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Cruise Report POSEIDON 189/4 MIPAMEHR-MAST I - Investigations on Hydrothermalism at Santorini, Greece

Bericht über die Forschungsreise POSEIDON 189/4 MIPAMEHR-MAST
Untersuchungen zum Hydrothermalismus bei Santorin, Griechenland

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1. *Wissenschaftliche Fragestellung*

Die Forschungsreise POSEIDON 189/4 ist die zweite Kampagne innerhalb des Projektes "Modular Instrument Package and its Application in Mediterranean Hydrothermal Research (MIPAMEHR)", das im Rahmen des MAST-1-Programmes von der EG gefördert wird. Wissenschaftliches Ziel war die Auffindung und Evaluierung hydrothermaler Austrittsstellen am Cimotoe Seamount (Straße von Sizilien) und im Gebiet von Santorin (Griechenland).

Die Forschungsreise POSEIDON 189/4 war in ihrem Fahrtabschnitt im Arbeitsgebiet Santorin zugleich der erste Forschungsaufenthalt eines ausländischen Forschungsschiffes in griechischen Hoheitsgewässern. Dies wurde durch den Einsatz der griechischen Projektpartner ermöglicht.

Forschungsschwerpunkt des MIPAMEHR-Projektes ist die Suche und Erkundung von submarinen Austrittstellen hydrothermaler Lösungen ("hydrothermal vents" bzw. "hydrothermal plumes") vor allem im Bereich vulkanischer Inselbögen des Mittelmeeres mit Hilfe modularer Instrumentpakete. Der tektonische Rahmen und die Untersuchung von hydrothermalen "Plumes" geben Hinweise auf damit zusammenhängende erzbildende Prozesse am bzw. unter dem Meeresboden. Für die Suche und Lokalisierung von hydrothermalen Austrittsstellen wird neben seismischen, topographischen und magnetischen Indikationen das chemische Signal der hydrothermalen "Plumes" ausgewertet. Dieses soll durch on-line und in-situ Messungen verschiedener Parameter wie z.B. Temperatur, Trübung, gelöstes H_2S, Mn, Fe mittels Sensoren erfolgen. Die Meßergebnisse werden mit Navigationsdaten kombiniert und kartographisch dargestellt, so daß aus der Form und Dimension der Konzentrationsgradienten in Isolinienkarten auf die Lage der hydrothermalen Quellen geschlossen werden kann. Die on-line-Meßergebnisse der Sensoren werden durch die Analyse von gleichzeitig genommenen Wasserproben auf weitere "Tracer"-Elemente wie z.B. gelöstes Methan, Mn, Fe, Zn, Seltene Erden ergänzt. Nach der Lokalisierung eines submarinen Hydrothermalfeldes erfolgt mit den visuellen Unterwassertechniken des OFOS ("Ocean Floor Observation System") eine detaillierte Untersuchung.

Im Rahmen des MIPAMEHR-Projektes wurde in wissenschaftlich-technischer Zusammenarbeit ein Paket chemischer ASCREV-Sensoren (für Fe, Mn, Zn, Pb) entwickelt (University of Newcastle, England) und in das modifizierte OFOS-Modul (GTG, Kiel) integriert, so daß dieses System später auch von kleineren Forschungsschiffen eingesetzt werden kann. Ein neu implementiertes Transponder-Navigationssystem erlaubt dabei eine sehr genaue Positionierung des OFOS in allen drei Dimensionen.

Ein Problem zuverlässiger Gaskonzentrationsmessung im Tiefenwasser stellt die eventuelle Entmischung von Gasen während des Hievvorganges des Wasserschöpfers infolge von Druckentlastung dar. Das gilt allerdings nur dort, wo eine Sättigung oder Übersättigung des Wassers an gelösten Gasen vorkommt. Eine solche Situation ist im Bereich hydrothermaler Austritte möglich und kann im flachen Wasser durch Blasenbildung auch erkannt werden. Daher wurde ein gasdichter Wasserschöpfer entwickelt, der eine verlustfreie Beprobung gelöster Gase wie Helium, Kohlendioxid und besonders von Methan als Indikator für hydrothermale Aktivität - auch in Wasserproben aus Wassertiefen > 3000 m - gewährleistet (GCA, Lehrte). Die Methananalysen wurden sofort an Bord durchgeführt.

Mit einer neu entwickelten Methode zur Anreicherung von Spurenelementen können Elemente wie Fe, Mn, Zn, Seltene Erden, die als Tracer in hydrothermalen "Plumes" dienen, aus Seewasser automatisch extrahiert und on-line mit dem ICP-Massenspektrometer oder einem anderen Analysenverfahren gemessen werden (GPI, Universität Kiel). Mit Hilfe dieser Methode sollen die während der Reise genommenen Wasserproben nach der Rückkehr in das Heimatlabor Kiel untersucht werden. Mit den Ergebnissen läßt sich der Hydrothermalismus und seine räumliche Verbreitung weiter charakterisieren.

Die Vorerkundung höffiger submariner Hydrothermalgebiete im Bereich des Ägäischen Inselbogens erfolgte mit geophysikalischen und meeresgeologischen Methoden (National Centre for Marine Research, Athen, Griechenland).

Die Forschungsreise POSEIDON 189/4 wurde im Rahmen des MIPAMEHR-Projektes unter zwei Aspekten durchgeführt: erstens sollte eine erstmalige Felderprobung der neuentwickelten Einzelkomponenten - modifiziertes OFOS und Transponder-Navigationssystem, elektrische und ASCREV-Sensoren ("UNT sensor package") , Gaswasserschöpfer - für sich sowie im Verbund mit dem gesamten Explorationssystem durchgeführt werden. Zweitens sollte mit diesen neuen Techniken und mit bereits etablierten Methoden das wissenschaftliche Ziel - die Auffindung und Evaluierung hydrothermaler Austrittsstellen am Cimotoe Seamount (Straße von Sizilien) und im Gebiet von Santorin (Griechenland) - erreicht werden. Insbesondere sollten OFOS-Beobachtungen des Meeresbodens und gleichzeitig direkt übermittelte chemische Sensordaten Aussagen über das Vorkommen von geochemischen Anomalien ermöglichen. Darüberhinaus wurde eine systematische Probennahme durchgeführt, um die hydrothermale Aktivität insbesondere im Bereich von Santorin mit in diesen Gebieten bisher nicht untersuchten geochemischen Parametern wie gelöstes Methan, Seltene Erden weiter zu charakterisieren.

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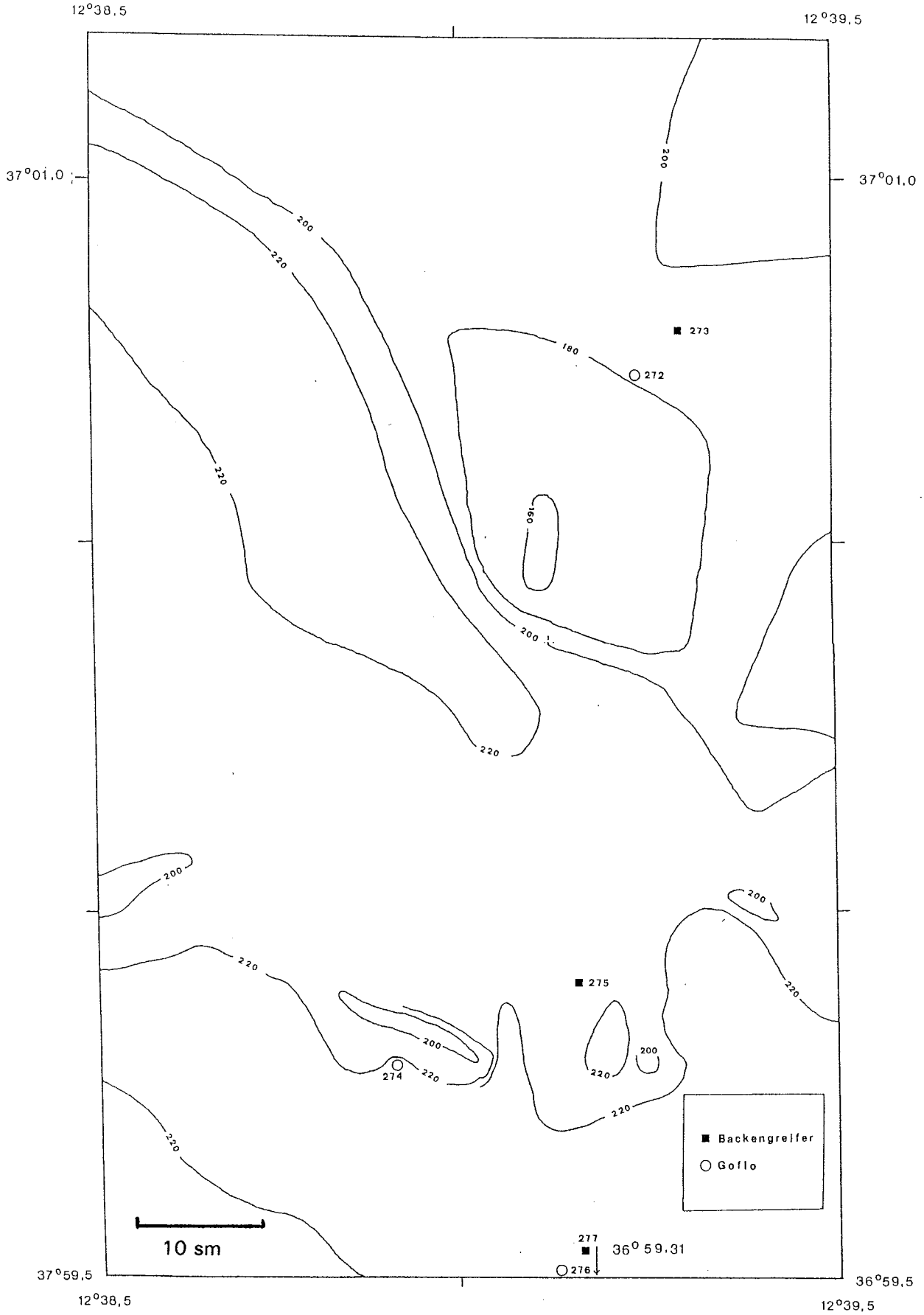

Abb. 2-1: Übersicht über Arbeitsgebiet und Stationen am Cimotoe-"Seamount", Straße von Sizilien, im Rahmen der POSEIDON 189/4 Forschungsreise (Bathymetrie aus Puteanus 1990)

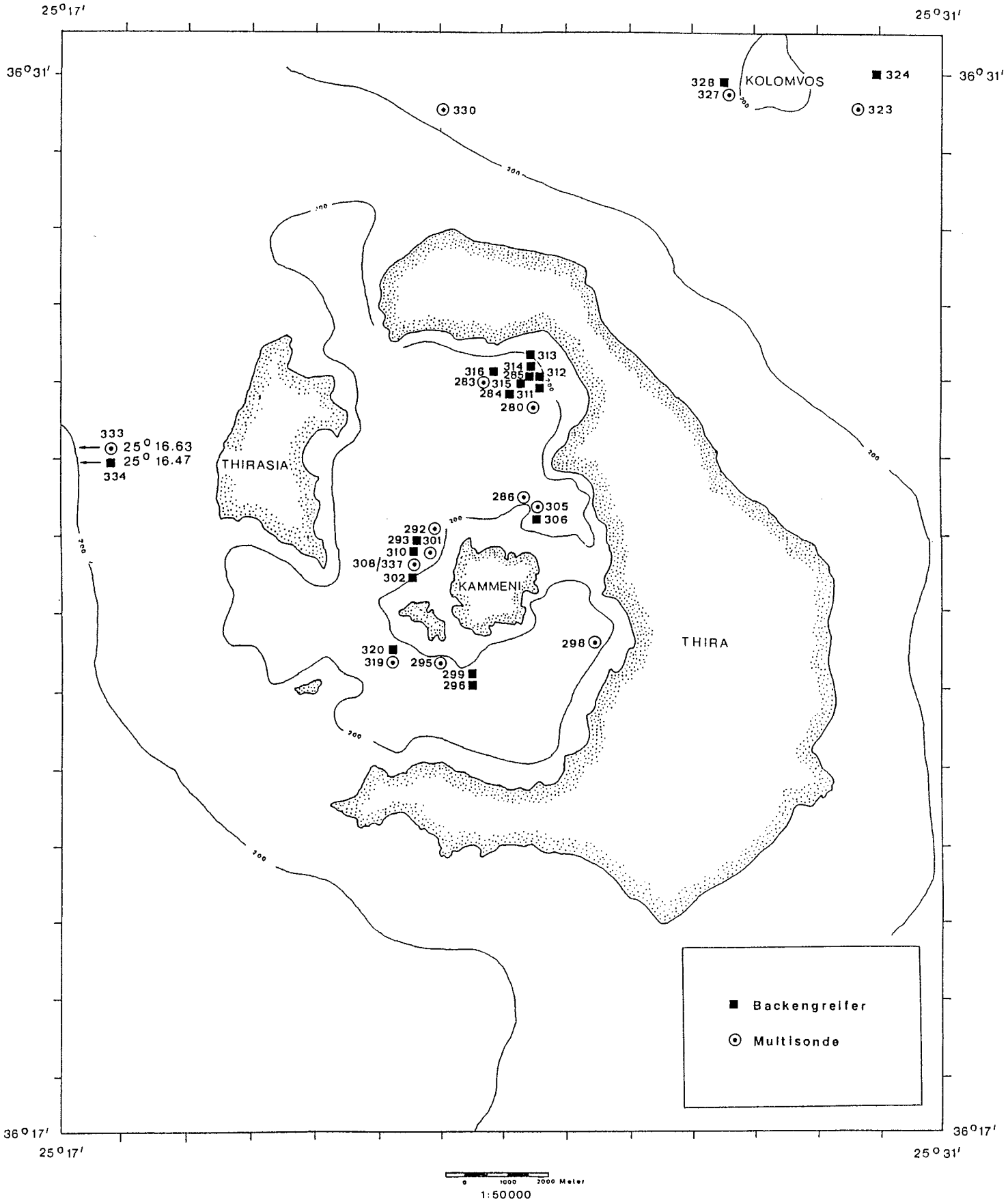

Abb. 2-2 a: Übersicht über Arbeitsgebiet und Stationen im Bereich von Santorin, Griechenland, im Rahmen der POSEIDON 189/4 Forschungsreise: Einsätze von Backengreifer und Multisonde

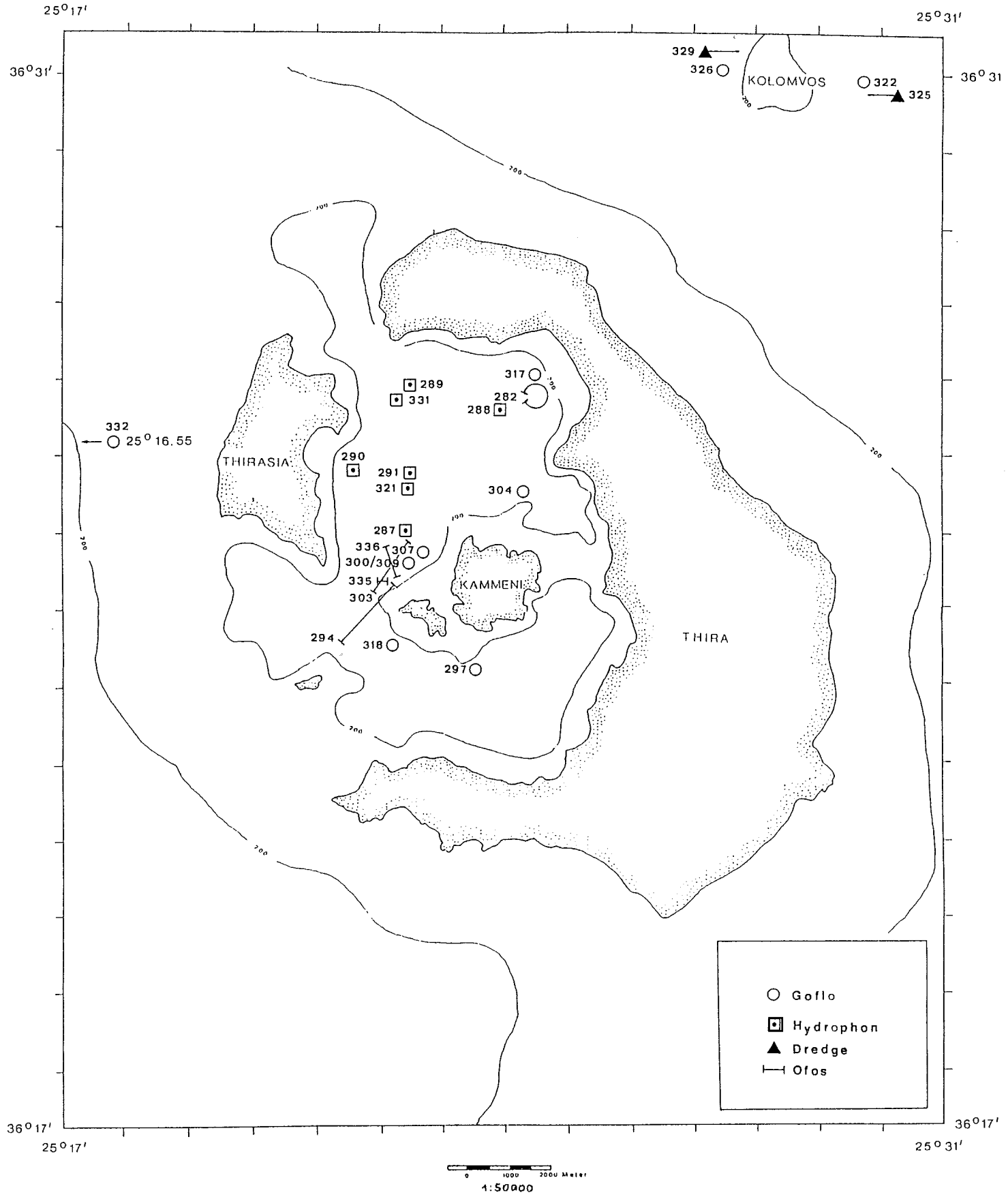

Abb. 2-2 b: Übersicht über Arbeitsgebiet und Stationen im Bereich von Santorin, Griechenland, im Rahmen der POSEIDON 189/4 Forschungsreise: Einsätze von GO-Flo-Wasserschöpfer, Hydrophon/ Transpondern, Dredge und OFOS

2. *Fahrtverlauf*

26.3.1992

Eintreffen von sechs Kieler Wissenschaftlern an Bord von FS Poseidon in Messina um ca. 15.00 Uhr. Beginn des Aufbaues der Spurengasanalytik im Geologie-Labor (M. Schmitt). Im Chemie-Labor Aufbau des Meerwasser-Filtrierstandes in einer Clean-bench (Probenvorbereitung für nachfolgende Spurenelement-Analytik) sowie der Meßplätze für gelösten Sauerstoff, Salzgehalt, Titrationsalkalinität und pH (D. Garbe-Sch.).

Auslaufen Messina um 24.00 Uhr. Erstes Ziel ist das Gebiet am und um den CIMOTOE-Seamount (LAT. 37°00.71; Long. 12°39.11), wo während der Forschungsfahrt Poseidon 172-4 Untersuchungen bezüglich Hydrothermalismus durchgeführt wurden (Abb. 2-1). Die damaligen Messungen der Methangehalte waren erst nach der Fahrt 172-4 durchgeführt worden und daher jetzt durch die sofortige Analyse an Bord zu überprüfen.

27.3.1992

Dampfzeit zum Arbeitsgebiet CIMOTOE-Seamount. Besprechung mit Wissenschaftlern und Arbeitseinteilung. Einrichten der Labors. Auspacken des Containers. Zusammenbau und Testen der Apparaturen. Vorplanung der Arbeiten am CIMOTOE-Seamount. Es sollen nur Stationen der Fahrt 172-4 angelaufen werden, die in Detailkarten vermerkt sind.

28.3.1992

Schlechtes Wetter. Nur GOFLO und Backengreifer eingesetzt.
09.30 auf Station (272 GF). Vier Schöpfer eingesetzt an der Position, wo im Fahrtbericht der Reise Poseidon 172-4 erhöhte Kohlenwasserstoffmengen im Wasser festgestellt wurden (Lat. 37°00.71; Long. 12°39.11; WT 185 m). Die Fallgewichte lösen nicht aus. Um 10.00 Uhr Wiederholung des Einsatzes mit 5 Schöpfern. Da einige Schöpfer stark undicht sind, werden aus diesen nur etwa 1-2 l Wasser erhalten. An der gleichen Position wird um 10.30 Uhr ein Backengreifer (273 BG) gefahren, der voll mit grünlich-grauem, tonigem Sediment und vereinzelt grobem Muschelbruch gefüllt an Deck kommt. Die folgenden Stunden werden die Wasserproben analysiert (Methan, Geochemie). Die nach wie vor rauhe See läßt weiterhin nur den GOFLO und Backengreifer-Einsatz zu. Um 13.10 Uhr wurden an der Station 274 GF (Lat. 36°59.85; Long. 12°38.88; WT 200 m - 230 m durch Drift) 4 GOFLO Schöpfer gefahren. Anschließend an die Untersuchungen der Wassersäule wird der Backengreifer an der gleichen Lokation eingesetzt (275 BG). Der Inhalt des Greifers besteht aus Korallenbruch.

Zwei Stunden Analysenzeit (Methan, Geochemie). Um 16.00 Uhr wurde ein weiterer kombinierter GOFLO und Backengreifer Einsatz durchgeführt (Lat. 36°59.55; Long. 12°39.15; WT ca. 220 m, 276 GF und 277 BG). Der Backengreifer war mit grauem Schlamm gefüllt.

29.3.1992

Weitere Zunahme des Seeganges. Windstärke bis 9 Bft. Nach Besprechung mit Kapitän Andresen und dem Abhören des Wetterberichtes werden die Arbeiten am CIMOTOE-Seamount abgebrochen. Ablaufen in Richtung Griechenland um 08.00 Uhr.

Zusammenfassung der Arbeiten am CIMOTOE-Seamount

Die beiden Tage waren durch rauhen Seegang bestimmt. Es konnten nur GOFLO und Backengreifer ohne Risiko eingesetzt werden. Die angelaufenen Stationen am CIMOTOE-Seamount wurden mit dem Ziel untersucht, eventuelle Hinweise auf möglichen Hydrothermalismus zu erhalten. Insbesondere wurden Stationen angelaufen, wo bereits für Poseidon 172-4 Untersuchungen der Sedimente und der Wassersäule durchgeführt wurden. Die damaligen Beobachtungen (Fe-hydroxide, Methan und höhere KW; vgl. Puteanus, 1990) konnten nicht bestätigt werden. Leider konnten die Arbeiten in der Wassersäule am CIMOTOE-Seamount während der Reise 189-4 wegen des starken Seeganges nicht abgeschlossen werden, so daß zu dem gegenwärtigen Zeitpunkt keine Entscheidung über eventuell hier vorkommenden Hydrothermalismus getroffen werden kann.

30.3.1992

Dampfzeit. Um ca. 14.00 Uhr wird die Wasserstation 278 MS gefahren. Wassertiefe ca. 3500 m. Test des Balgwasserschöpfers. 12 Schöpfer wurden in 1000 m WT ausgelöst. Der Versuch in 3480 m WT Schöpfer auszulösen ist nicht erfolgreich, da Spannungsabfall an der Sonde zu registrieren war.

31.3.1992

Dampfzeit. Um 13.15 Uhr auf der Wasserstation 279 MS. Es erfolgte wiederum bei ca. 2400 m ein Spannungsabfall an der Sonde. Es wird die Reparatur eines Kabelfehlers durchgeführt. Ein zweiter Versuch, die Sonde auf Tiefe zu fahren, muß aber dennoch aus den gleichen Gründen abgebrochen werden.

1.4.1992
Dampfzeit.

2.4.1992
Ankunft morgens in Santorin. Einklarieren, Zoll, Organisation des Transports vom und zum Schiff.

3.4.1992
Um 12.30 Uhr Eintreffen der englischen bzw. griechischen Teilnehmer bzw. Gäste und von Herrn Haushahn von der Firma ADM an Bord. Planung der Arbeiten mit Varnavas, Anagnostou und Marshall. Griechen von Bord um 15.15 Uhr. Engländer arbeiten am OFOS. Die fünf Sensoren Eh, pH, Fe, H_2S, T werden von der englischen Arbeitsgruppe installiert. FS Poseidon liegt fest an der Boje.

4.4.1992
0.8.30 Uhr Griechen an Bord (Die griechischen Gäste mußten an Land im Hotel übernachten, da 15 Wissenschaftler auf FS Poseidon nicht untergebracht werden können). Wasserstation (280 MS) auf Vorschlag Varnavas in einer Bucht der Caldera (Lat. 36°26.64; Lon. 25°24.32), in der Hydrothermalaktivität vermutet wird (Abb. 2-2a und 2-2b). Um 10.25 Uhr wird der OFOS an der gleichen Position probeweise eingesetzt (281 OFOS). Um 13.00 Uhr wird der OFOS auf Vorschlag Varnavas wiederum in dieser Bucht (siehe Detailkarte) eingesetzt (282 MS). Die erkennbaren Sedimente haben fleckenhaft verteilt kleine (2 bis 5 cm im Durchmesser) Löcher bzw. "Krater", die wahrscheinlich biogenen Ursprungs sind. Dazu fallen helle Flächen (vielleicht "Bakterienrasen" ; Kommentar von Varnavas) auf. Ferner fallen polygonalähnliche Sedimentstrukturen (Krusten?) auf. Auch die folgende Wasserstation (283 MS) erbringt keine Methananreicherungen, die auf eine Hydrothermalquelle in der untersuchten Bucht hinweisen würde. Bei 36°26.977 LAT. und 25°24. 078 LON. erwähnt ein Engländer eine Änderung in den Aufzeichnungen des H_2S Sensors. Backengreifer (284 BG) erbrachte rote und schwarze Krusten und viel Detritus des nahegelegenen Kraterrandes.

Die Engländer bauen ihre Sensoren vom OFOS ab und verlassen das Schiff um ca. 18.00 Uhr.

5.4.1992

Um 08.45 Uhr Wasserstation (286 MS) bei Nea Kammeni. Die Transponder werden anschließend ausgelegt. Ein Backengreifer bei Nea Kammeni (293 BG) erbrachte braunen Kies und Sand und grünen feinkörnigen Schlamm. Um 14.00 Uhr OFOS- Einsatz entlang der von Varnavas erwähnten Hauptstörungszone (Kurs 030). Die Wasserstation (295 MS) erbrachte keine Methananomalie. Der Backengreifer (296 BG) war mit rotem Schlamm gefüllt. Varnavas und Mitarbeiter sowie Begleiter von C. Anagnostou gehen von Bord.

6.4.1992

Auslaufen 08.30. Fortsetzung der Arbeiten in der Caldera. 08.45 GOFLO (297 GF) (LAT. 36°23.53; LON. 25°23.75). 09.15 Kranzwasserschöpfer an der gleichen Position (298MS). Danach ein Backengreifer (299BG). 10.15 Uhr Beginn der Kalibrierung für die Transponder-Navigation. 13.30 Uhr GOFLO (Lat. 36°24.45; LON. 25°22.60); Kranzwasserschöpfer und Backengreifereinsatz an gleicher Position (300GF, 301MS, 302BG, Ergebnisse siehe in den Stations-Protokollen im Anhang). 15.00 Uhr Fortsetzung des OFOS-Tracks entlang der Hauptstörung (303OFOS). Danach Einsatz von GOFLO, Kranzwasserschöpfer und Backengreifer (304GF, 305MS, 306BG). 18.00 Einlaufen und Probenbearbeitung.

7.4.1992

8 bis 9 Bft Windstärke. Daher nicht Auslaufen zum COLOMBOS-Seamount wie geplant, sondern ab 08.00 Uhr Fortsetzen der Arbeiten in der Caldera. 08.30 GOFLO, Multisonde/ Schöpfer und Backengreifer an der Position Lat. 36°24.67; Lon. 25°22.88 (307GF, 308MS, 309GF, 310 BG). Von 10.00 Uhr bis ca. 12.00 Uhr wurde ein Backengreiferprofil entlang der 200 m Wasserlinie (Start LAT 36°27.10; LON. 25°24.71) sowie ein GOFLO gefahren. Die Sedimentbeschreibungen finden sich bei den Stationsprotokollen (311bis 316BG, 317GF). Im allgemeinen wurde vor allem Detritus von der sehr nahegelegenen Kraterwand erhalten. Allerdings enthielt ein Backengreifer rötlichen Schlamm eventuell hydrothermaler Herkunft. 12.30 Uhr GOFLO, Schöpfer und Backengreifer an der Station 36°23.70 LAT. und 25°22.25 LON (318GF, 319MS, 320BG). Der weitere Einsatz des OFOS und die Stationen GOFLO, Multisonde und Backengreifer bei Therasia mußten wegen starken Seeganges ausfallen. Abschließend wurde ein Kurs zum Test der Transponder-Navigation gefahren (321XP). Einlaufen um 17.00 Uhr.

8.4.1992

COLOMBOS-Seamount. Der geplante OFOS-Einsatz wurde nicht durchgeführt, da die Kartenangaben bezüglich der Wassertiefen sehr falsch lagen und bordseitig keine Karten erstellt werden konnten. Die 200 m Wassertiefen-Linie ist ca. 1 sm verschoben gegenüber den Kartenangaben. Am COLOMBOS wurden 4 Wasserstationen (322GF, 323MS, 326GF, 327 MS; siehe Karte) sowie zwei Backengreifer (324BG, 328 BG) gefahren. Die CTD-Daten der Multisonde lassen einen gut durchmischten Wasserkörper erkennen. Auch hier durfte nur bis 200 m Wassertiefe gearbeitet werden. Es wurden 2 Dredgen gefahren (bergaufwärts), die mit fast ausschließlich Bims-Tuff gefüllt an Deck kamen (325DR, 329 DR). Eine Referenzwasserstation auf der Rückfahrt am Eingang zur Caldera (330 MS) erbrachte ähnliche Methankonzentrationen wie in der Caldera und auch am COLOMBOS-Seamount.

9.4.1992

Auslaufen 08.00 Uhr. Wasserstation (333 MS) außerhalb der Caldera. OFOS-Einsatz Kurs 320 senkrecht zur Störung (und senkrecht zu den langen OFOS-Tracks vom 5.4. und 6.4.) in 2 kurzen Profilen. Abbruch der Arbeiten 13.00 Uhr. Transponder aufnehmen. Wasserstation 337 MS zur Verifizierung von 292 MS. Einlaufen ca. 15.30 Uhr.

10.4.1992

Ausklarieren, Zollabwicklung. 11.00 Auslaufen in Richtung Korinth-Kanal.

11.4.1992

08.00 Eintreffen am Korinth-Kanal. Durchfahrt. Ablaufen in Richtung Messina.

12.4.1992

Dampfzeit. 08.00 Uhr Multisondentest auf 3200 m Wassertiefe (338 MS, Koordinaten siehe Stationsprotokolle). Die Schöpfer lösen aus. Methandaten deutlich niedriger als im Bereich Santorin. Fehler am Trübungsmesser, daher vor dem Einsatz abgeklemmt (Haushahn).

13.4.1992

08.00 Einlaufen Messina. Löscharbeiten auf LKW. Verabschiedung.

Die Genehmigung der griechischen Behörde zur Durchführung von Forschungsarbeiten mit FS POSEIDON im Bereich von Santorin während der Reise Poseidon 189/4 beschränkte die Arbeiten auf Wassertiefen größer als 200 m. Dies war insofern nachteilig für unser Vorhaben, als die Beprobung von hydrothermalen Austrittsstellen im Flachwasser bei den vulkanisch aktiven Kammeni Inseln nicht durchgeführt werden konnte. Proben von diesen Quellen für hydrothermale Produkte im Flachwasser wären zu Vergleichszwecken von sehr großem wissenschaftlichen Wert gewesen.

STATISTIK

Insgesamt	65	Stationen,
davon	13	GOFLO-Schöpfer-Stationen,
	16	MS Multisonde-/ NISKIN-Schöpfer-Stationen,
	20	BG Backengreifer-Stationen,
	2	DR Dredge-Stationen,
	6	OFOS-Stationen,
	8	XP Transponder-Stationen

Die detaillierten Stationsberichte sind im Anhang 11.1 "Station Reports" enthalten.

3. *Geology of the CIMOTOE area*

The CIMOTOE Seamount is located in the Strait of Sicily. The Strait of Sicily is characterized by shallow water depth dividing the Mediterranean Sea into western and eastern basin. The sea region belongs to the northern part of the African plate and is floored by continental crust which is covered by Mesozoic/ Cenozoic sediments. Generally, water depths are shallow (on average about 350 m; Colantoni 1975) but reach 1350, 1580, and 1720 m in three major depressions of the Pantelleria, Linosa, and Malta basins, respectively. Tensional and shear faults trending NW-SE predominate. Structurally, Calanchi et al. (1989) have divided the Strait of Sicily rift system into a central rift zone with the Pantelleria, Linosa and Malta grabens, and the western and eastern plateaus. The eastern plateau includes the Adventure Bank to the northwest as well as Graham and Nameless Bank. The Cimotoe seaumount lies between Graham and Nameless Bank. The volcanic nature of the axial islands of the Strait of Sicily (Pantelleria and Linosa) has been recognized for a long time. Numerous volcanic centres have been inferred or recognized in the area but quantitative data on submarine volcanism are scarce (Carapezza et al. 1979; Beccaluva et al. 1981). Details of the geology and results from a geophysical survey during POSEIDON 172/4 can be found in Puteanus (1990).

4. *Results from the CIMOTOE area*

4.1 *Hydrography*

Due to rough sea conditions during our research activities in this area it was not possible to use the water sampler rosette and CTD multi sensor for hydrographic studies. However, at stations 272, 274 and 276 GF water samples were taken with Go-Flo samplers. The on-board analytical results for chlorinity/ salinity, titration alkalinity, dissolved oxygen and pH revealed normal sea water conditions (see chap. 4.3 and tables in appendix 11.2). The sampled deep water below 120 m water depth was homogenous in composition of the components analyzed here. No anomalies could be detected in near- bottom water samples.

During the 0.4 μm Nuclepore filtration of approx. 1.5 L of bottom water from stations 272 and 274 GF (180m and 235 water depth) particulate matter could be observed accumulating on the membrane filters. The colour of this material was light grey with a faint greenish tint. This observation may confirm Puteanus (1990) who reported OFOS TV observations of turbid bottom waters near this site. The origin of this particulate matter is assumed now to be resuspended sedimentary material (due to strong bottom currents) rather than

hydrothermal particles as proposed by Puteanus (1990). This will be proved by later chemical analyses of this matter.

4.2 Dissolved methane

In 1990 during POSEIDON cruise 172/4 sea water from the Cimotoe area was sampled in order to find evidence for hydrothermal acitivity in the Strait of Sicily (Puteanus, 1990). However, during this cruise no water degassing unit was installed on-board. Therefore, these water samples were analysed for their methane content several weeks after the cruise in the land lab. The results showed that the water samples which were stored in stainless steel pressure cylinders contained unusually high methane concentrations up to 11680 nL/L. In addition higher hydrocarbons and unsaturated hydrocarbons were detected. These anomally high concentrations of hydrocarbons in sea water could either reflect natural degradation processes of organic matter or its origin may be secondary, perhaps related to the storage of the water within the steel containers.

During POSEIDON cruise 189/4 light hydrocarbons were measured on-board directly after the water samples were taken (Schmitt et al., 1991). Furthermore, gas aliquots were collected for stable isotope analysis (^{13}C, D) for later genetic characterization of the gas components.

Due to rough sea conditions during our presence in the Strait of Sicily only four water samples (from three stations) could be taken from the Cimotoe Seamount area (Tab. 11.4.A and B in the appendix). However, methane concentrations are low (19 to 28 nL/L) and, thus, they fall in the normal range reported for methane in sea water. Furthermore, higher hydrocarbons were also not detected. Therefore, at present there is no evidence for active hydrothermalism in the Cimotoe Seamount area. However, to test the hypothesis of a secondary origin of light hydrocarbons during long-time storage of sea water in stainless steel cylinders we collected water samples similar as it was done during Poseidon cruise 172/4. These samples will be degassed and analysed several weeks after the cruise and the results can then be compared with the data measured directly on board after water sampling.

4.3 Water chemistry

Methods.

Sampling and sample preparation for dissolved inorganic constituents.

For sampling of seawater from predefined water depths up to 5 GO-Flo samplers were used in series on a hydrowire. These water samplers are made of PVC with a volume of 5 L. In the Santorini area water samples were also taken with multiple remote controlled Niskin samplers, which were combined with a multi-sensor package (sensors for pressure, conductivity, temperature, dissolved oxygen, salinity, pH, and turbidity). Additionally to the Niskin sampling, near-bottom water was sampled with the GO-Flo sampler to avoid sample contamination from the water surface layer.

For the determination of dissolved oxygen an approx. 60 mL aliquot was taken and immediately conditioned with 500 μL $MnCl_2$ and KI/KOH solution, respectively. Another 100 mL subsample was taken for the determination of both the non-conservative parameters (pH, alkalinity, chlorinity/ salinity) and the major elements (after return to the Kiel lab). The samples were stored in a refrigerator. A third subsample of 500 mL and 1000 mL, respectively, was taken for later preconcentration and analysis of trace elements after the return to Kiel. Within 1 hour after subsampling on-board, these water samples were filtrated through preconditioned 0.4 μm NUCLEPORE polycarbonate filters and acidified to 0.2 % (v/v) with subboiled nitric acid. The pressurized filtration was carried out under a clean bench using SARTORIUS all-plastic filtration units and nitrogen of 99.9990 purity as the pressure gas. Filtrated samples were stored in NALGENE FEP Teflon and HDPE flasks, respectively. The sample flasks were put into two plastic bags and stored dark and cool until analysis in the on-shore lab.

In the Cimotoe area where relative turbid bottom waters were sampled, the membrane filters were collected for further investigations.

Analytical methods for the determination of diss. O_2, pH, alkalinity, and chlorinity/ salinity.

Initially, dissolved oxygen was determined following the Winkler method described by Grasshoff et al. (1983). The precision obtained on replicate samples was in the range of 0.02 ml O_2/L ($\pm$ 0.5 %rel.). From station 283 MS onwards, the O_2-sensor from the multisonde was used for continuous profiling of dissolved oxygen. The sensor was calibrated against titrimetrically analyzed seawater samples using the method mentioned before.

Chlorinity and salinity were determined using the Mohr-Knudsen silver nitrate titration method as described by Grasshoff et al. (1983). The silver nitrate solution was standardized against I.A.P.S.O. standard seawater of 35.006 o/oo salinity. The error of the on-board

determinations was 0.05 o/oo (0.2 %rel.). From station 284 onwards, the chlorinity-sensor from the multisonde was used for continuous profiling. The sensor was calibrated against titrimetrically analyzed seawater samples using the method mentioned before.

Alkalinity was determined using a modified method outlined by Barnes (1959) and Grasshoff et al. (1983). 20 mL of seawater were titrated with 0.02 N HCl to pH of 4.00, 3.50, and 3.20. The titration alkalinity was averaged from the 3 determinations. The f_H-value was taken from tables (Barnes, 1959), correcting for chlorinity. The precision was 0.02 meq (0.7 %rel.).

The pH measurements were done with a SCHOTT ion specific electrode after adjusting Delta-pH and slope control with standard solutions of pH 7.00 and pH 9.00. The error was in the range of 0.01 pH.

Results.

As was pointed out in Chapter 4.1, the on-board analytical results from water samples below 140 m water depth for chlorinity/ salinity (38.61 ± 0.1 g dcm^{-3}) , titration alkalinity ($2.71 \pm .03$ meq), dissolved oxygen ($4.33 \pm .08$ mL dcm^{-3}) and pH ($8.18 \pm .01$) are typical for normal sea water (compare the analytical results in appendix 11.2). The sampled deep water below 120 m water depth was homogenous in composition in respect to these components. No anomalies or indications for hydrothermal activity could be detected in near- bottom water samples.

10 water samples from all stations were taken, filtrated and preserved for subsequent preconcentration and analysis of trace elements after return to Kiel.

4.4 Sedimentology

The grab sampler was used on three stations (273, 275, and 277 BG) at water depths of 198, 236, and 225 m. The sampler was filled at all stations with muddy sediments of greyish to greenish-greyish colour. The sediment surface within the grab sampler showed brownish colours at the latter two stations indicating oxidizing conditions near the sediment surface. Biogenic remnants like coral shill, bivalve shells, forams etc. were abundant in all samples. Sample 275 BG contained an 1 cm long worm (polychaete?). No indications for submarine volcanism or hydrothermalism could be found.

5. *Geology of the SANTORINI area*

The Santorini island consists of the remnants of a large volcanoe situated within the Southern Aegean Volcanic Arc. This arc extends from the Isthmos of Corinth over the islands of Methana, Aegina, Milos, Santorini, Kos, and Nisyros to Asia Minor.

The islands mainly comprise of Pliocene to recent calcalkaline lavas and pyroclastics (Nicholls, 1971). The Upper Pumice layer which covers most of the archipelago derived from a major eruption in around 1400 B.C..

The morphology of Santorini is determined by a fractured caldera connected to the sea via two channels located between the main islands Thera and Therasia. The islands of Palea and Nea Kammeni are situated in the central part within the caldera (Fig. 2-2a). These islands are the centre of recent volcanic activity. Small embayments around Palea and Nea Kammeni contain submarine hydrothermal deposits in shallow water depths (Varnavas and Cronan, 1988; Smith and Cronan, 1983; Puchelt, 1972).

