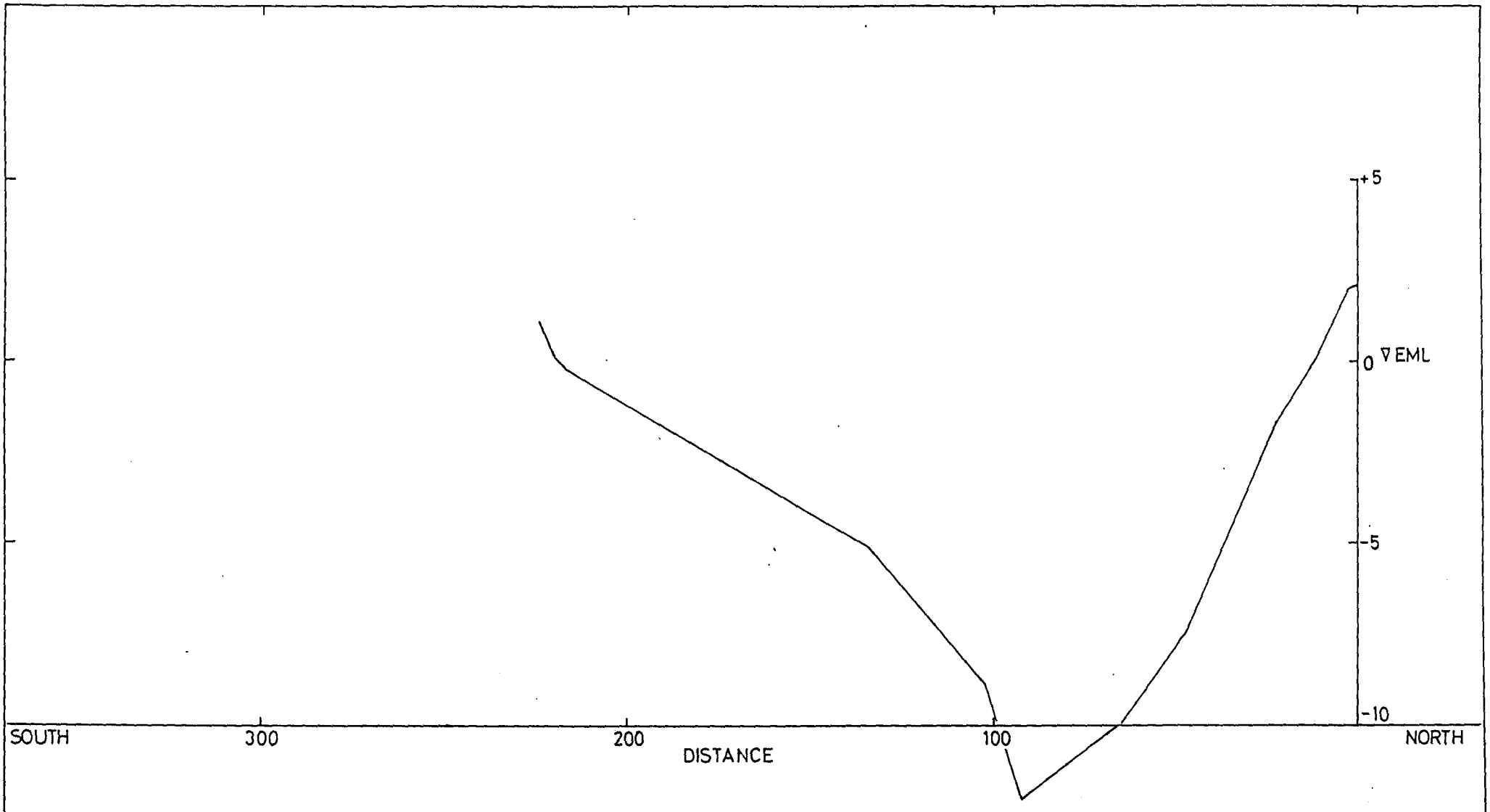


TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS- SECTION D 8 - OCTOBER 1986	FIGURE 8 c

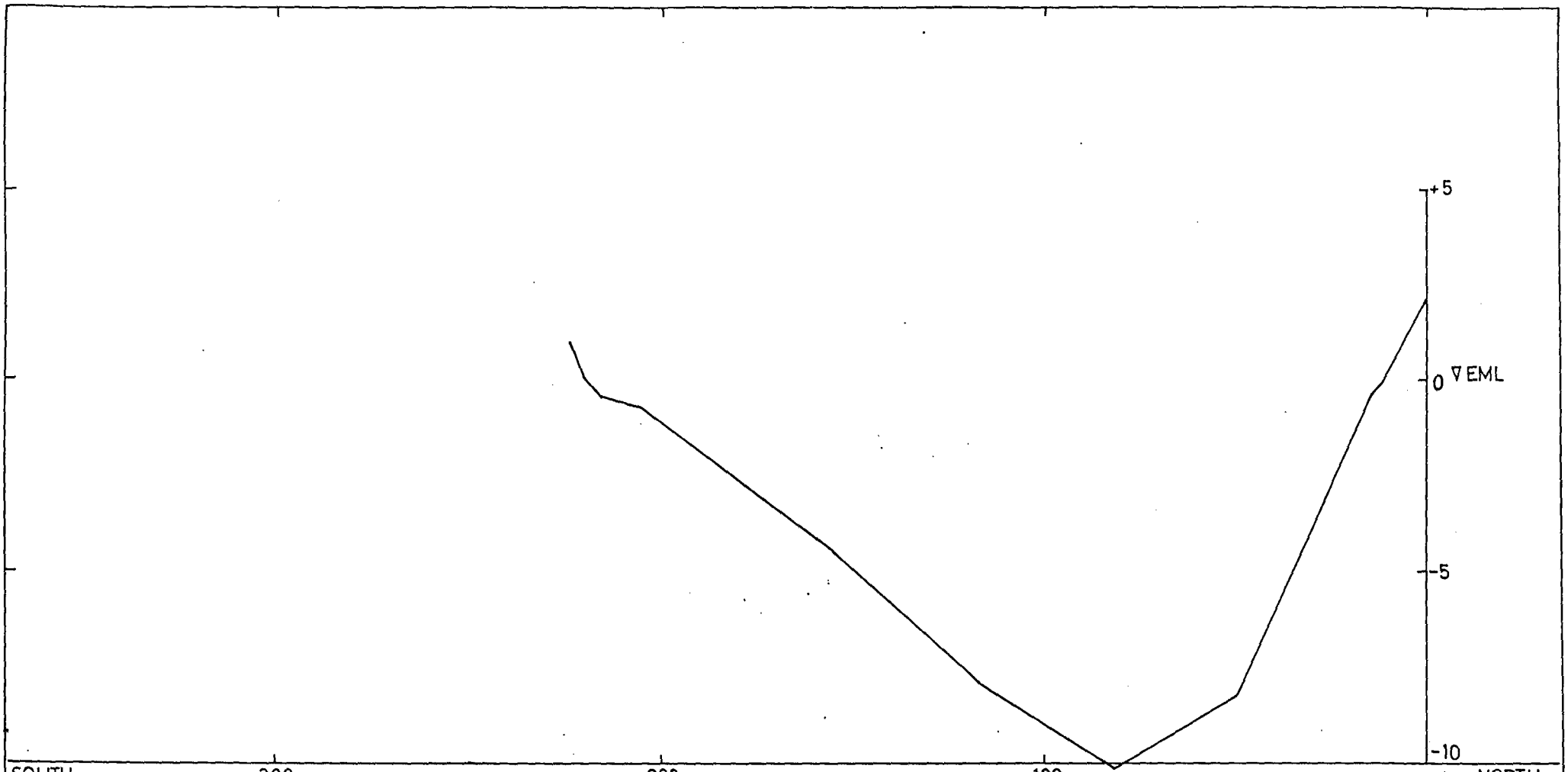
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY



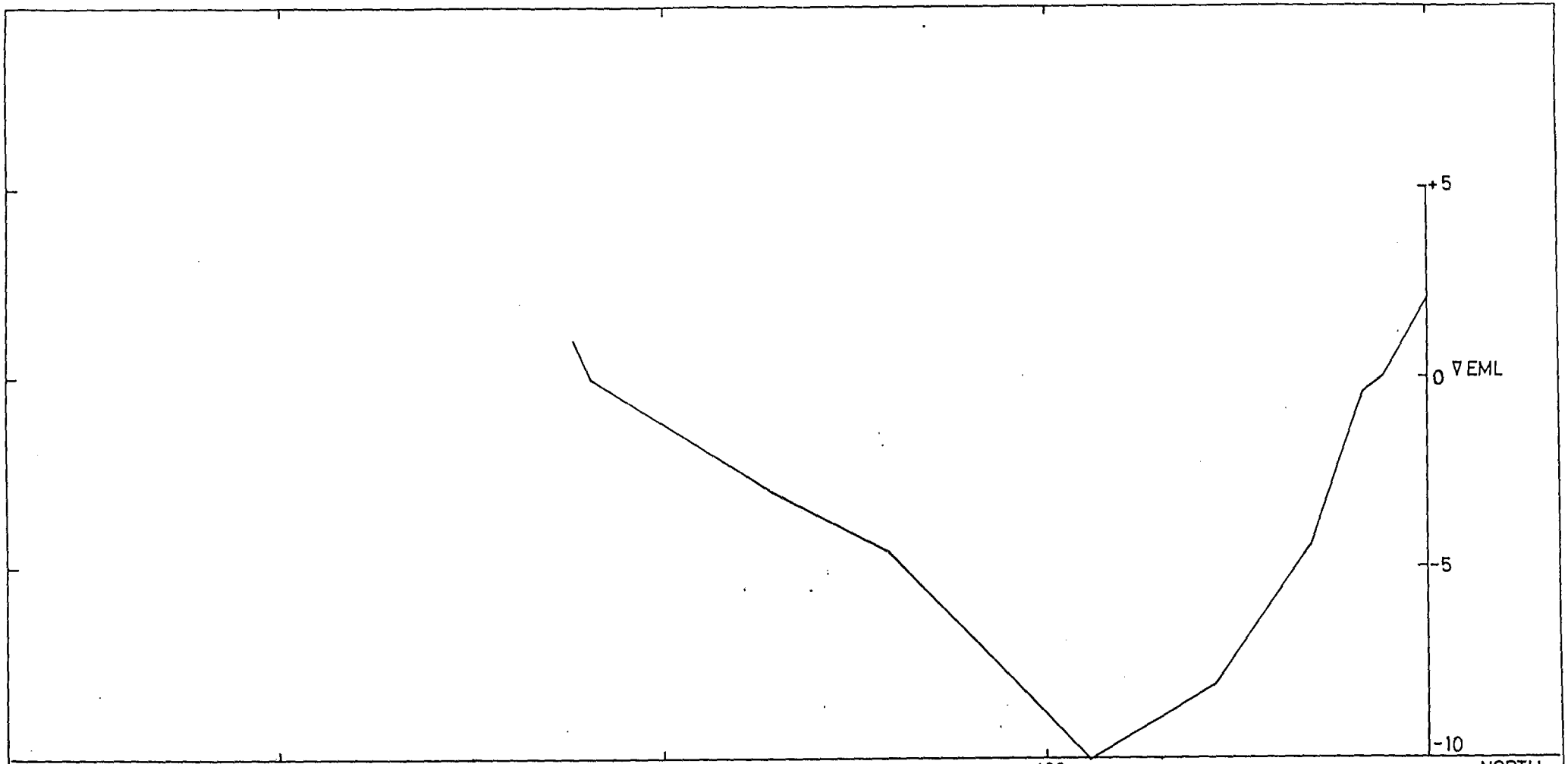
TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS - SECTION D8 - FEBRUARY 1987	FIGURE 8 d
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		



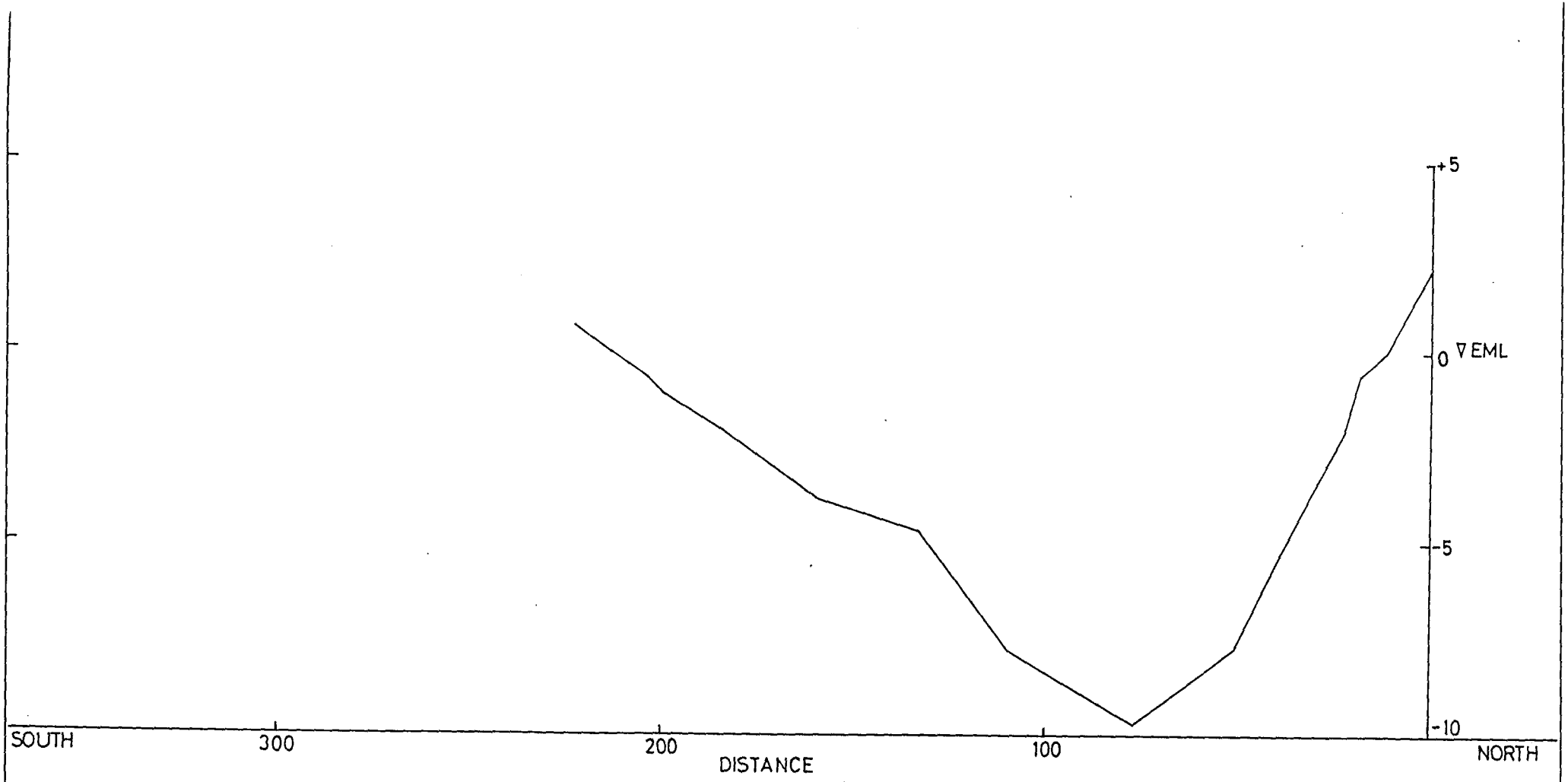
TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS-SECTION D8 - APRIL 1987	FIGURE 8 e
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		



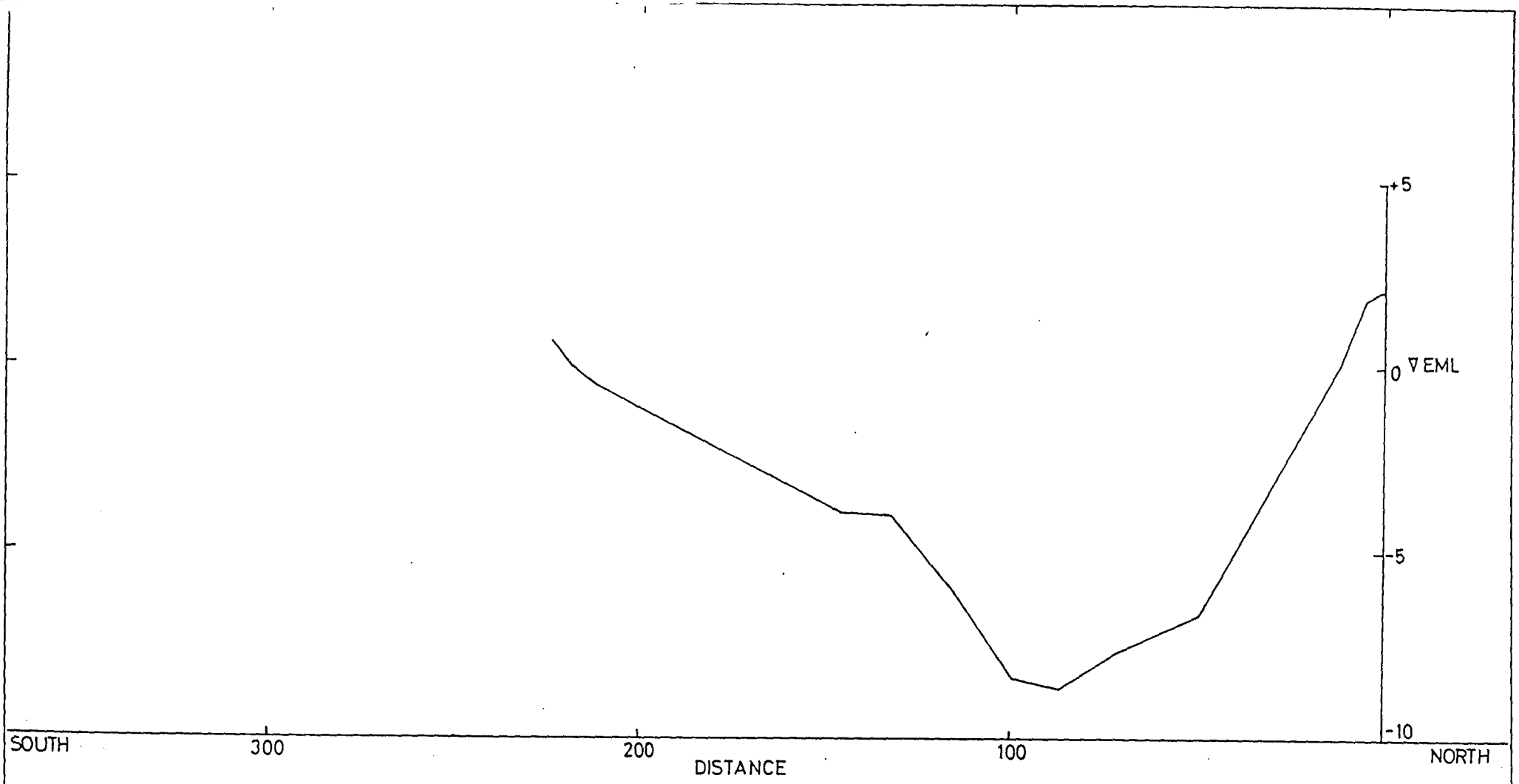
TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS- SECTION D 8 - JUNE 1987	FIGURE 8 f
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		



TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS-SECTION D8 - SEPTEMBER 1987	FIGURE 8 g
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		

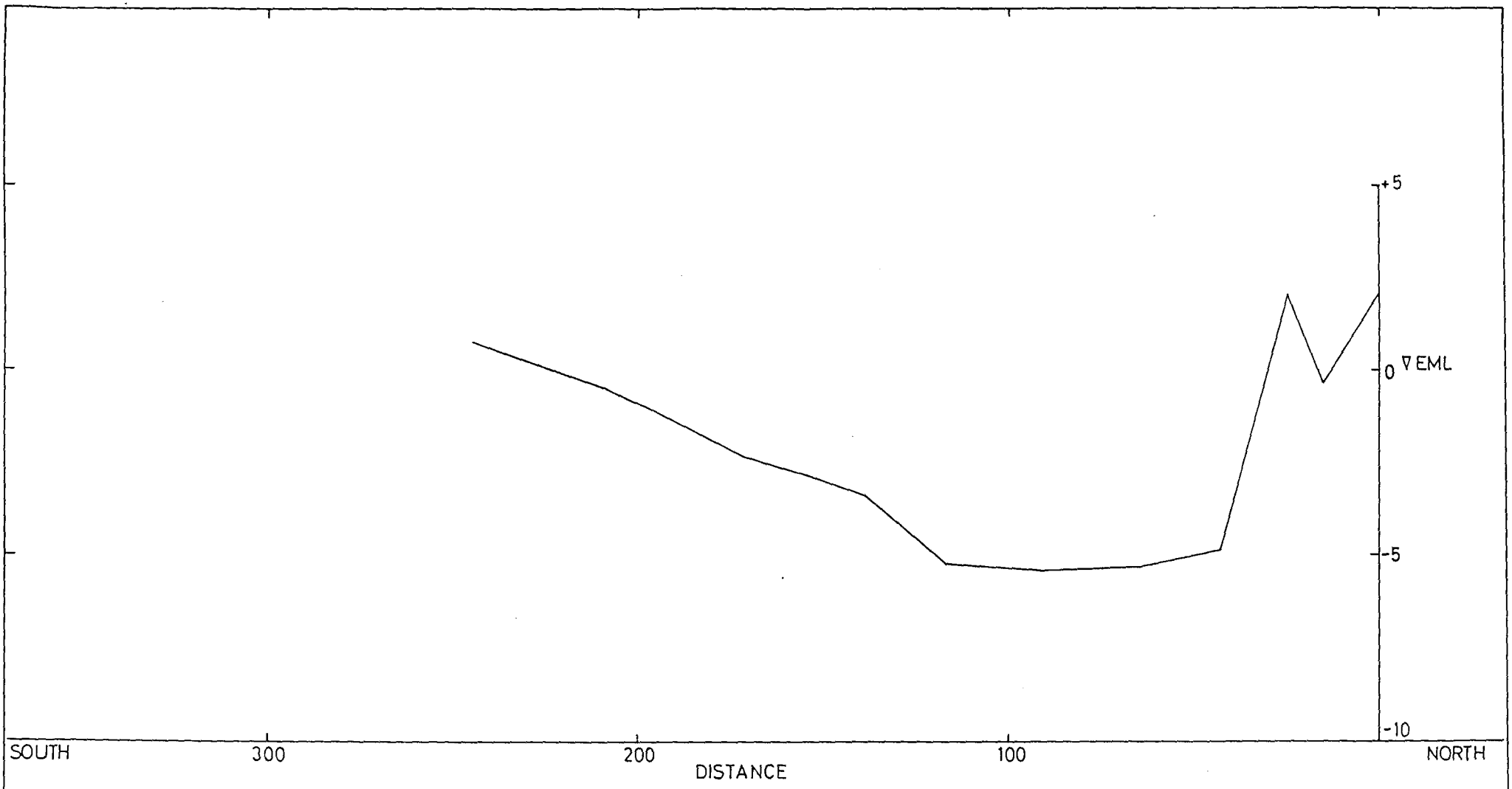


TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS-SECTION D8 - OCTOBER 1987	FIGURE 8h
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		

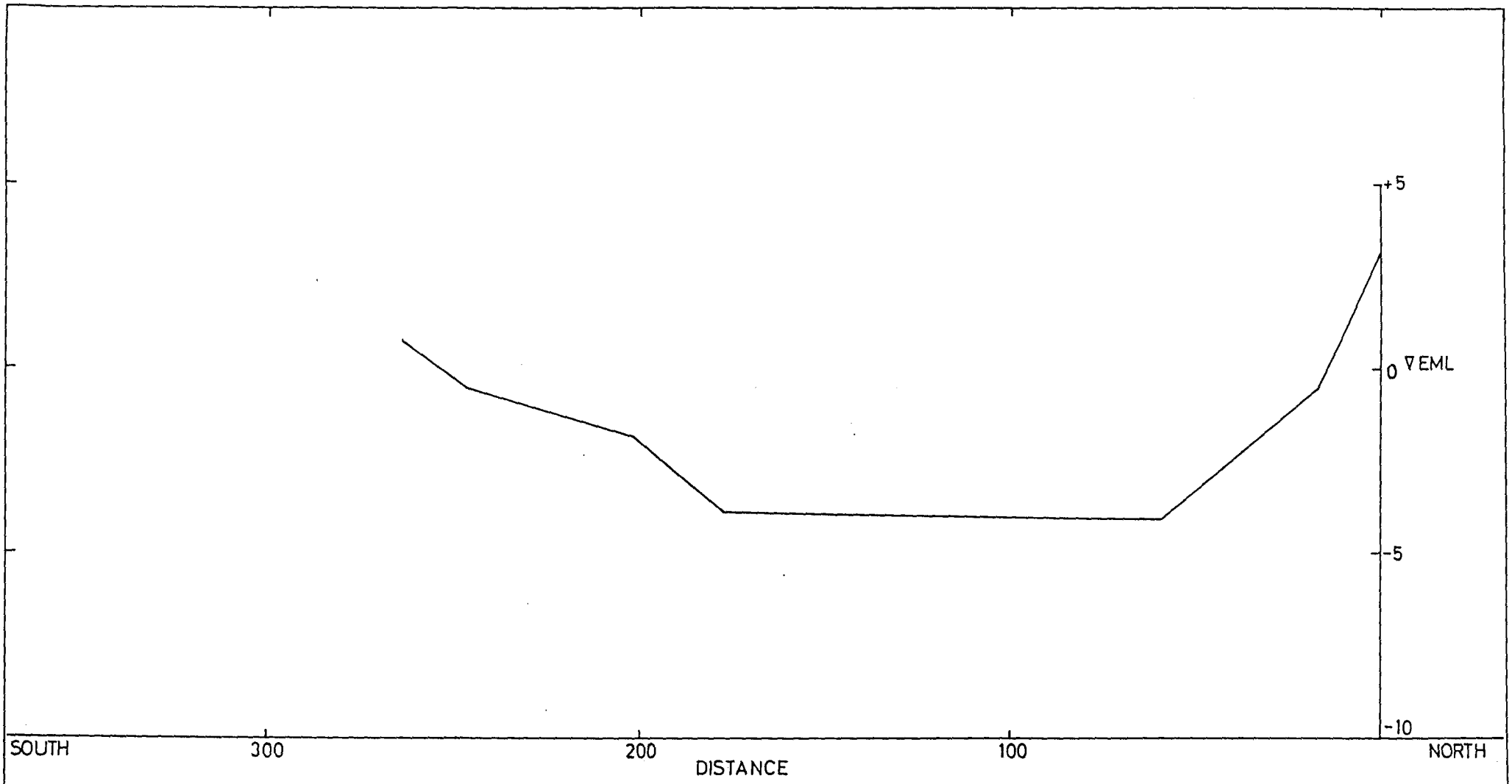


TRACED:	ST. LUCIA DREDGING	FIGURE
CHECKED:	CROSS-SECTION D 8 - FEBRUARY 1988	8i
DATE:		
REF:		

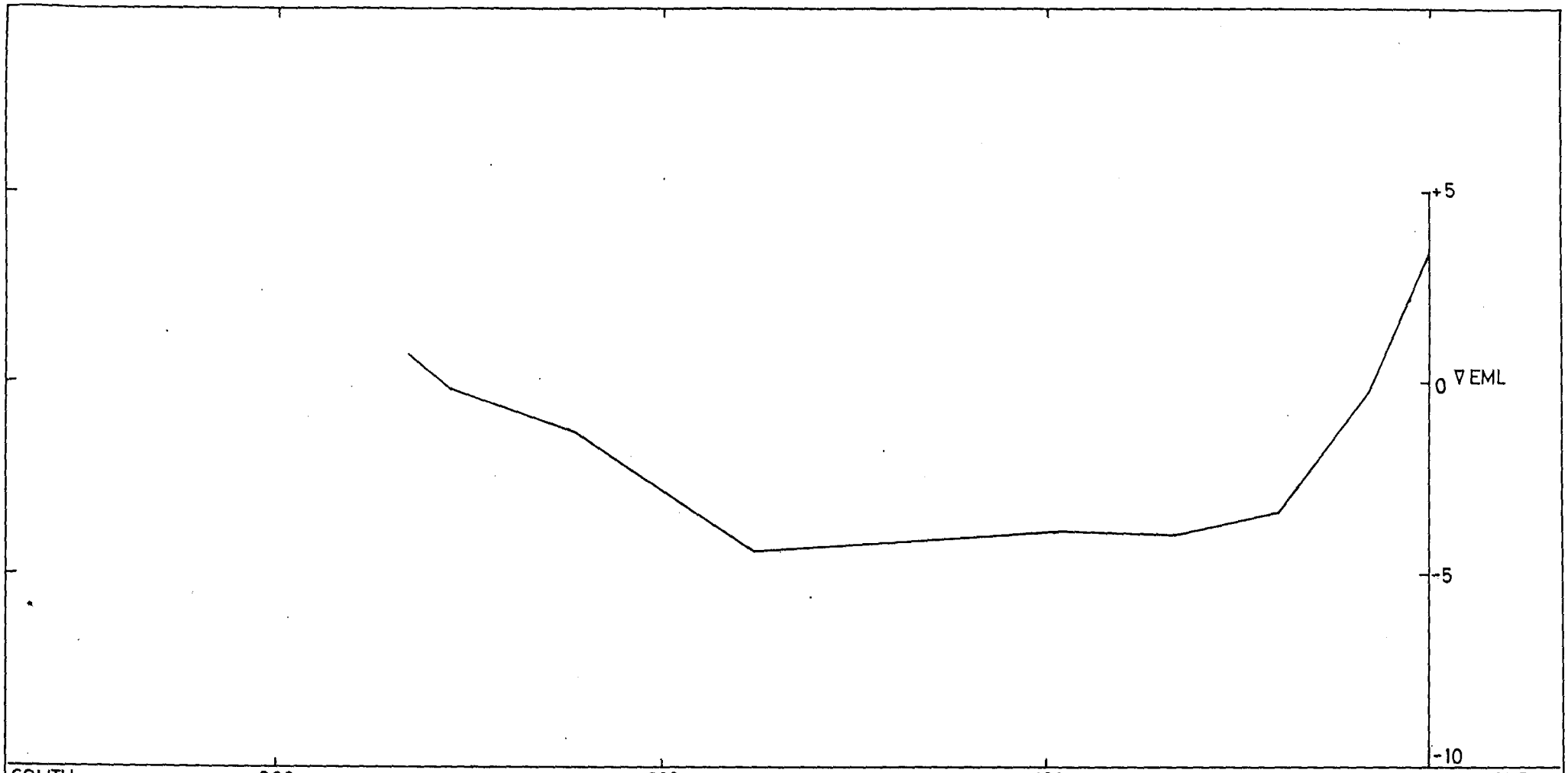
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY



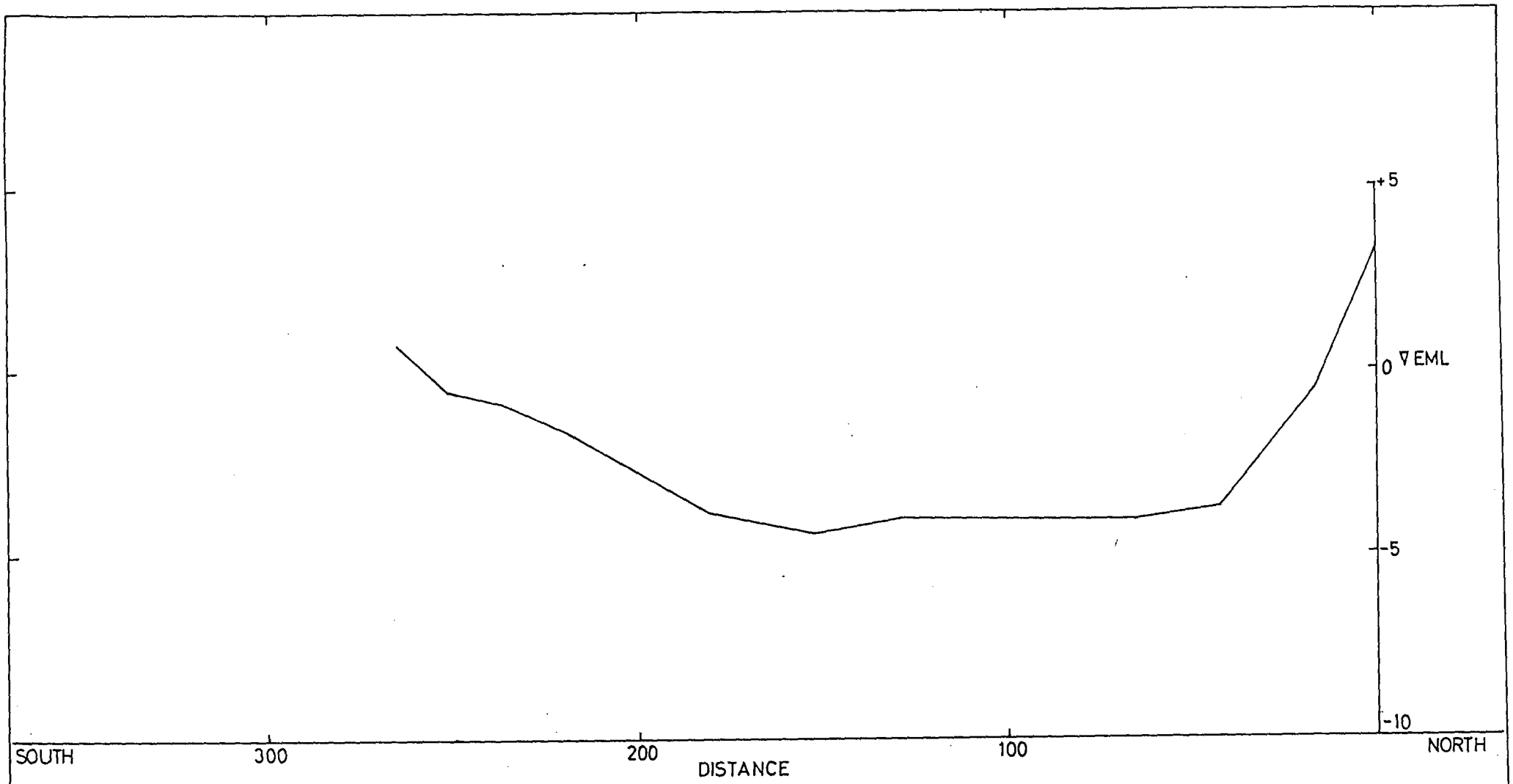
TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS-SECTION D8 - APRIL 1988	FIGURE 8j
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		



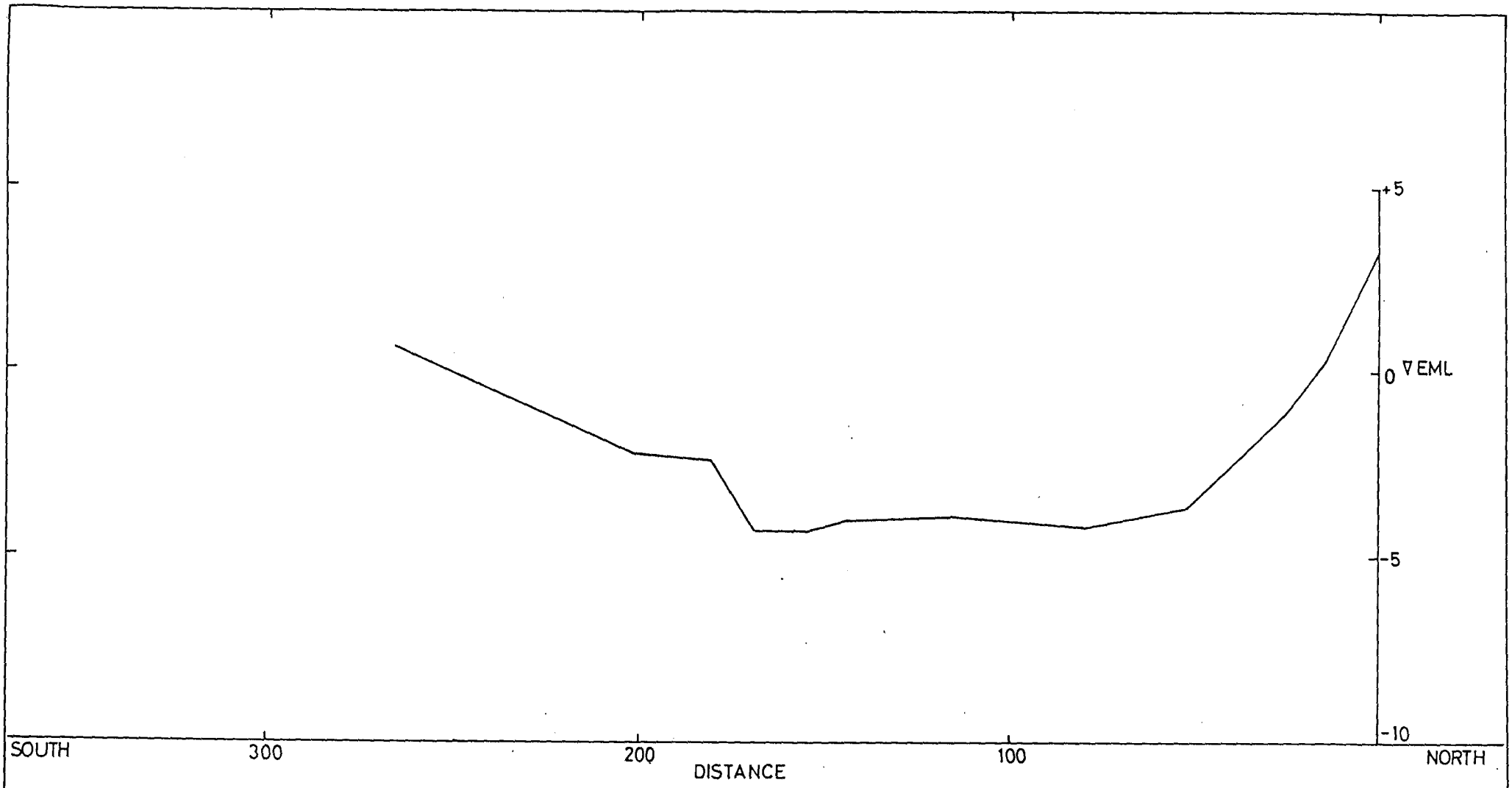
TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS- SECTION D9 - JUNE 1986	FIGURE 9a
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		



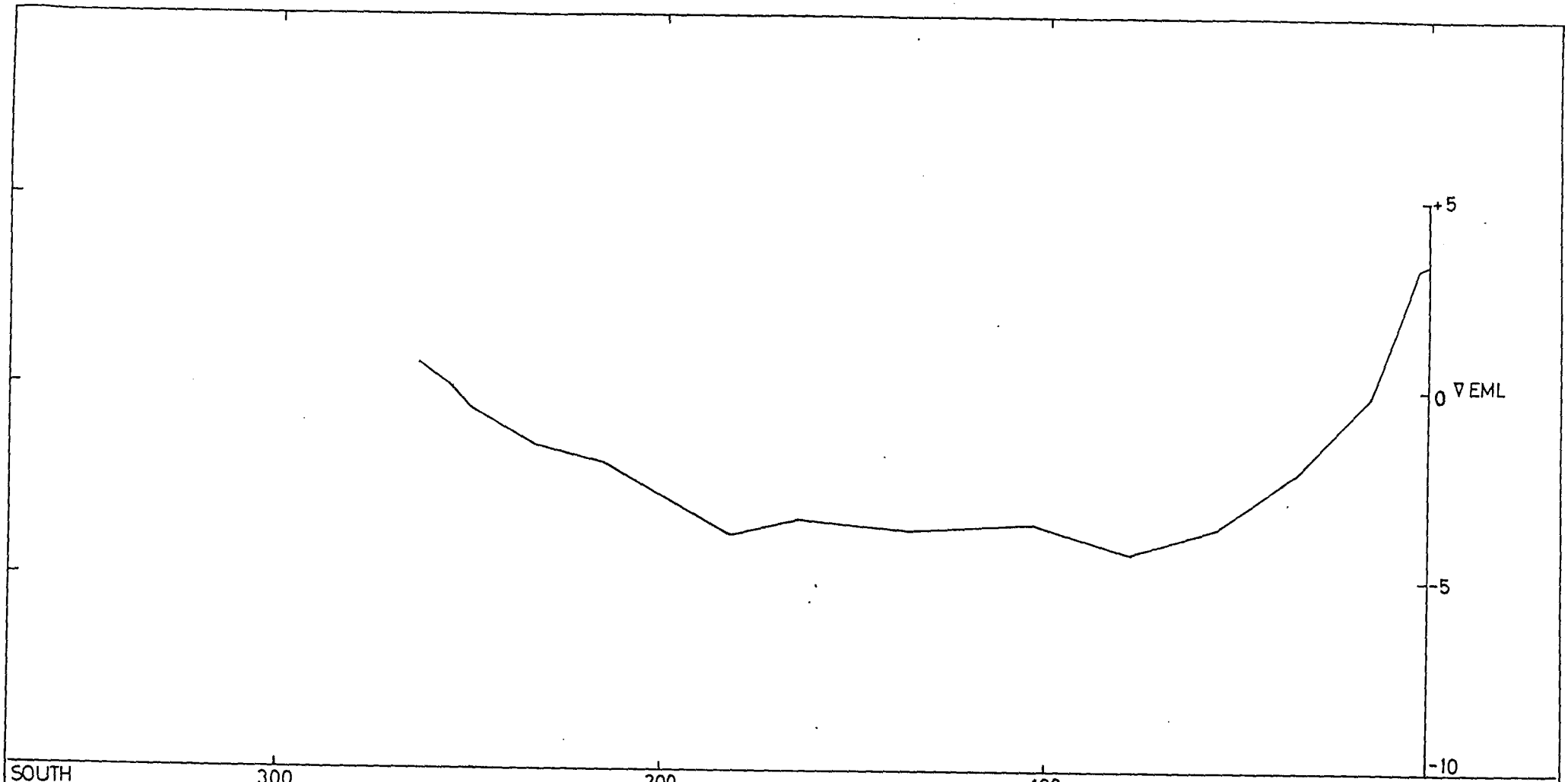
TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS-SECTION D9 - AUGUST 1986	FIGURE 9b
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		



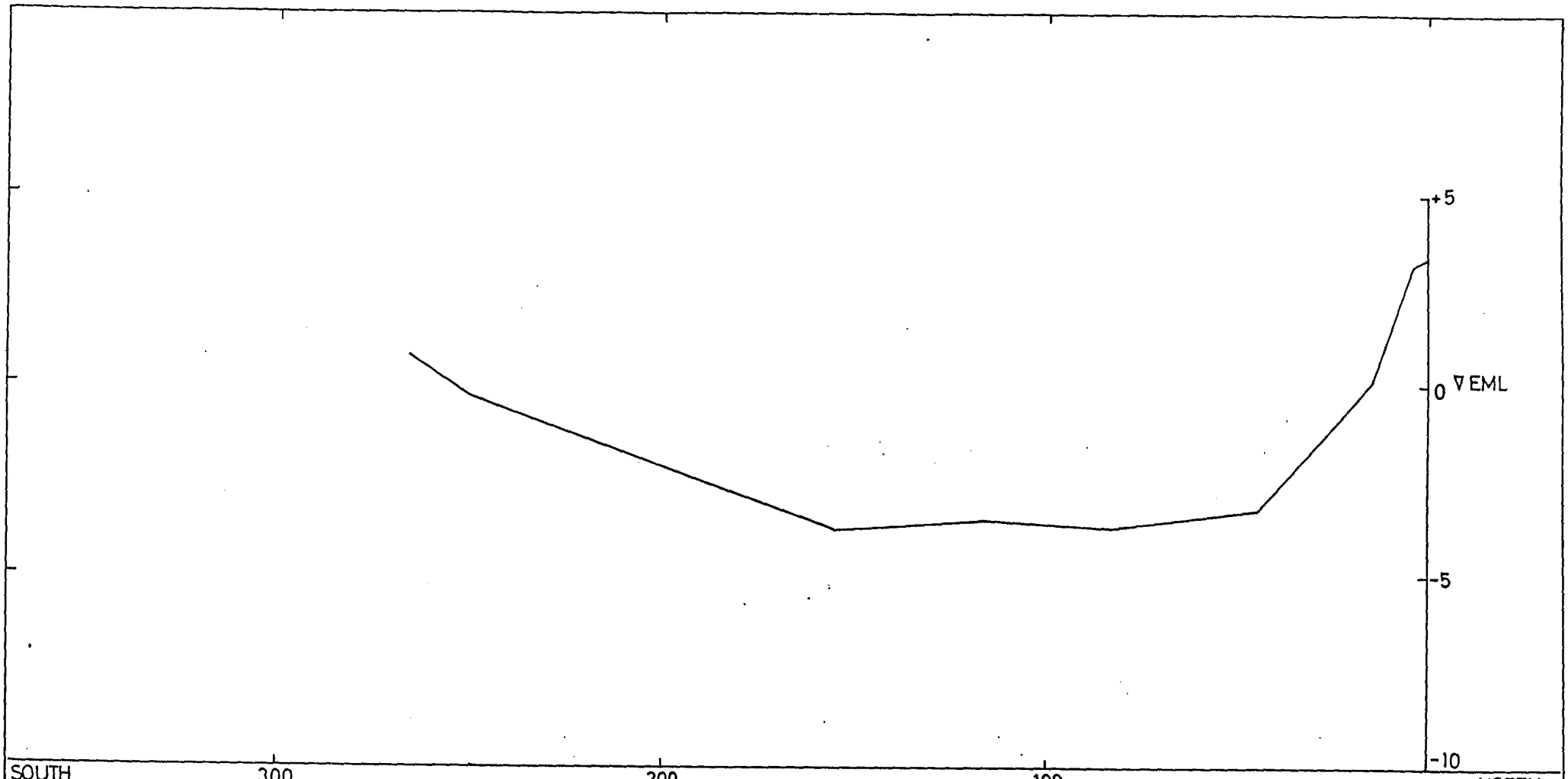
TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS-SECTION D9 - OCTOBER 1986	FIGURE 9c
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		



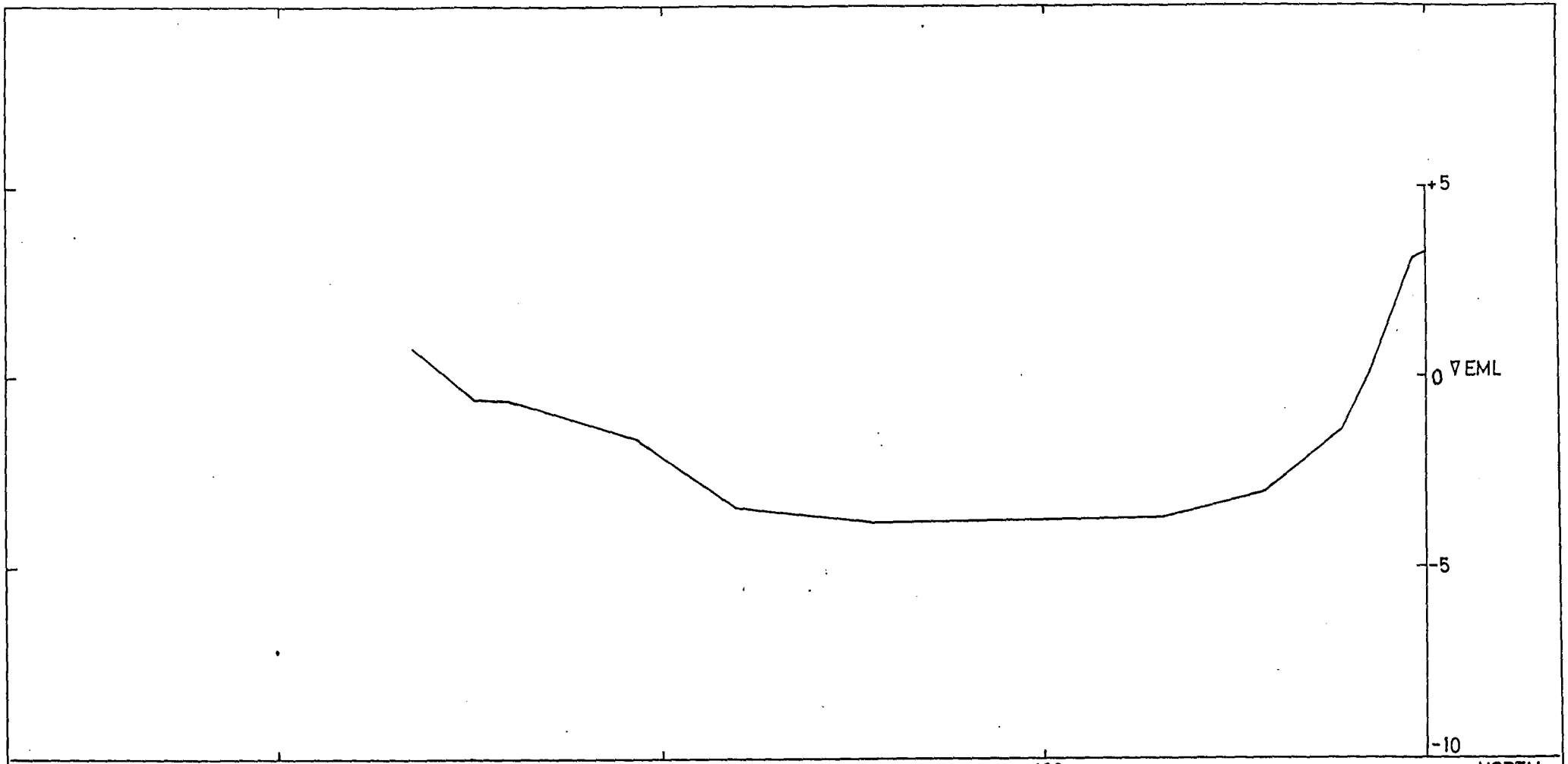
TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS-SECTION D9 - FEBRUARY 1987	FIGURE 9d
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		



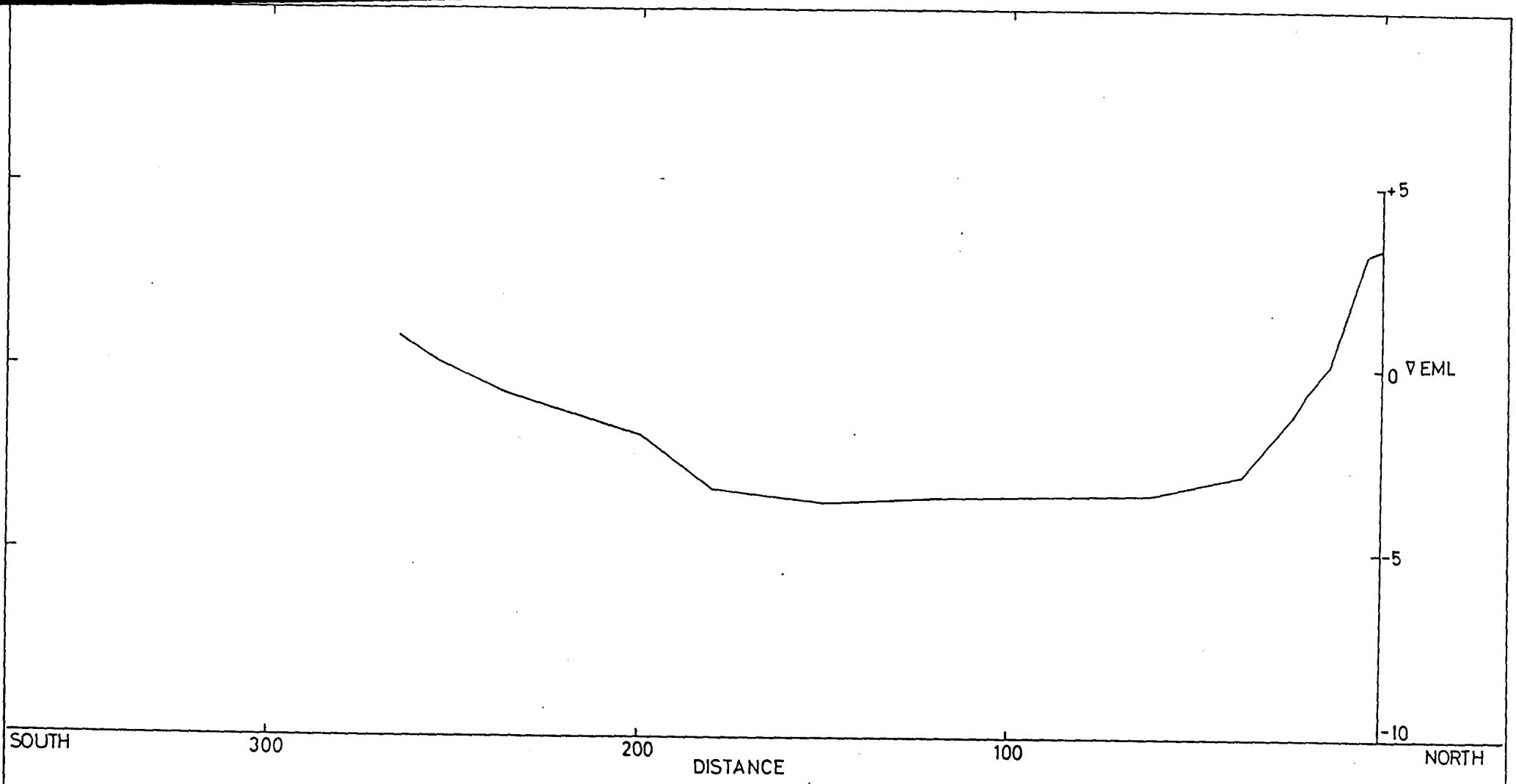
TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS- SECTION D9 - APRIL 1987	FIGURE 9e
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		



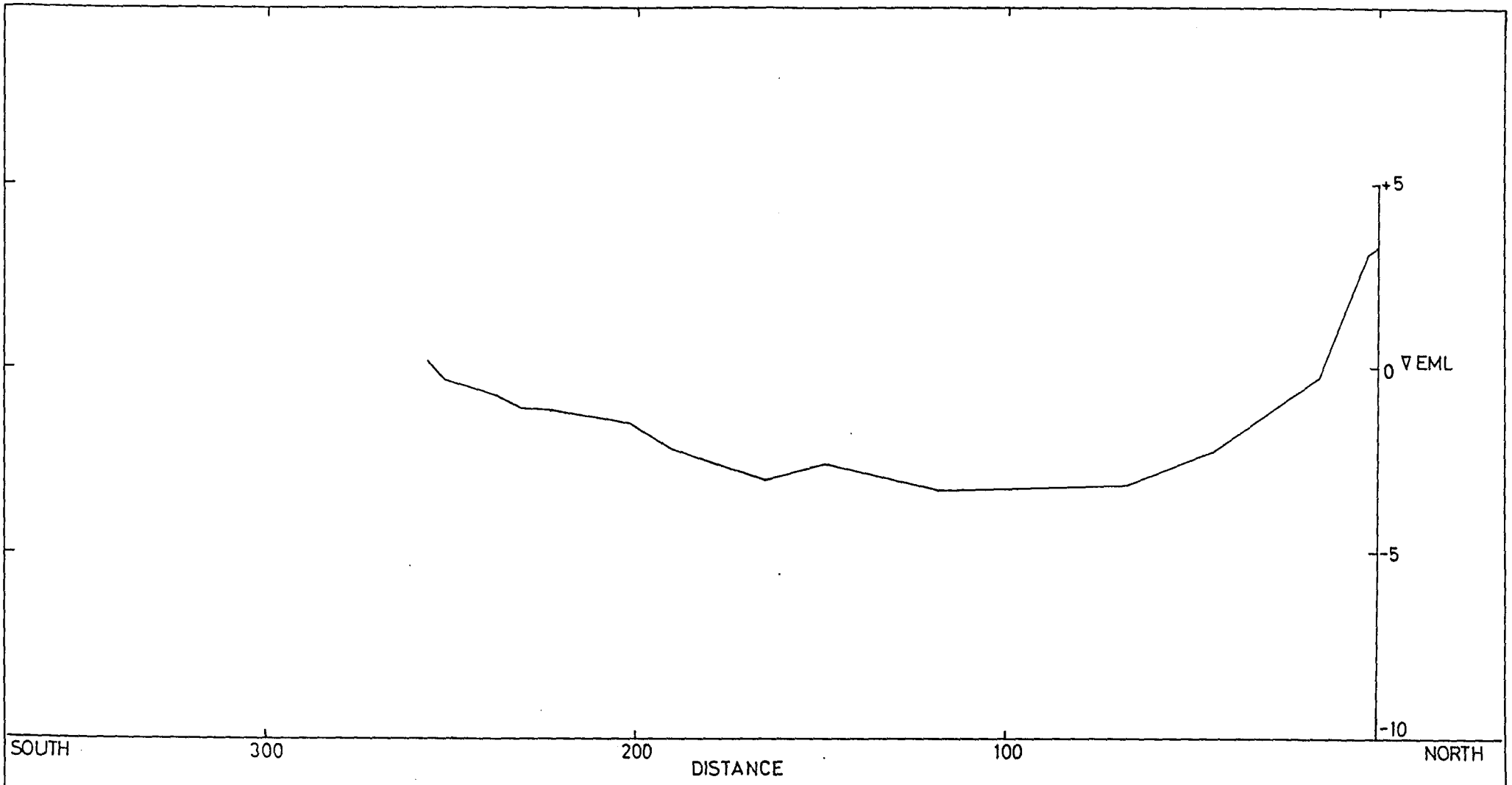
TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS-SECTION D9 - JUNE 1987	FIGURE 9 f
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		



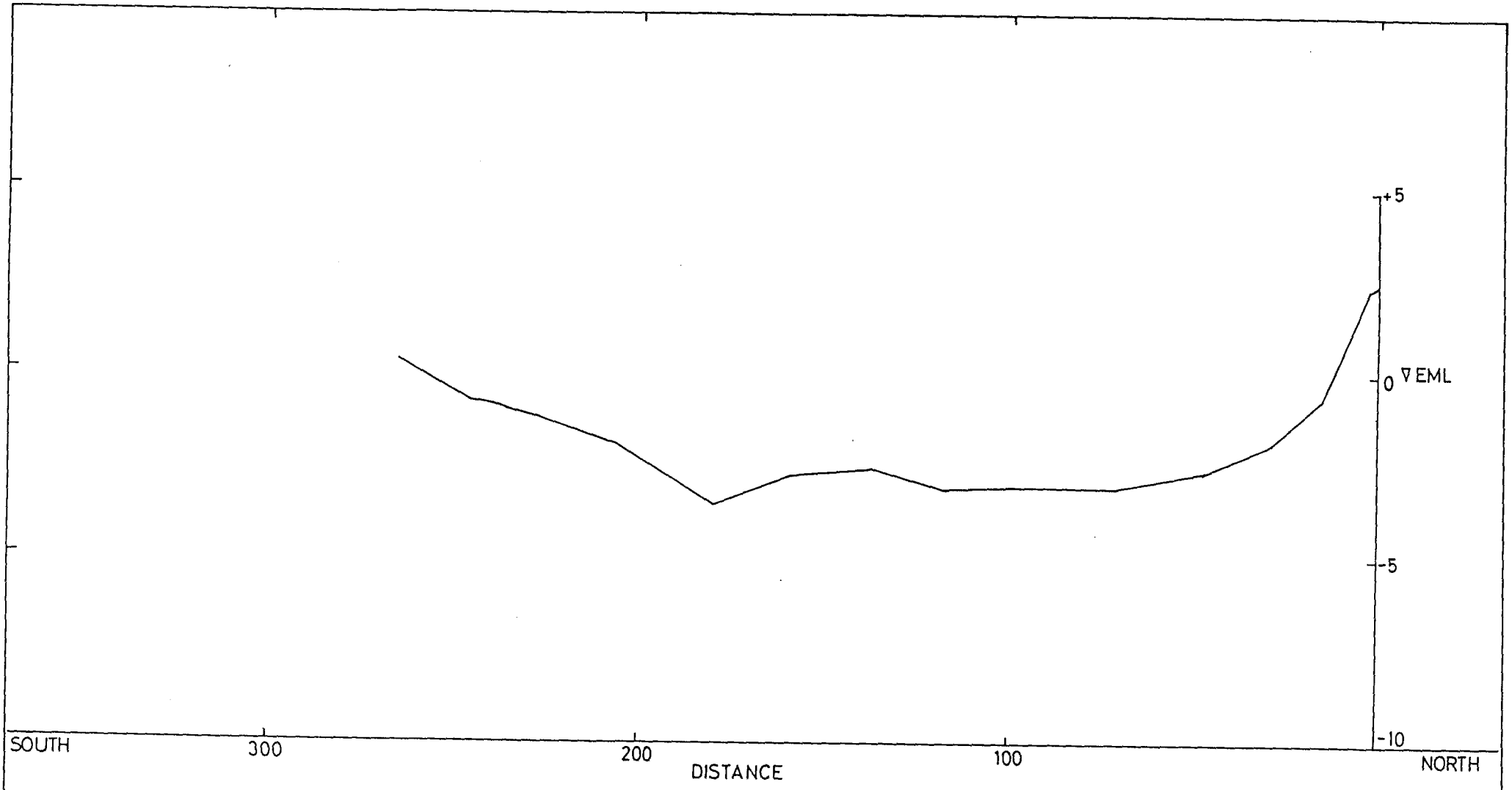
TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS- SECTION D9 - SEPTEMBER 1987	FIGURE 9g
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		



TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS-SECTION D9 - OCTOBER 1987	FIGURE 9h
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		

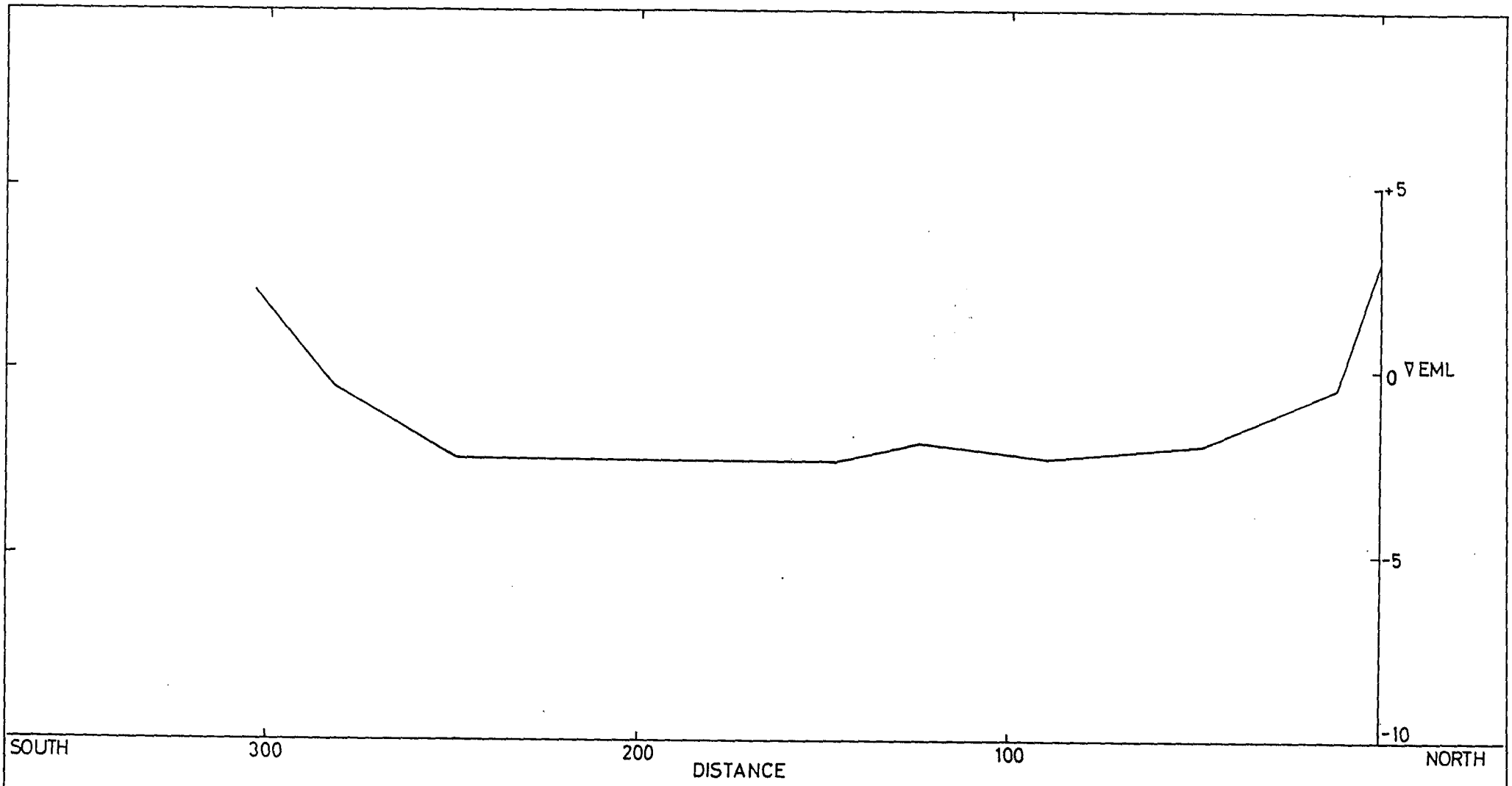


TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS- SECTION D 9 - FEBRUARY 1988	FIGURE 9i
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		