6. *Results from the SANTORINI area*

6.1 *Hydrography/ Multi-sensor profiles in the water column*

Stations 280, 283, 286, 292, 295, 298, 301, 305, 308, 319 ,337 MS within the caldera
After calibration of the sensors attached to the rosette against titrimetrically determined results (see chap. 4.3) at station 280 MS (see appendix 11.2) multi-sensor profile measurements in the water column were performed at all water stations covering temperature, conductivity, pH, salinity, dissolved oxygen, and transmission. The profile plots can be found in Appendix 11.3.

During the first days of work within the caldera (280 to 305 MS) calm weather conditions (wind SW 1, sea very smooth, blue sky) prevailed. As a consequence, all parameters show steep gradients, and water stratification could be observed within the upper 60-70 m of the water column. Below this depth the water down to the sea bottom was characterized by rather constant conditions. After station 307 weather turned to strong winds of 6-7 Bft. and moderate sea. This resulted in a mixing of the surface water which is documented in the profile 308 MS.

In the area of the 280 and 283 MS stations recently active hydrothermal effluents were indicated by Varnavas (pers. comm.). Only a slight increase in temperature (approx. 0.1 °C) of the near-bottom water could be observed in the 280 MS temperature.

Stations 292, 301, 308 and 337 covered the northern channel between Palea and Nea Kammeni island whereas stations 295, 319 were located near the southern channel. Around the Kammeni islands hydrothermal activity is indicated by hot gaseous springs and iron-rich precipitates in shallow water depth. The anomalies for oxygen and conductivity in 308 MS may be ascribed to the storm event rather than to hydrothermal effects. Nevertheless, stations 301, 337, and 319 which are situated in the currents passing between the Kammeni islands show high oxygen saturation in the deep water (approx. 70-75%) compared to all other stations (< 70%).

Station 298 was located near the steep slope in the southern part of the caldera. A pronounced peak in oxygen saturation can be observed in the euphotic layer. At 130 m water depth there is an anomaly in temperature and conductivity which cannot be explained yet.

Station 333 MS located W of Thirasia was a background station remote from hydrothermal influence within the caldera. The profiles show remnants of stratification in the upper water body. Downwards, the profiles look rather disturbed which may be ascribed to the rough weather conditions and resulting currents. Station 330 represents another remote station located in the current through the northern outlet of the Santorini caldera.

Stations 323 and 327 explored the Colombos Seamount. Straight profiles of all parameters through the whole water column describe a well mixed water body.

6.2 Dissolved methane

(Stations 280, 283, 286, 292, 295, 298, 301, 305, 308, 319, 323, 327, 333, 337 MS)
During the past the Santorini hydrothermal field in the Central Hellenic Volcanic Arc has been studied extensively (Butuzova 1966; Puchelt 1972; Smith and Cronan, 1983; Varnavas et al. 1991). Although it was found that metalliferous sediments within the caldera of Santorini are related to shallow submarine hydrothermal activity (Smith and Cronan, 1983) little is known about the gas content of the hydrothermal fluids (Puchelt 1972). High methane concentrations are expected to occur in hydrothermally influenced sea water. Thus, during Poseidon cruise 189/4 a systematic water sampling program with on board analysis

was performed within the caldera of Santorini. Later isotopic analysis of methane (and other gas components) is thought to give information on the origin of the gas compounds (e.g. of mantle, biogenic or thermogenic origin).

Research activities during cruise 189/4 were restricted to water depths >200 m. This restriction prevented direct sampling of the known fumaroles near Palea Kammeni and Nea Kammeni. However, several water stations were positioned close to these two islands (Fig. 2-2; Fig. 11.4-1 in the Appendix). Water sampling was performed using both the common NISKIN bottles and the SCHMITT sampler (for a comparison of the data gained by both sampling techniques see Chapter 7.5 and Appendix 11.4-A). Parallel to water sampling hydrographic parameters (temperature, dissolved oxygen, pH, salinity, light transmission) were recorded by a multiprobe (ADM electronics). All data are given in the Appendix 11.3.

The hydrographic parameters of the relatively shallow Santorini caldera show a well-mixed water body. Variations occur in the uppermost 50 to 80 m of the water column (surface water). No hydrographic anomalies which could be possibly related to active hydrothermal venting have been recorded.

The results of methane analyses are given in Appendix 11.4-A (Figs. 11.4-1 to 11.4-16). Frequency diagrams show the methane concentrations for all samples (Figs. 11.4-17) for the various sea areas (Figs. 11.4-18 to 11.4-21) and for all surface waters (Fig. 11.4-22). Methane concentrations in the sea water from Santorini range from 6 nL/L to 44 nL/L. These concentrations fall in the normal range reported for methane in sea water. Furthermore, vertical profiles of methane concentrations vs. water depth did not reveal any significant anomaly (Figs. 11.4-2 to 11.4-16). It should be mentioned, however, that the water body within the relatively shallow caldera is well mixed (compare Appendix 11.3) and, therefore, methane plumes are not likely to be formed. Nevertheless, based on methane anlyses in sea water there is no evidence for recent hydrothermal activity in the deeper parts of the caldera (including Colombos Seamount).

6.3 Water chemistry

Stations 280, 283, 286, 292, 295, 298, 301, 305, 308, 319, 337 MS, 297, 300, 304, 307, 309, 317, 318, 322, 326, 332 GF

Hydrothermal effluents within the Santorini caldera, which have been investigated in detail at the Kammeni islands (e.g. Puchelt 1972, Smith and Cronan 1983) are reported to contain elevated concentrations of dissolved Mn, Fe, Cu, Zn. Mixing of the hydrothermal solutions

with normal sea water leads to a zoned precipitation of the metals within more or less short distances to the effluents in shallow water depths. However, some metal species will be maintained in solution forming a trail or plume which can be recognized by its elevated concentrations in relation to the ambient sea water. Whereas hydrothermalism in the shallow waters around the Kammeni islands is well documented, only little is known about possible effluents in greater water depths at the floor of the caldera. Moreover, the geochemistry of the Rare Earths which has not been investigated in the Santorini caldera so far offers some new insights into the genesis of hydrothermal precipitates.

The sampling strategy within the caldera was based on a systematic survey using OFOS and water samples with the aim to locate formerly unknown hydrothermal sources. Since the probability to identify hydrothermal plumes/ trails or to find new effluents is greatest in the vicinity to the recently active volcanic centre the sampling concentrated around the Kammeni islands and along a fault system trending SW-NE through the caldera (Varnavas, pers. comm.). Sampling for subsequent trace element geochemical investigations was confined to bottom waters. Concentrations of elements of hydrothermal origin should be highest in the near-bottom waters.

Bottom water was sampled both with normal Niskin water samplers attached to the rosette (bottom contact information!) and with a GO-Flo sampler on a hydrowire. 35 water samples were treated as described in Chapter 4.3. The preserved water samples will be analyzed with ICP-MS for Rare Earths and transitional metals after return and preconcentration in the on-shore lab in Kiel.

6.4 Sedimentology and geochemistry

Stations 282 OFOS, 284, 285, 311, 312, 313, 314, 315, 316 BG in the NE caldera
The video system of the OFOS allowed a close visual observation of the sediment surface in the Santorini caldera. During the full circle survey along the 200 m isobath in the northeastern part of the caldera a flat and smooth seafloor could be observed. The surface was covered with many holes of approx. 5 cm in diameter which appeared to occur in circular clusters (Fig. 6.4-1). The shape and clustered occurrence of this holes suggests a biotic origin (benthic organisms living in colonies) rather than a hydrothermal origin.

Locally some patches with high reflectivity could be observed on the video screen. Large patches with diameters in the meter range were nearly circular in shape (Fig. 6.4-2), once

showing a small edifice in the centre (Fig. 6.4-3). Nearby, smaller patches were connected forming a network or "polygons".

Sediments recovered from this area by the VanVeen grab sampler comprised coarse, black to red scoria, lava fragments, pumice and debris from the nearby caldera walls (312 BG), grey-green coarse vocaniclastic sand, covered with brownish sandy silt (313 BG), coarse black tuffaceous sand (314, 315 BG), and smooth brownish clayey silt.

The sediment surfaces in the grab sampler were covered with solid brownish crusts (311, 313, 315 BG), grading into soft chocolate-like crusts (312 BG) and finally into light-brown to reddish colloidal FeOOH of jelly-like texture (314 BG, Fig. 6.4-4). The thickness of the colloidal FeOOH-jelly was approx. 5-7 cm. We suggest that this water rich FeOOH-jelly on top of the sediments in the grab sampler is identical with the patches of high reflectivity observed with the OFOS. Observations of this kind were made only at this site within the caldera. 20 sediment samples have been taken for subsequent geochemical and sedimentological analysis.

Stations 294 , 303, 335, 336 OFOS, 293, 296, 299, 302, 306, 310 BG around Kammeni islands

Around the Kammeni islands two short profiles down-slope (335, 336 OFOS) and one profile along the 200 m isobath (303 OFOS) were governed. During the OFOS observations the sediment looked rather uniform and smooth. Again, many clustered holes of 2-5 cm, a few up to 10 cm in diameter covered the seafloor (294 OFOS). Near the slope to the Kammeni islands large lava fragments and rocks covered the seafloor.

Sediments recovered with the grab sampler comprised brown sand and gravel (293 BG) reddish FeOOH mud (296 BG); brown silty sand with black sand grains of lava (299, 302 BG), and brownish clayey silt (320 BG). Samples were taken for geochemical and sedimentological investigations.

Stations 324 , 328, 334 BG, 325 , 329 DR at Colombos Seamount

The Colombos Seamount N Santorini (Fig. 2-1) which is considered to be of volcanic origin and possibly shows hydrothermal activity was investigated during this cruise.

Both of the dredges were filled with volcanic tuffaceous rocks: whitish pumice which resembles the "Upper Pumice" from Santorini, a few well-rounded greenish pumice fragments, cementated coarse lapilli-sand, and a few specimen of phyllitic rock (325 DR).

Fig. 6.4-1: Clusters of holes in soft sediment covered large areas within the Santorini caldera. Note "footprints" and freshly accumulated sediment hills around the holes indicating recent activity of benthic organisms. (station 282 OFOS, distance to sea bottom 1.2 m, water depth approx. 200 m)

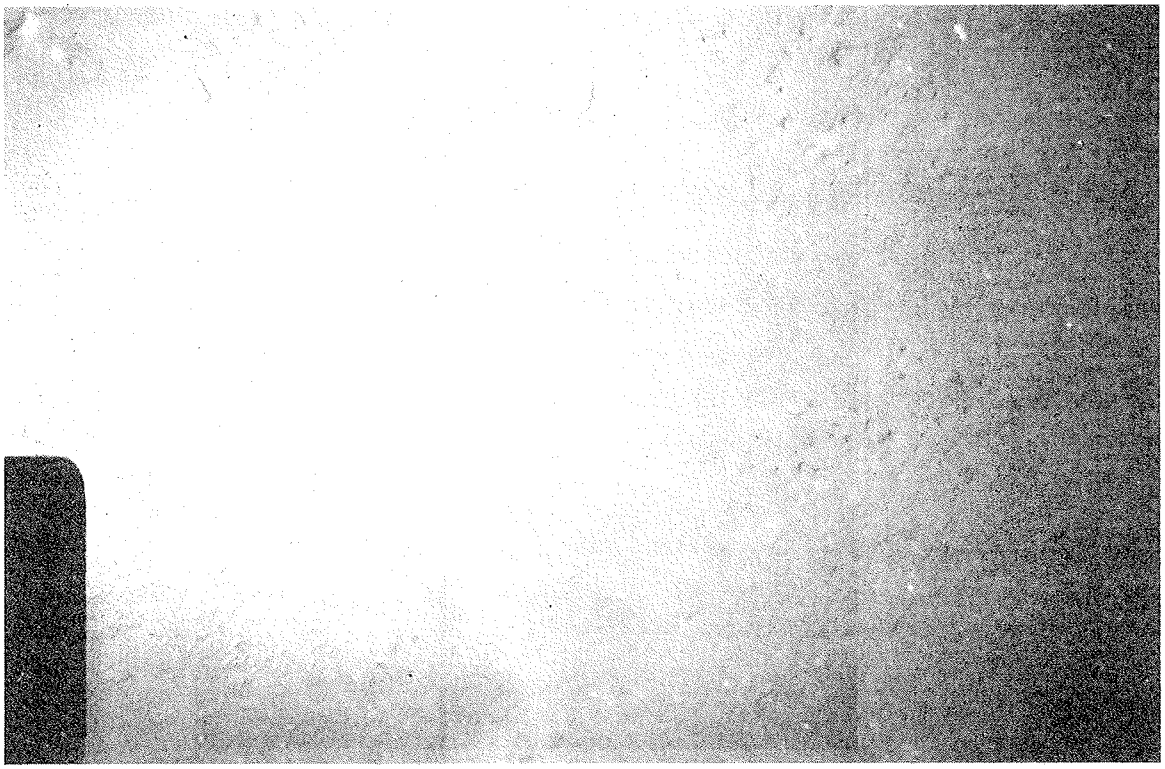

Fig. 6.4-2: Circular shaped patch of material with high reflectivity on top of fine grained sediment surface. Note the structured surface of this material which is assumed to be identical with jelly-like colloidal ironoxide-hydroxides recovered from this site. (282 OFOS, approx. 200 m water depth, 3.1 m distance to sea bottom)

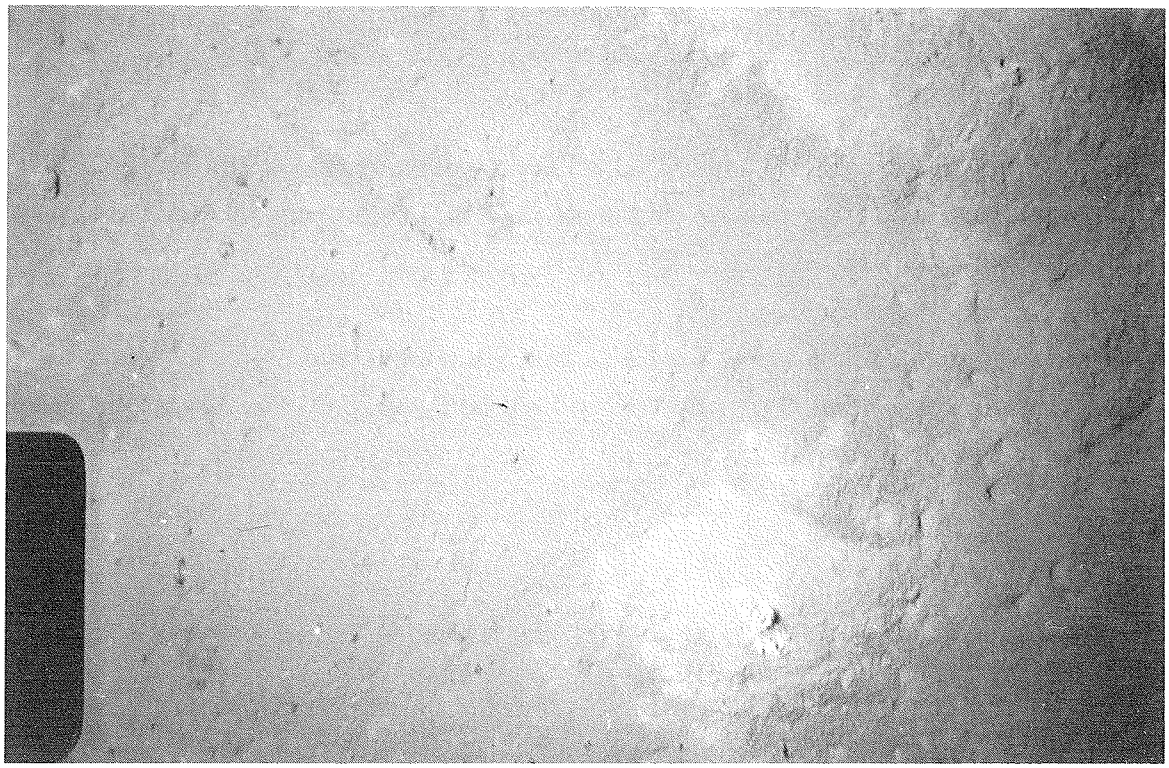

Fig. 6.4-3: Orange to yellow coloured patches of probably iron-rich precipitates. Note the small edifice in the centre of the lower patch. (282 OFOS, approx. 200m water depth, 1.8 m distance to sea bottom)

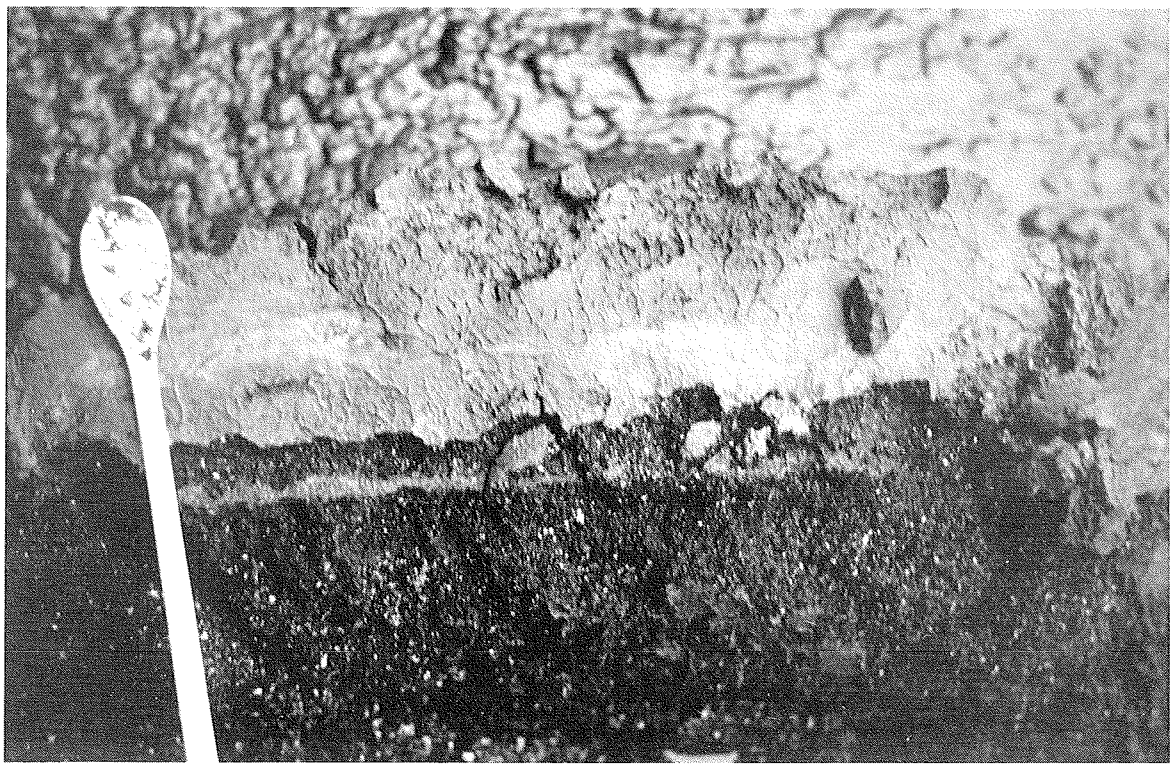

Fig. 6.4-4: The grab sampler at Station 314 BG was filled with black tuffaceous coarse sand, which was covered with a 5 cm thick layer of jelly-like , light-brown to yellow, colloidal ironoxide-hydroxides.

The finer sediment could only be sampled with the grab sampler and comprised grey-black gravelly coarse-sand with many pumice fragments (324 BG) or brown silty clay with rubble of black-coated pumice (328 BG, 329 DR).

It was disadvantageous that the top of the Colombos Seamount could not be sampled during this cruise because the restrictive permission confined our work only to water depths below 200 m.

7 Technical report

7.1 General

As this cruise was part of the MAST project MIPAMEHR emphasis was put on scientific and technical aspects. Within the MIPAMEHR project the so-called OFOS, which was formerly known mainly as "TV/Photo sledge", is upgraded towards a multi-sensor survey tool by adding electro-chemical sensoring. As a further improvement of the survey system, an underwater navigation system is supplied for precise location of the towed vehicle.

The main technical tasks of the cruise were

- First in-situ integration test of the newly developed Newcastle multisensor unit with the OFOS system, and
- First application of an underwater transponder navigation system which was purchased within the MIPAMEHR project.

7.2 OFOS integration tests

The Ocean Floor Observation System was purchased by the Geological Institute of Kiel University (GIK) in 1988, and was manufactured by Preussag Marine Technology. This system is rated for operation down to 6000 m water depth and consists basically of

- Real-time video camera with flood lights
- High capacity photo camera with flash
- CTD probe

Power supply (mainly for the flood lights) is achieved by pressure compensated deep sea accumulators. TV and data transmission over one single coaxial cable is handled by the specially designed telemetry electronics. The system is connected to the ship via a steel-armoured coaxial cable, and is towed at low speed with bottom distances usually between 2 and 8 meters.

As a subject of MIPAMEHR, the OFOS sensoring capabilities are extended by electrochemical sensors, developed by the University of Newcastle upon Tyne (UNT). Necessary modifications of the OFOS for sensor integration had been done by GEOMAR Technologie

GmbH (GTG), and comprised

- Mechanical adaptions
- Sensor power supply
- Sensor data transmission interface
- Telemetry extension

Additionally was mounted a Niskin water sampler with on-board release control.

Prior to the cruise there had been carried out a short joint laboratory test in Kiel with OFOS and the UNT unit, the cruise itself was the first opportunity for an integration test under real conditions.

Like on the earlier cruise Poseidon 172-4, the equipment was handled by an on-board winch with about 2000 m armoured coaxial cable of 10 mm diameter. This thin cable offers only little safety margin in mechanical strength, compared to e.g. the 18 mm cables on R/V "Sonne". But as neither rough sea nor very rough bottom morphology was to be expected, the risk was tolerable. Thanks again to the discipline of the winch operators, who always precisely followed the commands given to them through the ship's wire-com.

On transit from Messina to Santorini the OFOS was installed on the ship and prepared for connection of the sensor unit. A first test deployment had been envisaged at Cimotoe in the Strait of Sicily, but due to the bad weather conditions these plans were given up.

After arrival in the Santorini Caldera three collegues from the Newcastle group joined the cruise for two days. On April 3 the sensor units were made operational and the communication link was tested. Some minor problems occured, e.g. the connector pins for data receive and transmit lines had to be exchanged - a very common problem.

OFOS Station No. 281 on April 4 was the first deployment of the UNT sensor unit (see Figs. 7.4-1 and -2). The equipment was lowered to 40 m depth and data output was observed. As no dramatic failure like water invasion occured, lowering was continued until bottom view at about 350 m water depth. The UNT sensors - and everything else - worked, and after a while the equipment was hoisted on deck again for inspection.

As no failures were detected, a second deployment followed. During station No. 282 an area proposed by Prof. Varnavas was surveyed by TV, photo and sensoring. Raw data from the chemical sensors were recorded. After 2 1/2 hours without technical problems the station was finished. Unfortunately, the UNT sensor unit subsequently had to be dismounted again for further development work in Newcastle.

During the following days only the OFOS with its original components (except the water sampler) was available. With this configuration, four more OFOS profiles were made within the Santorini Caldera.

7.3 Transponder navigation

As a supporting system for OFOS, transponder navigation equipment was purchased by GTG from manufacturer MORS/OCEANO, France. Following a short test in the Baltic Sea, this cruise was the first application of the system. Transponder navigation is based on the calculation of distances in water from run-time measurements of sound. The GTG Long Baseline System (see Fig. 7.3-1) consists of

- At least 3 acoustic transponders moored to the bottom
- A hydrophone towed near the surface (or fix mounted on ship)
- The underwater object with an additional transponder to be tracked
- An on-board computer with software for position calculation

Navigation accuracy of the system is rated down to 1 m in repeatability under best conditions. System performance very much depends on quality of installation / calibration and sound propagation conditions.

The bottom transponders, rated for 6000 m water depth, are equipped with a floatation pack for recovery and can be released from the anchor weight by acoustic command. By several suppliers there are offered also expendable ones which stay at the sea floor and can not be recovered. This type was not used on the cruise.

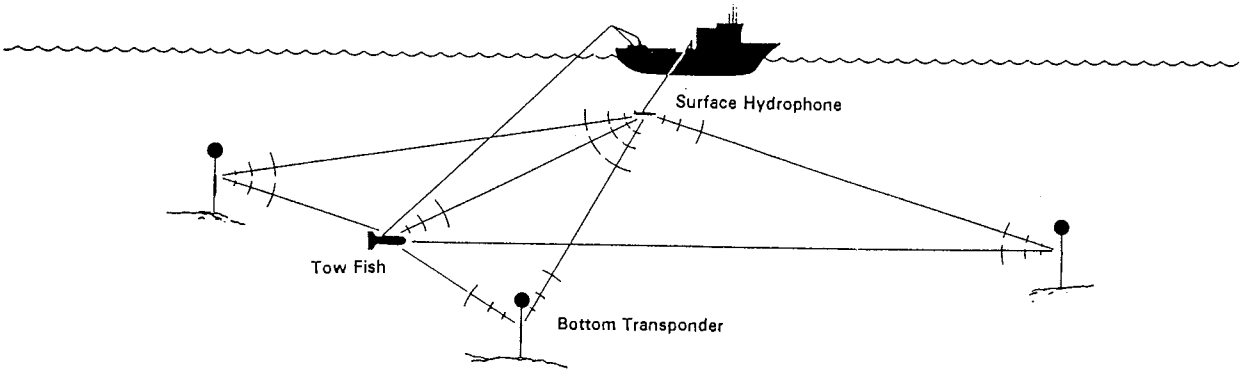

Fig. 7.3-1: Layout of the Long Baseline Transponder Navigation System

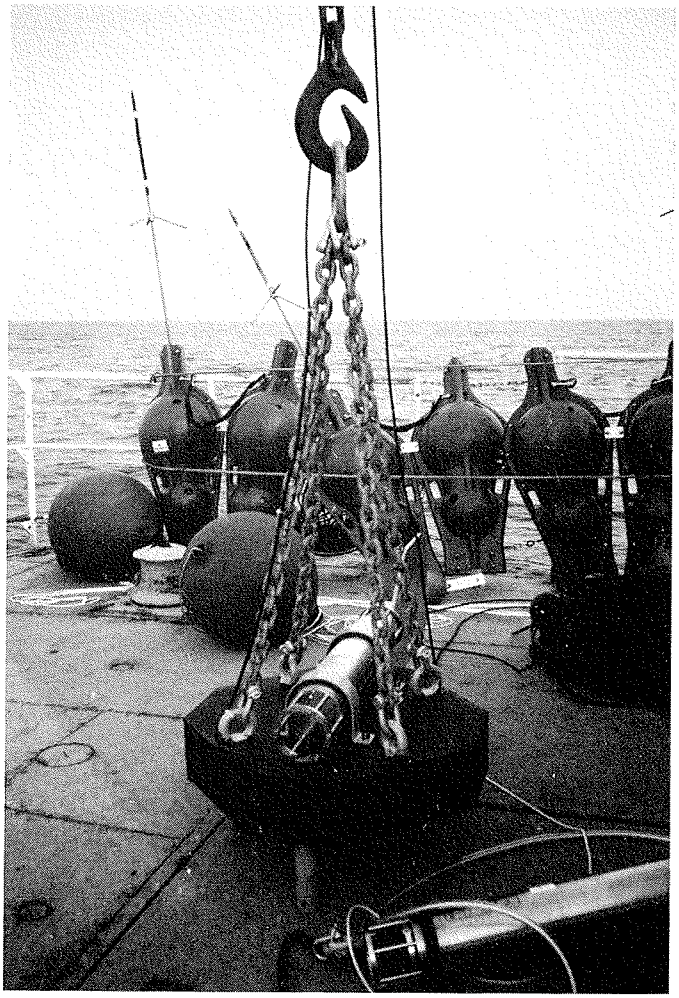

Fig. 7.3-2: Transponder navigation system. Foreground: Bottom transponder; center part: Noise reduction baffle with surface hydrophone; background: Flotation packs with glass spheres

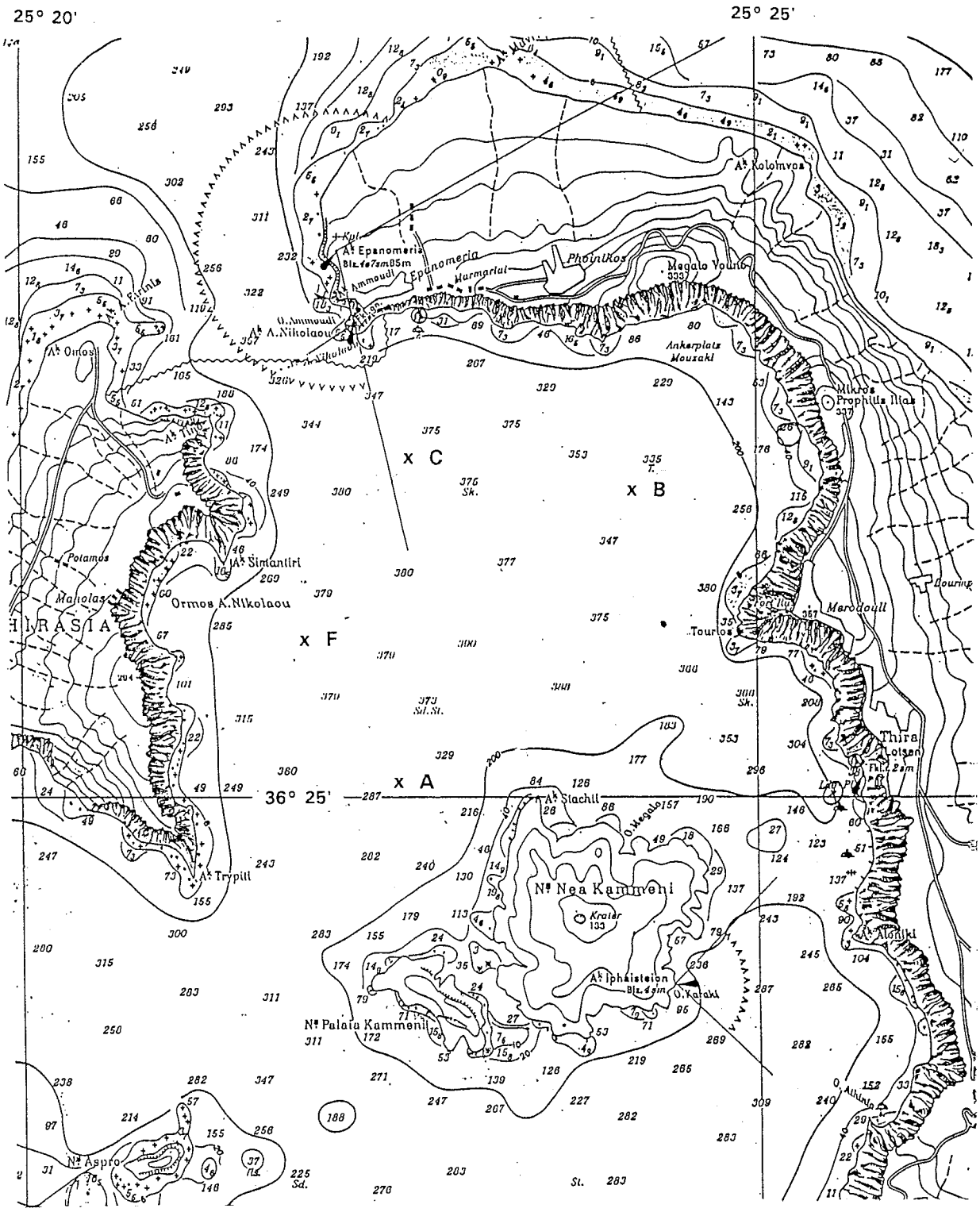

Fig. 7.3-3: Mooring positions for bottom transponder A, B, C, and F.

As the sound run-time measurement is sensitive to acoustic noise, the surface hydrophone is mounted to a noise absorbing baffle (Fig. 7.3-2). Additionally, the baffle serves as a stable platform in water because of its weight (about 400 kg). On R/V "Poseidon" it was towed at 7 m depth, i.e. 3 m below keel.

To set up the transponder navigation system, 4 bottom transponders were layed out in Santorini Caldera on April 5. Positions (see Fig. 7.3-3) were chosen according to bottom morphology for good acoustic coverage of the working area. A sound velocity profile was derived from CTD data of water sampling stations and input to the navigation computer for improvement of range calculations.

Next to this, the transponder array had to be calibrated. The calibration method recommended by the manufacturer is a statistical one. This is achieved by steaming through the transponder array and making range measurements at several selected locations. A first attempt to do this was made on April 6, but besides some problems with noise, which could be overcome by changing the hydrophone and switching off the ship's echosounders, the navigation software turned out to be the most critical part. Frequent run-time errors made calibration data acquisition impossible this day.

After many hours spent at the computer to find out conditions causing run-time errors, the third calibration trial in the end was successful - it was the evening of April 8, still only one more working day to come. Unfortunately the ship's GPS equipment did not offer an appropriate computer interface, so GPS data could not be fed on-line to the transponder navigation. Thus its calibration could not be made in absolute geodetic coordinates, but relative to the first transponder (A). For position of this transponder the software assumes the manually recorded drop position, which can be different from the actual position on the sea floor.

The last two OFOS stations on April 9 were the only ones with position recording by the transponder navigation system (see plots in Appendix 11.6). The plots show position of the so-called ship's reference origin which can be defined by operator, not that of the surface hydrophone. As reference was chosen the ship's foremast, where the GPS antenna is mounted.

It should be noted that coordinates are numbered in meters according to the UTM grid, which is standard for commercial offshore operations. Calibration errors seem to be comparably small, there is only little difference between the plotted positions and the GPS positions recorded in station reports.

Additionally to the ship's position, the transponder navigation should have calculated also the underwater location of OFOS. But the transponder mounted on OFOS only delivered rather unreliable values. Possibly the mounting position has to be optimized, but there was no time left to verify this. GTG will find out after the cruise - besides solving the software problems.

Recovery of the bottom transponders as the last action in the working area caused no problems. It took less than 1 1/2 hours until the last transponder was taken on deck.

7.4 Test of the UNT multisensor unit

Resolution of minor problems.
Examination of the Newcastle sensor system for damage by transit did not reveal any obvious problems. The OFOS unit did require repositioning to facilitate access to case internals and this was quickly carried out. The 12-pin connector which connects the Newcastle equipment to the OFOS system had been protected from water contact as it was covered in plastic. The pump housing had not been filled with kerosene as requested since this was not necessary as no previous submersions or powering up had been carried out. After the OFOS unit had been repositioned the pump casing and case 2 were therefore filled with kerosene, so as to prevent electrical faults in the event of seal failure.

Power to the Newcastle equipment for system checking was supplied through the OFOS system by a regulated 0 and 24V supply. The OFOS system was used to regulate the power supply to the $\pm$12V necessary for the chemical sensor system. The deep sea batteries which would power up the OFOS system could not be used as the required orientation giving access to the Newcastle equipment could not allow the batteries to be installed.

On completion of damage assessment tests which identified a damaged line driver in the communications system, installation of ligand reagents into their associated pipework was carried out. The communications fault was within the OFOS system and when rectified communications were achieved.

The ASCREV electronics and hardware were readied for installation. Case 1 was opened and the connecting power lines from Case 3 were checked for polarity etc. The ASCREV electronics were powered up and using dummy cells and a DVM the wave form was monitored. As a consequence of a slight difference in the regulated power supplies between the equipment available on board ship and that used in Newcastle the wave form was obser-

ved to move a little too far positive. This was corrected on the d.c. trimmer. The sampling positions were checked and agreed with the values set before transportation. In addition the reference potential values for the ASCREV cells were measured and adjusted to accommodate the differences between sea water in the Newcastle area and in the Aegean test area. Upon completion of the pre-start up checks the electronics were sealed into their case and powered up for final checking using the 0/24V supply.

Upon switching on the power the power supply tripped out, this effect had been experienced in Kiel and had been attributed to a power surge on start up. A damaged relay was located within Case 1 and replaced. On powering up the system again a communications problem was observed which was diagnosed as being either a fault on the Newcastle communications equipment or an interfacing fault with the OFOS equipment. Investigation revealed an interfacing fault caused a very small variation in timing between the two systems, this was easily overcome.

Once the pipework containing the chemical reagents was installed the sample fluid flowrate was checked and the completed OFOS system was uprighted and readied for deployment in the test area. A few photographs with explanations are given in Figs. 7.4-1 and 7.4-2.

Data obtained by stationary vertical dive with OFOS and integrated Newcastle sensor system.

The first deployment of the OFOS and Newcastle sensor system was in the Kammeni water area off the coast of Santorini. In figure 2-2 a map showing the approximate area of this first submersion is shown (281 OFOS). The OFOS unit did not enter the water until around 10:30 BST up until this time the Poseidon sailed to the test area and final activities were carried out on the system by personnel from Kiel and Newcastle. During this time the deep sea batteries were installed as well as checking of the photographic equipment and verification of communications. Whilst the OFOS unit was awaiting deployment the temperature probe of the CTD unit indicated the rising ambient temperature to approximately 25 °C.

At approximately 10:30 BST the OFOS unit was submerged to a depth of approximately 40m. At this depth the OFOS system was held for a short period and communications etc were closely monitored for signs of failure and uncharacteristic behaviour. However, all outputs were as expected suggesting that no ingress of sea water to the electronics had occured. It was therefore decided to continue with the submersion of the system. The OFOS unit eventually progressed to a depth of approximately 372m, a little short of the sea bed

which was visible on a TV screen aboard ship. The picture being communicated to the monitoring screen from the camera on board the OFOS.

Depth was determined from the on board ship displays of cable length which was lowering the OFOS unit and the ships own sonar equipment. Descent speed of the OFOS system was also monitored using the ships equipment attached to the cable winch lowering the OFOS. The speed of descent varied between approximately 10m/min and 30m/min the total time for descent being approximately 20mins including the holding time at the 40m position. The unit was held at the final depth of 372m for only a few minutes.

In summary therefore the total time submerged was about 37 mins. Which involved a 7 mins hold at 40m (the point which data was started to be collected), on a 13 mins descent to the sea bed. This was then followed by 4 min hold at the sea bed 372m, after which a 12 min ascent, the OFOS unit was standing back on the deck of the Poseidon.

During the descent and continuously with the final recovery on deck the output of the chemical sensors of the Newcastle system was monitored on board Poseidon, allowing only 36 up dates of data in total.

It is reiterated here again from a previous section, and added, that the data derived and shown below is not in chemical units and has not received any data post or real time processing. It is therefore `raw` data and wholly unsuitable for any but the most tentative inspection. This is especially so because the calibration procedures and data processing are still being developed.

Shown in the figures in Appendix 11.7, with very little comment here, and see section below for a detailed comment, are various computer graphical printouts. Thus fig. 11.7-1 to -10 inclusive show data respectively for pH, Eh, $S^{=}$, dissolved H_2S, iron ASCREV data as, cell1 (T5-T1), cell2 (T5-T1), cell2-cell1, dissolved oxygen is a dummy cell as is hydrogen and finally temperature.