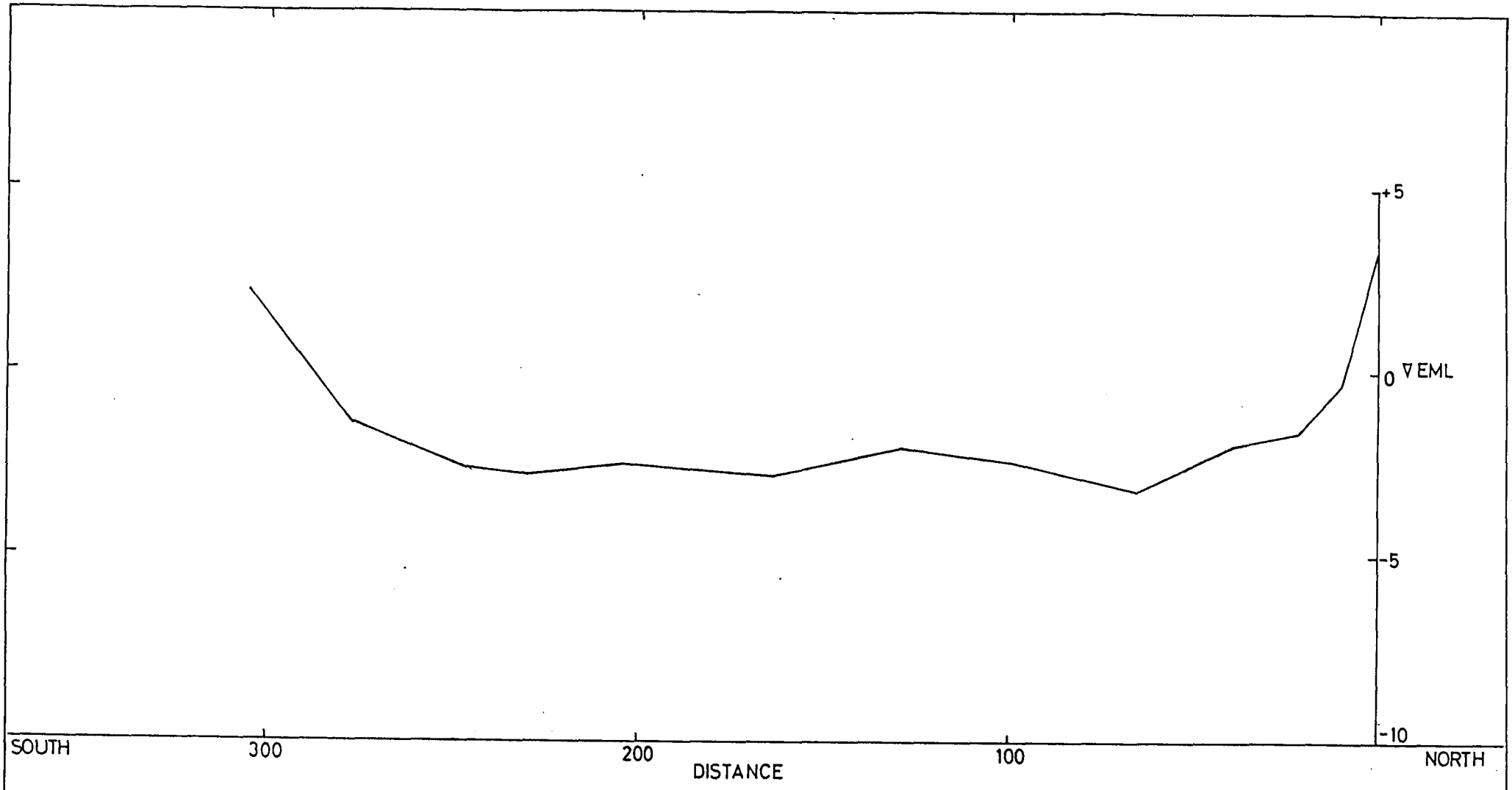


TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS-SECTION D9 - APRIL 1988	FIGURE 9j

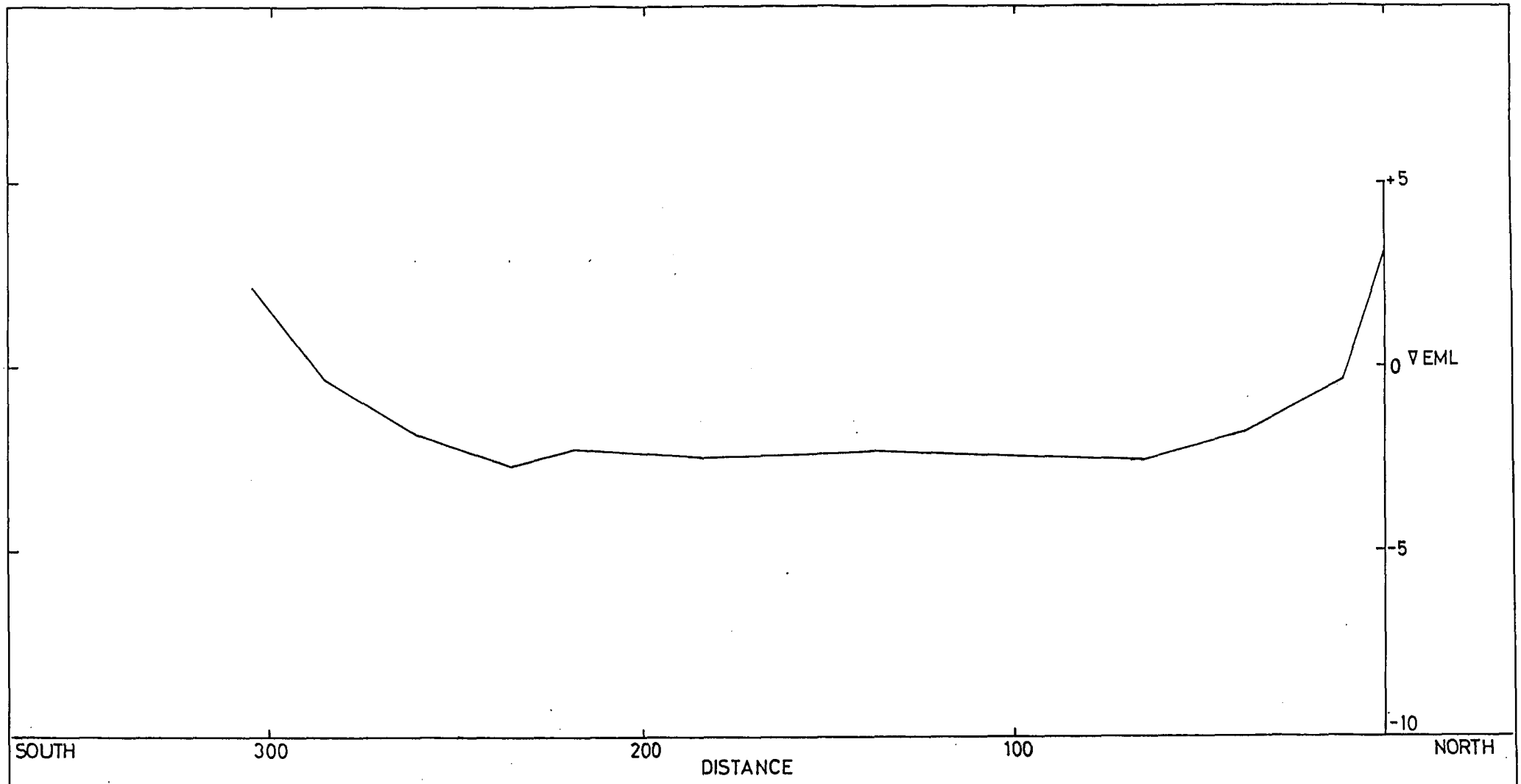
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY



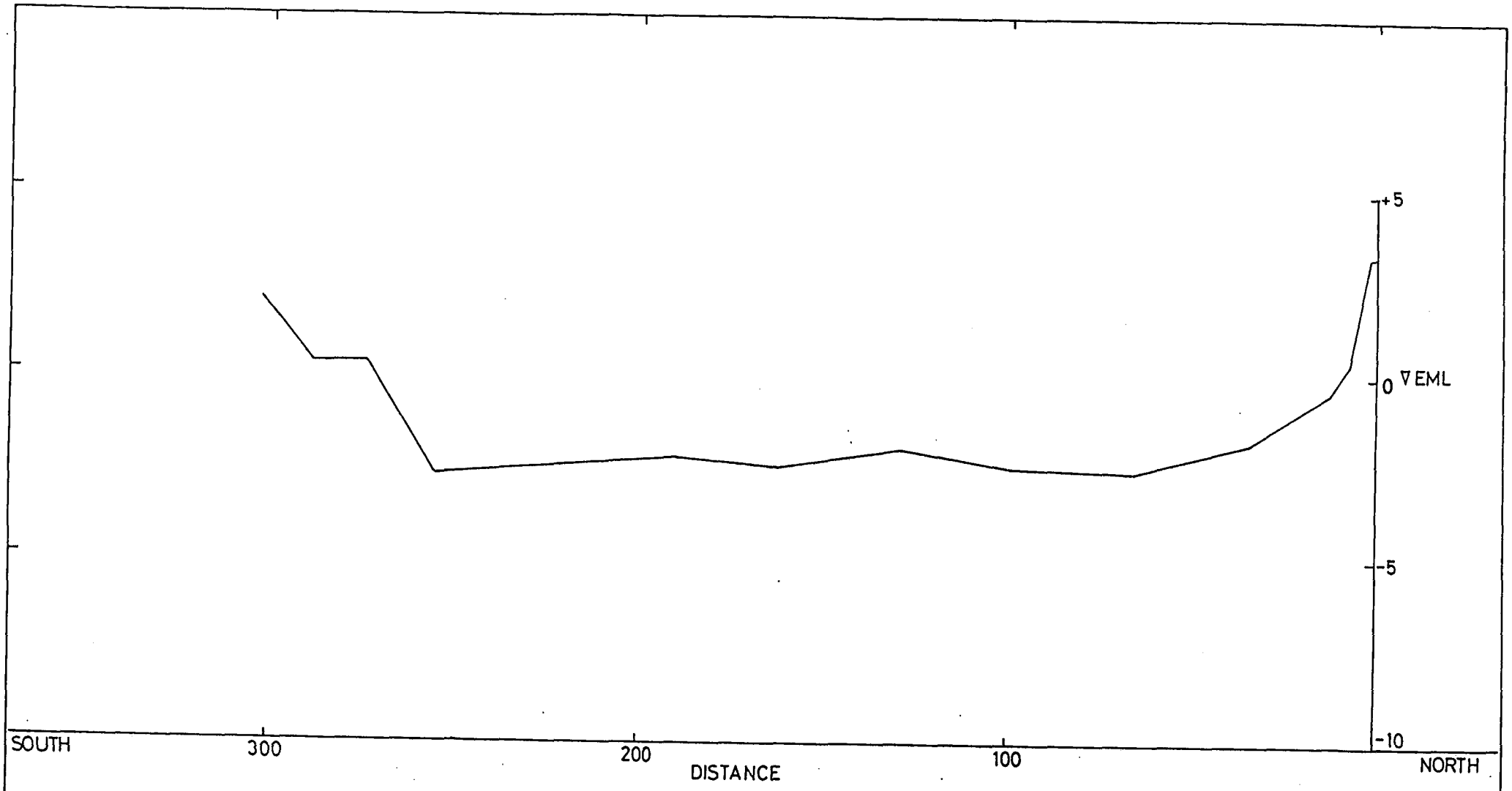
TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS-SECTION D10 - JUNE 1986	FIGURE 10 a
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		



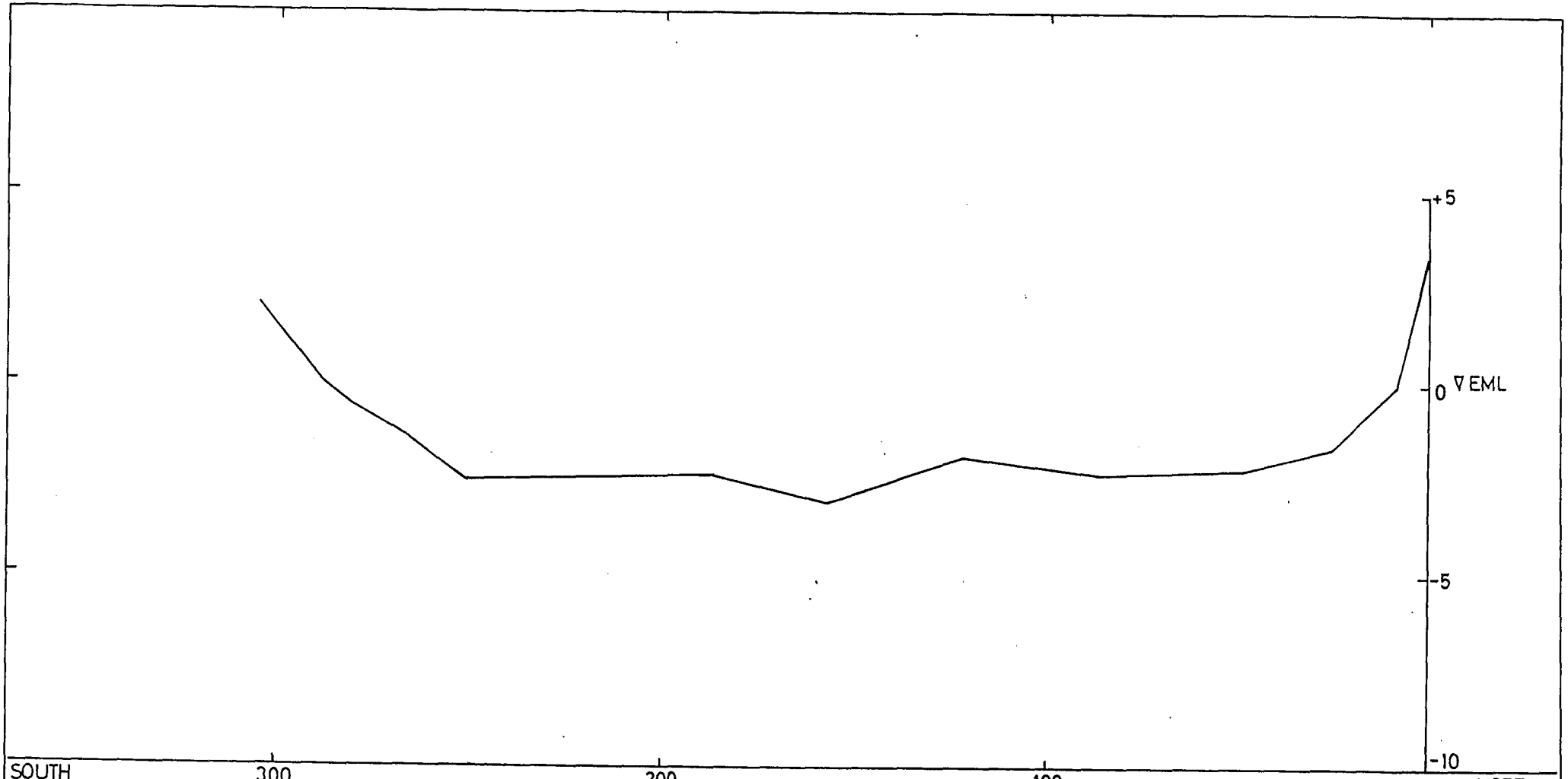
TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS- SECTION D10 - AUGUST 1986	FIGURE 10 b
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		



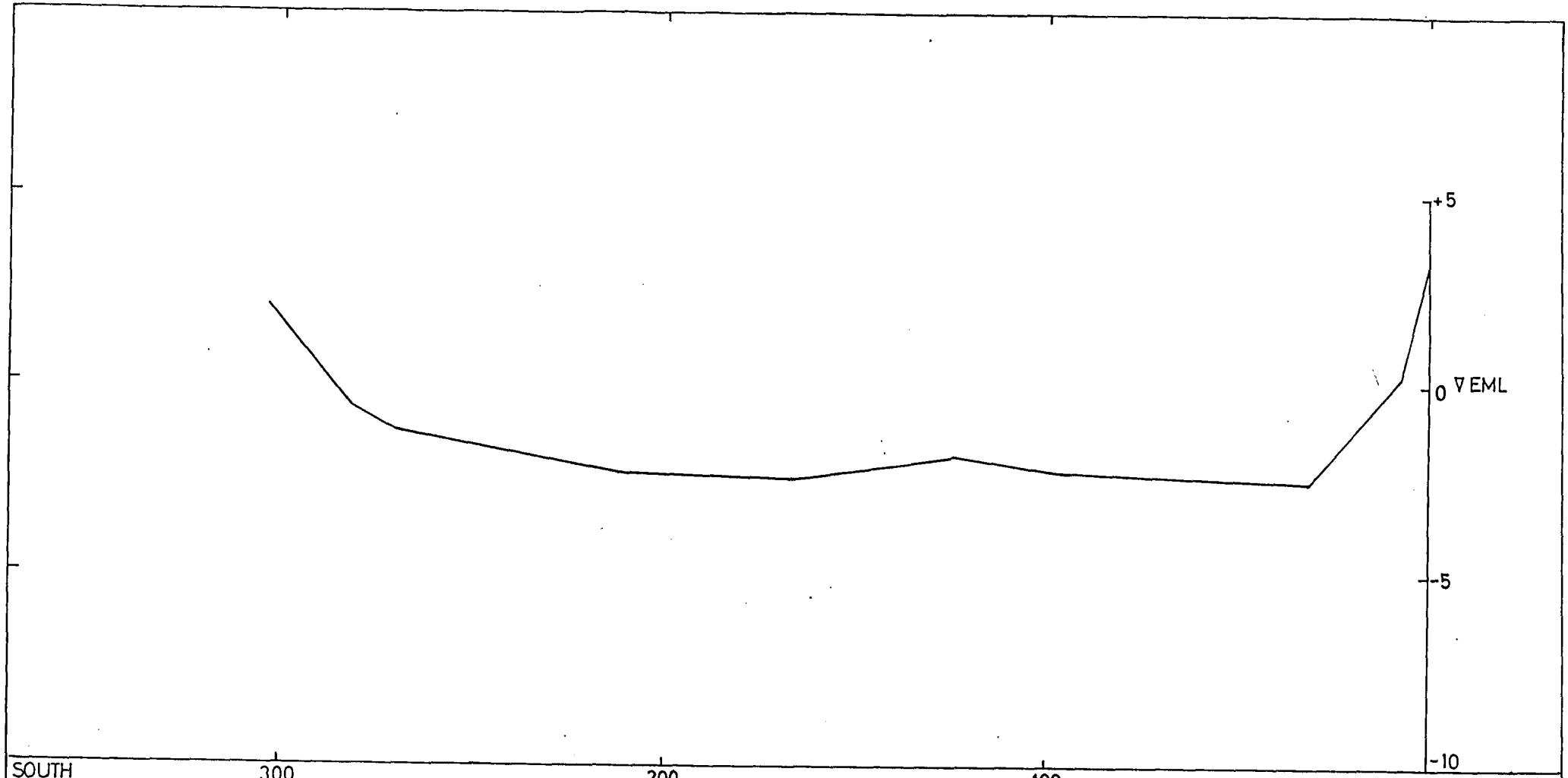
TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS - SECTION D10 - OCTOBER 1986	FIGURE 10 c
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		



TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS-SECTION D10 - FEBRUARY 1987	FIGURE 10 d
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		

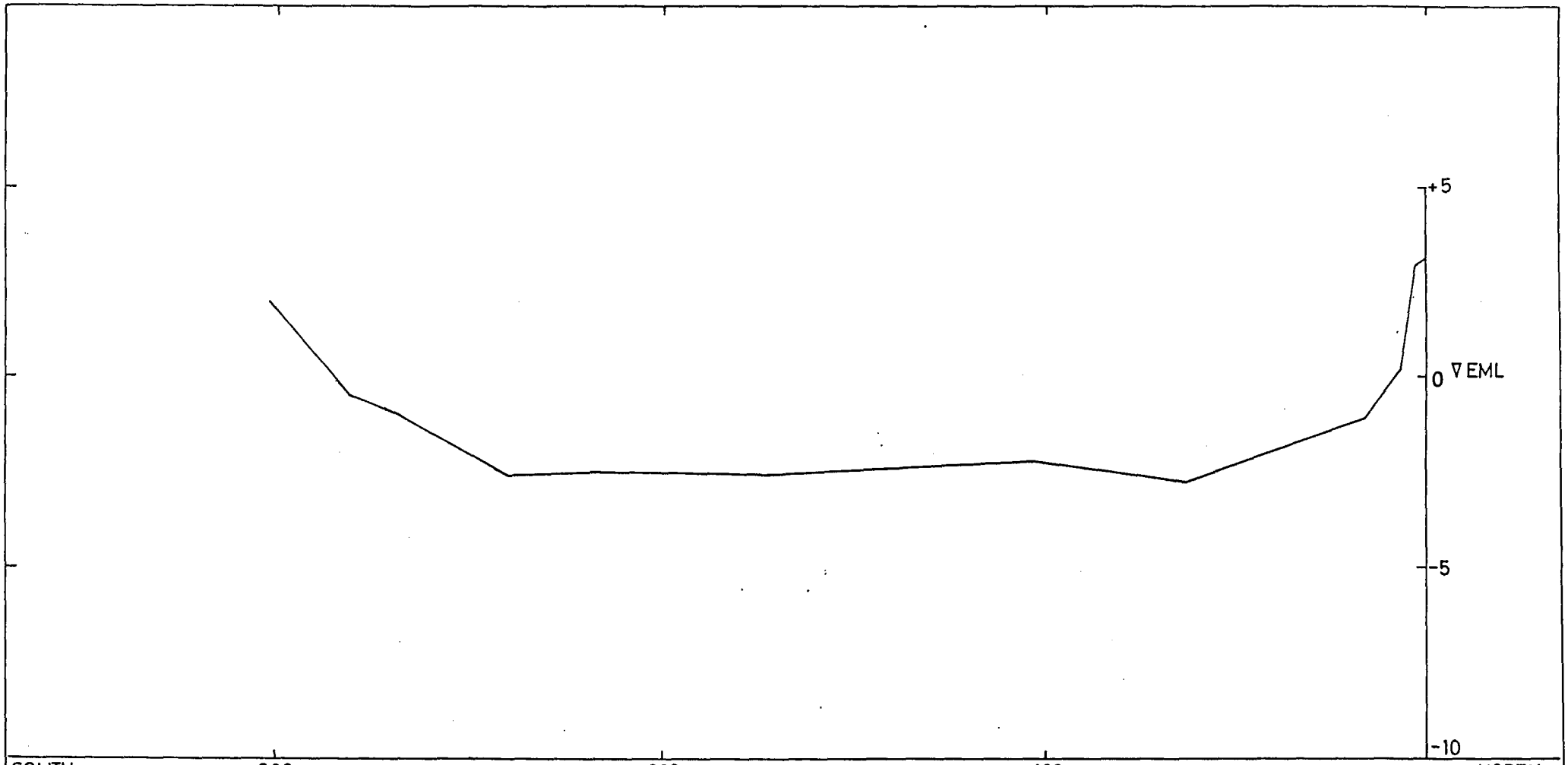


TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS- SECTION D10 - APRIL 1987	FIGURE 10 e
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		

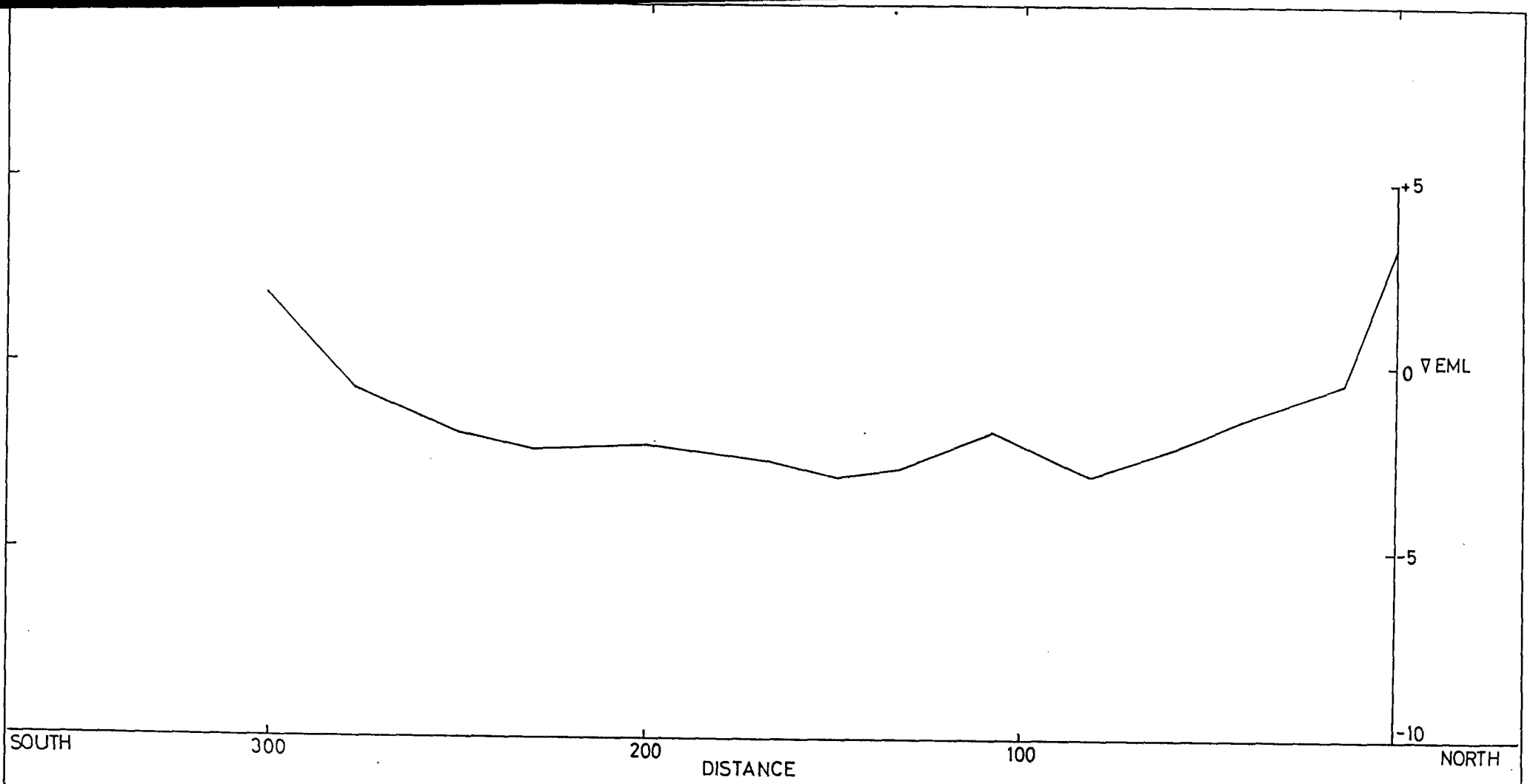


TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS-SECTION D10 - JUNE 1987	FIGURE 10f

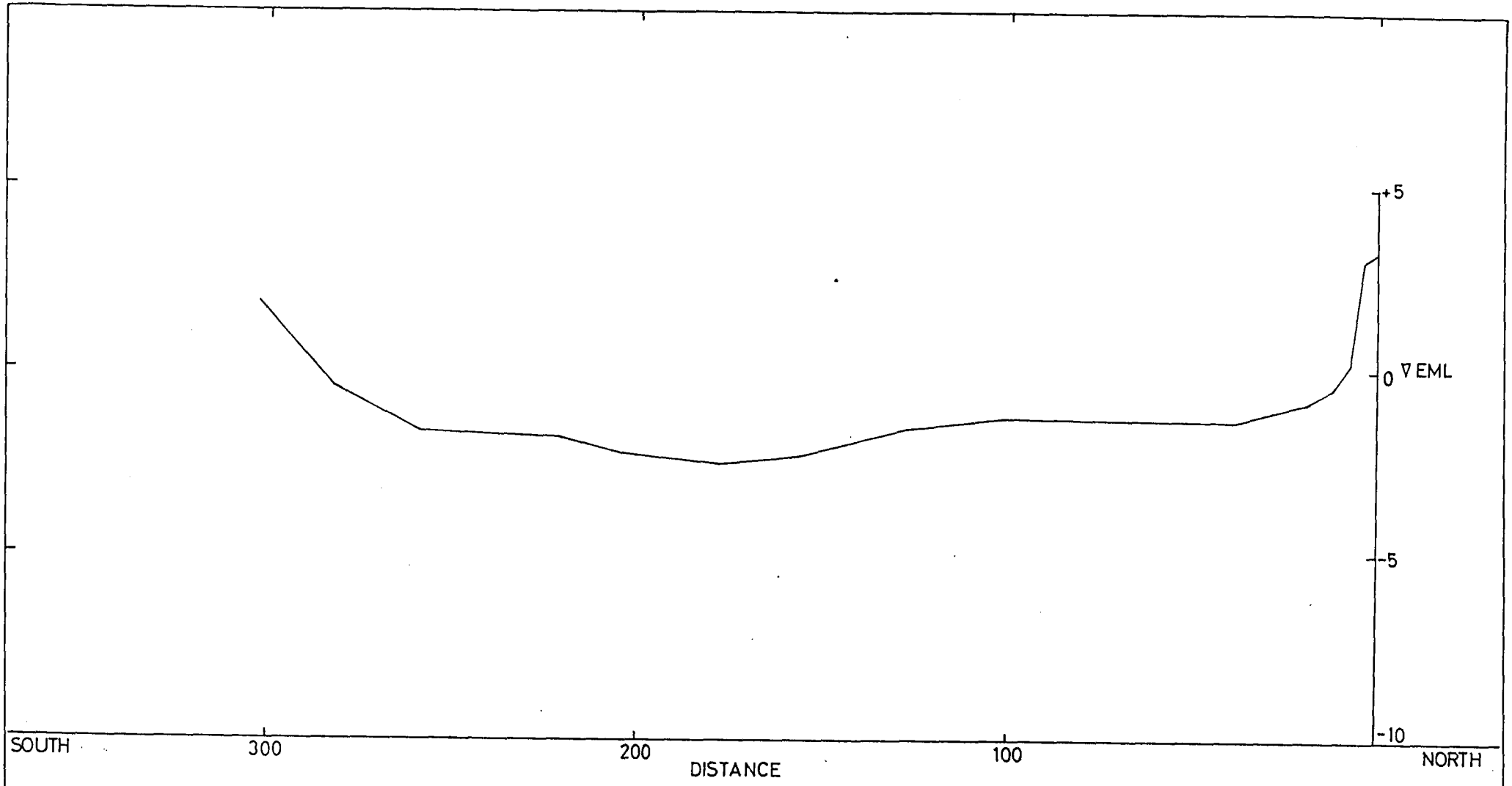
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY



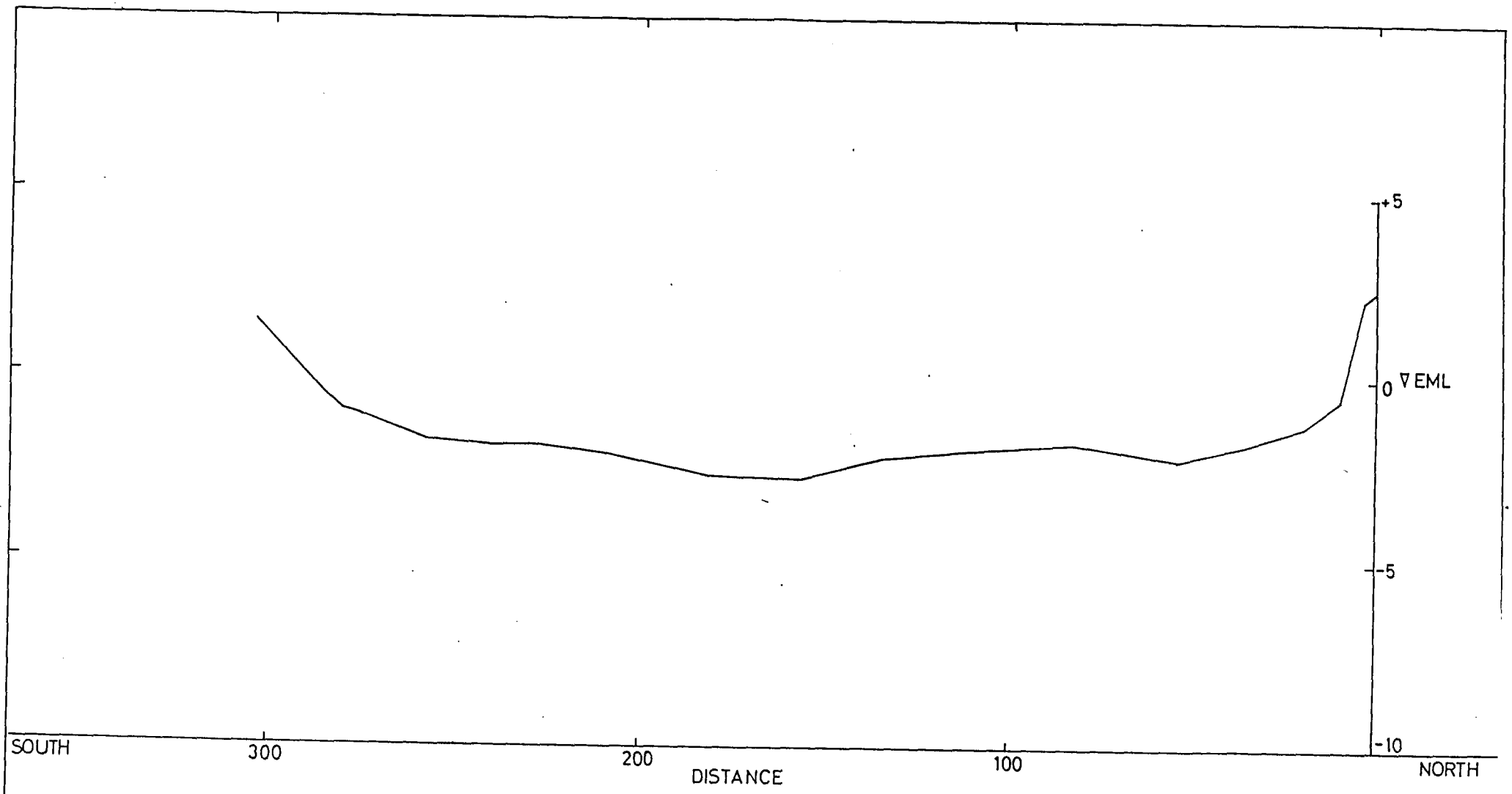
TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS- SECTION D10 - SEPTEMBER 1987	FIGURE 10 g
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		



TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS- SECTION D 10 - OCTOBER 1987	FIGURE 10h
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		

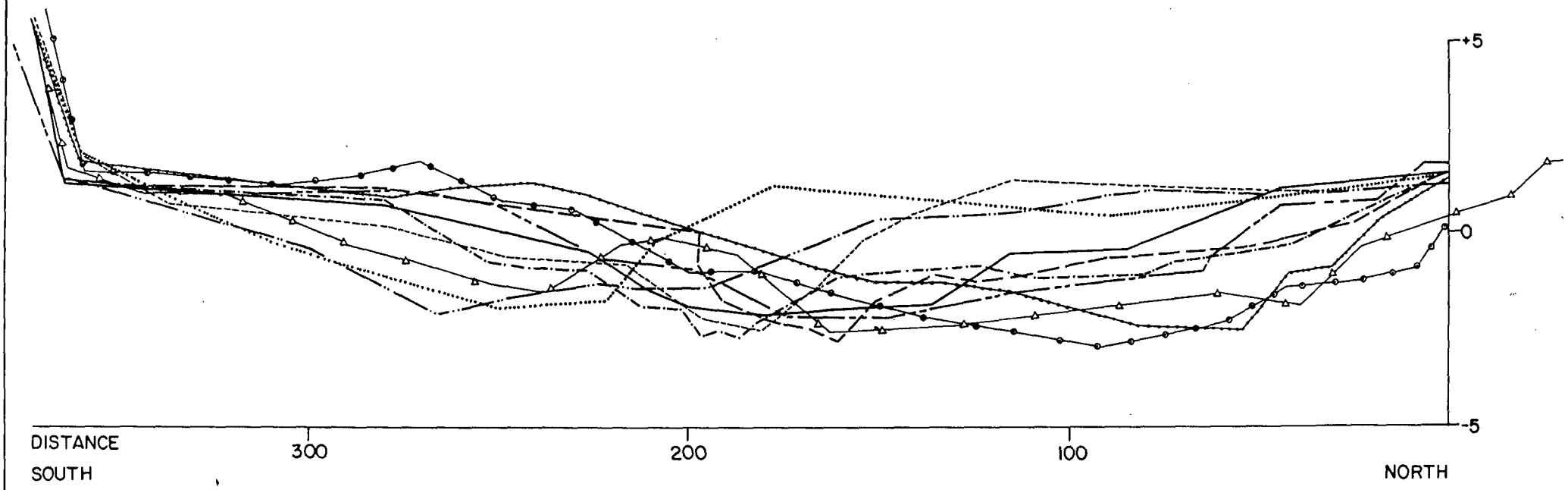


TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS-SECTION D10 - FEBRUARY 1988	FIGURE 10i
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		



TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS- SECTION DIO - APRIL 1988	FIGURE 10 j
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		

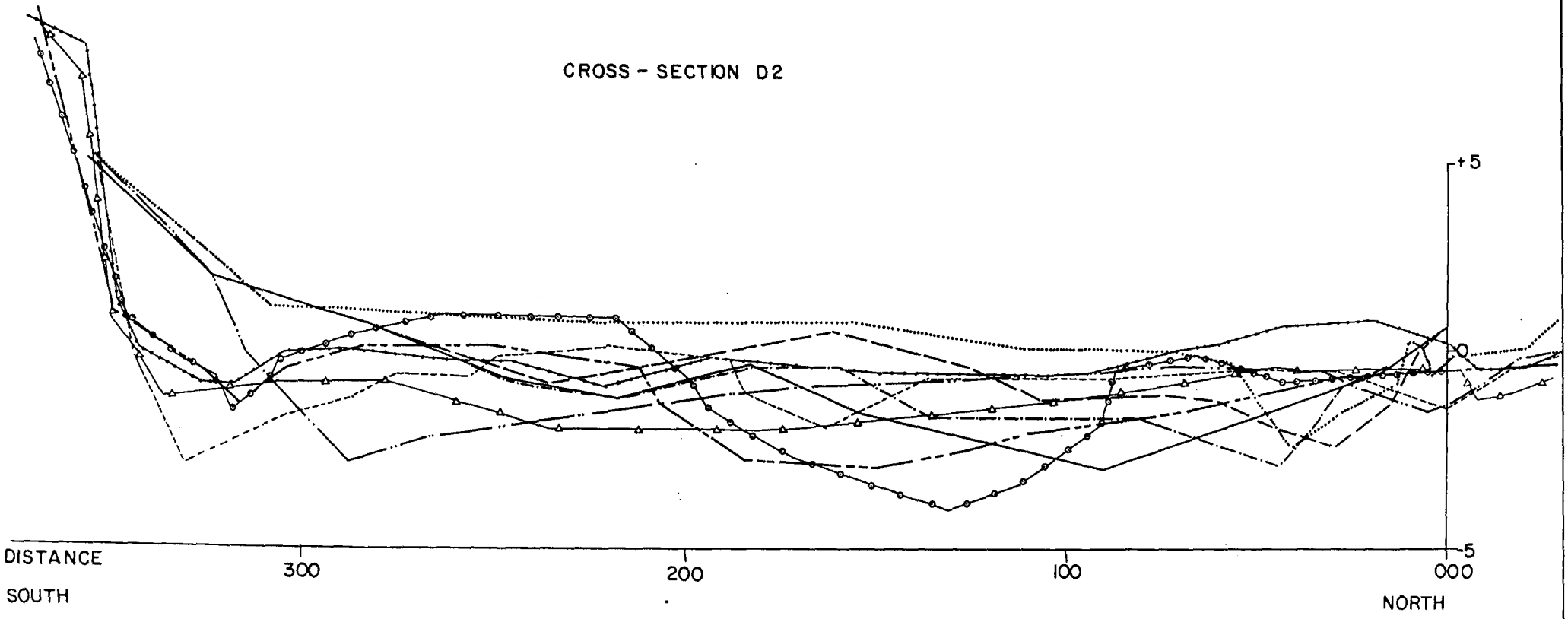
CROSS – SECTION D1



KEY :

- FEBRUARY 1988
- APRIL 1988
- OCTOBER 1987
- JUNE 1986
- AUGUST 1986
- OCTOBER 1986
- DECEMBER 1986
- FEBRUARY 1987
- APRIL 1987
- JUNE 1987
- SEPTEMBER 1987

TRACED: CHECKED: DATE: REF :	ST. LUCIA DREDGING COMPARATIVE CHANGE IN CROSS-SECTION D1 JUNE 1986 to APRIL 1988	FIGURE 11
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		



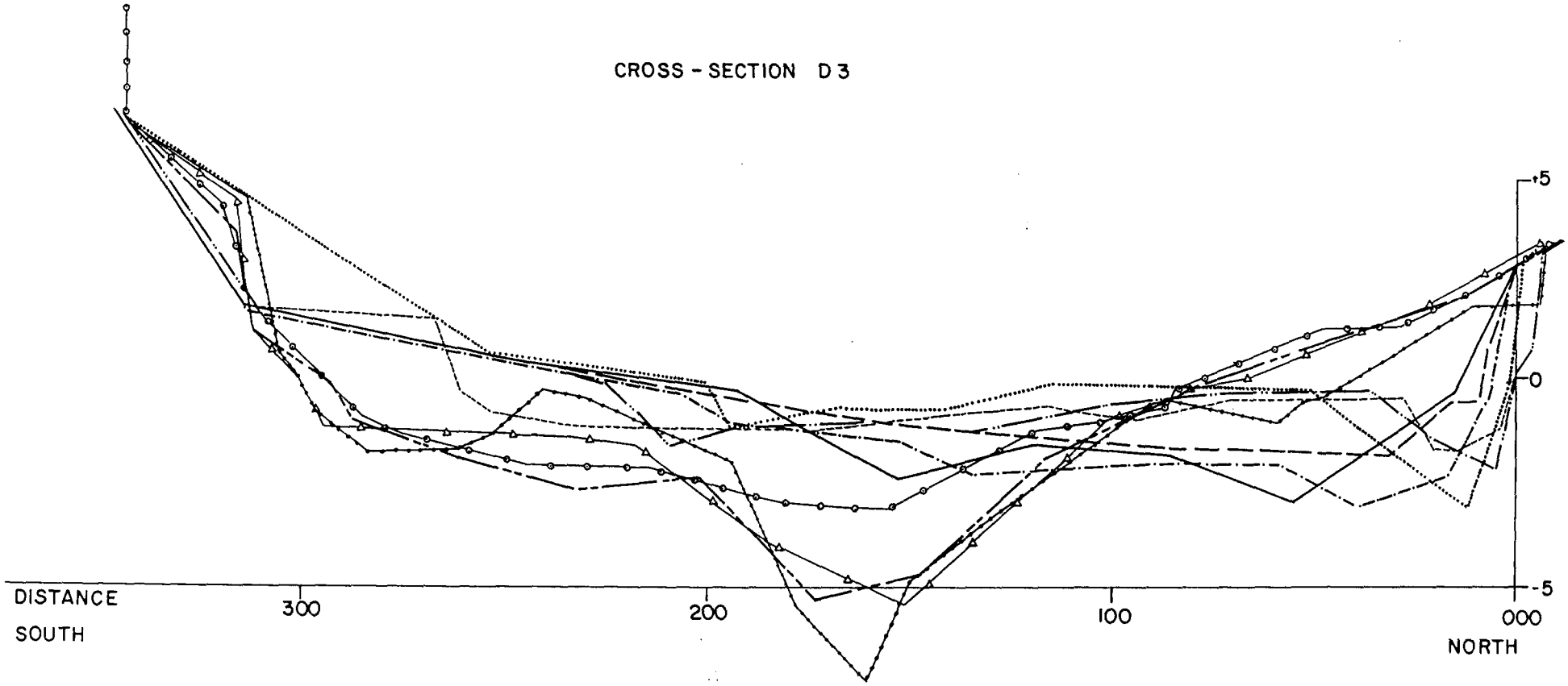
FEBRUARY 1988
APRIL 1988
OCTOBER 1987

KEY:

JUNE 1986
AUGUST 1986
OCTOBER 1986
DECEMBER 1986
FEBRUARY 1987
APRIL 1987
JUNE 1987
SEPTEMBER 1987

TRACED: CHECKED: DATE: REF:	ST LUCIA DREDGING COMPARATIVE CHANGE IN CROSS - SECTION D2 JUNE 1986 to APRIL 1988	FIGURE 12
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		

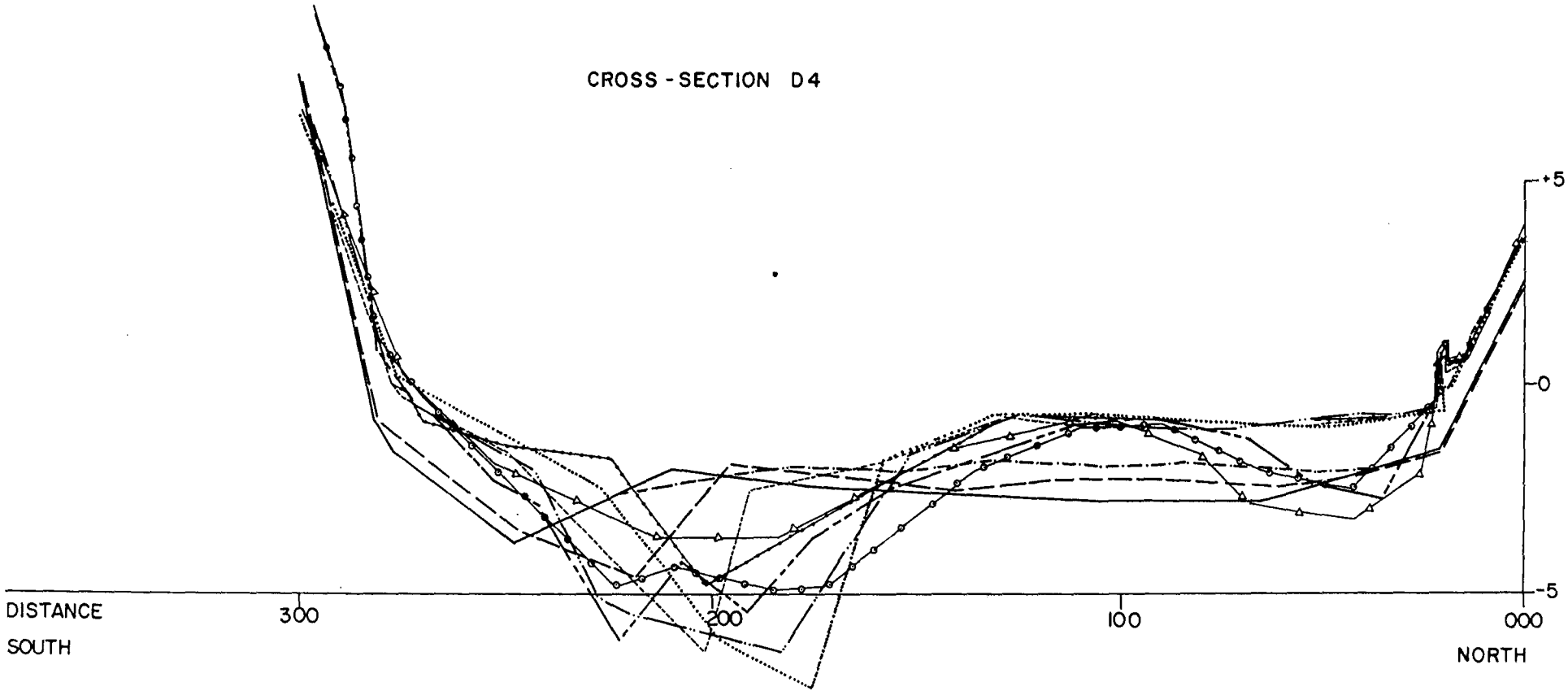
CROSS - SECTION D 3



KEY :

- JUNE 1986
- AUGUST 1986
- OCTOBER 1986
- DECEMBER 1986
- FEBRUARY 1987
- APRIL 1987
- JUNE 1987
- SEPTEMBER 1987
- FEBRUARY 1988
- APRIL 1988
- OCTOBER 1987

TRACED : CHECKED : DATE : REF :	ST. LUCIA DREDGING COMPARATIVE CHANGE IN CROSS-SECTION D3 JUNE 1986 to APRIL 1988	FIGURE 13
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		

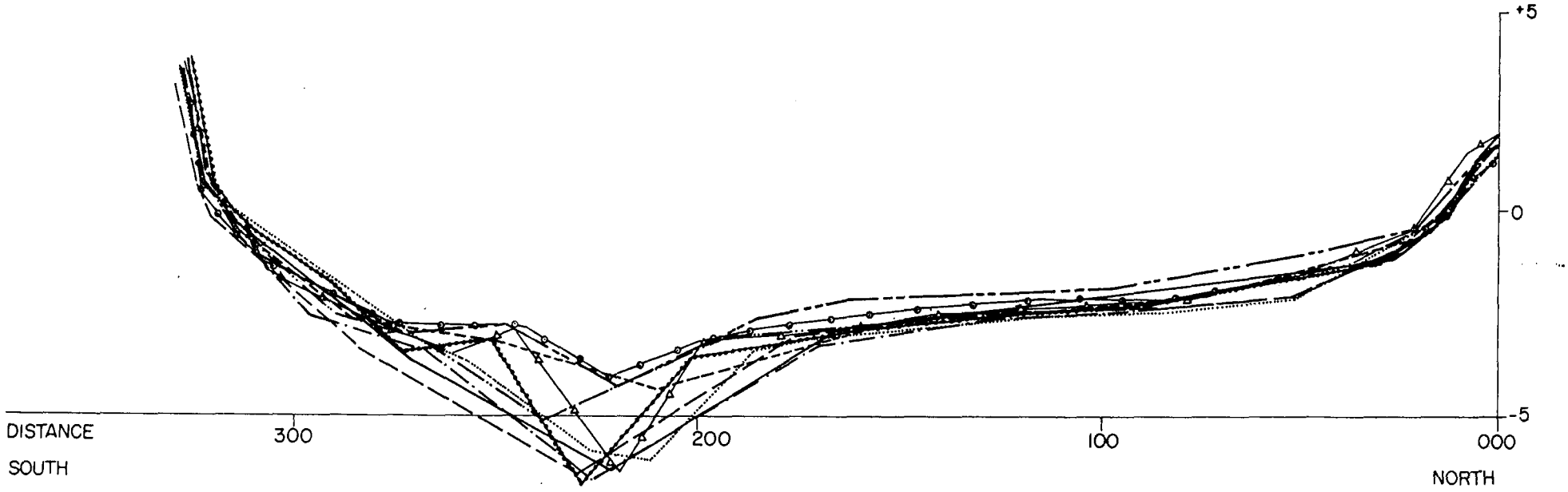


KEY:

- FEBRUARY 1988
- APRIL 1988
- OCTOBER 1987
- JUNE 1986
- AUGUST 1986
- OCTOBER 1986
- DECEMBER 1986
- FEBRUARY 1987
- APRIL 1987
- JUNE 1987
- SEPTEMBER 1987

TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING COMPARATIVE CHANGE IN CROSS-SECTION D4 JUNE 1986 to APRIL 1988	FIGURE 14
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		

CROSS - SECTION D5



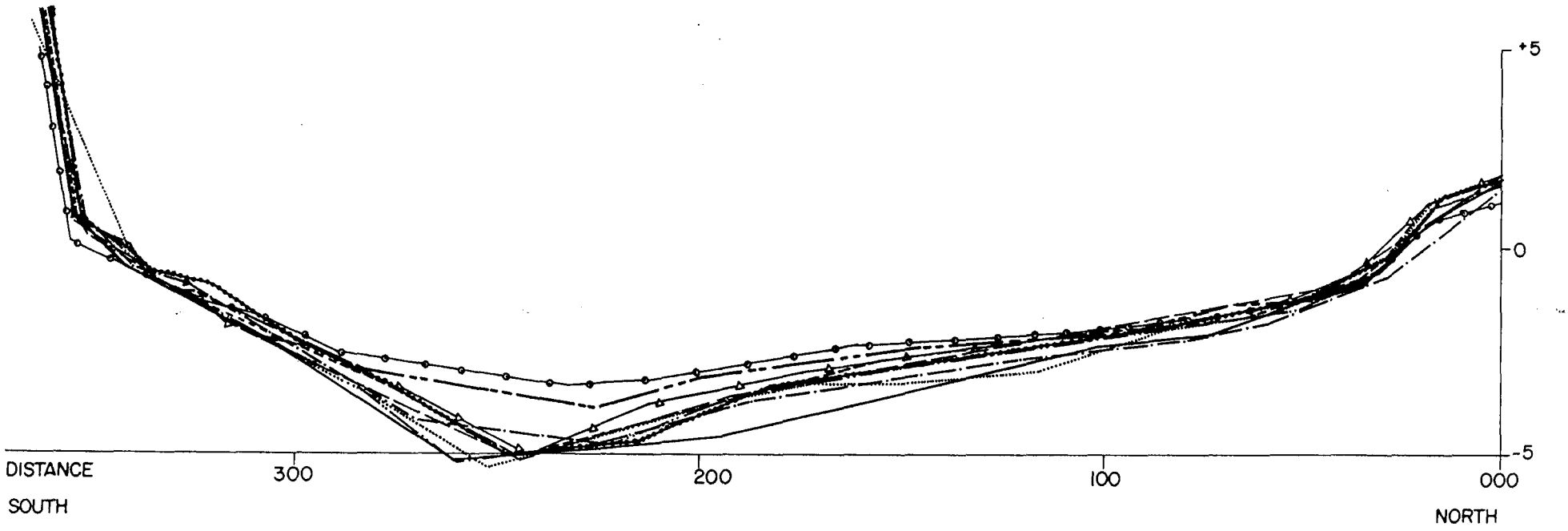
FEBRUARY 1988
APRIL 1988
OCTOBER 1987

KEY:

JUNE 1986
AUGUST 1986
OCTOBER 1986
DECEMBER 1986
FEBRUARY 1987
APRIL 1987
JUNE 1987
SEPTEMBER 1987

TRACED: CHECKED: DATE: REF:	ST LUCIA DREDGING COMPARATIVE CHANGE IN CROSS-SECTION D5 JUNE 1986 to APRIL 1988	FIGURE : 15
	NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY	

CROSS-SECTION D6

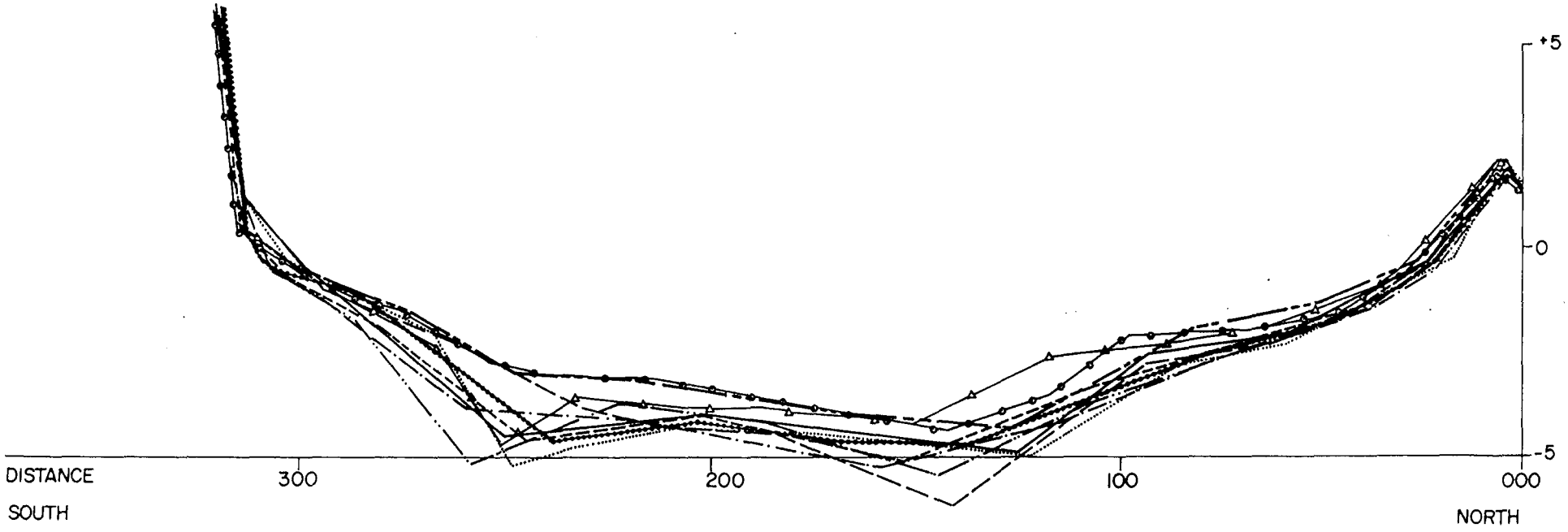


KEY:

- JUNE 1986
- AUGUST 1986
- OCTOBER 1986
- DECEMBER 1986
- FEBRUARY 1987
- APRIL 1987
- JUNE 1987
- SEPTEMBER 1987
- FEBRUARY 1988
- APRIL 1988
- OCTOBER 1987

TRACED: CHECKED: DATE: REF:	ST LUCIA DREDGING COMPARATIVE CHANGE IN CROSS-SECTION D6 JUNE 1986 to APRIL 1988	FIGURE : 16
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		

CROSS-SECTION D7

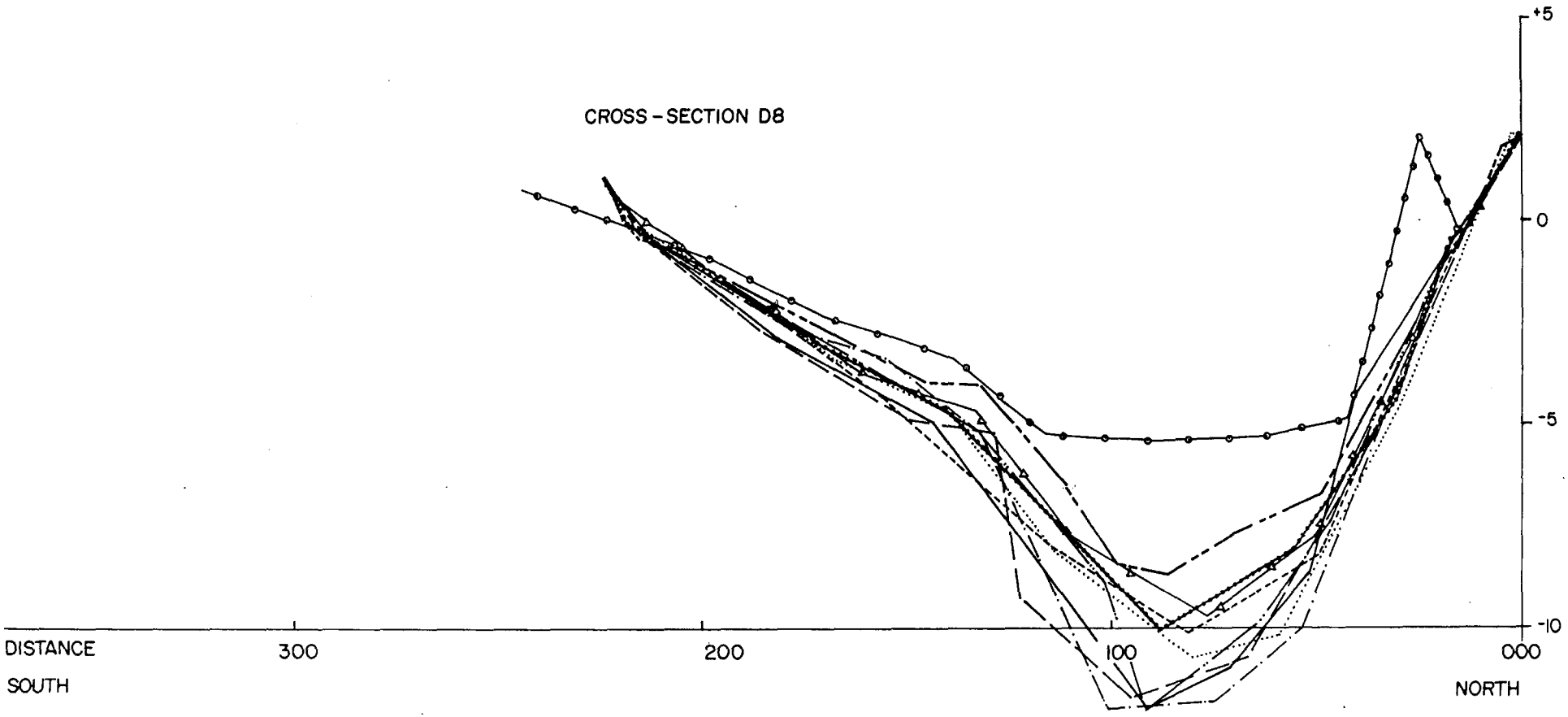


FEBRUARY 1988
APRIL 1988
OCTOBER 1987

KEY:

JUNE 1986
AUGUST 1986
OCTOBER 1986
DECEMBER 1986
FEBRUARY 1987
APRIL 1987
JUNE 1987
SEPTEMBER 1987

TRACED: CHECKED: DATE: REF:	ST LUCIA DREDGING COMPARATIVE CHANGE IN CROSS-SECTION D7 JUNE 1986 to APRIL 1988	FIGURE : 17
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		