Data obtained during trawl of OFOS and integrated Newcastle sensor system.
After what was considered to be a successful deployment of the complete OFOS system during the morning, in the afternoon towing of the system in a trawling action was carried out. The area of the trawling activities is shown in Fig. 11.7-11, this figure was produced from the longitude, latitude and time data available on board ship, produced by the ships own equipment. This data was collected manually as retrieval of this information could not be achieved automatically. Moreover, this information, even though it did appear that it was being updated continuously, could not be collected continuously. Therefore the route of

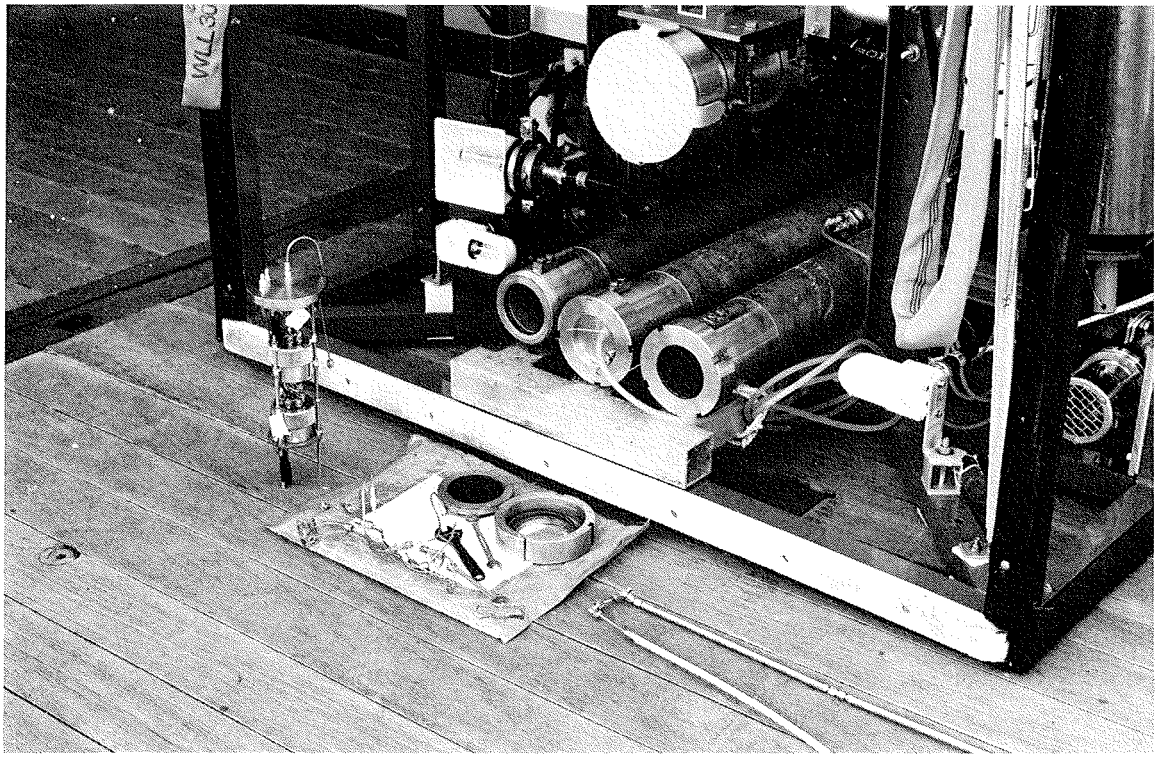

Fig. 7.4-1: Metal ion sensors ready for mounting into equipment

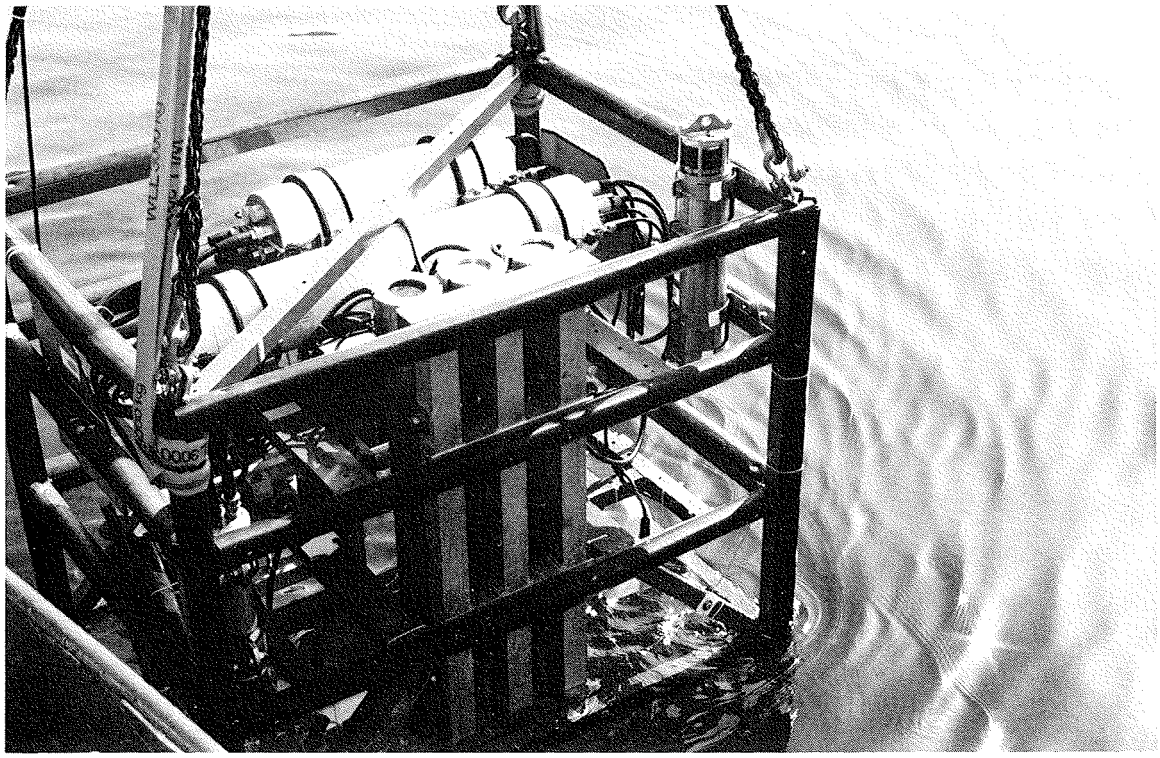

Fig. 7.4-2: Complete OFOS being lowered ready for deployment

the POSEIDON shown in Fig. 11.7-11 appears a little erratic. Although areas of particular interest annotated on the figure and discussed below could easily be identified.

Trawling of the OFOS unit was achieved simply by lowering the system into the sea by the winch, and whilst still suspended the ship sailed at slow speed causing the OFOS to be dragged along through the water. The OFOS unit was trawled at a position a little above the sea bed, for almost all the time the camera unit on board the OFOS could clearly see the sea floor. However, the unit could not be maintained at a constant depth because the sea floor was not flat. Control of the OFOS's position relative to the sea floor was almost entirely by visual inspection of the TV pictures relayed from the OFOS and commands to the winch operator to raise and lower the unit as approriate. On at least one occasion the OFOS hit the the sea floor and sediment was seen to be disturbed on the monitoring screen.

The data produced from the trawling exercise (station 282 OFOS) is highlighted in Fig. 11.7-11 to Fig. 11.7.19 inclusive with very little comment but see section below for detailed comment. Data is given in order of pH, Eh, $S^{=}$, H_2S, ASCREV cell data and temperature.

Significance of results of tests and data.

Most of the tests planned were possible. Of major importance being that of no fluid leakage occurred in the system, the electronics functioned adequately considering their present status of operation and that no degrading of the data retrieved was discernible. Moreover, the software, general ease of handling of equipment was most acceptable.

Comparing the information obtained from the vertical descent and the trawl, the latter provided the most useful data. Because of the dive being a little short, insufficient time for temperature equilibrium of the system as a whole may not have been established when submerged. Especially when OFOS had been stood on deck for some hours in an ambient temperature of approximately 25 °C, and a sea water temperature of around 13 °C. The position of the temperature sensors which govern the important compensation circuits for various parts of the system may require re-locating or modification, as well as the filling of outer cases with kerosene as already suggested.

Moreover only at most 36 updates of data were possible for the vertical dive, only a fraction of which may have true significance, in terms of the absolute values obtained, because of the temperature effect. The vertical dive as far as we are awarewas not over a particular place of interest or a known vent. Possibly therefore the only relevant parts of the

data as such would be at the sea bed and for a few meters away from the bottom, and on the return because of the temperature change constraints.

It is very likely and without evidence to the contrary that the majority of our data collected in the Santorini area was equivalent to normal sea water background values. However, attempting now a very, very cautious consideration of the trends seen. The amplitude and sign have very little meaning at present for the reasons expressed earlier per force. One obvious trend is seen with the H_2S in the stationary vertical dive. The data provides a mirror image type curve with depth. One explanation being that it is known that gas sensors possess virtually instantaneous (milli-seconds) response to change, whilst the passive sensors pH etc, require at least a 10 to 15 second delay in response to change in concentration. It is recognised that the largest changes in units or concentration of pH and other species in the oceans occur in the first few tens to 400m or so of depth from the surface than say between 1000 to 2000m. These considerable effects (for example, pH can in some cases alter by two units within the first 200m), are due to the CO_2, CO_3^{--}, HCO_3^-, pH equilibria. pH, Eh, even $S^=$, are seen for the vertical ascent as well as for the initial descent during the trawl.

Care in interpretation also needs awareness of the in a stationary vertical dive due to the disturbances of the water column when a rapid descent and or ascent is made as in the case here. Such disturbances would be magnified as concentrated changes when very low concentration of species are involved especially near the surface.

Laboratory tests with our Eh electrodes suggest in anoxic sea waters and in the absence of predominant redox couples values around -50 to -60mV whilst the presence of ferrous ferric couples could provide swings of potential from less than -500mV to greater than -800mV. Such swings are seen during the various locations and progress of the trawl. Apparent swings of the $S^=$ sensor are also seen a specific example is highlighted later.

Concerning the ASCREV data and especially with respect to the time duration of the vertical dive. The ASCREV system due to a running in time, now only recently appreciated, of the reagent pellets requires between 30 to 40 minutes before the system becomes constant in a constant background environment. Thus the data retrieved by the fast short depth dive was produced before the system was fully operable. In future deployments either in some way the system be brought into commission quickly or a period of running in needs to be considered or allowed before each dive or trawl. Never the less, even with the dive unprocessed raw data a careful inspection can see that for Cell 1 the scatter decreases with time. (Viewing only here the flat portions of the plots). n.b. Cell 1 (T5-T1) data is from the cell which does not measure iron. The trawl data shows the same effect. Cell 2 (T5-T1)

shows less scatter with increasing time or during the ascent all without exception are positive. Cell 2-Cell 1, shows barely a change on the ascent demonstrating virtually a constant value of Fe^{3+} apart from the values given at the bottom. To much `noise` is apparent in the descent for the various reasons given earlier.

Referring now to particular parts of the trawl as shown in fig. 11.7-11 and especially areas (1), (2) and (3). At point (1) the OFOS hit the sea bed and disturbed a mound of silt at 263m, pH, Eh and $S^{=}$ responded shortly afterwards with large changes. At positions (2) and (3) Poseidon effectively retraced almost a short circle. ie, location (2) and (3) are very close and possible in a line. Thus, by considering the raw data plots shown in fig. 11.7-12 to -199 of data plots at particular times and locations the following may be hazarded. At location (2) between 14:22:14 to 14:32:38 hrs pH, Eh and $S^{=}$ show strong activity and in location (3), at about 14:55:16hrs there is little activity for pH, Eh and $S^{=}$, but a strong signal for H_2S.

For locations (2) and (3) and data from ASCREV Cell 1 as expected is relatively constant and low in both cases. Cell 2 does not show much greater activity apart from just before (1) and between location (3), a maximum with a quiet response in area (2). The same effect is shown for Cell 2-Cell 1 which gives a curve trend starting before (1) and ends at location (3), with a maximum just before or about location (2).

7.5 Test of the SCHMITT water sampler

Gas-tight water bottles were developed to collect deep ocean water which is saturated with gas. This situation although unlikely to occur under normal-marine conditions may, however, well exist in hydrothermal vent areas where large amounts of gas are injected into the water column. The SCHMITT sampler allows deep ocean water to be sampled without gas losses during uplift of the bottles.

The SCHMITT water sampler (Fig. 7.5-1 and Fig. 11.4C-1) consists of two O-ring sealed plate valves (V1 and V2) and a water container with an expandable volume (F) mounted in a rack. All parts of the system are made out of V4A steel and plastic. The water container was tested to be gastight up to 10 bars. The volume of the sampler is variable from 2.0 L to 2.5 L. The gas possibly released during uplift can be sampled near the upper valve (G). The remaining water is sampled via a teflon-sealed ball valve (H). The valves V1 and V2 are closed by a rod (S) and two levers (K1, K2) controlled by the releaser system.

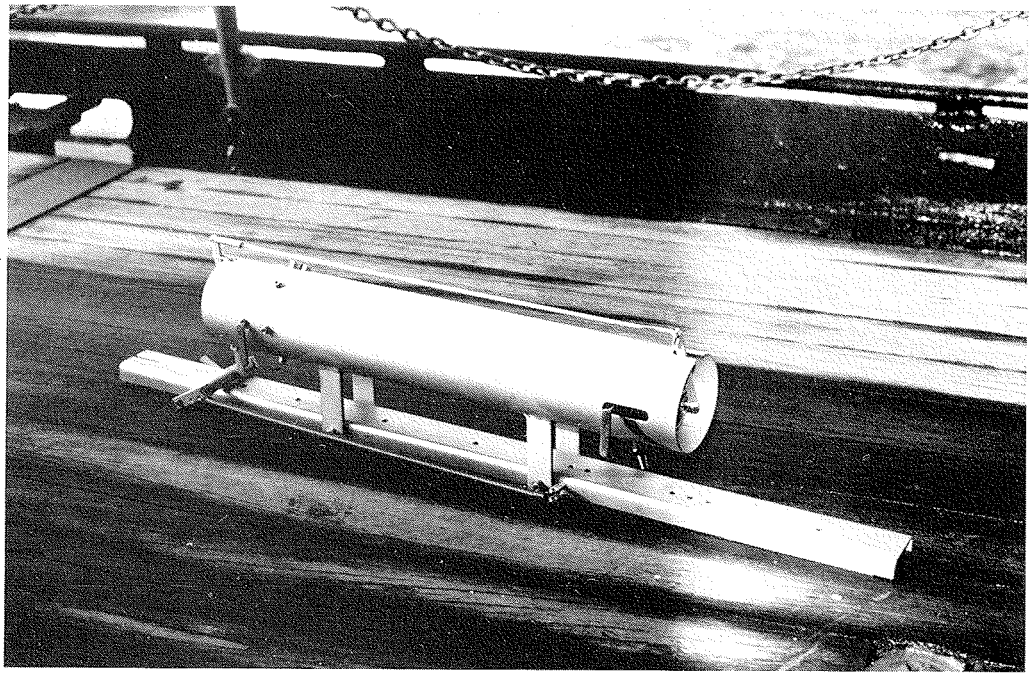

Fig. 7.5-1: The new SCHMITT water sampler for sampling of dissolved gases from great water depths

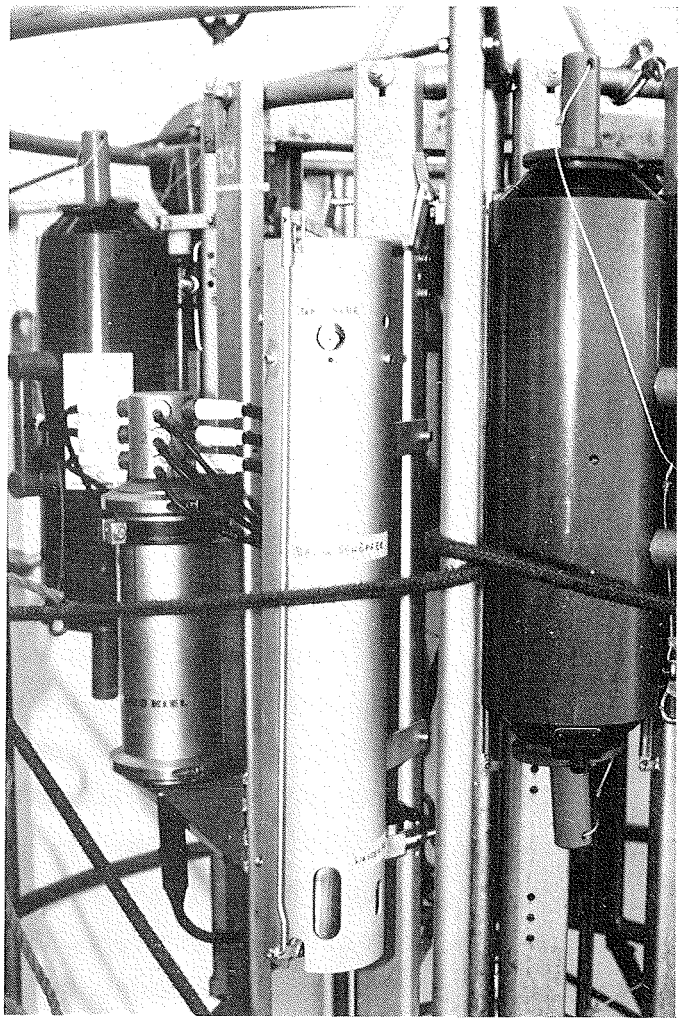

Fig. 7.5-2: The SCHMITT water sampler mounted at position 1 on the rosette.

The SCHMITT sampler fits the commonly-used Hydro-Bios rosette water sampling device (R). The releaser system is identical (Fig. 7.5-2). The water sampler may also be attached to the OFOS system. During POSEIDON 189/4 the SCHMITT sampler was used parallel to the common NISKIN bottles. The mechanical parts worked perfectly well.

During this cruise both sampling techniques (NISKIN and SCHMITT) were compared in respect to the methane concentrations of the collected water. Table 7.5-1 shows no significant differences in the methane concentration of both bottle types. Duplicate analyses showed a good reproducibility (1 s = ± 0,4nLCH4/L).

Tab. 7.5-1: Comparison of Niskin Water Sampler and Bellows Water Sampler

Station MS	Depth m	Niskin nLCH4/L	Schmitt nLCH4/L	Difference nLCH4/L	Remarks
278	1000	10,2	12,0	+1,8	Rel. failed
280	350	25,1	25,2	+0,1	
286	180	18,0	21,2	+3,2	
305	246	32,4	32,0	-0,2	
338	3352	18,4	18,0	-0,4	Valve open

However, during the POSEIDON 189/4 cruise the bottom water conditions were always far below gas saturation. Thus, the situation where an usefull application of the SCHMITT sampler is anticipated was not met during this cruise.

8. *Conclusions and future aspects*

During the research cruise PO 189/4 both on-board monitoring of hydrographic parameters (CTD) and analysis of dissolved methane in water samples (CH4) did not give evidence for recent hydrothermal activity at the Cimotoe Seamount (Strait of Sicily) and within the caldera of Santorini (Ionic Sea). Moreover, water samples were taken and preserved for subsequent enrichment and analysis of trace elements (transition metals, Rare Earths) with the aim to monitor possibly elevated concentrations of hydrothermal elements. However, these preliminary results hold only true for water depths greater than 200 m. Grab samples within the caldera revealed brownish to greenish muddy sediments or sediments rich in coarse-grained volcaniclastics. However, also orange jelly-like colloidal sediments and more solid crusts have been sampled within the caldera (northeastern embayment). These sediments are either hydrothermal in origin or they are related to diagenetic processes.

Detailed geochemical analyses (Rare Earths, major and trace elements) are currently performed to clarify the genesis of those iron-rich sediments.

The technical aspects of cruise PO 189/4 showed that the OFOS system can now exactly be operated using the new transponder system. Furthermore, a chemical sensor system (UNT sensor system) was attached to the OFOS. The electrodes (pH, Eh, S=, H2S, 1 ASCREV) worked well under water and first results were obtained for bottom water in the caldera of Santorini. In the future the sensor system has to be completed and operated within a sea area known for hydrothermal activity. The SCHMITT gas sampler worked mechanically well. Comparisons of the gas concentrations were made using both the NISKIN and the SCHMITT sampler. The methane concentrations were identical (within the analytical error) for water samples containing low methane concentrations. However, in the future the SCHMITT sampler has to be tested in sea areas with hydrothermal activity and associated strong gas emanations.

Methane analysis performed on board during PO 189/4 showed concentrations in the normal range reported for sea water. However, fumarolic gases occur near Nea Kammeni (Santorini). Future work should concentrate on these gas emanations. Isotopic analysis will give evidence on the origin of the methane and carbon dioxide associated with fumarolic gases. Near the Kammeni Islands hydrothermally activity has led to the precipitation of iron-rich sediments. The colloidal Fe-rich sediments recovered during this cruise might be similar to these well-known deposits and it is of particular interest to compare both sediment types in terms of trace element, especially Rare Earth geochemistry.

9. Acknowledgement

Thanks are due to Captain Andresen and the crew of R/V POSEIDON for excellent cooperation on board.

Hints and suggestions by Prof. S. Varnavas during our survey within the Santorini caldera were of particular value and are kindly acknowledged.

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11. Appendix

11.1 Station Reports for Station Nos. 272 to 337

11.2 Results from water analyses (chlorinity, alkalinity, diss. oxygen, pH) on-board ship

11.3 Multi-sensor profiles in the water column

11.4 Dissolved methane

A) Station data and analytical results for dissolved methane

B) Profiles and histograms of dissolved methane in the water column

C) Schematic drawing of the SCHMITT Water Sampler

11.5 Scetch map of the bottom transponder positions

11.6 Plots of OFOS tracks

11.7 Plots of signals from the UNT Chemical Sensor Package

ERRATUM

Appendix 11.3 (Multisensor Profiles):

Conductivity is given in **[μs cm^{-1}]**

Dissolved Oxygen is given in **[% saturation]**

****

STATION REPORT

Station No.:	272 GF
GIK No.:	
Area:	CIMOTOE
Date:	28.03.92
Latitude:	37°06.09 N
Longitude:	12°39.21 E
Water depth:	183 m
Station time (UTC):	08:53 - 09:46
Total time (min):	46
Topography:	
Direction:	
Remarks:	Wind W 7-8 Bft, cloudy, sea 5-6, very rough
Results:	4 water depths sampled: 120, 140, 160, 180 m, 2 samples for Methane analysis, 4 samples for seawater analysis (major and trace elements).

****

STATION REPORT

Station No.:	273 BG
GIK No.:	
Area:	CIMOTOE
Date:	28.03.92
Latitude:	37°00.73 N
Longitude:	12°39.34 E
Water depth:	198 m
Station time (UTC):	09:20 - 09:29
Total time (min):	9
Topography:	
Direction:	280°
Remarks:	Wind W 7-8, cloudy, sea 5-6, very rough
Results:	filled with greyish to greenish-greyish sediment (mud). 2 samples, Shells, forams, worm 1 cm long (polychaete?) 1 Foto (BOTZ)

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STATION REPORT

Station No.:	274 GF
GIK No.:	
Area:	CIMOTOE
Date:	28.03.92
Latitude:	36°59.8 N
Longitude:	12°38.9 E
Water depth:	236 m
Station time (UTC):	12:02 - 12:31
Total time (min):	29
Topography:	
Direction:	
Remarks:	Wind W 6, cloudy, sea 5-6, very rough
Results:	5 Water depths sampled: 155, 175, 195, 215, 235 m 2 samples for Methane analysis, 4 samples for seawater analysis (major and trace elements).

****

STATION REPORT

Station No.:	275 BG
GIK No.:	
Area:	CIMOTOE
Date:	28.03.92
Latitude:	36°59.79 N
Longitude:	12°39.14 E
Water depth:	236 m
Station time (UTC):	12:45 - 12:51
Total time (min):	6
Topography:	
Direction:	276°
Remarks:	Wind W 6, cloudy, sea 5-6, very rough
Results:	Coral-shill, little mud, greenish-brownish, 3 samples (corals)

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STATION REPORT

Station No.:	276 GF
GIK No.:	
Area:	CIMOTOE
Date:	28.03.92
Latitude:	36°59.6 N
Longitude:	12°39.1 E
Water depth:	225 m
Station time (UTC):	15:07 - 15:32
Total time (min):	25
Topography:	
Direction:	
Remarks:	Wind W 6-8, cloudy, sea 5-6, very rough
Results:	5 Water depths sampled: 140, 160, 180, 200, 220 m, 2 samples for Methane analysis, 4 samples for seawater analysis (major and trace elements).

****

STATION REPORT

Station No.:	277 BG
GIK No.:	
Area:	CIMOTOE
Date:	28.03.92
Latitude:	36°59.31 N
Longitude:	12°39.17 E
Water depth:	223 m
Station time (UTC):	15:35 - 16:10
Total time (min):	35
Topography:	
Direction:	276°
Remarks:	Wind W 6-8, cloudy, sea 5-6, very rough sea
Results:	mud, greenish-grey, with pale brown-reddish surface
(slightly oxidized or algae)	
	2 samples (mud)

****

STATION REPORT

Station No.:	278a MS
GIK No.:	
Area:	IONIAN SEA
Date:	30.03.92
Latitude:	36° 21.53 N
Longitude:	17° 38.92 E
Water depth:	3480 m
Station time (UTC):	12:19 - 13:05
Total time (min):	46
Topography:	
Direction:	
Remarks:	Wind WSW 4-5, sea moderate, blue sky, cloudy
Results:	Test of the SCHMITT bellow sampler for dissolved gases, 1000 m water depth, 4 samples for Methane analysis

****

STATION REPORT

Station No.:	278b MS
GIK No.:	
Area:	IONIAN SEA
Date:	30.03.92
Latitude:	36° 21.53 N
Longitude:	17° 38.92 E
Water depth:	3480 m
Station time (UTC):	13:35 - 15:30
Total time (min):	115
Topography:	
Direction:	
Remarks:	Wind WSW 4-5, sea moderate, blue sky, cloudy
Results:	Test of the SCHMITT bellow sampler for dissolved gases. At 2912 m water depth cable voltage failed. No sample.

****

STATION REPORT

Station No.:	279a MS
GIK No.:	
Area:	IONIAN SEA
Date:	31.03.92
Latitude:	36°10.43 N
Longitude:	21°11.31 E
Water depth:	4300 m
Station time (UTC):	11:17 - 12:56
Total time (min):	99
Topography:	
Direction:	
Remarks:	Wind SW 2-3, sea slight, blue sky, cloudy
Results:	Test of the SCHMITT bellow sampler for dissolved gases. At 2500 m water depth cable voltage failed. No sample.

****

STATION REPORT

Station No.:	279b MS
GIK No.:	
Area:	IONIAN SEA
Date:	31.03.92
Latitude:	36°11.24 N
Longitude:	21°11.76 E
Water depth:	4300 m
Station time (UTC):	16:00 - 16:50
Total time (min):	50
Topography:	
Direction:	
Remarks:	Wind SW 2-3, sea slight, blue sky, cloudy
Results:	Test of the SCHMITT bellow sampler for dissolved gases. At 2674 m water depth cable voltage failed. No sample.

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STATION REPORT

Station No.:	280 MS
GIK No.:	
Area:	SANTORINI CALDERA
Date:	04.04.92
Latitude:	36°26.64 N
Longitude:	25°24.32 E
Water depth:	354 m
Station time (UTC):	06:15 - 06:35
Total time (min):	20
Topography:	
Direction:	
Remarks:	Wind SW 2-3, sea slight, blue sky, cloudy
Results:	9 water samples for methane analysis, 3+8 samples for seawater analysis (major and trace elements)

****

STATION REPORT

Station No.:	281 OFOS
GIK No.:	
Area:	SANTORINI CALDERA
Date:	04.04.92
Latitude:	36°26.62 N
Longitude:	25°24.49 E
Water depth:	350 m
Station time (UTC):	07:19 - 08:00
Total time (min):	41
Topography:	
Direction:	
Remarks:	Wind SW 1, sea very smooth, blue sky, cloudy
Results:	Technical test of the UNT sensor pack: sensors working, no leakage problems Video tape # 1

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Research Cruise POSEIDON 189/4
Messina - Santorini - Messina
26.03.92 - 13.04.92

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STATION REPORT

Station No.:	282 OFOS	
GIK No.:		
Area:	SANTORINI CALDERA	
Date:	04.04.92	
Latitude:	36°26.67 N (start) to	36°26.98 (end)
Longitude:	25°24.58 E	25°24.60
Water depth:	350 m	
Station time (UTC):	10:00 - 12:25	
Total time (min):	145	
Topography:		
Direction:		
Remarks:	Wind SW 1, sea very smooth, blue sky, cloudy	
Results:	full circle survey along the 200 m isobath. smooth and flat seafloor, with very many holes, which appear in circular clusters of about 5 to 15 (suggested to be of biotic origin); very locally sediment with higher reflectivity ("brighter" on the b/w video screen) than the surrounding sediment, occurring in form of a network or in round patches (suggested to be identical with colloform iron precipitates sampled later from this site, cf station 314 BG) Video tape # 1	

****

OFOS track:

Latitude	**Longitude**	**Time UTC**
36°26.669 N	25°24.579 E	10:06:44
36°26.618 N	25°24.558 E	10:11:47
36°26.620 N	25°24.577 E	10:16:44
36°26.651 N	25°24.592 E	10:21:44
36°26.672 N	25°24.588 E	10:26:44
36°26.725 N	25°24.613 E	10:31:49
36°26.758 N	25°24.701 E	10:41:52
36°26.776 N	25°24.695 E	10:46:44
36°26.773 N	25°24.823 E	10:51:44
36°26.817 N	25°24.824 E	10:56:44
36°26.839 N	25°24.819 E	11:01:44
36°26.861 N	25°24.837 E	11:06:44
36°26.888 N	25°24.806 E	11:11:44
36°26.979 N	25°24.743 E	11:16:44

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Research Cruise POSEIDON 189/4
Messina - Santorini - Messina
26.03.92 - 13.04.92

****

Latitude	Longitude	Time UTC
36°27.005 N	25°24.710 E	11:11:44
36°27.044 N	25°24.615 E	11:31:46
36°27.091 N	25°24.629 E	10:36:44
36°27.059 N	25°24.645 E	11:41:44
36°27.048 N	25°24.722 E	11:46:44
36°27.054 N	25°24.806 E	11:51:44
36°26.983 N	25°24.790 E	11:56:44
36°26.976 N	25°24.760 E	12:01:50
36°27.979 N	25°24.604 E	12:14:13

****

STATION REPORT

Station No.:	283 MS
GIK No.:	
Area:	SANTORINI CALDERA
Date:	04.04.92
Latitude:	36°27.01 N
Longitude:	25°24.03 E
Water depth:	341 - 338 m
Station time (UTC):	12:48 - 13:15
Total time (min):	27
Topography:	
Direction:	
Remarks:	Wind SW 1, sea very smooth, blue sky, cloudy
Results:	11 water samples for methane analysis 1+1 bottom water for trace element analysis

****

STATION REPORT

Station No.:	284 BG
GIK No.:	
Area:	SANTORINI CALDERA
Date:	04.04.92
Latitude:	36°26.967 N
Longitude:	25°24.105 E
Water depth:	340 m
Station time (UTC):	13:15 - 13:30
Total time (min):	15
Topography:	
Direction:	192°
Remarks:	Wind SW 1, sea very smooth, blue sky, cloudy
Results:	red rocks

****

STATION REPORT

Station No.:	285 BG
GIK No.:	
Area:	SANTORINI CALDERA
Date:	04.04.92
Latitude:	36°27.047 N
Longitude:	25°24.716 E
Water depth:	
Station time (UTC):	14:14
Total time (min):	
Topography:	
Direction:	121°
Remarks:	Wind SW 1, sea very smooth, blue sky, cloudy
Results:	equipment failed, damaged

****

STATION REPORT

Station No.:	286 MS
GIK No.:	
Area:	SANTORINI CALDERA
Date:	05.04.92
Latitude:	36°25.09 N
Longitude:	25°24.38 E
Water depth:	162 m
Station time (UTC):	05:53 - 06:14
Total time (min):	21
Topography:	
Direction:	
Remarks:	Wind SW 1, sea very smooth, blue sky, cloudy
Results:	10 water samples for methane analysis, 1+1 bottom water for trace element analysis, 1 surface water sample

****

STATION REPORT

Station No.:	287 XP
GIK No.:	
Area:	SANTORINI CALDERA
Date:	05.04.92
Latitude:	36°25.02 N
Longitude:	25°22.60 E
Water depth:	329 m
Station time (UTC):	09:44 - 09:47
Total time (min):	3
Topography:	
Direction:	
Remarks:	Wind SW 1, sea very smooth, blue sky, cloudy
Results:	Positioning of Transponder ALPHA

****

STATION REPORT

Station No.:	288 XP
GIK No.:	
Area:	SANTORINI CALDERA
Date:	05.04.92
Latitude:	36°26.55 N
Longitude:	25°24.07 E
Water depth:	379 m
Station time (UTC):	10:16 - 10:18
Total time (min):	2
Topography:	
Direction:	
Remarks:	Wind SW 1, sea very smooth, blue sky, cloudy
Results:	Positioning of Transponder BRAVO

****

STATION REPORT

Station No.:	289 XP
GIK No.:	
Area:	SANTORINI CALDERA
Date:	05.04.92
Latitude:	36°26.69 N
Longitude:	25°22.54 E
Water depth:	378 m
Station time (UTC):	10:38 - 10:41
Total time (min):	3
Topography:	
Direction:	
Remarks:	Wind SW 1, sea very smooth, blue sky, cloudy
Results:	Positioning of Transponder CHARLIE

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STATION REPORT

Station No.:	290 XP
GIK No.:	
Area:	SANTORINI CALDERA
Date:	05.04.92
Latitude:	36°25.82 N
Longitude:	25°21.90 E
Water depth:	379 m
Station time (UTC):	10:58 - 11:11
Total time (min):	13
Topography:	
Direction:	
Remarks:	Wind SW 1, sea very smooth, blue sky, cloudy
Results:	Positioning of Transponder FOXTROT

****

STATION REPORT

Station No.:	291 XP
GIK No.:	
Area:	SANTORINI CALDERA
Date:	05.04.92
Latitude:	36°25.70 N
Longitude:	25°22.80 E
Water depth:	379 m
Station time (UTC):	11:25 - 12:22
Total time (min):	57
Topography:	
Direction:	
Remarks:	Wind SW 1, sea very smooth, blue sky, cloudy
Results:	Test of Transponder Navigation System Hydrophon in water on Bb

****

STATION REPORT

Station No.:	292 MS
GIK No.:	
Area:	SANTORINI CALDERA
Date:	05.04.92
Latitude:	36°24.60 N
Longitude:	25°22.88 E
Water depth:	216 m
Station time (UTC):	09:45 - 10:09
Total time (min):	24
Topography:	
Direction:	
Remarks:	Wind SW 1, sea very smooth, blue sky, cloudy
Results:	11 water samples for methane analysis, 1 water sample for isotope analysis, 1+1 bottom water for trace element analysis, 1+1 surface water samples

****

STATION REPORT

Station No.:	293 BG
GIK No.:	
Area:	SANTORINI CALDERA NEAR KAMMENI
Date:	05.04.92
Latitude:	36°24.635 N
Longitude:	25°22.904 E
Water depth:	191 m
Station time (UTC):	10:16 - 10:29
Total time (min):	13
Topography:	
Direction:	
Remarks:	Wind SW 1, sea very smooth, blue sky, cloudy
Results:	filled 1/3 brown sand and gravel 2 samples

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STATION REPORT

Station No.:	294 OFOS	
GIK No.:		
Area:	SANTORINI CALDERA	
Date:	05.04.92	
Latitude:	36°23.42 N (start) to	36°24.21 (end)
Longitude:	25°21.31 E	25°22.24
Water depth:	260 m	
Station time (UTC):	11:05 - 13:11	
Total time (min):	126	
Topography:		
Direction:	Heading 030?	
Remarks:	Wind SW 1, sea very smooth, blue sky, cloudy	
Results:	sediment relatively uniform, holes ϕ 2-5 cm, several > ϕ 10 cm ca. 80 photos, Video tapes # 1,2	

OFOS Track

Latitude	**Longitude**	**Time UTC**
36°23.460 N	25°21.279 E	11:01:58
36°23.423 N	25°21.300 E	11:09:09
36°23.426 N	25°21.312 E	11:14:09
36°23.402 N	25°21.320 E	11:19:09
36°23.432 N	25°21.352 E	11:24:09
36°23.504 N	25°21.429 E	11:29:09
36°23.541 N	25°21.462 E	11:34:09
36°23.561 N	25°21.470 E	11:39:12
36°23.589 N	25°21.477 E	11:44:09
36°23.663 N	25°21.515 E	11:49:09
36°23.722 N	25°21.569 E	11:55:09
36°23.753 N	25°21.592 E	12:00:09
36°23.803 N	25°21.619 E	12:05:09
36°23.844 N	25°21.652 E	12:10:09
36°23.882 N	25°21.684 E	12:15:09
36°23.922 N	25°21.694 E	12:20:09
36°23.962 N	25°21.730 E	12:25:09
36°24.015 N	25°21.815 E	12:30:09
36°24.054 N	25°21.891 E	12:35:09
36°24.083 N	25°21.950 E	12:40:09
36°24.111 N	25°22.013 E	12:45:09
36°24.145 N	25°22.071 E	12:50:09
36°24.183 N	25°22.151 E	12:55:09
36°24.191 N	25°22.188 E	13:00:09
36°24.212 N	25°22.237 E	13:05:09

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STATION REPORT

Station No.:	295 MS
GIK No.:	
Area:	SANTORINI CALDERA
Date:	05.04.92
Latitude:	36°23.20 N
Longitude:	25°23.25 E
Water depth:	218 m
Station time (UTC):	13:50 - 14:12
Total time (min):	22
Topography:	
Direction:	
Remarks:	Wind SW 1, sea very smooth, blue sky, cloudy
Results:	11 water samples for methane analysis 1 water sample for isotope analysis 1+1 bottom water sample for trace element analysis 1 surface water sample

****

STATION REPORT

Station No.:	296 BG
GIK No.:	
Area:	SANTORINI CALDERA
Date:	05.04.92
Latitude:	36°23.114 N
Longitude:	25°23.307 E
Water depth:	216 m
Station time (UTC):	14:08 - 14:21
Total time (min):	13
Topography:	
Direction:	
Remarks:	Wind SW 1, sea very smooth, blue sky, cloudy
Results:	full with mud, FeOOH, red, some sandy particles

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STATION REPORT

Station No.:	297 GF
GIK No.:	
Area:	SANTORINI CALDERA
Date:	06.04.92
Latitude:	36°23.475 N
Longitude:	25°23.904 E
Water depth:	202 m
Station time (UTC):	06:32 - 06:55
Total time (min):	23
Topography:	
Direction:	
Remarks:	Wind E 3, sea slight, cloudy
Results:	1 water sample for trace element analysis 200 m cable length

****

STATION REPORT

Station No.:	298 MS
GIK No.:	
Area:	SANTORINI CALDERA
Date:	06.04.92
Latitude:	36°23.48 N
Longitude:	25°25.89 E
Water depth:	214 m
Station time (UTC):	06:36 - 07:01
Total time (min):	25
Topography:	
Direction:	
Remarks:	Wind E 3, sea slight, cloudy
Results:	water drift ca. 0,5 m/sec 11 water samples for methane analysis 1 water sample for trace element analysis

****

STATION REPORT

Station No.:	299 BG
GIK No.:	
Area:	SANTORINI CALDERA
Date:	06.04.92
Latitude:	36°23.416 N
Longitude:	25°25.843 E
Water depth:	222 m
Station time (UTC):	07:13:10
Total time (min):	
Topography:	
Direction:	
Remarks:	Wind E 3, sea slight, cloudy
Results:	Silty sand, brown with black grains of sand downwards: grey with black grains of sand, white "filaments" (worms 5 cm long), odourless, 4 samples.

****

STATION REPORT

Station No.:	300 GF
GIK No.:	
Area:	SANTORINI CALDERA
Date:	06.04.92
Latitude:	36°24.485 N
Longitude:	25°22.553 E
Water depth:	240 m
Station time (UTC):	09:44 - 09:54
Total time (min):	10
Topography:	
Direction:	
Remarks:	Wind E 3, sea slight, cloudy
Results:	1 water sample for trace element analysis 225 m cable length

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STATION REPORT

Station No.:	301 MS
GIK No.:	
Area:	SANTORINI CALDERA
Date:	06.04.92
Latitude:	36°24.57 N
Longitude:	25°22.61 E
Water depth:	236-242 m
Station time (UTC):	10:05 - 10:28
Total time (min):	23
Topography:	
Direction:	
Remarks:	Wind E 3, sea slight, cloudy
Results:	10 water sample for methane analysis 1 bottom water sample for trace element ananlysis

****

STATION REPORT

Station No.:	302 BG
GIK No.:	
Area:	SANTORINI CALDERA
Date:	06.04.92
Latitude:	36°24.475 N
Longitude:	25°22.510 E
Water depth:	190 m
Station time (UTC):	10:52 - 11:12
Total time (min):	20
Topography:	
Direction:	
Remarks:	Wind E 3, sea slight, cloudy
Results:	sandy silt, silty sand with black lava fragments, bryozoes 0-10 cm, brown, > 10 cm sediment depth greyish-green 5 samples

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STATION REPORT

Station No.:	303 OFOS	
GIK No.:		
Area:	SANTORINI CALDERA	
Date:	06.04.92	
Latitude:	36°24.20 N (start) to	36°25.03 N (end)
Longitude:	25°22.13 E	25°22.74 E
Water depth:	245 m	
Station time (UTC):	11:43 - 13:22	
Total time (min):	99	
Topography:	predominantly plain, one topographic high with 190 m water depth	
Direction:		
Remarks:	Wind E 3, sea slight, cloudy	
Results:	Covered with sediment, holes ϕ 2-5 cm, only a few with bigger diameters Video tape # 2, 80 photos	

OFOS track:

Latitude	**Longitude**	**Time UTC**
36°24.21 N	25°22.13 E	11:57
36°24.33 N	25°22.22 E	12:08
36°24.558 N	25°22.387 E	12:27
36°24.608 N	25°22.423 E	12:34
36°24.654 N	25°22.475 E	12:39
36°24.700 N	25°22.492 E	12:44
36°24.745 N	25°22.512 E	12:49
36°24.806 N	25°22.570 E	12:54
36°24.833 N	25°22.609 E	12:59
36°24.892 N	25°22.670 E	13:05
36°24.972 N	25°22.708 E	13:10

****

STATION REPORT

Station No.:	304 GF
GIK No.:	
Area:	SANTORINI CALDERA
Date:	06.04.92
Latitude:	36°25.189 N
Longitude:	25°24.414 E
Water depth:	218 m
Station time (UTC):	13:50 - 14:02
Total time (min):	12
Topography:	
Direction:	
Remarks:	Wind E 3, sea slight, cloudy
Results:	1 water sample for trace element analysis 200 m cable length

****

STATION REPORT

Station No.:	305 MS
GIK No.:	
Area:	SANTORINI CALDERA
Date:	06.04.92
Latitude:	36°25.12 N
Longitude:	25°24.40 E
Water depth:	212 m
Station time (UTC):	14:08 - 14:30
Total time (min):	22
Topography:	
Direction:	
Remarks:	Wind E 3, sea slight, cloudy
Results:	11 water samples for methane analysis 1 bottom water sample for trace element analysis

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STATION REPORT

Station No.:	306 BG
GIK No.:	
Area:	SANTORINI CALDERA
Date:	06.04.92
Latitude:	36°25.094 N
Longitude:	25°24.407 E
Water depth:	219 m
Station time (UTC):	14:33 - 14:57
Total time (min):	24
Topography:	
Direction:	
Remarks:	Wind E 3, sea slight, cloudy
Results:	no samples

****

STATION REPORT

Station No.:	307 GF
GIK No.:	
Area:	SANTORINI CALDERA
Date:	07.04.92
Latitude:	36°24.664 N
Longitude:	25°22.851 E
Water depth:	223 m
Station time (UTC):	05:30 - 05:39
Total time (min):	9
Topography:	
Direction:	
Remarks:	Wind S-W 6-7, squally, sea moderate, overcast
Results:	1 water sample for trace element analysis 200 m cable length

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STATION REPORT

Station No.:	308 MS
GIK No.:	
Area:	SANTORINI CALDERA
Date:	07.04.92
Latitude:	36°24.68 N
Longitude:	25°22.73 E
Water depth:	239 m
Station time (UTC):	05:45 - 06:15
Total time (min):	30
Topography:	
Direction:	
Remarks:	Wind S-W 6-7, squally, sea moderate, overcast
Results:	11 water sample for methane analysis 1 bottom water sample for trace element analysis

****

STATION REPORT

Station No.:	309 GF
GIK No.:	
Area:	SANTORINI CALDERA
Date:	07.04.92
Latitude:	36°24.62 N
Longitude:	25°22.75 E
Water depth:	238 m
Station time (UTC):	06:15 - 06:23
Total time (min):	8
Topography:	
Direction:	
Remarks:	Wind S-W 6-7, squally, sea moderate, overcast
Results:	2 water samples (10, 20 m) for trace element analysis 1 water sample for methane analysis

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STATION REPORT

Station No.:	310 BG
GIK No.:	
Area:	SANTORINI CALDERA
Date:	07.04.92
Latitude:	36°24.621 N
Longitude:	25°22.787 E
Water depth:	223 m
Station time (UTC):	06:20 - 06:30
Total time (min):	10
Topography:	
Direction:	
Remarks:	Wind S-W 6-7, squally, sea moderate, overcast
Results:	ca. 0-7 cm brown sandy silt ca. 7-10 cm greyish green sandy silt 5 samples

****

STATION REPORT

Station No.:	311 BG
GIK No.:	
Area:	SANTORINI CALDERA
Date:	07.04.92
Latitude:	36°27.052 N
Longitude:	25°24.661 E
Water depth:	213 m
Station time (UTC):	07:01 - 07:15
Total time (min):	14
Topography:	
Direction:	
Remarks:	Wind S-W 6-7, squally, sea moderate, overcast
Results:	gravel-sand (lava and pumice), Fe-rich, crusts (fragments of 2-5 cm ϕ), sediment surface in the grab sampler was covered with colloidal FeOOH 3 samples

****

STATION REPORT

Station No.:	312 BG
GIK No.:	
Area:	SANTORINI CALDERA
Date:	07.04.92
Latitude:	36°27.068 N
Longitude:	25°24.742 E
Water depth:	184 m
Station time (UTC):	07:28 - 07:45
Total time (min):	17
Topography:	
Direction:	
Remarks:	Wind S-W 6-7, squally, sea moderate, overcast
Results:	silty sand with lava fragments, sediment surface in the grab sampler covered with soft, chocolate-like, brown crusts 2 samples

****

STATION REPORT

Station No.:	313 BG
GIK No.:	
Area:	SANTORINI CALDERA
Date:	07.04.92
Latitude:	36°27.209 N
Longitude:	25°24.632 E
Water depth:	177 m
Station time (UTC):	07:55 - 08:03
Total time (min):	8
Topography:	
Direction:	
Remarks:	Wind S-W 6-7, squally, sea moderate, overcast
Results:	0-7 cm brown sandy silt with Fe-crusts 7-12 cm grey-green coarse-sand, 3 samples

****

STATION REPORT

Station No.:	314 BG
GIK No.:	
Area:	SANTORINI CALDERA
Date:	07.04.92
Latitude:	36°27.231 N
Longitude:	25°24.509 E
Water depth:	205 m
Station time (UTC):	08:15 - 08:25
Total time (min):	10
Topography:	
Direction:	
Remarks:	Wind S-W 6-7, squally, sea moderate, overcast
Results:	0-5 cm light-brown colloidal FeOOH 5-15 cm black tuffaceous coarse-sand 3 samples, 4 photos

****

STATION REPORT

Station No.:	315 BG
GIK No.:	
Area:	SANTORINI CALDERA
Date:	07.04.92
Latitude:	36°27.236 N
Longitude:	25°24.258 E
Water depth:	250 m
Station time (UTC):	08:32 - 08:45
Total time (min):	13
Topography:	
Direction:	
Remarks:	Wind S-W 6-7, squally, sea moderate, overcast
Results:	brown Fe-crusts on top of black tuffaceous sand 1 sample

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STATION REPORT

Station No.:	316 BG
GIK No.:	
Area:	SANTORINI CALDERA
Date:	07.04.92
Latitude:	36°27.228 N
Longitude:	25°23.977 E
Water depth:	280 m
Station time (UTC):	08:55 - 09:10
Total time (min):	15
Topography:	
Direction:	
Remarks:	Wind S-W 6-7, squally, sea moderate, overcast
Results:	brownish clayey silt 3 samples

****

STATION REPORT

Station No.:	317 GF
GIK No.:	
Area:	SANTORINI CALDERA
Date:	07.04.92
Latitude:	36°27.085 N
Longitude:	25°24.659 E
Water depth:	199 m
Station time (UTC):	09:19 - 09:27
Total time (min):	8
Topography:	
Direction:	
Remarks:	Wind S-W 6-7, squally, sea moderate, overcast
Results:	1 water sample for methane analysis 1 water sample for trace element analysis 190 m cable-length

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STATION REPORT

Station No.:	318 GF
GIK No.:	
Area:	SANTORINI CALDERA
Date:	07.04.92
Latitude:	36°23.437 N
Longitude:	25°22.201 E
Water depth:	204 m
Station time (UTC):	10:16 - 10:24
Total time (min):	8
Topography:	
Direction:	
Remarks:	Wind S-W 6-7, squally, sea moderate, overcast
Results:	1 water sample for trace element analysis 210 m cable-length

****

STATION REPORT

Station No.:	319 MS
GIK No.:	
Area:	SANTORINI CALDERA
Date:	07.04.92
Latitude:	36°23.44 N
Longitude:	25°22.27 E
Water depth:	215 m
Station time (UTC):	10:27 - 10:50
Total time (min):	23
Topography:	
Direction:	
Remarks:	Wind S-W 6-7, squally, sea moderate, overcast
Results:	10 water sample for methane analysis 1 bottom water sample for trace element analysis

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STATION REPORT

Station No.:	320 BG
GIK No.:	
Area:	SANTORINI CALDERA
Date:	07.04.92
Latitude:	36°23.410 N
Longitude:	25°22.402 E
Water depth:	226 m
Station time (UTC):	10:53 - 11:05
Total time (min):	12
Topography:	
Direction:	
Remarks:	Wind S-W 6-7, squally, sea moderate, overcast
Results:	brownish clayey silt samples for geochemistry and sedimentology 2 samples

****

STATION REPORT

Station No.:	321 XP
GIK No.:	
Area:	SANTORINI CALDERA
Date:	07.04.92
Latitude:	36°24.95 N
Longitude:	25°22.30 E
Water depth:	277 m
Station time (UTC):	11:30 - 13:25
Total time (min):	115
Topography:	
Direction:	
Remarks:	Wind S-W 6-7, squally, sea moderate, overcast
Results:	Acquisition for transponder calibration

****

STATION REPORT

Station No.:	322 GF
GIK No.:	
Area:	COLOMBUS SEAMOUNT
Date:	08.04.92
Latitude:	36°30.737 N
Longitude:	25°29.733 E
Water depth:	206 m
Station time (UTC):	06:46 - 06:53
Total time (min):	7
Topography:	
Direction:	
Remarks:	Wind W 4, sea moderate, cloudy
Results:	200 m cable-length 1 water sample for trace element analysis

****

STATION REPORT

Station No.:	323 MS
GIK No.:	
Area:	COLOMBUS SEAMOUNT
Date:	08.04.92
Latitude:	36°30.77 N
Longitude:	25°29.76 E
Water depth:	207 m
Station time (UTC):	06:56 - 07:28
Total time (min):	32
Topography:	
Direction:	
Remarks:	Wind W 4, sea moderate, cloudy
Results:	11 water samples for methane analysis 1 bottom water sample for trace element analysis

****

STATION REPORT

Station No.:	324 BG
GIK No.:	
Area:	COLOMBUS SEAMOUNT
Date:	08.04.92
Latitude:	36°31.019 N
Longitude:	25°29.894 E
Water depth:	202 m
Station time (UTC):	07:32 - 07:44
Total time (min):	12
Topography:	
Direction:	
Remarks:	Wind W 4, sea moderate, cloudy
Results:	grey-black gravelly coarse-sand with many pumice fragments 2 samples for geochemisty and sedimentology

****

STATION REPORT

Station No.:	325 DR	
GIK No.:		
Area:	COLOMBUS SEAMOUNT	
Date:	08.04.92	
Latitude:	36°30.624 N (start)	36°30.770 N (end)
Longitude:	25°30.188 E	25°29.684 E
Water depth:	274 m	200 m
Station time (UTC):	08:09 - 09:02	
Total time (min):	53	
Topography:		
Direction:		
Remarks:	Wind W 4, sea moderate, cloudy	
Results:	Dredge filled with volcanic rocks: whitish tuffaceous material similar to "Upper Pumice" on Santorini, a few rounded greenish pumice fragments; cementated coarse-sand, phyllite 3 photos, 1 sample	

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STATION REPORT

Station No.:	326 GF
GIK No.:	
Area:	COLOMBUS SEAMOUNT
Date:	08.04.92
Latitude:	36°31.127 N
Longitude:	25°27.692 E
Water depth:	208 m
Station time (UTC):	09:50 - 09:56
Total time (min):	6
Topography:	
Direction:	
Remarks:	Wind W 4, sea moderate, cloudy
Results:	1 water sample for trace element analysis 200 m cable-length

****

STATION REPORT

Station No.:	327 MS
GIK No.:	
Area:	COLOMBUS SEAMOUNT
Date:	08.04.92
Latitude:	36°31.02 N
Longitude:	25°27.64 E
Water depth:	205 m
Station time (UTC):	10:10 - 10:25
Total time (min):	15
Topography:	
Direction:	
Remarks:	Wind W 4, sea moderate, cloudy
Results:	12 water sample for methane analysis 1 bottom water sample for trace element analysis

****

STATION REPORT

Station No.:	328 BG
GIK No.:	
Area:	COLOMBUS SEAMOUNT
Date:	08.04.92
Latitude:	36°31.082 N
Longitude:	25°27.642 E
Water depth:	214 m
Station time (UTC):	10:26 - 10:33
Total time (min):	7
Topography:	
Direction:	
Remarks:	Wind W 4, sea moderate, cloudy
Results:	black rubble of pumice (ϕ 1-3 cm) bedded in brown silty clay 2 samples

****

STATION REPORT

Station No.:	329 DR	
GIK No.:		
Area:	COLOMBUS SEAMOUNT	
Date:	08.04.92	
Latitude:	36°31.128 N (start)	36°31.136 N (end)
Longitude:	25°27.126 E	25°27.843 E
Water depth:	287 m	176 m
Station time (UTC):	10:46 - 11:22	
Total time (min):	36	
Topography:		
Direction:	115° - 95°	
Remarks:	Wind W 4, sea moderate, cloudy	
Results:	Volcanic tuffaceous rocks appearing more wethered than 325 DR. Rounded pumice (2-5 cm ϕ) with brownish to blackish surface. Mud. 1 sample, 2 photos	

****

STATION REPORT

Station No.:	330 MS
GIK No.:	
Area:	N' SANTORINI
Date:	08.04.92
Latitude:	36°30.61 N
Longitude:	25°23.03 E
Water depth:	240 m
Station time (UTC):	12:10 - 12:35
Total time (min):	25
Topography:	
Direction:	
Remarks:	Wind W 4, sea moderate, cloudy
Results:	11 water samples for methane analysis 1 bottom water sample for trace element analysis N current out of caldera

****

STATION REPORT

Station No.:	331a XP
GIK No.:	
Area:	SANTORINI CALDERA
Date:	08.04.92
Latitude:	36°26.79 N
Longitude:	25°22.27 E
Water depth:	376 m
Station time (UTC):	13:15 - 13:20
Total time (min):	5
Topography:	
Direction:	
Remarks:	Wind W 4, sea moderate, cloudy
Results:	Hydrophone on Bb

****

STATION REPORT

Station No.:	331b XP
GIK No.:	
Area:	SANTORINI CALDERA
Date:	08.04.92
Latitude:	36°26.79 N
Longitude:	25°22.27 E
Water depth:	375 m
Station time (UTC):	13:20 - 14:26
Total time (min):	66
Topography:	
Direction:	
Remarks:	Wind W 4, sea moderate, cloudy
Results:	Transponder array calibration

****

STATION REPORT

Station No.:	332 GF
GIK No.:	
Area:	SW SANTORINI
Date:	09.04.92
Latitude:	36°26.006 N
Longitude:	25°16.537 E
Water depth:	238 m
Station time (UTC):	06:10 - 06:20
Total time (min):	10
Topography:	
Direction:	
Remarks:	Wind E 3, sea slight, cloudy
Results:	1+1 water sample for trace element analysis 220 m cable-length

Christian-Albrechts-Universität Kiel

Research Cruise POSEIDON 189/4
Messina - Santorini - Messina
26.03.92 - 13.04.92

****

STATION REPORT

Station No.:	333 MS
GIK No.:	
Area:	SW SANTORINI
Date:	09.04.92
Latitude:	36°26.11 N
Longitude:	25°16.56 E
Water depth:	222 m
Station time (UTC):	06:21 - 06:41
Total time (min):	20
Topography:	
Direction:	
Remarks:	Wind E 3, sea slight, cloudy
Results:	11 water samples for methane analysis 1 bottom water sample for trace element analysis SW current into caldera

****

STATION REPORT

Station No.:	334 BG
GIK No.:	
Area:	W' SANTORINI
Date:	09.04.92
Latitude:	36°25.960 N
Longitude:	25°16.469 E
Water depth:	231 m
Station time (UTC):	06:46 - 07:00
Total time (min):	14
Topography:	
Direction:	
Remarks:	Wind E 3, sea slight, cloudy
Results:	brownish clayey silt with biogenic fragments 3 samples

****

STATION REPORT

Station No.:	335 OFOS
GIK No.:	
Area:	SANTORINI CALDERA
Date:	09.04.92
Latitude:	36°24.36 N (start)
Longitude:	25°22.27 E
Water depth:	180 m
Station time (UTC):	07:50 - 08:49
Total time (min):	59
Topography:	
Direction:	
Remarks:	Wind E 3, sea slight, cloudy
Results:	slope downwards away from Nea Kammeni, rough ground made of lava flows and volcanic debris; at the end of this track plain ground with smooth sediment cover, with holes. For OFOS track see chapter 7.2 (transponder navigation) Video tape # 2, 175 photos

****

STATION REPORT

Station No.:	336 OFOS	
GIK No.:		
Area:	SANTORINI CALDERA	
Date:	09.04.92	
Latitude:	36°24.48 N (start) to	36°24.78 N (end)
Longitude:	25°22.38 E	25°22.23 E
Water depth:	200 - 275 m	
Station time (UTC):	09:16 - 09:57	
Total time (min):	41	
Topography:		
Direction:		
Remarks:	Wind E 3, sea slight, cloudy	
Results:	gentle slope downwards, smooth sediment cover, with holes. For OFOS track see chapter 7.2 (transponder navigation) 1 water sample during heave at 160 m Video tape # 2, 65 photos	

Christian-Albrechts-Universität Kiel

Research Cruise POSEIDON 189/4
Messina - Santorini - Messina
26.03.92 - 13.04.92

****

STATION REPORT

Station No.:	337 MS
GIK No.:	
Area:	SANTORINI CALDERA
Date:	09.04.92
Latitude:	36°24.63 N
Longitude:	25°22.82 E
Water depth:	221 m
Station time (UTC):	11:53 - 12:08
Total time (min):	15
Topography:	
Direction:	
Remarks:	Wind E 3, sea slight, cloudy
Results:	Test of CTD-probe 4 water samples for methane analysis

****

BG =	VAN VEEN grab sampler
DR =	Chain sack Dredge
GF =	GO-FLO water sampler, 5 L
MS =	Multi-sensor and water sampler rosetta (10 NISKIN water samplers and 1 SCHMITT bellow sampler for dissolved gases)
OFOS =	deep-towed and remote controlled "Ocean Floor Observation System", carrying 1 video camera, 35 mm foto camera, illumination system, 1 NISKIN water sampler 3 L volume, 1 CTD-sensor package, 1 pinger, UNT sensor unit (temporarily)
XP =	Transponder Navigation System calibration station

****

WATER ANALYSES on-board ship POSEIDON 189/4

Station: **272 GF CIMOTOE**
Latitude: 37°06.09 N
Longitude: 12°39.21 E
Date: 28.03.92
Time UTC: 8.53-9.39
Water depth: 183 m
Water sampler type: GO-FLO, 5 L

Water depth [m]	CHLORINITY [g Cl/L]	SALINITY [o/oo]	ALKALINITY [meq]	OXYGEN [ml O2/L]	pH	Remarks	
120				5.16		water sampler leaky	
140	21.30	38.48	2.67	4.80	8.17		
160	21.37	38.61	2.69	4.53	8.18		
180	21.49	38.82	2.68	4.24	8.19		

Station: **274 GF CIMOTOE**
Latitude: 36°59.8 N
Longitude: 12°38.9 E
Date: 28.03.92
Time UTC: 12.02-12.31
Water depth: 236 m
Water sampler type: GO-FLO, 5 L

Water depth [m]	CHLORINITY [g Cl/L]	SALINITY [o/oo]	ALKALINITY [meq]	OXYGEN [ml O2/L]	pH	Remarks	
155	21.35	38.57	2.70	4.34	8.20		
175	21.44	38.73	2.71	4.32	8.18		
195	20.93	37.81	2.60	6.01	8.22	contaminated by surface	
215	21.35	38.57	2.72	4.32	8.19		water
235	21.40	38.66	2.75	4.28	8.19		

Appendix 11.2:

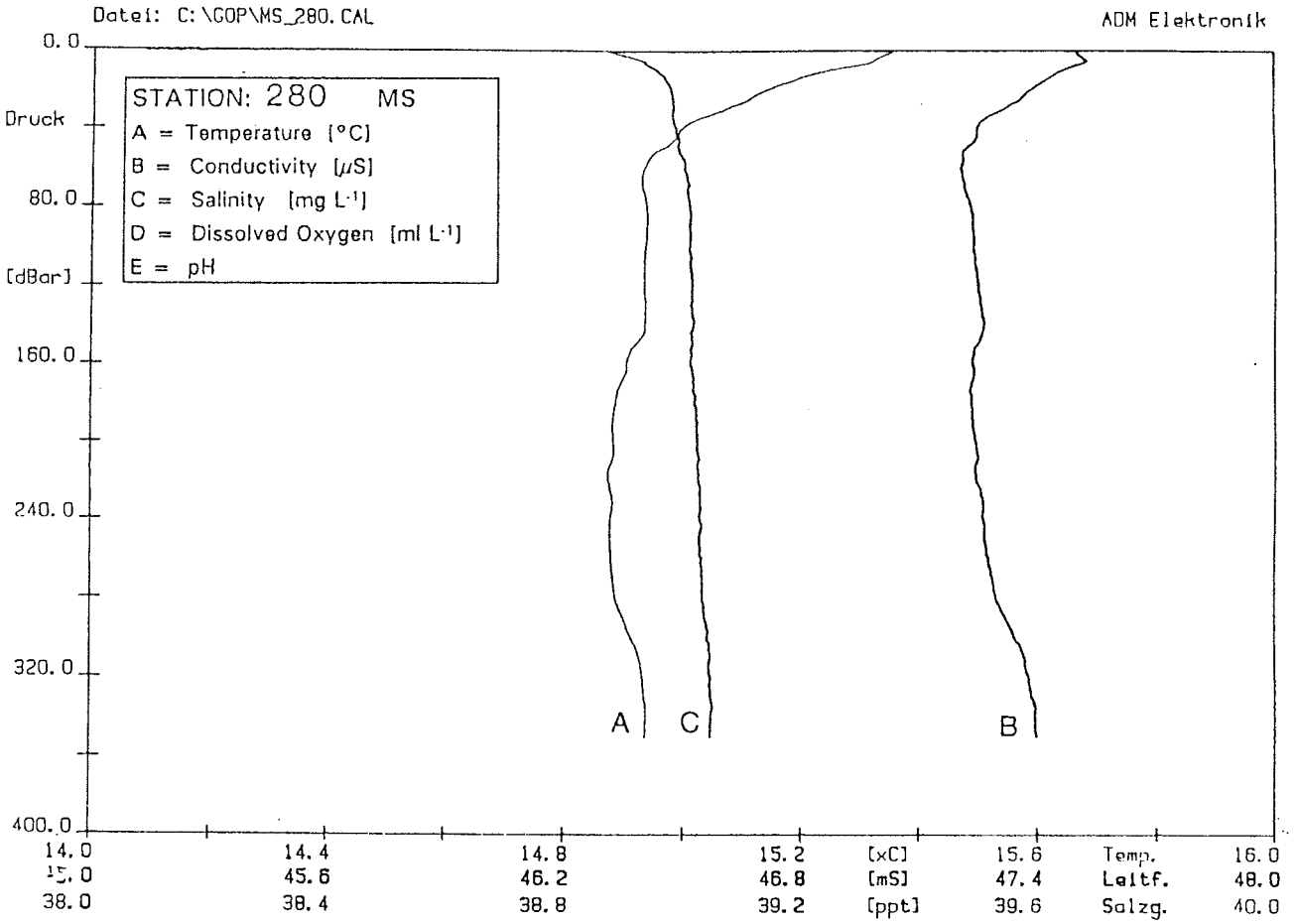
WATER ANALYSES on-board ship POSEIDON 189/4

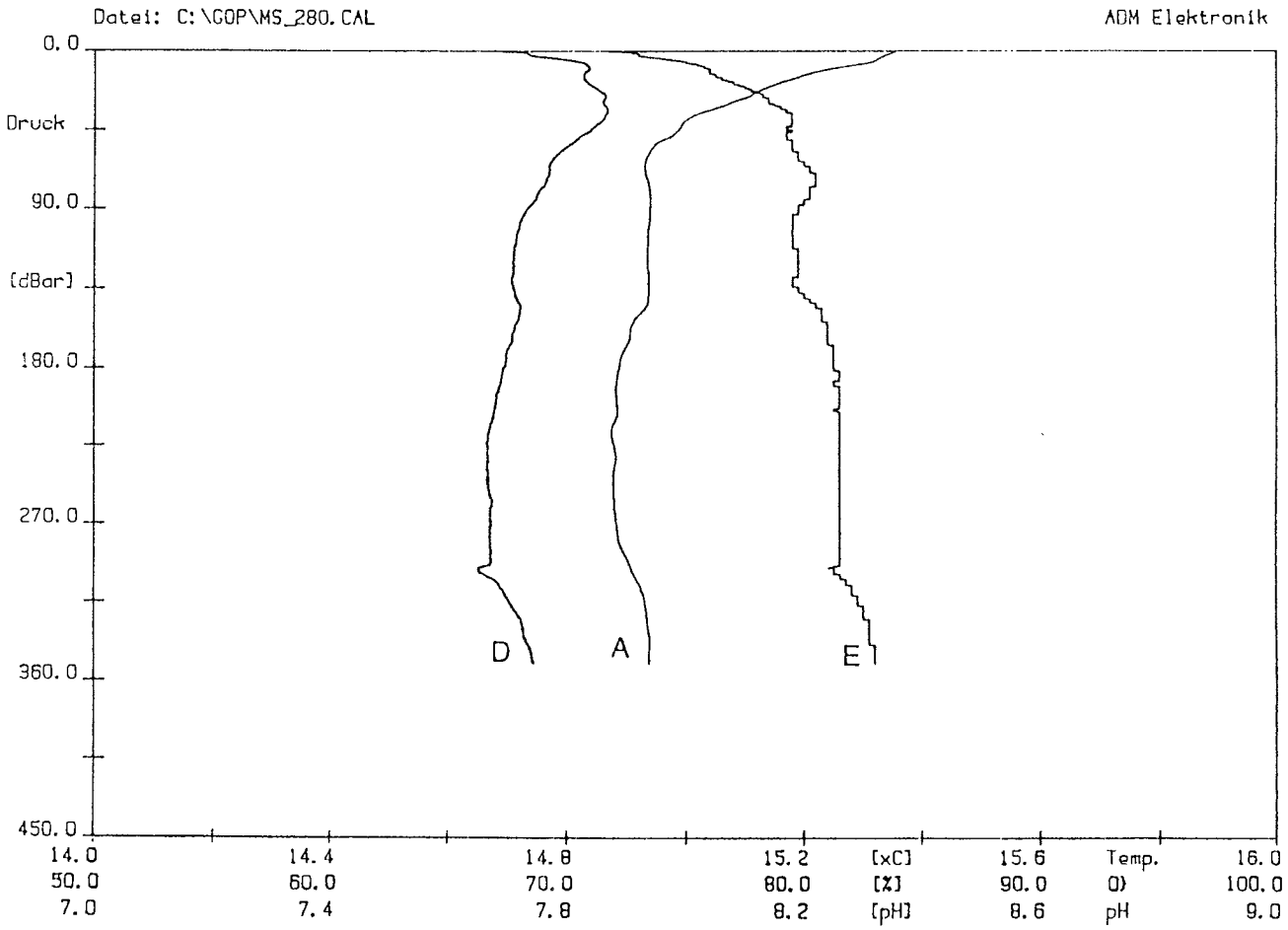
Station: **276 GF CIMOTOE**
Latitude: 36°59,6 N
Longitude: 12°39,1 E
Date: 28-03-92
Time UTC: 15:07-15:32
Water depth: 225 m
Water sampler type: GO-FLO, 5 L

Water depth [m]	CHLORINITY [g Cl/L]	SALINITY [o/oo]	ALKALINITY [meq]	OXYGEN [ml O2/L]	pH	Remarks	
140	21.09	38.10	2.68	4.93	8.19	contaminated by surface	
160	21.32	38.52	2.73	4.34	8.17		water
180						sampler not closed	
200	21.37	38.61	2.73	4.33	8.17		
220	21.40	38.66	2.73	4.31	8.18		

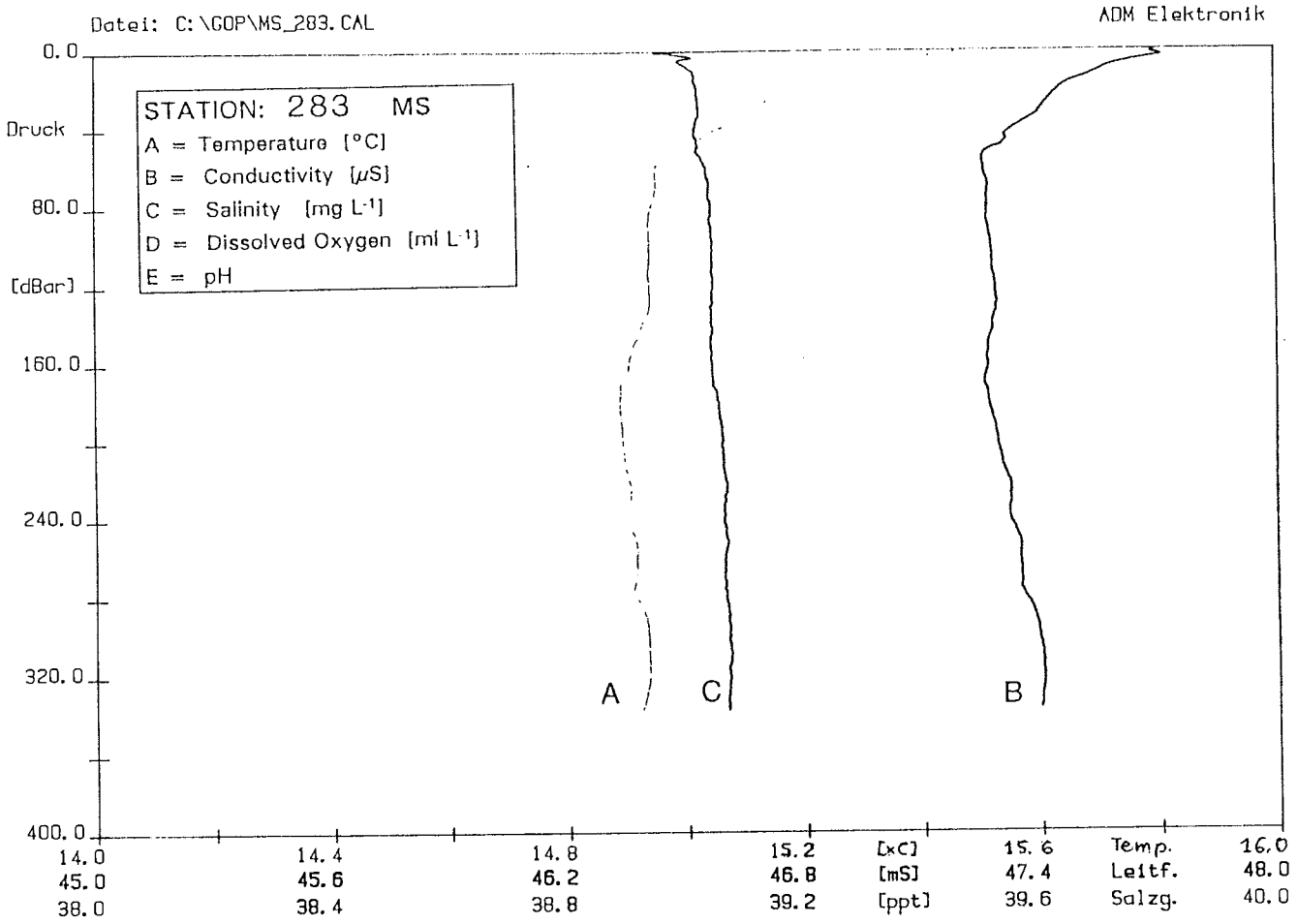
Station: **280 MS SANTORINI CALDERA**
Latitude: 36°26.64 N
Longitude: 25°24.32 E
Date: 04-04-92
Time UTC: 06:15-06:35
Water depth: 354m
Water sampler type: NISKIN, 3 L

Water depth [m]	CHLORINITY [g Cl/L]	SALINITY [o/oo]	ALKALINITY [meq]	OXYGEN [ml O2/L]	pH	Remarks	
70	21.52	38.87	2.71	5.56	8.22		
110	21.62	39.05	2.70	5.52	8.22		
150	21.63	39.07	2.70	5.51	8.21		
190	21.53	38.89	2.70	5.42	8.22		
230	21.61	39.05	2.71	5.38	8.20		
270	21.59	39.00	2.71	5.40	8.20		
310	21.63	39.07	2.72	5.39	8.20		
345	21.68	39.16	2.72	5.59	8.19		