FEBRUARY 1988

APRIL 1988

OCTOBER 1987

KEY:

JUNE 1986

AUGUST 1986

OCTOBER 1986

DECEMBER 1986

FEBRUARY 1987

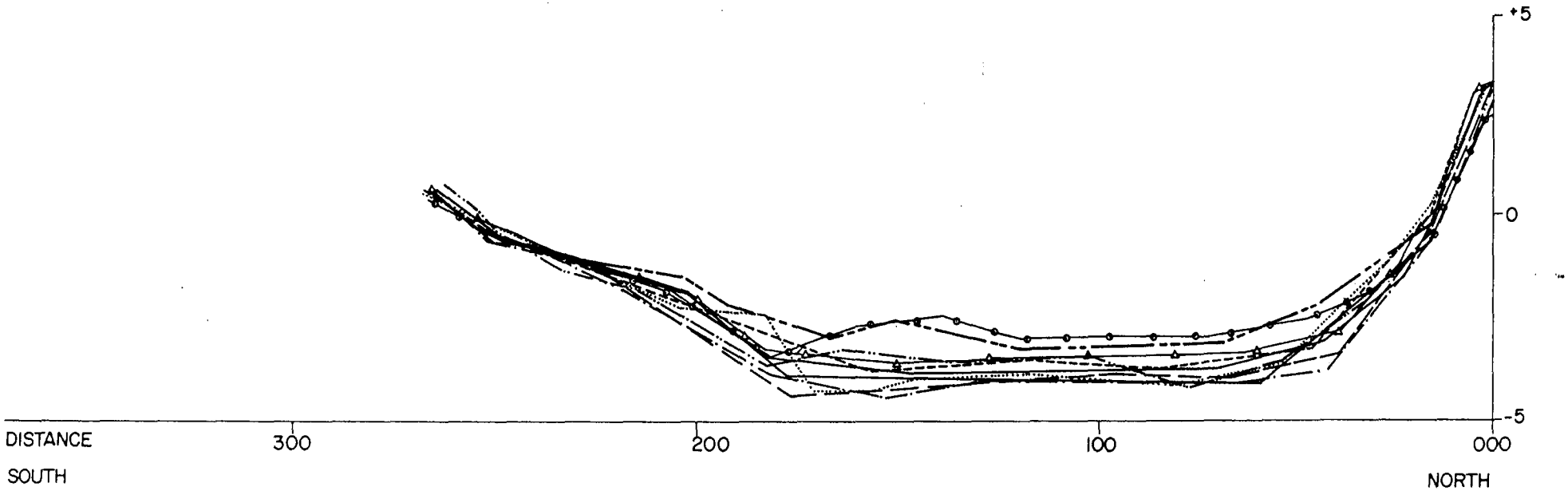
APRIL 1987

JUNE 1987

SEPTEMBER 1987

TRACED: CHECKED: DATE: REF:	ST LUCIA DREDGING COMPARATIVE CHANGE IN CROSS-SECTION D8 JUNE 1986 to APRIL 1988	FIGURE : 18
	NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY	

CROSS - SECTION D9

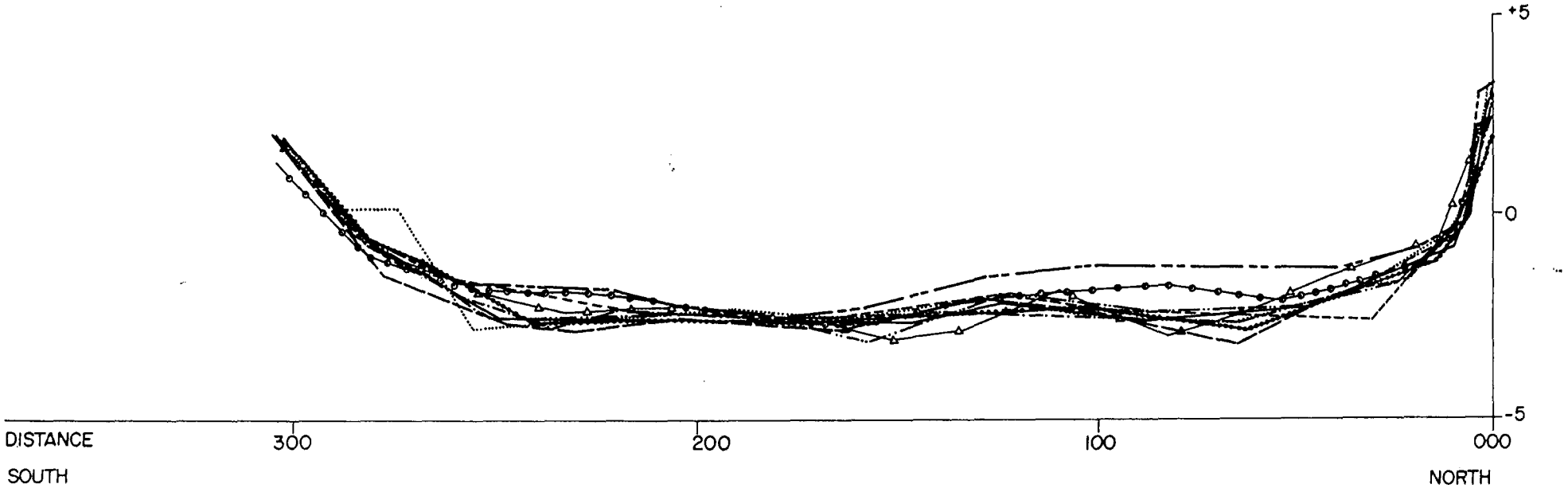


KEY:

- JUNE 1986
- AUGUST 1986
- OCTOBER 1986
- DECEMBER 1986
- FEBRUARY 1987
- APRIL 1987
- JUNE 1987
- SEPTEMBER 1987
- FEBRUARY 1988
- APRIL 1988
- OCTOBER 1987

TRACED: CHECKED: DATE: REF:	ST LUCIA DREDGING COMPARATIVE CHANGE IN CROSS-SECTION D9 JUNE 1986 to APRIL 1988	FIGURE : 19
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		

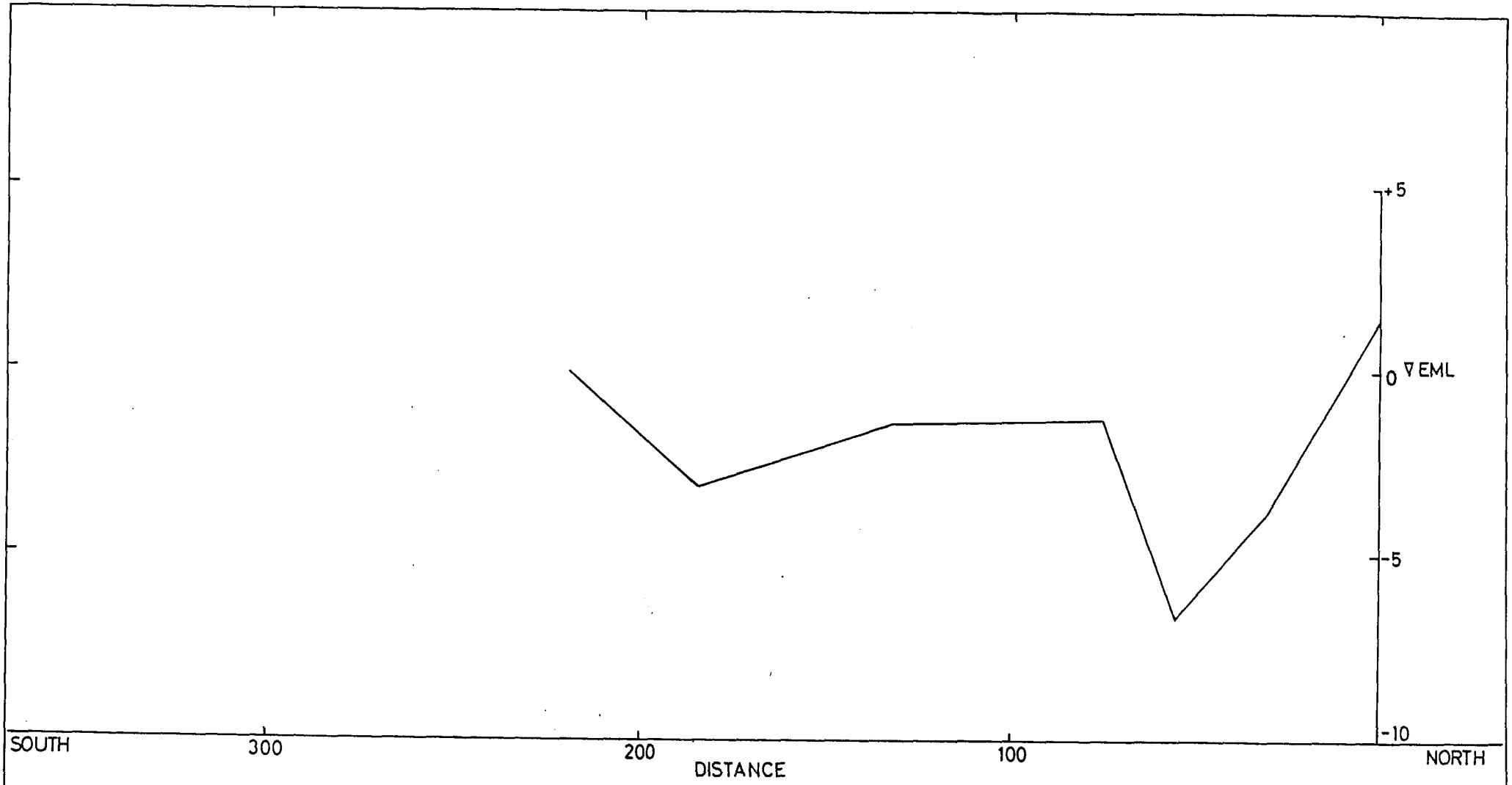
CROSS-SECTION DIO



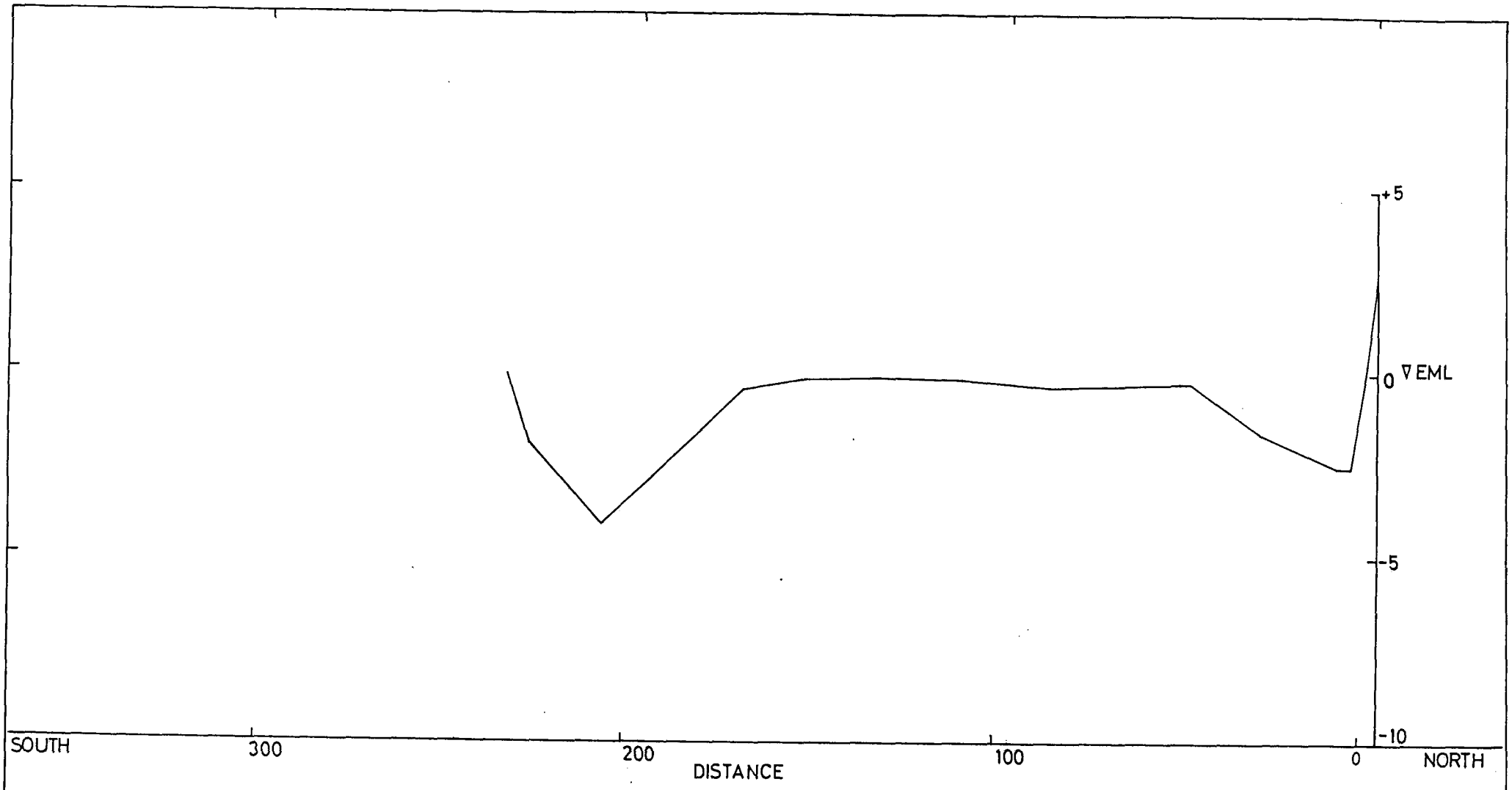
KEY:

- JUNE 1986
- AUGUST 1986
- OCTOBER 1986
- DECEMBER 1986
- FEBRUARY 1987
- APRIL 1987
- JUNE 1987
- SEPTEMBER 1987
- FEBRUARY 1988
- APRIL 1988
- OCTOBER 1987

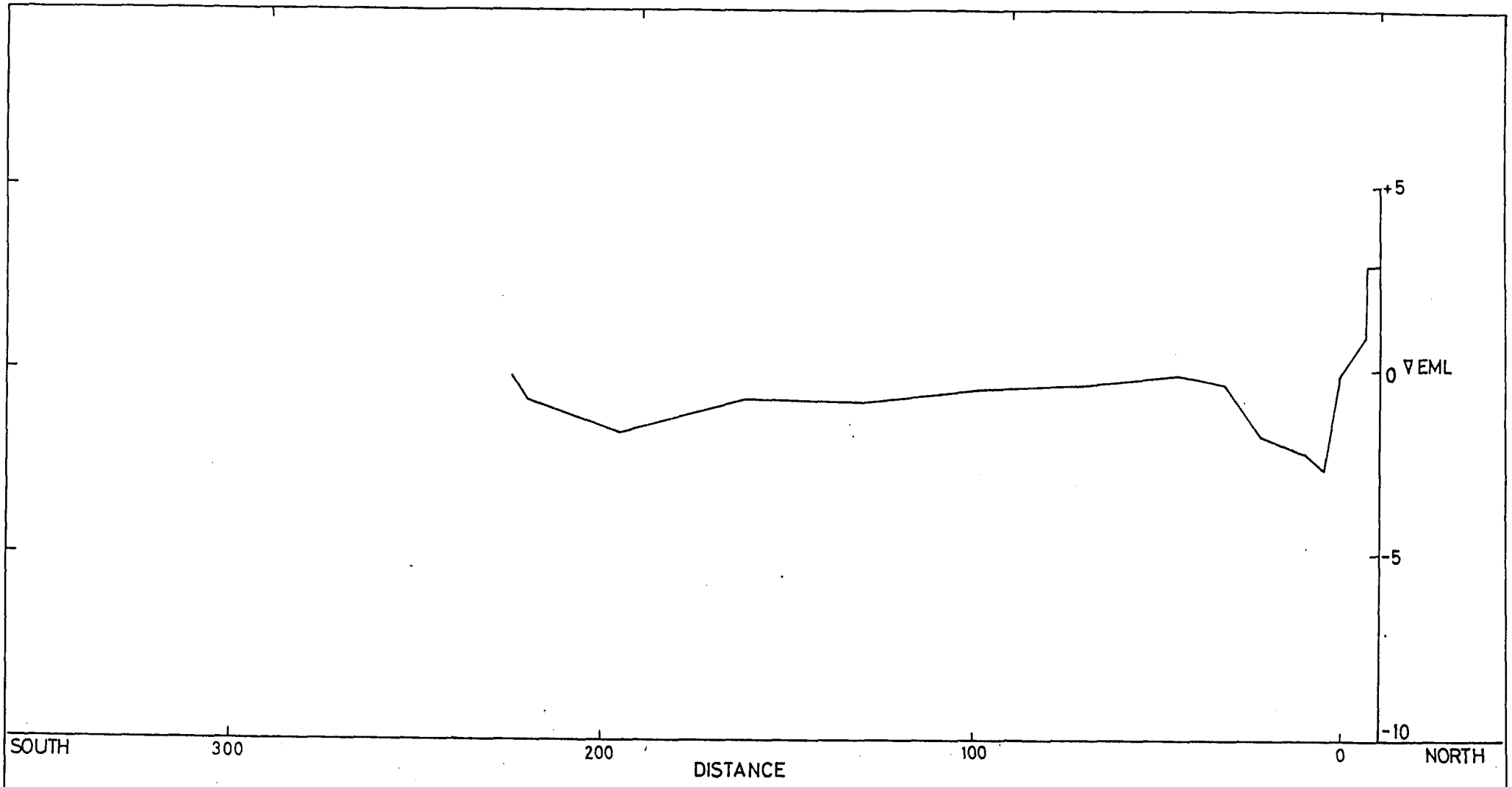
TRACED: CHECKED: DATE: REF:	ST LUCIA DREDGING COMPARATIVE CHANGE IN CROSS-SECTION DIO JUNE 1986 to APRIL 1988	FIGURE : 20
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		



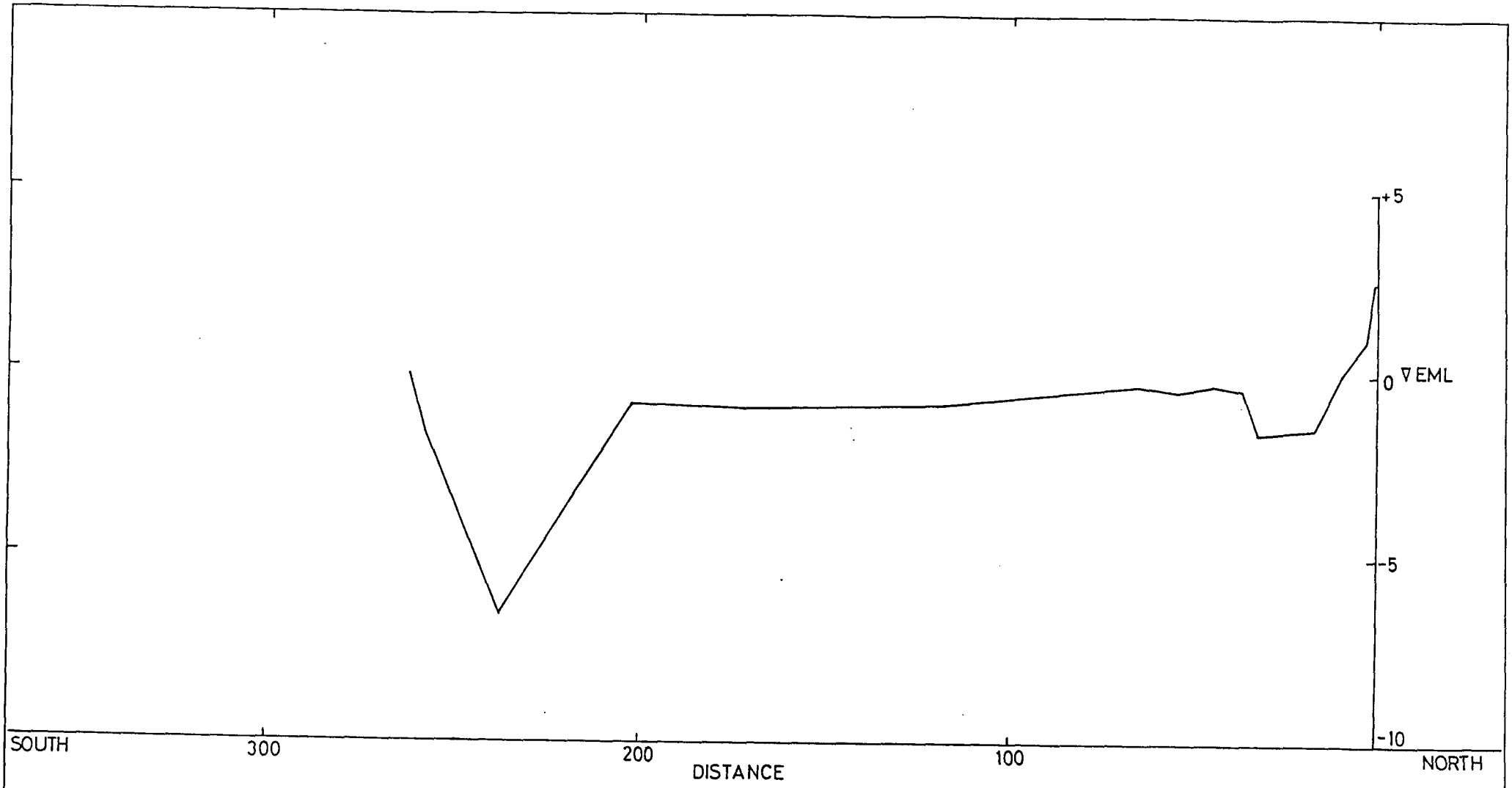
TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS- SECTION D3A - OCTOBER 1986	FIGURE 21a
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		



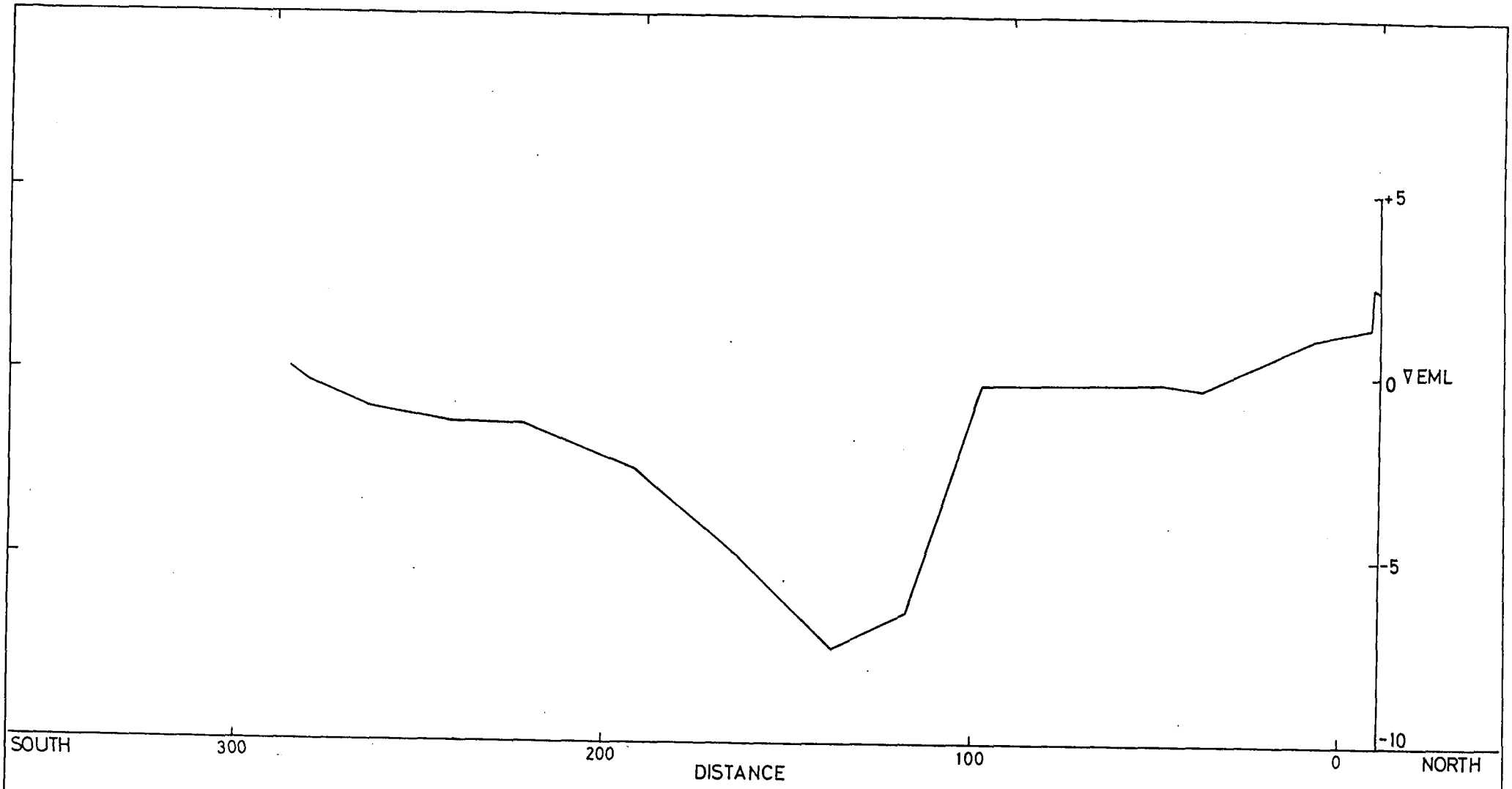
TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS-SECTION D3A - FEBRUARY 1987	FIGURE 21b
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		



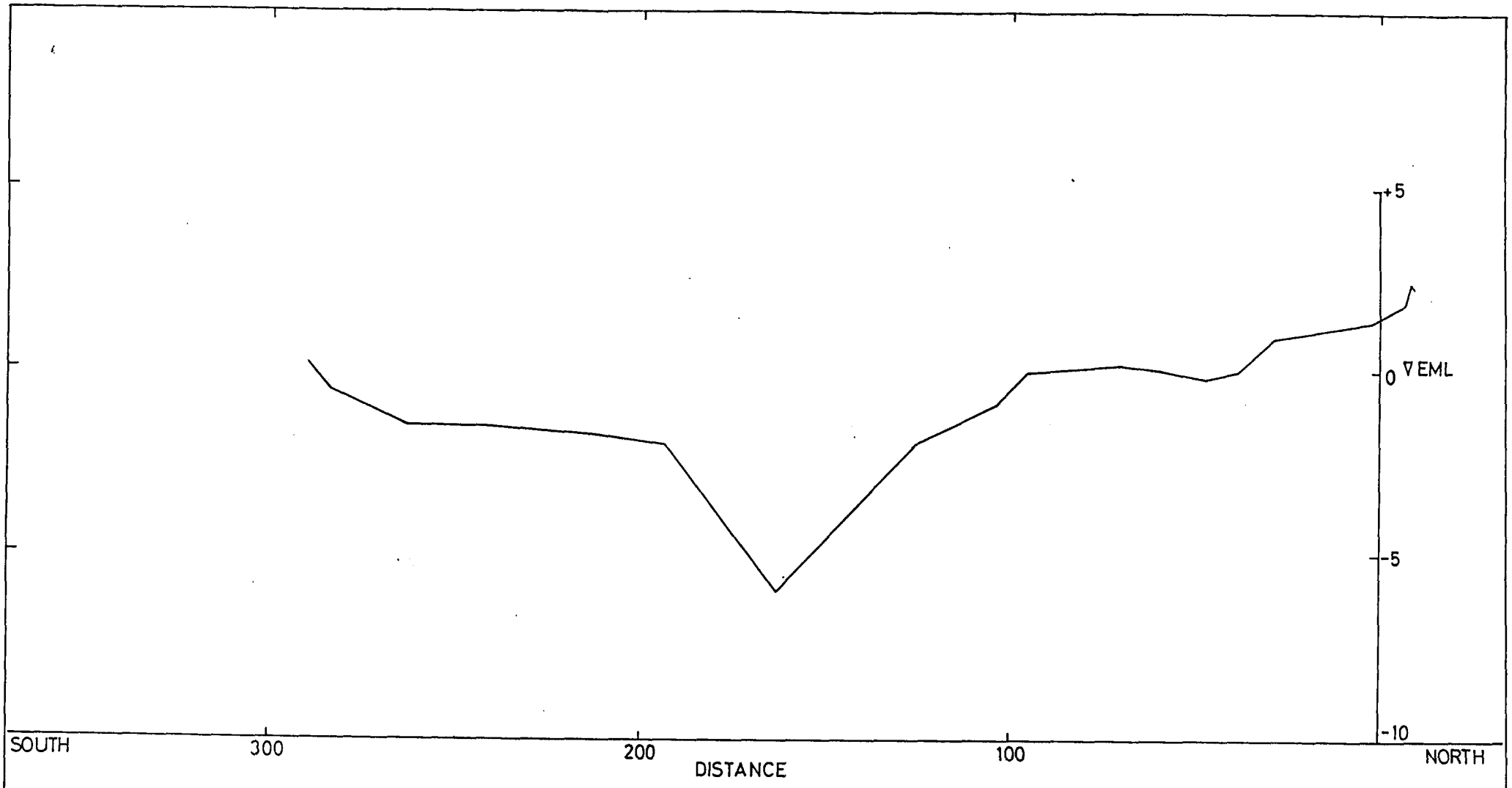
TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS - SECTION D3A - APRIL 1987	FIGURE 21 c
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		



TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS - SECTION D3A - JUNE 1987	FIGURE 21d
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		

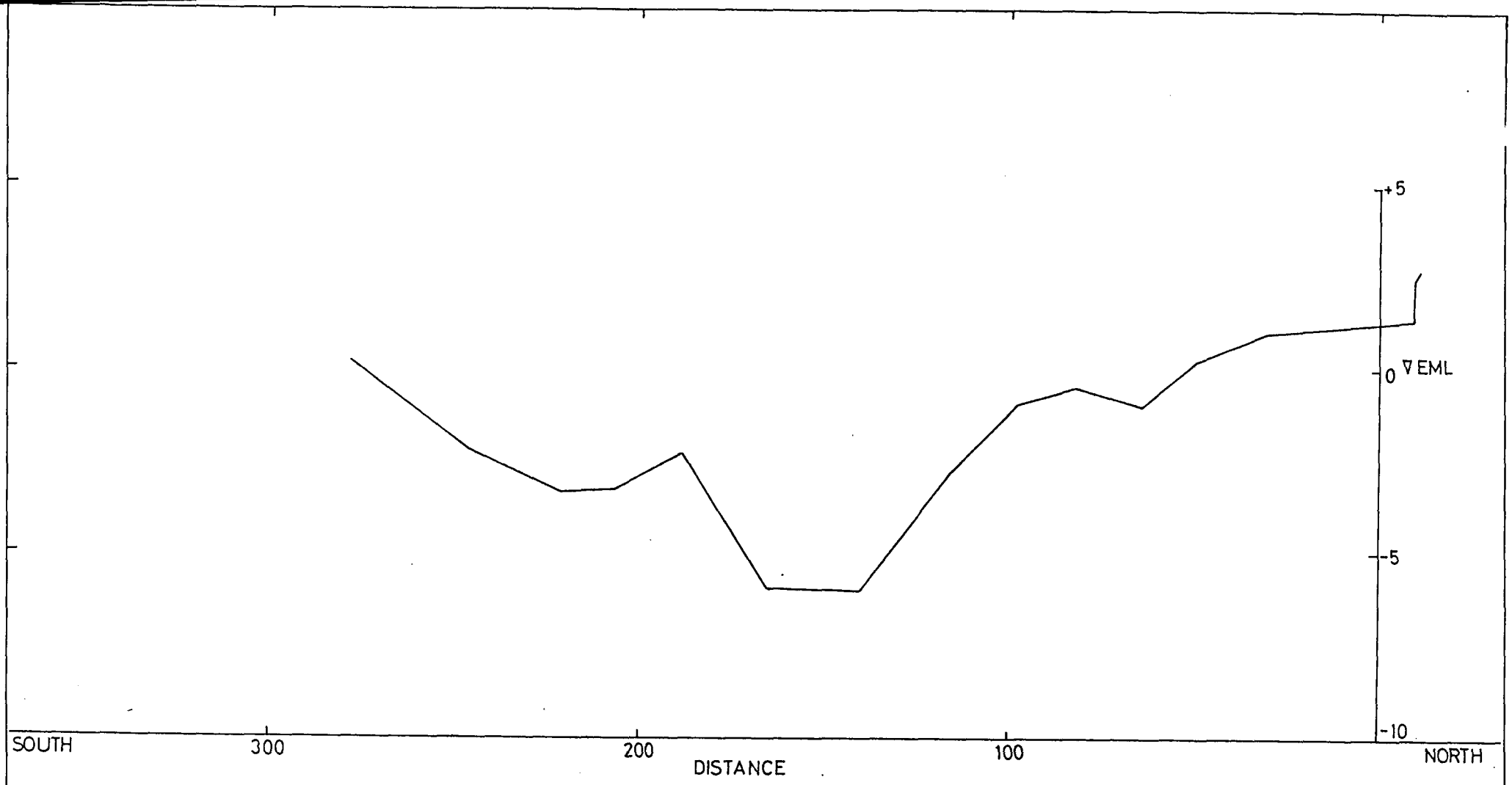


TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS-SECTION D3A- SEPTEMBER 1987	FIGURE 21e
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		

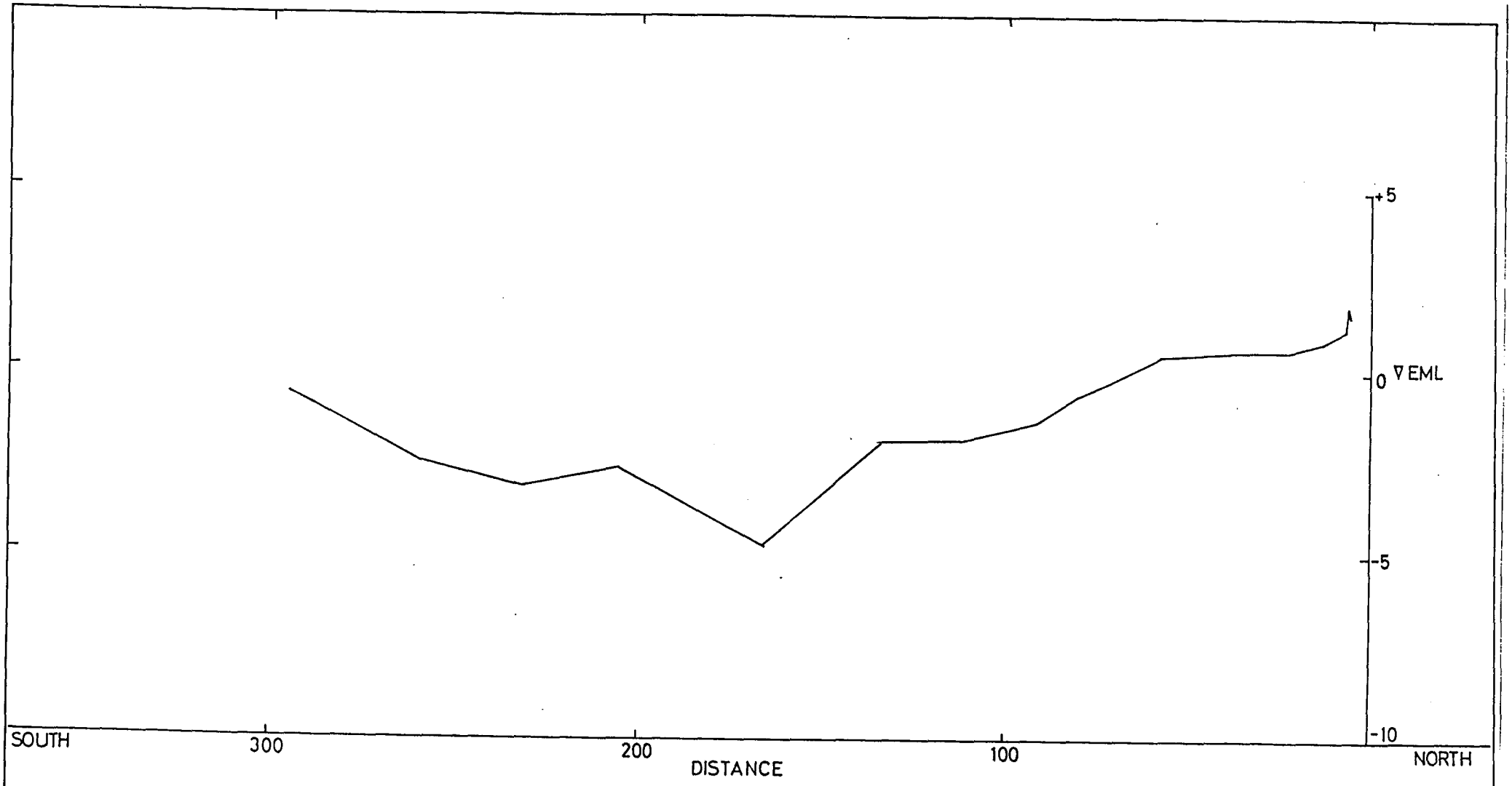


TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS- SECTION D3A- OCTOBER 1987	FIGURE 21f

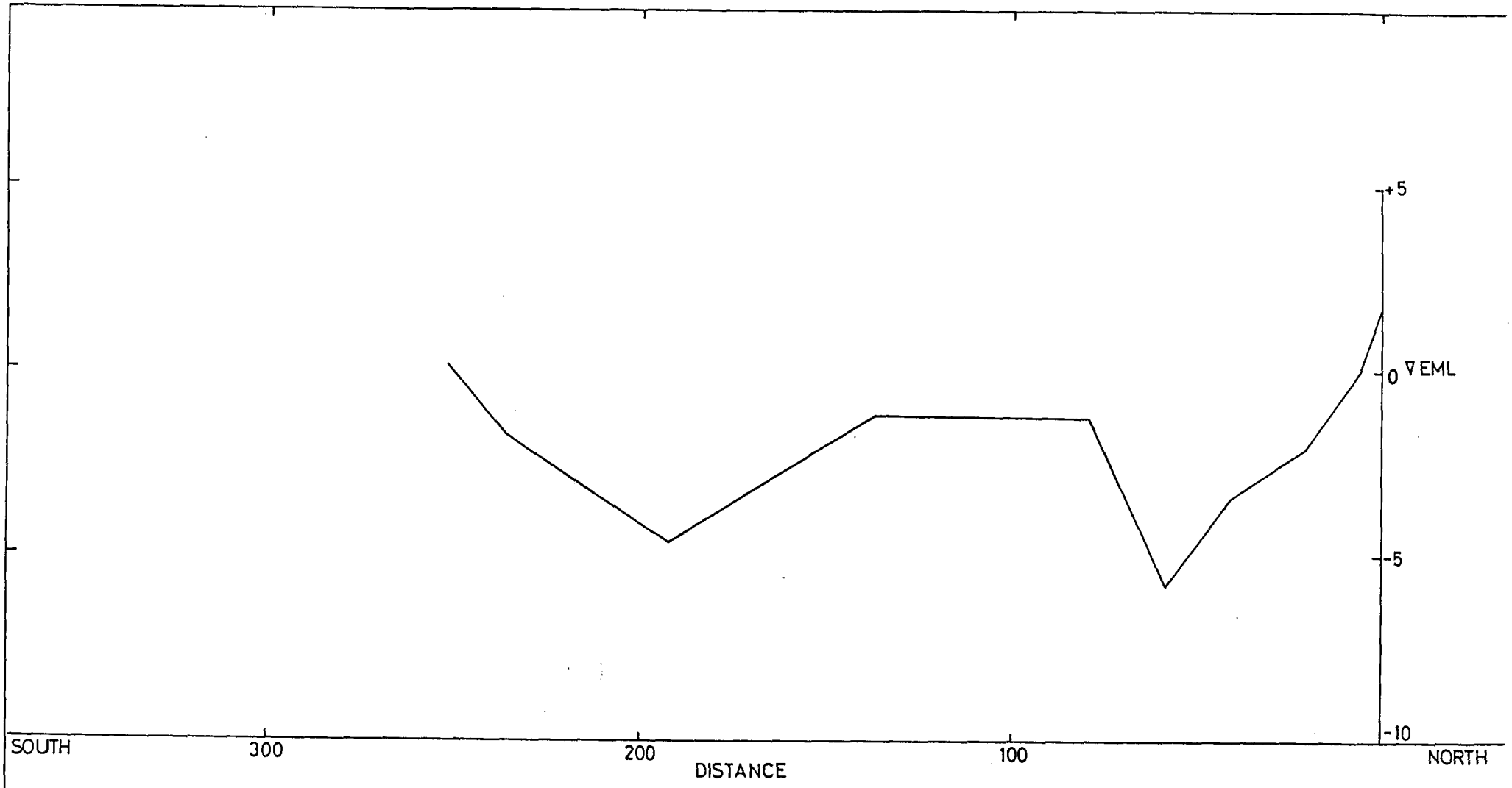
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY



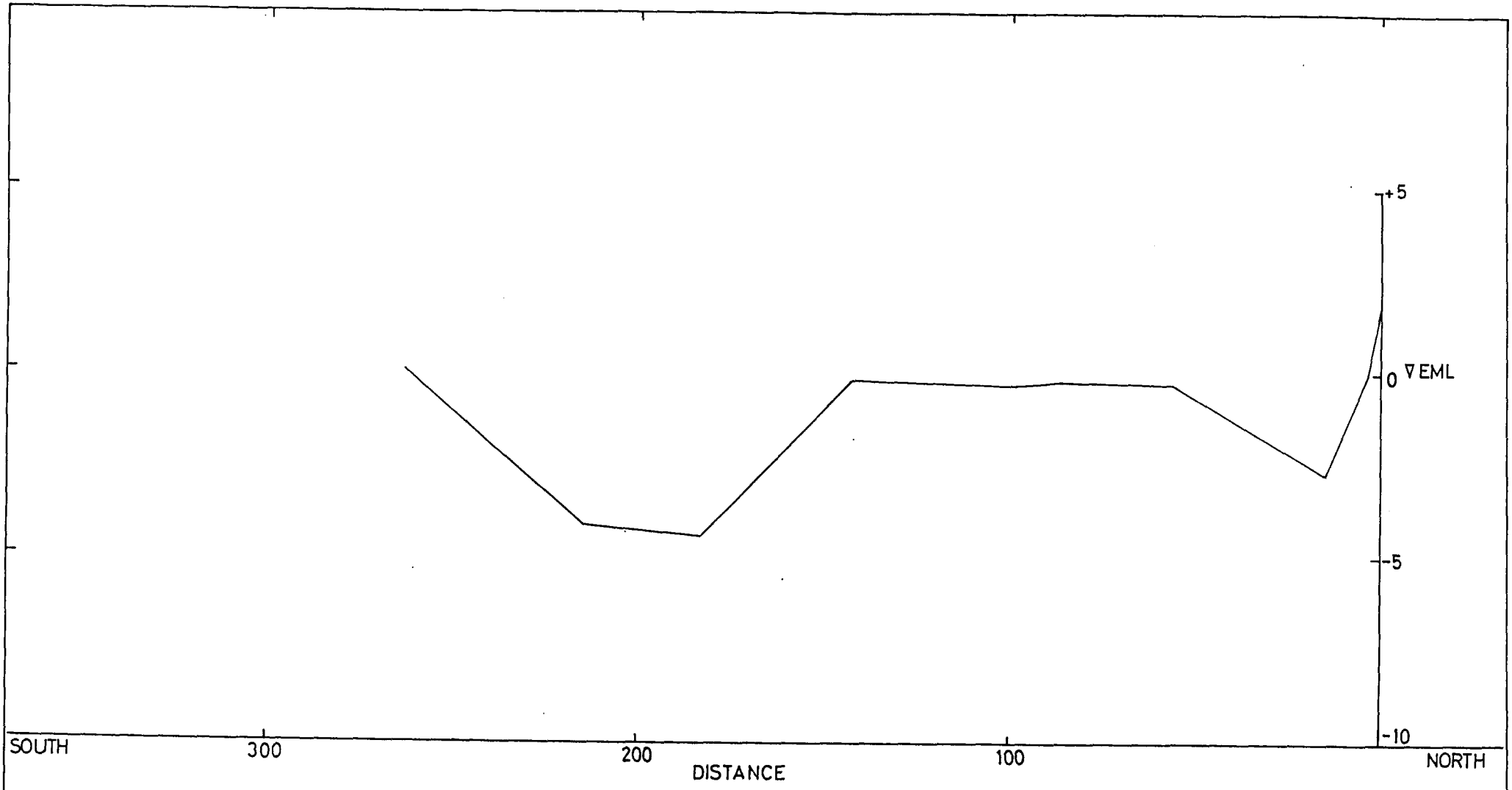
TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS- SECTION D3A - FEBRUARY 1988	FIGURE 21g
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		



TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS- SECTION D3A - APRIL 1988	FIGURE 21h
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		

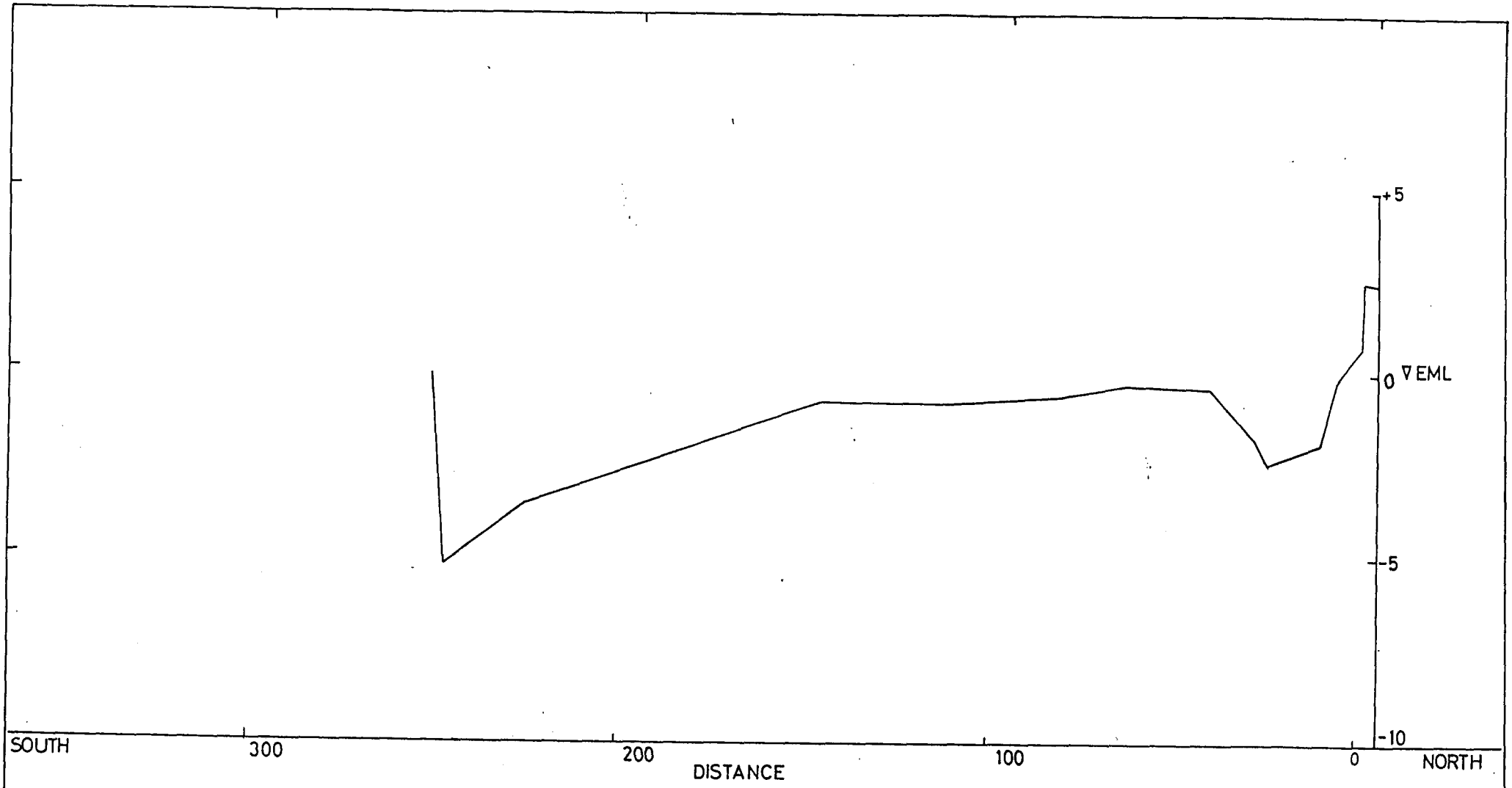


TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS-SECTION D3B - OCTOBER 1986	FIGURE 22a
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		

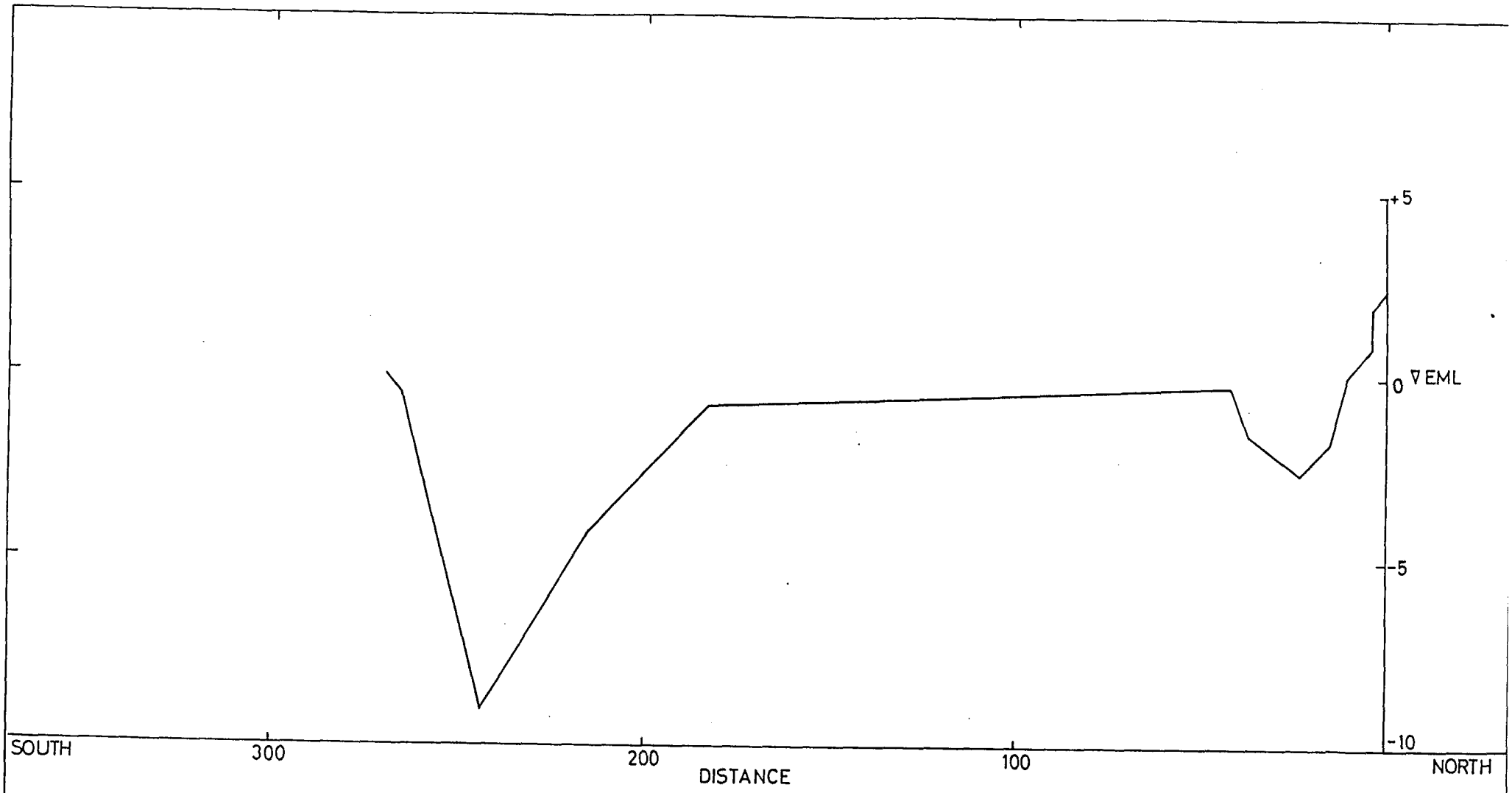


TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS- SECTION D3B - FEBRUARY 1987	FIGURE 22b

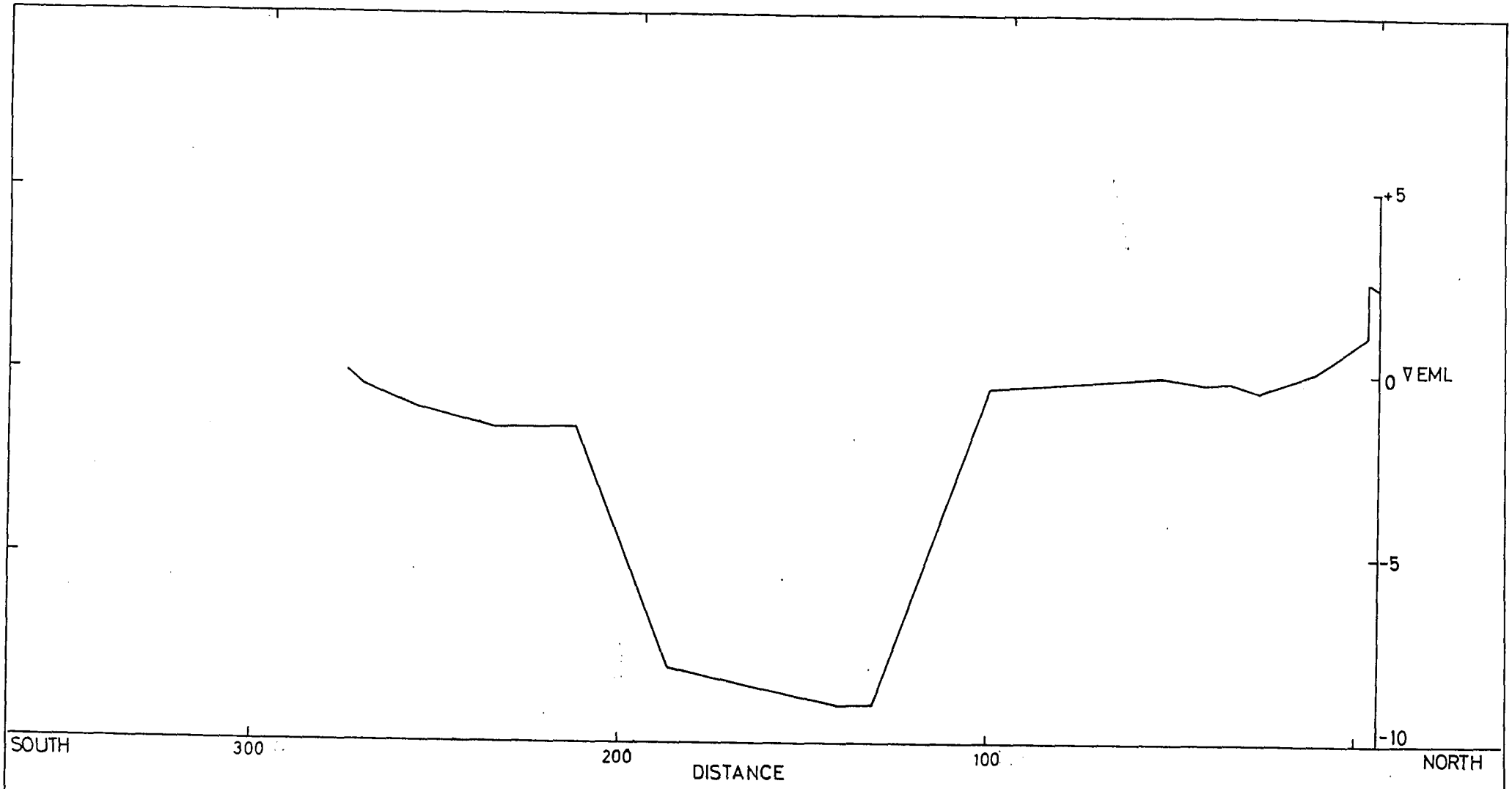
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY



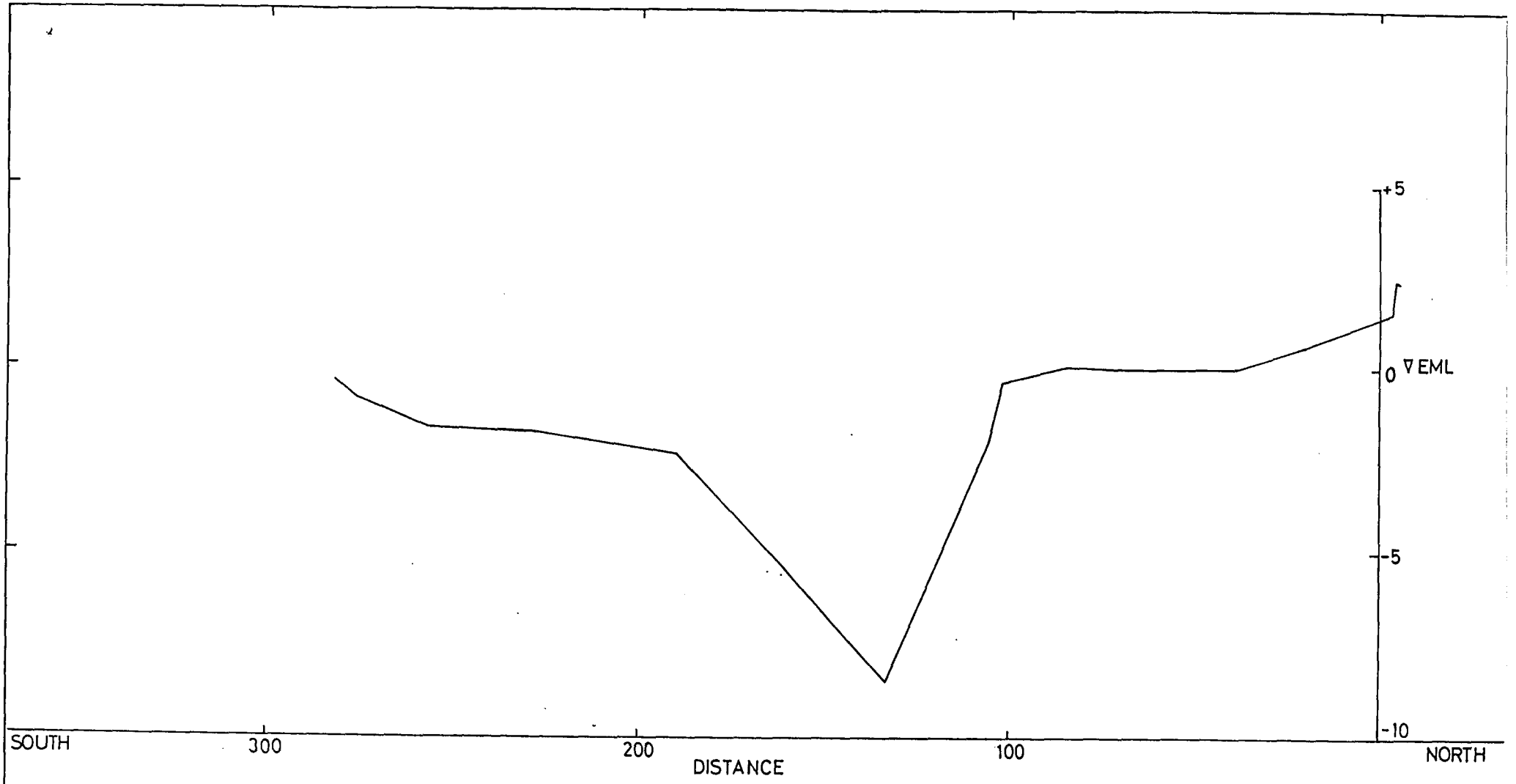
TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS-SECTION D3B- APRIL 1987	FIGURE 22c
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		



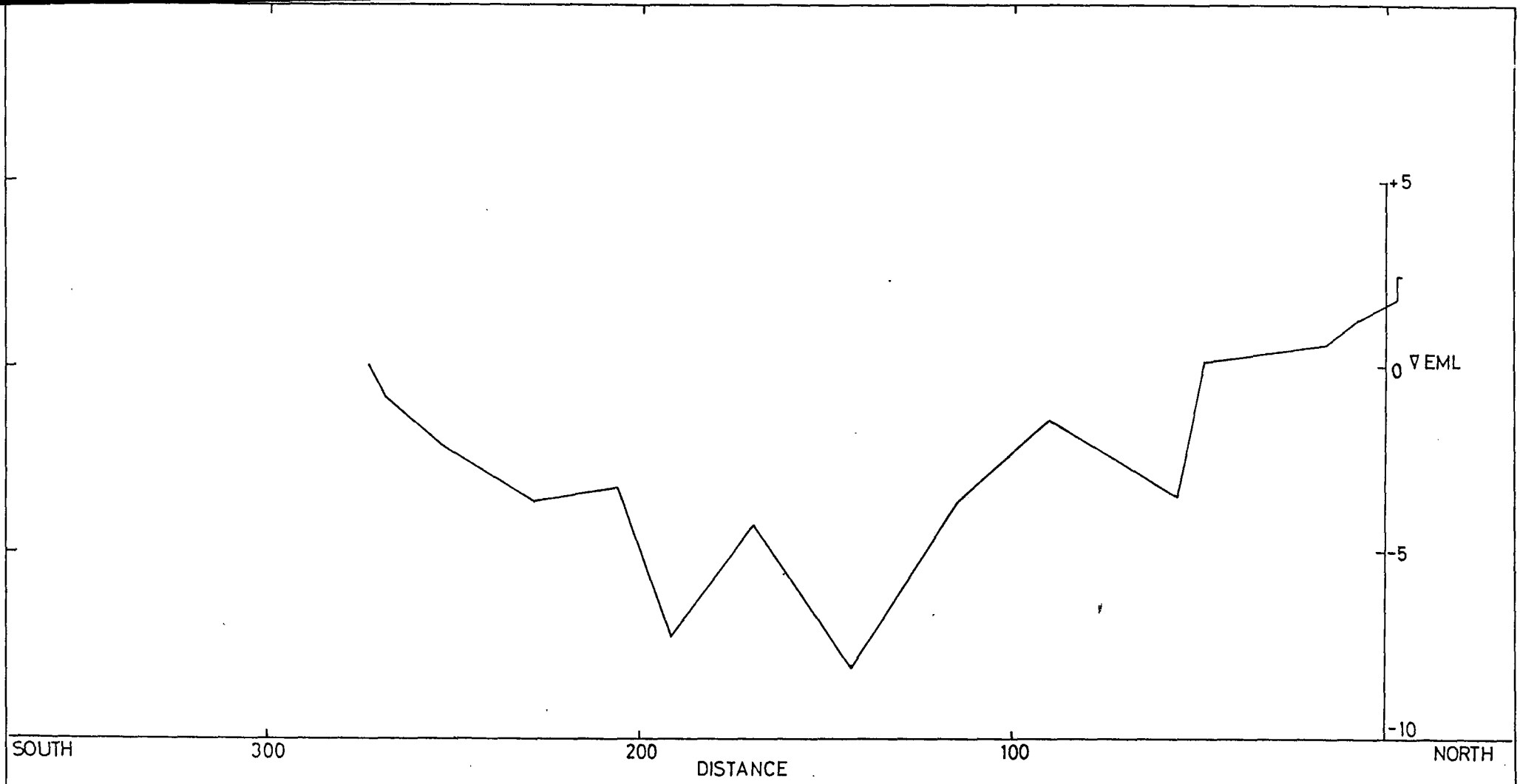
TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS - SECTION D3B - JUNE 1987	FIGURE 22d
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		