Appendix 11.3: Multisensor profiles in the water column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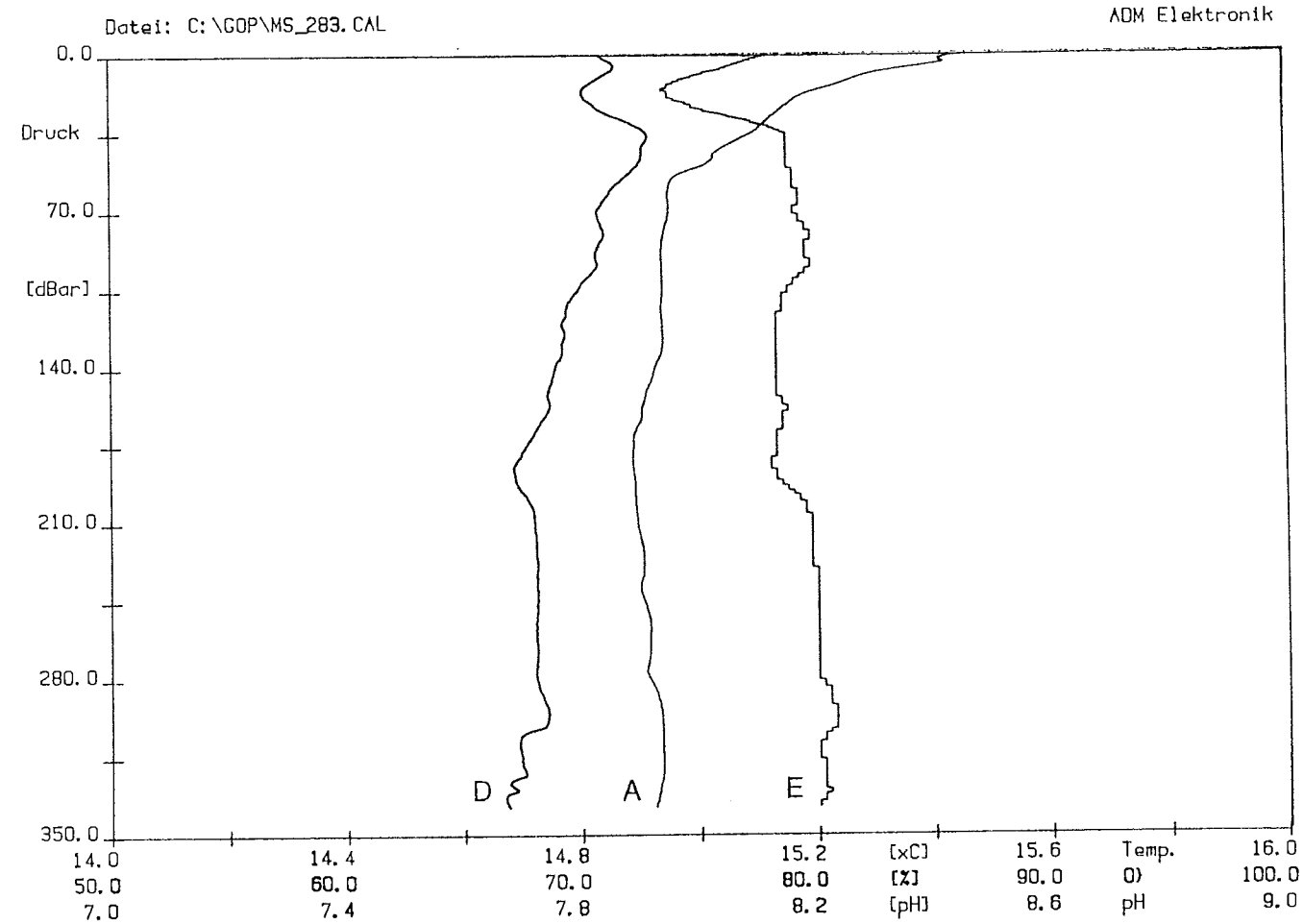
ADM Elektronik
STATION: 283 MS
A = Temperature [°C]
B = Conductivity [µS]
C = Salinity [mg L-1]
D = Dissolved Oxygen [ml L-1]
E = pH
Druck
[dBar]
0.0
80.0
160.0
240.0
320.0
400.0
A
C
B
14.0 14.4 14.8 15.2 [xC] 15.6 Temp. 16.0
45.0 45.6 46.2 46.8 [mS] 47.4 Leitf. 48.0
38.0 38.4 38.8 39.2 [ppt] 39.6 Salzg. 40.0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ADM Elektronik
Druck
[dBar]
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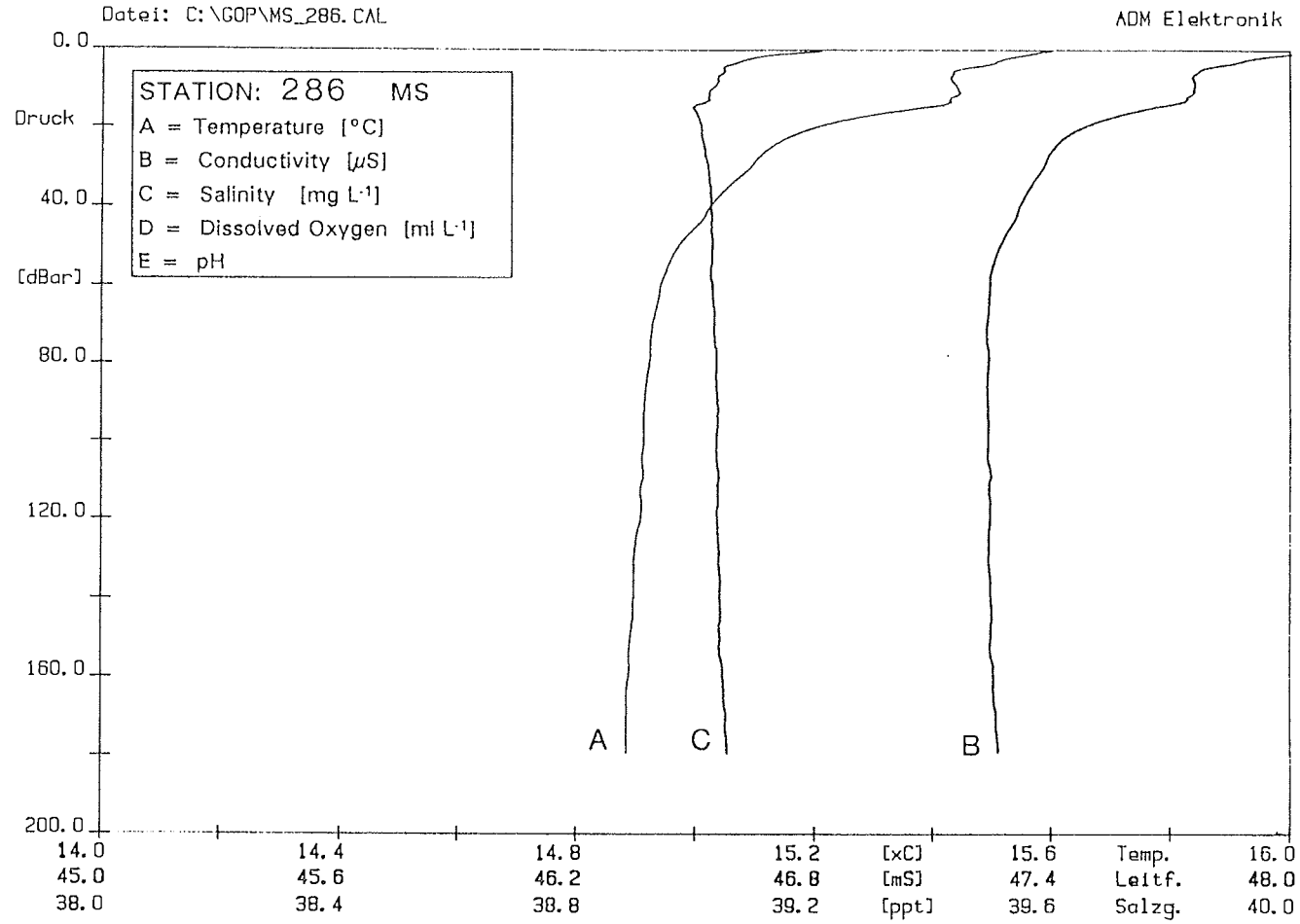
70.0
140.0
210.0
280.0
350.0
D
A
E
14.0 14.4 14.8 15.2 [xC] 15.6 Temp. 16.0
50.0 60.0 70.0 80.0 [%] 90.0 O) 100.0
7.0 7.4 7.8 8.2 [pH] 8.6 pH 9.0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B = Conductivity [µS]
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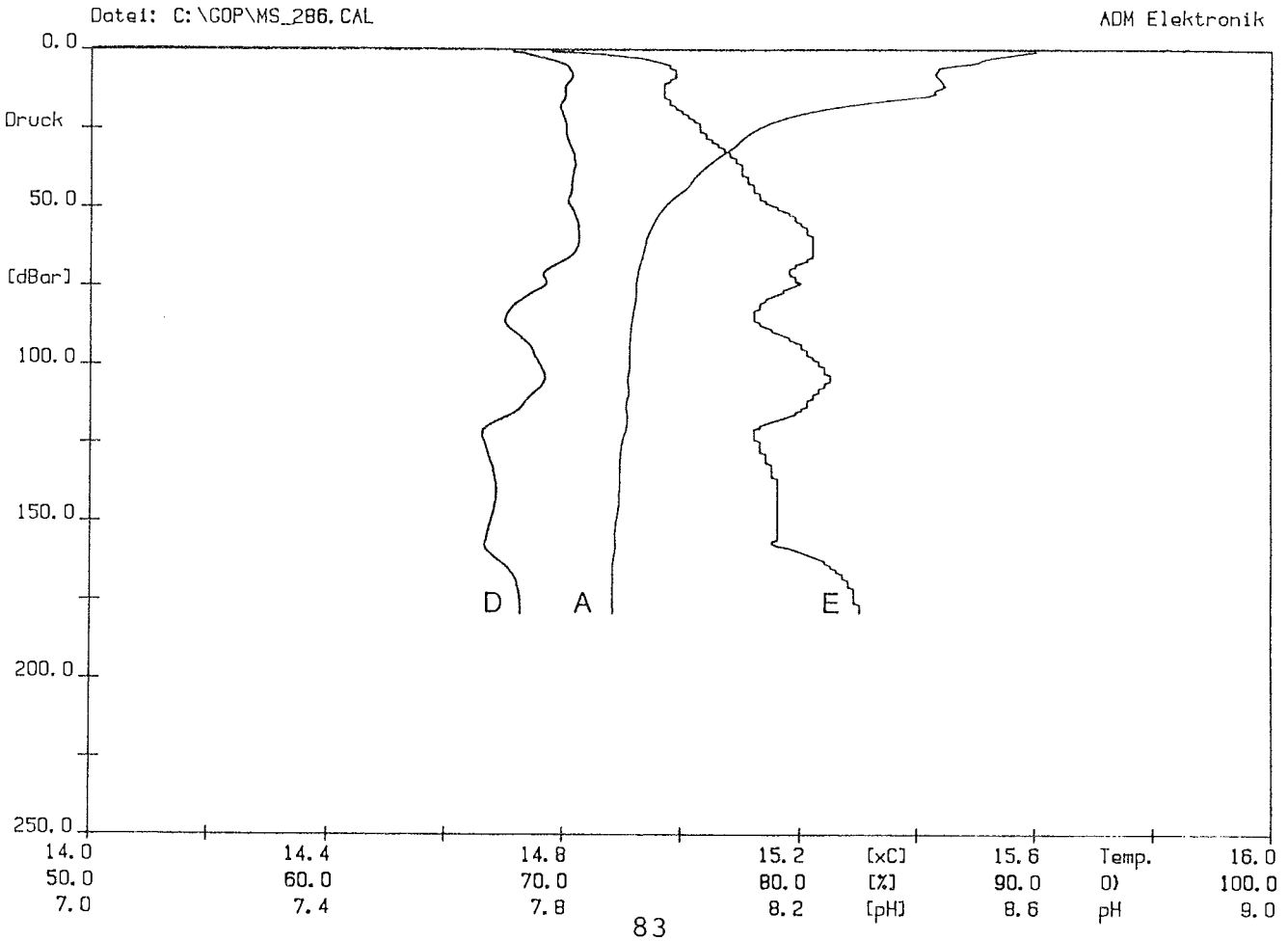
D = Dissolved Oxygen [ml L-1]
E = pH
Druck
[dBar]
0.0
40.0
80.0
120.0
160.0
200.0
A
C
B
14.0 14.4 14.8 15.2 [xC] 15.6 Temp. 16.0
45.0 45.6 46.2 46.8 [mS] 47.4 Leitf. 48.0
38.0 38.4 38.8 39.2 [ppt] 39.6 Salzg. 40.0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Druck
[dBar]
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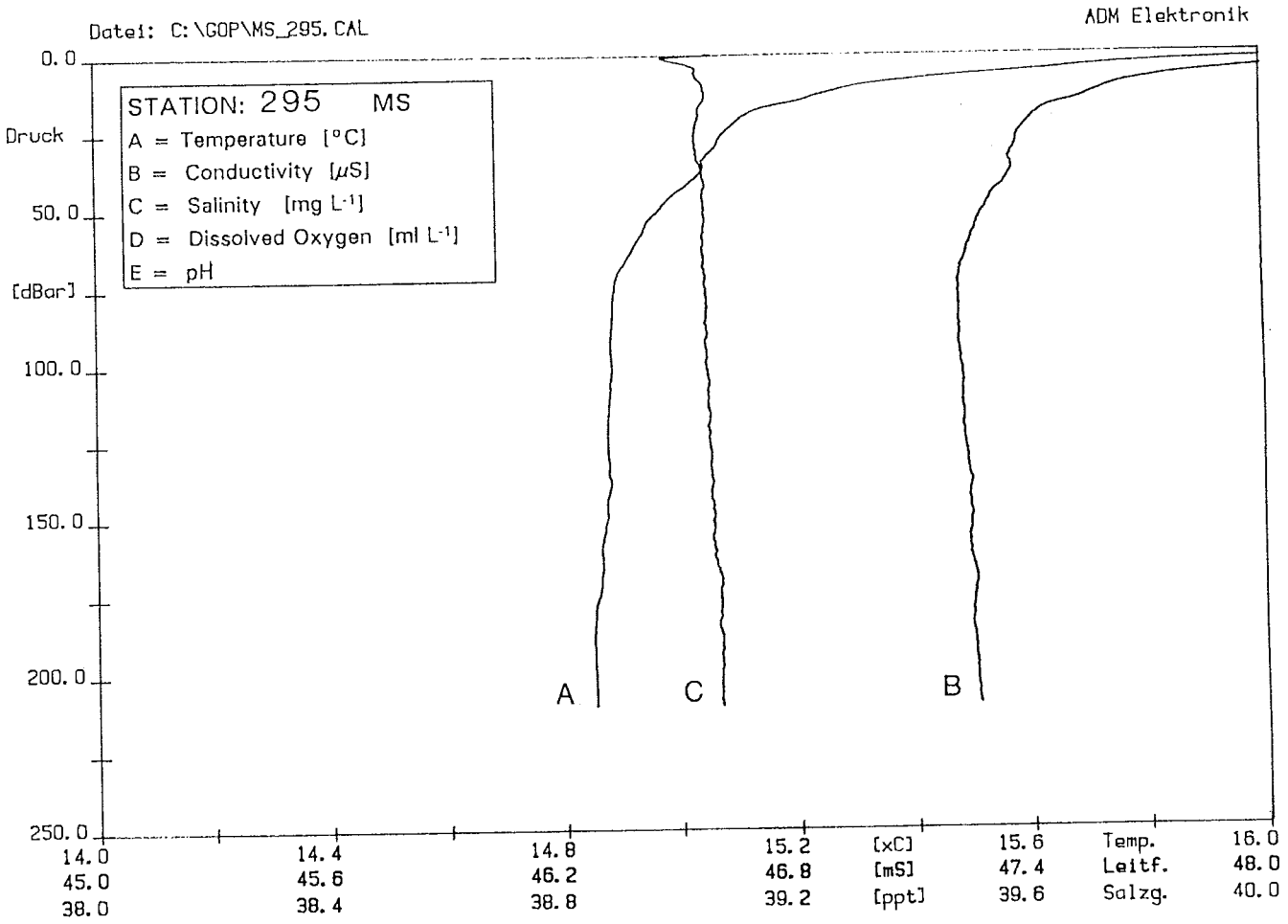
100.0
150.0
200.0
250.0
D
A
E
14.0 14.4 14.8 15.2 [xC] 15.6 Temp. 16.0
50.0 60.0 70.0 80.0 [%] 90.0 O) 100.0
7.0 7.4 7.8 8.2 [pH] 8.6 pH 9.0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STATION: 295 MS
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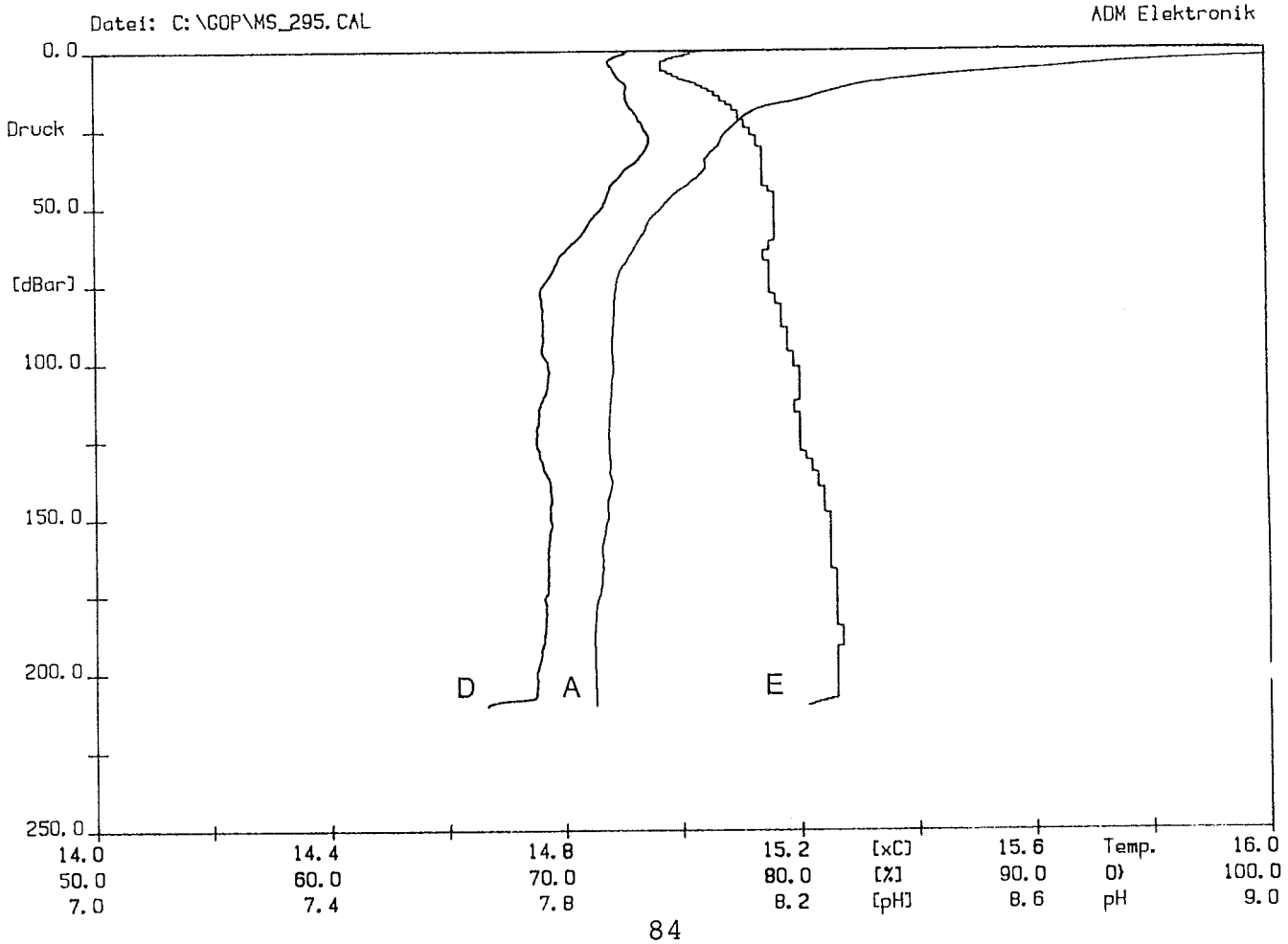
B = Conductivity [µS]
C = Salinity [mg L-1]
D = Dissolved Oxygen [ml L-1]
E = pH
Druck
[dBar]
0.0
50.0
100.0
150.0
200.0
250.0
A
C
B
14.0 14.4 14.8 15.2 [xC] 15.6 Temp. 16.0
45.0 45.6 46.2 46.8 [mS] 47.4 Leitf. 48.0
38.0 38.4 38.8 39.2 [ppt] 39.6 Salzg. 40.0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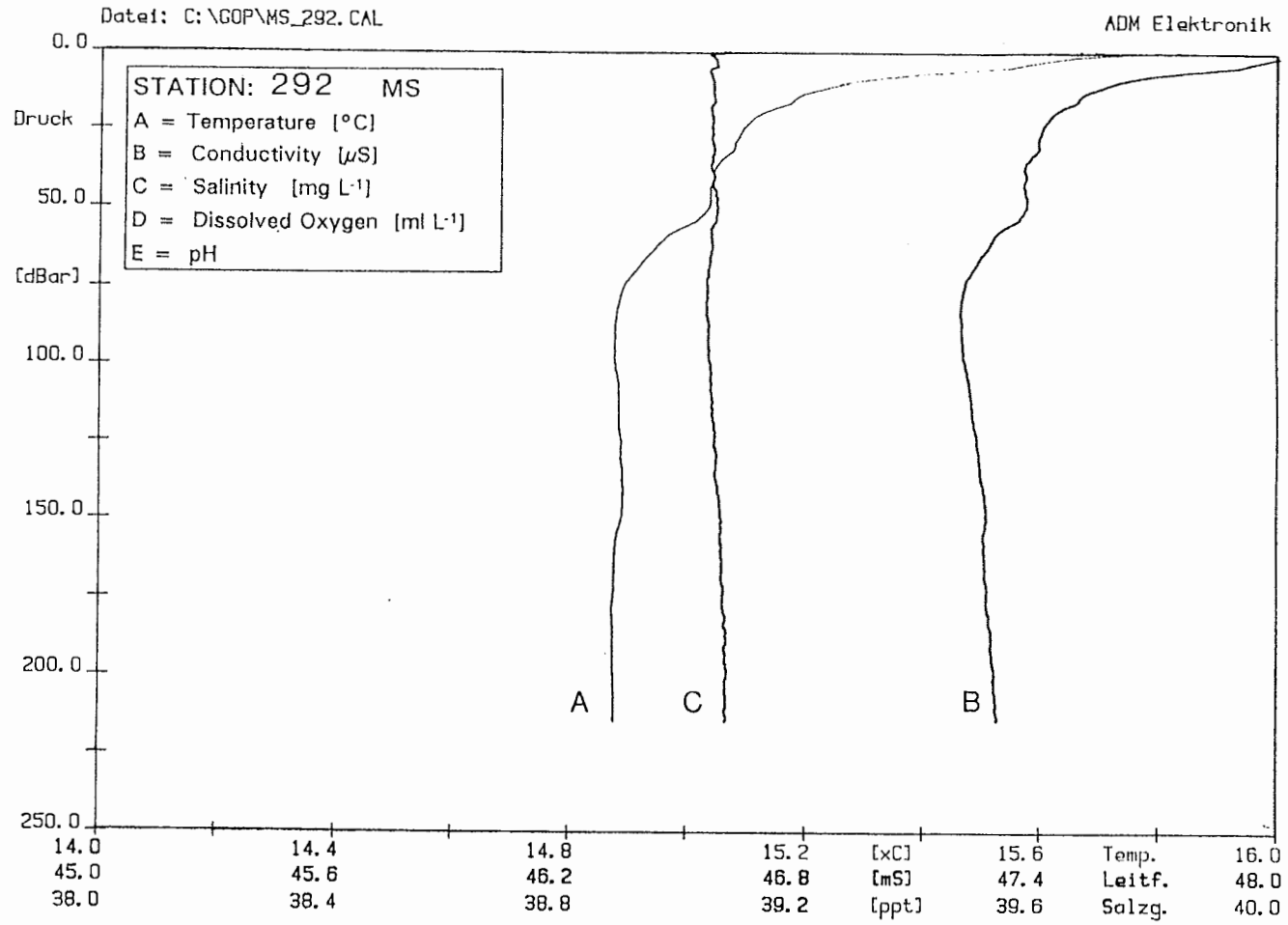
Druck
[dBar]
0.0
50.0
100.0
150.0
200.0
250.0
D
A
E
14.0 14.4 14.8 15.2 [xC] 15.6 Temp. 16.0
50.0 60.0 70.0 80.0 [%] 90.0 O) 100.0
7.0 7.4 7.8 8.2 [pH] 8.6 pH 9.0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STATION: 292 MS
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D = Dissolved Oxygen [ml L-1]
E = pH
Druck
[dBar]
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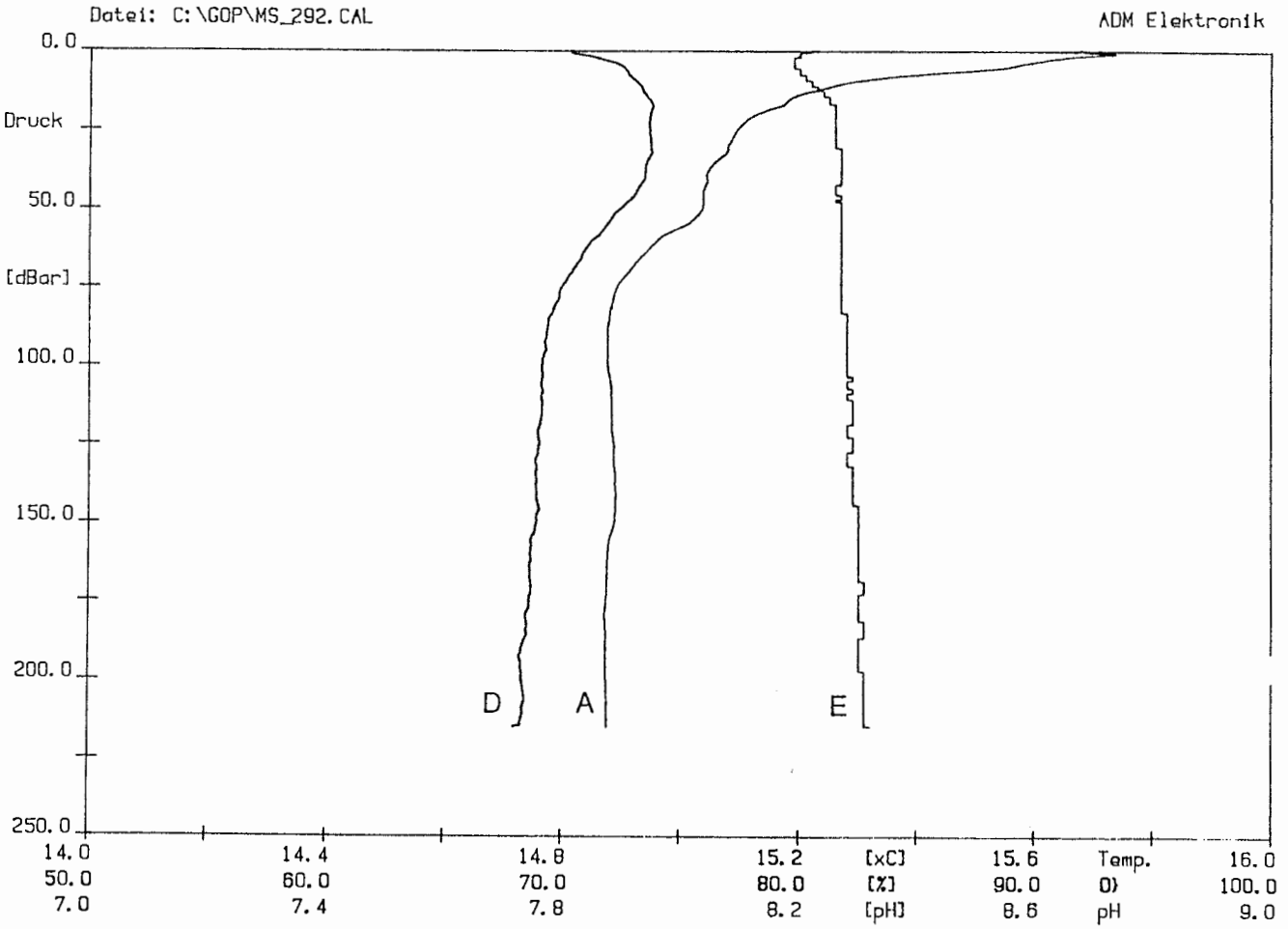
50.0
100.0
150.0
200.0
250.0
A
C
B
14.0 14.4 14.8 15.2 [xC] 15.6 Temp. 16.0
45.0 45.6 46.2 46.8 [mS] 47.4 Leitf. 48.0
38.0 38.4 38.8 39.2 [ppt] 39.6 Salzg. 40.0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Druck
[dBar]
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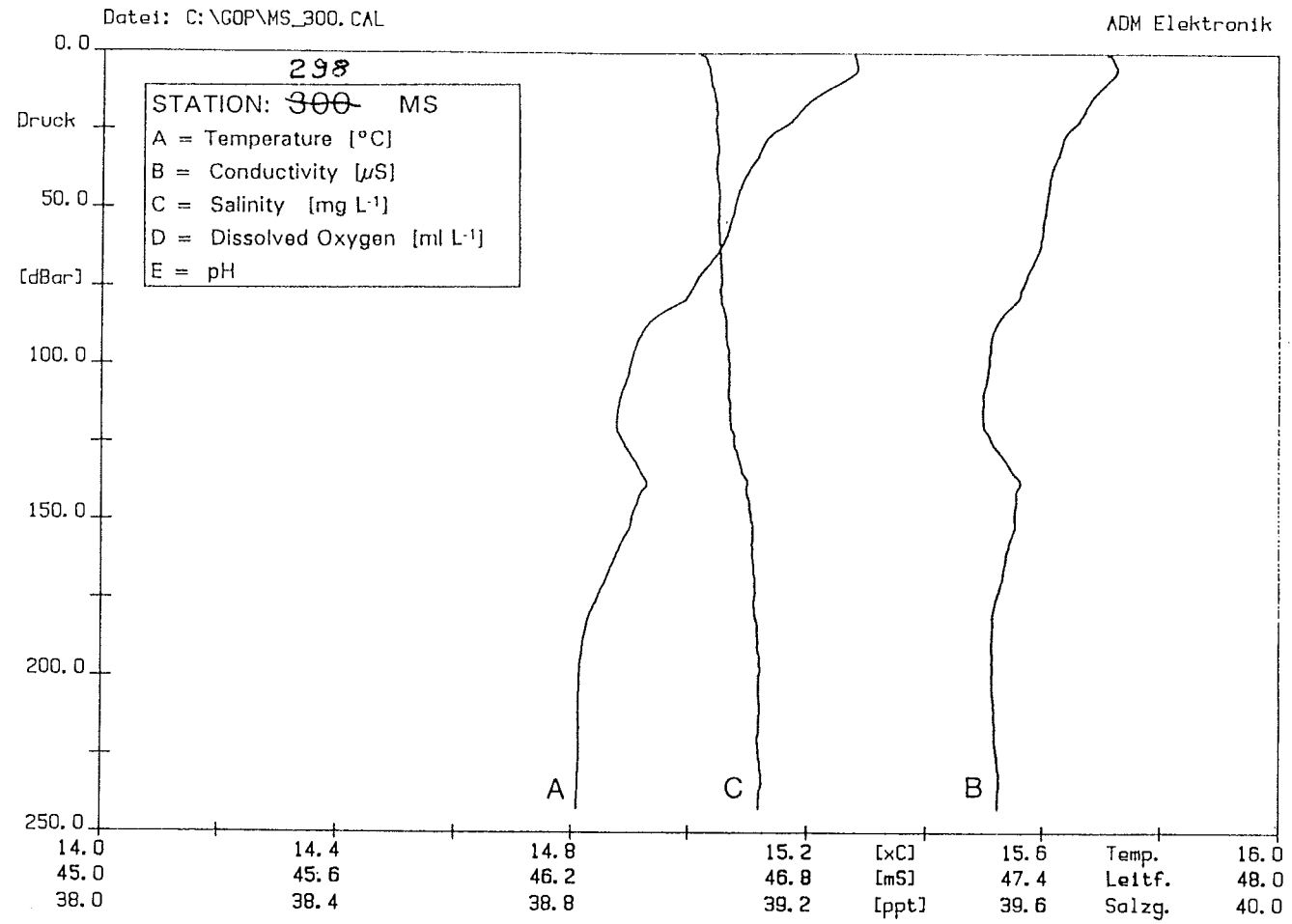
150.0
200.0
250.0
D
A
E
14.0 14.4 14.8 15.2 [xC] 15.6 Temp. 16.0
50.0 60.0 70.0 80.0 [%] 90.0 O) 100.0
7.0 7.4 7.8 8.2 [pH] 8.6 pH 9.0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ADM Elektronik
298
STATION: 300 MS
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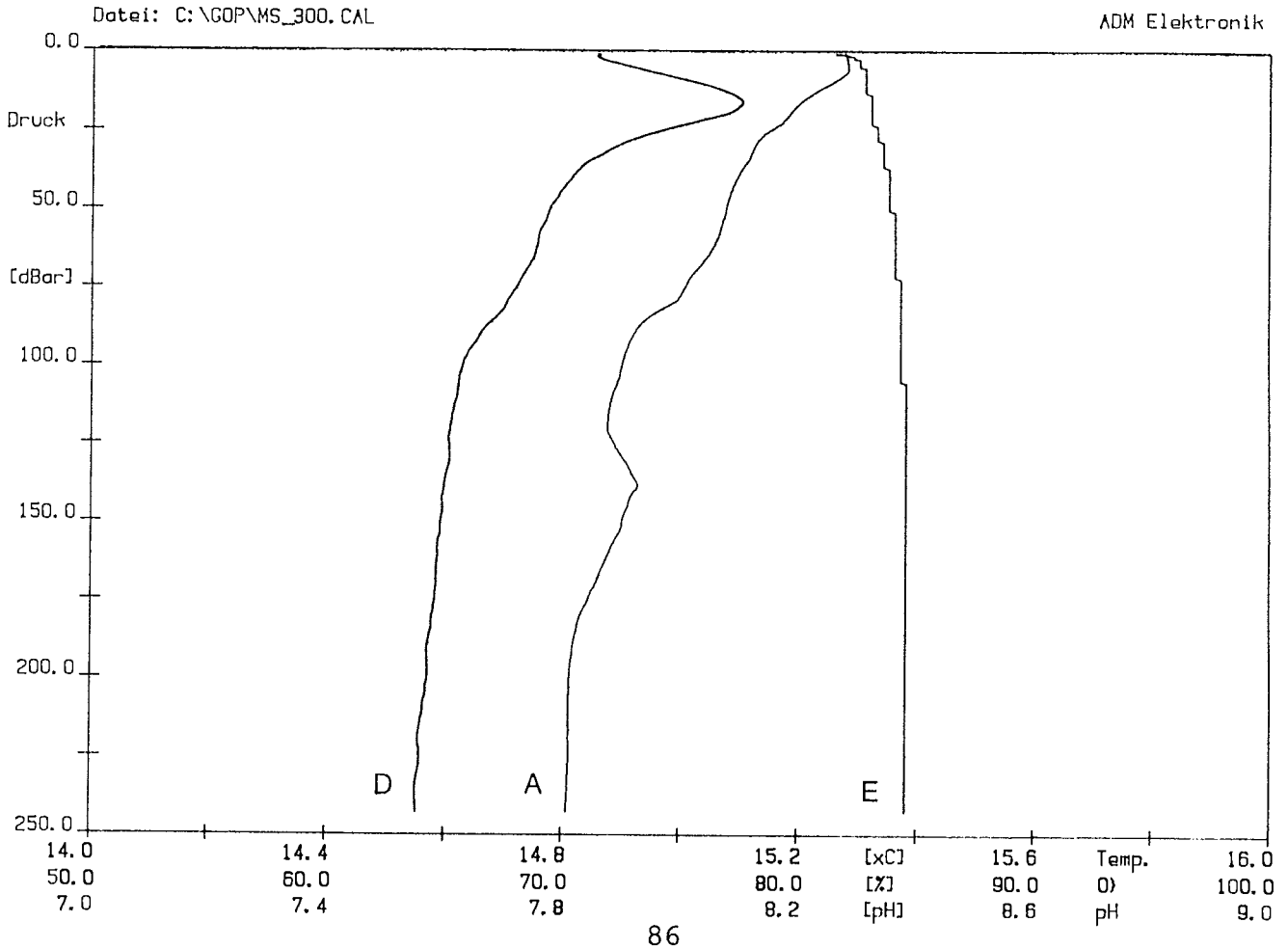
C = Salinity [mg L-1]
D = Dissolved Oxygen [ml L-1]
E = pH
Druck
[dBar]
0.0
50.0
100.0
150.0
200.0
250.0
A
C
B
14.0 14.4 14.8 15.2 [xC] 15.6 Temp. 16.0
45.0 45.6 46.2 46.8 [mS] 47.4 Leitf. 48.0
38.0 38.4 38.8 39.2 [ppt] 39.6 Salzg. 40.0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ADM Elektronik
Druck
[dBar]
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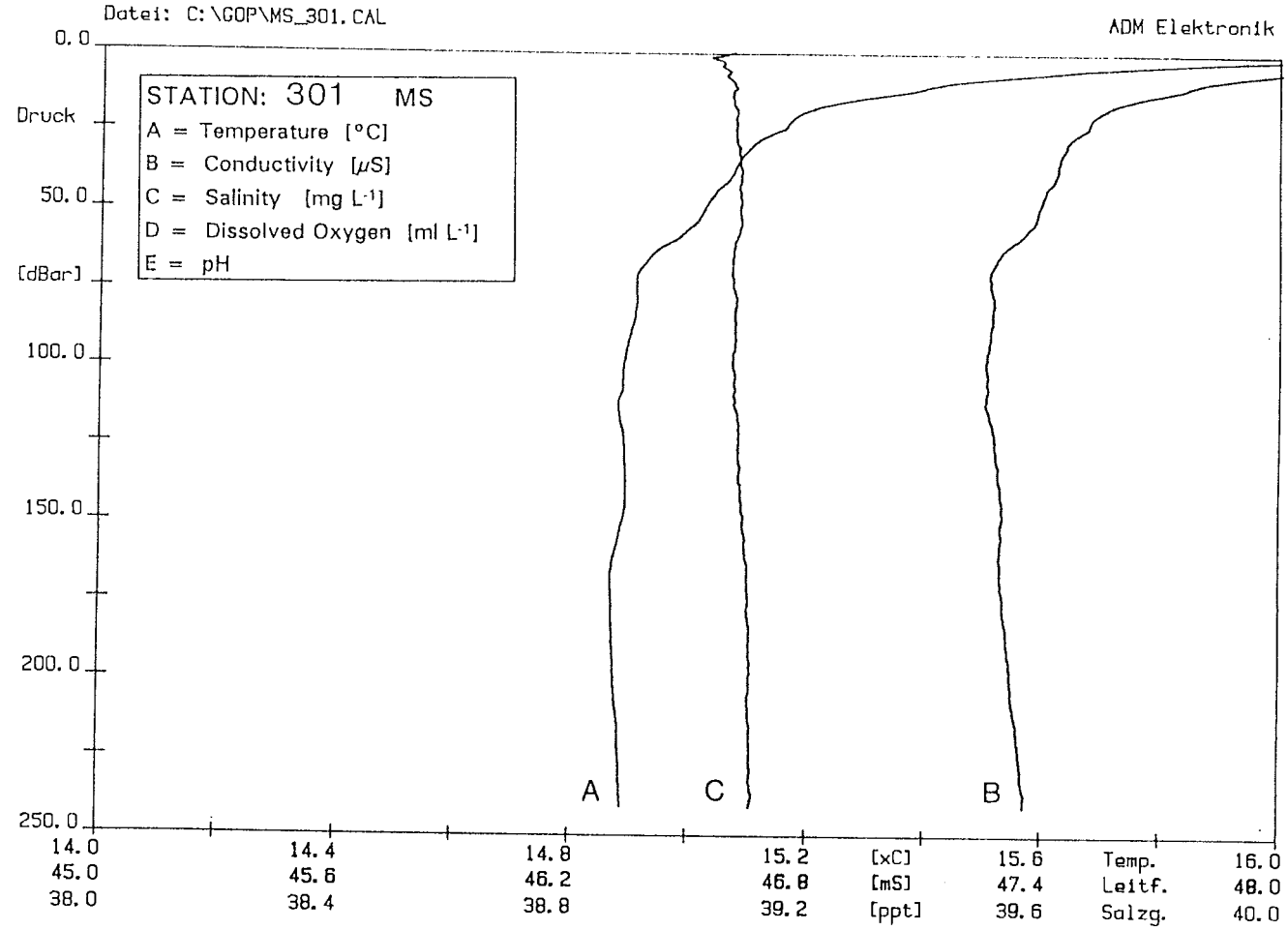
50.0
100.0
150.0
200.0
250.0
D
A
E
14.0 14.4 14.8 15.2 [xC] 15.6 Temp. 16.0
50.0 60.0 70.0 80.0 [%] 90.0 O) 100.0
7.0 7.4 7.8 8.2 [pH] 8.6 pH 9.0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D = Dissolved Oxygen [ml L-1]
E = pH
Druck
[dBar]
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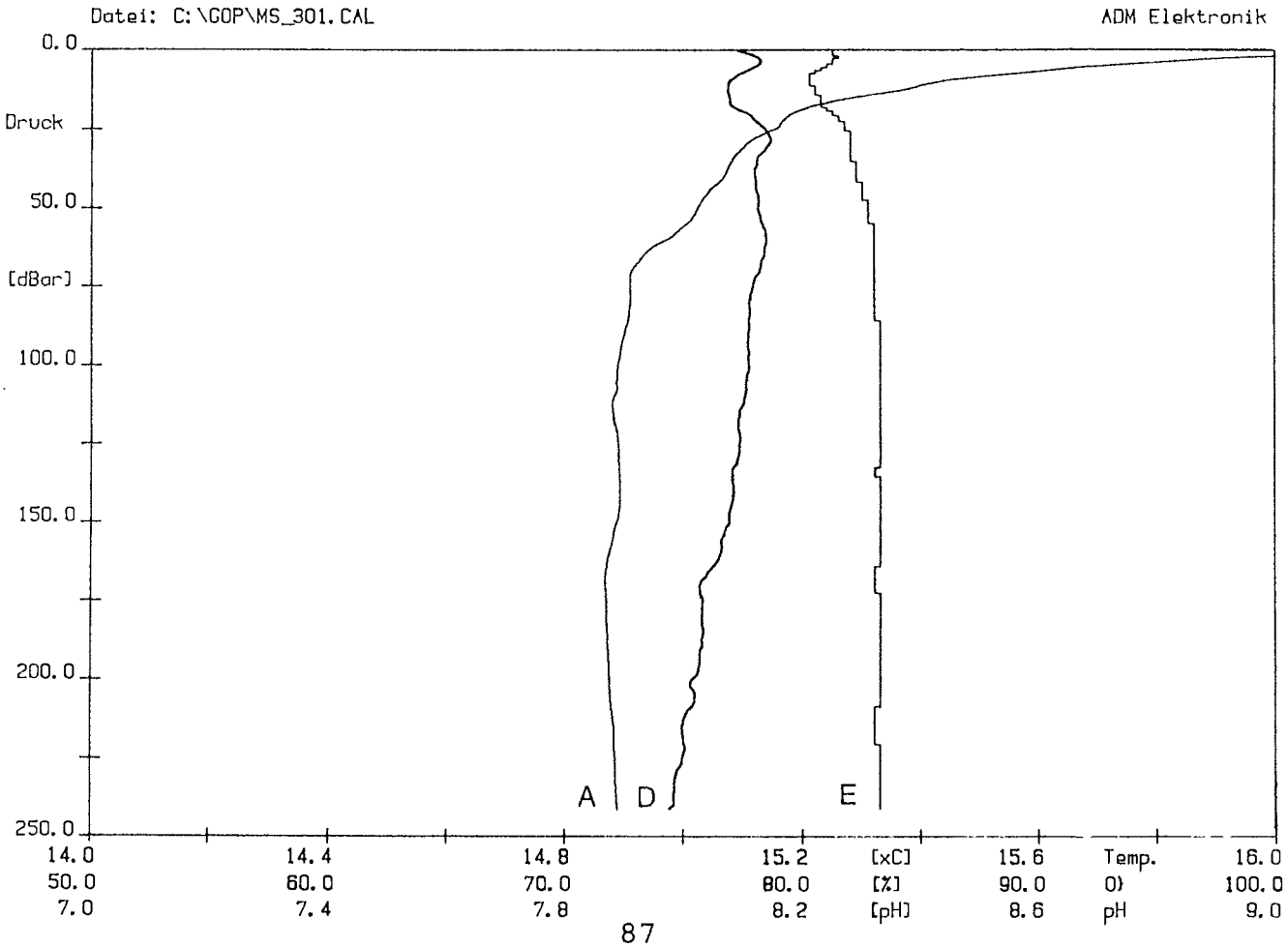
50.0
100.0
150.0
200.0
250.0
A
C
B
14.0 14.4 14.8 15.2 [xC] 15.6 Temp. 16.0
45.0 45.6 46.2 46.8 [mS] 47.4 Leitf. 48.0
38.0 38.4 38.8 39.2 [ppt] 39.6 Salzg. 40.0


Datei: C:\GOP\MS_301.CAL
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Druck
[dBar]
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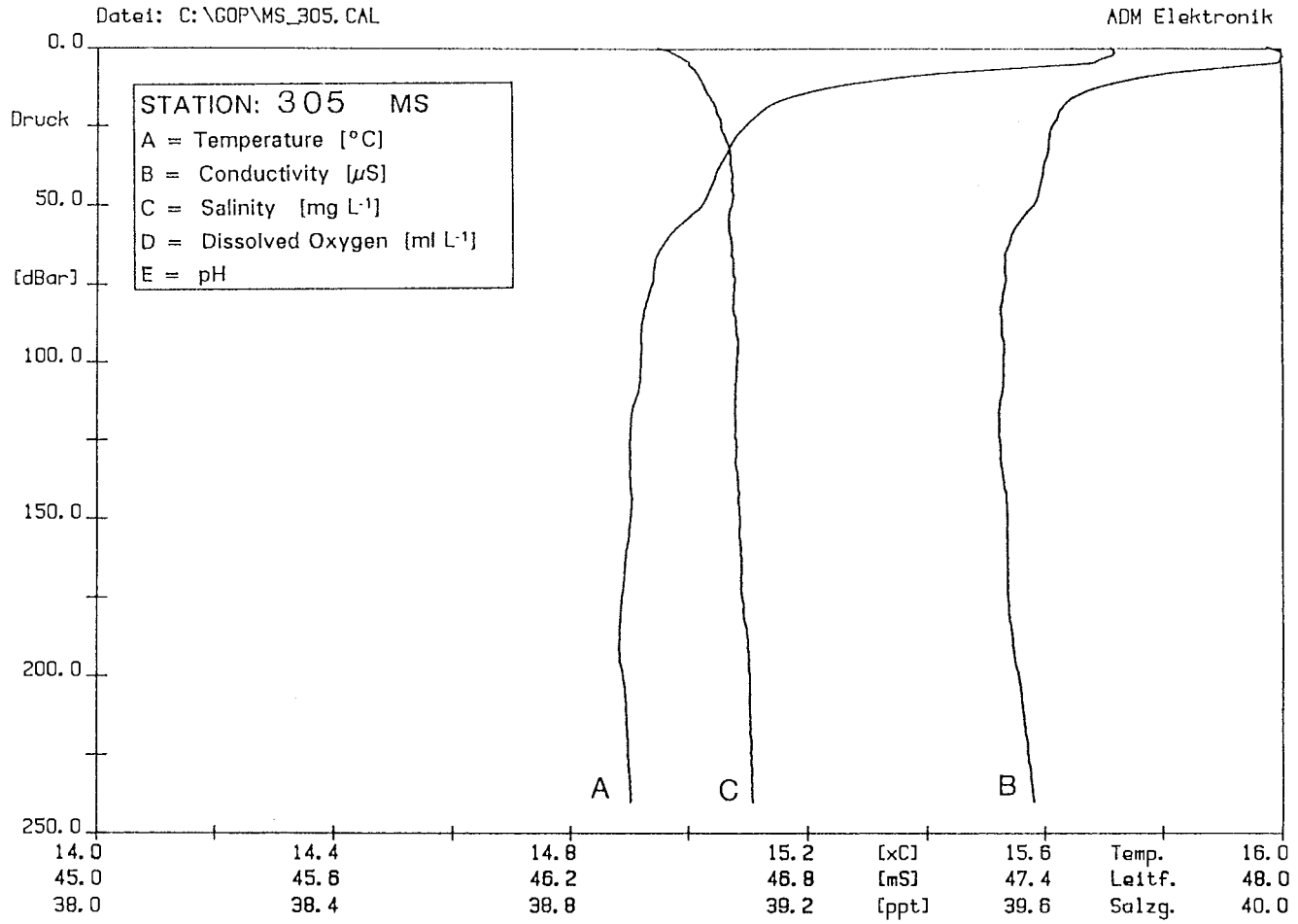
50.0
100.0
150.0
200.0
250.0
A
D
E
14.0 14.4 14.8 15.2 [xC] 15.6 Temp. 16.0
50.0 60.0 70.0 80.0 [%] 90.0 O) 100.0
7.0 7.4 7.8 8.2 [pH] 8.6 pH 9.0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ADM Elektronik
STATION: 305 MS
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D = Dissolved Oxygen [ml L-1]
E = pH
Druck
[dBar]
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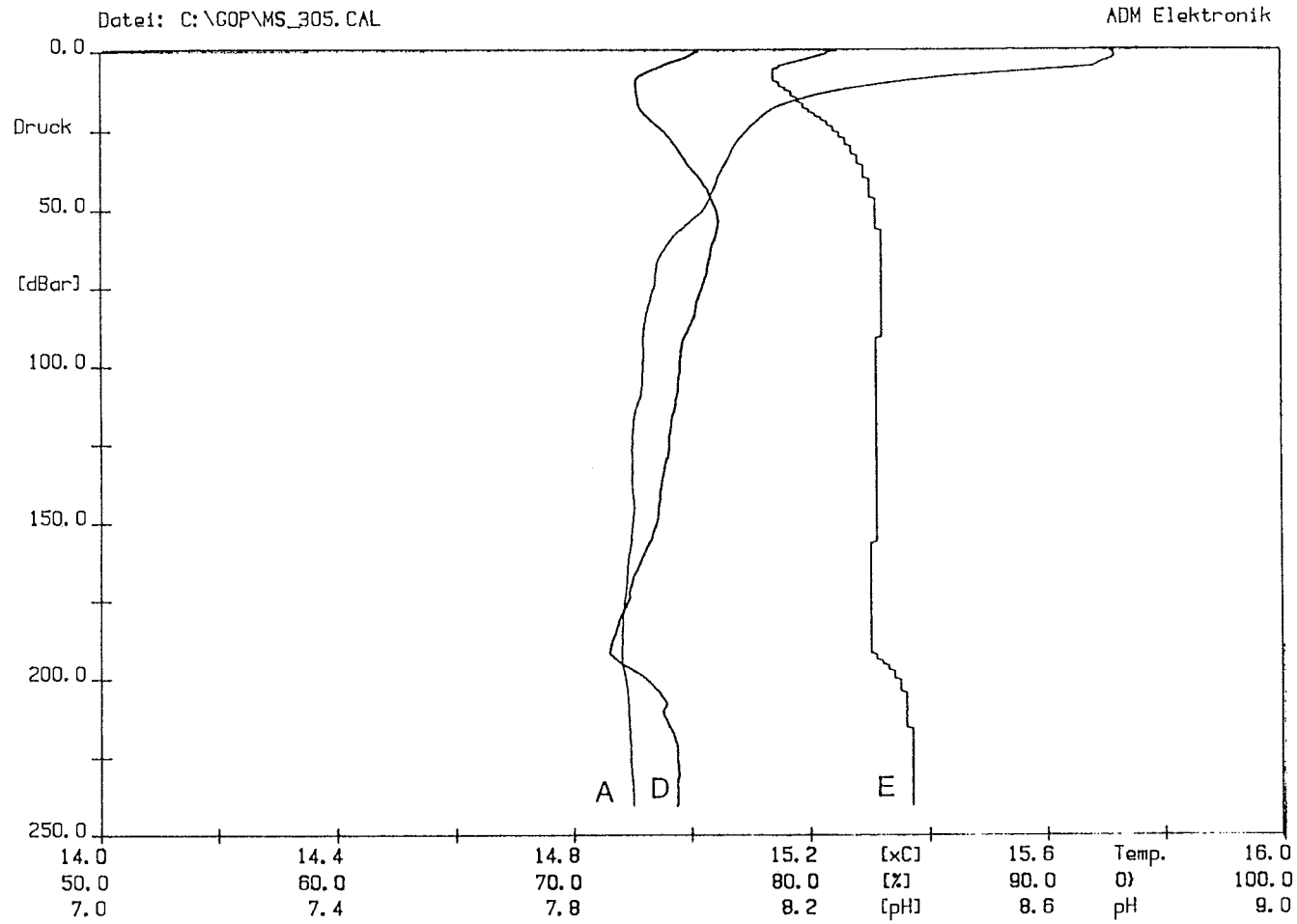
50.0
100.0
150.0
200.0
250.0
A
C
B
14.0 14.4 14.8 15.2 [xC] 15.6 Temp. 16.0
45.0 45.6 46.2 46.8 [mS] 47.4 Leitf. 48.0
38.0 38.4 38.8 39.2 [ppt] 39.6 Salzg. 40.0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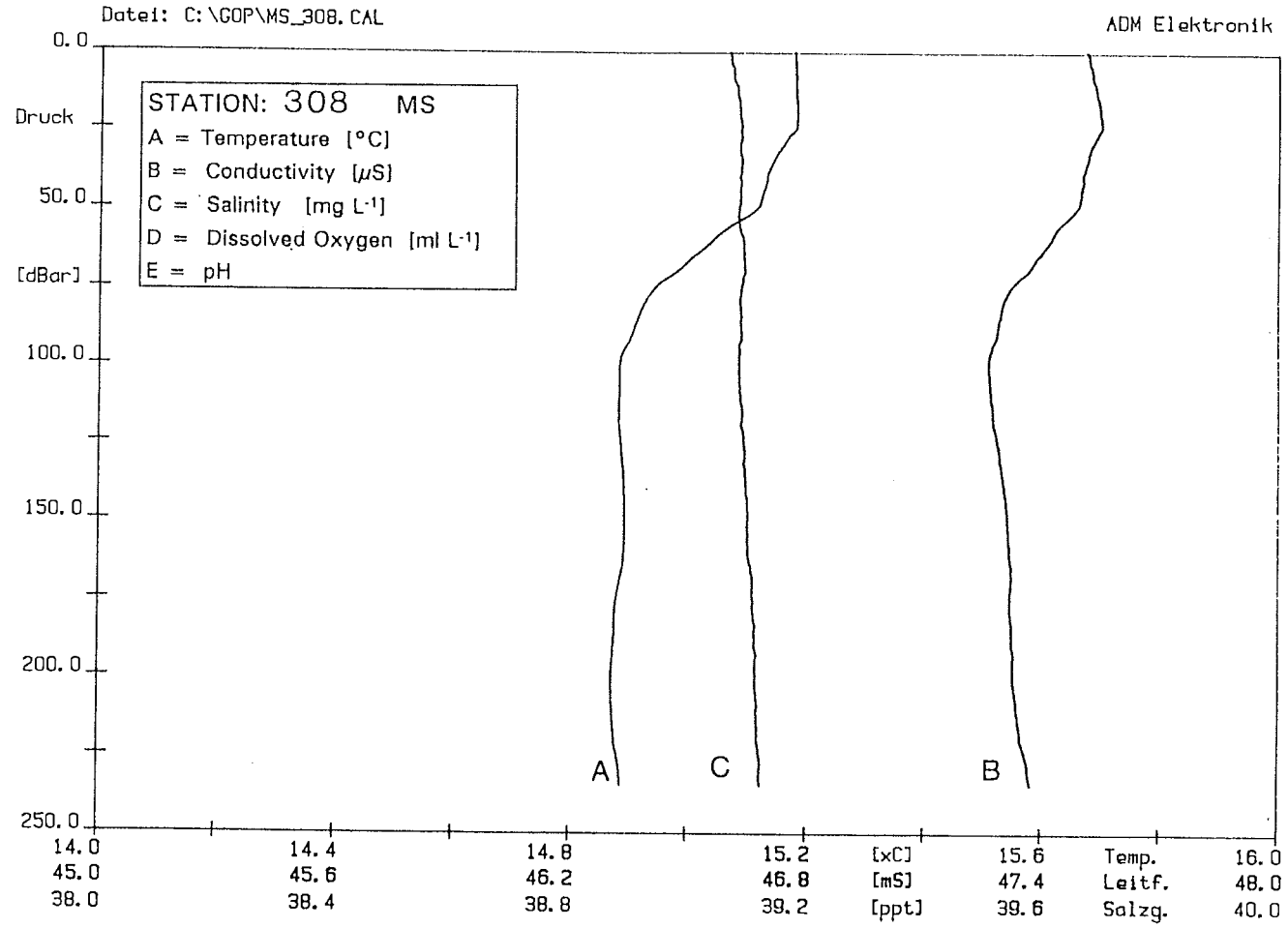
150.0
200.0
250.0
A
D
E
14.0 14.4 14.8 15.2 [xC] 15.6 Temp. 16.0
50.0 60.0 70.0 80.0 [%] 90.0 O) 100.0
7.0 7.4 7.8 8.2 [pH] 8.6 pH 9.0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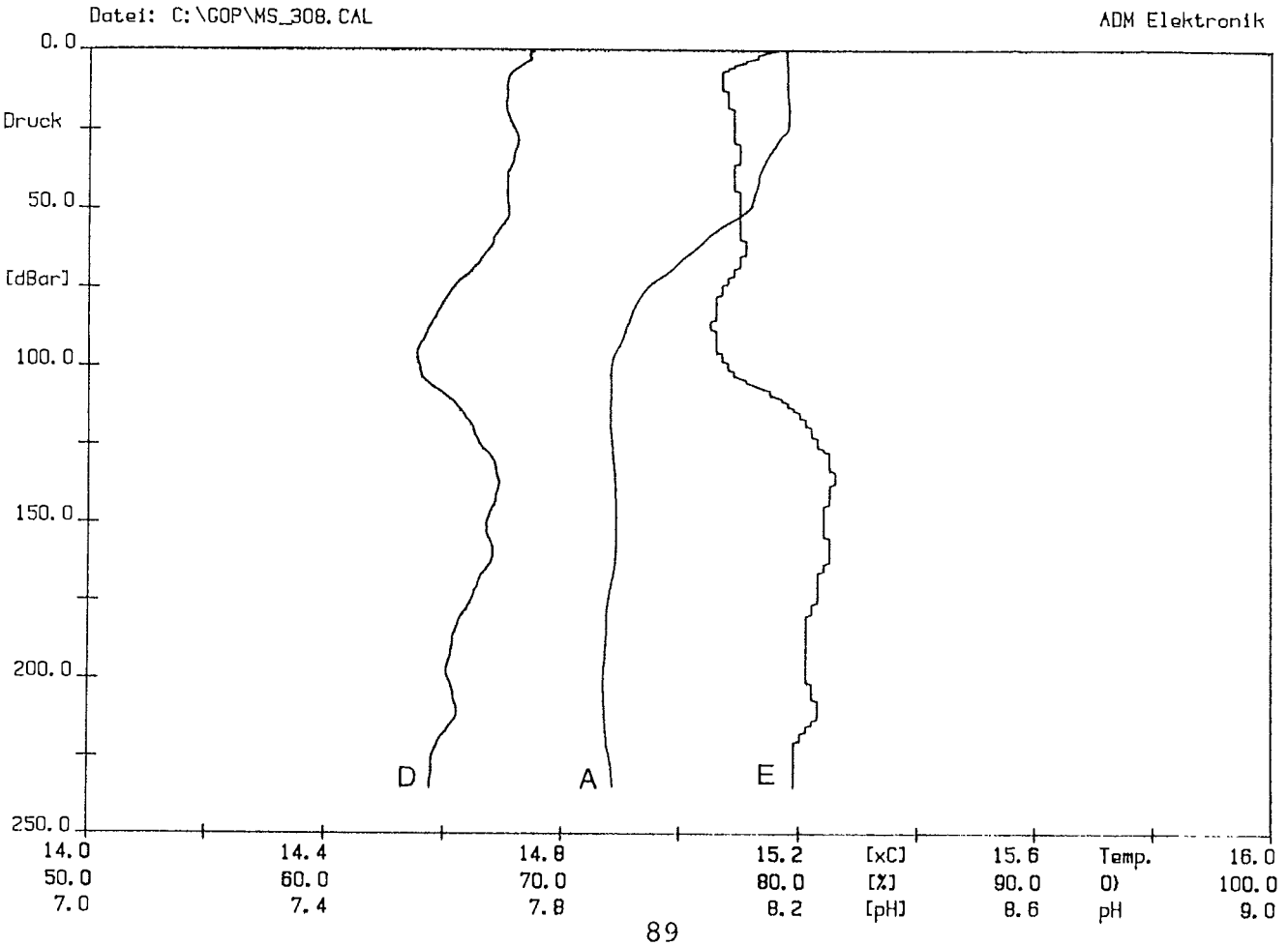
ADM Elektronik
STATION: 308 MS
A = Temperature [°C]
B = Conductivity [µS]
C = Salinity [mg L-1]
D = Dissolved Oxygen [ml L-1]
E = pH
Druck
[dBar]
0.0
50.0
100.0
150.0
200.0
250.0
A
C
B
14.0 14.4 14.8 15.2 [xC] 15.6 Temp. 16.0
45.0 45.6 46.2 46.8 [mS] 47.4 Leitf. 48.0
38.0 38.4 38.8 39.2 [ppt] 39.6 Salzg. 40.0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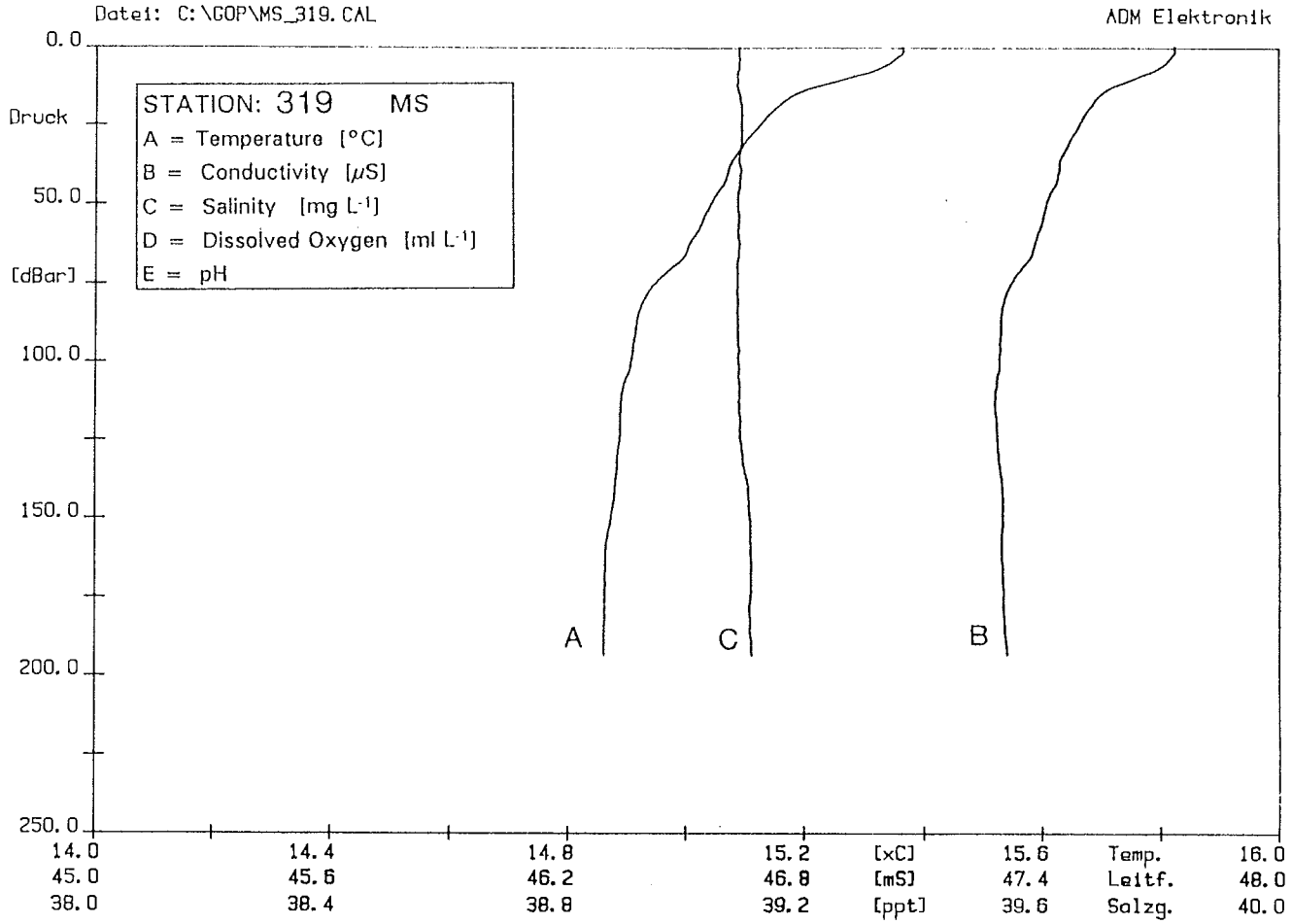
ADM Elektronik
Druck
[dBar]
0.0
50.0
100.0
150.0
200.0
250.0
D
A
E
14.0 14.4 14.8 15.2 [xC] 15.6 Temp. 16.0
50.0 60.0 70.0 80.0 [%] 90.0 O) 100.0
7.0 7.4 7.8 8.2 [pH] 8.6 pH 9.0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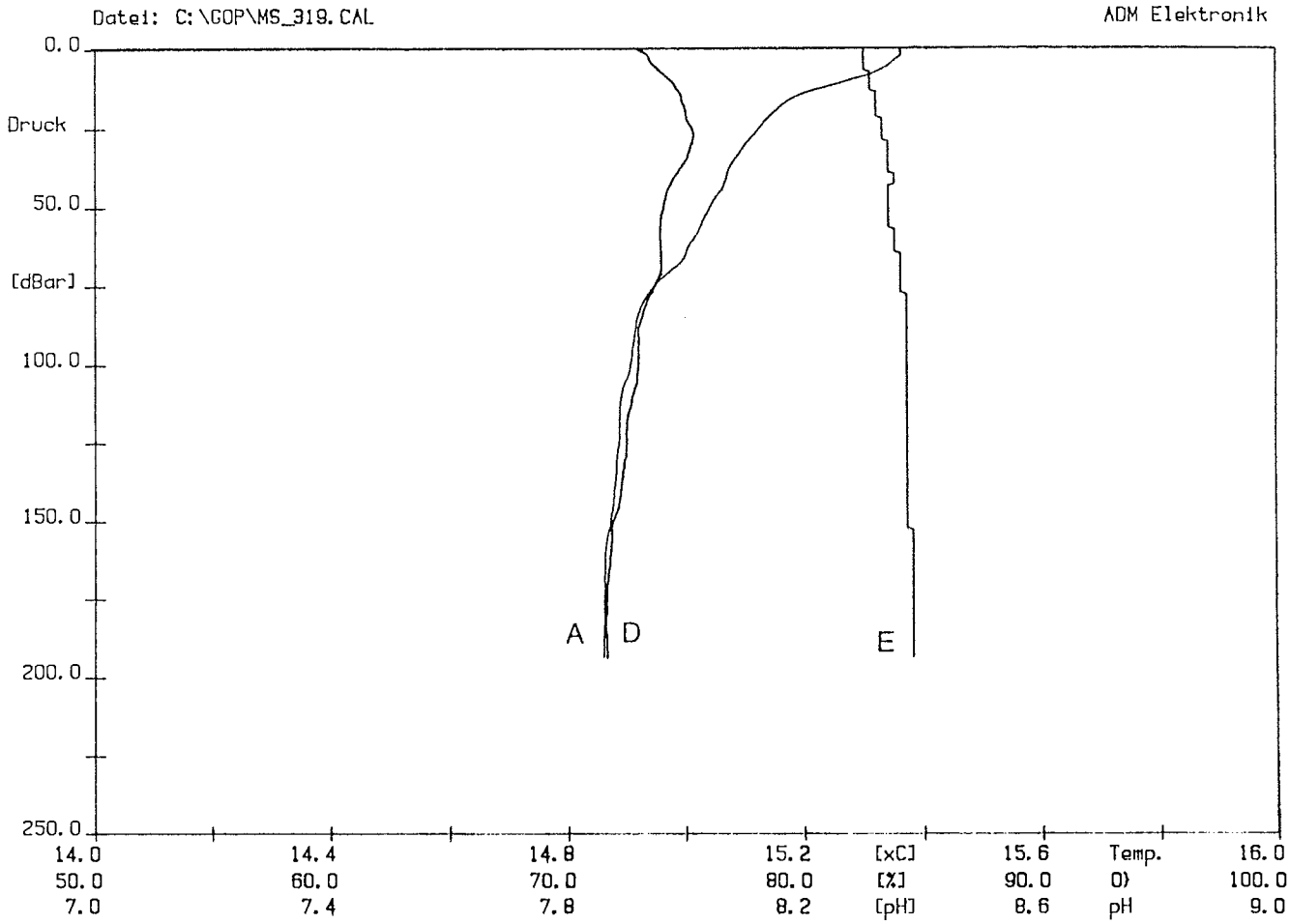
ADM Elektronik
STATION: 319 MS
A = Temperature [°C]
B = Conductivity [µS]
C = Salinity [mg L-1]
D = Dissolved Oxygen [ml L-1]
E = pH
Druck
[dBar]
0.0
50.0
100.0
150.0
200.0
250.0
A
C
B
14.0 14.4 14.8 15.2 [xC] 15.6 Temp. 16.0
45.0 45.6 46.2 46.8 [mS] 47.4 Leitf. 48.0
38.0 38.4 38.8 39.2 [ppt] 39.6 Salzg. 40.0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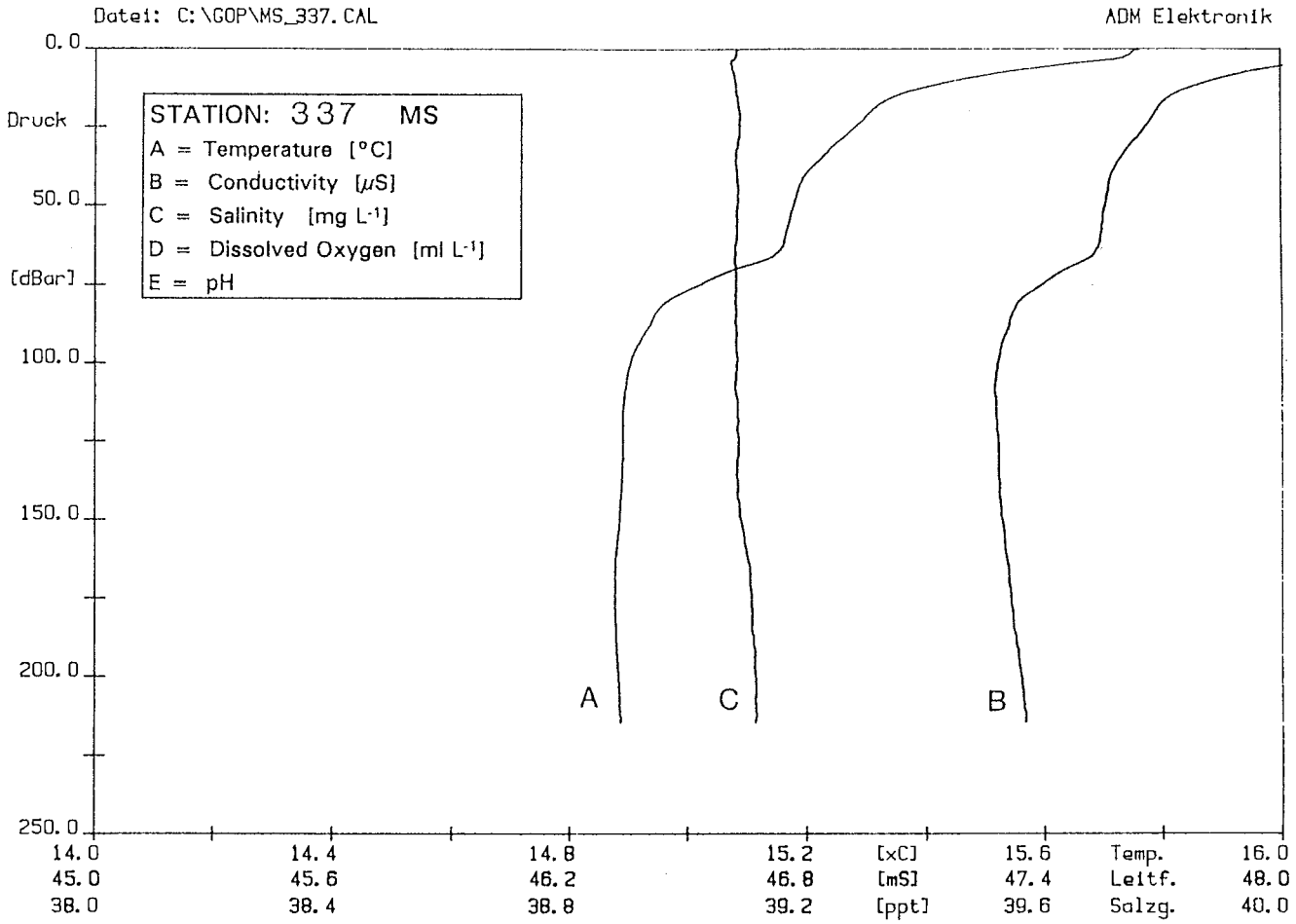
ADM Elektronik
Druck
[dBar]
0.0
50.0
100.0
150.0
200.0
250.0
A
D
E
14.0 14.4 14.8 15.2 [xC] 15.6 Temp. 16.0
50.0 60.0 70.0 80.0 [%] 90.0 O) 100.0
7.0 7.4 7.8 8.2 [pH] 8.6 pH 9.0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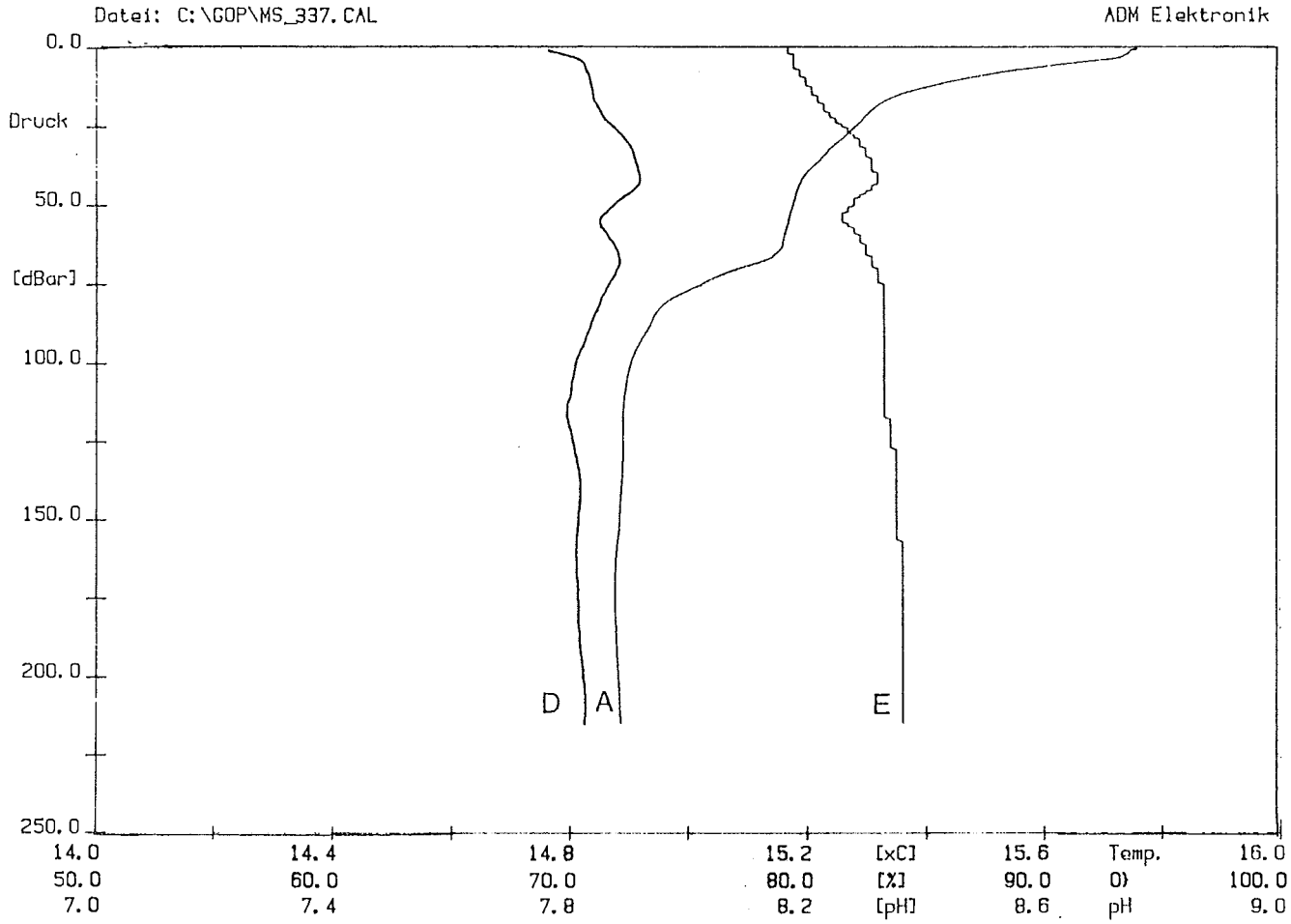
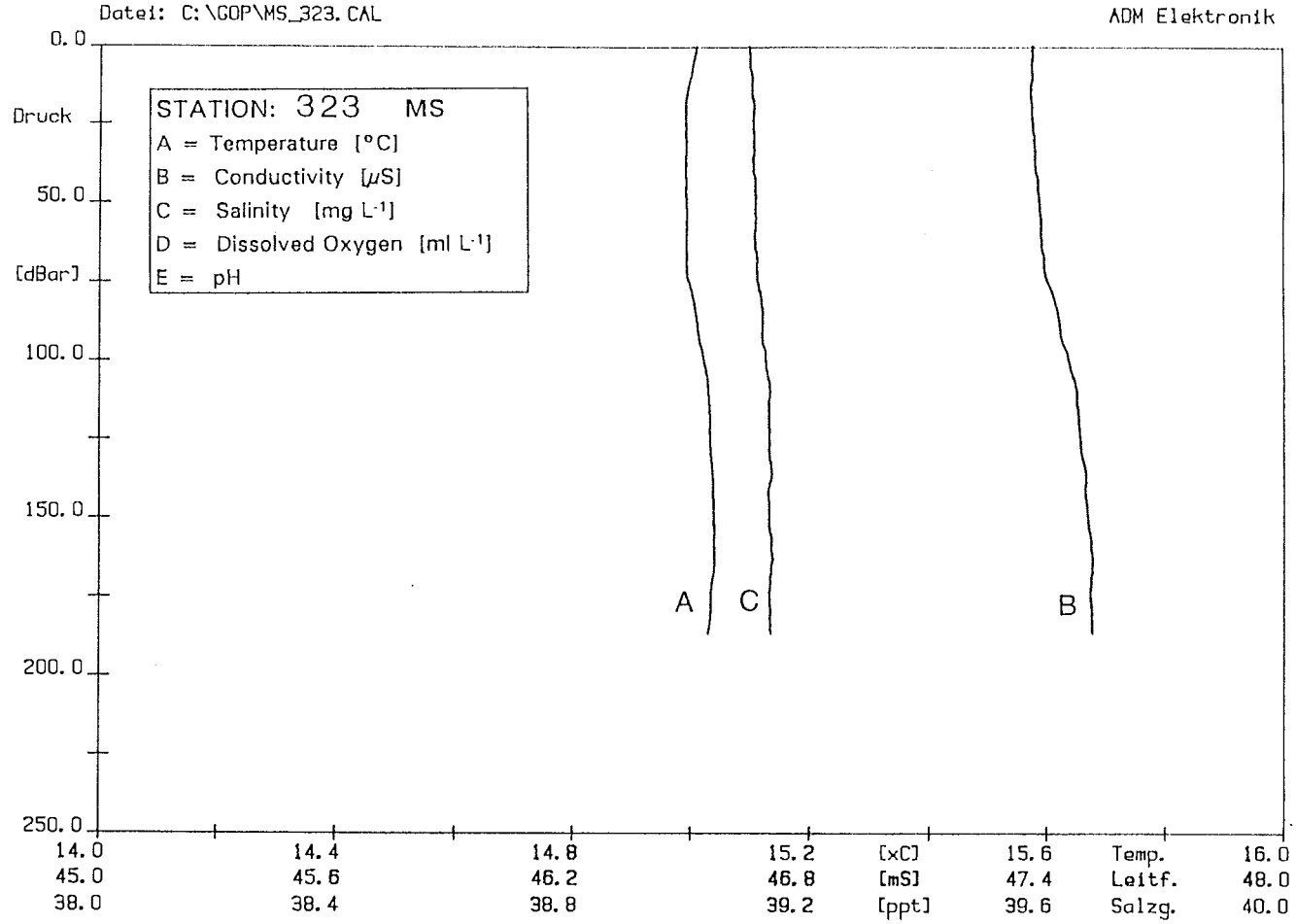
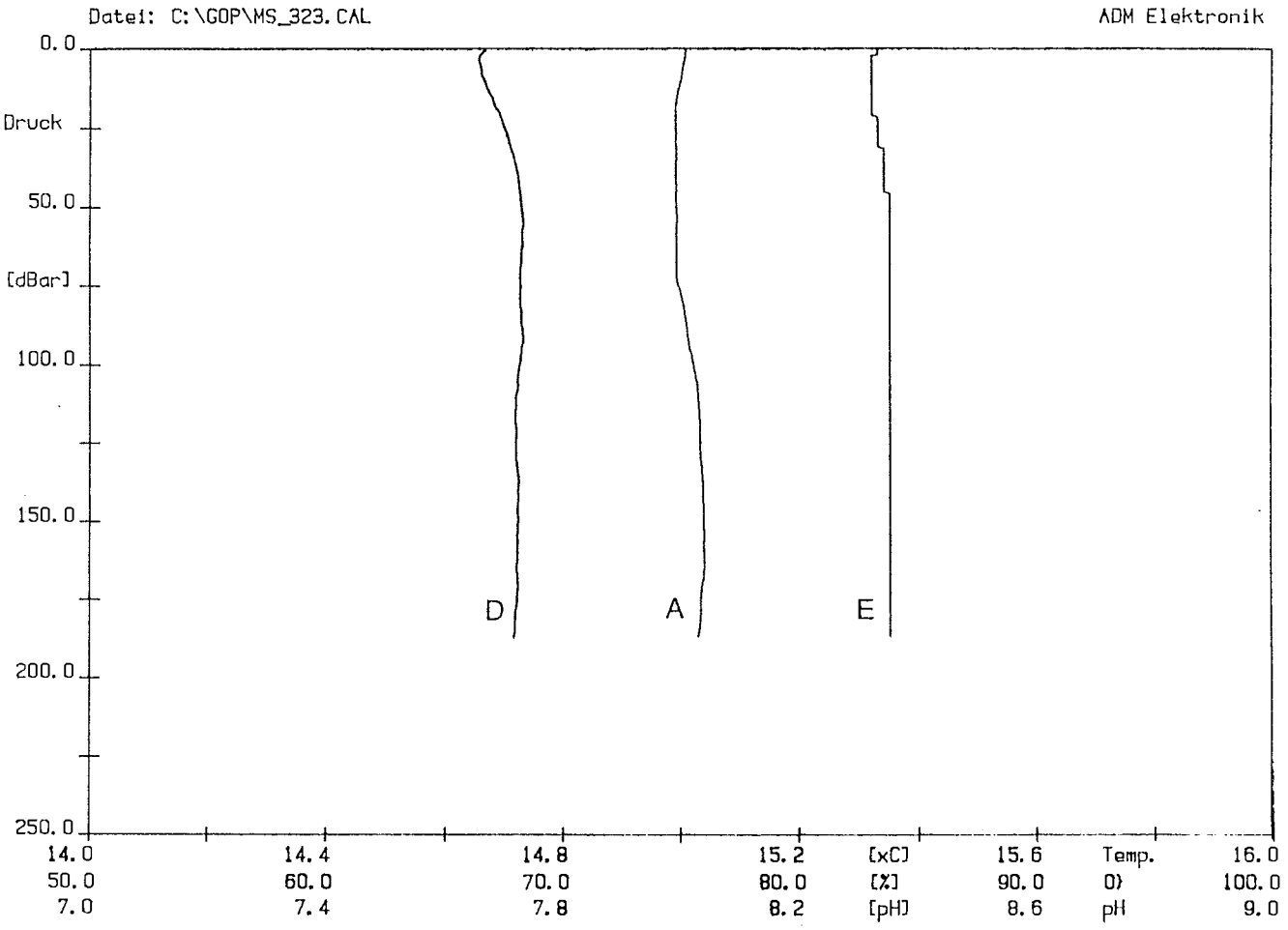
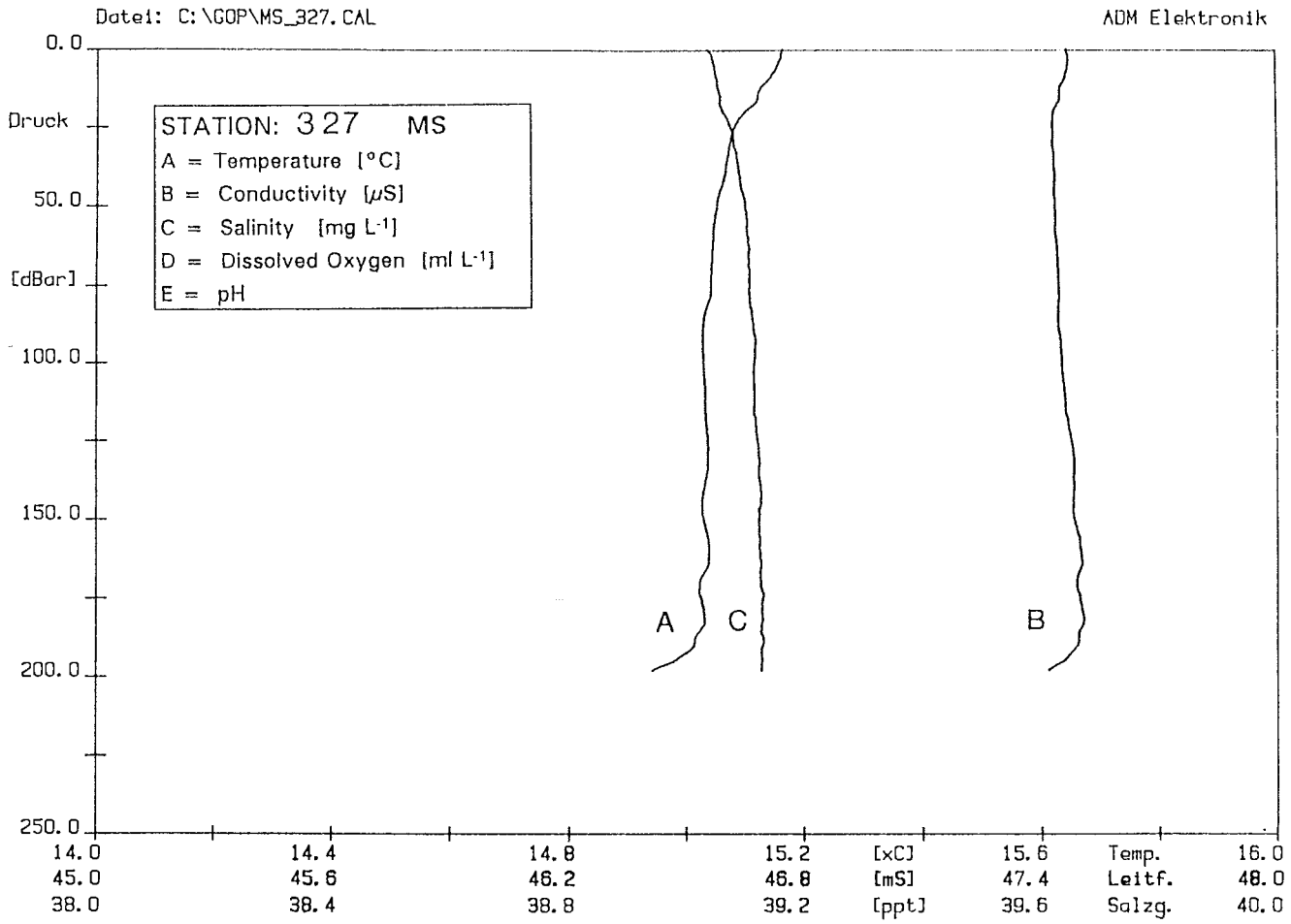
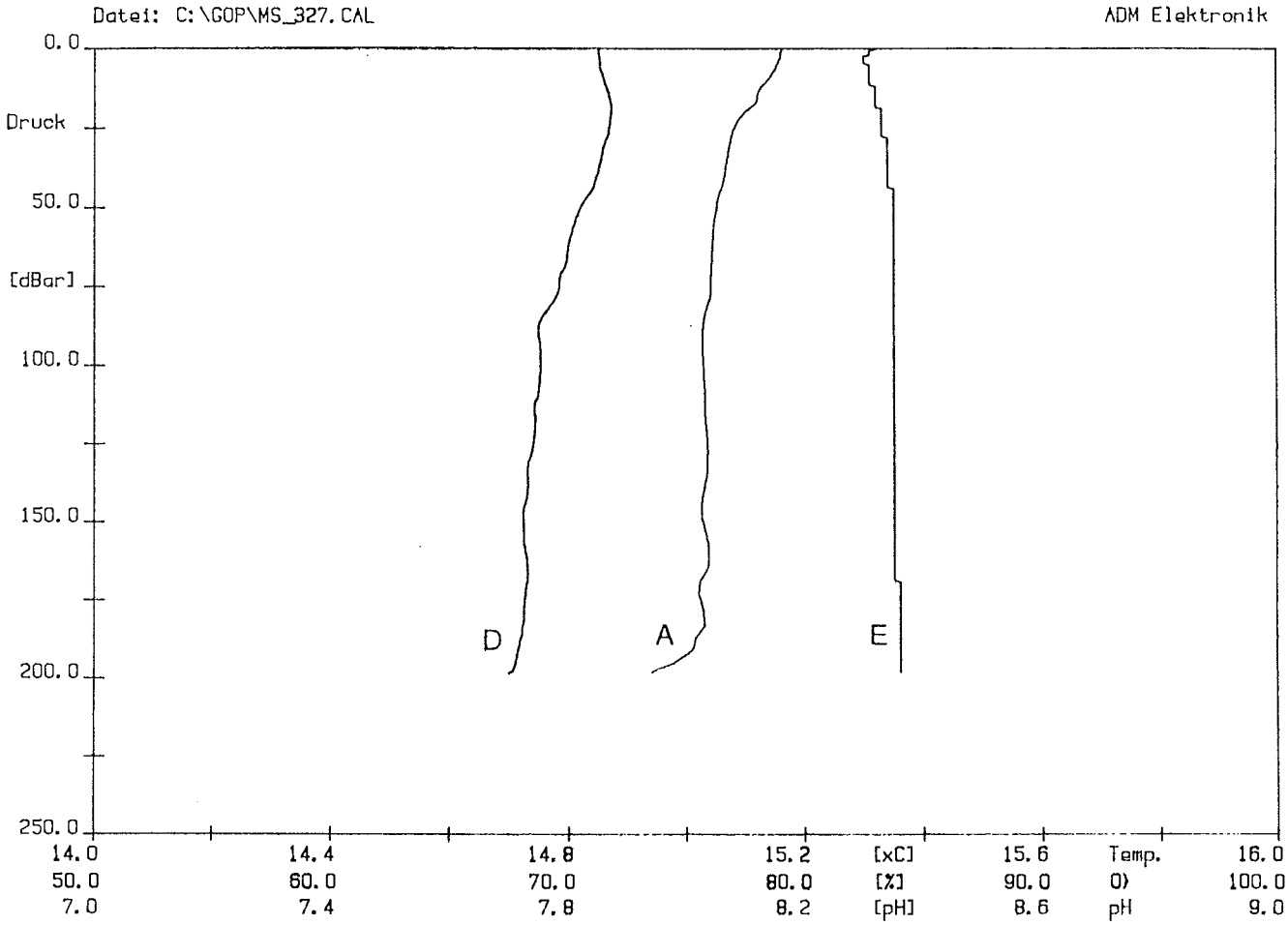
ADM Elektronik
STATION: 337 MS
A = Temperature [°C]
B = Conductivity [µS]
C = Salinity [mg L-1]
D = Dissolved Oxygen [ml L-1]
E = pH
Druck
[dBar]
0.0
50.0
100.0
150.0
200.0
250.0
A
C
B
14.0 14.4 14.8 15.2 [xC] 15.6 Temp. 16.0
45.0 45.6 46.2 46.8 [mS] 47.4 Leitf. 48.0
38.0 38.4 38.8 39.2 [ppt] 39.6 Salzg. 40.0