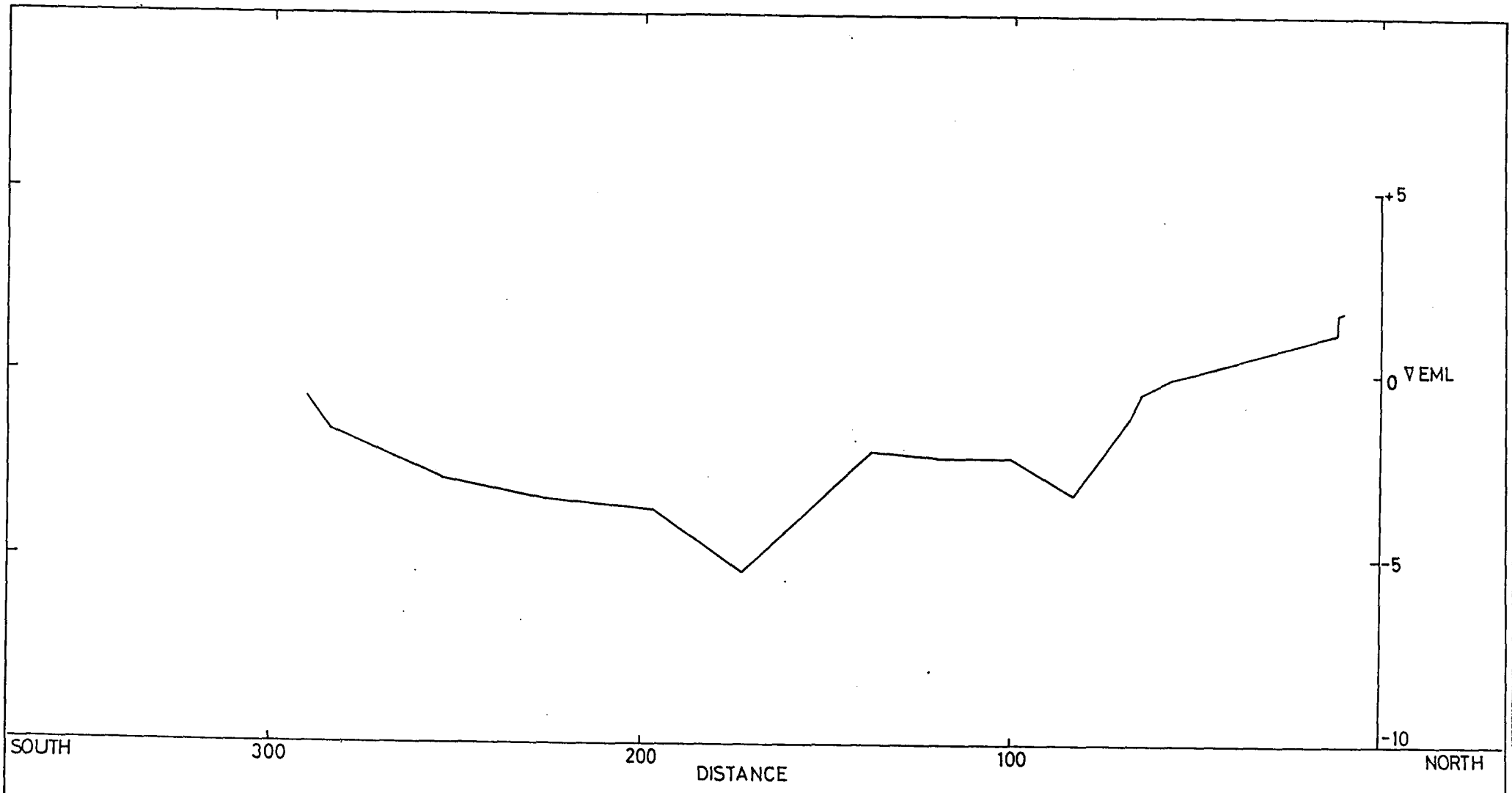
TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS - SECTION D3B - SEPTEMBER 1987	FIGURE 22e
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		



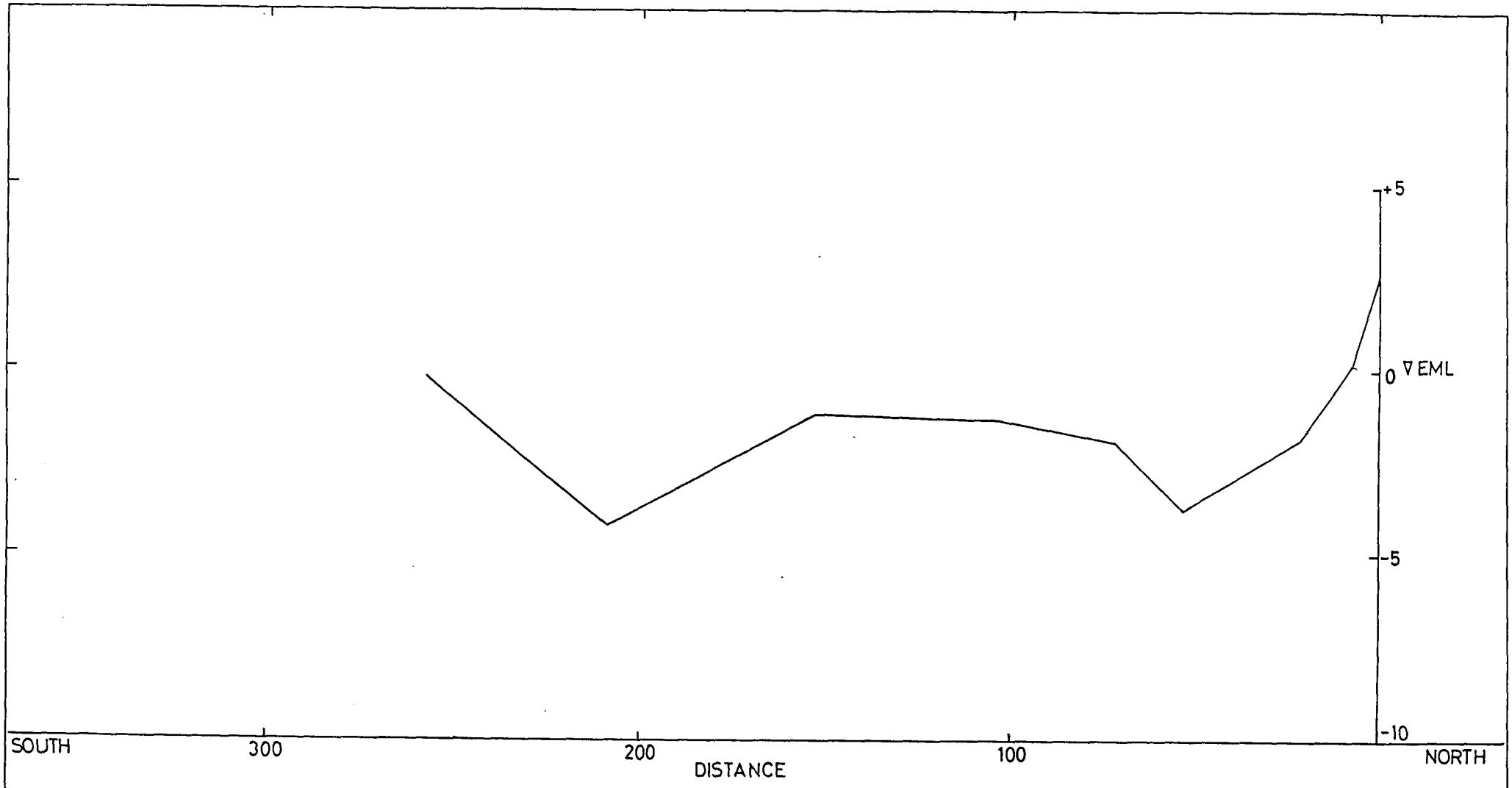
TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS-SECTION D3B- OCTOBER 1987	FIGURE 22f
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		



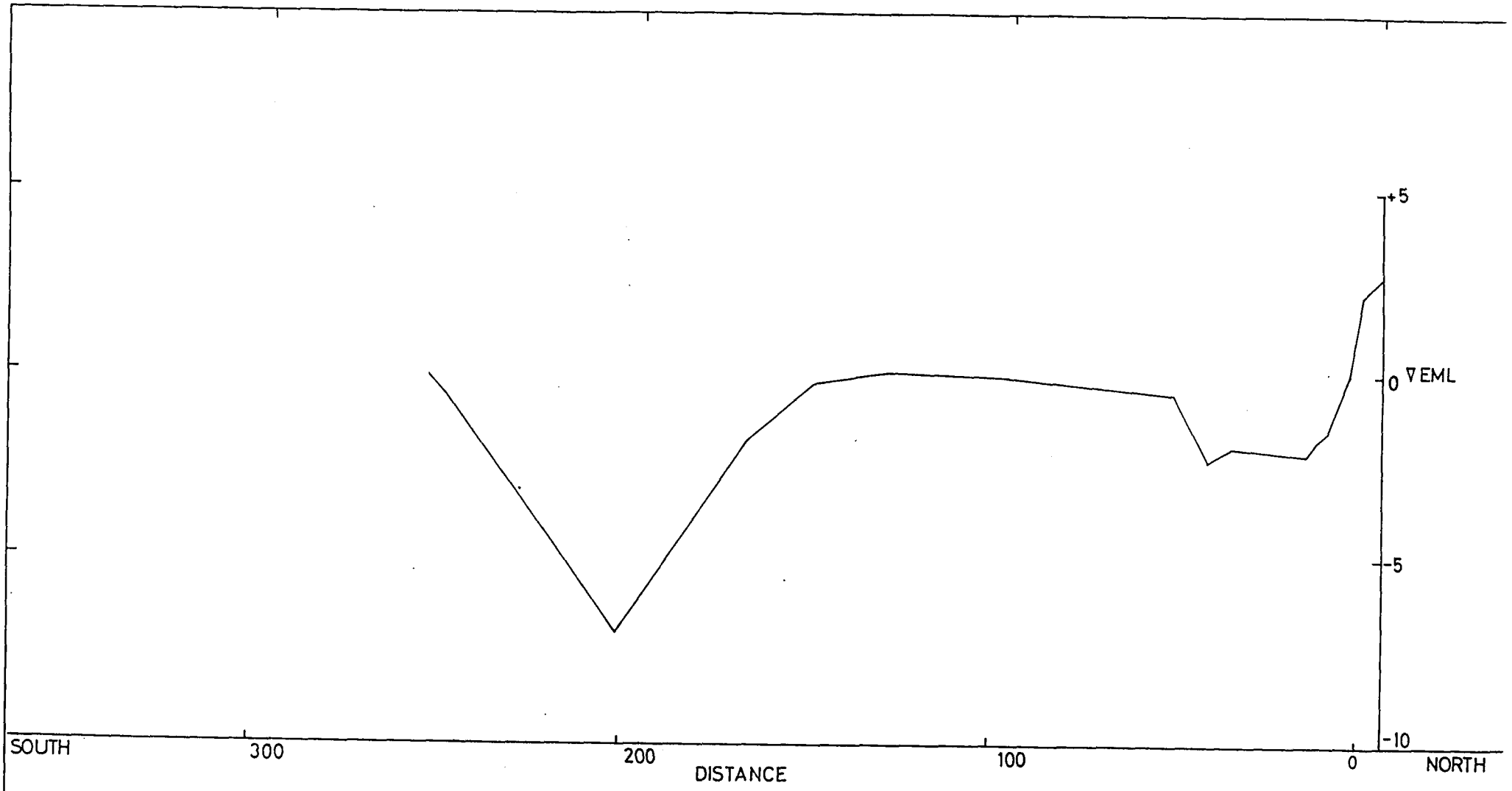
TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS-SECTION D3B - FEBRUARY 1988	FIGURE 22g
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		



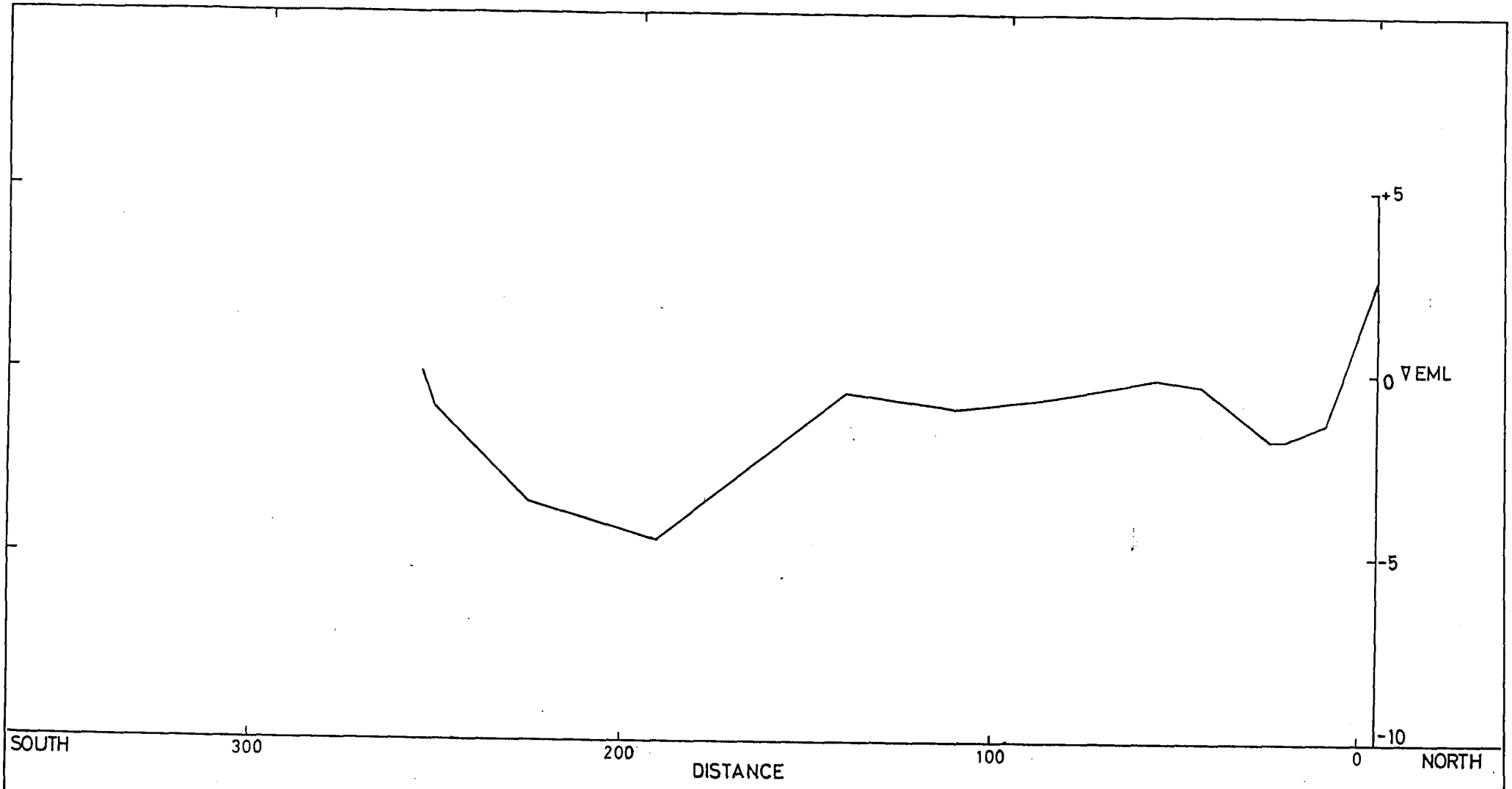
TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS - SECTION D3B - APRIL 1988	FIGURE 22 h
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		



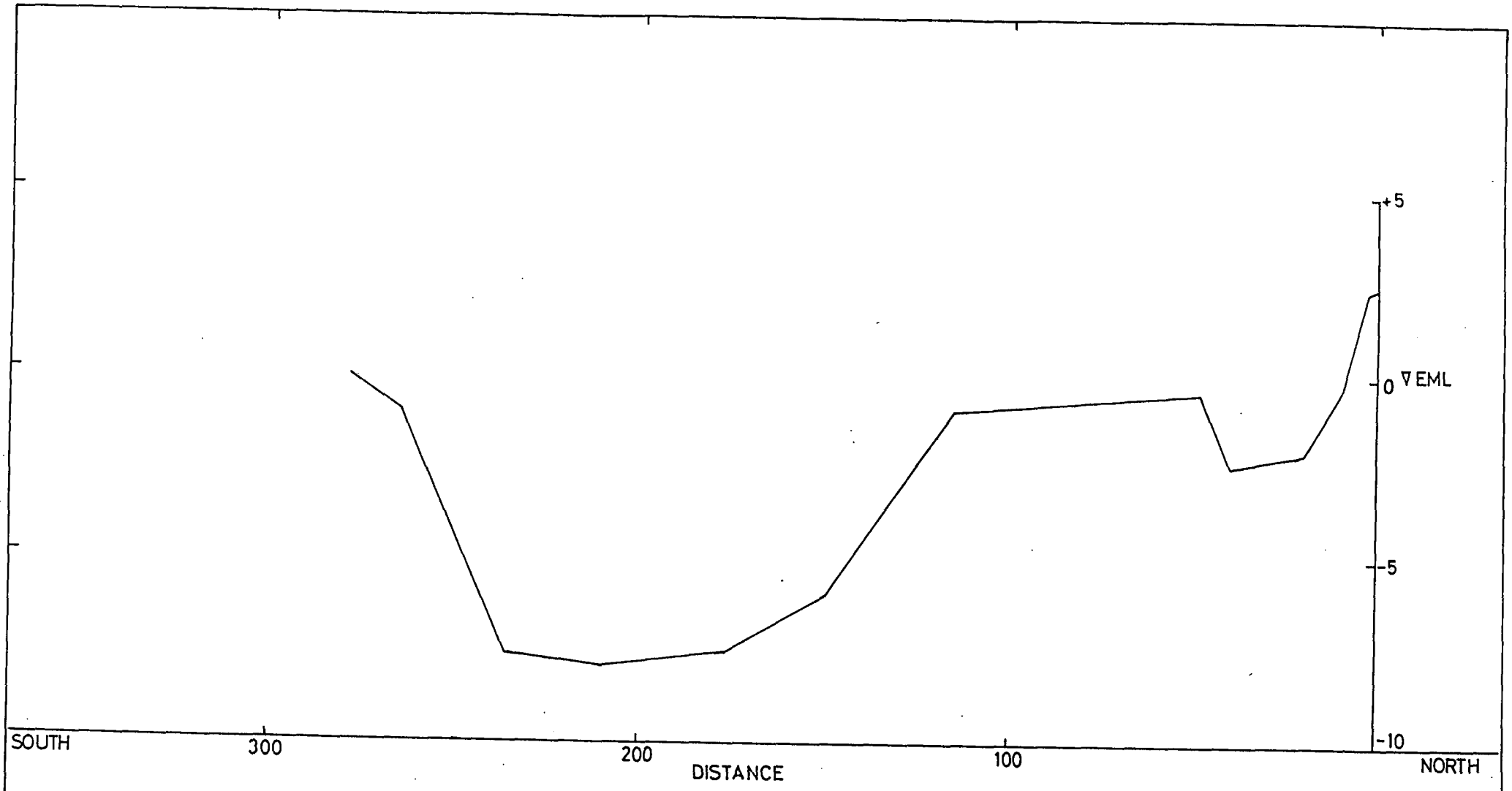
TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS-SECTION D3C - OCTOBER 1986	FIGURE 23a
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		



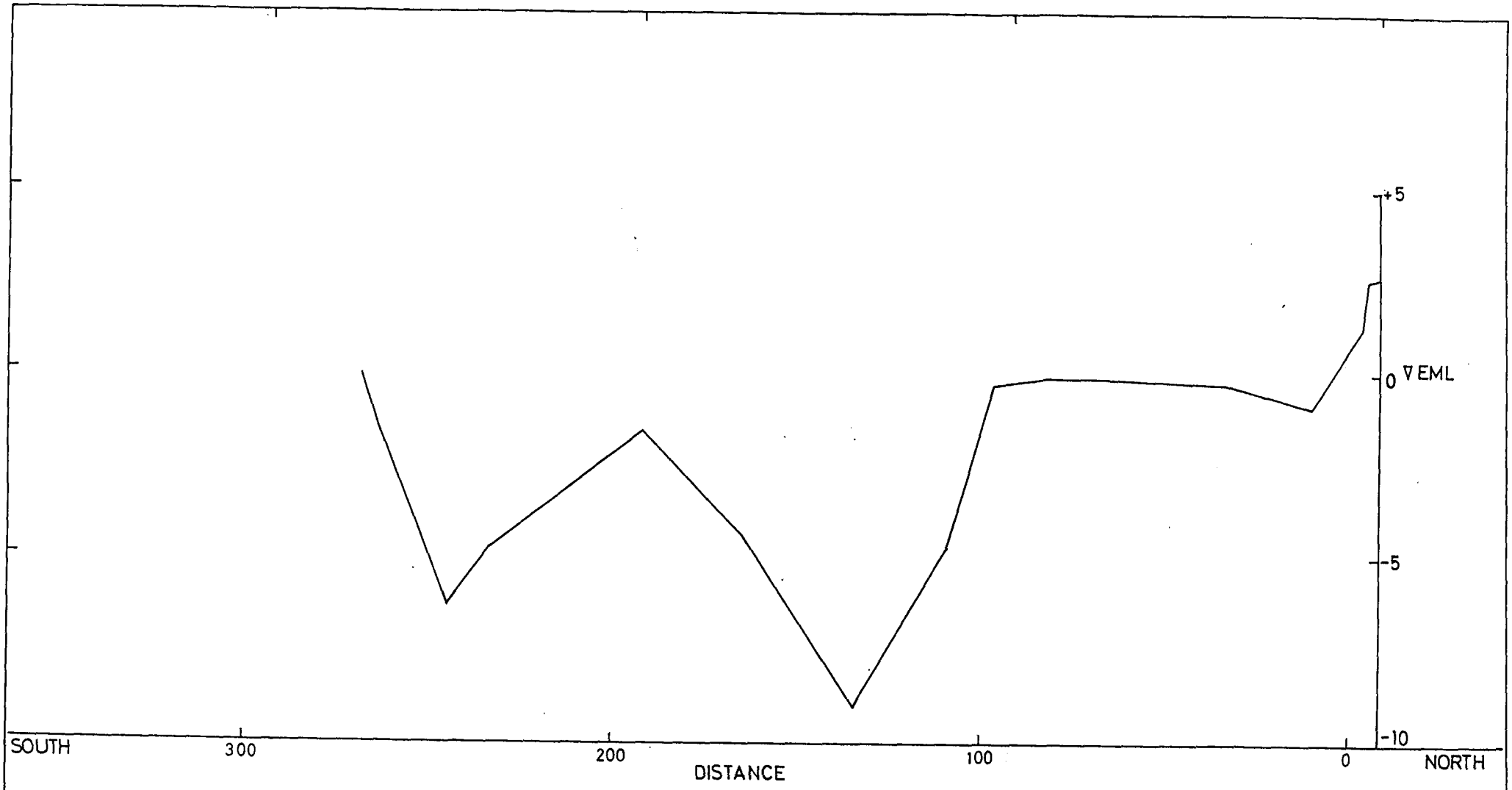
TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS- SECTION D3C - FEBRUARY 1987	FIGURE 23b
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		



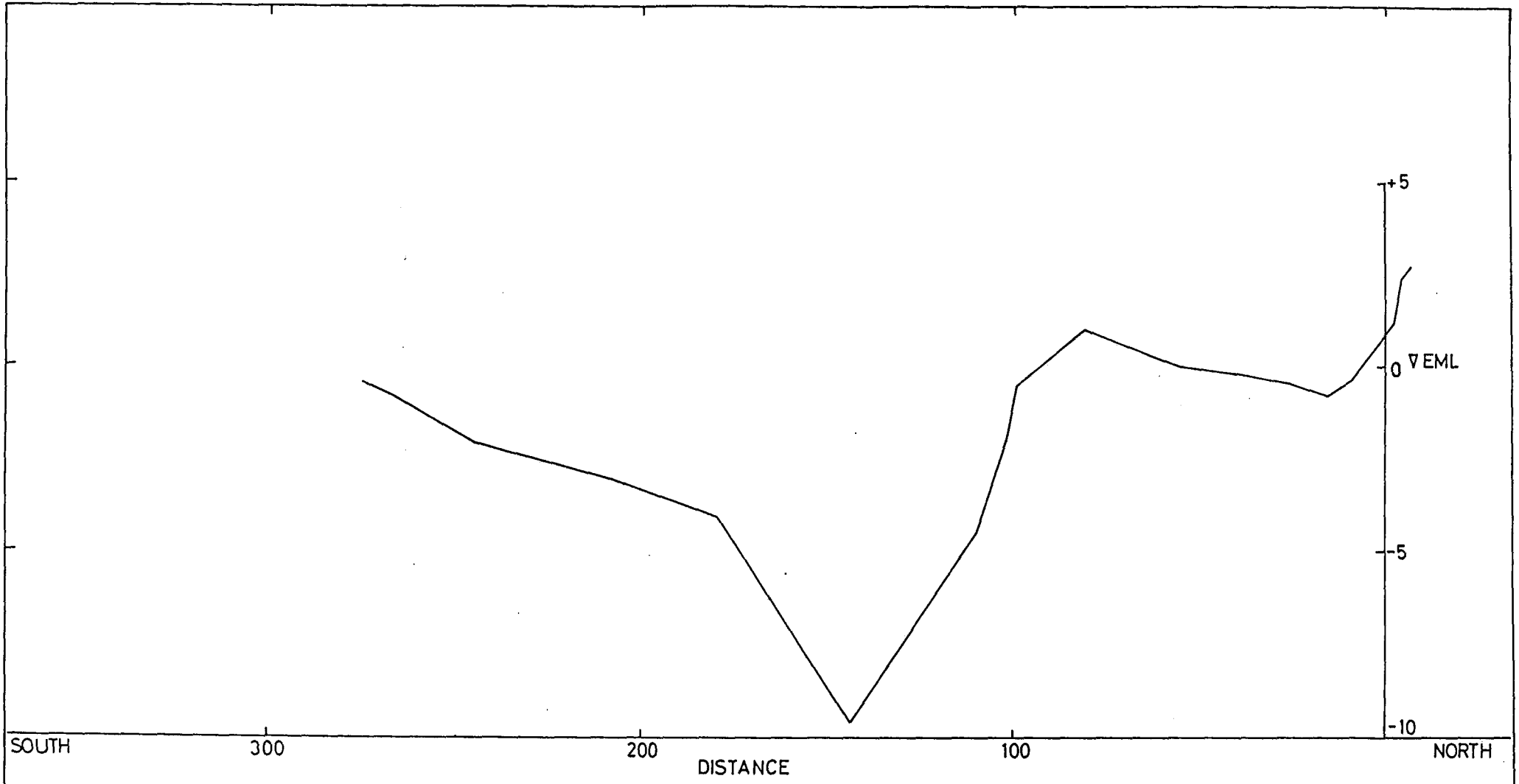
TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS - SECTION D3C - APRIL 1987	FIGURE 23 c
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		



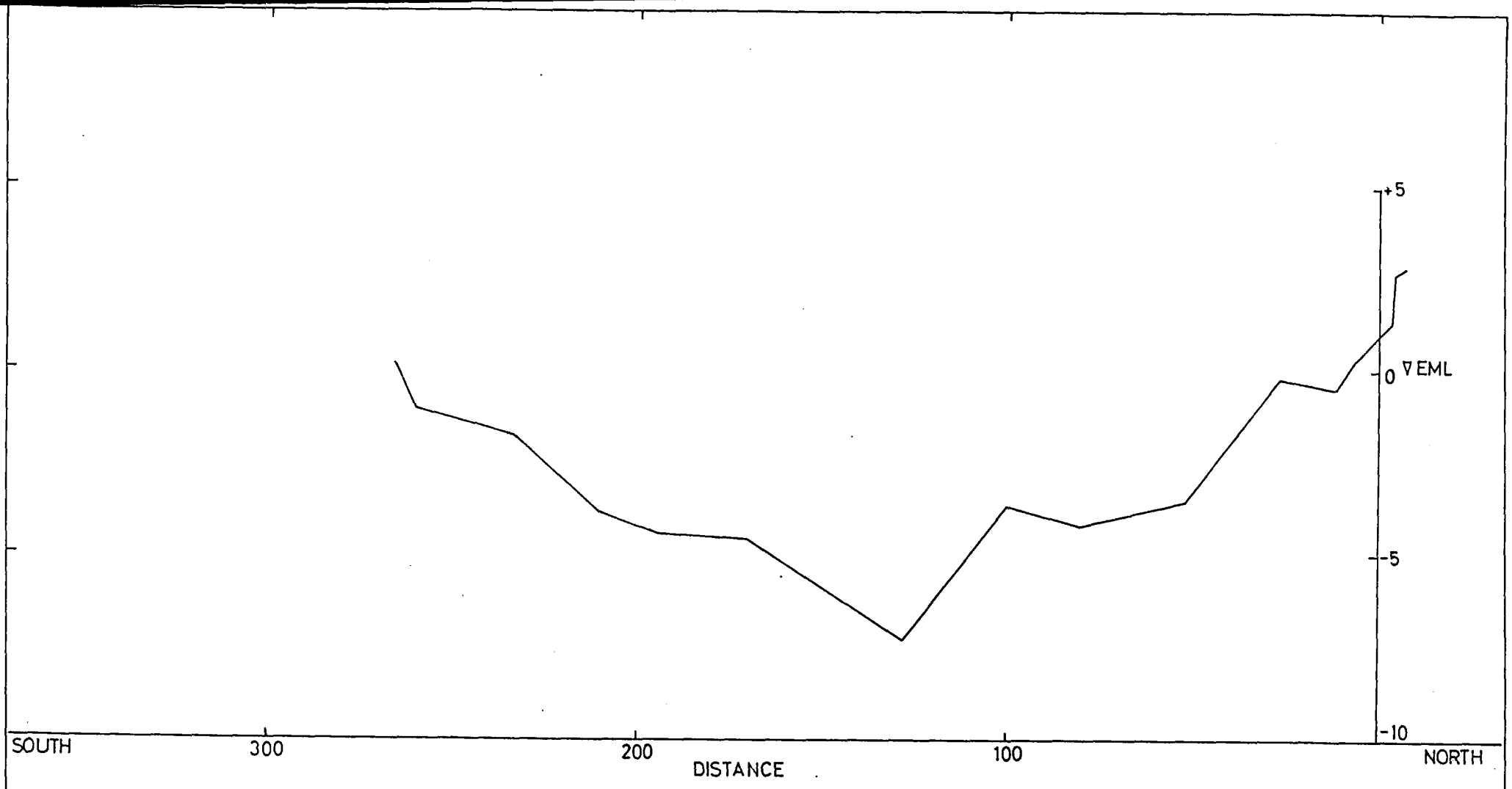
TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS- SECTION D3C - JUNE 1987	FIGURE 23d
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		



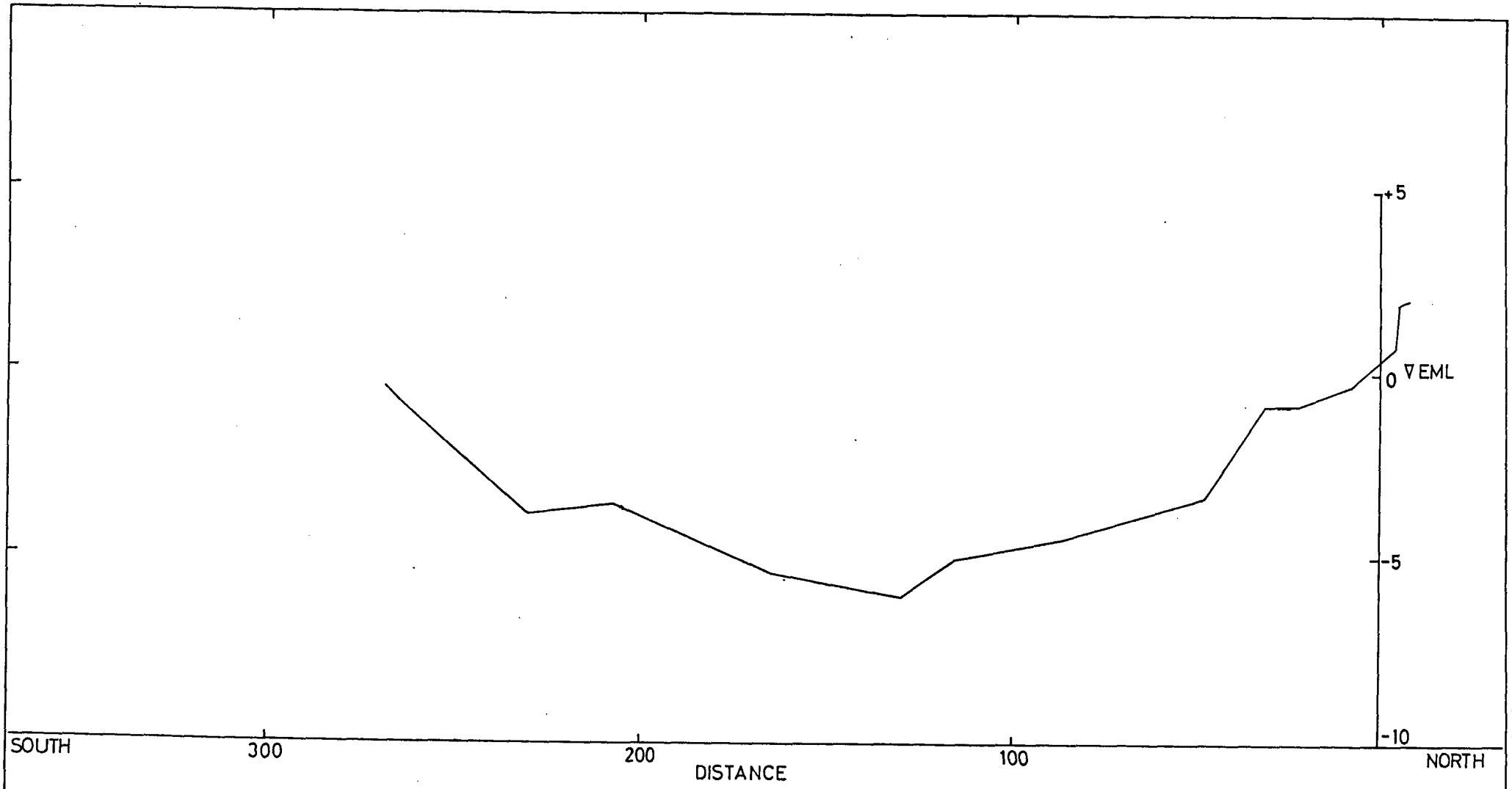
TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS - SECTION D3C - SEPTEMBER 1987	FIGURE 23 e
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		



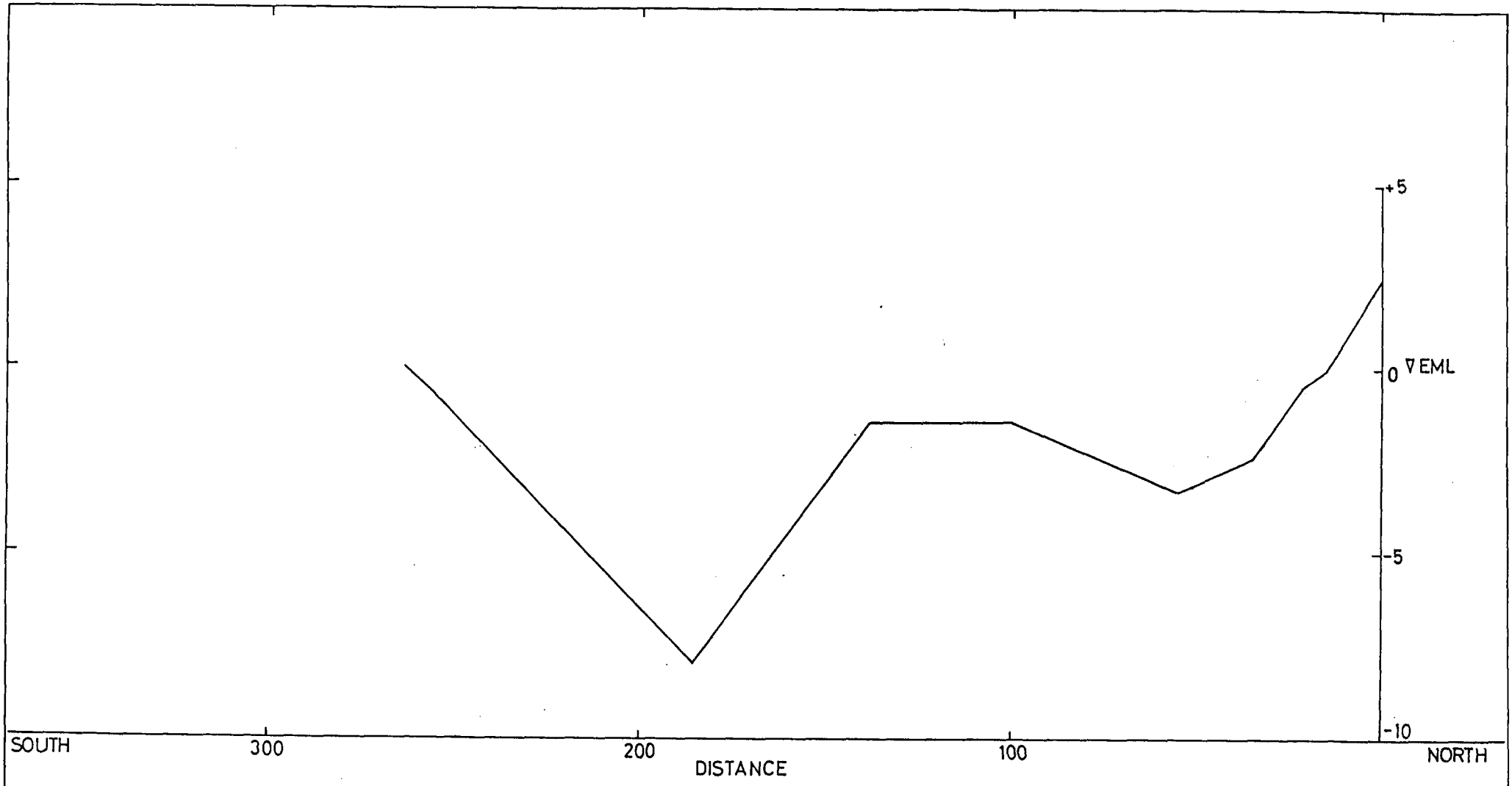
TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS - SECTION D3C - OCTOBER 1987	FIGURE 23 f
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		



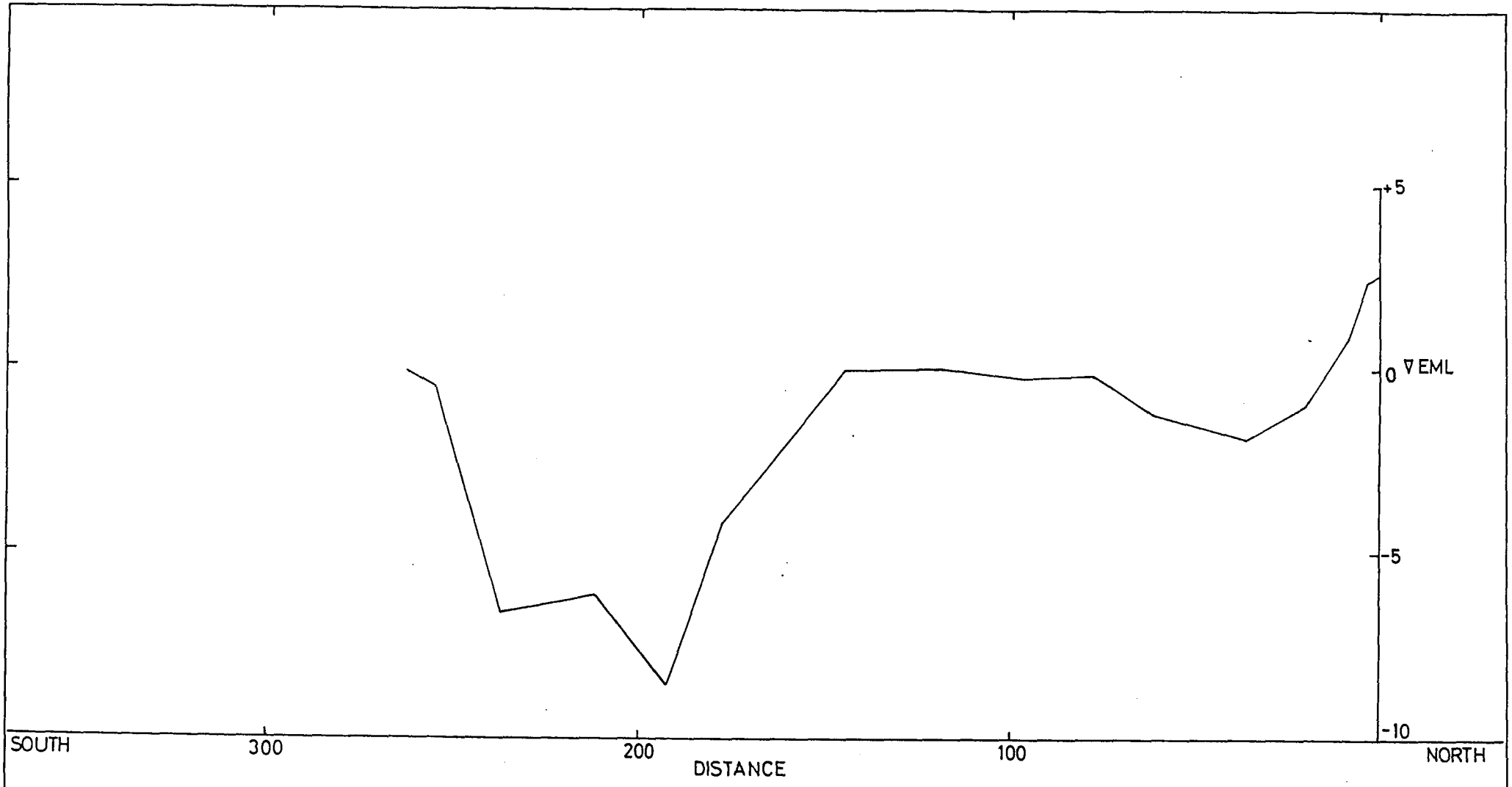
TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS- SECTION D3C - FEBRUARY 1988	FIGURE 23g
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		



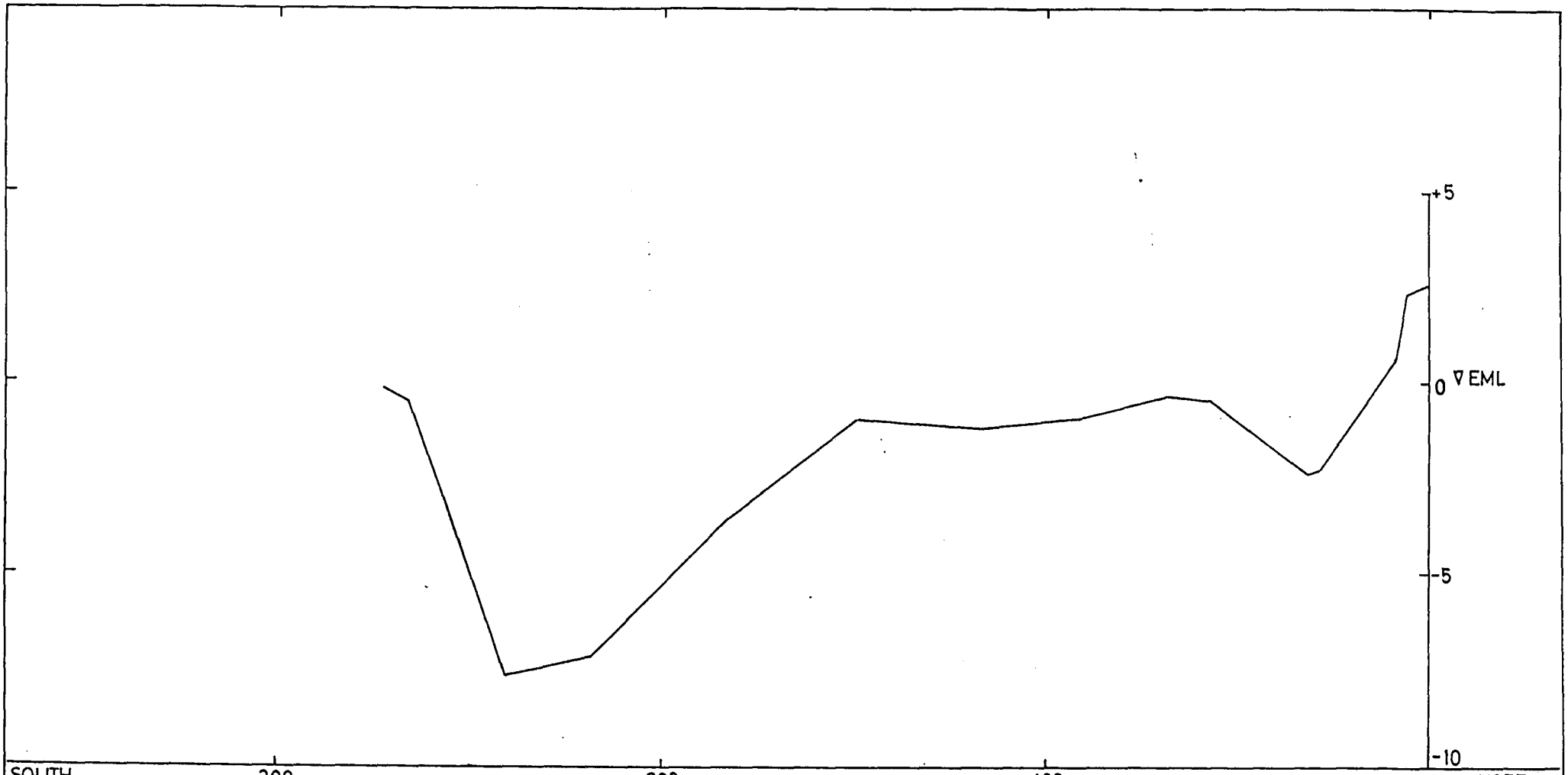
TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS - SECTION D3C - APRIL 1988	FIGURE 23h
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		



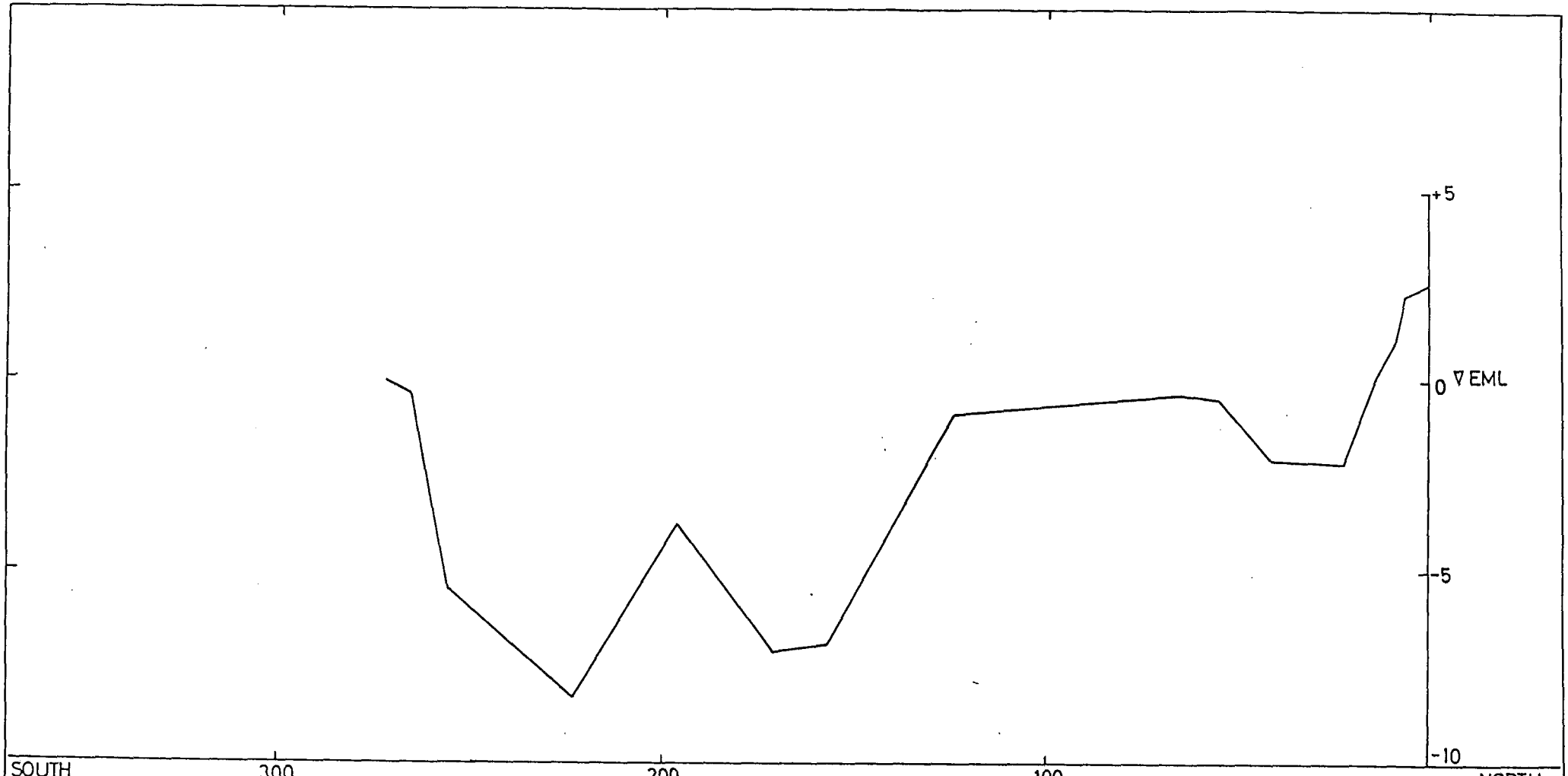
TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS-SECTION D3D - OCTOBER 1986	FIGURE 24a
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		



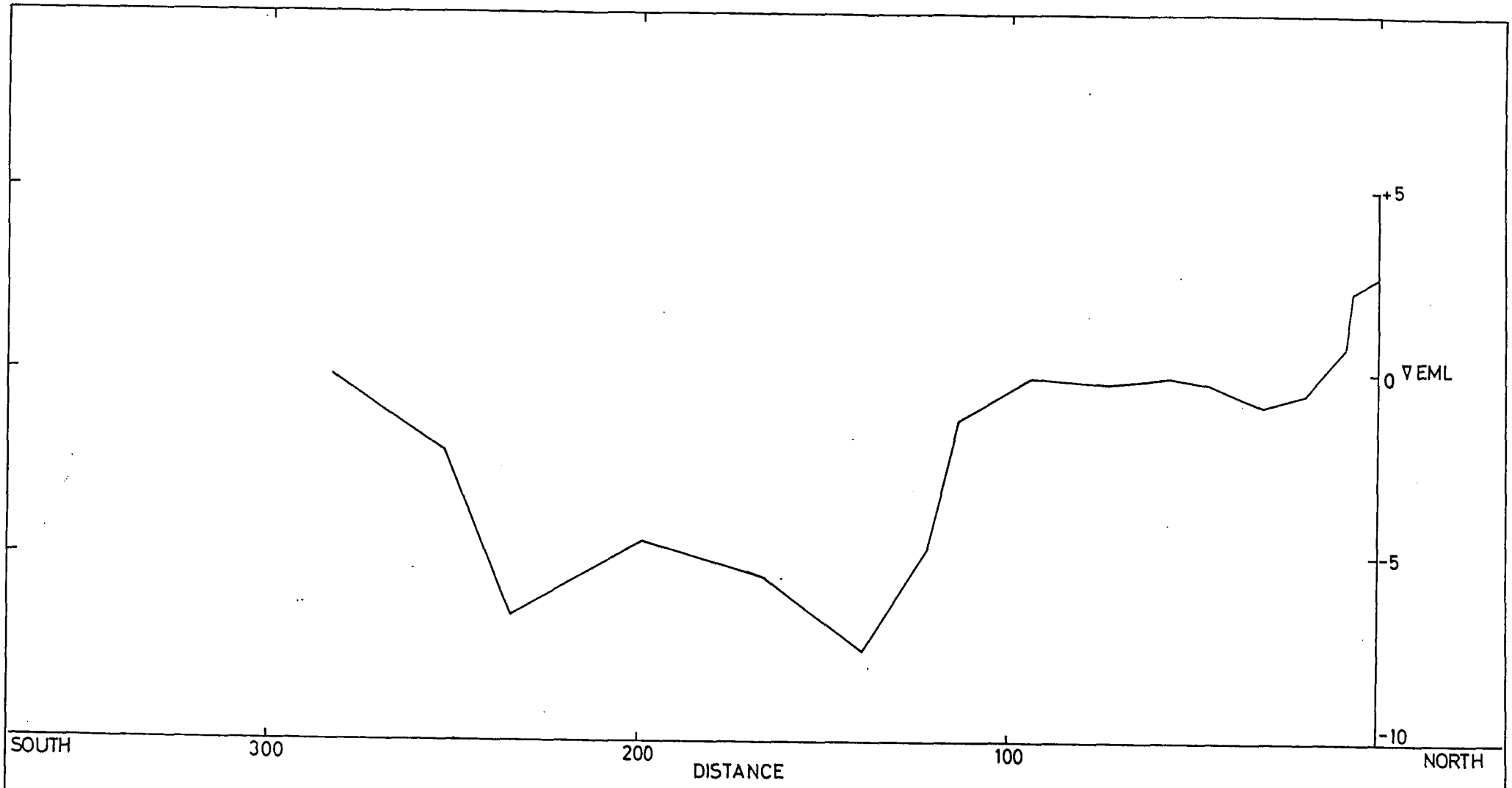
TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS- SECTION D3D - FEBRUARY 1987	FIGURE 24 b
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		



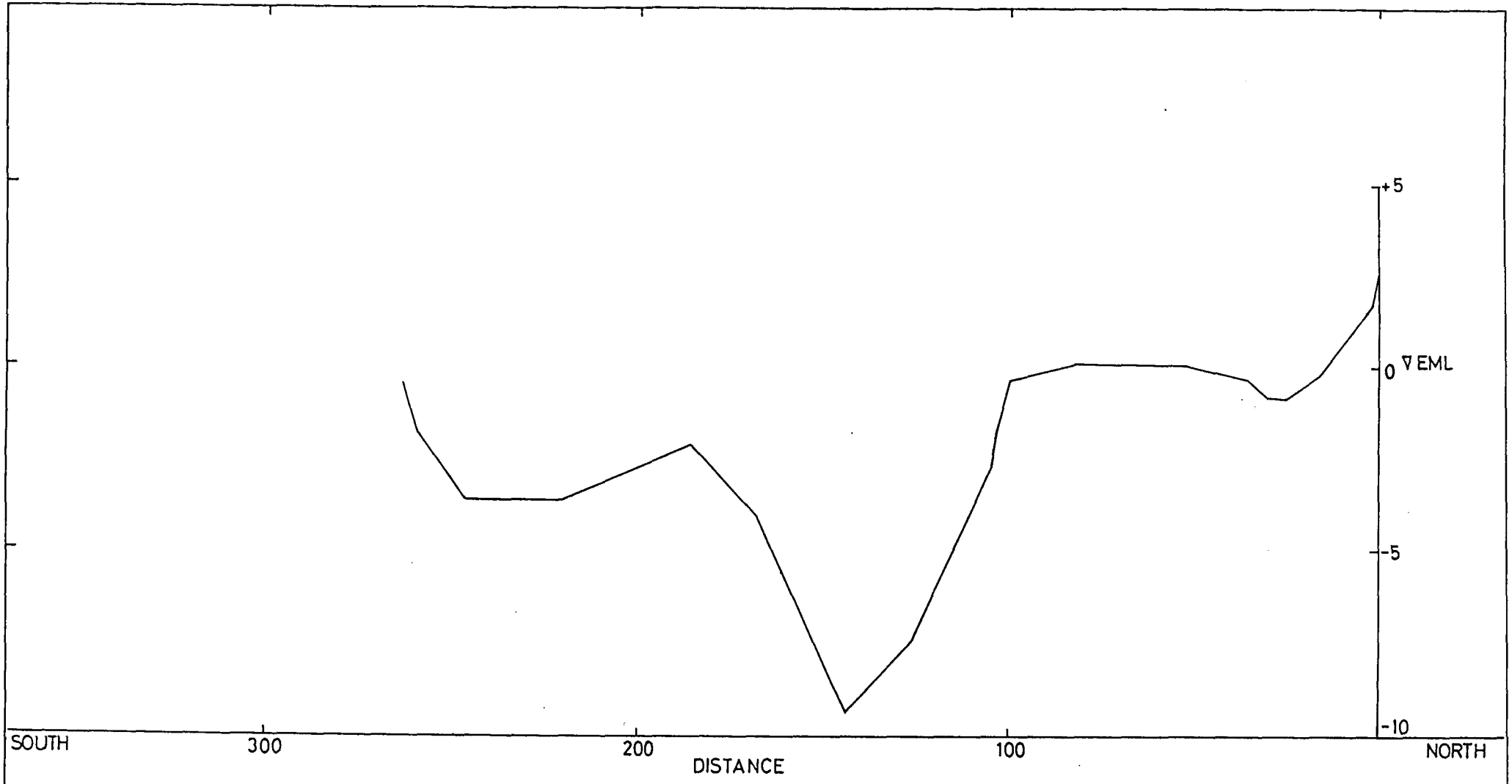
TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS-SECTION D3D - APRIL 1987	FIGURE 24c
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		



TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS- SECTION D3D - JUNE 1987	FIGURE 24d
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		

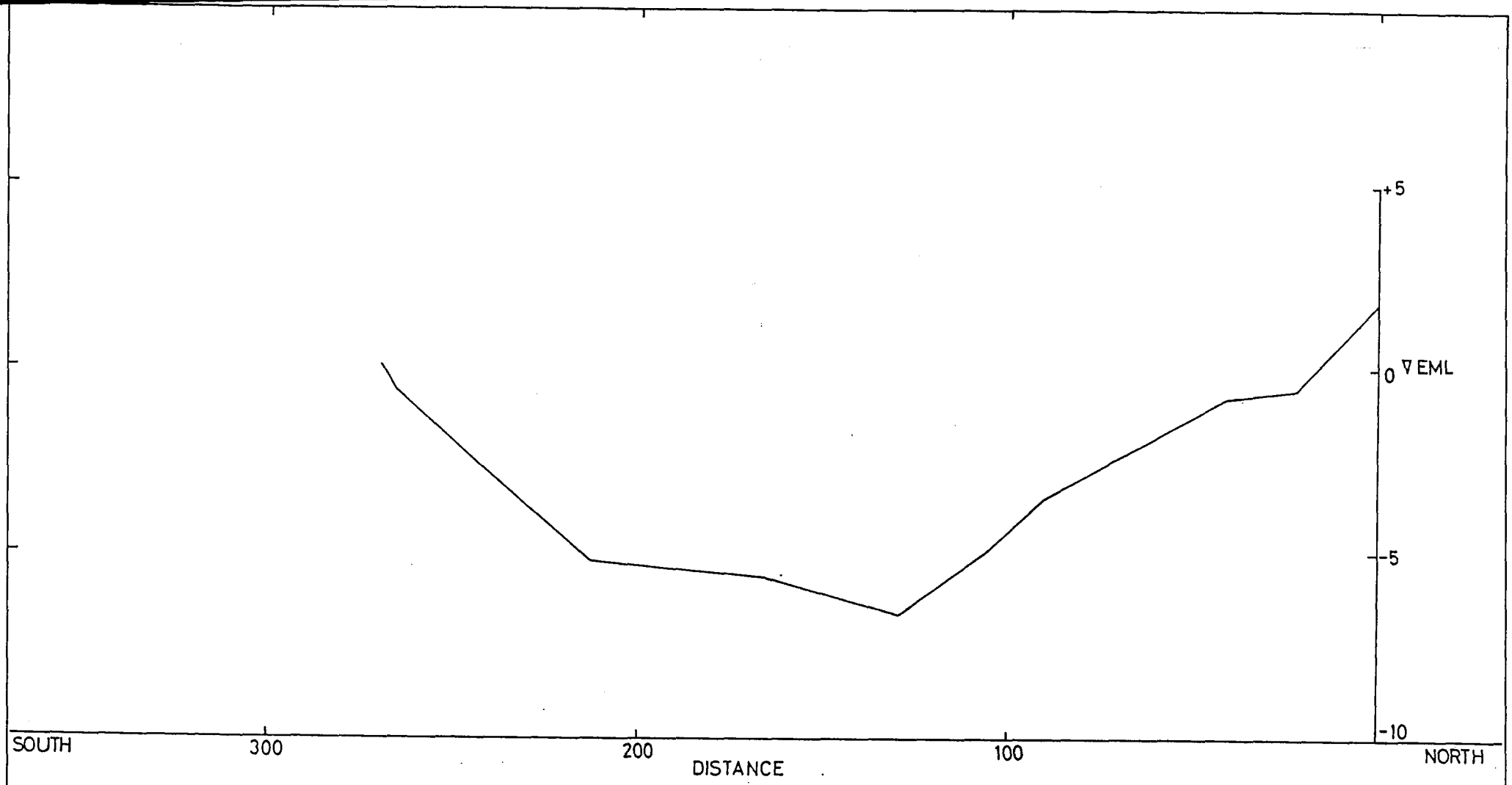


TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS- SECTION D3D - SEPTEMBER 1987	FIGURE 24e
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		