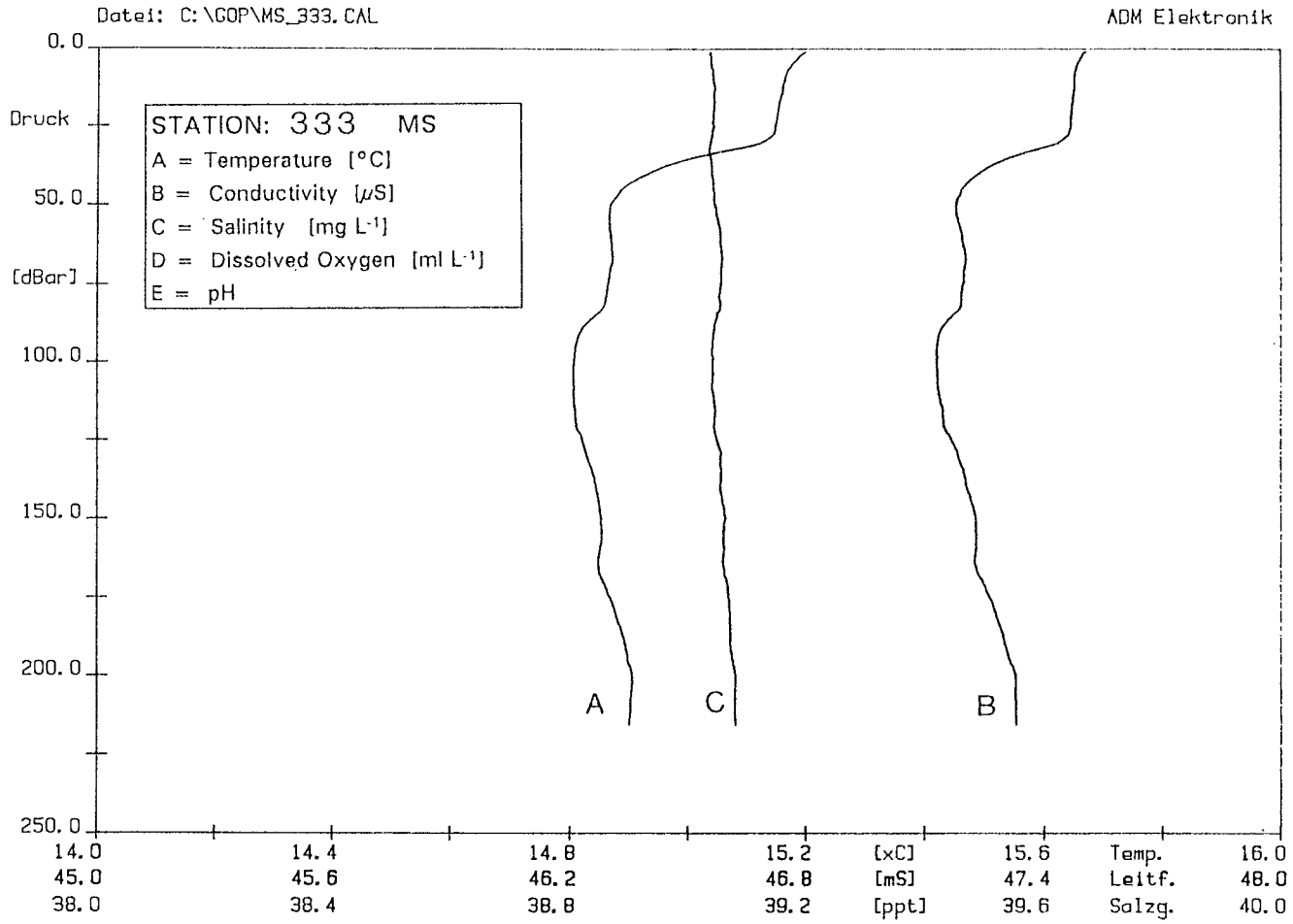

Datei: C:\GOP\MS_337.CAL
ADM Elektronik
Druck
[dBar]
0.0
50.0
100.0
150.0
200.0
250.0
D
A
E
14.0 14.4 14.8 15.2 [xC] 15.6 Temp. 16.0
50.0 60.0 70.0 80.0 [%] 90.0 O) 100.0
7.0 7.4 7.8 8.2 [pH] 8.6 pH 9.0

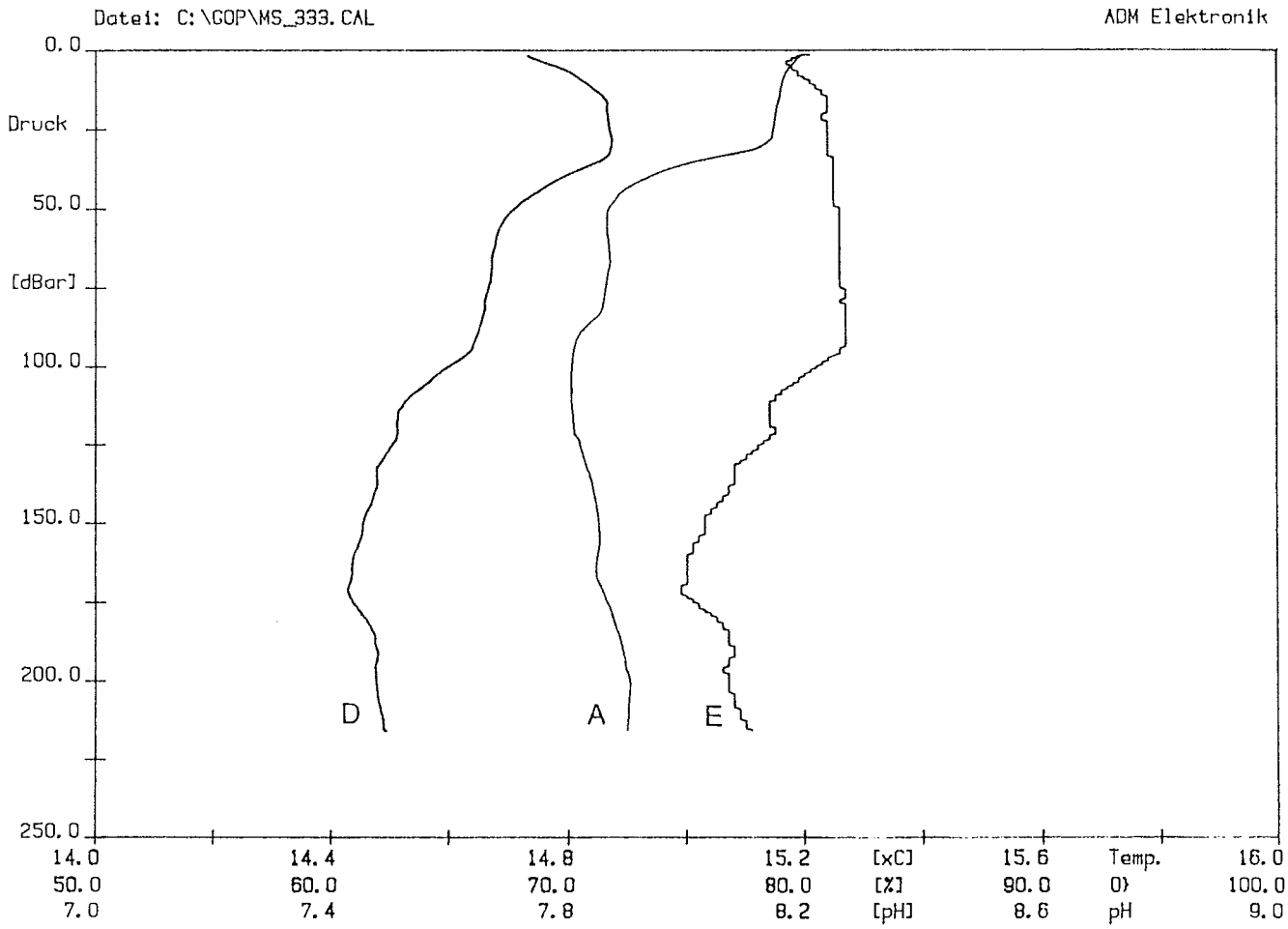

Datei: C:\GOP\MS_323.CAL
ADM Elektronik
STATION: 323 MS
A = Temperature [°C]
B = Conductivity [µS]
C = Salinity [mg L-1]
D = Dissolved Oxygen [ml L-1]
E = pH
Druck
[dBar]
0.0
50.0
100.0
150.0
200.0
250.0
A
C
B
14.0 14.4 14.8 15.2 [xC] 15.6 Temp. 16.0
45.0 45.6 46.2 46.8 [mS] 47.4 Leitf. 48.0
38.0 38.4 38.8 39.2 [ppt] 39.6 Salzg. 40.0


Datei: C:\GOP\MS_323.CAL
ADM Elektronik
Druck
[dBar]
0.0
50.0
100.0
150.0
200.0
250.0
D
A
E
14.0 14.4 14.8 15.2 [xC] 15.6 Temp. 16.0
50.0 60.0 70.0 80.0 [%] 90.0 O) 100.0
7.0 7.4 7.8 8.2 [pH] 8.6 pH 9.0


Datei: C:\GOP\MS_327.CAL
ADM Elektronik
STATION: 327 MS
A = Temperature [°C]
B = Conductivity [µS]
C = Salinity [mg L-1]
D = Dissolved Oxygen [ml L-1]
E = pH
Druck
[dBar]
0.0
50.0
100.0
150.0
200.0
250.0
A
C
B
14.0 14.4 14.8 15.2 [xC] 15.6 Temp. 16.0
45.0 45.6 46.2 46.8 [mS] 47.4 Leitf. 48.0
38.0 38.4 38.8 39.2 [ppt] 39.6 Salzg. 40.0


Datei: C:\GOP\MS_327.CAL
ADM Elektronik
Druck
[dBar]
0.0
50.0
100.0
150.0
200.0
250.0
D
A
E
14.0 14.4 14.8 15.2 [xC] 15.6 Temp. 16.0
50.0 60.0 70.0 80.0 [%] 90.0 O) 100.0
7.0 7.4 7.8 8.2 [pH] 8.6 pH 9.0


Datei: C:\GOP\MS_333.CAL
ADM Elektronik
STATION: 333 MS
A = Temperature [°C]
B = Conductivity [µS]
C = Salinity [mg L-1]
D = Dissolved Oxygen [ml L-1]
E = pH
Druck
[dBar]
0.0
50.0
100.0
150.0
200.0
250.0
A
C
B
14.0 14.4 14.8 15.2 [xC] 15.6 Temp. 16.0
45.0 45.6 46.2 46.8 [mS] 47.4 Leitf. 48.0
38.0 38.4 38.8 39.2 [ppt] 39.6 Salzg. 40.0


Datei: C:\GOP\MS_333.CAL
ADM Elektronik
Druck
[dBar]
0.0
50.0
100.0
150.0
200.0
250.0
D
A
E
14.0 14.4 14.8 15.2 [xC] 15.6 Temp. 16.0
50.0 60.0 70.0 80.0 [%] 90.0 O› 100.0
7.0 7.4 7.8 8.2 [pH] 8.6 pH 9.0

Appendix 11.4-A: Dissolved Methane

Station Data and Analytical Results of Water Stations

Station	**272 GF**	**N**	**37° 07'**	
Date	**28.3.92**	**E**	**12° 39'**	
GMT	**8:53**	**WT(m)**	**183**	

Sampler	Type	Depth m	Water ml deg.	Gas ml+TV	Counts FID	CH4 nL/L	Remarks
1	GOFLO						empty
2	GOFLO	160,0	1050	12,0	32125	64,2	
3	GOFLO						empty
4	GOFLO	120,0	1100	7,4	21659	25,5	
5	GOFLO						not used

Station	**274 GF**	**N**	**36° 60'**	
Date	**28.3.92**	**E**	**12° 39'**	
GMT	**12:02**	**WT(m)**	**235**	

Sampler	Type	Depth m	Water ml deg.	Gas ml+TV	Counts FID	CH4 nL/L	Remarks
1	GOFLO	235,0	1100	5,0	23694	18,8	
2	GOFLO	215,0	1100	6,8	22992	24,9	
3	GOFLO						empty
4	GOFLO						empty
5	GOFLO						empty

Station	**276 GF**	**N**	**36° 59,3'**	
Date	**28.3.92**	**E**	**12° 39,2`**	
GMT beg.	**15:07**	**WT(m)**	**3480**	
GMT end	**15:32**			

Sampler	Type	Depth m	Water ml deg.	Gas ml+TV	Counts FID	CH4 nL/L	Remarks
1	GOFLO	220,0	<1	0,0			empty
2	GOFLO	200,0	1100	6,5	26770	27,7	
3	GOFLO						empty
4	GOFLO						empty
5	GOFLO						empty

Station	**278 MS**	**N**	**36° 21,53'**
Date	**28.3.92**	**E**	**17° 38,92'**
GMT beg.	**12:19**	**WT(m)**	**3480**
GMT end	**13:05**		

Sampler	Type	Depth m	Water ml deg.	Gas ml+TV	Counts FID	CH4 nL/L	Remarks
1	BGS	1000,0	1100	5,5	11627	10,2	flow
2	NIS	1000,0	920	10,4	10281	20,3	VTG(high vac)
3	NIS	1000,0	1100	12,5	10523	20,9	VTG(low vac)
4	NIS	1000,0	1100	6,5	11571	12,0	flow
5	NIS	1000,0					flow
6	NIS	1000,0	stored				Bombe evac.
7	NIS	1000,0					nicht ausgel.
8	NIS	1000,0	failed				Bombe flow
9	NIS	1000,0					reserve
10	NIS	1000,0					reserve
11	NIS	1000,0					reserve
12	NIS	1000,0					reserve

Station	**279 MS**	**N**	**36° 21,53'**
Date	**28.3.92**	**E**	**17° 38,92'**
GMT beg.	**12:19**	**WT(m)**	**3480**
GMT end	**13:05**		

Sampler	Type	Depth m	Water ml deg.	Gas ml+TV	Counts FID	CH4 nL/L	Remarks
1	BGS	1000,0	1100	5,5	11627	10,2	flow
2	NIS						VTG(high vac)
3	NIS						VTG(low vac)
4	NIS						flow
5	NIS						flow
6	NIS						Bombe evac.
7	NIS						nicht ausgel.
8	NIS						Bombe flow
9	NIS						reserve
10	NIS						reserve
11	NIS						reserve
12	NIS						reserve

Station	**280 MS**	**N**	**36° 26,64'**
Date	**4.4.92**	**E**	**25° 24,32'**
GMT beg.	**6:15**	**WT(m)**	**354**
GMT end	**6:35**		

Sampler	Type	Depth m	Water ml deg.	Gas ml+TV	Counts FID	CH4 nL/L	Remarks
7	NIS	70,0	1050	11,0	17548	32,1	
3	NIS	110,0	1120	2,0	19571	6,1	
4	NIS	150,0	1120	4,3	19331	13,0	
5	NIS	190,0	1120	4,8	17688	13,3	
6	NIS	230,0	1120	3,8	12396	7,4	
2	NIS	270,0	1120	2,8	19325	8,4	
8	NIS	310,0	1120	2,8	19156	8,4	
1	BGS	350,0	1120	11,0	14694	25,2	
12	NIS	350,0	1120	9,0	17873	25,1	

Station	**283 MS**	**N**	**36° 27,00'**
Date	**4.4.92**	**E**	**25° 24,11**
GMT beg.	**12:48**	**WT(m)**	**338**
GMT end	**13:15**		

Sampler	Type	Depth m	Water ml deg.	Gas ml+TV	Counts FID	CH4 nL/L	Remarks
10	NIS	60,0	1110	8,1	20608	26,3	
9	NIS	78,0	1130	10,2	18067	28,5	
7	NIS	100,0	1050	8,4	18897	26,4	
8	NIS	120,0	1110	7,8	17673	21,7	
6	NIS	164,0	1120	5,8	18111	16,4	
5	NIS	240,0	1120	5,8	20956	19,0	
3	NIS	300,0	1120	5,8	16741	15,2	
1	BGS	340,0	1120	4,8	16116	12,1	

Station	**286 MS**	**N**	**36° 25,09'**
Date	**5.4.92**	**E**	**25° 24,38`**
GMT beg.	**5:53**	**WT(m)**	**162**
GMT end	**6:14**		

Sampler	Type	Depth m	Water ml deg.	Gas ml+TV	Counts FID	CH4 nL/L	Remarks
10	NIS	50,2	1110	8,2	17867	23,1	
8	NIS	82,5	1100	8,3	20630	27,2	
7	NIS	100,4	1050	5,8	16126	15,6	
5	NIS	126,8	1120	9,6	14193	21,3	
4	NIS	149,8	1120	4,8	17813	13,3	
3	NIS	160,0	1150	4,8	17289	12,6	
2	NIS	168,5	1100	4,8	13872	10,6	
1	BGS	179,6	1120	5,8	19920	18,0	
12	NIS	179,6	1120	5,6	24202	21,2	

Station	**292 MS**	**N**	**36° 24,67'**
Date	**5.4.92**	**E**	**25° 22,88'**
GMT beg.	**9:45**	**WT(m)**	**216**
GMT end	**10:09**		

Sampler	Type	Depth m	Water ml deg.	Gas ml+TV	Counts FID	CH4 nL/L	Remarks
2	NIS	40,0	1120	7,0	19509	21,3	
12	NIS	68,0	1120	8,7	18000	24,4	
4	NIS	80,0	1120	3,8	17099	10,1	
5	NIS	100,0	1120	4,3	21684	14,6	
6	NIS	120,0	1120	5,8	20064	18,2	
7	NIS	140,0	1140	8,5	16624	21,7	
8	NIS	160,0	1130	10,5	17691	28,7	
9	NIS	180,0	1130	7,9	17429	21,3	
1	BGS	200,0	1120	7,0	21744	23,8	
10	NIS	216,4	1120	12,2	22353	42,6	

Station	**295 MS**	**N**	**36° 24,67'**
Date	**5.4.92**	**E**	**25° 22,88'**
GMT beg.	**9:45**	**WT(m)**	**216**
GMT end	**10:09**		

Sampler	Type	Depth m	Water ml deg.	Gas ml+TV	Counts FID	CH4 nL/L	Remarks
2	NIS	39,1	1120	8,9	20011	27,8	
3	NIS	59,8	1120	7,2	21832	24,5	
4	NIS	79,2	1120	8,5	17368	23,0	
5	NIS	99,5	1120	9,8	17868	27,3	
6	NIS	119,2	1130	10,1	18003	28,1	
7	NIS	139,8	1060	9,3	17331	26,6	
8	NIS	160,2	1120	9,7	18570	28,1	
9	NIS	182,7	1130	8,8	20397	27,8	
10	NIS	209,7	1120	9,5	20951	31,1	
12	NIS	212,8	1120	9,0	18176	25,5	

Station	**298 MS**	**N**	**36° 23,48`**
Date	**6.4.92**	**E**	**25° 23,89'**
GMT beg.		**WT(m)**	**230**
GMT end			

Sampler	Type	Depth m	Water ml deg.	Gas ml + TV	Counts FID	CH4 nL/L	Remarks
1	NIS	30,0	1120	6,8	20434	20,4	
2	NIS	50,0	1130	6,8	19488	19,3	
3	NIS	70,0	1120	12,0	16942	29,8	
4	NIS	90,0	1120	8,8	20245	26,1	
5	NIS	110,0	1110	8,8	18748	24,4	
6	NIS	130,0	1120	9,2	19010	25,6	
7	NIS	150,0	1060	10,7	22400	37,1	
8	NIS	170,0	1120	7,0	21753	22,3	
12	NIS	198,0	1120	7,5	21848	24,0	
1	BGS	225,0	1120	8,5	21589	26,9	

Station	**301 MS**	**N**	**36° 24,53'**
Date	**6.4.92**	**E**	**25° 22,61'**
GMT beg.	**10:05**	**WT(m)**	**240**
GMT end	**10:28**		

Sampler	Type	Depth m	Water ml deg.	Gas ml + TV	Counts FID	CH4 nL/L	Remarks
1	NIS	30,0	1120	6,8	21731	21,7	
2	NIS	50,3	1120	5,8	21455	18,2	
3	NIS	69,9	1120	8,8	20636	26,6	
4	NIS	89,6	1120	7,4	20329	22,1	
5	NIS	109,5	1120	12,8	14201	26,7	
6	NIS	129,1	1050	8,9	17092	23,8	
7	NIS	149,9	1120	8,6	19378	24,4	
9	NIS	168,2	1120	8,1	19230	22,8	
10	NIS	189,2	1120	8,7	21402	27,3	
12	NIS	208,5	1120	7,4	21138	22,9	

Station	**305 MS**	**N**	**36° 25,12'**
Date	**6.4.92**	**E**	**25° 24,39'**
GMT beg.	**10:05**	**WT(m)**	**240**
GMT end	**10:28**		

Sampler	Type	Depth m	Water ml deg.	Gas ml + TV	Counts FID	CH4 nL/L	Remarks
2	NIS	29,4	1120	10,6	23829	37,0	
3	NIS	60,4	1120	9,8	21483	30,9	
4	NIS	89,5	1120	4,8	22221	15,6	
5	NIS	109,4	1120	10,0	22250	32,6	
6	NIS	129,8	1130	8,5	22651	28,0	
7	NIS	149,8	1060	9,1	20159	28,4	
8	NIS	170,3	1120	10,8	21747	34,4	
9	NIS	195,6	1140	7,9	21650	24,6	
10	NIS	213,6	1120	10,1	21192	31,4	
12	NIS	245,8	1120	10,1	21853	32,4	
1	BGS	245,8	1130	10,1	21808	32,0	

Station	**308 MS**	**N**	**36° 24,68'**
Date	**7.4.92**	**E**	**25° 22,72'**
GMT beg.	**5:45**	**WT(m)**	**239**
GMT end	**6:15**		

Sampler	Type	Depth m	Water ml deg.	Gas ml + TV	Counts FID	CH4 nL/L	Remarks
0	Jar	0,0	1140	10,0	30758	43,7	
11	GOFLO	10,0	1110	10,6	27282	42,2	
2	NIS	38,5	1120	9,7	22305	31,7	
3	NIS	61,6	1120	8,4	22259	27,4	
4	NIS	79,5	1120	8,5	18263	22,8	
5	NIS	99,6	1120	7,3	21657	23,2	
6	NIS	118,7	1130	9,8	21890	31,2	
7	NIS	143,6	1070	6,3	19399	18,8	
8	NIS	158,9	1120	4,8	21940	15,4	
10	NIS	202,7	1130	8,4	21445	26,2	
1	BGS	223,6	1120	10,0	21623	31,7	
12	NIS	239,4	1120	8,8	22067	28,5	

Station	**319 MS**	**N**	**36° 23,62'**
Date	**7.4.92**	**E**	**25° 22,50'**
GMT beg.	**10:27**	**WT(m)**	**215**
GMT end	**10:50**		

Sampler	Type	Depth m	Water ml deg.	Gas ml+TV	Counts FID	CH4 nL/L	Remarks
0	Jar	0,0	1140	9,1	21171	27,4	
2	NIS	20,8	1120	8,1	23264	27,6	
3	NIS	40,4	1130	3,8	24900	13,8	
5	NIS	78,7	1120	9,1	18490	24,7	
6	NIS	100,0	1130	10,0	22592	32,8	
7	NIS	120,0	1070	10,4	20429	32,6	
8	NIS	139,0	1120	11,0	22641	36,5	
10	NIS	160,9	1120	14,8	15615	33,9	
12	NIS	196,3	1130	8,5	23392	28,9	

Station	**323 MS**	**N**	**36° 30,77'**
Date	**8.4.92**	**E**	**25° 29,75'**
GMT beg.	**6:56**	**WT(m)**	**207**
GMT end	**7:28**		

Sampler	Type	Depth m	Water ml deg.	Gas ml+TV	Counts FID	CH4 nL/L	Remarks
0	Jar	0,0	1140	12,1	24971	42,9	
3	NIS	39,5	1150	7,8	24737	27,2	
4	NIS	59,3	1140	8,4	26334	31,4	
5	NIS	79,1	1150	8,5	25771	30,8	
6	NIS	99,8	1140	11,8	26055	43,6	
7	NIS	120,1	1140	5,8	25205	20,8	
8	NIS	139,3	1150	11,3	25474	40,5	
9	NIS	160,9	1150	9,4	25980	34,4	
10	NIS	179,8	1120	9,7	25415	35,6	
12	NIS	191,9	1120	10,1	26421	38,6	

Station	**327 MS**	**N**	**36° 31,06'**
Date	**8.4.92**	**E**	**25° 27,70'**
GMT beg.	**10:00**	**WT(m)**	**205**
GMT end	**10:25**		

Sampler	Type	Depth m	Water ml deg.	Gas ml+TV	Counts FID	CH4 nL/L	Remarks
0	Jar	0,0	1130	11,2	22032	35,3	
2	NIS	19,5	1130	9,8	22088	31,0	
3	NIS	39,9	1130	6,8	26347	25,7	
5	NIS	79,1	1150	11,4	24908	40,0	
7	NIS	119,9	1140	10,3	25459	37,2	
9	NIS	157,9	1130	11,0	26385	41,6	
1	BGS	202,3	1130	12,3	24493	43,1	

Station	**330 MS**	**N**	**36° 30,61'**
Date	**8.4.92**	**E**	**25° 23,13'**
GMT beg.	**12:10**	**WT(m)**	**240**
GMT end	**12:25**		

Sampler	Type	Depth m	Water ml deg.	Gas ml+TV	Counts FID	CH4 nL/L	Remarks
0	Jar	0,0	1140	11,8	21358	35,8	
2	NIS	29,6	1130	10,6	22810	34,6	
4	NIS	89,4	1130	11,4	24708	40,3	
6	NIS	150,2	1140	11,0	21804	34,0	
8	NIS	200,0	1120	11,3	22106	36,1	
12	NIS	247,9	1150	11,2	22494	35,5	
1	BGS	246,8	1130	11,0	23352	36,8	

Station	**333 MS**	**N**	**36° 26,08'**
Date	**8.4.92**	**E**	**25° 16,57'**
GMT beg.	**6:21**	**WT(m)**	**222**
GMT end	**6:41**		

Sampler	Type	Depth m	Water ml deg.	Gas ml+TV	Counts FID	CH4 nL/L	Remarks
0	Jar	0,0	1130	10,1	22115	32,0	
2	NIS	19,8	1130	8,6	21237	26,2	
3	NIS	39,8	1150	7,0	21253	20,9	
4	NIS	60,5	1140	10,9	21023	32,5	
6	NIS	99,8	1150	10,2	20528	29,5	
8	NIS	139,8	1140	12,6	21477	38,4	
10	NIS	179,3	1140	10,7	20886	31,7	
1	BGS	204,7	1140	11,2	23417	37,2	
12	NIS	219,8	1150	10,9	22588	34,6	

Station	**337 MS**	**N**	**36° 24,65'**
Date	**9-4-92**	**E**	**25° 22,82'**
GMT beg.	**11:53**	**WT(m)**	**221**
GMT end	**12:08**		

Sampler	Type	Depth m	Water ml deg.	Gas ml+TV	Counts FID	CH4 nL/L	Remarks
1	BGS	218,4	1130	11,4	23392	38,2	
2	NIS	218,5					
3	NIS	218,3	1130	10,1	22981	33,2	
4	NIS	218,6	1130	10,3	22288	32,9	

Station	**338 MS**	**N**	**37° 55,43'**
Date	**12-4-92**	**E**	**18° 40,84'**
GMT beg.	**6:02**	**WT(m)**	**3240**
GMT end	**8:10**		

Sampler	Type	Depth m	Water ml deg.	Gas ml + TV	Counts FID	CH4 nL/L	Remarks
Surface	JAR	0,0	1120	7,5	18728	20,7	
3	NIS	800,7	1150	3,8	11302	6,2	
5	NIS	1400,2	1140	7,9	10828	12,4	
7	NIS	1994,3	1120	7,5	9256	10,2	
9	NIS	2605,9	1150	10,1	10691	15,5	
12	NIS	3351,7	1140	10,1	12536	18,4	
1	BGS	3352,0	1150	11,0	11392	18,0	

Appendix 11.4.-B: Dissolved Methane

Histrogramms of the Methane Concentration:

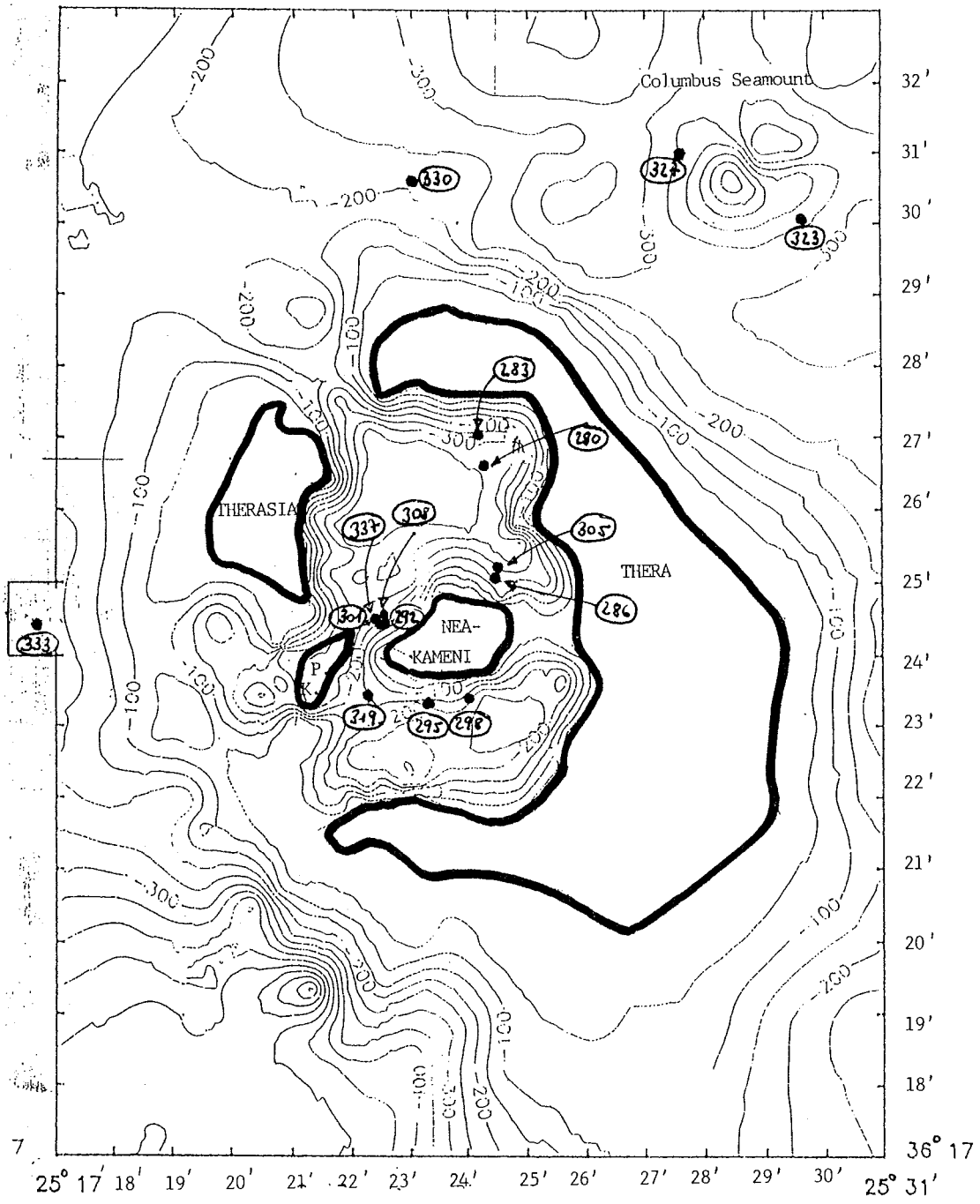


Figure 11.4-1 **Locations of Water Stations in the Area of Santorini and Columbus Seamount**