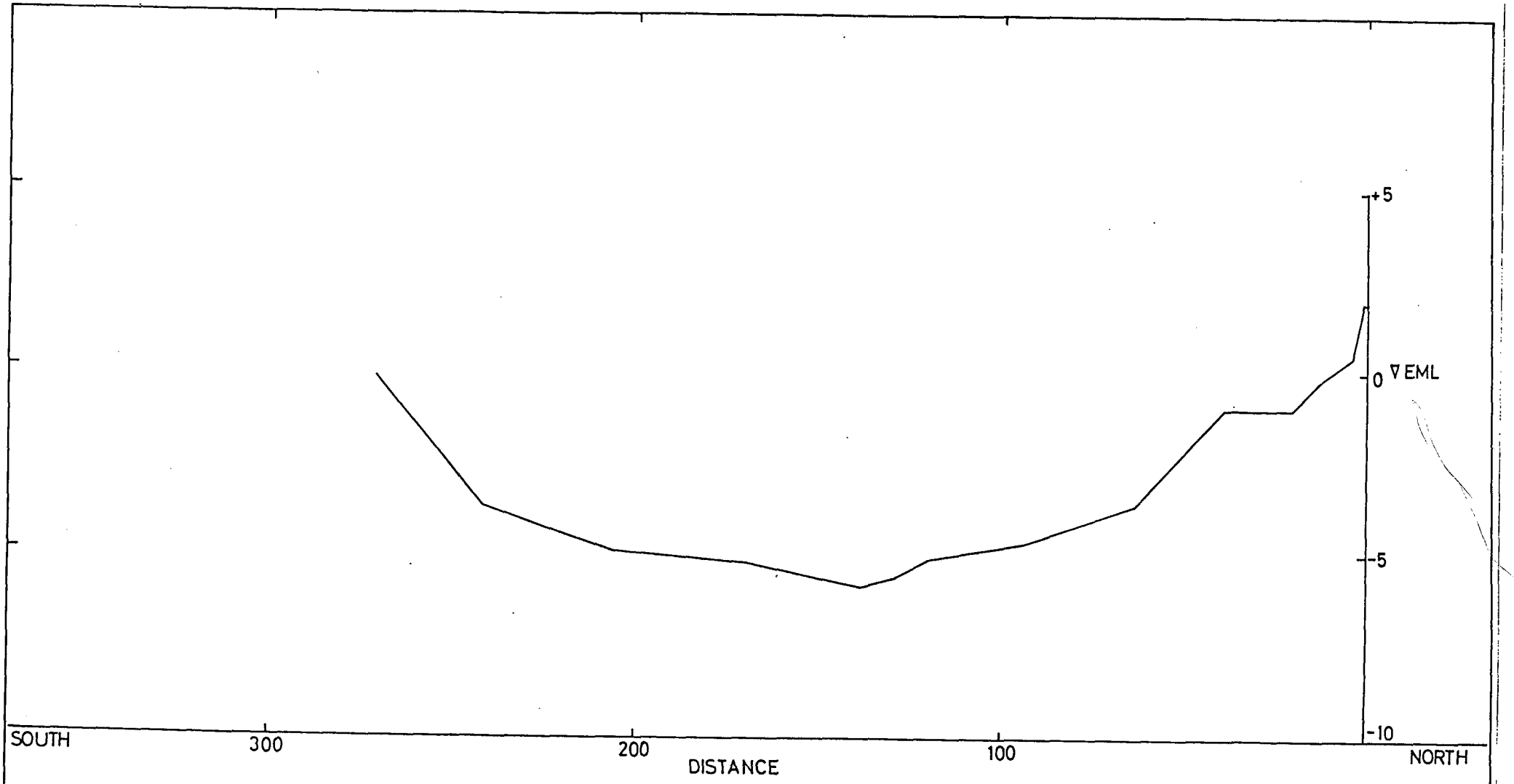


TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS-SECTION D3D- OCTOBER 1987	FIGURE 24f

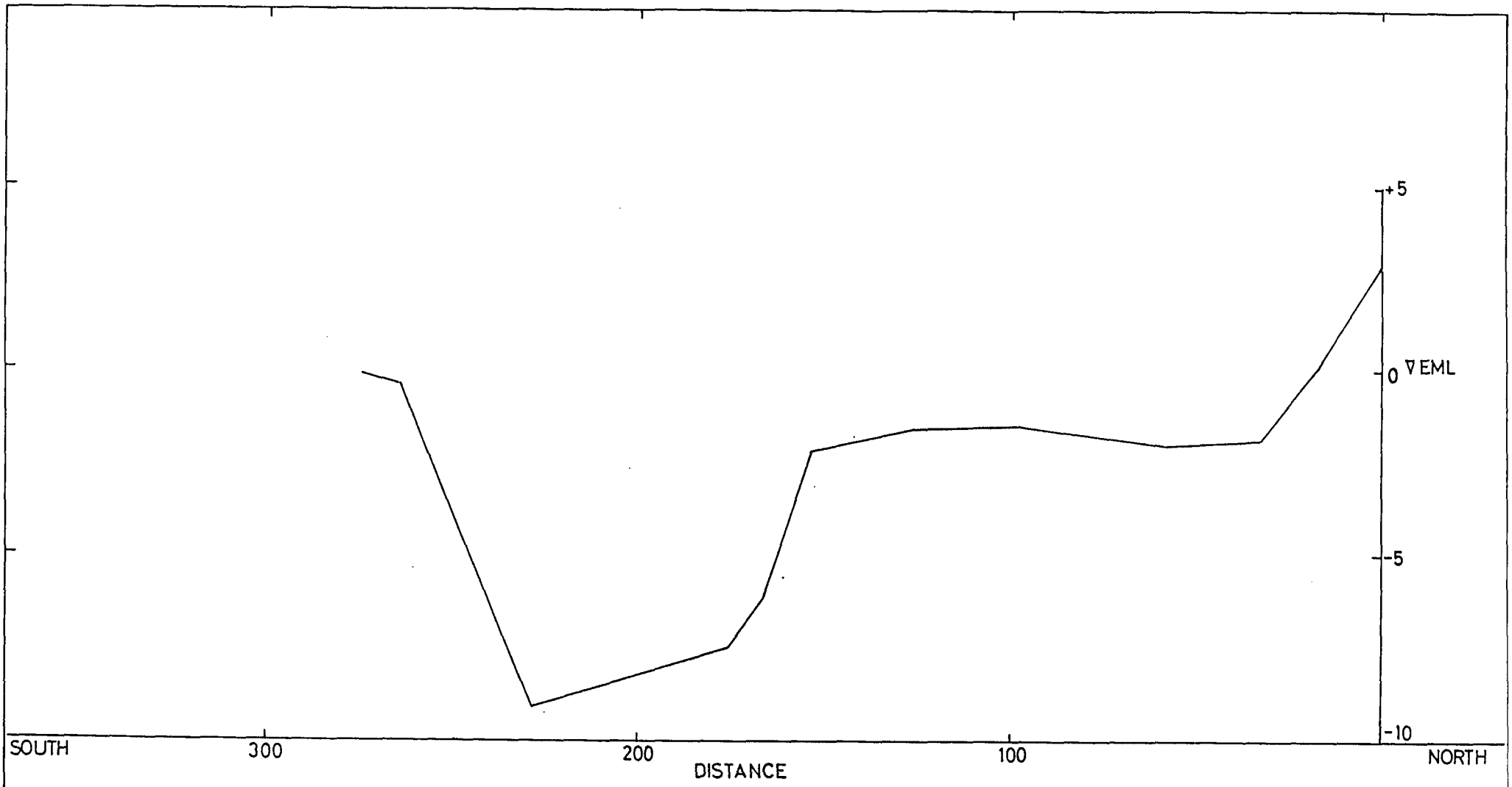
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY



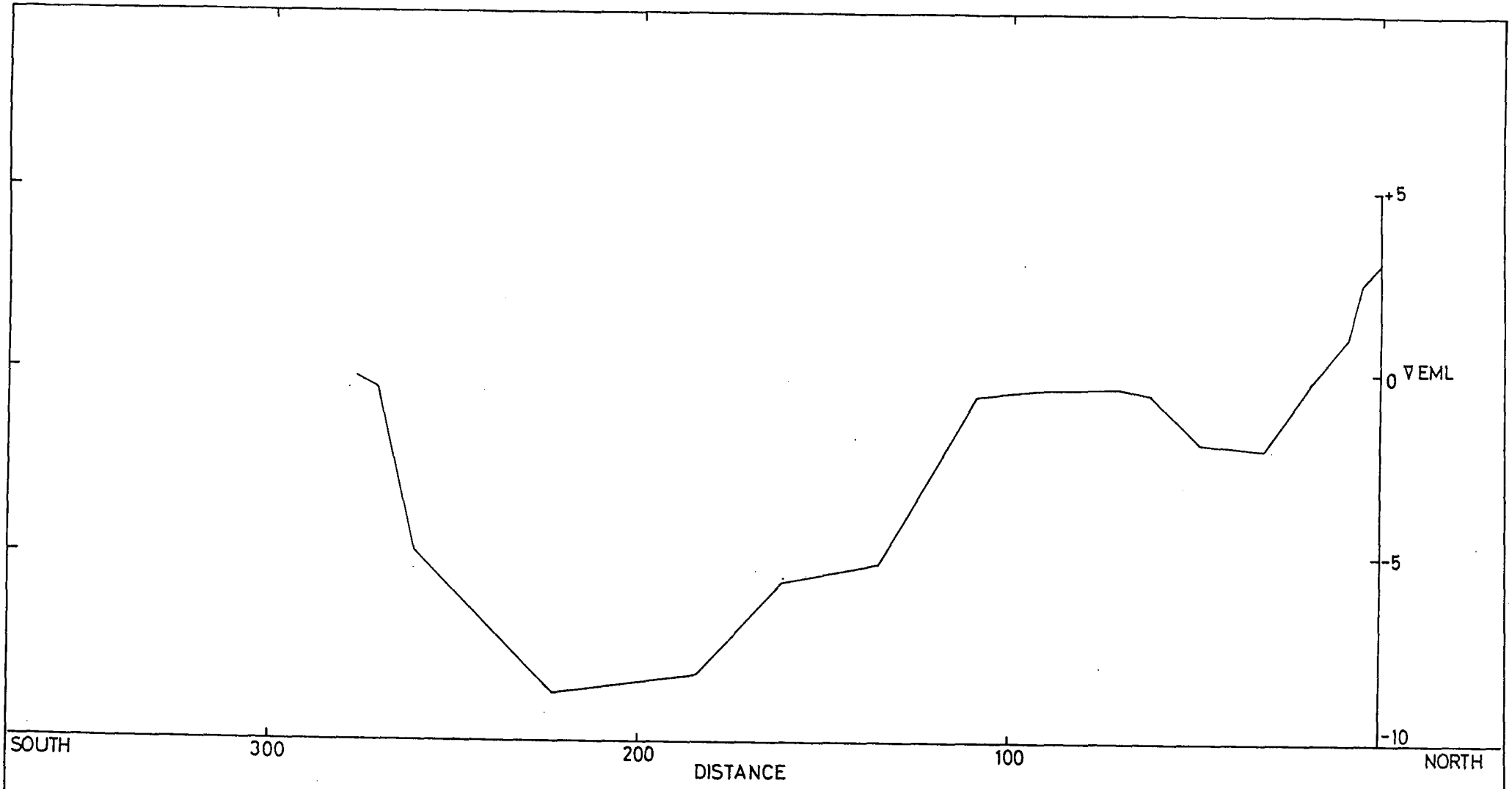
TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS-SECTION D3D - FEBRUARY 1988	FIGURE 24g
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		



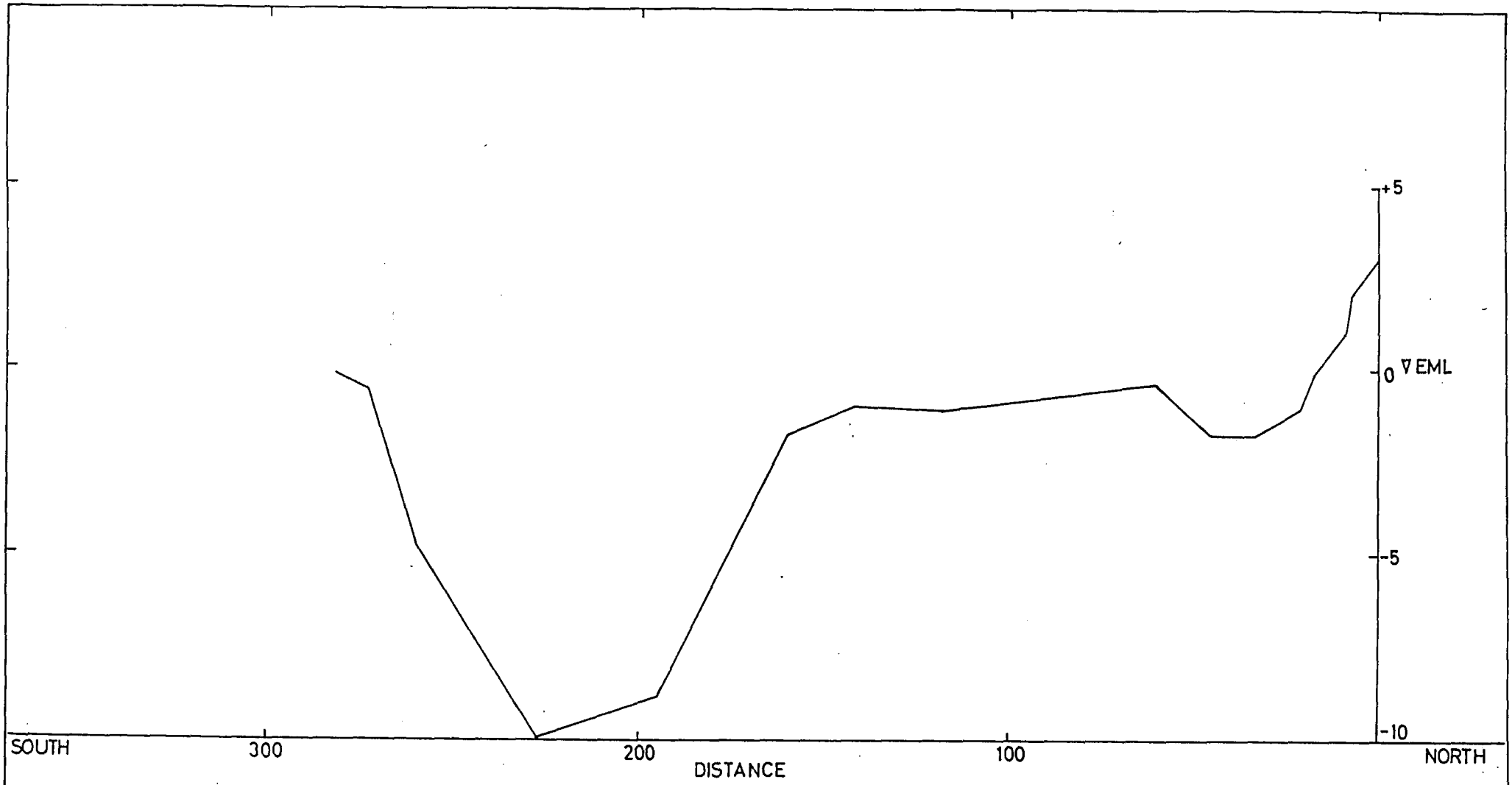
TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS- SECTION D3D - APRIL 1988 .	FIGURE 24 h
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		



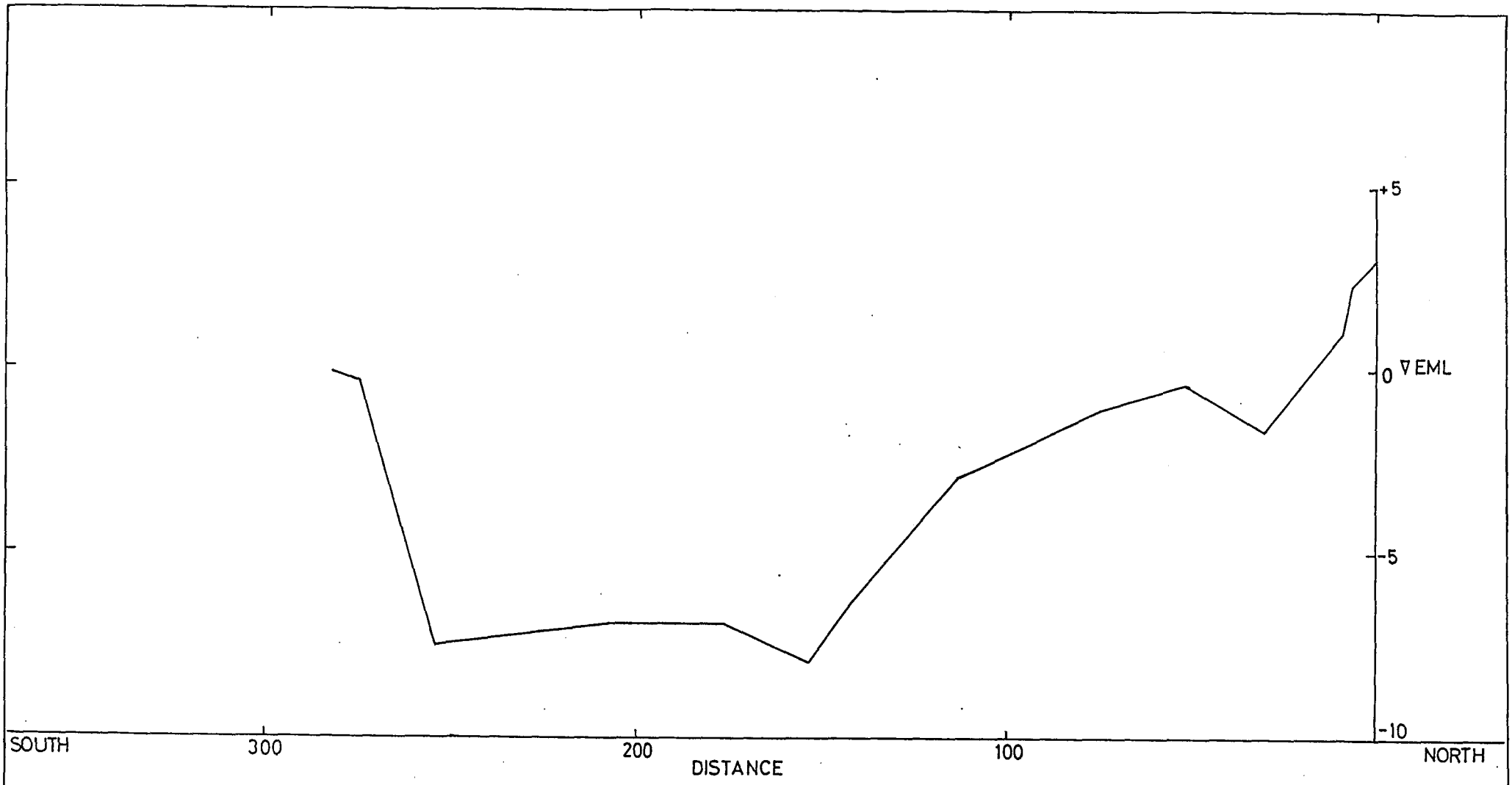
TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS-SECTION D3E - OCTOBER 1986	FIGURE 25a
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		



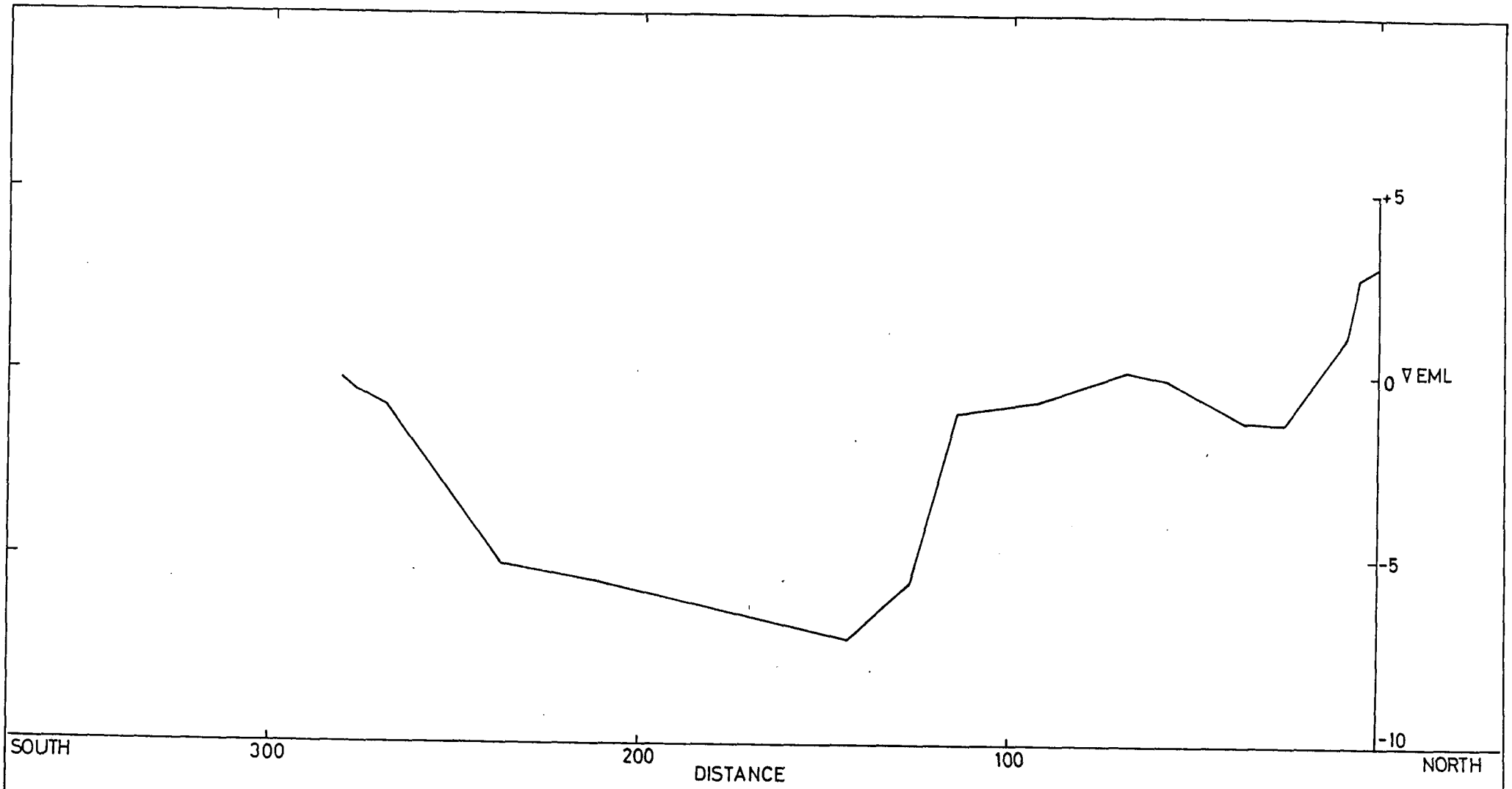
TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS- SECTION D3E - FEBRUARY 1987	FIGURE 25b
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		



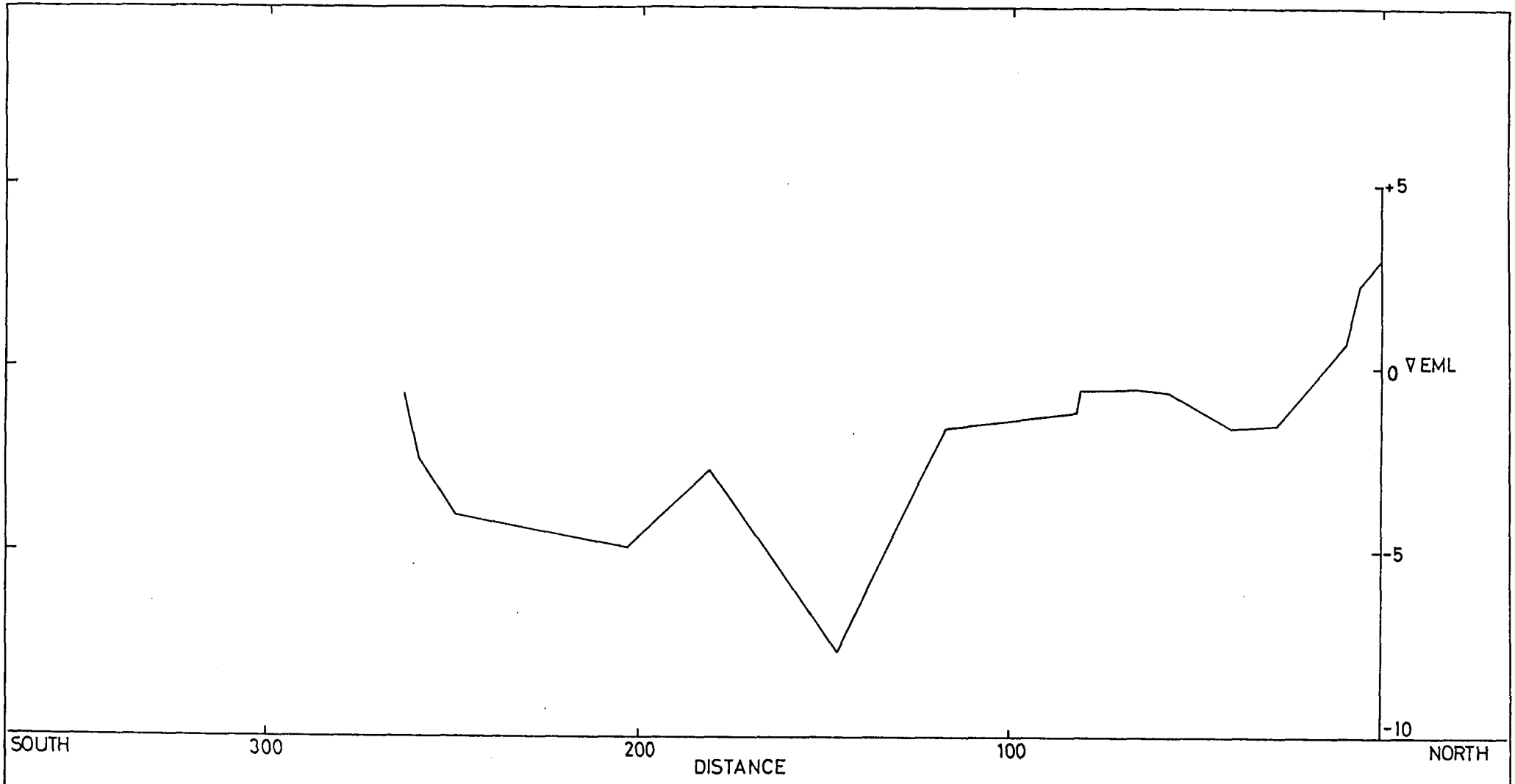
TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS- SECTION D3E - APRIL 1987	FIGURE 25c
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		



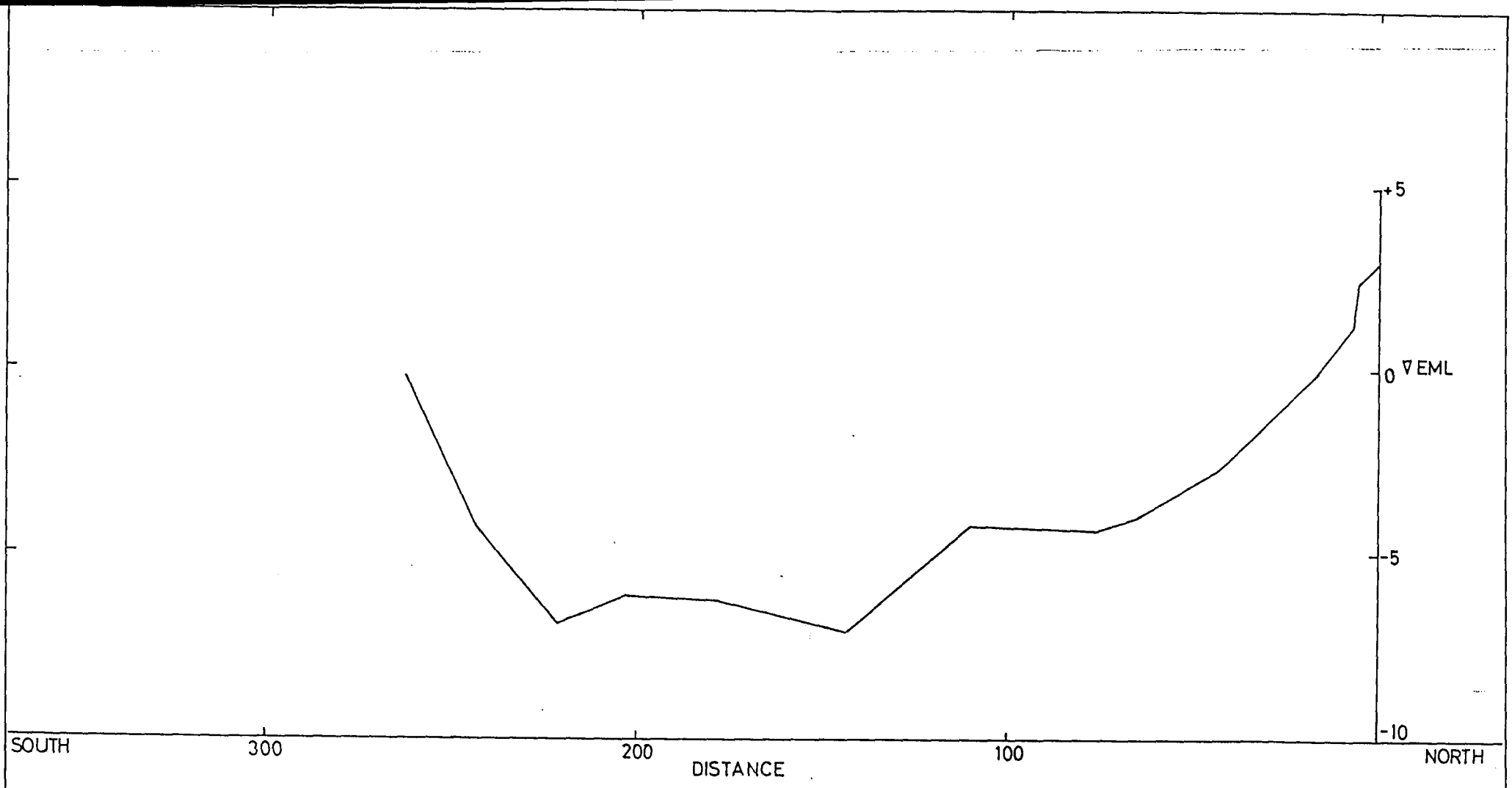
TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS- SECTION D3E - JUNE 1987	FIGURE 25d
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		



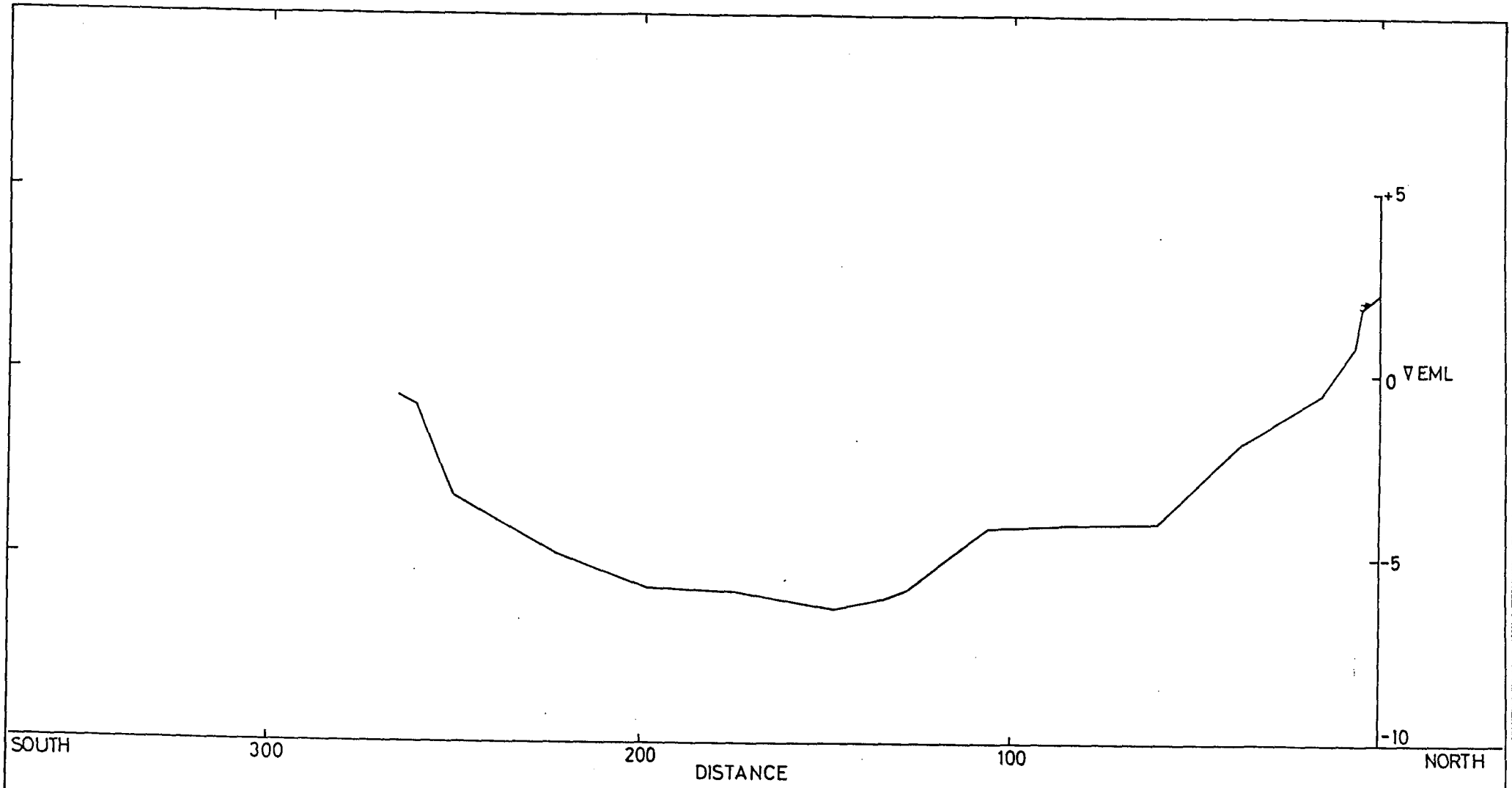
TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS- SECTION D3E- SEPTEMBER 1987	FIGURE 25e
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		



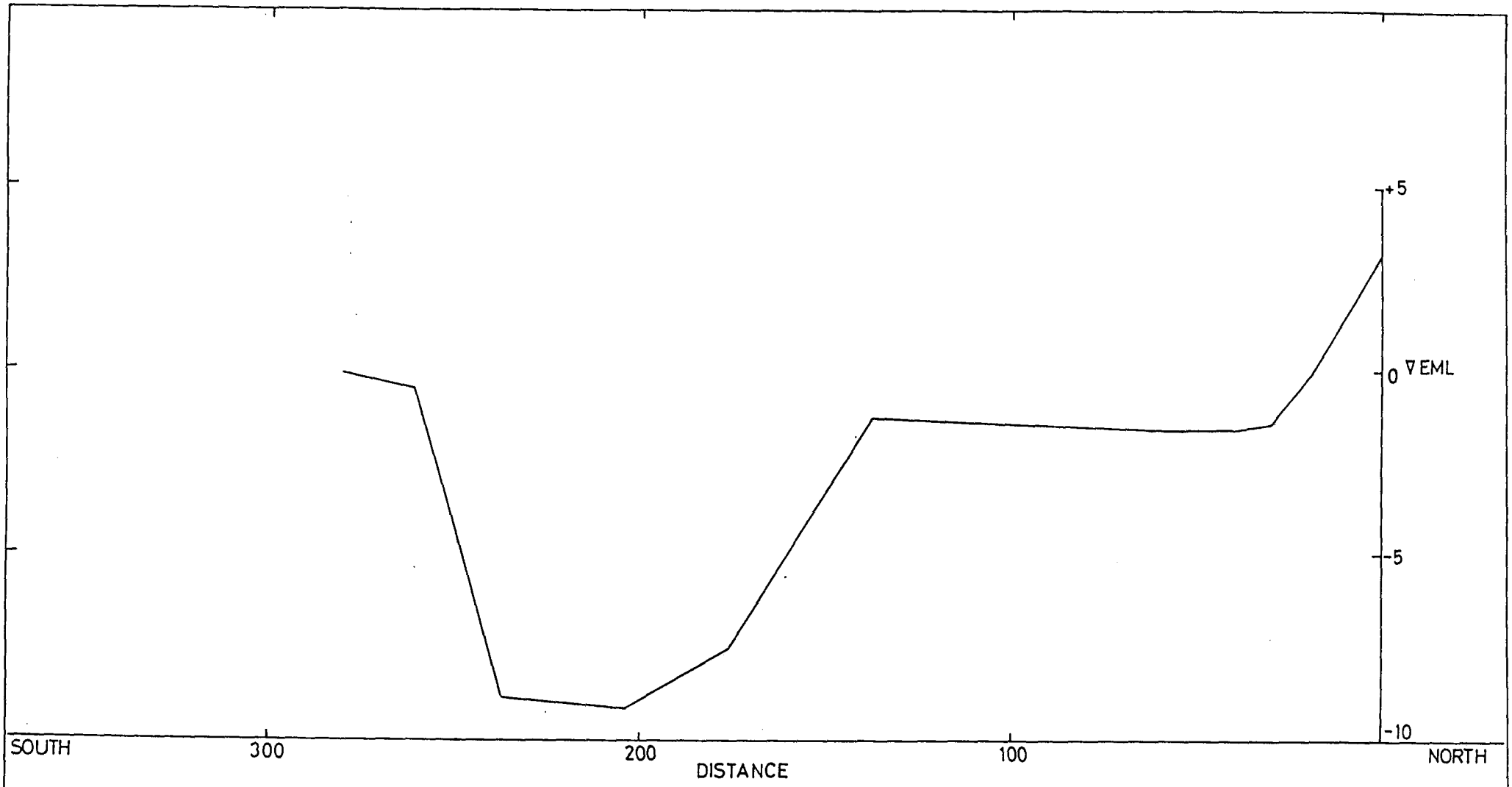
TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS - SECTION D3E - OCTOBER 1987	FIGURE 25 f
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		



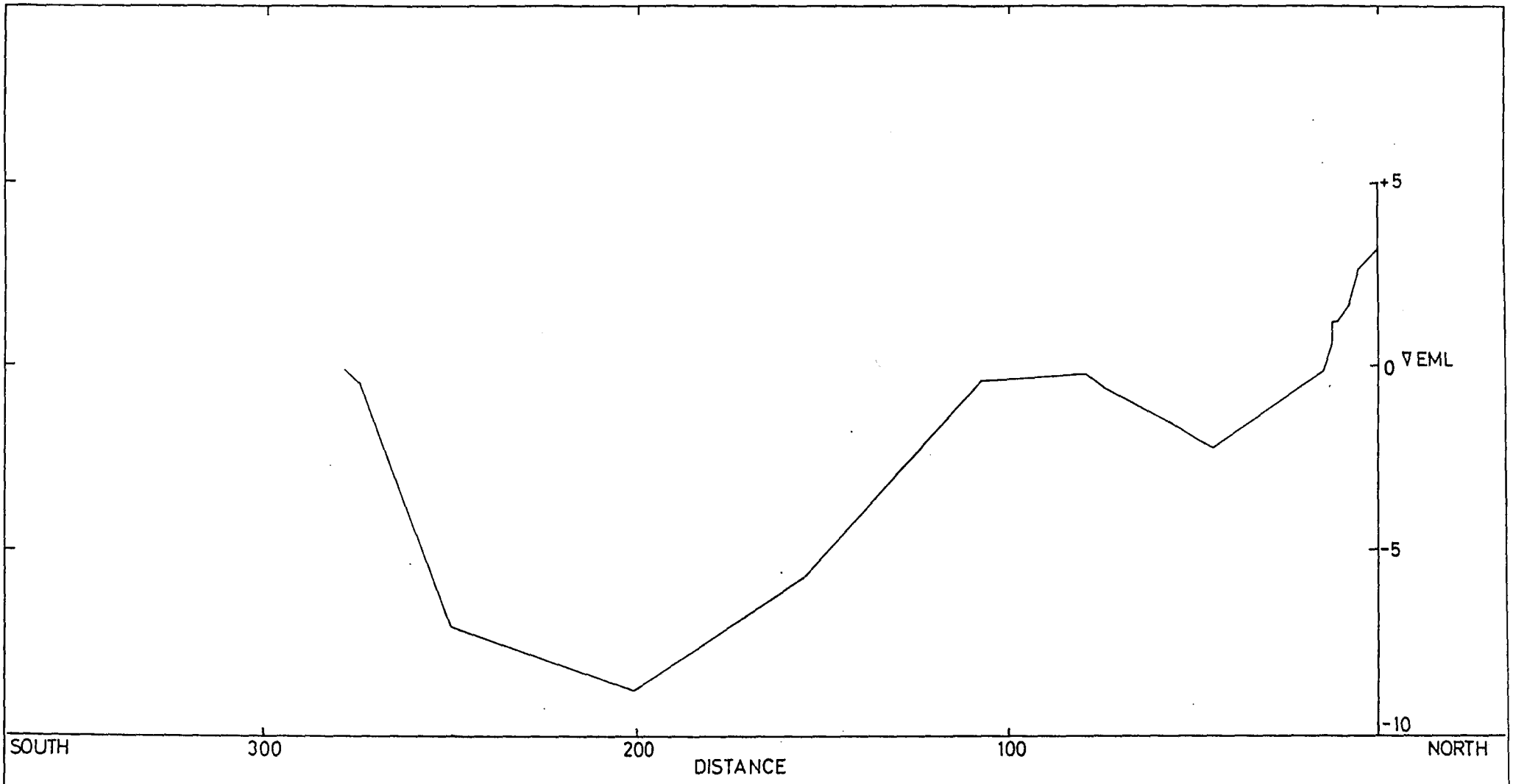
TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS-SECTION D3E - FEBRUARY 1988	FIGURE 25g
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		



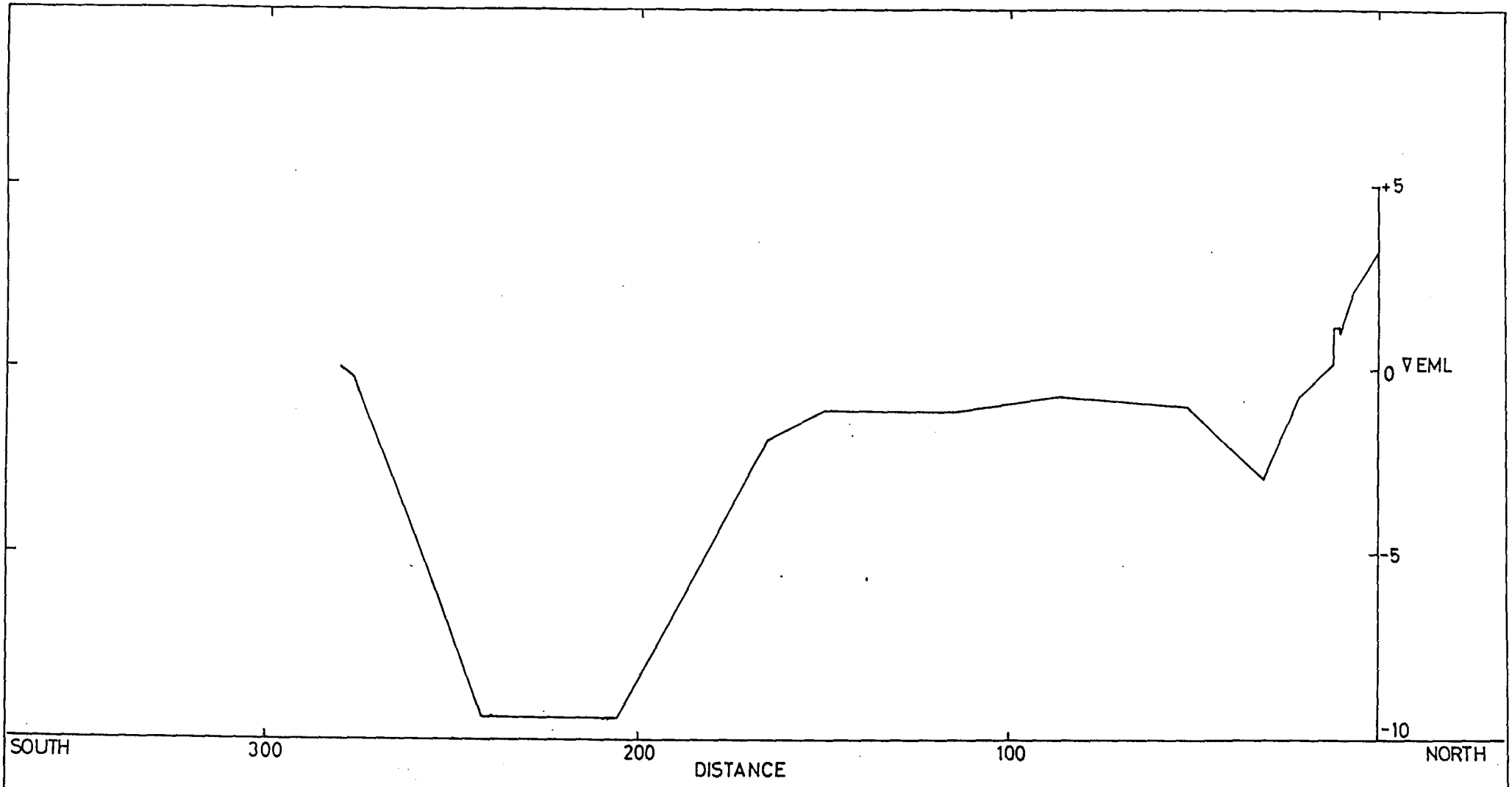
TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS- SECTION D3E - APRIL 1988	FIGURE 25h
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		



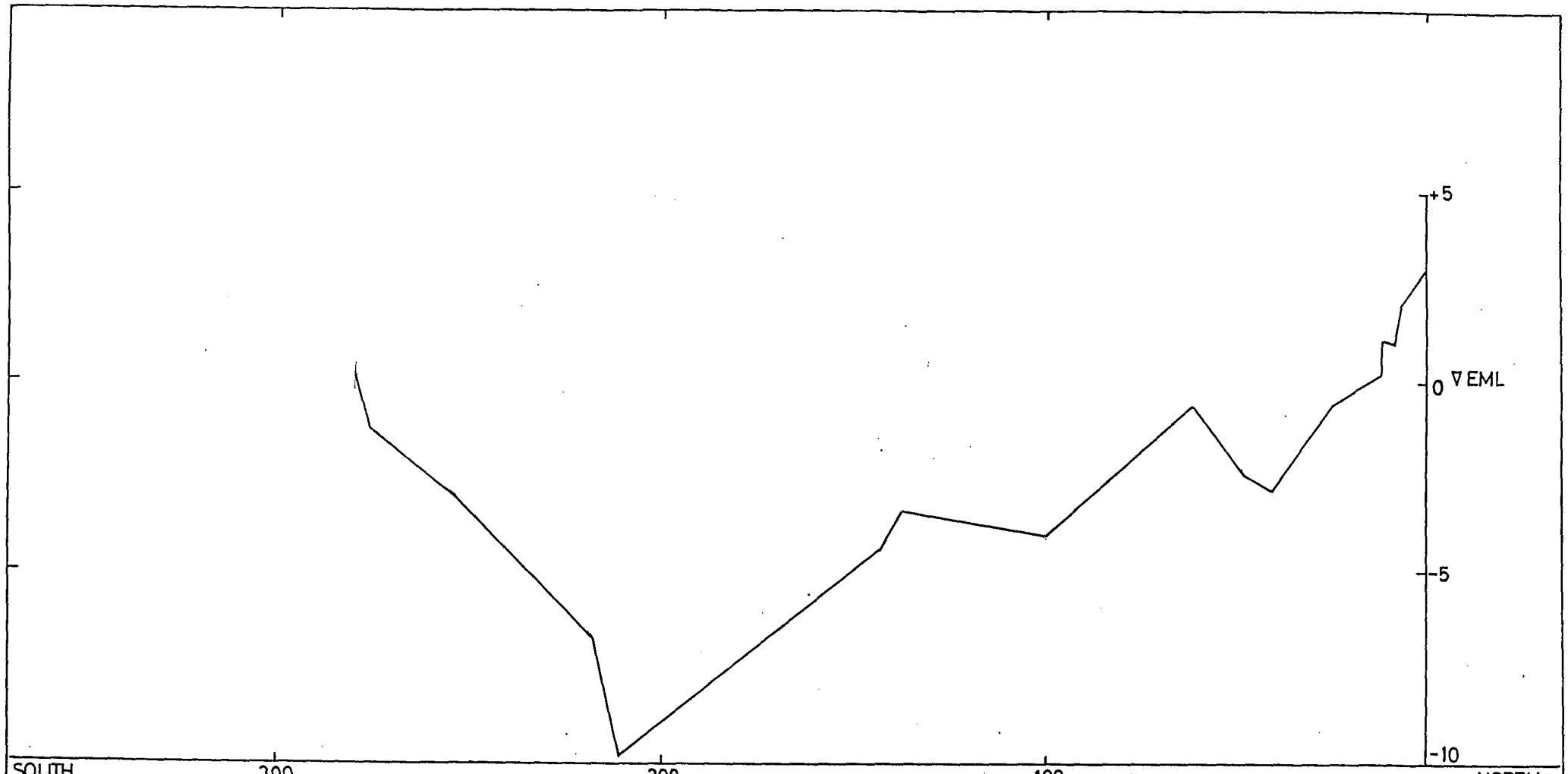
TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS-SECTION D3F - OCTOBER 1986	FIGURE 26a
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		



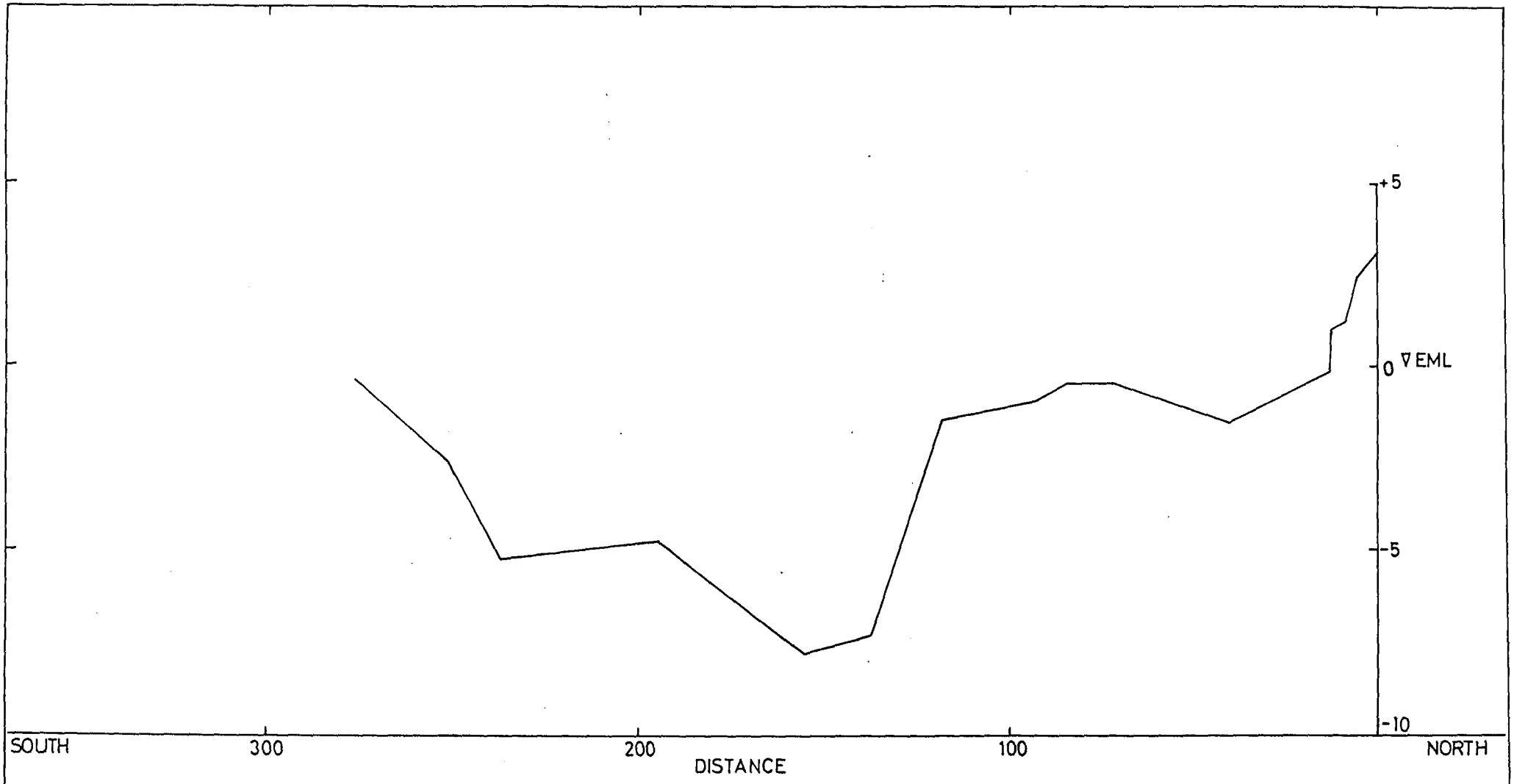
TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS-SECTION D3F - FEBRUARY 1987	FIGURE 26b
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		



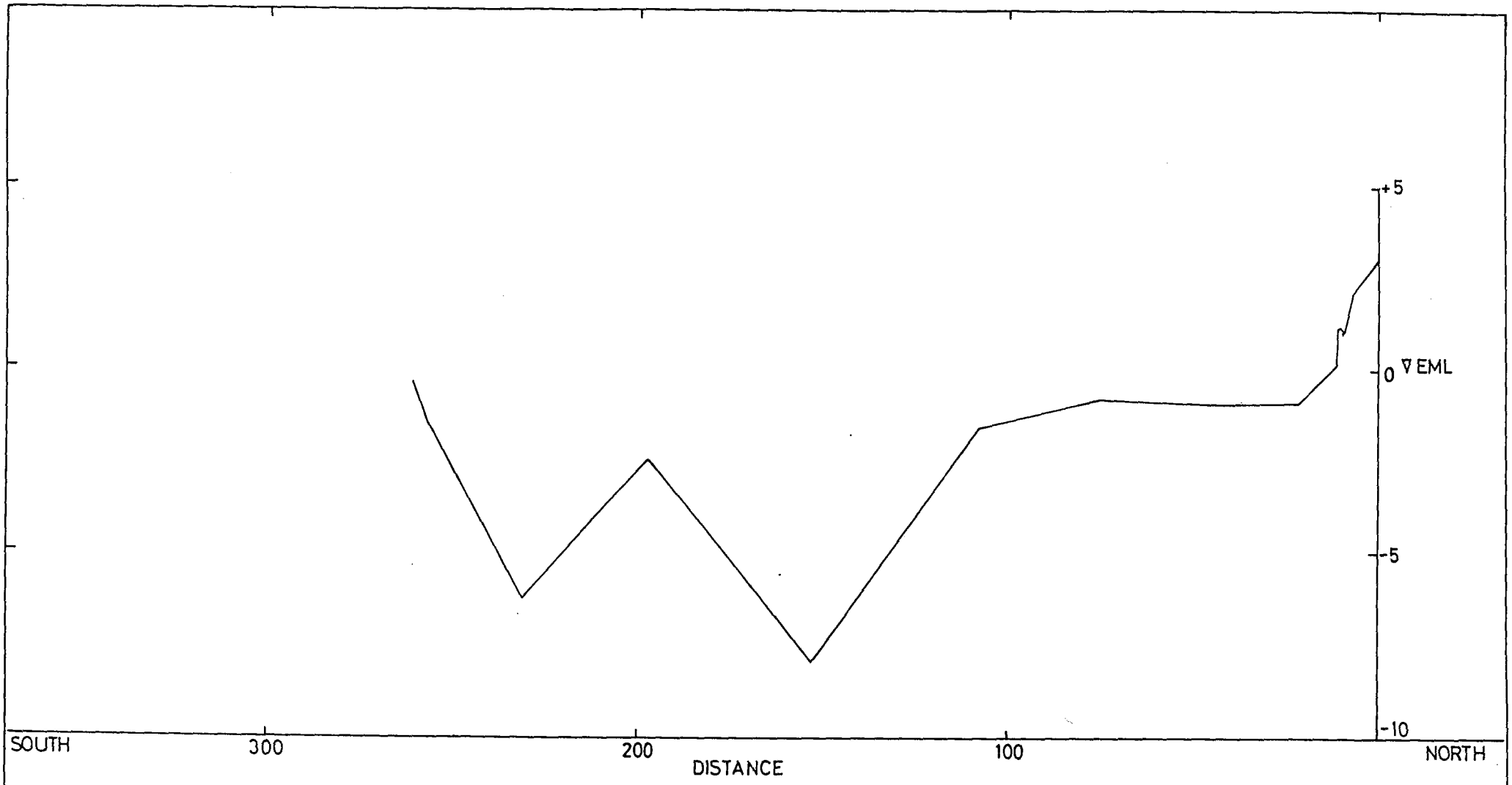
TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS- SECTION D3F - APRIL 1987	FIGURE 26c
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		



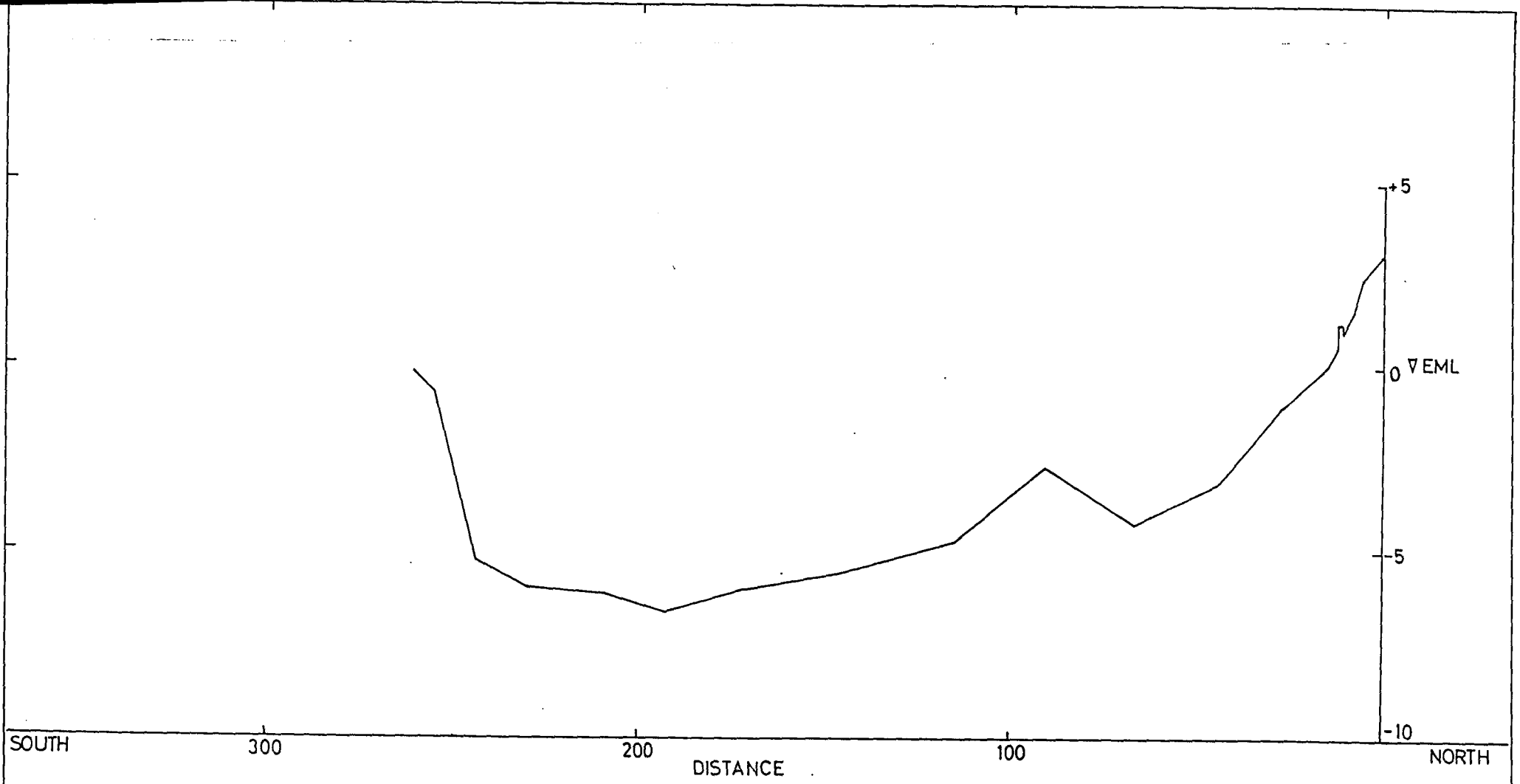
TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS-SECTION D3F - JUNE 1987	FIGURE 26d
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		



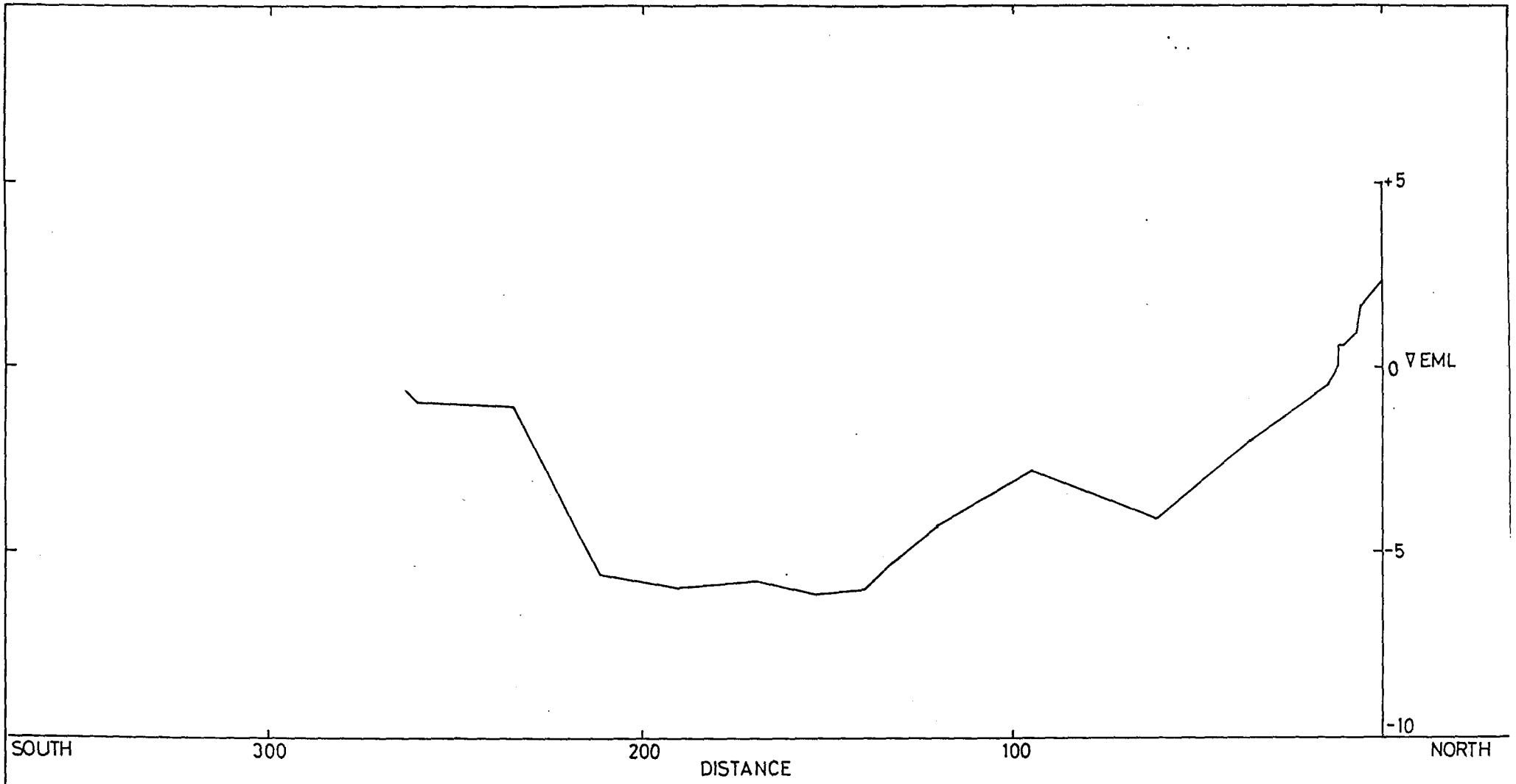
TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS - SECTION D3F - SEPTEMBER 1987	FIGURE 26e
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		



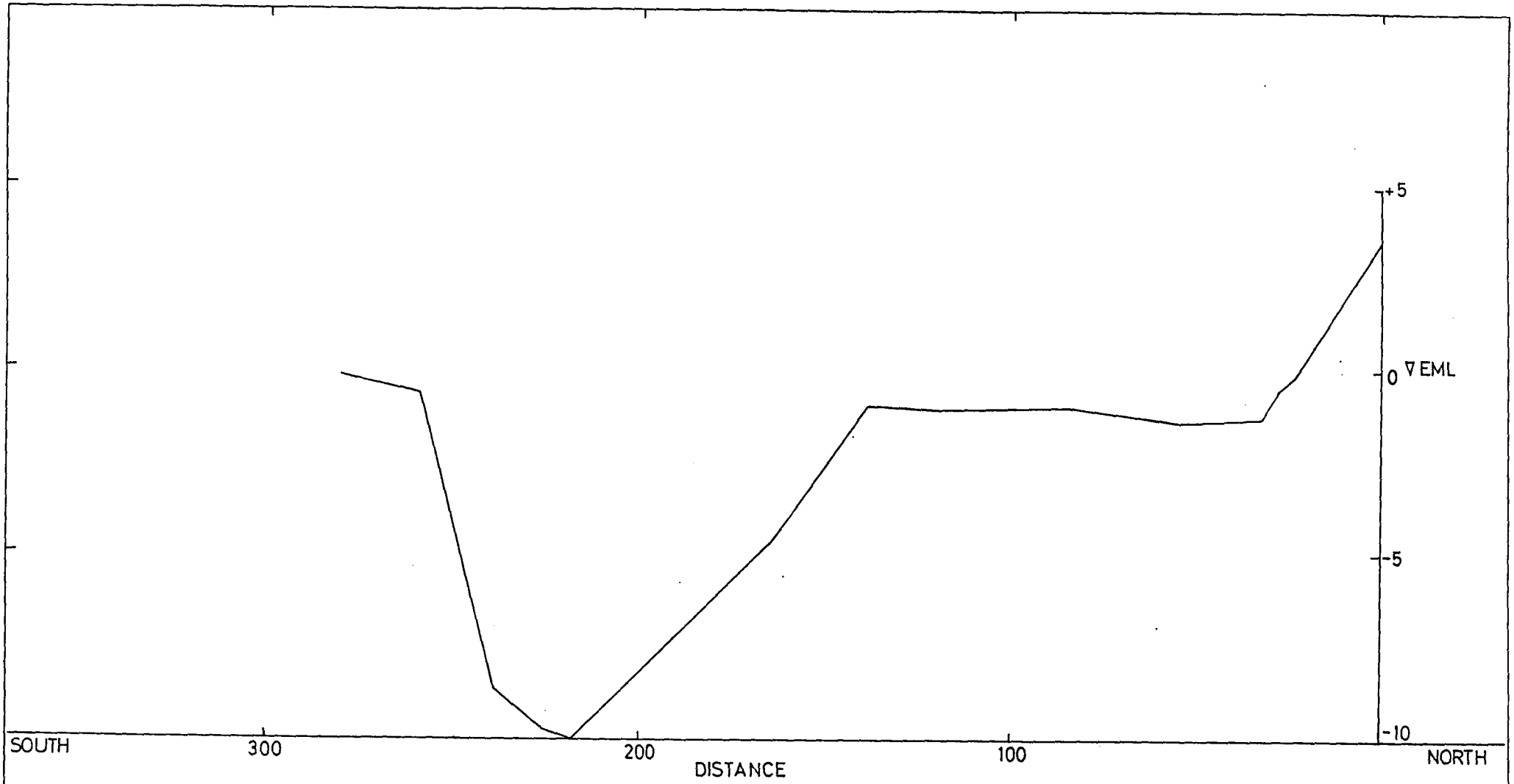
TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS- SECTION D3F - OCTOBER 1987	FIGURE 26f
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		



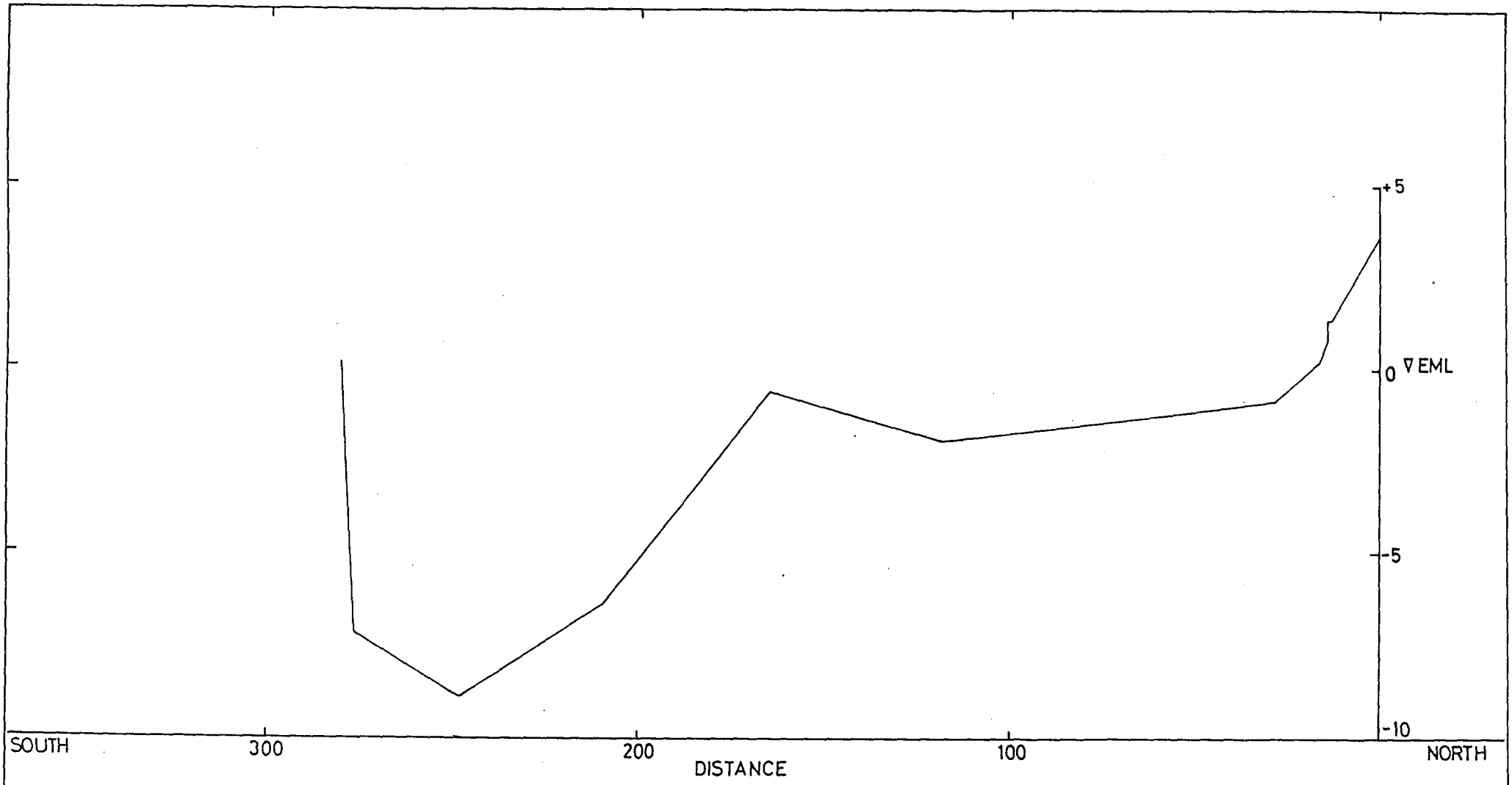
TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS-SECTION D3F - FEBRUARY 1988	FIGURE 26g
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		



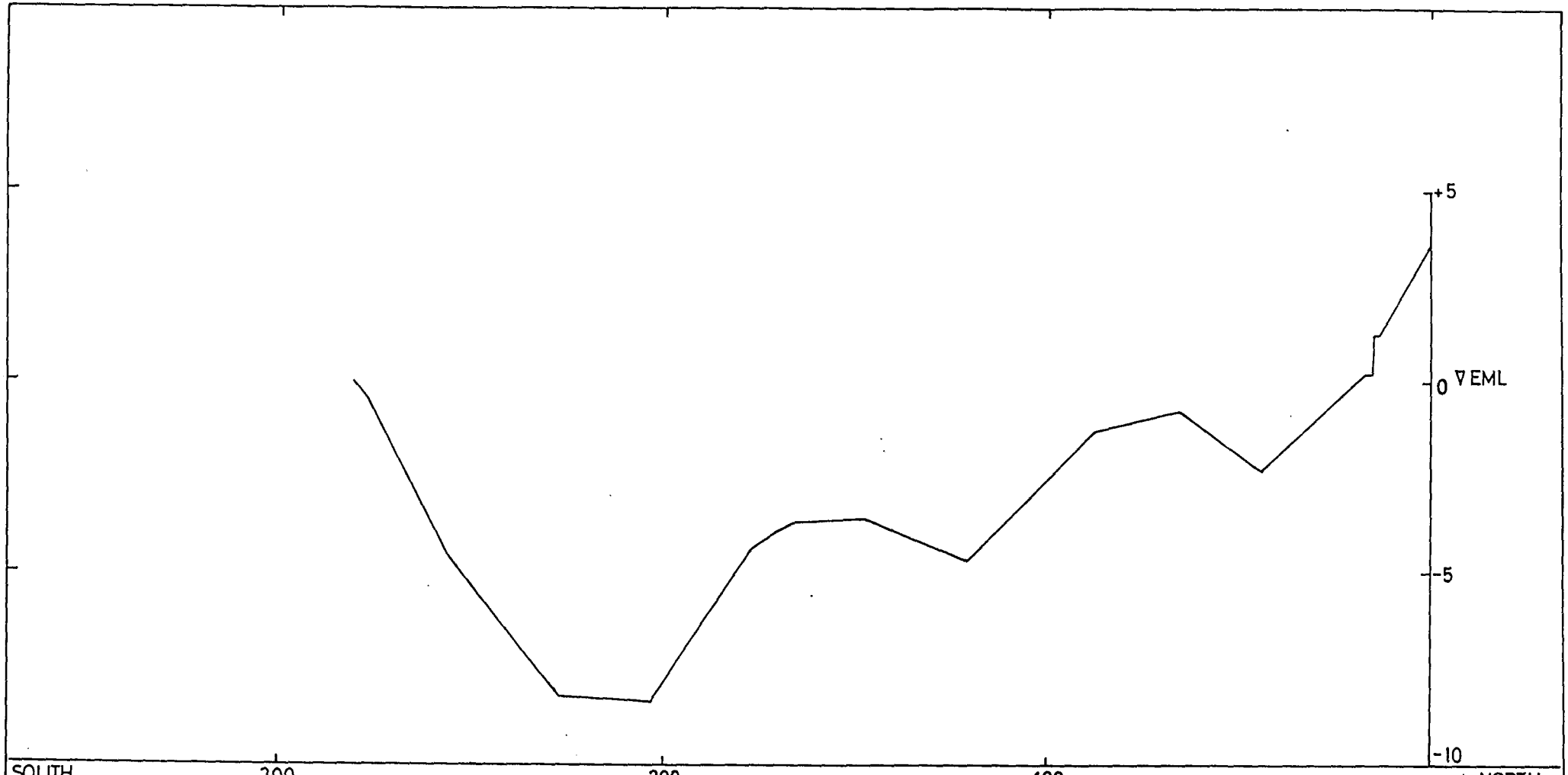
TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS - SECTION D3F - APRIL 1988	FIGURE 26h
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		



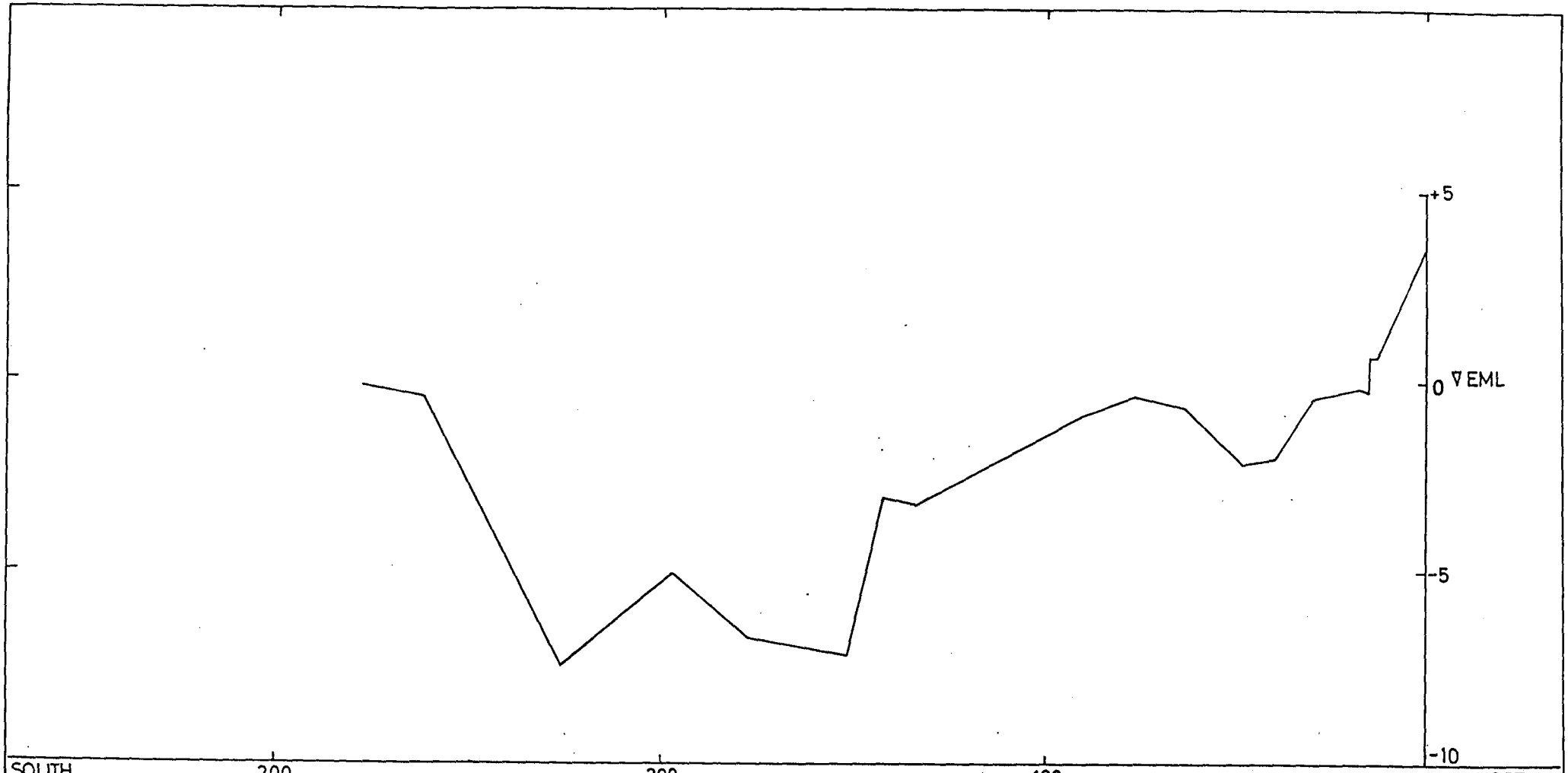
TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS- SECTION D 3G - OCTOBER 1986	FIGURE 27a
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		



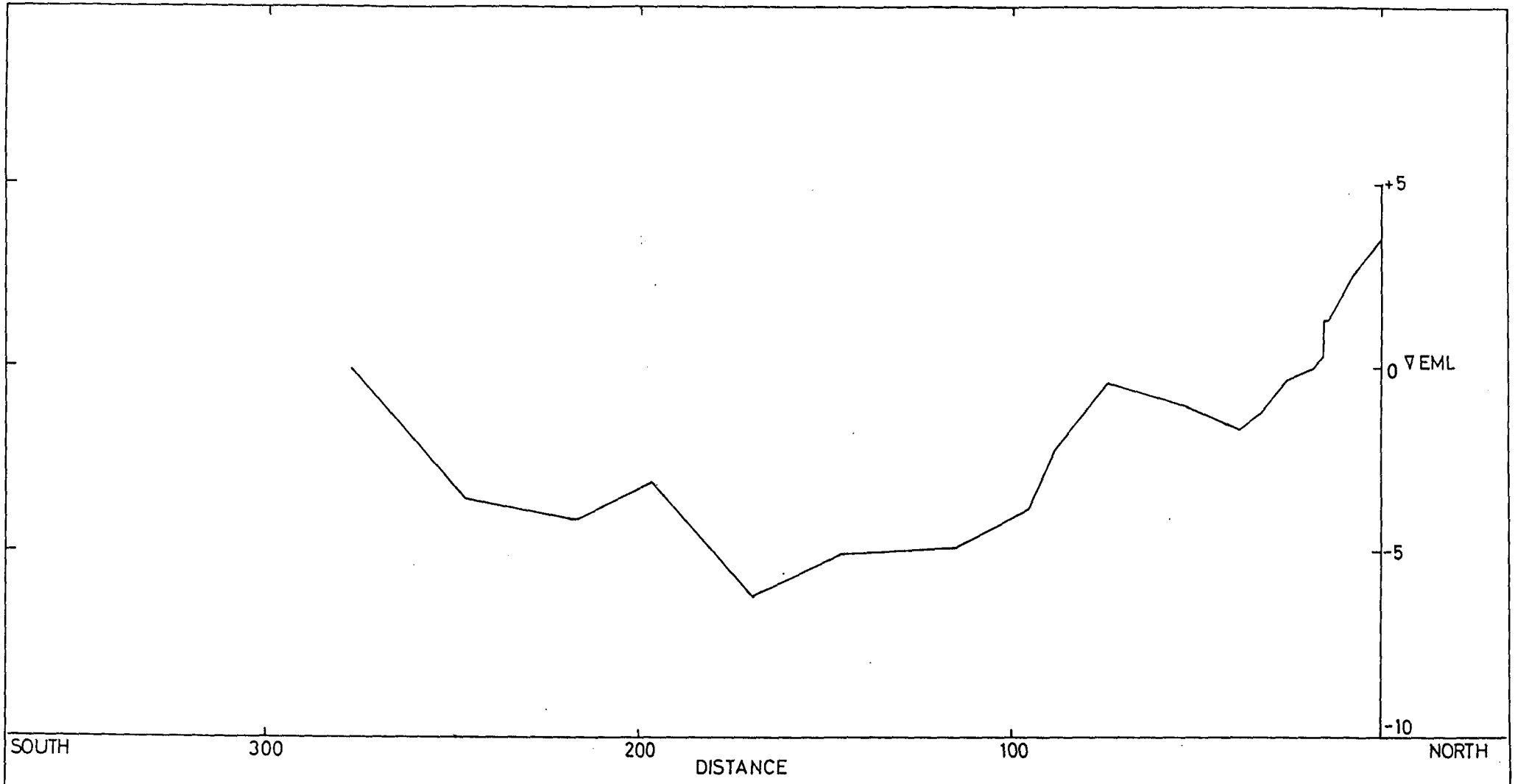
TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS- SECTION D3G - FEBRUARY 1987	FIGURE 27 b
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		



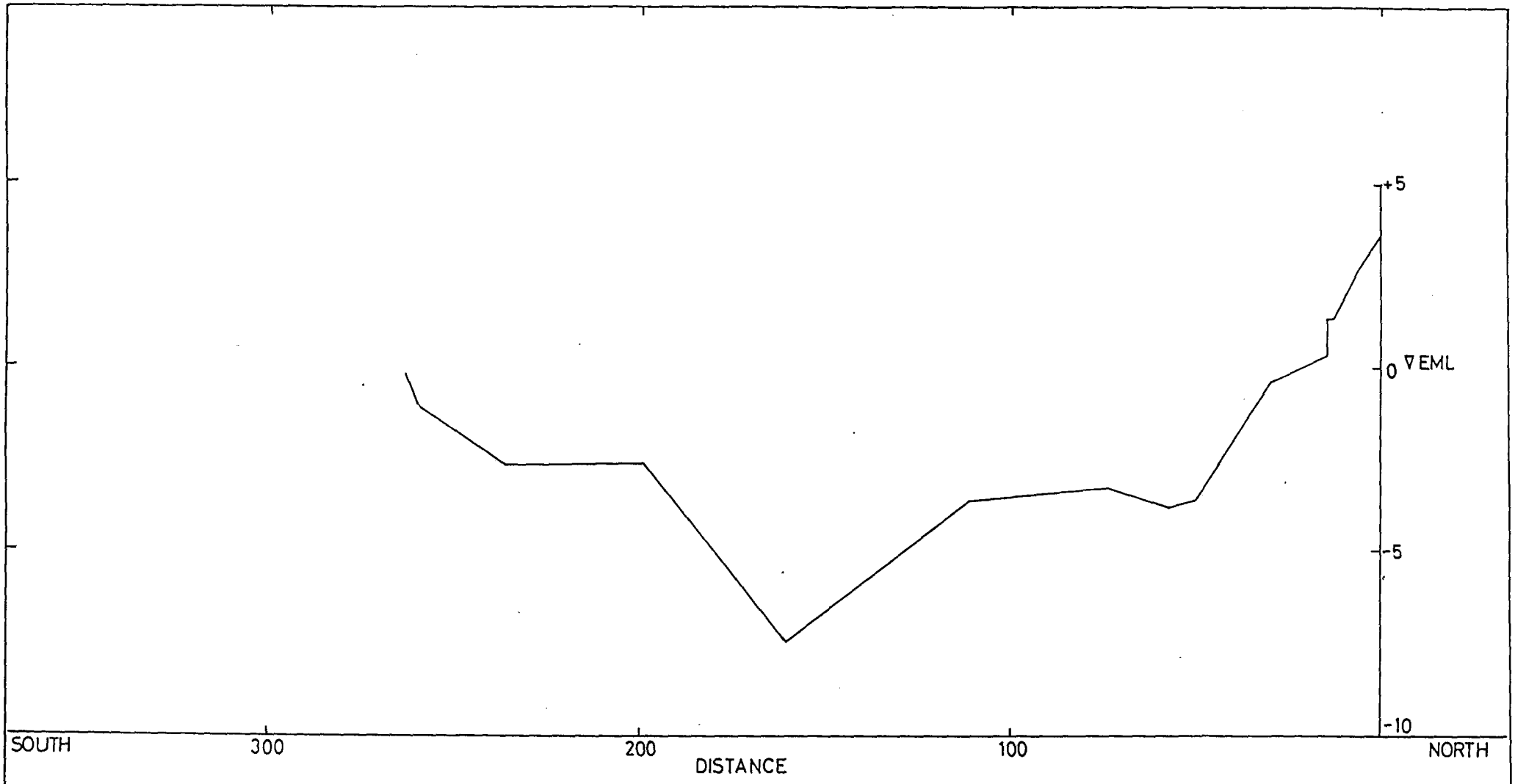
TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS - SECTION D3G - APRIL 1987	FIGURE 27c
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		



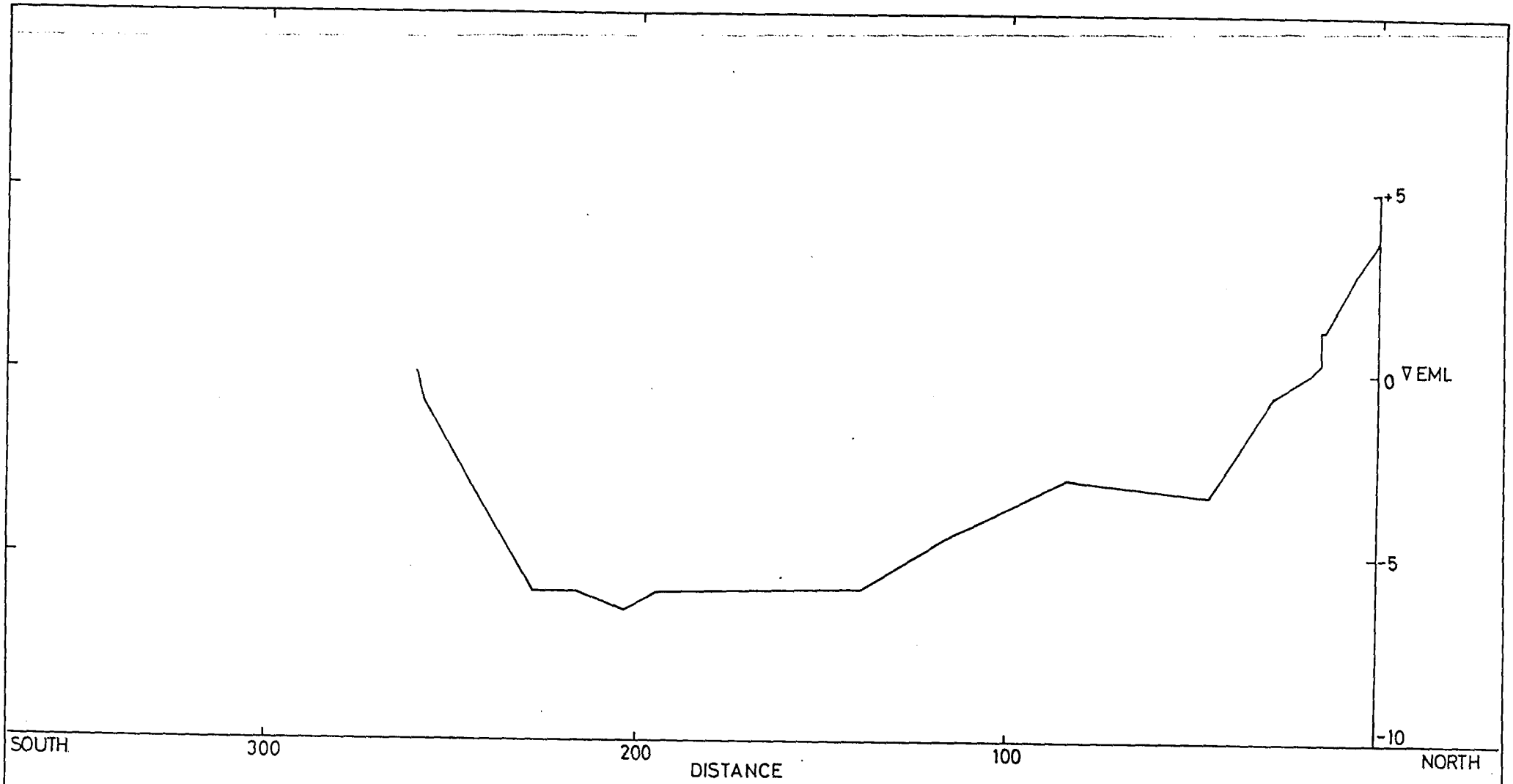
TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS-SECTION D3G - JUNE 1987	FIGURE 27d
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		



TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS-SECTION D3G- SEPTEMBER 1987	FIGURE 27e
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		

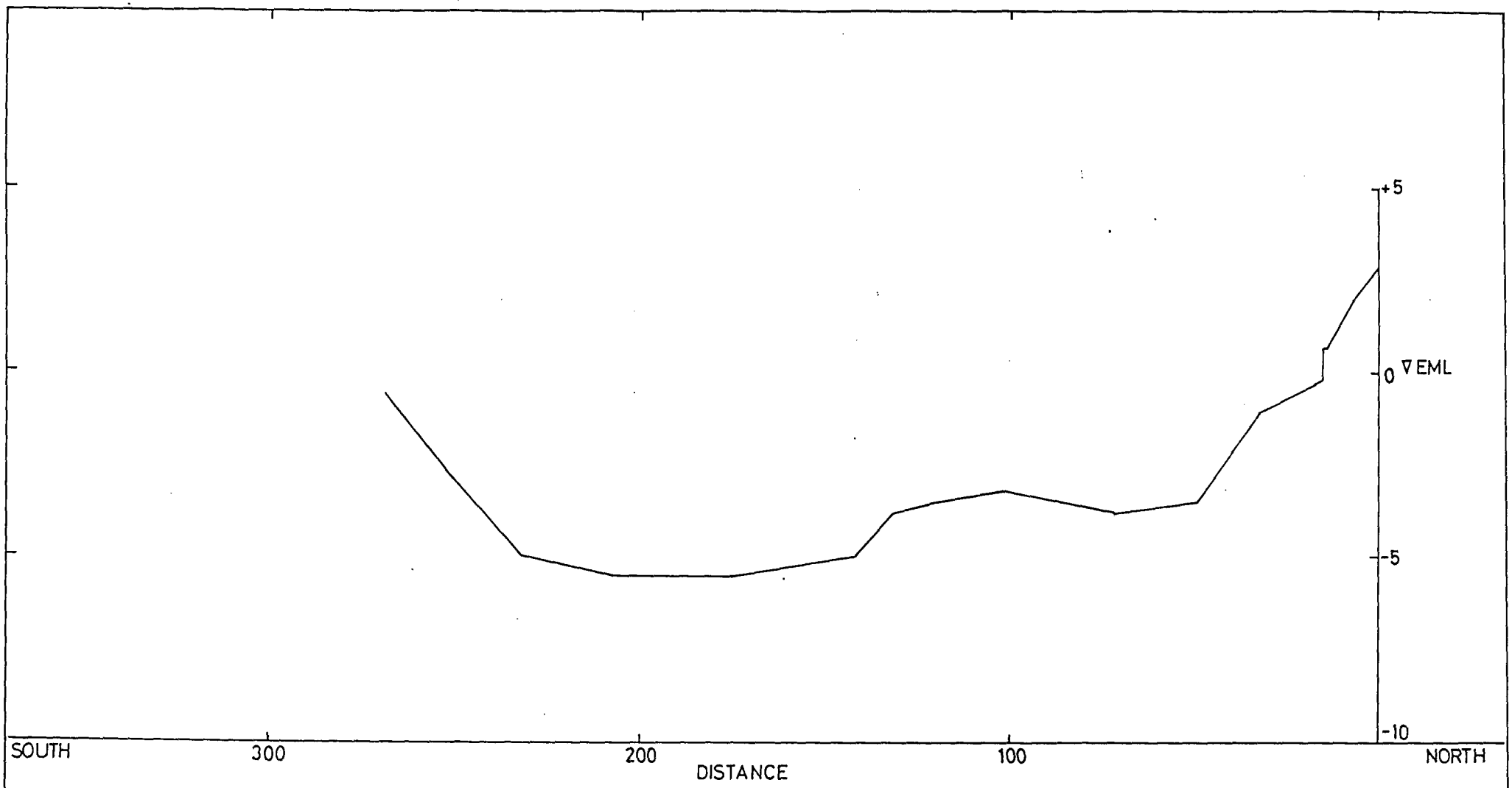


TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS - SECTION D3G - OCTOBER 1987	FIGURE 27f
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		

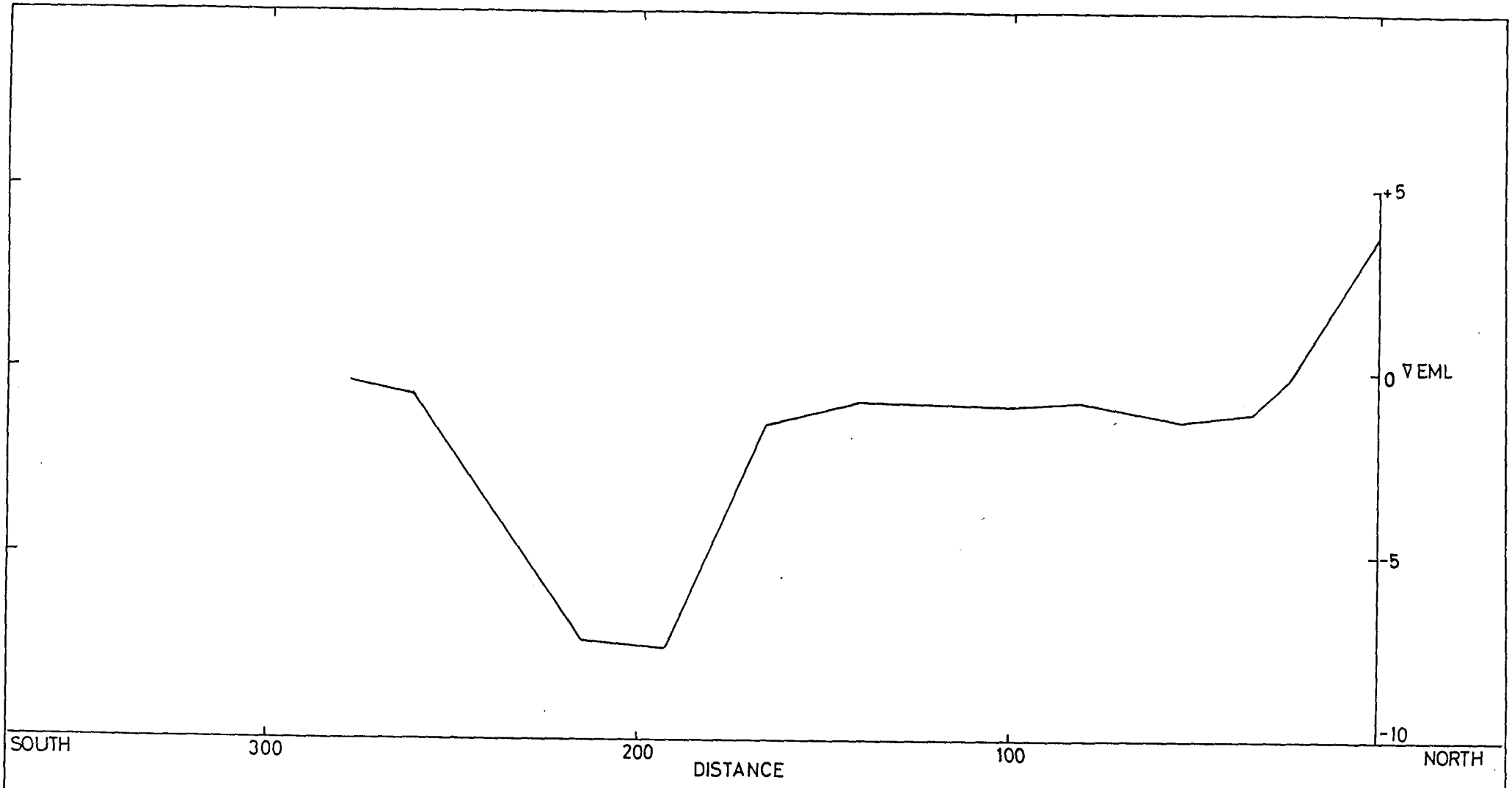


TRACED:	ST. LUCIA DREDGING	FIGURE
CHECKED:	CROSS-SECTION D3G - FEBRUARY 1988	27g
DATE:		
REF:		

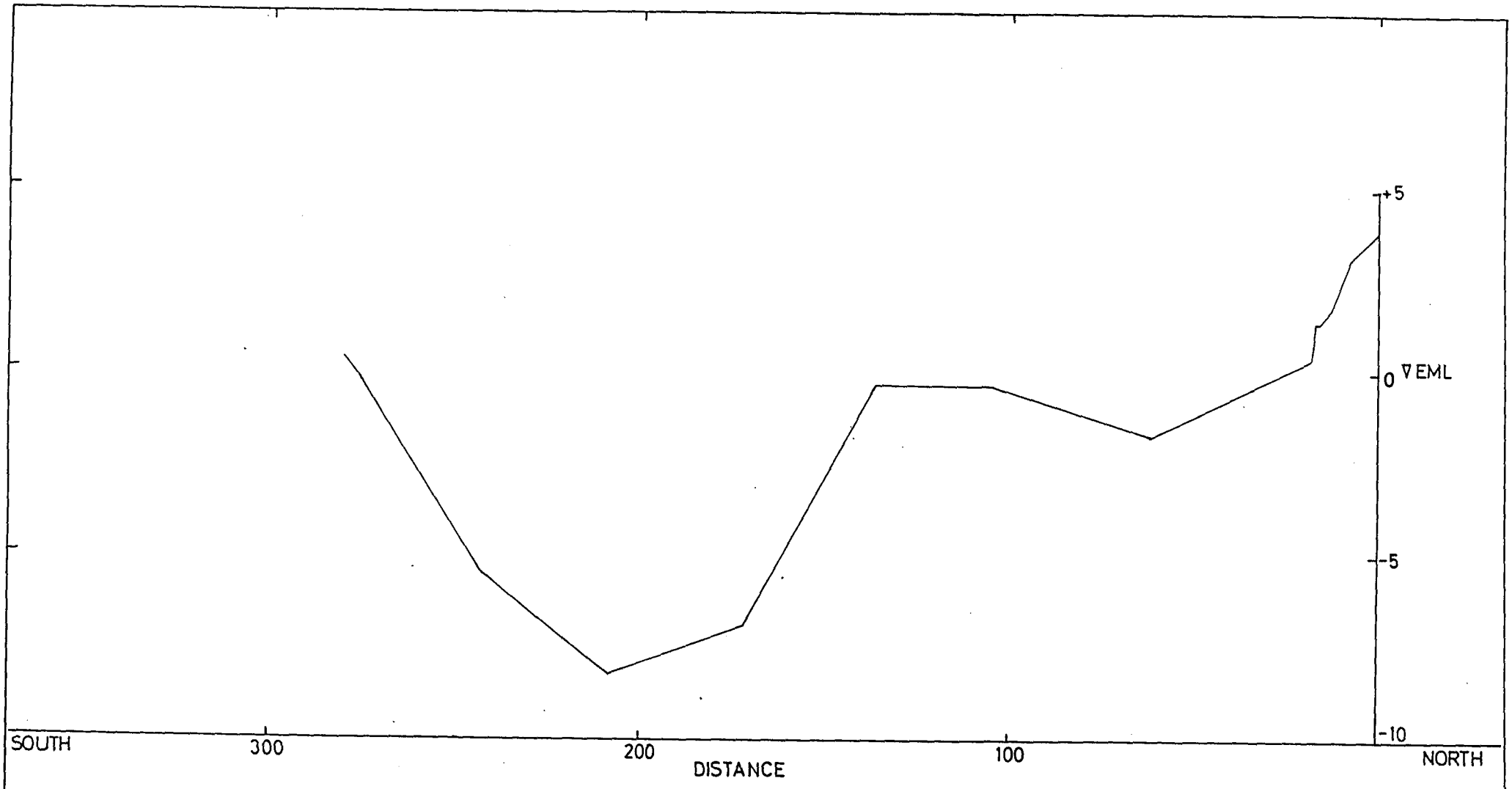
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY



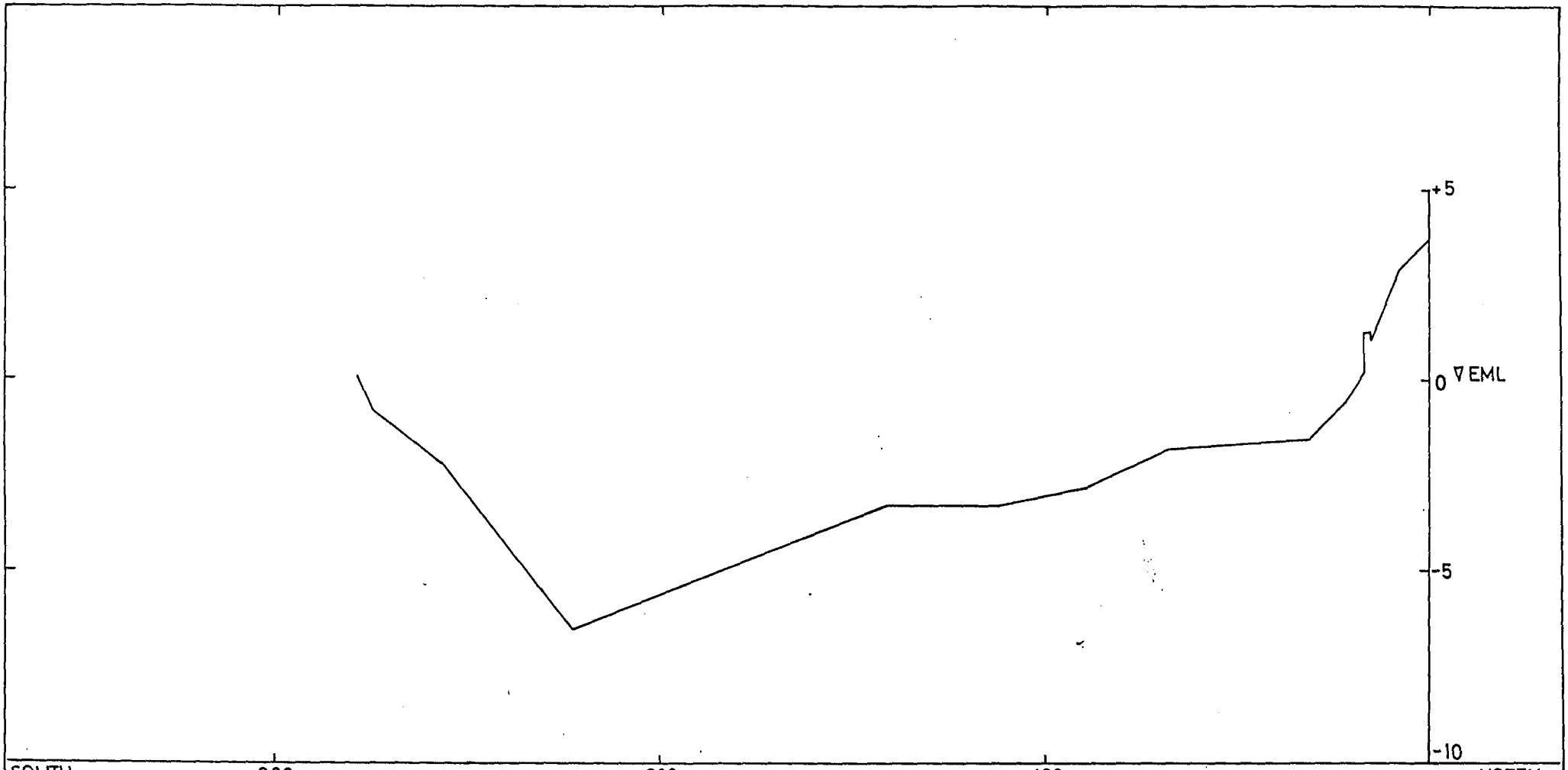
TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS - SECTION D3G - APRIL 1988	FIGURE 27h
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		



TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS - SECTION D3H - OCTOBER 1986	FIGURE 28a
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		

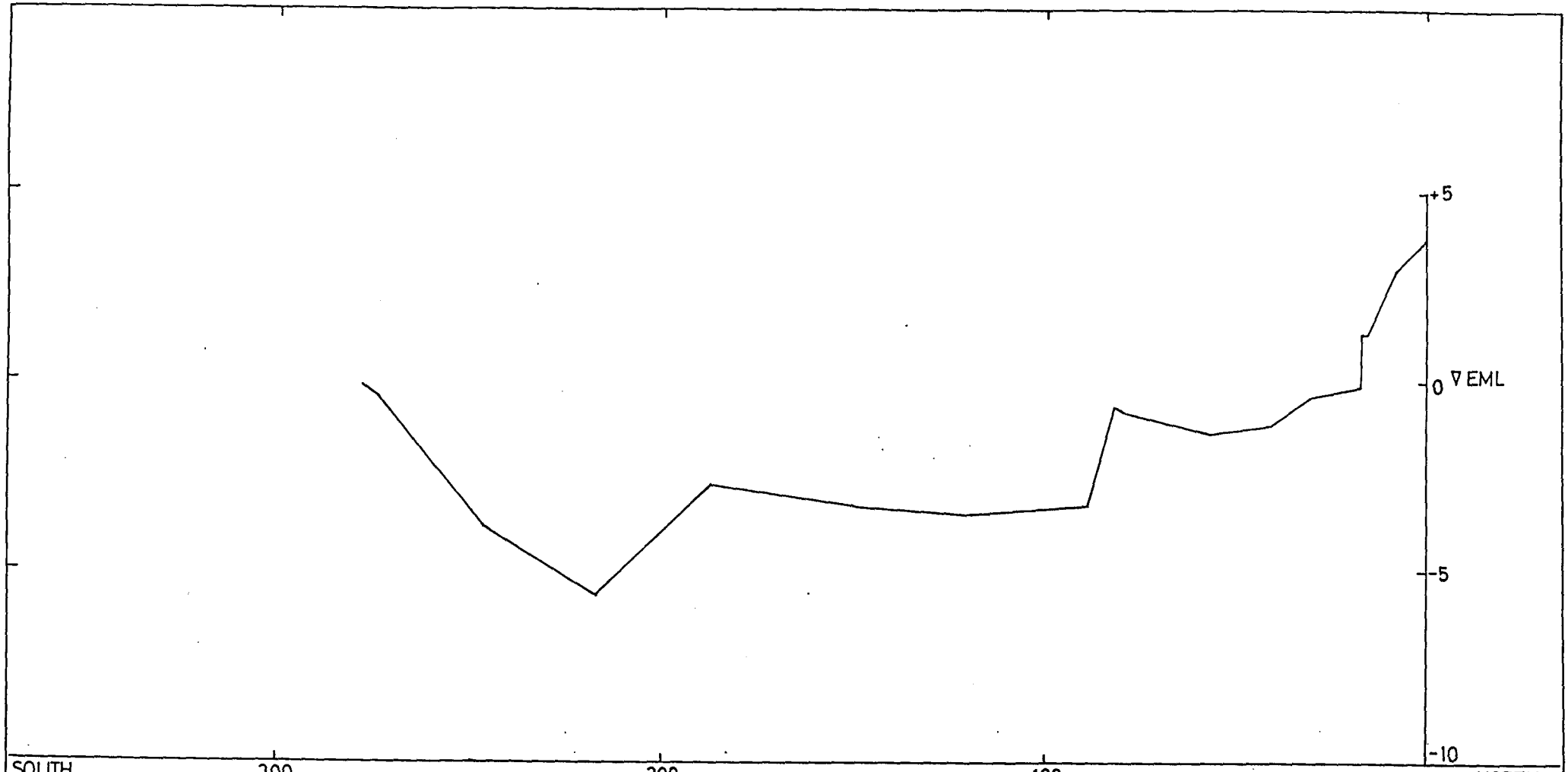


TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS- SECTION D3H - FEBRUARY 1987	FIGURE 28b
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		

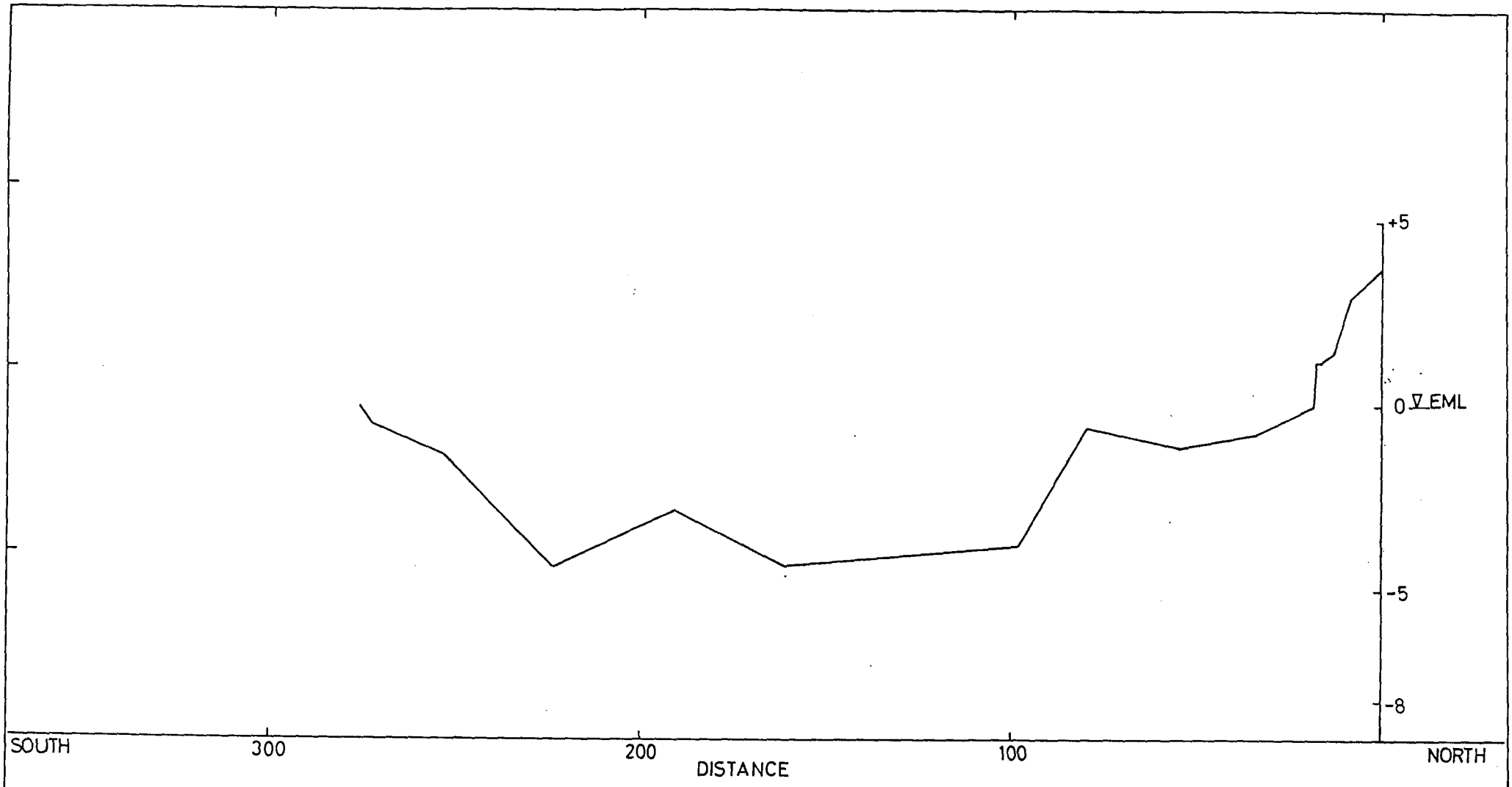


TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS - SECTION D3H - APRIL 1987	FIGURE 28c

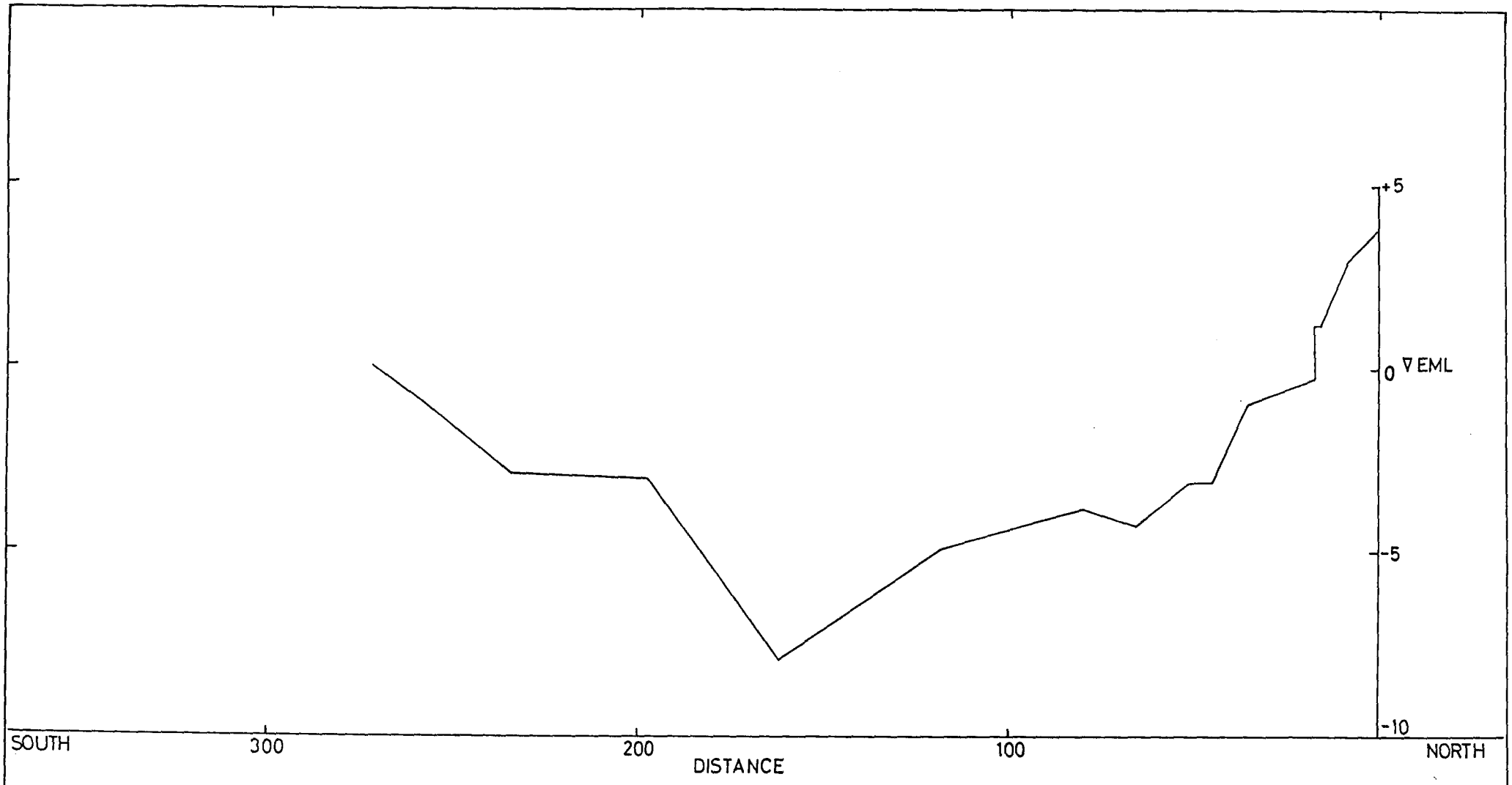
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY



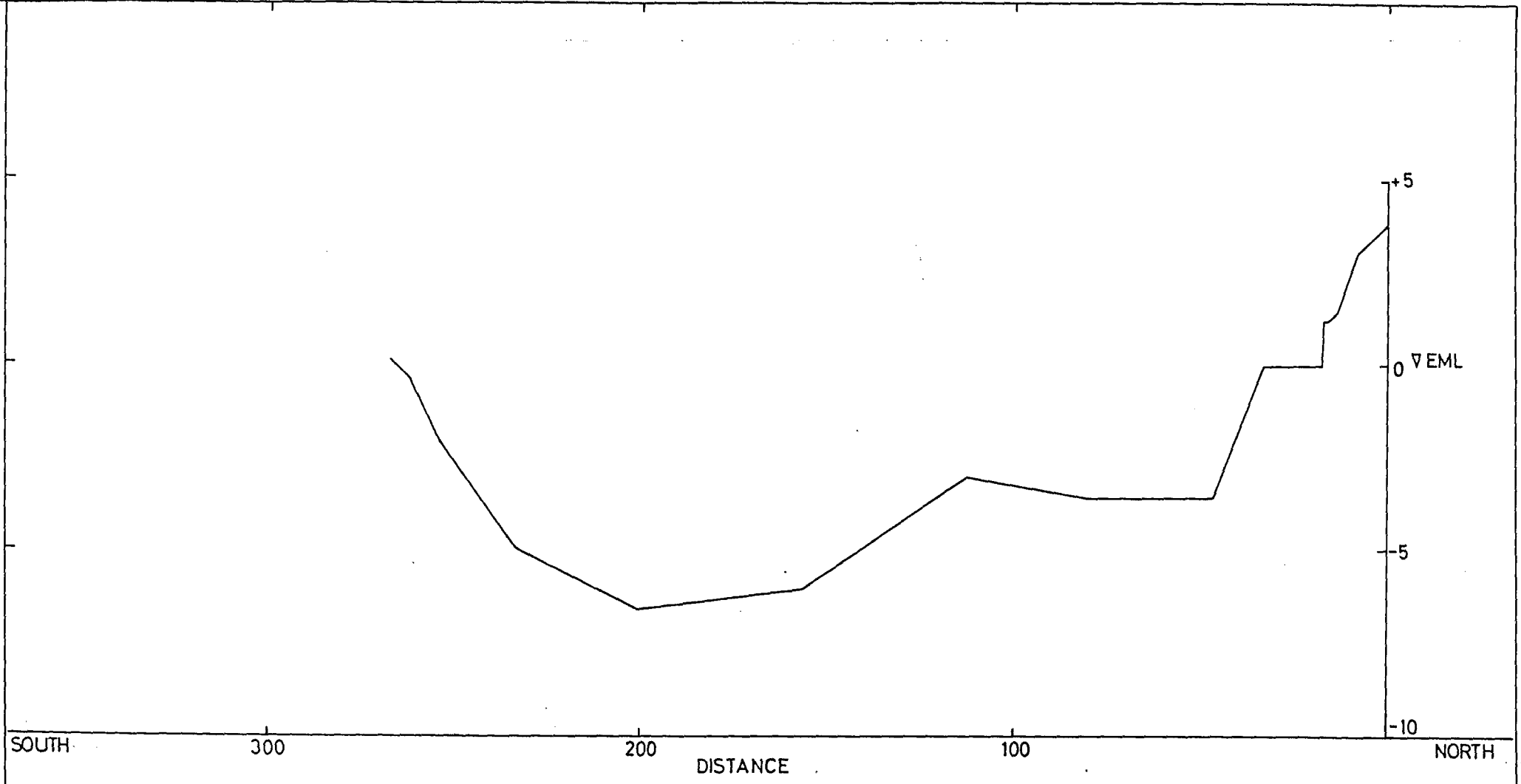
TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS-SECTION D3H - JUNE 1987	FIGURE 28d
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		



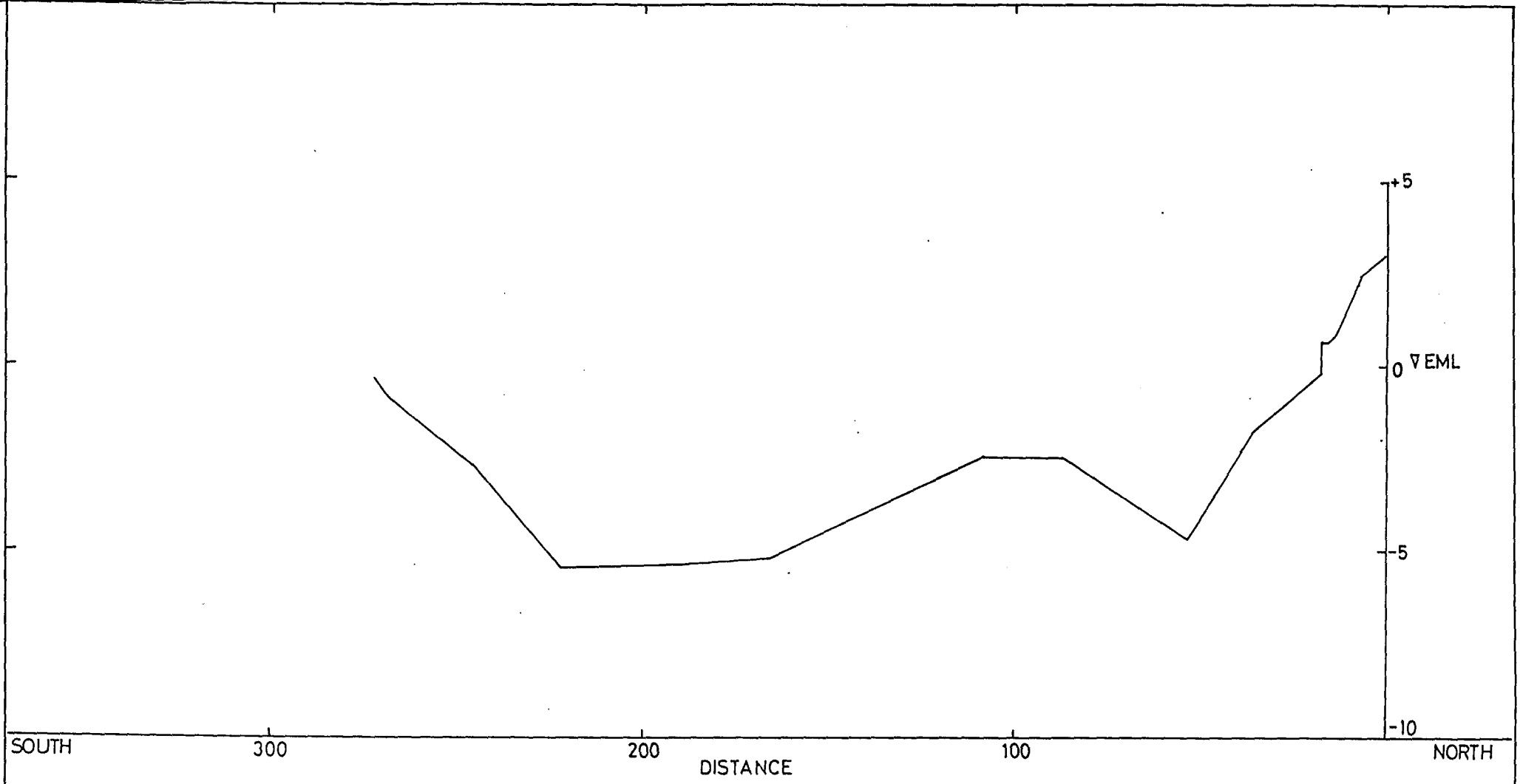
TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS- SECTION D3H- SEPTEMBER 1987	FIGURE 28 e
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		



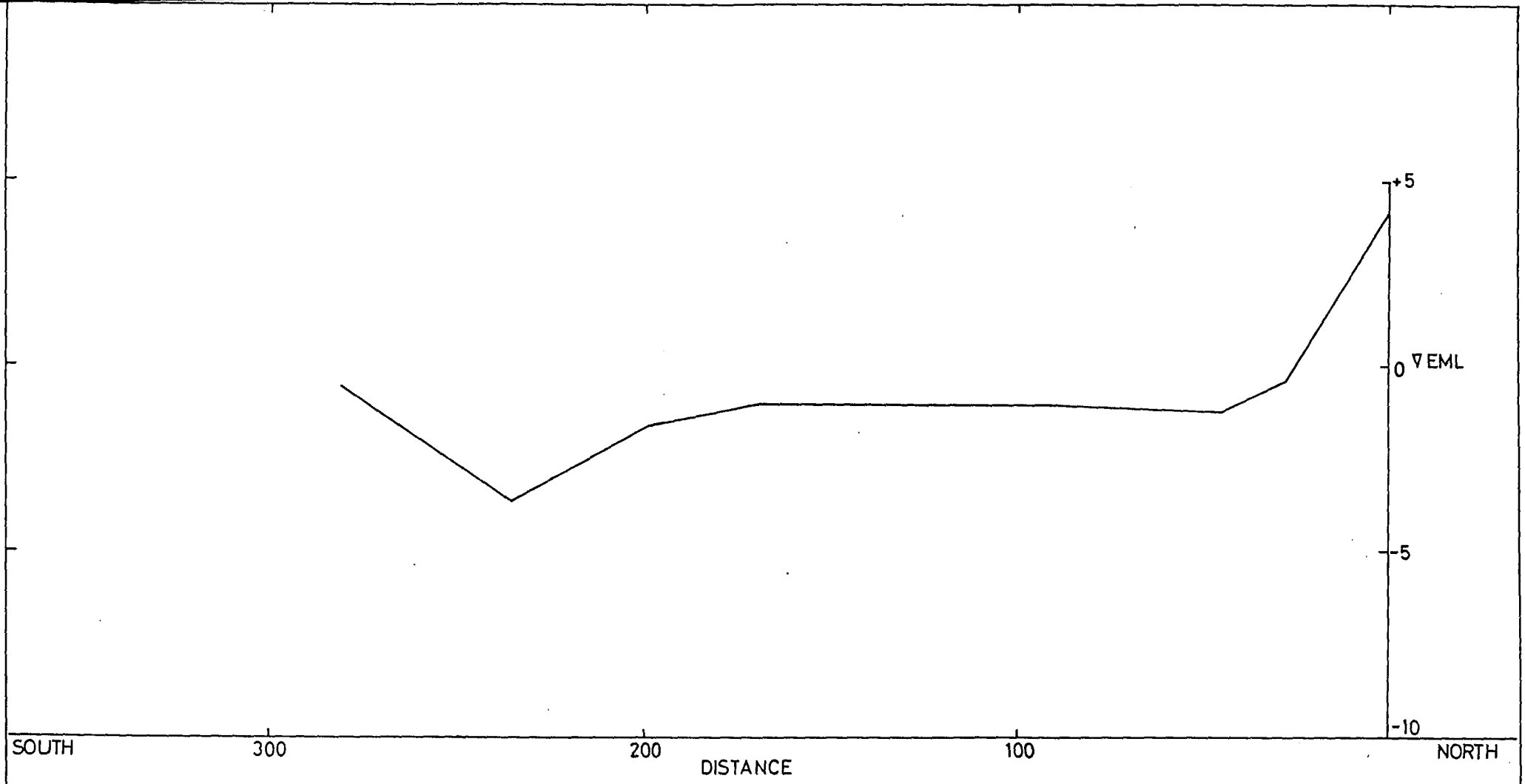
TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS - SECTION D3H - OCTOBER 1987	FIGURE 28 f
	NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY	



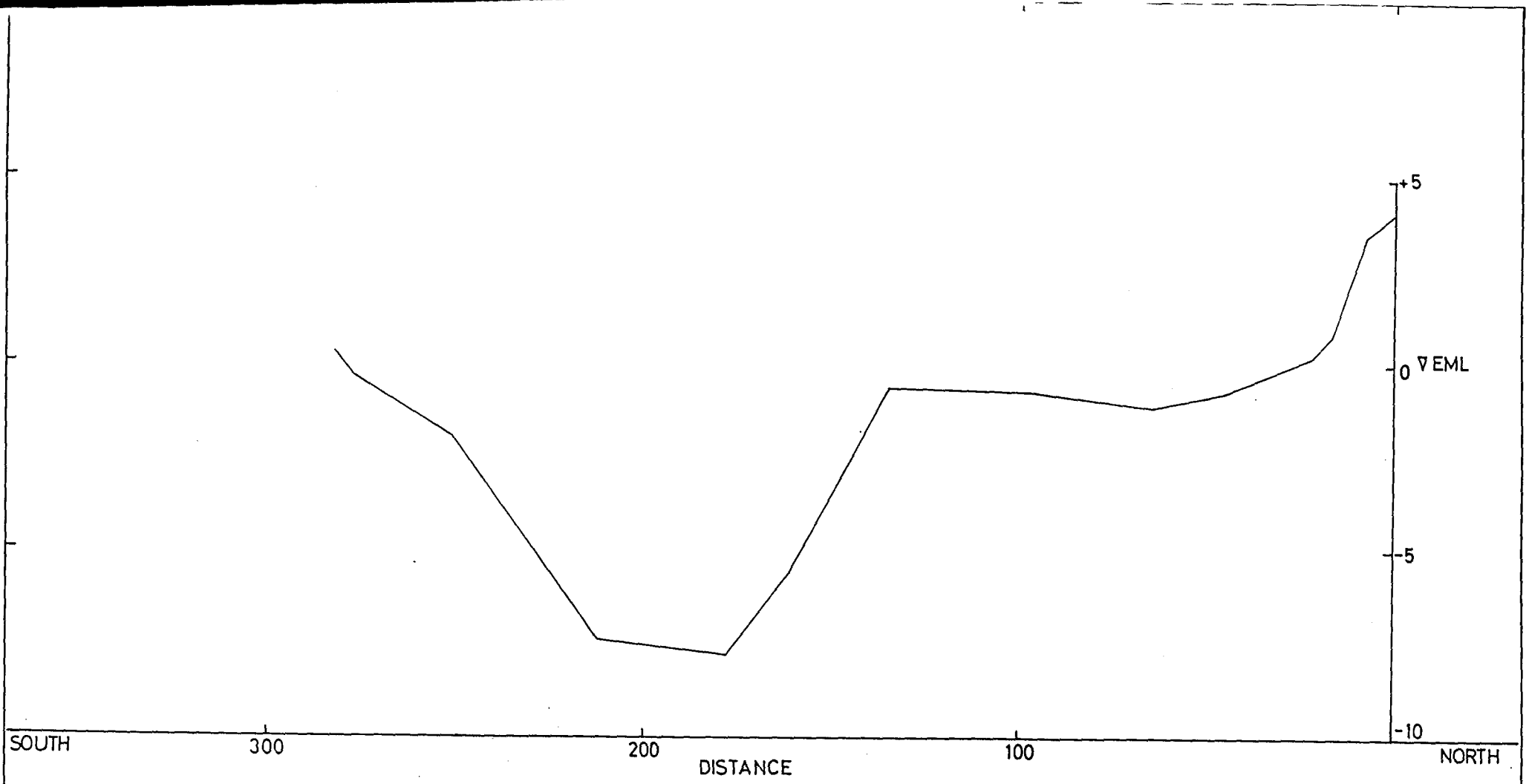
TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS-SECTION D3H - FEBRUARY 1988	FIGURE 28g
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		



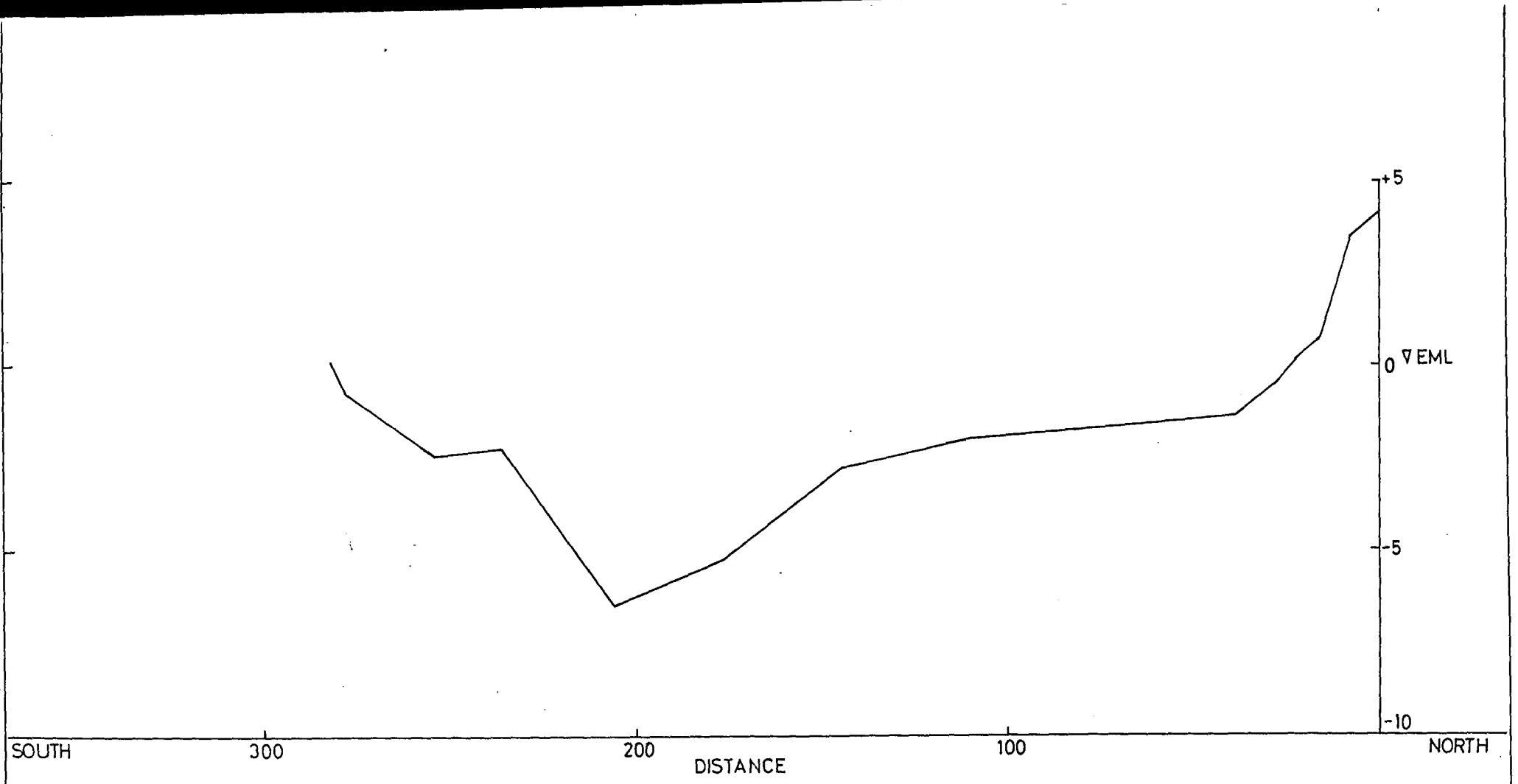
TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS-SECTION D3H- APRIL 1988	FIGURE 28h
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		



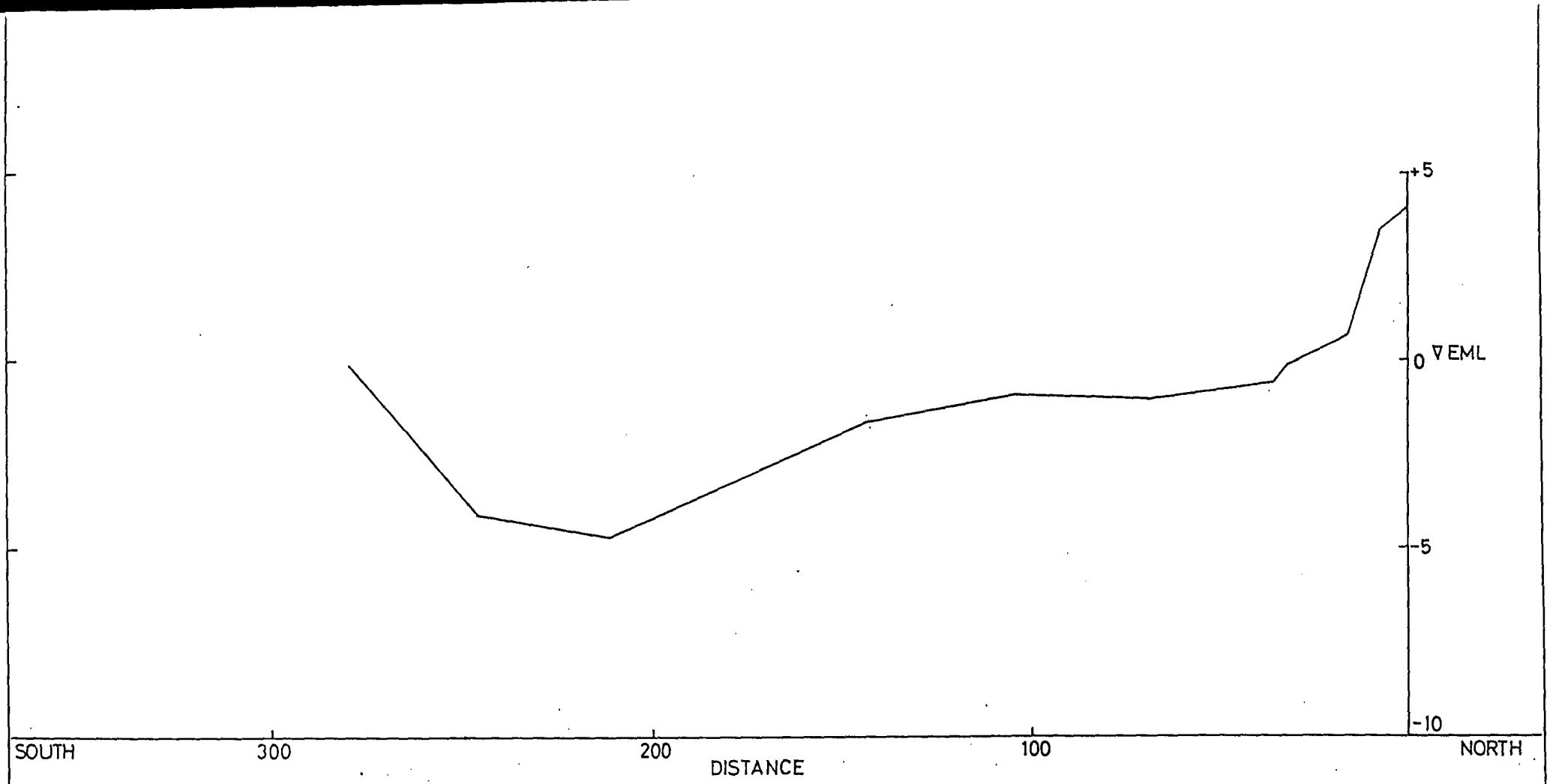
TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS-SECTION D31 - OCTOBER 1986	FIGURE 29a
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		



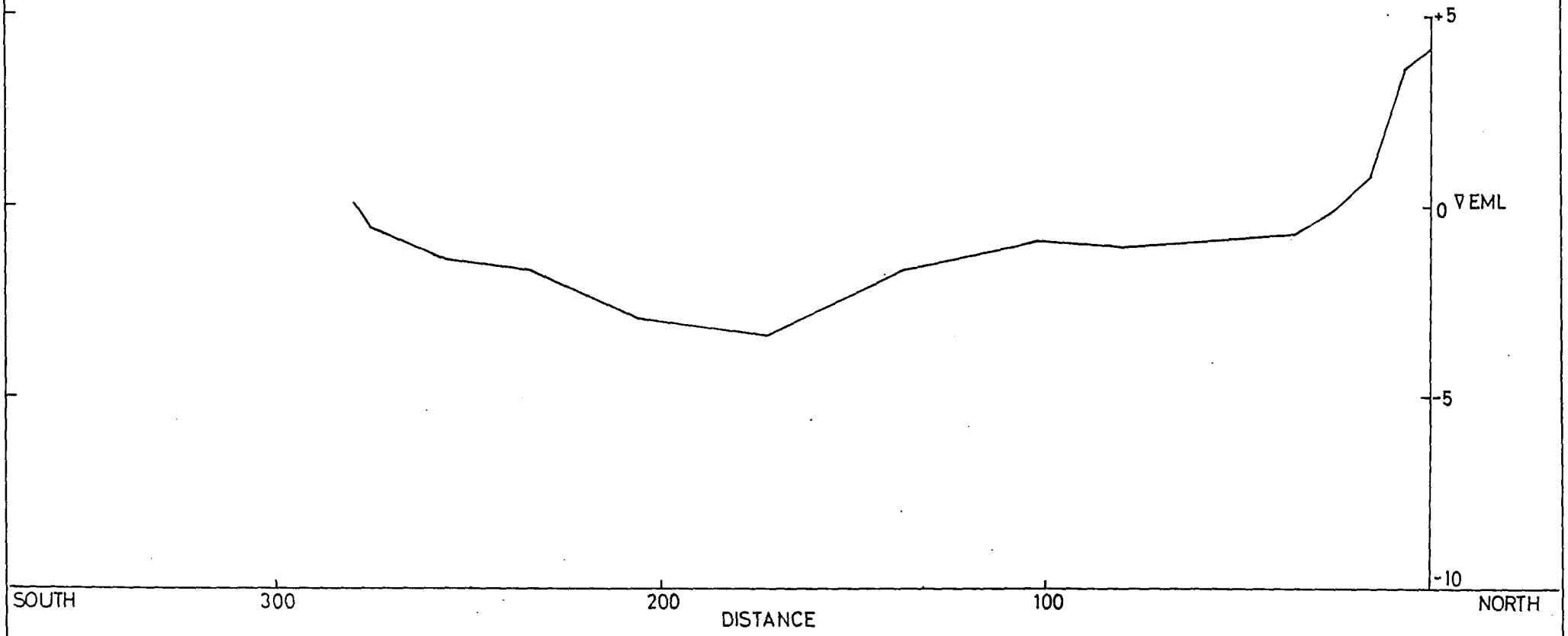
TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS-SECTION D3I - FEBRUARY 1987	FIGURE 29b
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		



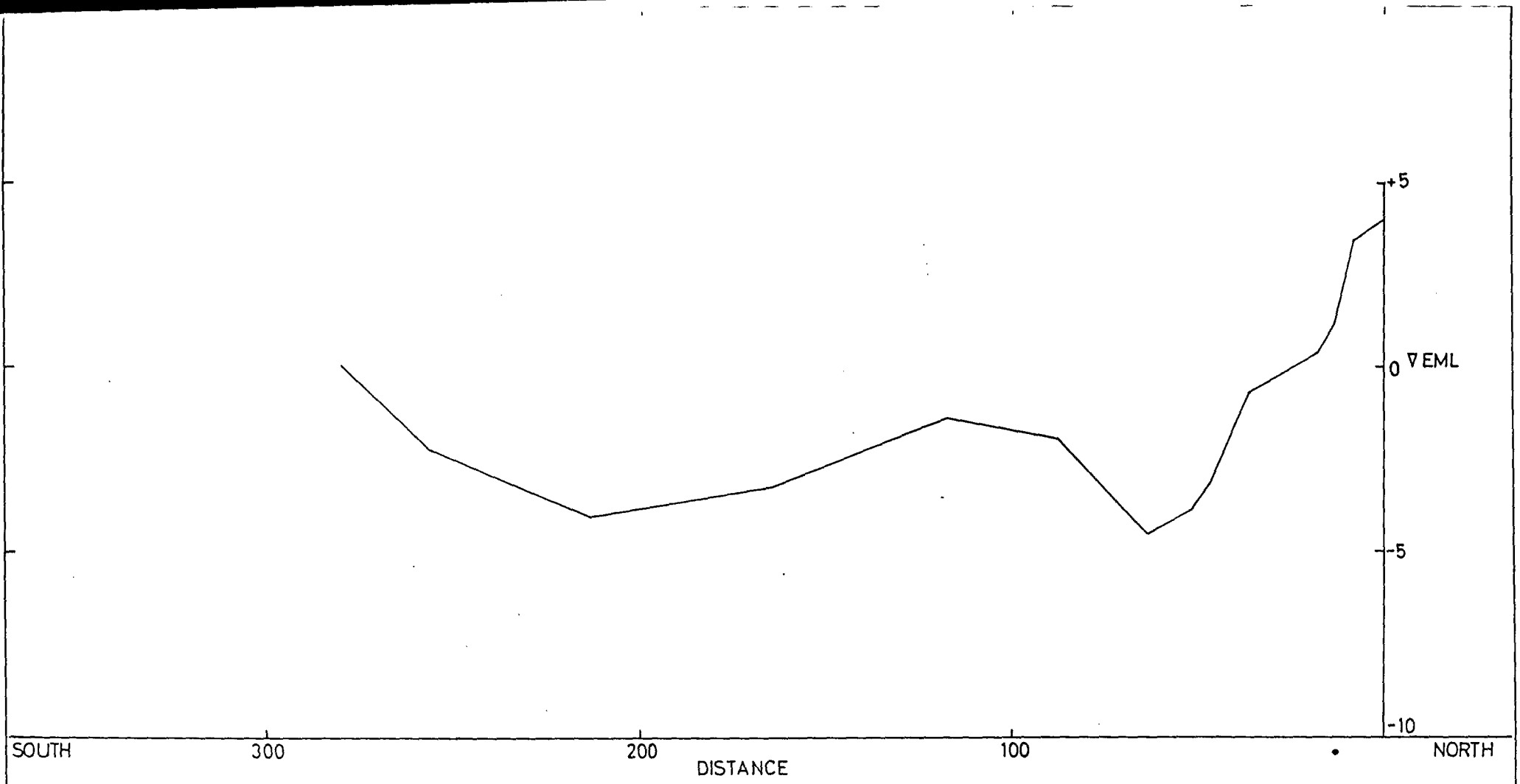
TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS - SECTION D 31 - APRIL 1987	FIGURE 29 c
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		



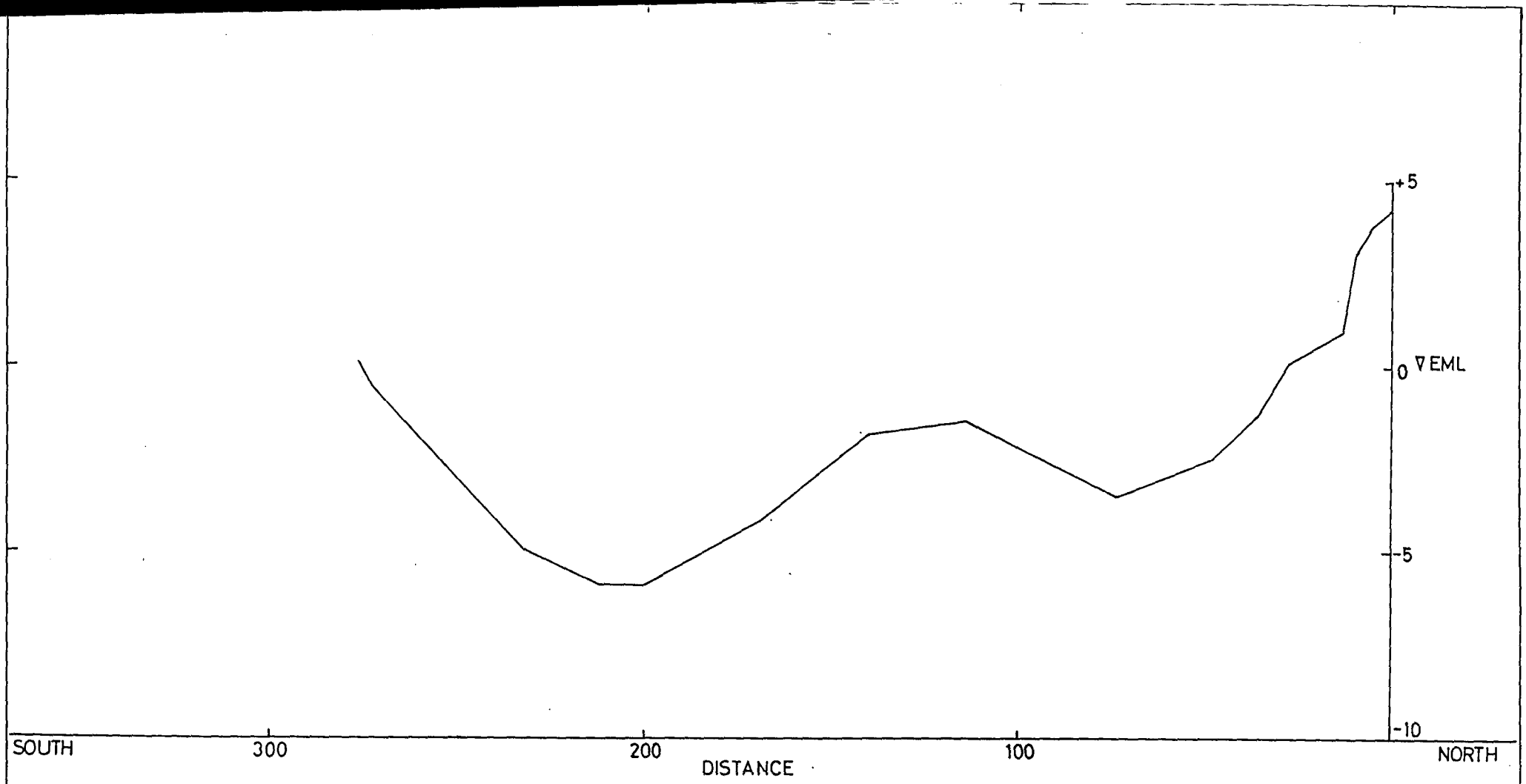
TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS-SECTION D3I - JUNE 1987	FIGURE 29 d
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		



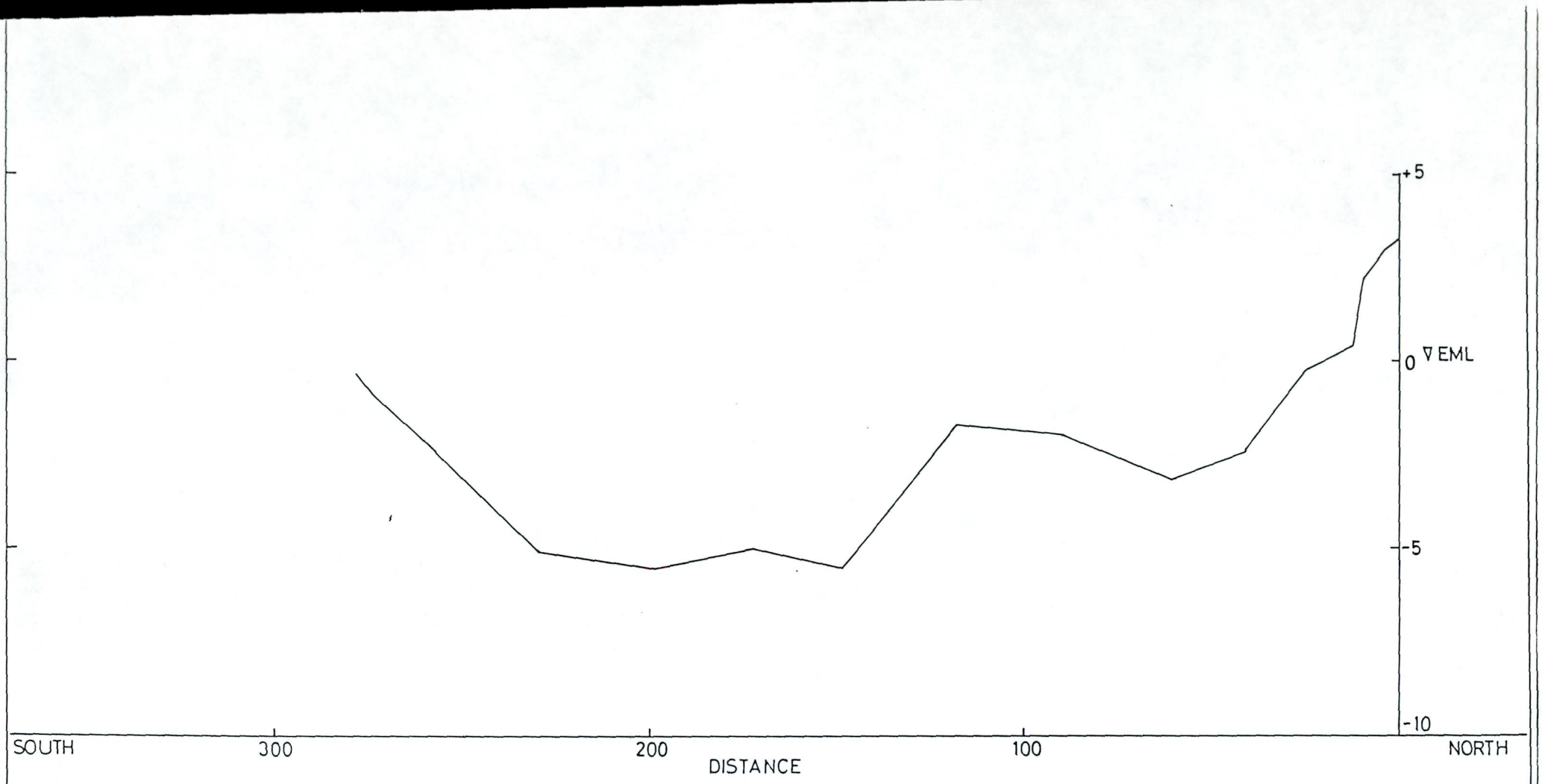
TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS-SECTION D31 - SEPTEMBER 1987	FIGURE 29e
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		



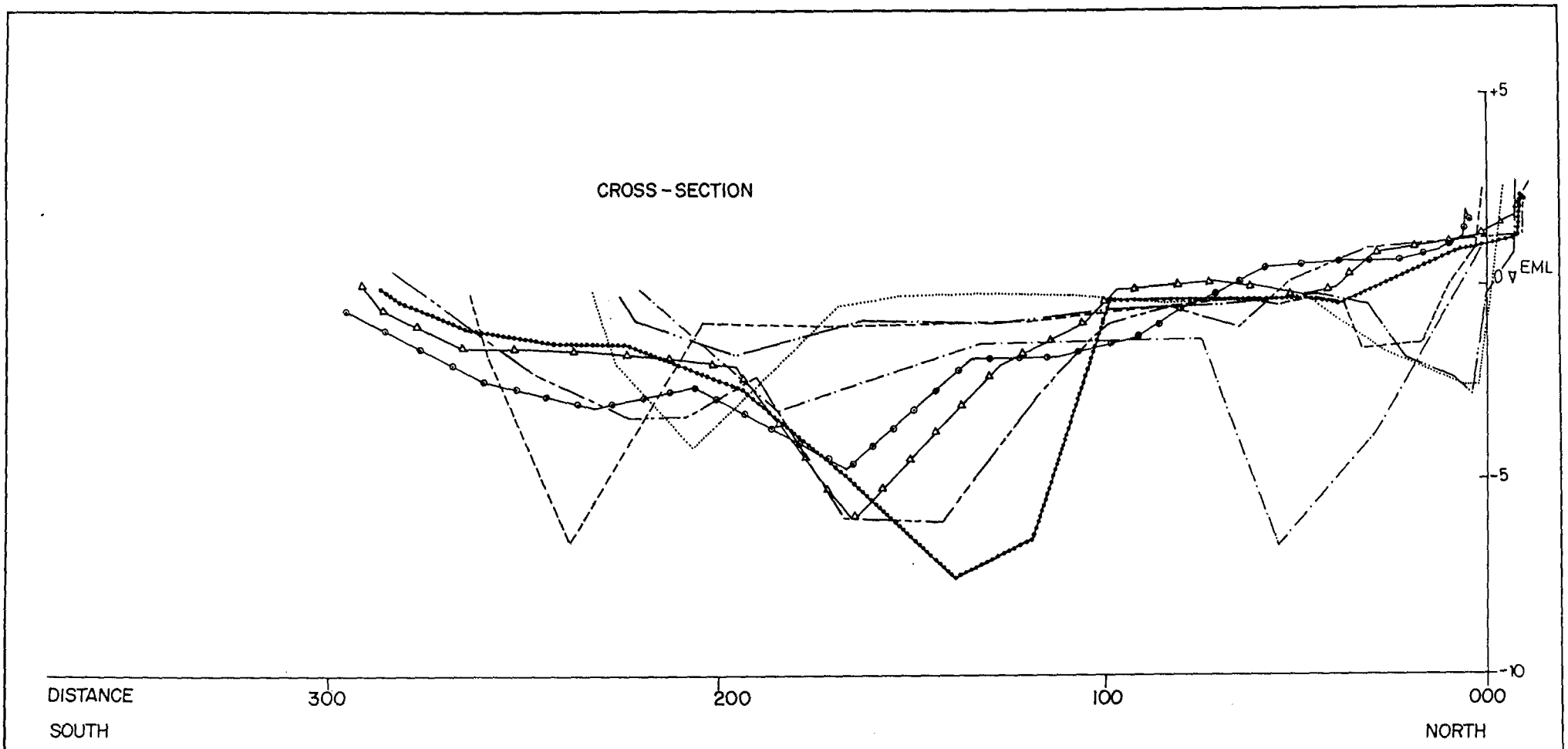
TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS - SECTION D31 - OCTOBER 1987	FIGURE 29 f
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		



TRACED:	ST. LUCIA DREDGING	FIGURE
CHECKED:	CROSS- SECTION D3I - FEBRUARY 1988	29g
DATE:		
REF:		
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		



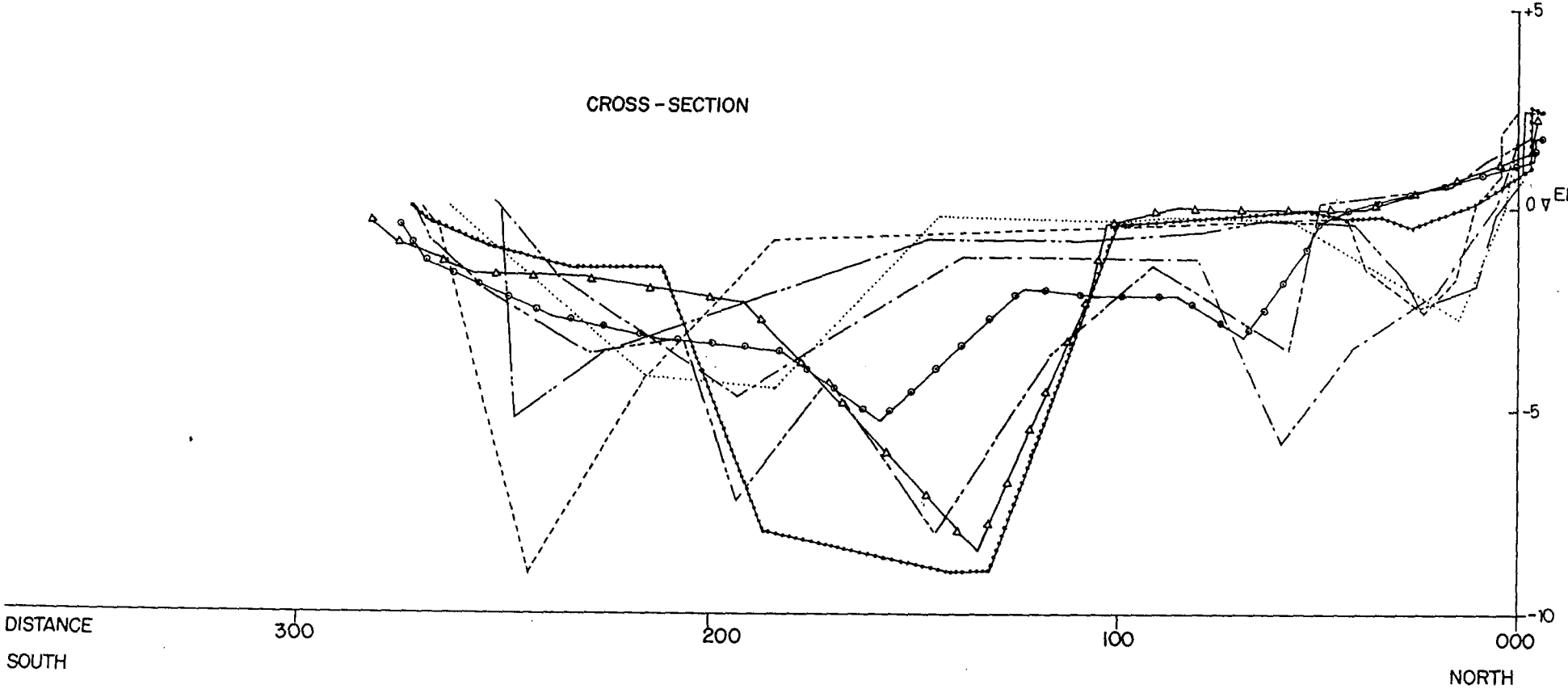
TRACED: CHECKED: DATE: REF:	ST. LUCIA DREDGING CROSS-SECTION D31 - APRIL 1988	FIGURE 29h
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		



KEY:

- JUNE 1986
- AUGUST 1986
- OCTOBER 1986
- DECEMBER 1986
- FEBRUARY 1987
- APRIL 1987
- JUNE 1987
- SEPTEMBER 1987
- OCTOBER 1987
- APRIL 1988
- FEBRUARY 1988

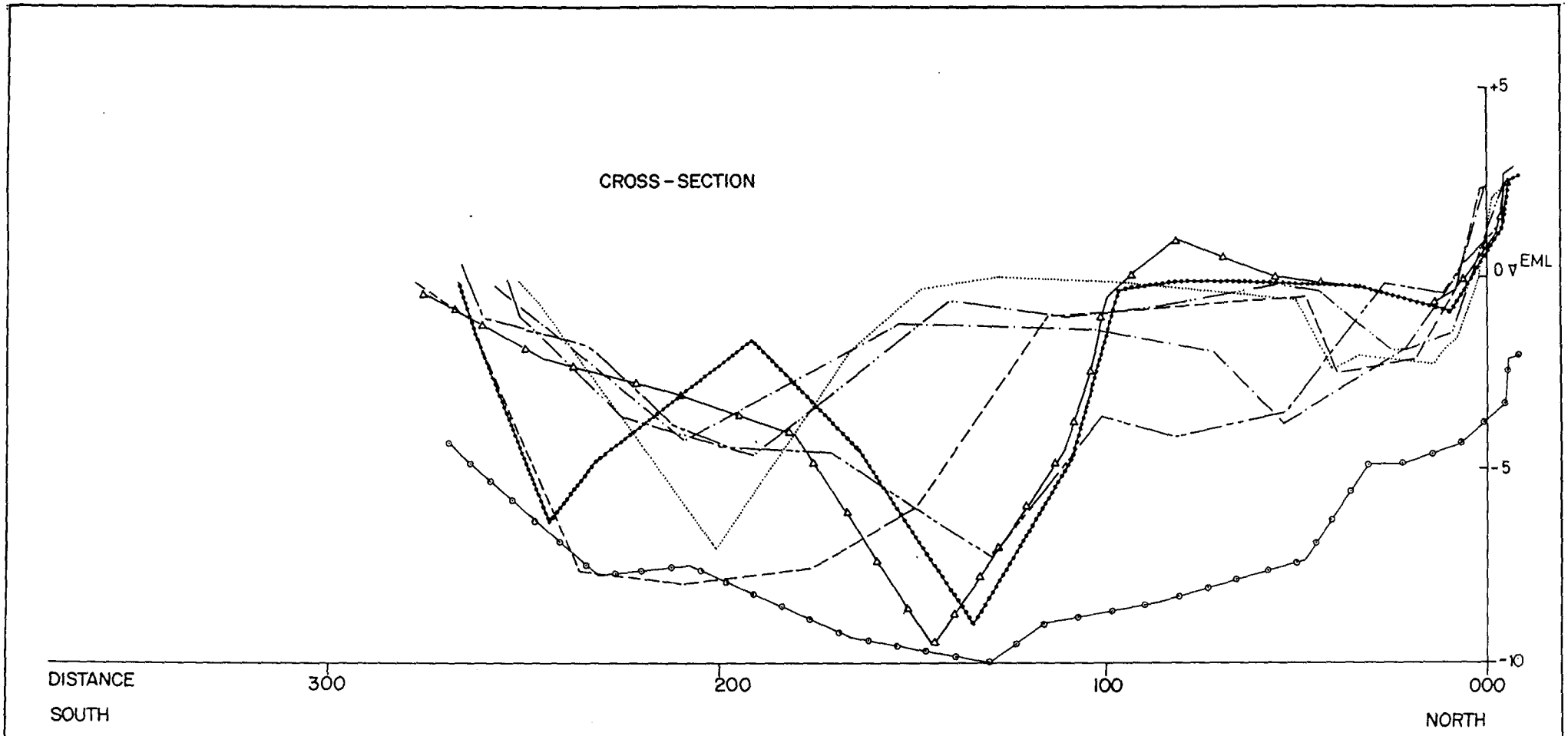
TRACED: CHECKED: DATE: REF:	ST LUCIA DREDGING COMPARATIVE CHANGE IN CROSS-SECTION D3A JUNE 1986 to APRIL 1988	FIGURE : 30
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		



KEY:

- JUNE 1986
- AUGUST 1986
- OCTOBER 1986
- DECEMBER 1986
- FEBRUARY 1987
- APRIL 1987
- JUNE 1987
- SEPTEMBER 1987
- OCTOBER 1987
- APRIL 1988
- FEBRUARY 1988

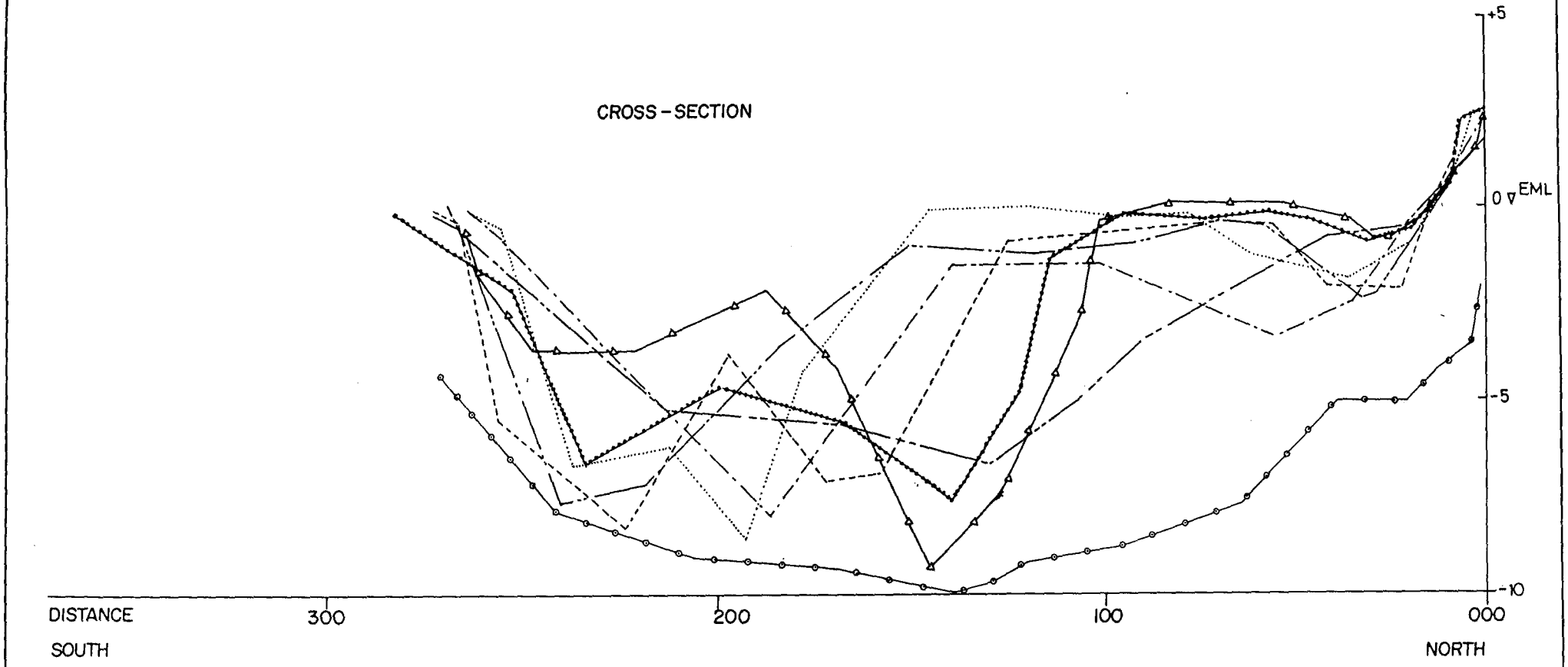
TRACED: CHECKED: DATE: REF:	ST LUCIA DREDGING COMPARATIVE CHANGE IN CROSS-SECTION D3B JUNE 1986 to APRIL 1988	FIGURE : 31
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		



KEY:

- JUNE 1986
- AUGUST 1986
- OCTOBER 1986
- DECEMBER 1986
- FEBRUARY 1987
- APRIL 1987
- JUNE 1987
- SEPTEMBER 1987
- OCTOBER 1987
- APRIL 1988
- FEBRUARY 1988

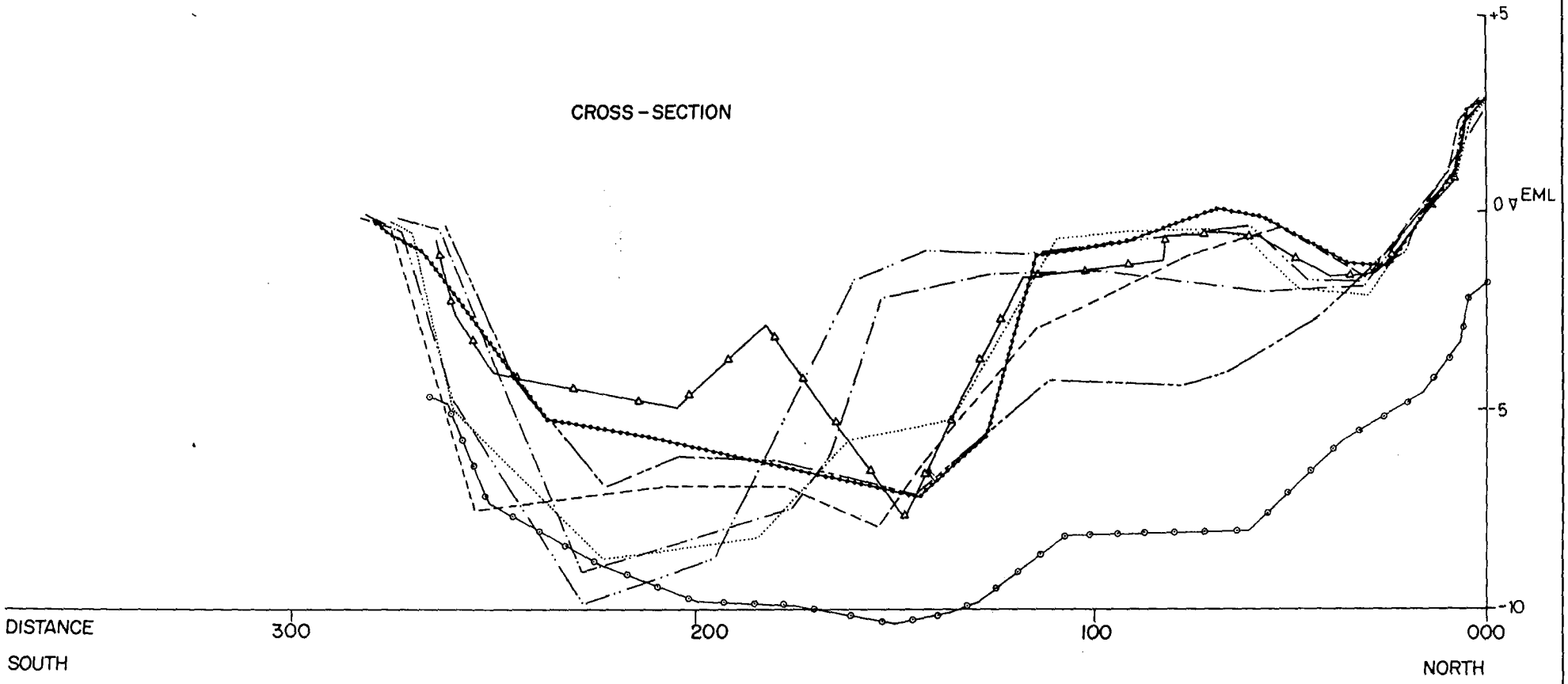
TRACED: CHECKED: DATE: REF:	ST LUCIA DREDGING COMPARATIVE CHANGE IN CROSS-SECTION D3C JUNE 1986 to APRIL 1988	FIGURE : 32
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		



KEY:

- JUNE 1986
- AUGUST 1986
- OCTOBER 1986
- DECEMBER 1986
- FEBRUARY 1987
- APRIL 1987
- JUNE 1987
- SEPTEMBER 1987
- OCTOBER 1987
- APRIL 1988
- FEBRUARY 1988

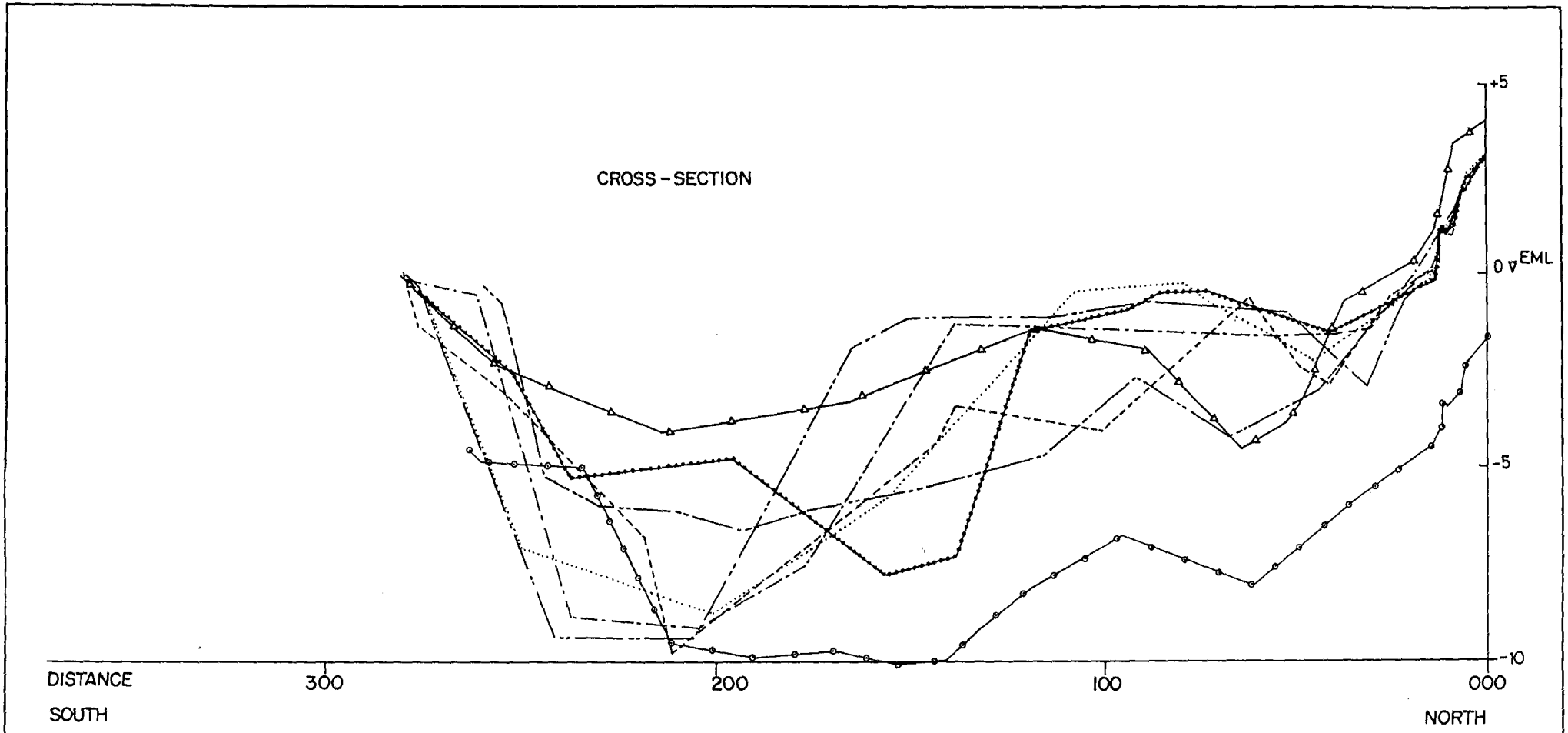
TRACED: CHECKED: DATE: REF:	ST LUCIA DREDGING COMPARATIVE CHANGE IN CROSS-SECTION D3D JUNE 1986 to APRIL 1988	FIGURE : 33
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		



KEY:

- JUNE 1986
- AUGUST 1986
- OCTOBER 1986
- DECEMBER 1986
- FEBRUARY 1987
- APRIL 1987
- JUNE 1987
- SEPTEMBER 1987
- OCTOBER 1987
- APRIL 1987
- FEBRUARY 1988

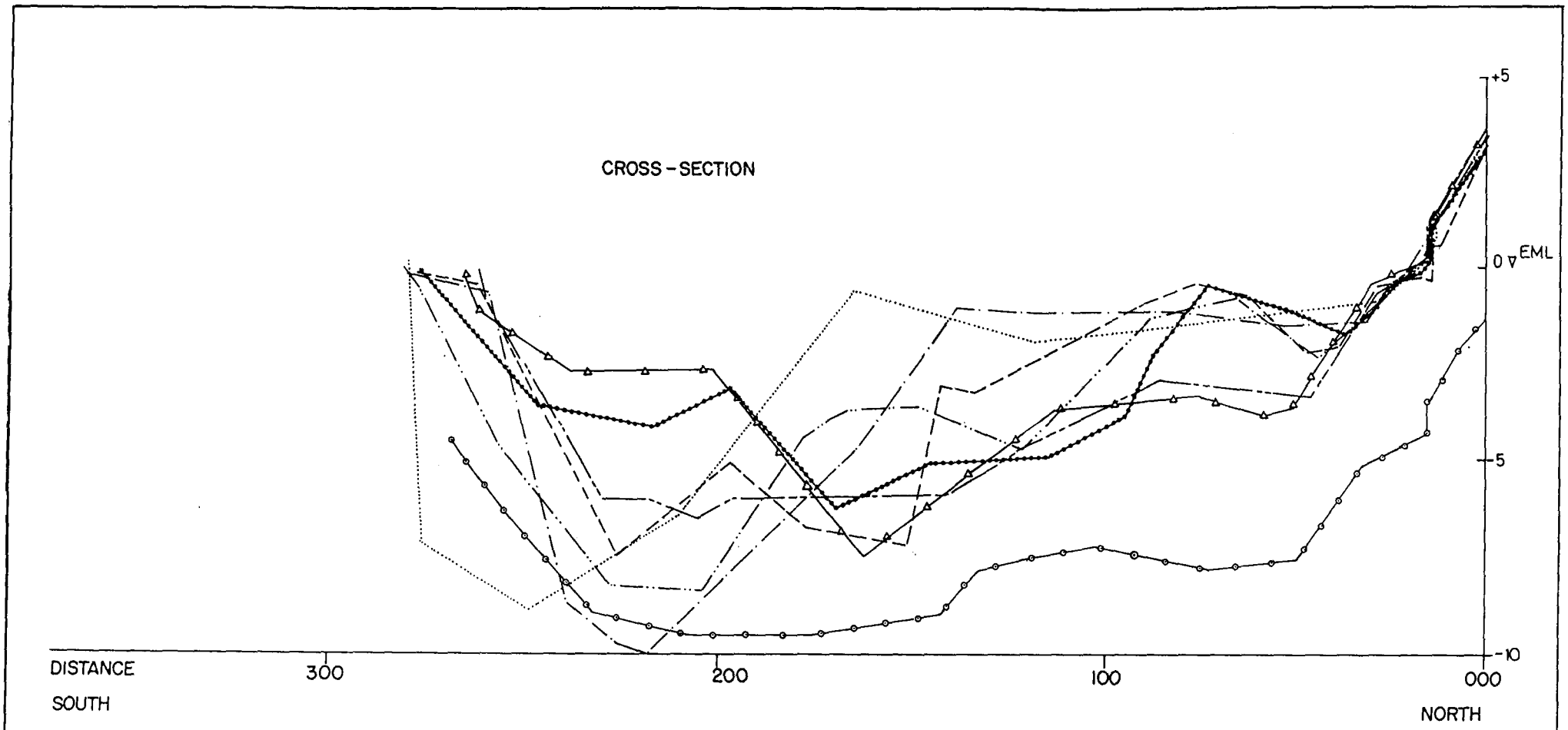
TRACED: CHECKED: DATE: REF:	ST LUCIA DREDGING COMPARATIVE CHANGE IN CROSS-SECTION D3E JUNE 1986 to APRIL 1988	FIGURE : 34
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		



KEY:

- JUNE 1986
- AUGUST 1986
- OCTOBER 1986
- DECEMBER 1986
- FEBRUARY 1987
- APRIL 1987
- JUNE 1987
- SEPTEMBER 1987
- OCTOBER 1987
- APRIL 1988
- FEBRUARY 1988

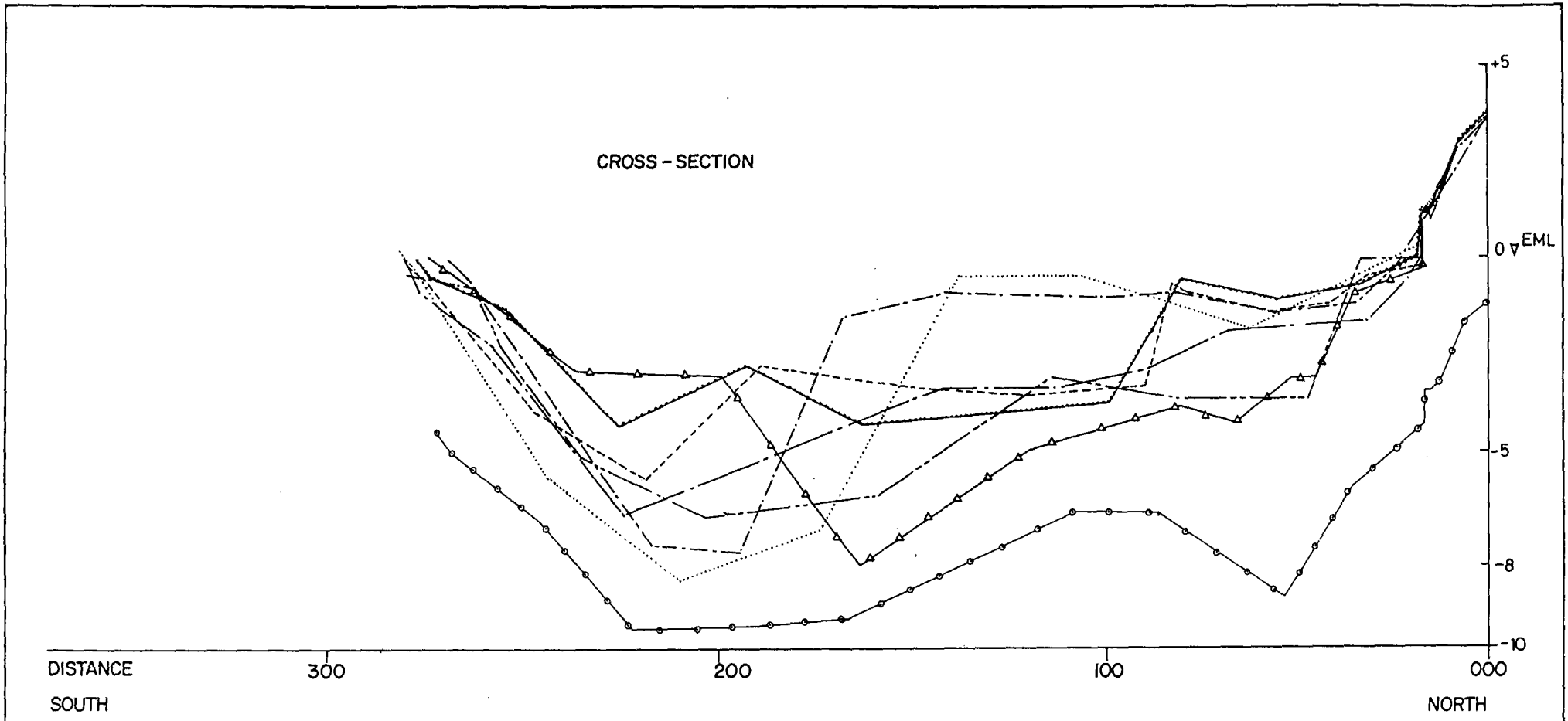
TRACED: CHECKED: DATE: REF:	ST LUCIA DREDGING COMPARATIVE CHANGE IN CROSS-SECTION D3F JUNE 1986 to APRIL 1988	FIGURE : 35
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		



KEY:

- JUNE 1986
- AUGUST 1986
- OCTOBER 1986
- DECEMBER 1986
- FEBRUARY 1987
- APRIL 1987
- JUNE 1987
- SEPTEMBER 1987
- OCTOBER 1987
- APRIL 1988
- FEBRUARY 1988

TRACED: CHECKED: DATE:	ST LUCIA DREDGING COMPARATIVE CHANGE IN CROSS-SECTION D3G JUNE 1986 to APRIL 1988	FIGURE : 36
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		

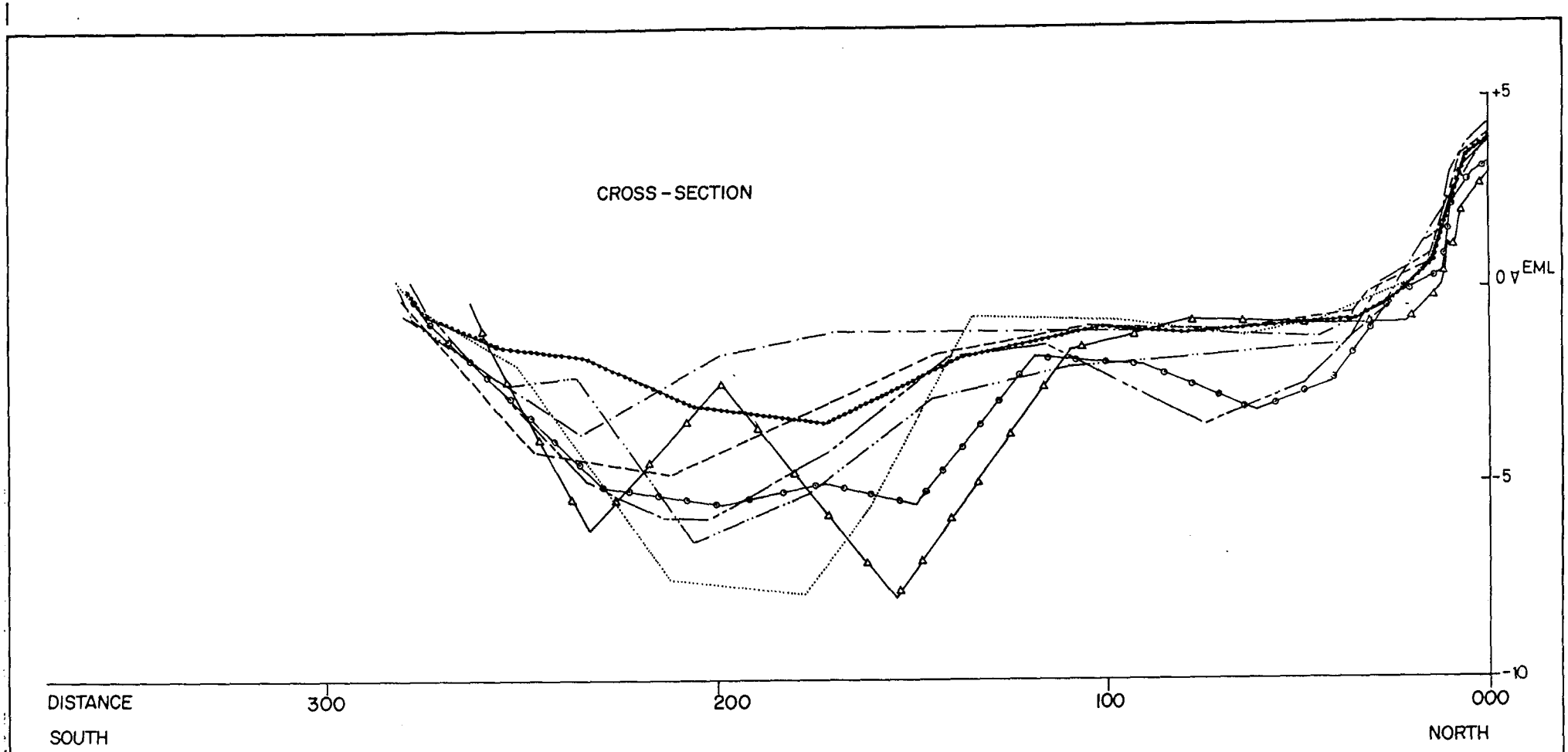


KEY:

- JUNE 1986
- AUGUST 1986
- OCTOBER 1986
- DECEMBER 1986
- FEBRUARY 1987
- APRIL 1987
- JUNE 1987
- SEPTEMBER 1987
- OCTOBER 1987
- APRIL 1988
- FEBRUARY 1988

TRACED: CHECKED: DATE: REF.:	ST LUCIA DREDGING COMPARATIVE CHANGE IN CROSS-SECTION D3H JUNE 1986 to APRIL 1988	FIGURE : 37

NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY



KEY:

- JUNE 1986
- AUGUST 1986
- OCTOBER 1986
- DECEMBER 1986
- FEBRUARY 1987
- APRIL 1987
- JUNE 1987
- SEPTEMBER 1987
- OCTOBER 1987
- APRIL 1988
- FEBRUARY 1988

TRACED: CHECKED: DATE: REV:	ST LUCIA DREDGING COMPARATIVE CHANGE IN CROSS-SECTION D31 JUNE 1986 to APRIL 1988	FIGURE: 38
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		

FIG 39: ST LUCIA CROSS-SECTIONS IN RELATION TO THE NUMBER OF CUTS TAKEN

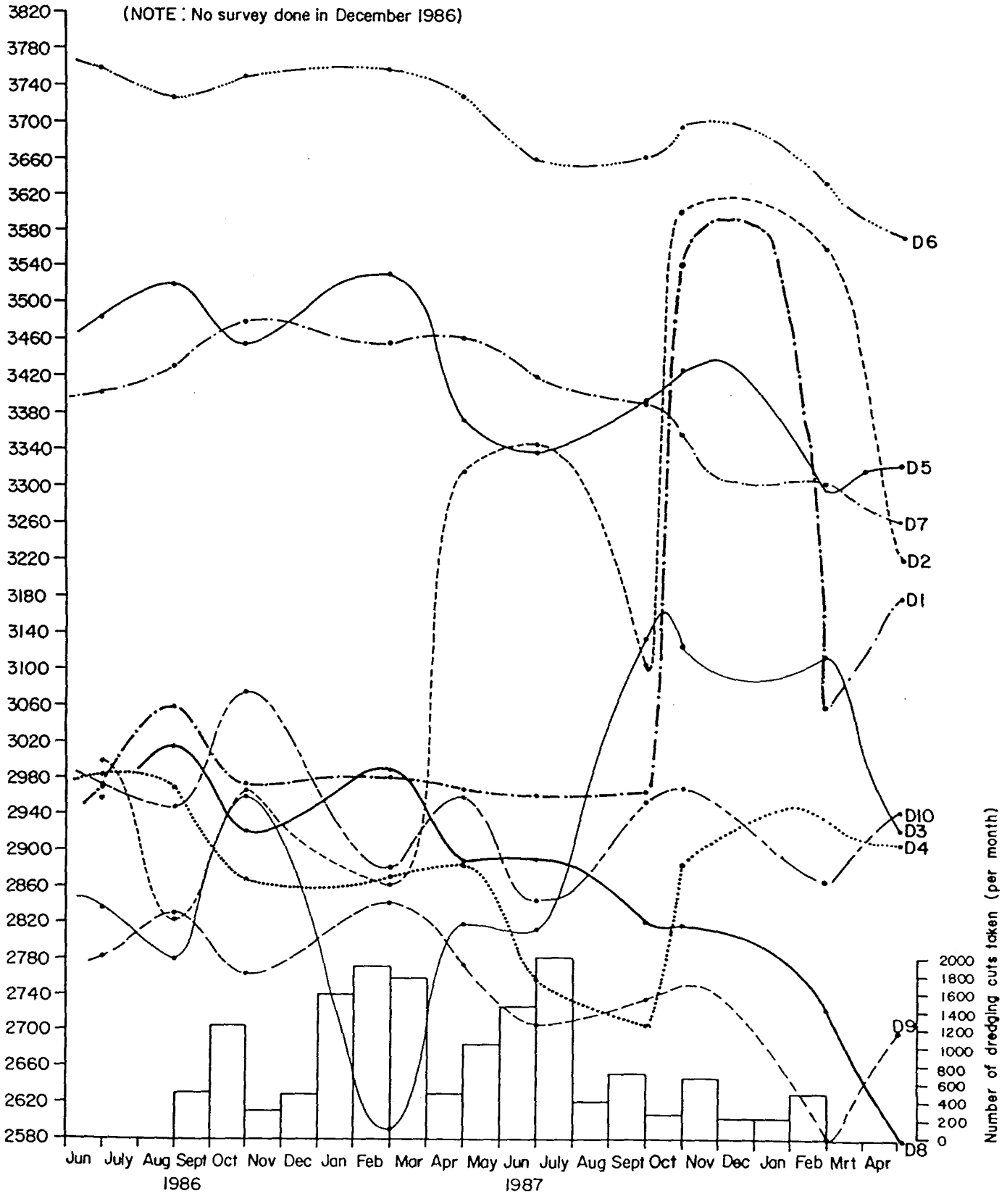
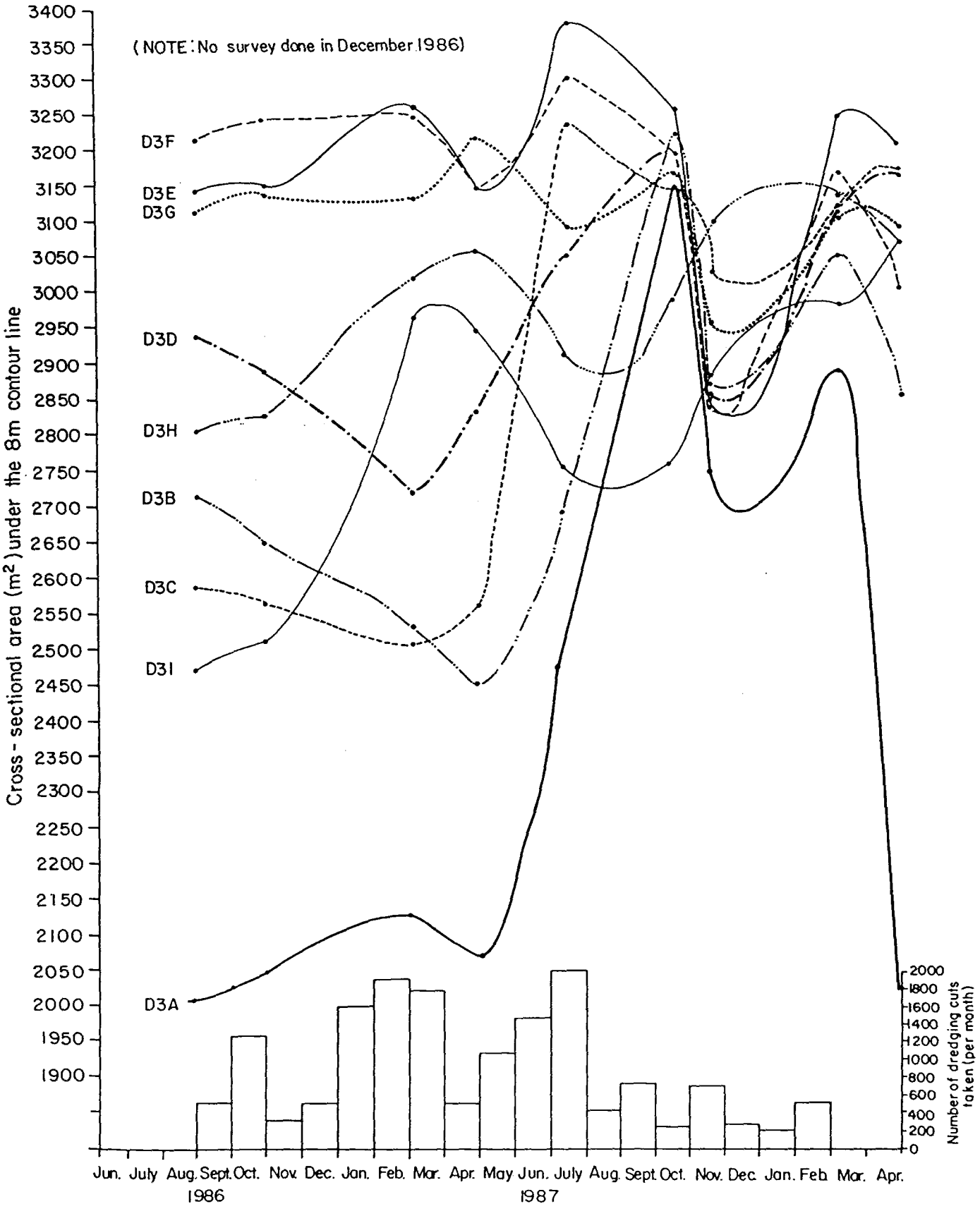
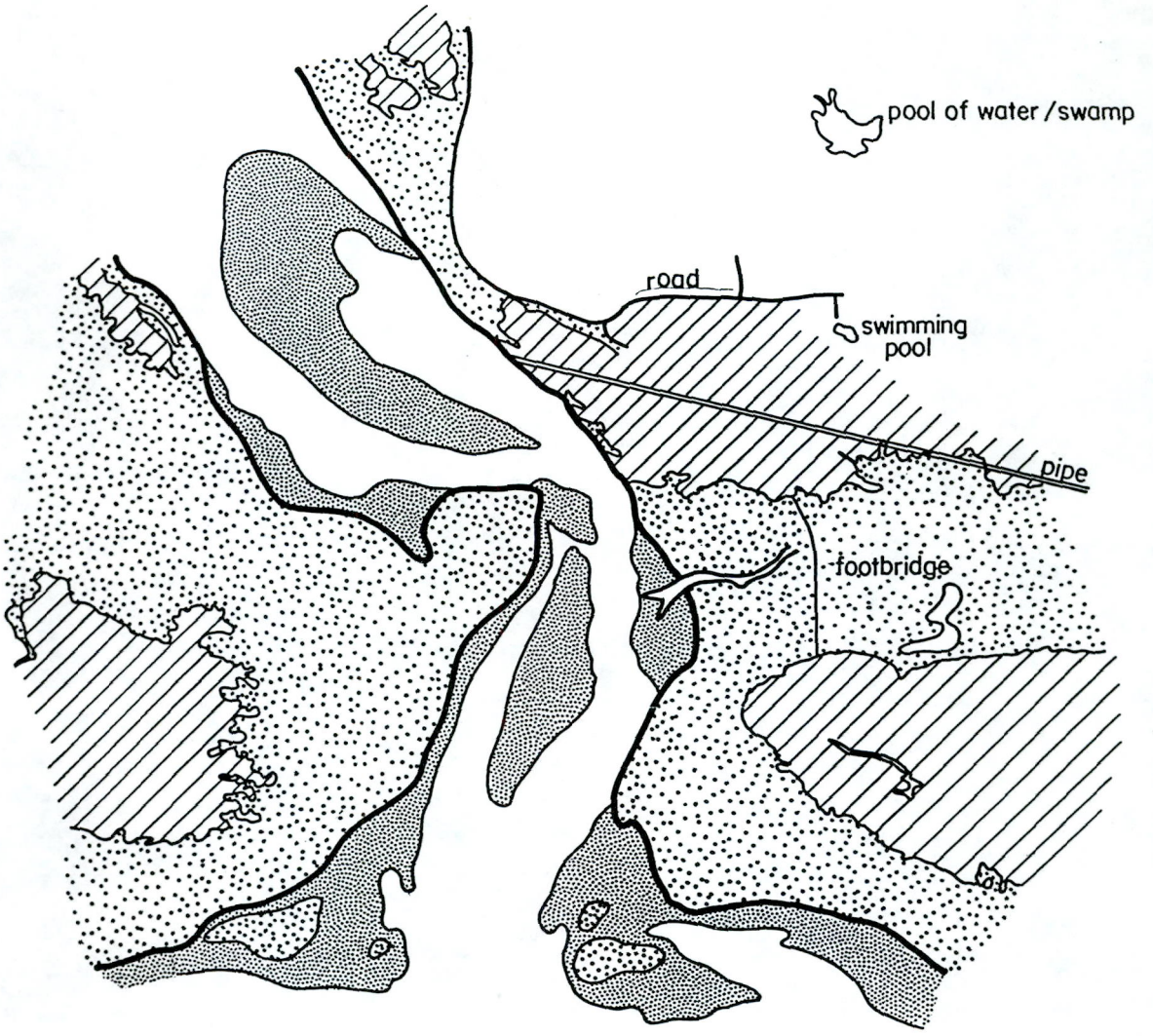


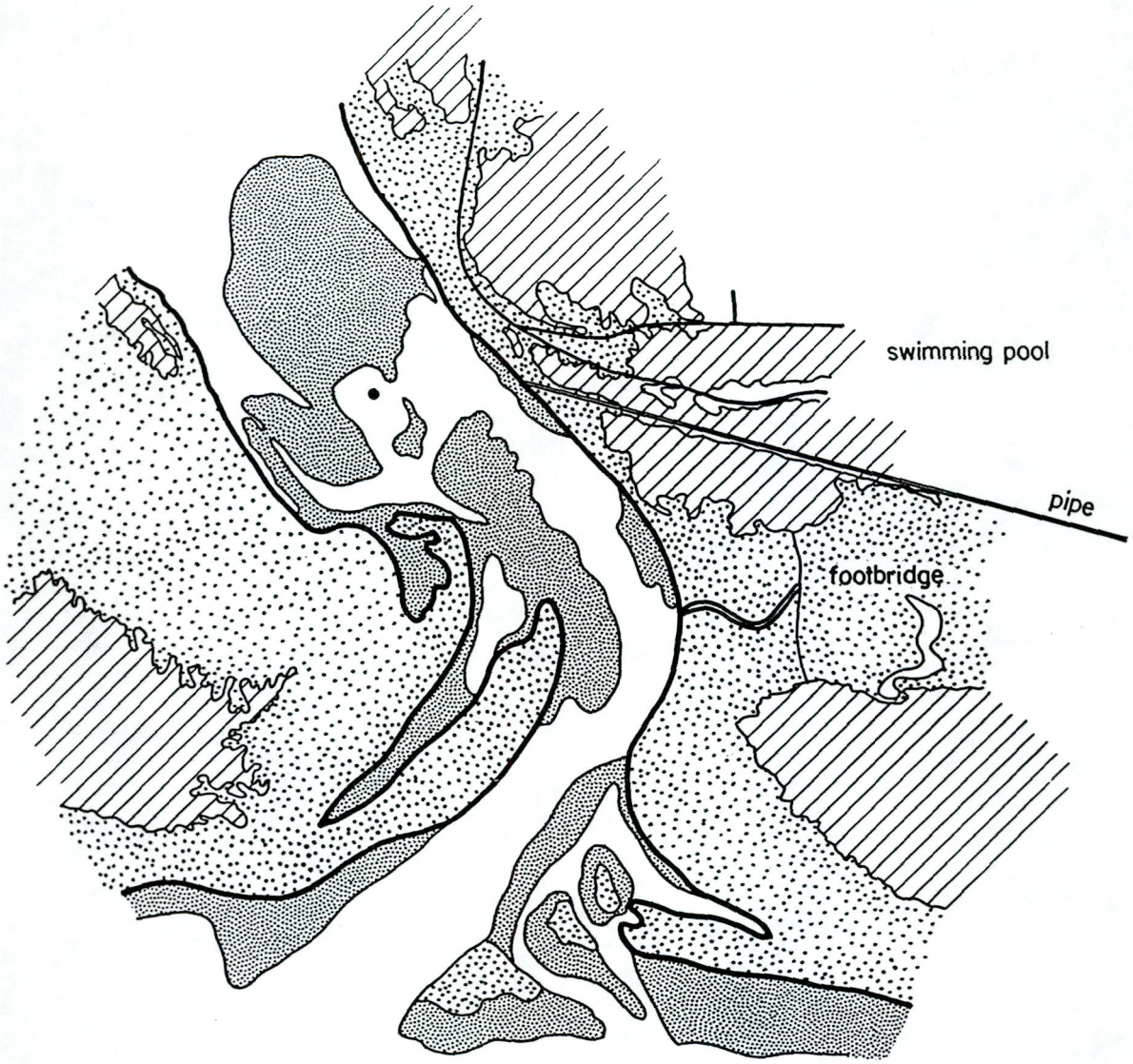
FIG. 40: ST LUCIA CROSS-SECTIONS BETWEEN D3 AND 4 IN RELATION TO THE NUMBER OF DREDGING CUTS TAKEN





TRACED: HEW CHECKED: DATE: REF.:	ST LUCIA DREDGING AERIAL PHOTOGRAPH 22·5·86	FIGURE 41a

NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY



Open sand

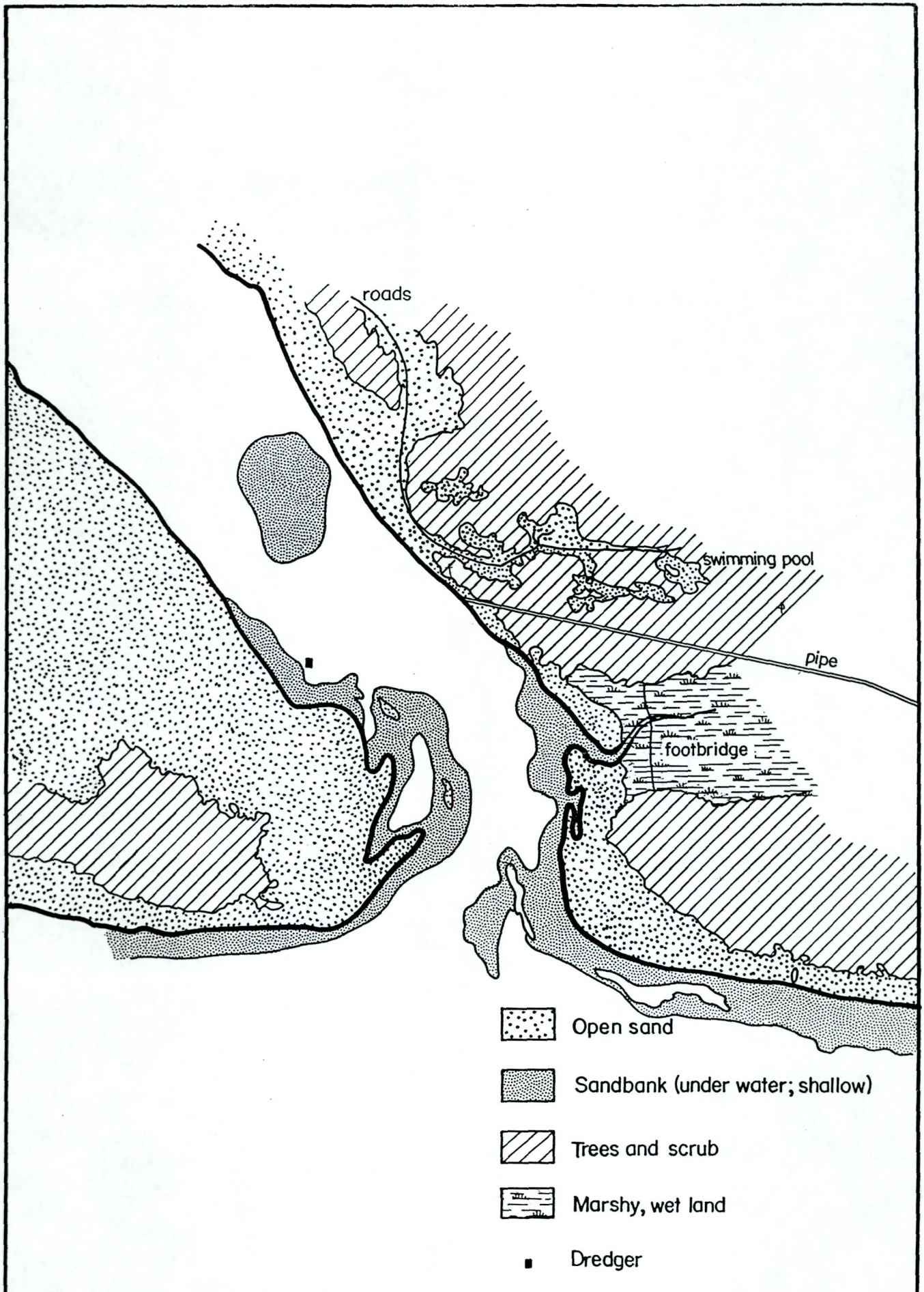
Sandbank (under water, shallow)

Trees and scrub

• Dredger

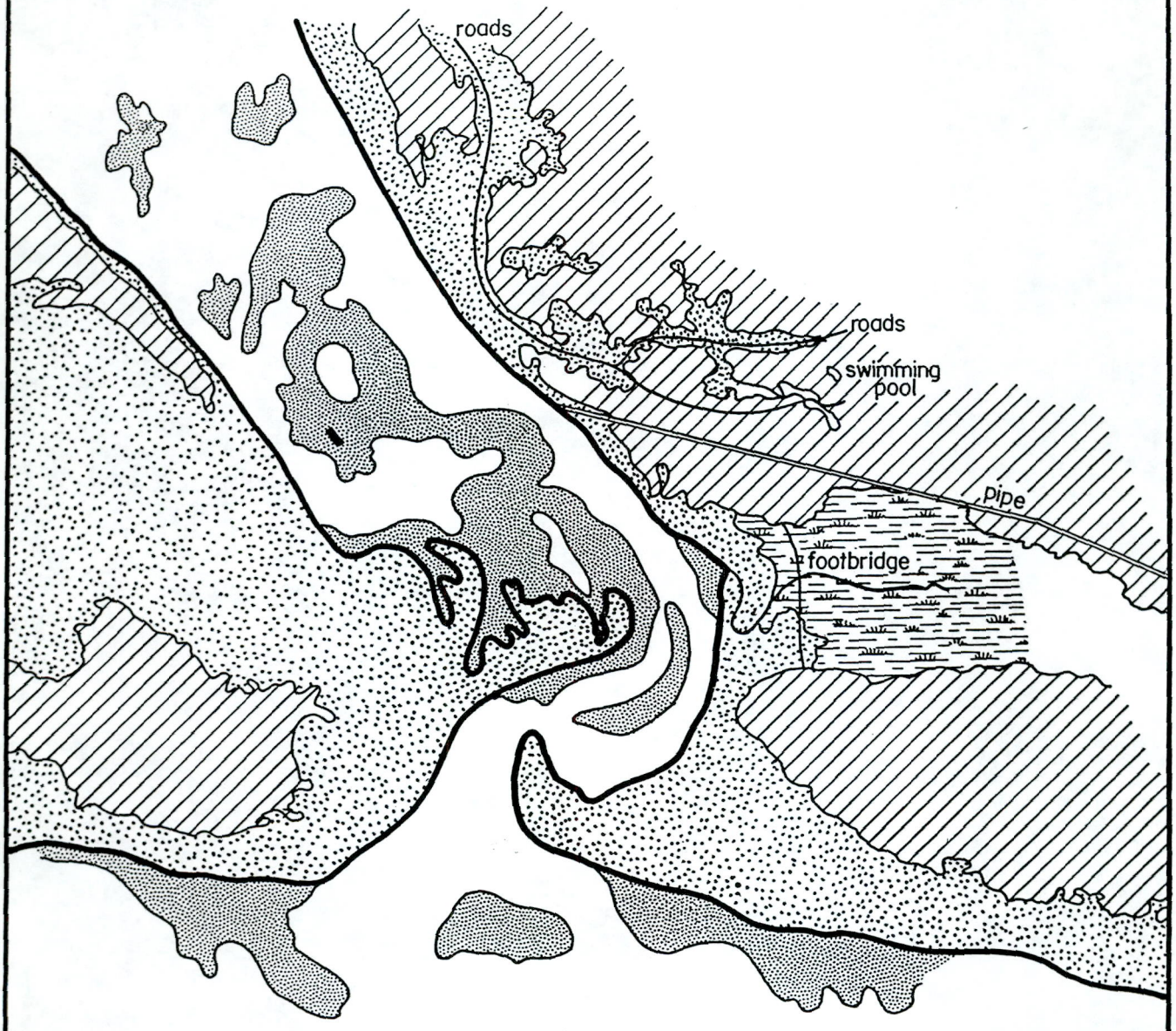
TRACED: HEW CHECKED: DATE: REF.:	ST LUCIA DREDGING AERIAL PHOTOGRAPH 21 · 8 · 86	FIGURE 41 b

NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY



TRACED: CHECKED: DATE: REF.:	ST LUCIA DREDGING AERIAL PHOTOGRAPH 3 · 11 · 86	FIGURE 41 c

NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY



Open sand

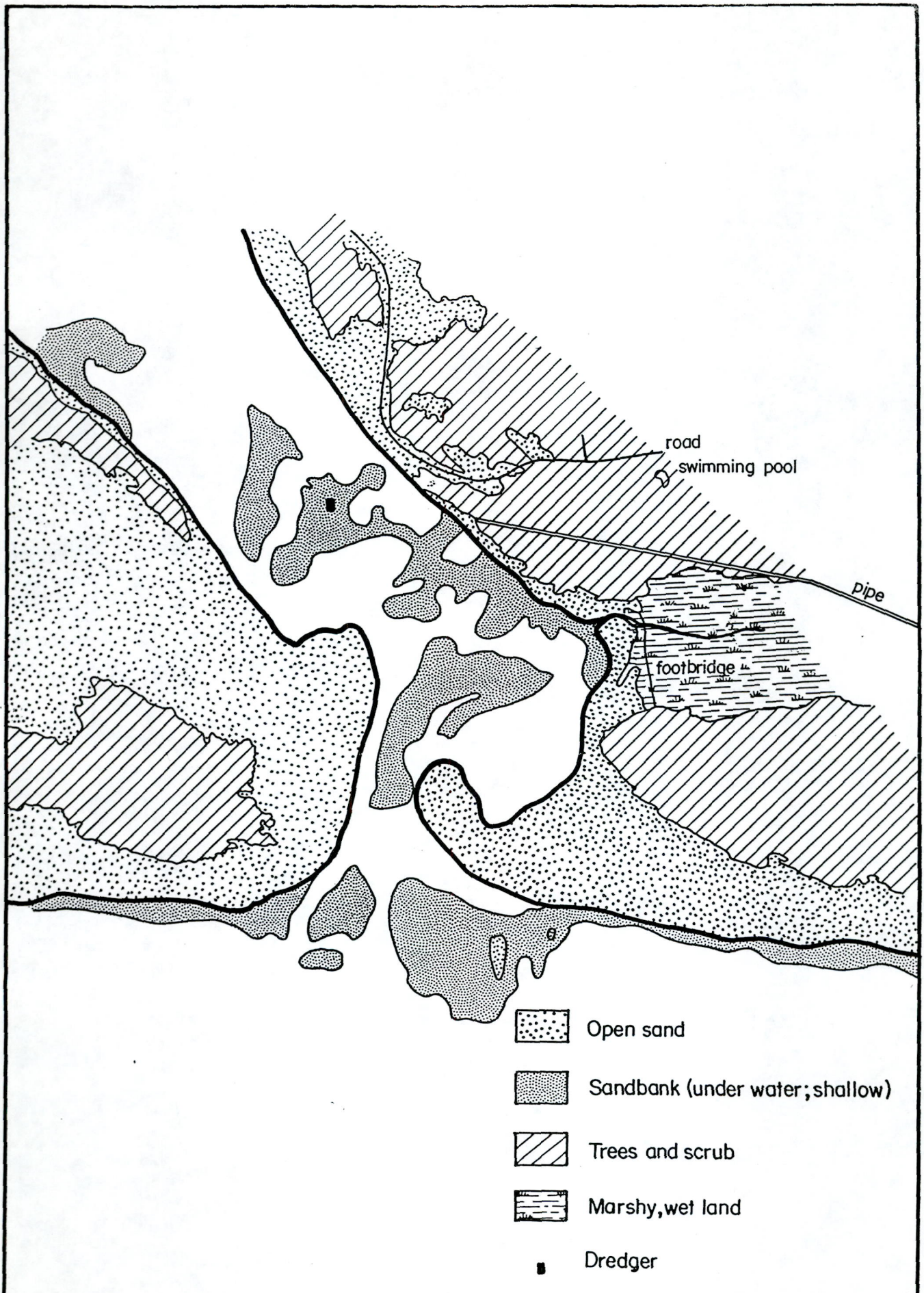
Sandbank (under water;shallow)

Trees and scrub

Marshy, wet land

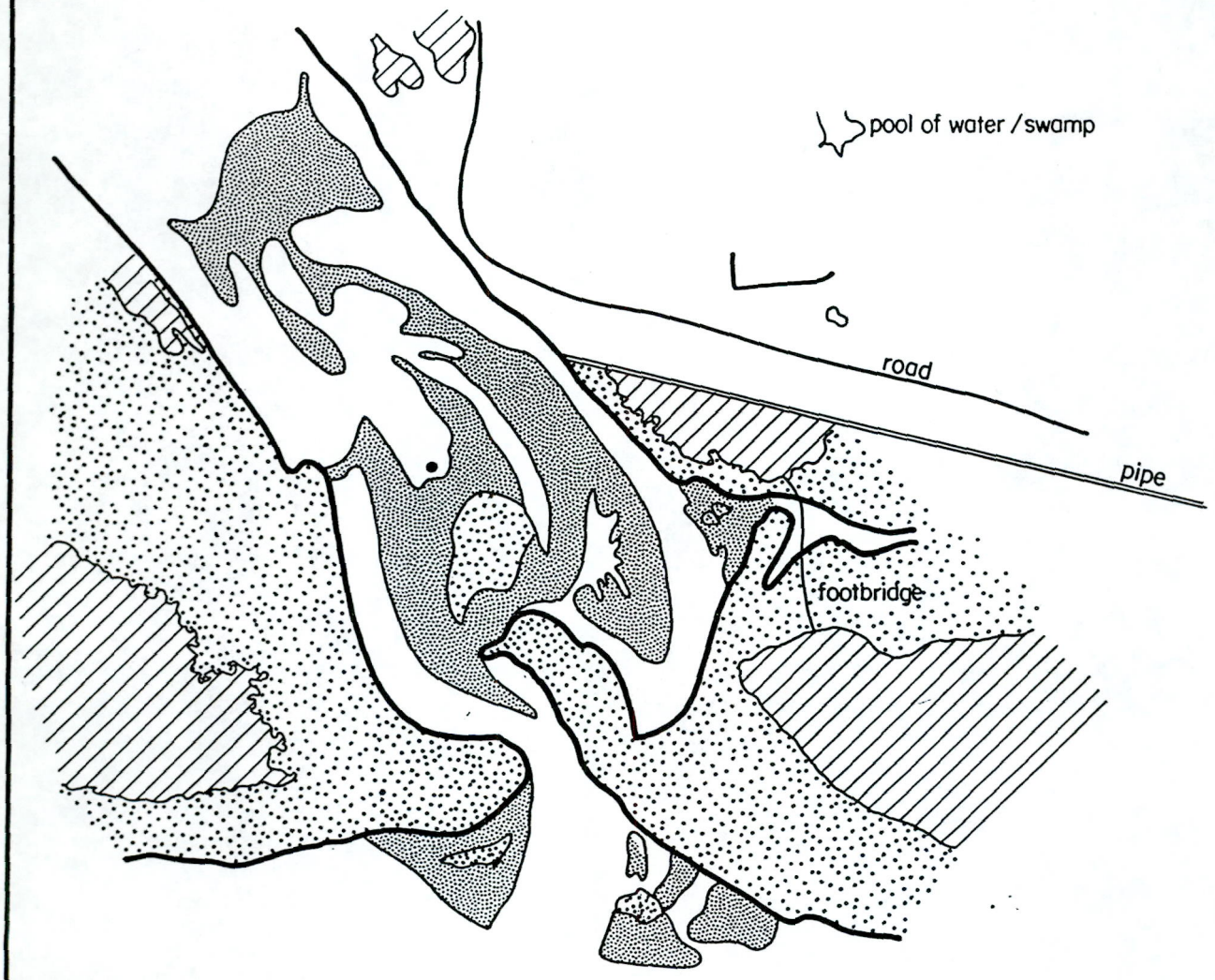
TRACED: CHECKED: DATE: REF.:	ST LUCIA DREDGING AERIAL PHOTOGRAPH 13 · 2 · 87	FIGURE 41d

NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY



TRACED: CHECKED: DATE: REF.:	ST LUCIA DREDGING AERIAL PHOTOGRAPH 13·4·87	FIGURE 41e

NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY



Open sand

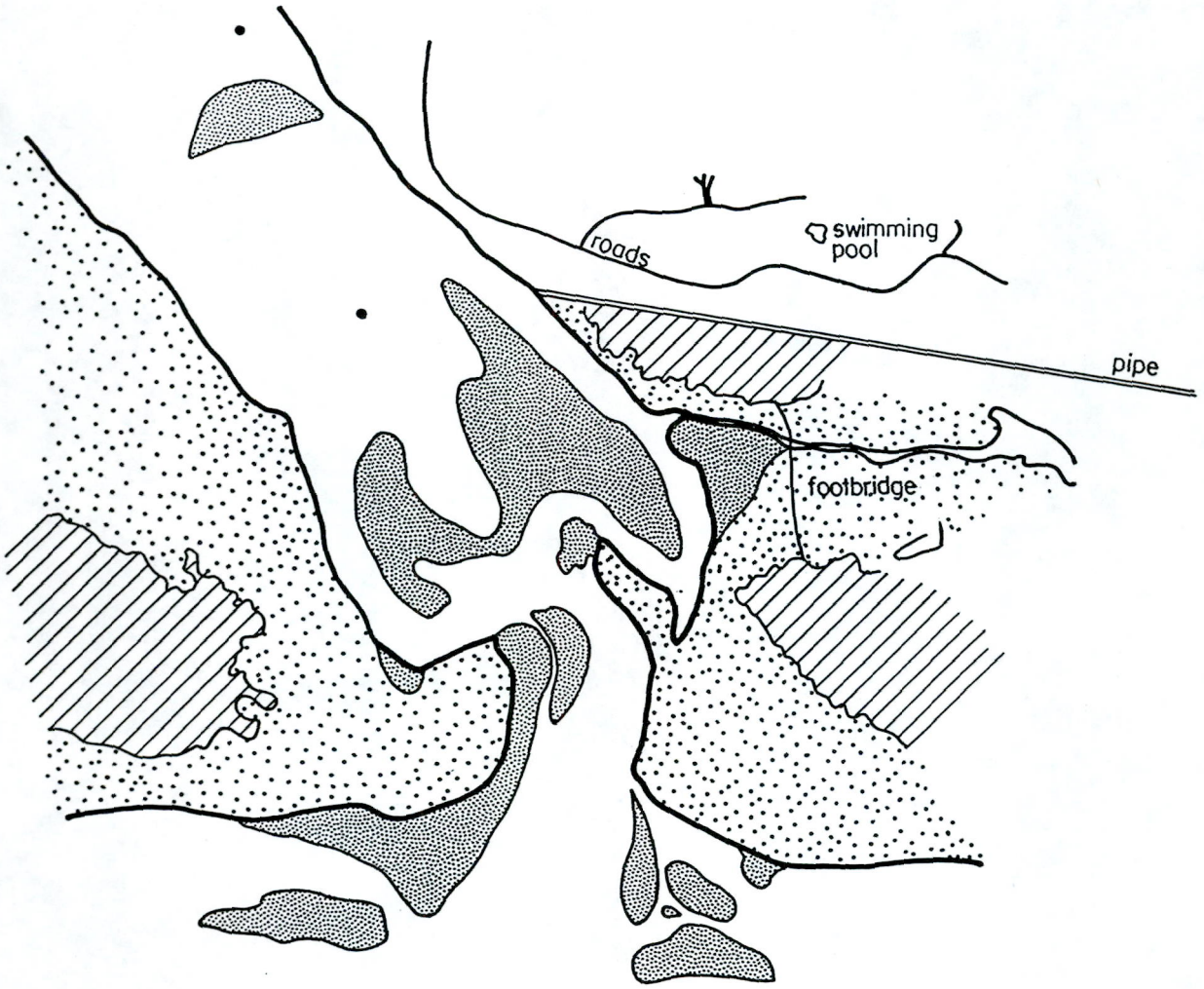
Sandbank (under water; shallow)

Trees and scrub

• Dredger

TRACED: HEW CHECKED: DATE: REF.:	ST LUCIA DREDGING AERIAL PHOTOGRAPH 10 · 7 · 87	FIGURE 41f

NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY



Open sand

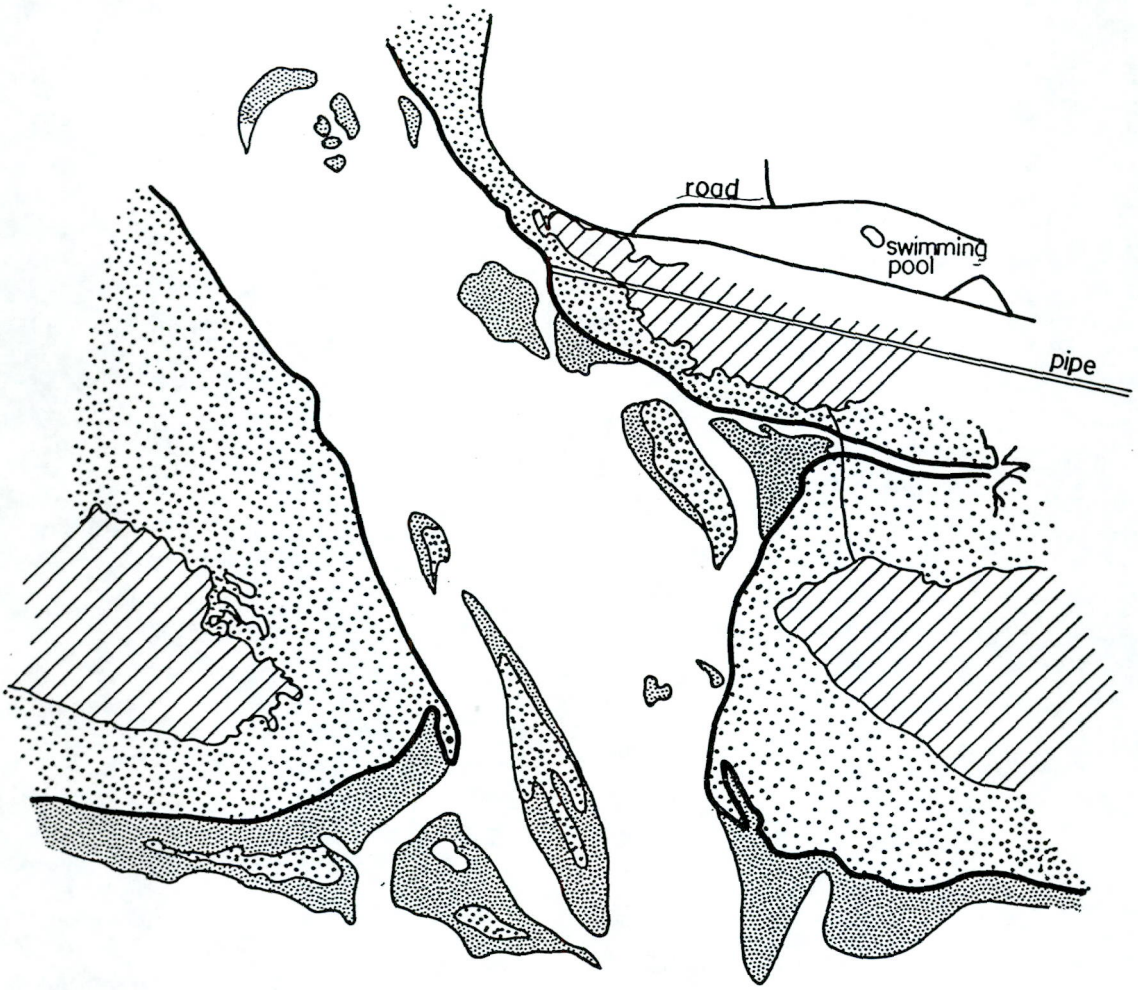
Sandbank (under water; shallow)

Trees and scrub

Dredger

TRACED: HEW CHECKED: DATE: REF.:	ST LUCIA DREDGING AERIAL PHOTOGRAPH 11 · 8 · 87	FIGURE 41g

NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY



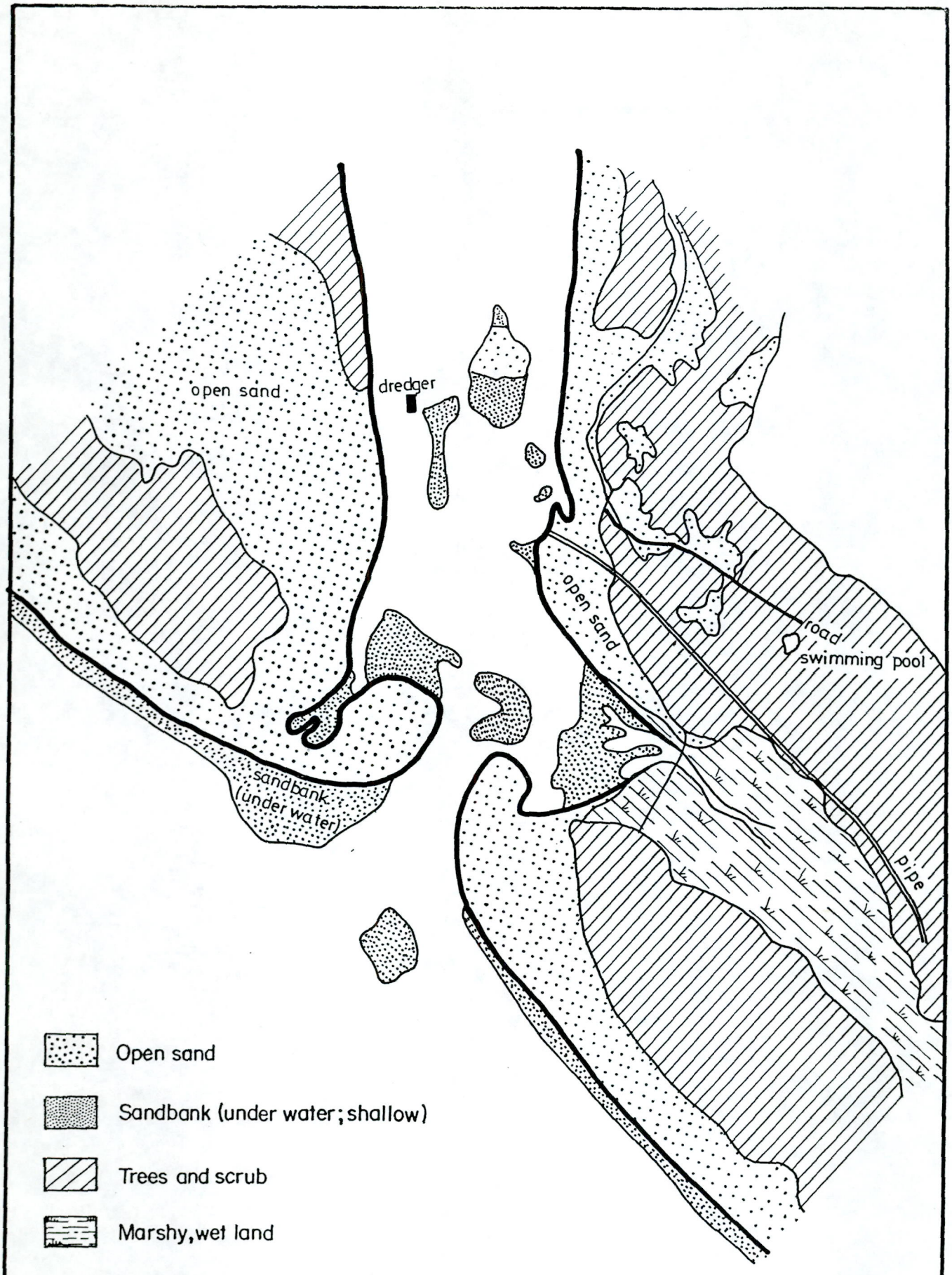
Open sand

Sandbank (under water; shallow)

Trees and scrub

TRACED: HEW CHECKED: DATE: REF.:	ST LUCIA DREDGING AERIAL PHOTOGRAPH 6·10·87 (after the flood)	FIGURE 41 h

NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY



TRACED: CHECKED: DATE: REF.:	ST LUCIA DREDGING AERIAL PHOTOGRAPH 3·2·88	FIGURE 41 i

NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY

FIG.42A: PERCENTAGE RATIO CUTS / AREA

ST.LUCIA ESTUARY

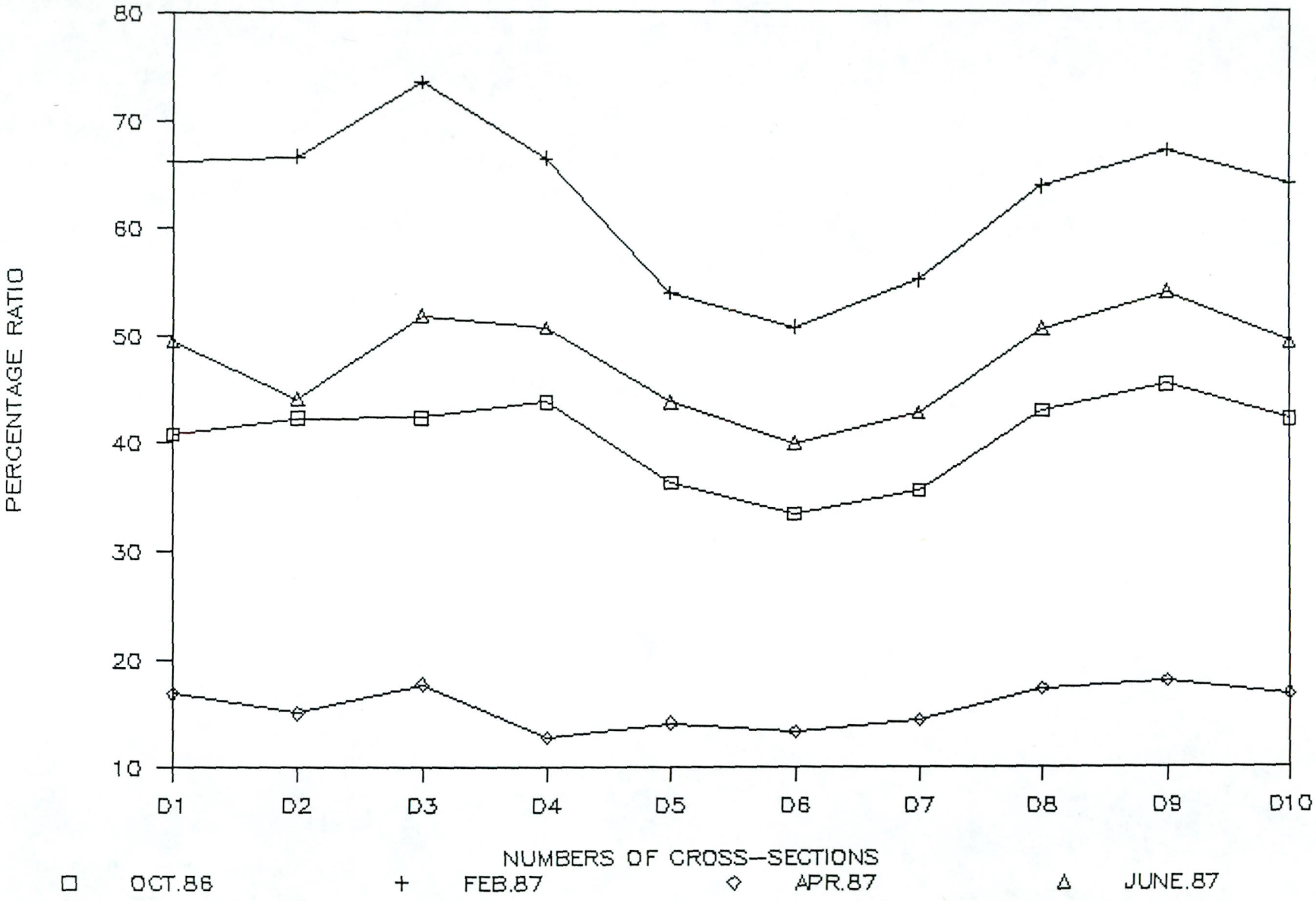


FIG.42B: PERCENTAGE RATIO CUTS / AREA

ST.LUCIA ESTUARY

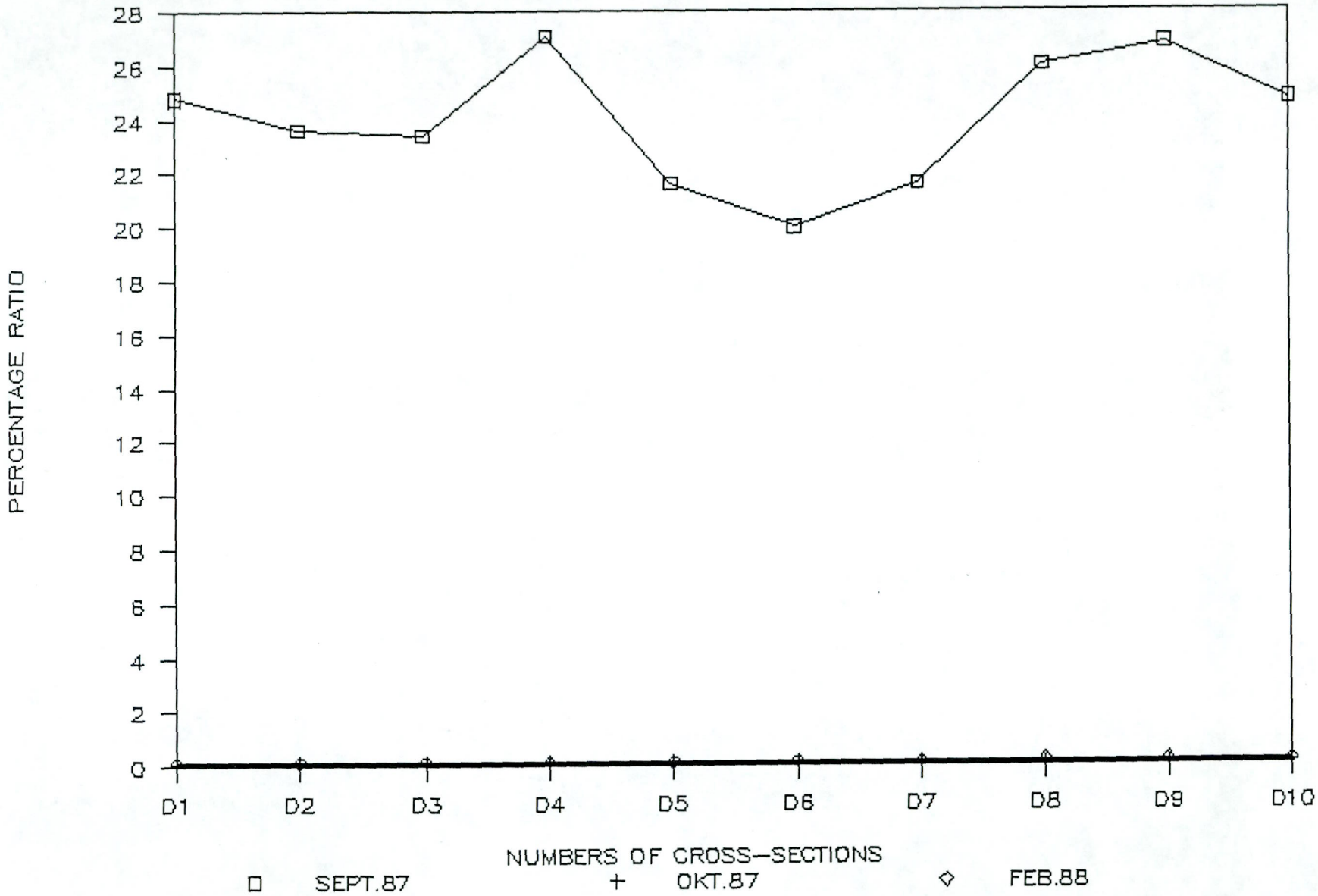


FIG 42C: RATIO CUTS / AREA ~ D3 & D4

ST. LUCIA ESTUARY

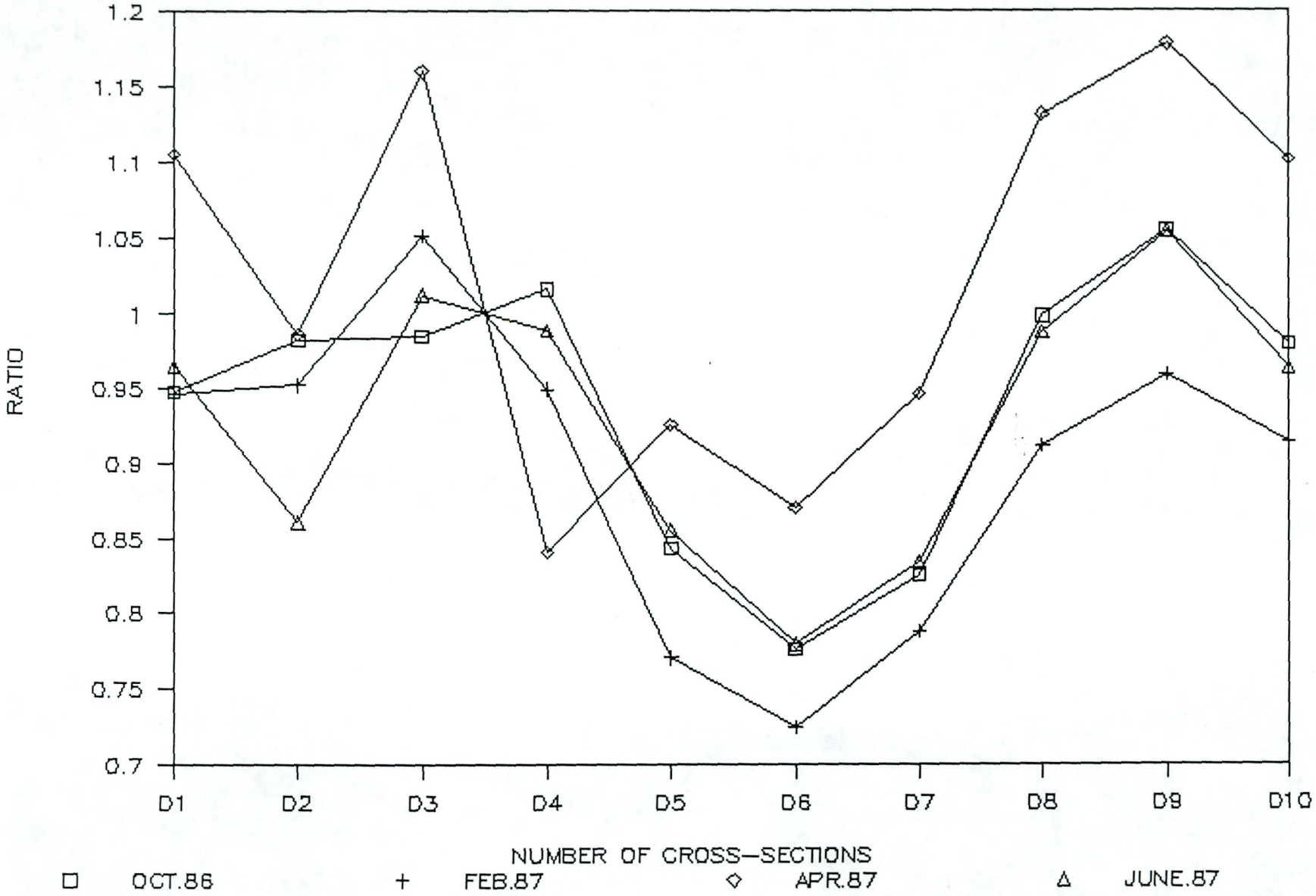


FIG 42D: RATIO CUTS / AREA ~ D3 & D4

ST. LUCIA ESTUARY

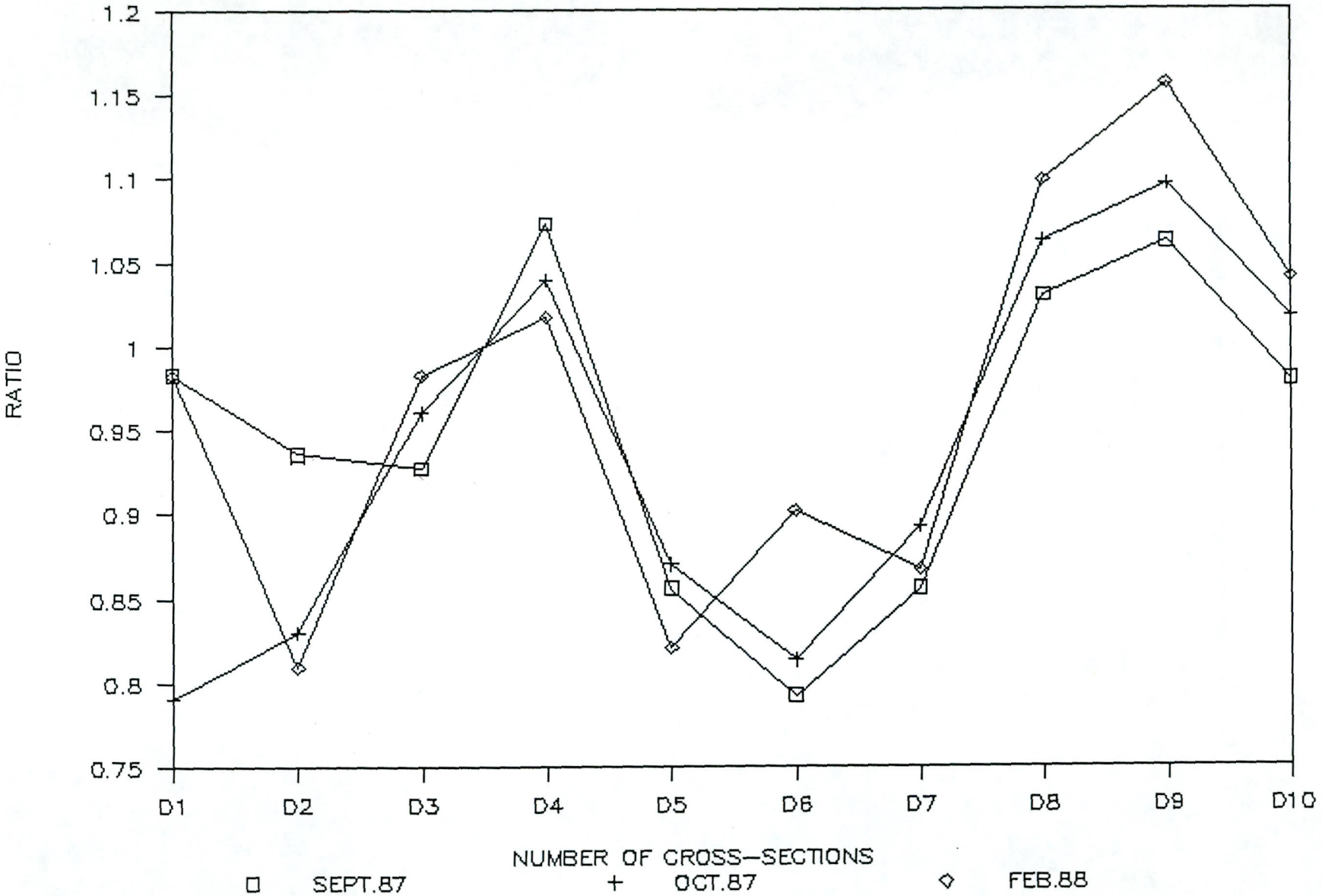


FIG 43A: CUT / AREA RATIO

ST. LUCIA ESTUARY

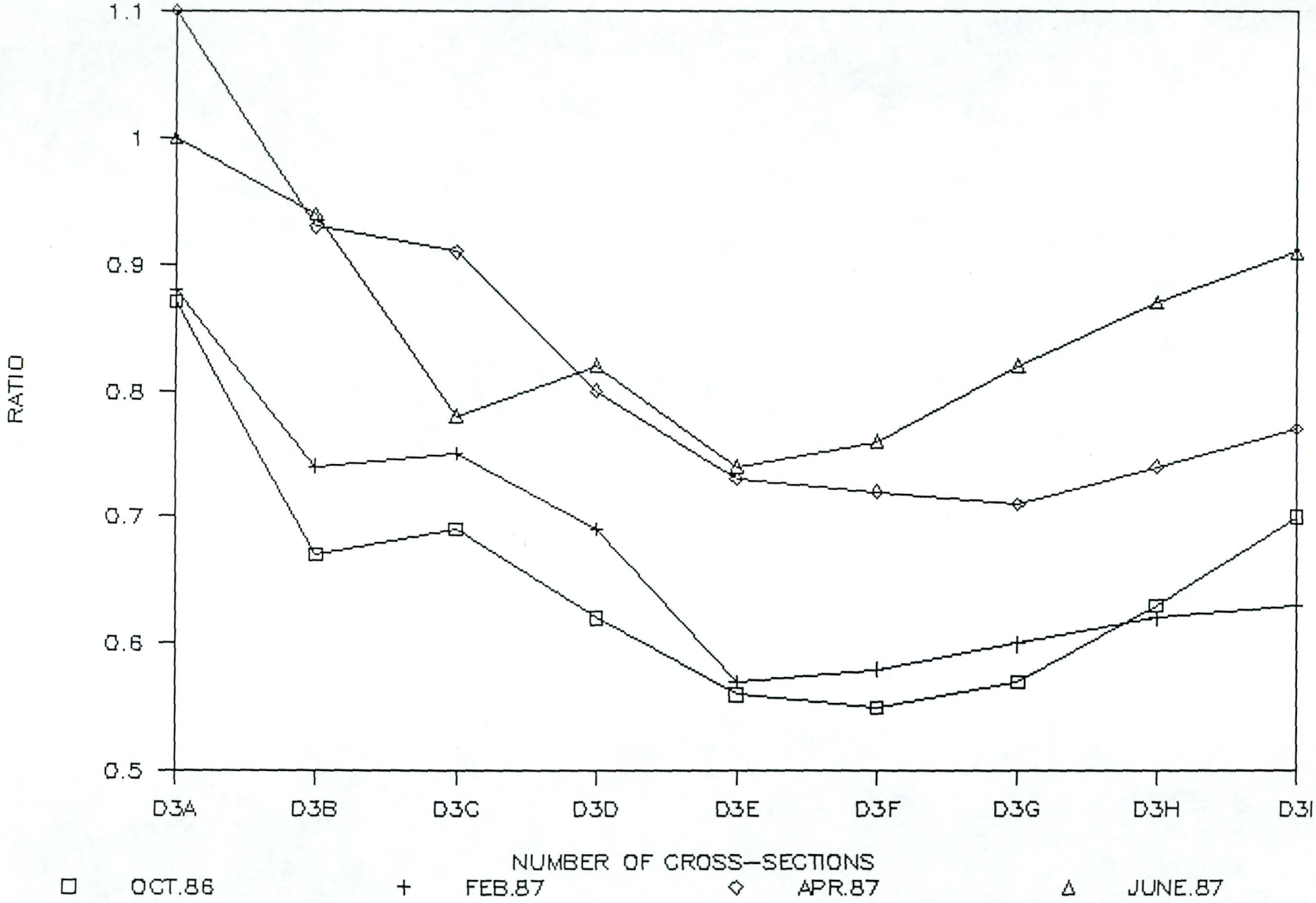


FIG 43B: CUT / AREA RATIO

ST. LUCIA ESTUARY