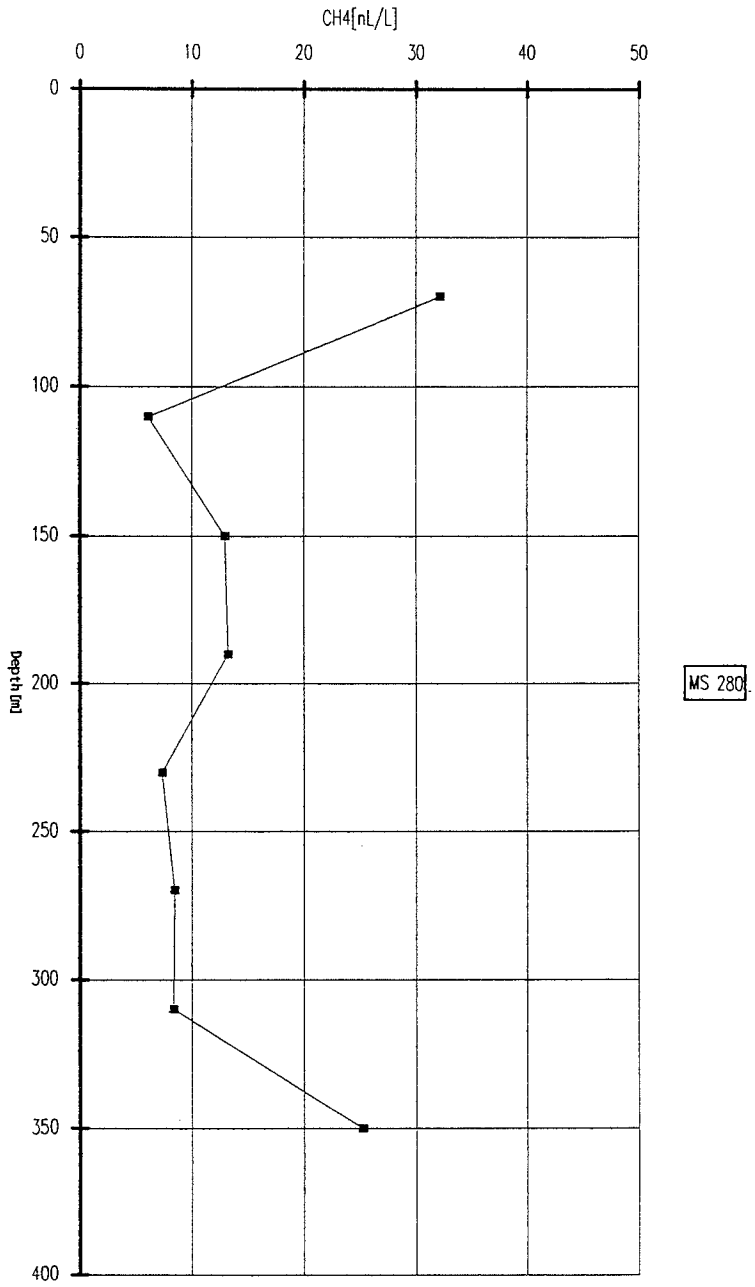


Figure 11.4-2 **Methane Profile of MS 280**

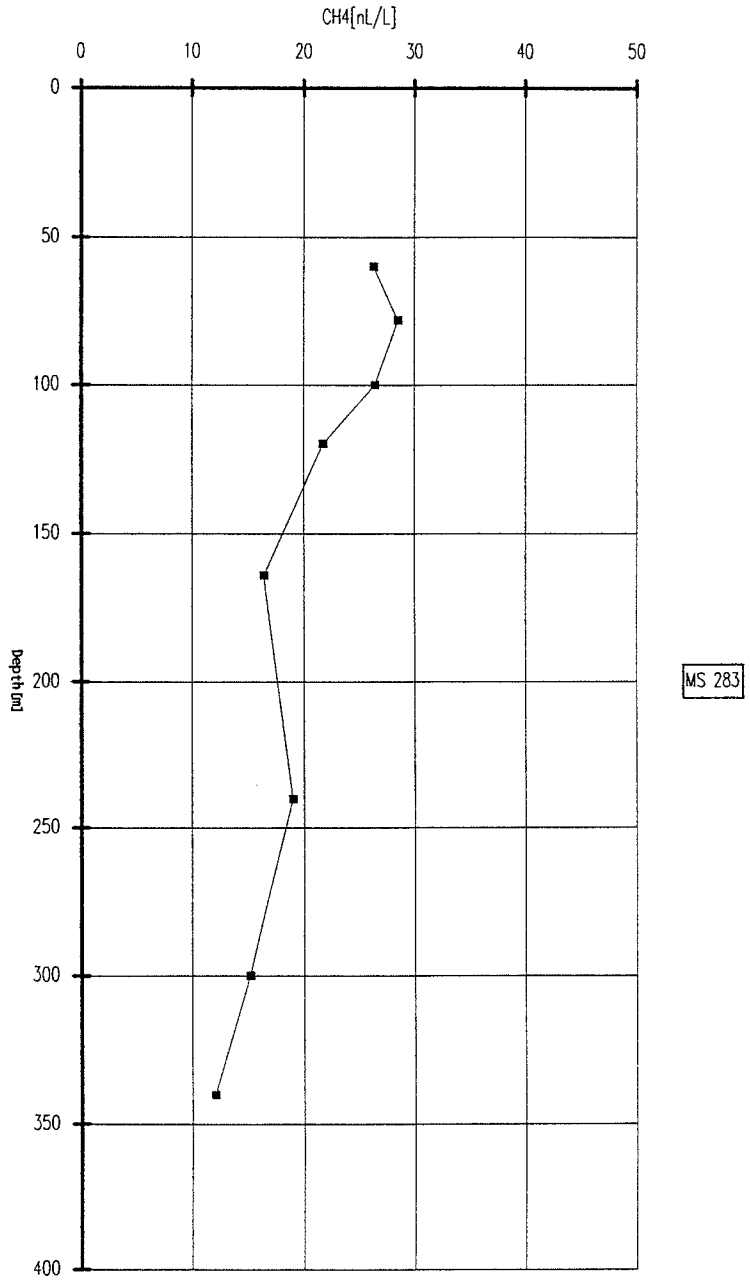


Figure 11.4-3 **Methane Profile of MS 283**

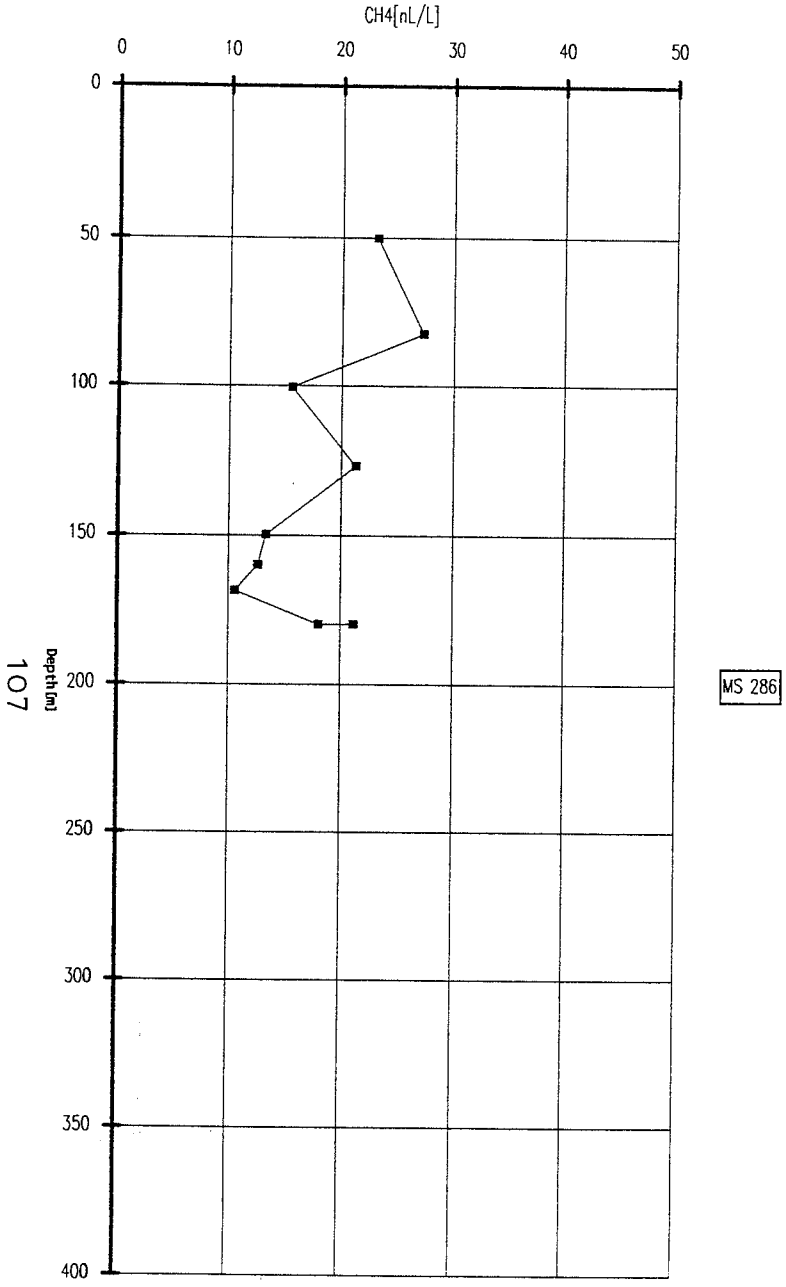


Figure 11.4-4 **Methane Profile of MS 286**

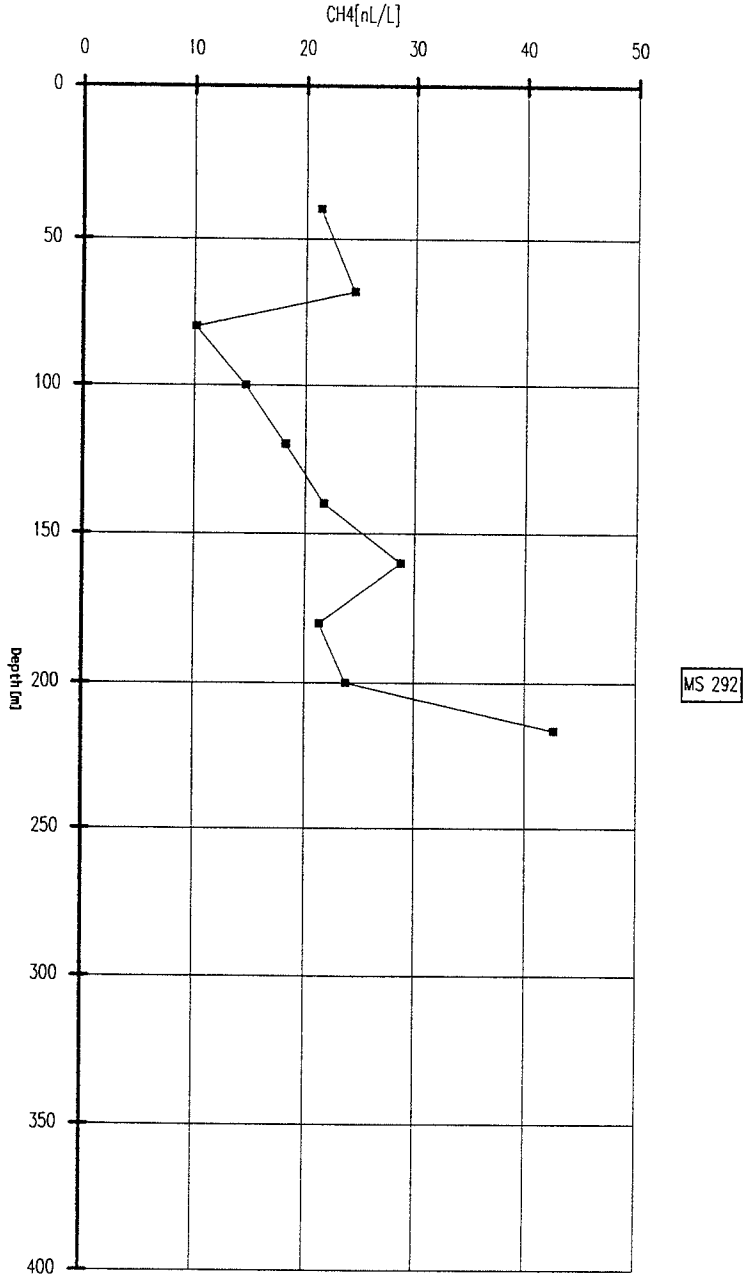


Figure 11.4-5 **Methane Profile of MS 292**

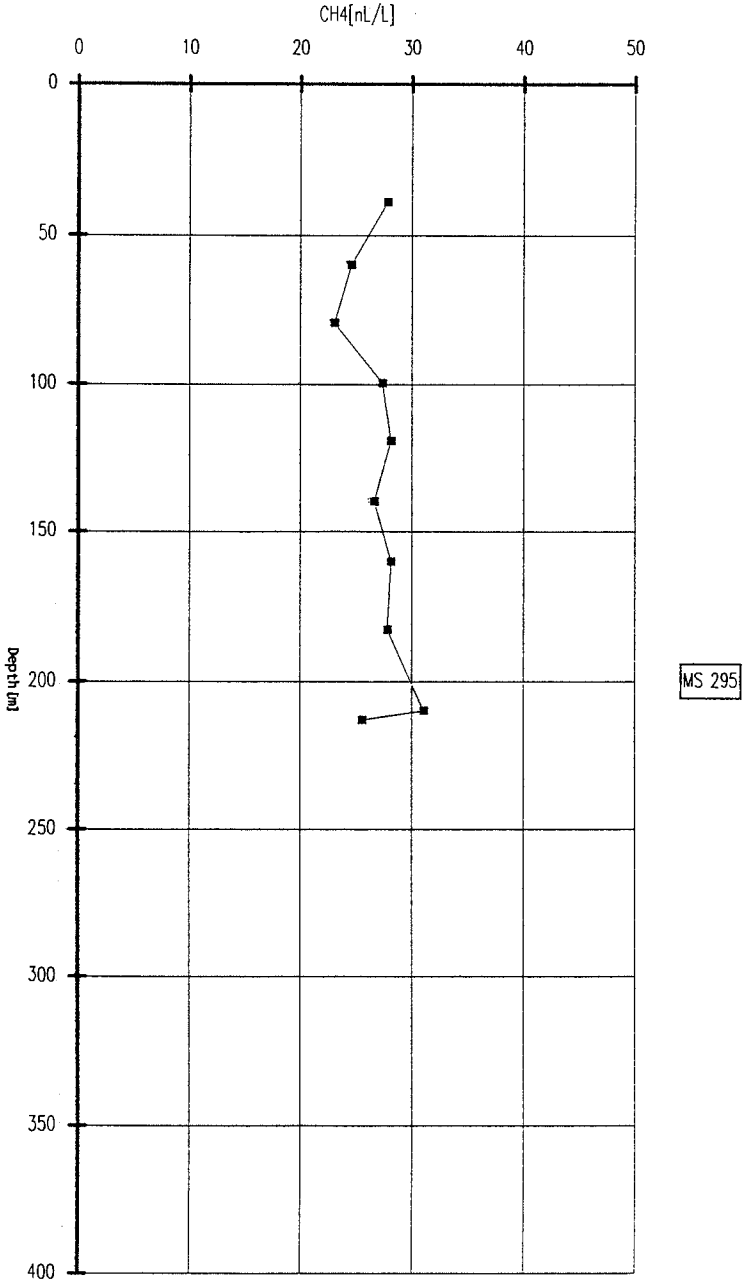


Figure 11.4-6 **Methane Profile of MS 295**

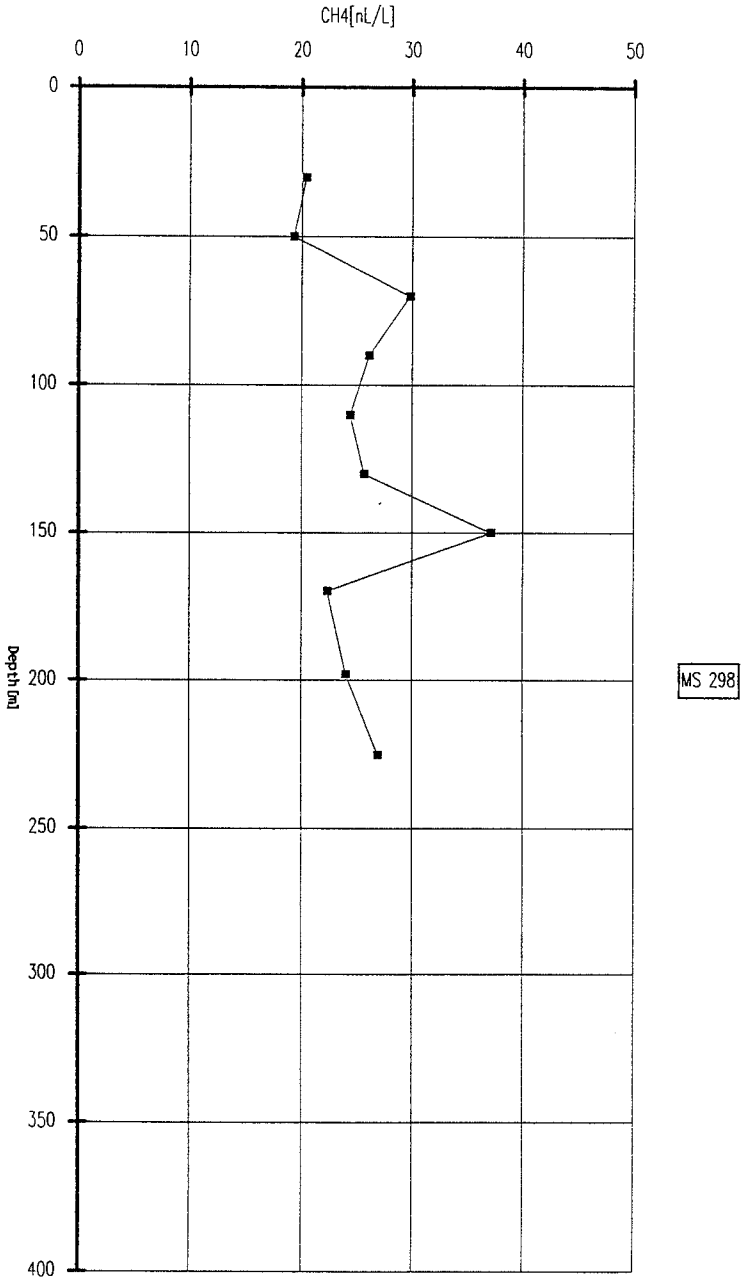


Figure 11.4-7 **Methane Profile of MS 298**

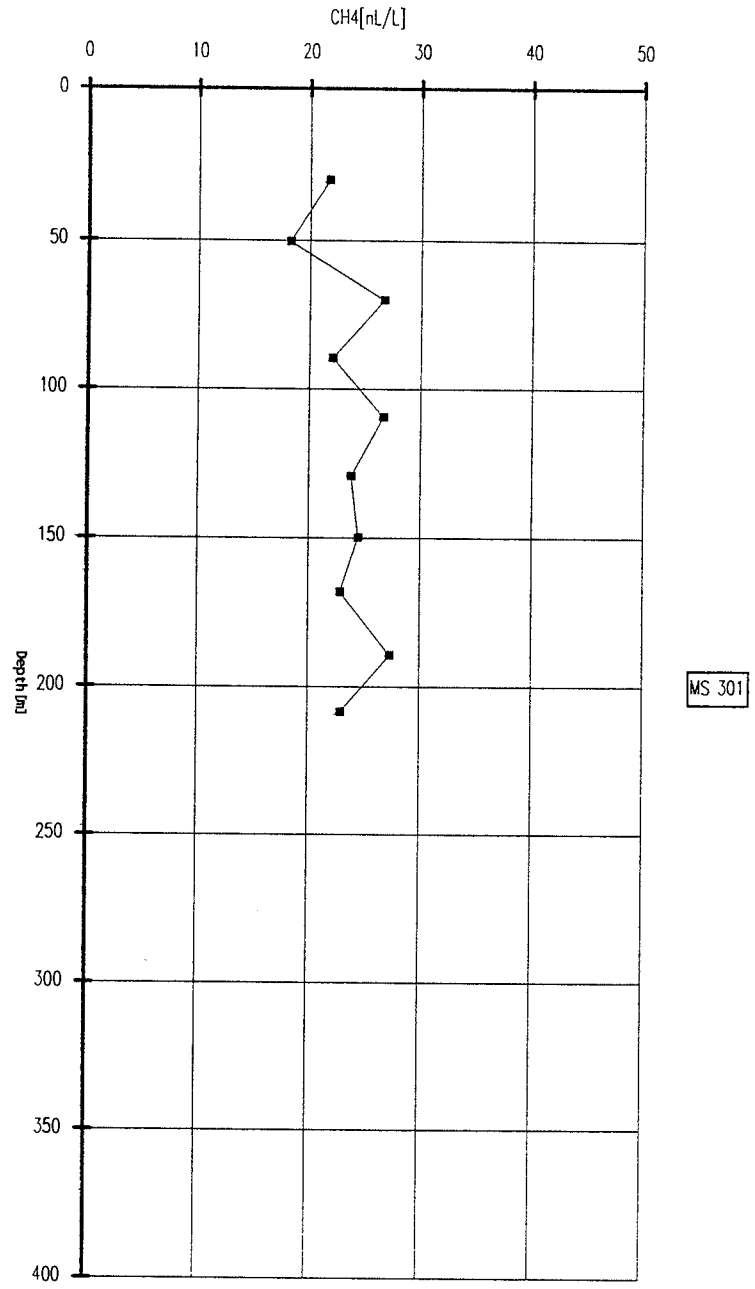


Figure 11.4-8 **Methane Profile of MS 301**

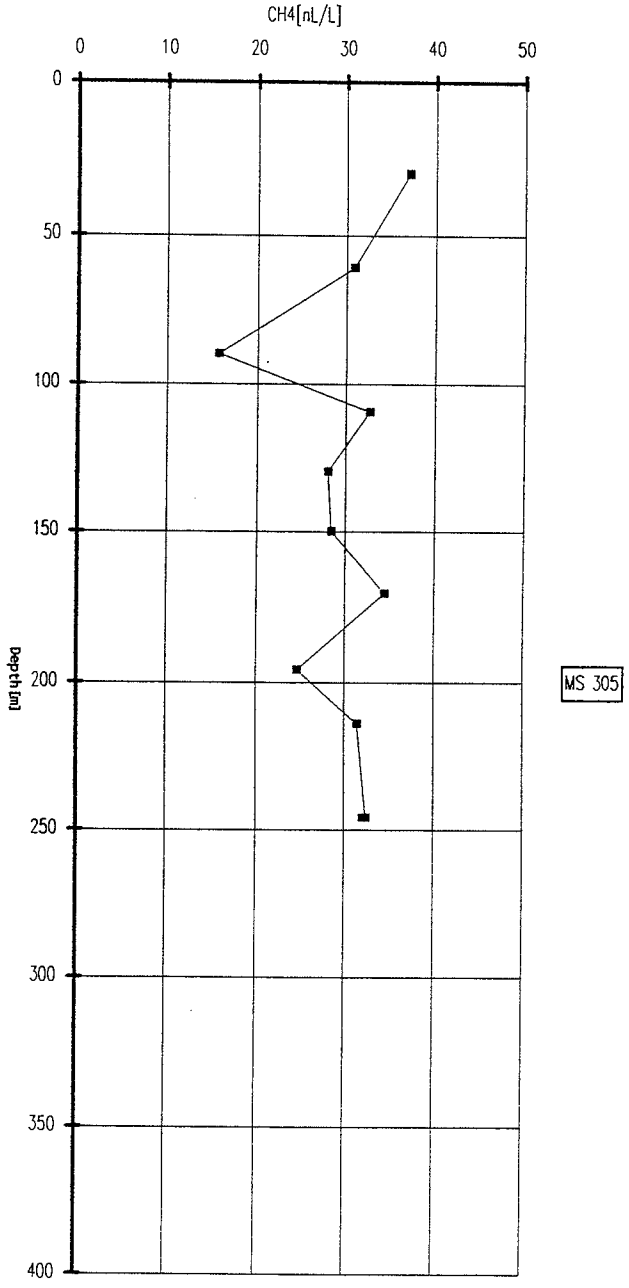


Figure 11.4-9 **Methane Profile of MS 305**

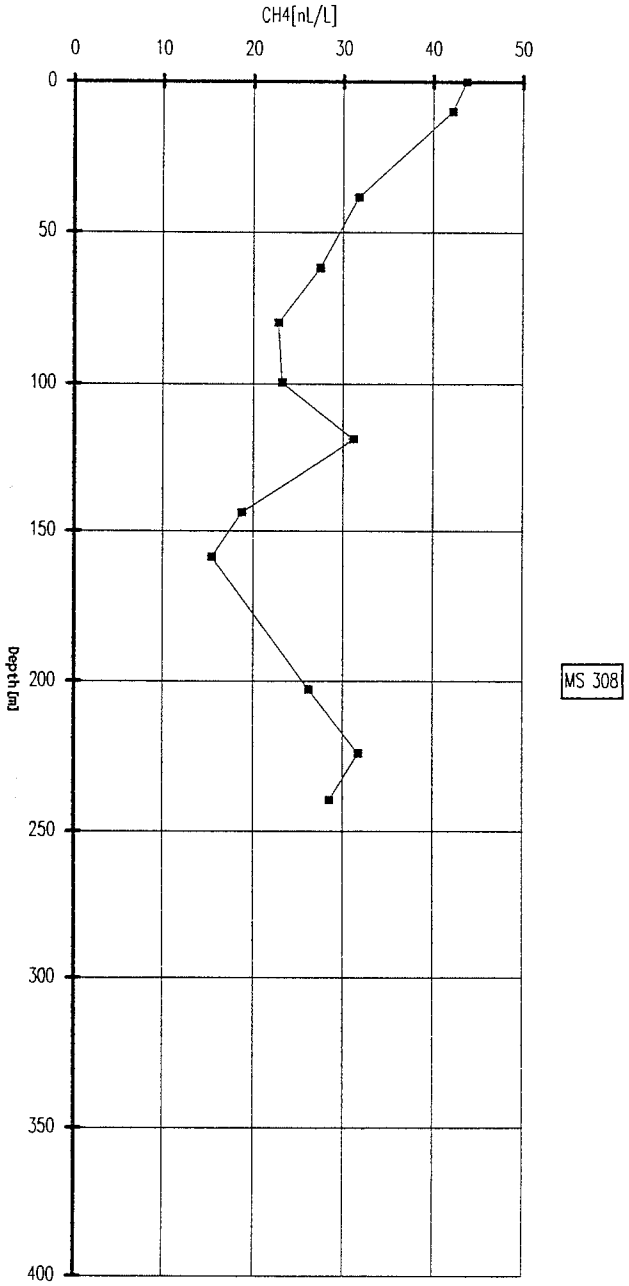


Figure 11.4-10 **Methane Profile of MS 308**

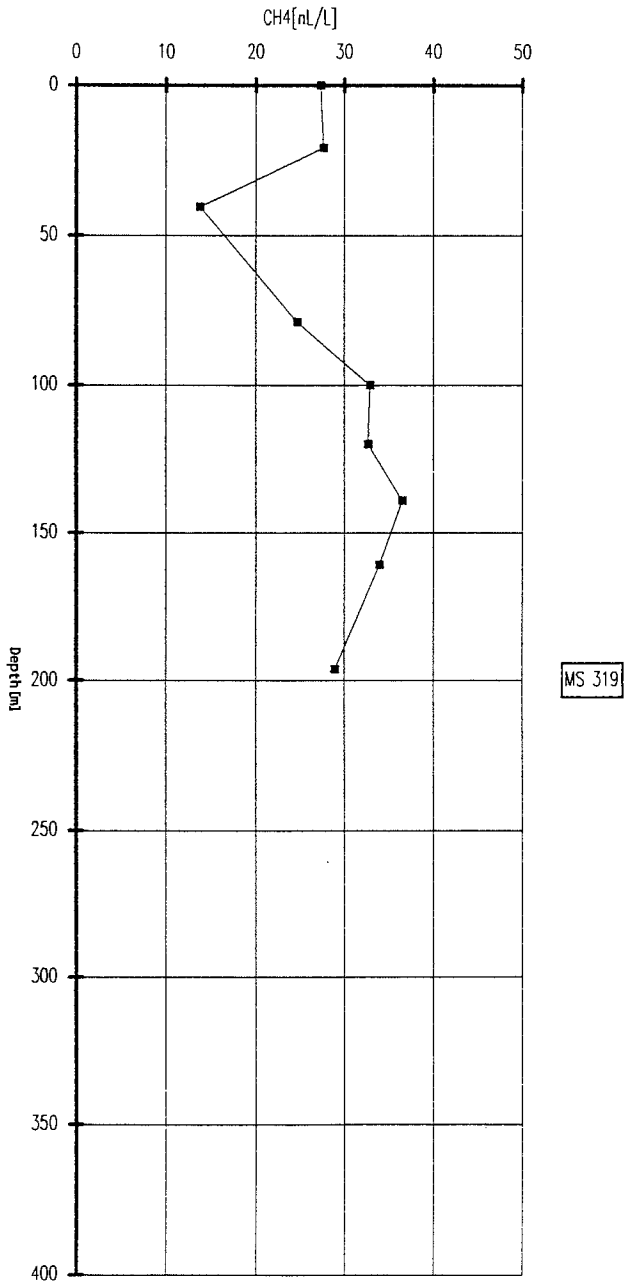


Figure 11.4-11 **Methane Profile of MS 319**

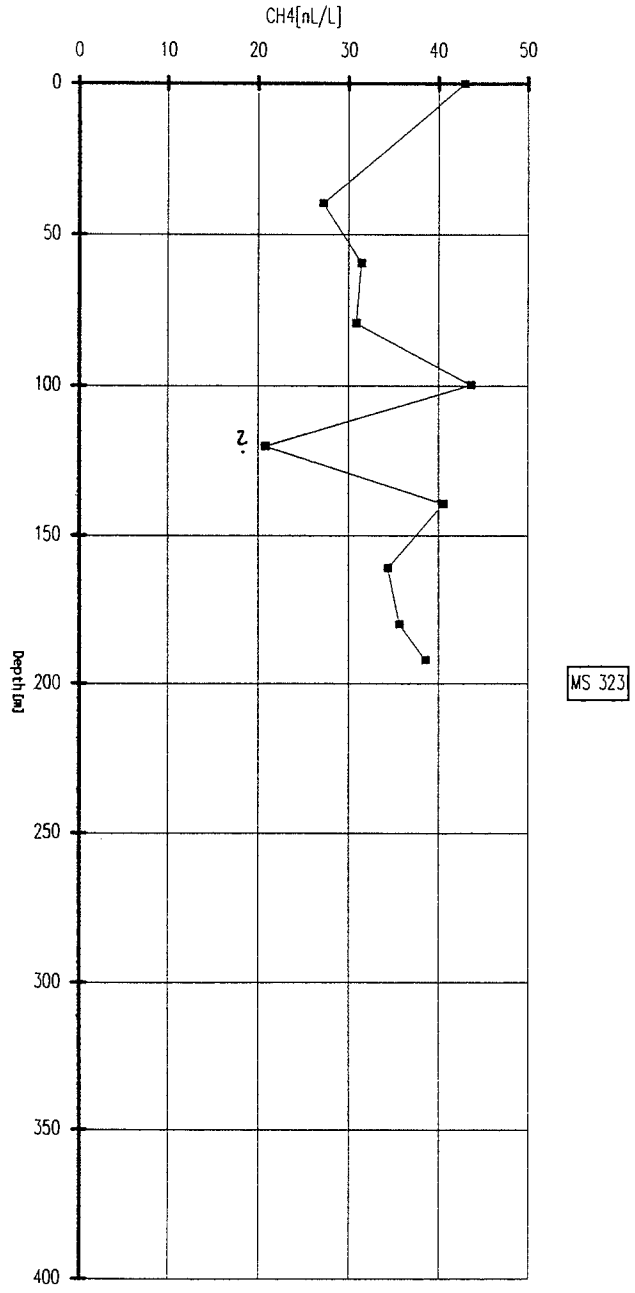


Figure 11.4-12 **Methane Profile of MS 323**

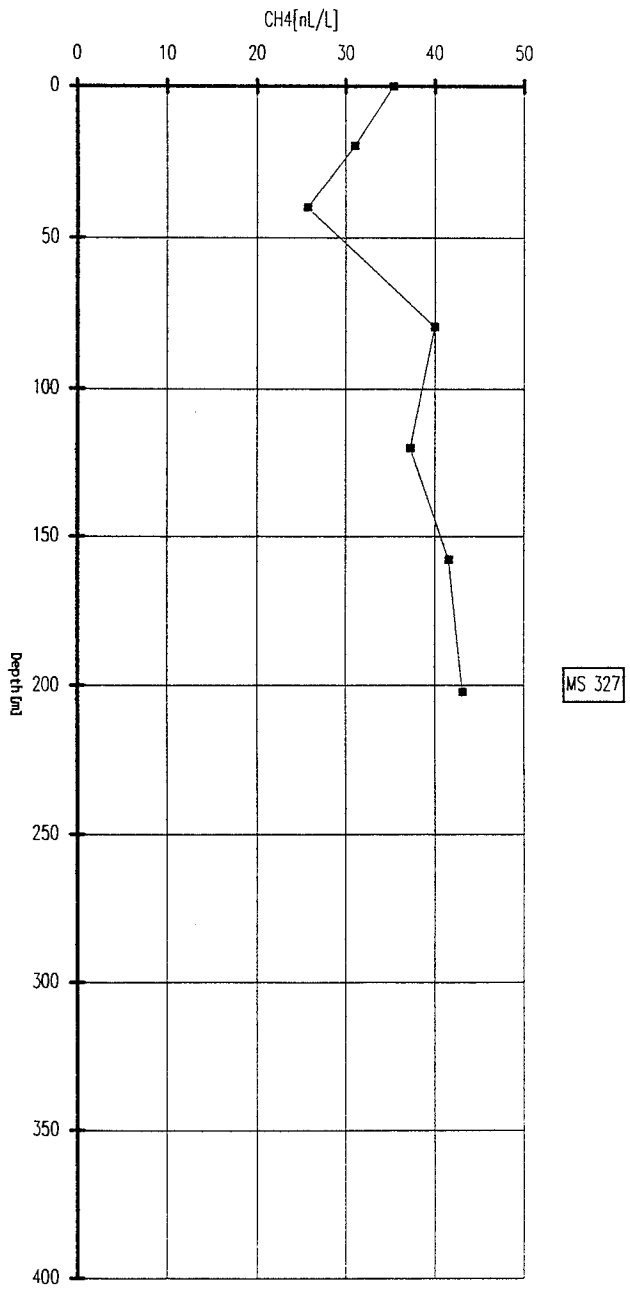


Figure 11.4-13 **Methane Profile of MS 327**

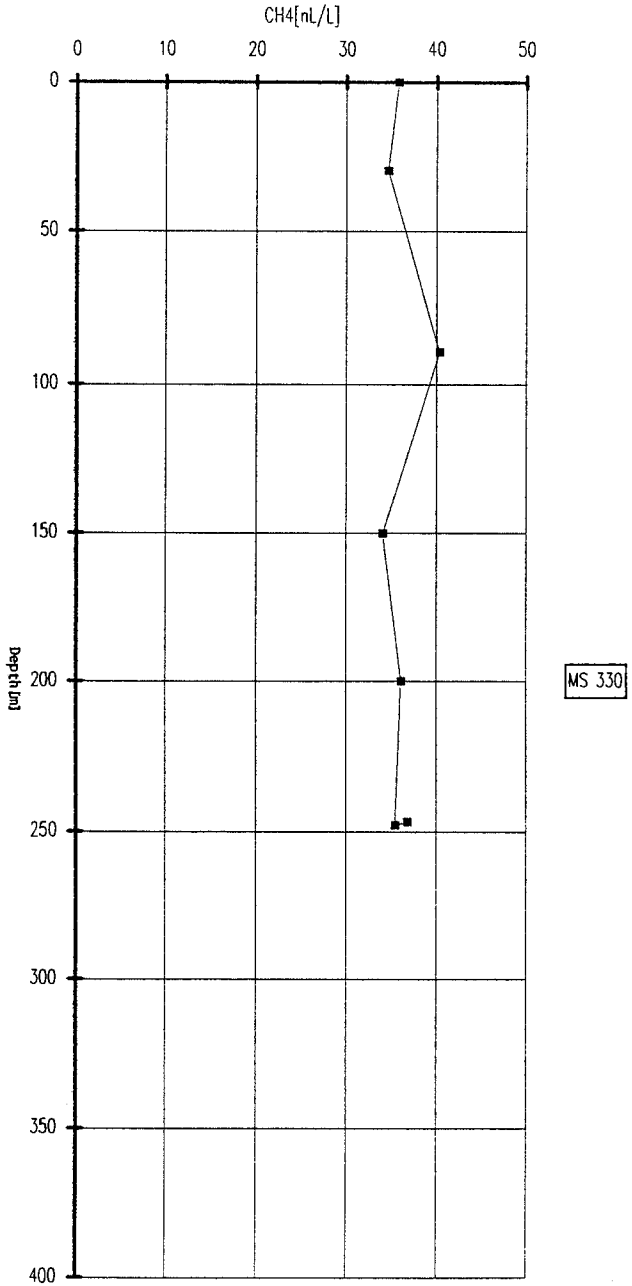


Figure 11.4-14 **Methane Profile of MS 330**

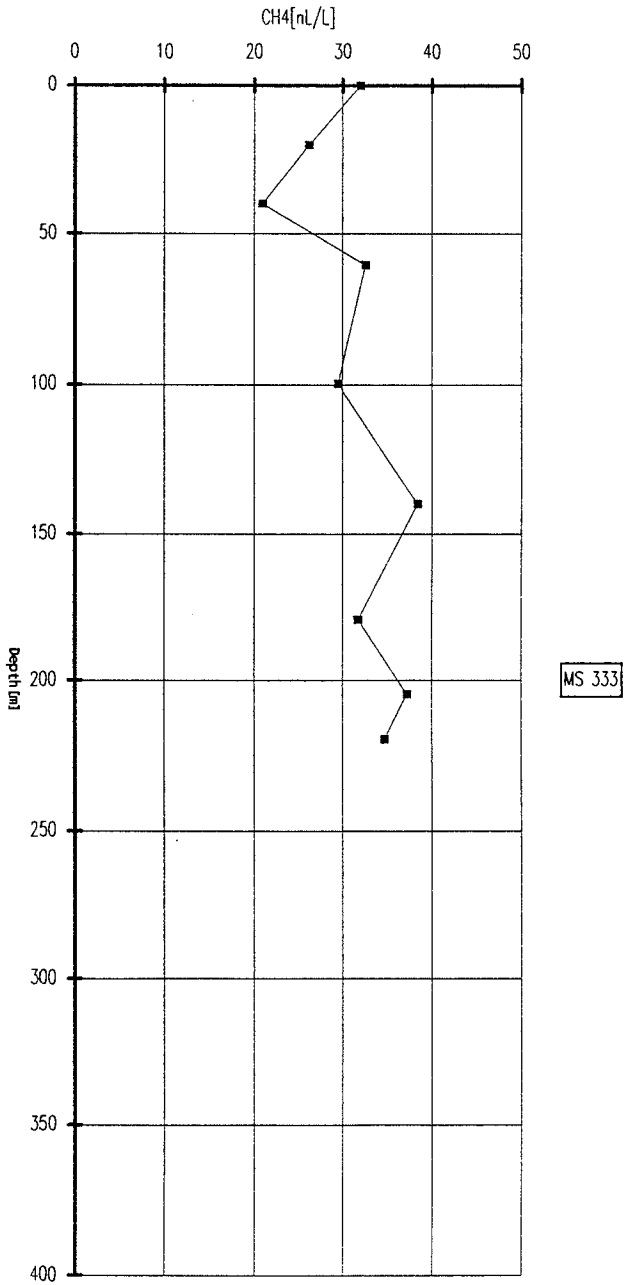


Figure 11.4-15 **Methane Profile of MS 333**

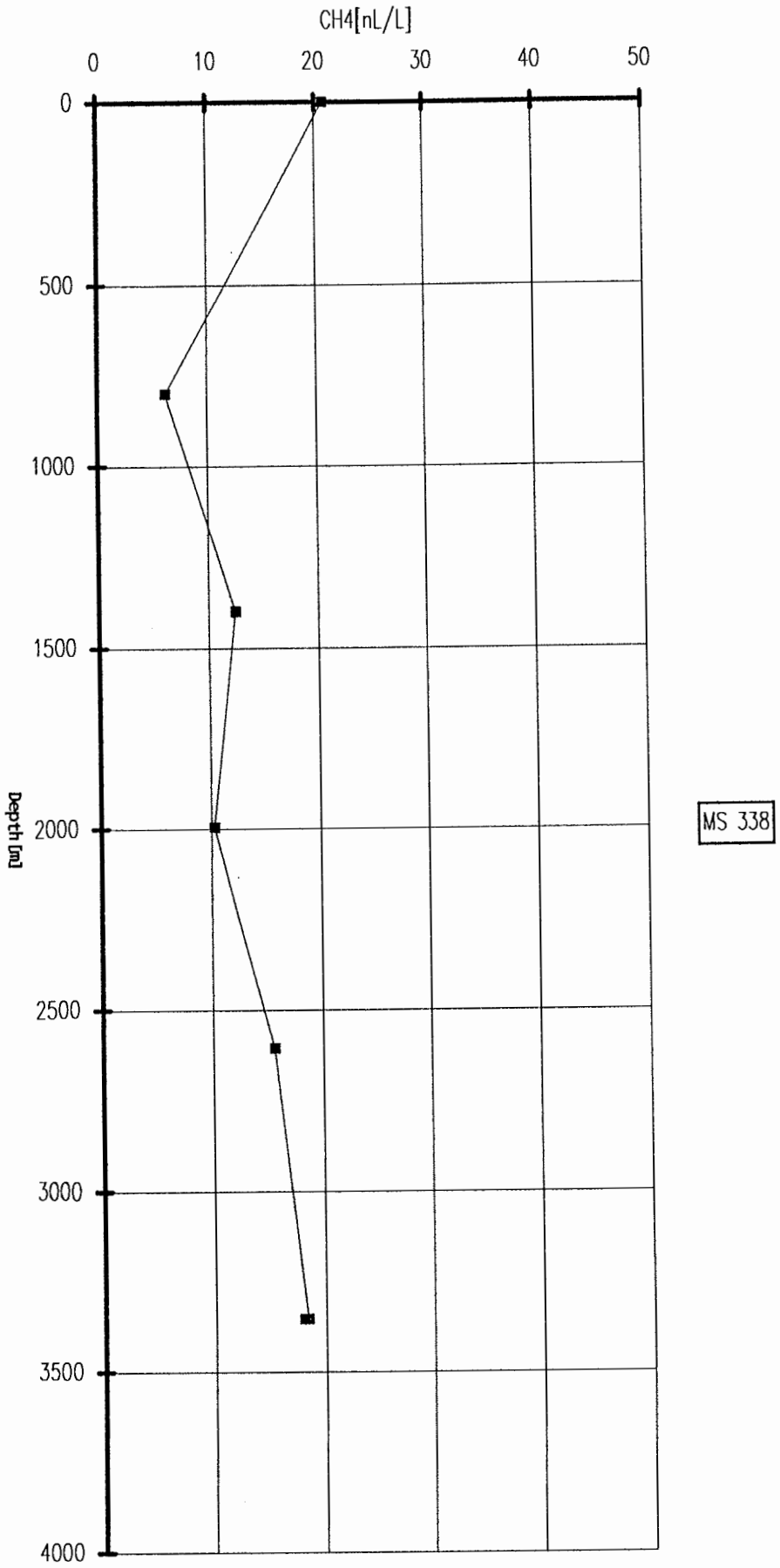


Figure 11.4-16 **Methane Profile of MS 338**

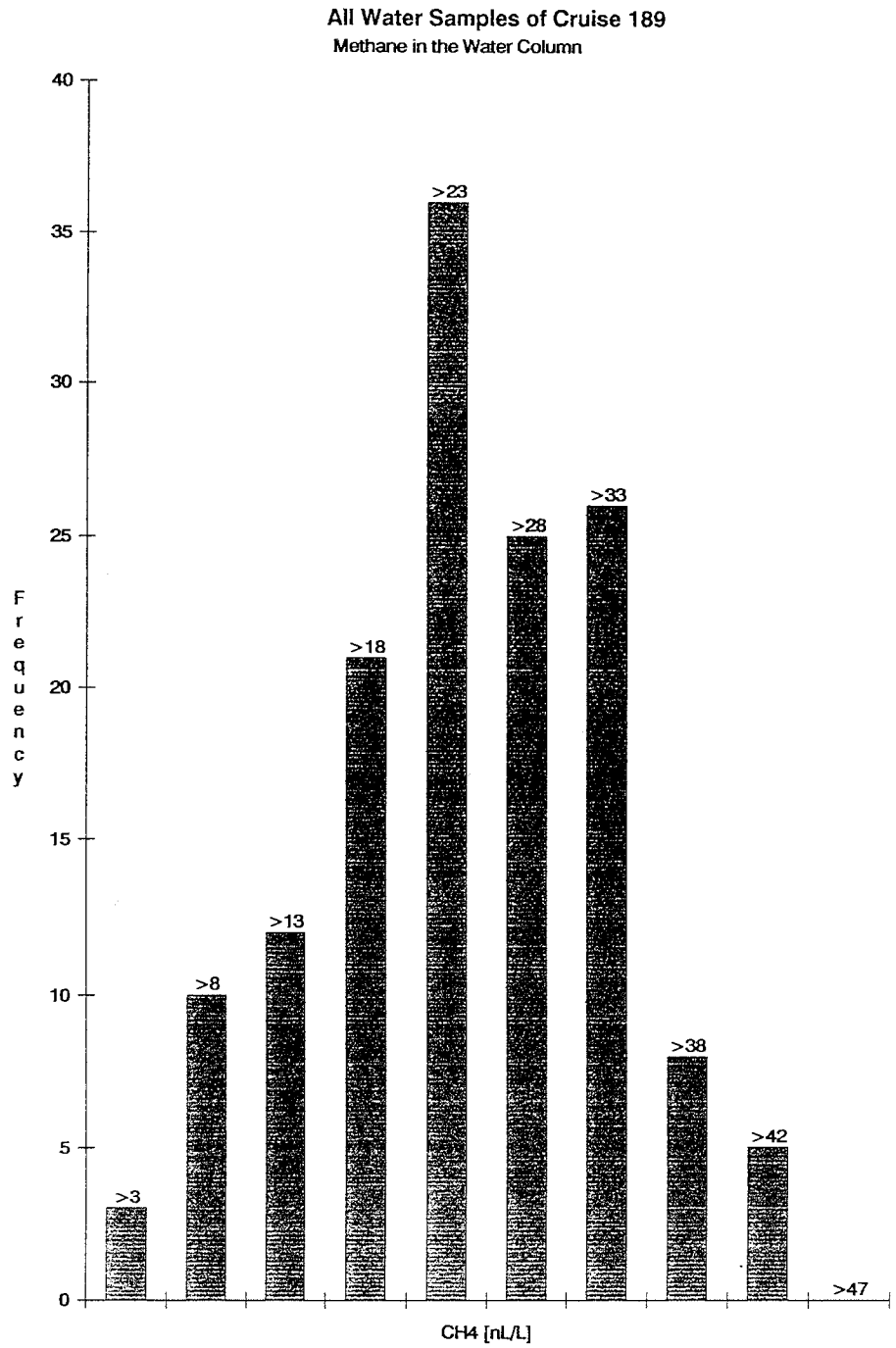


Figure 11.4-17

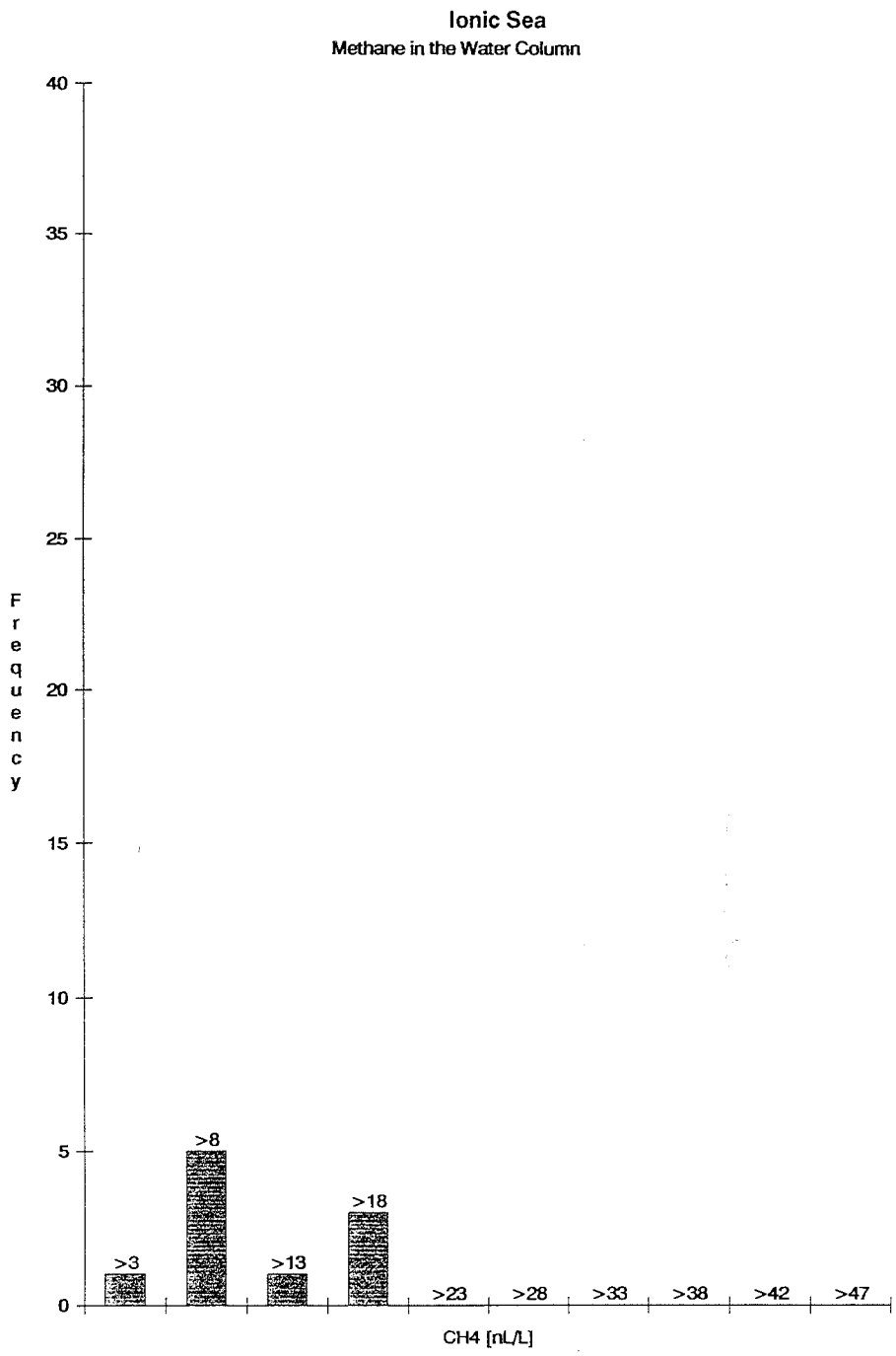


Figure 11.4-18

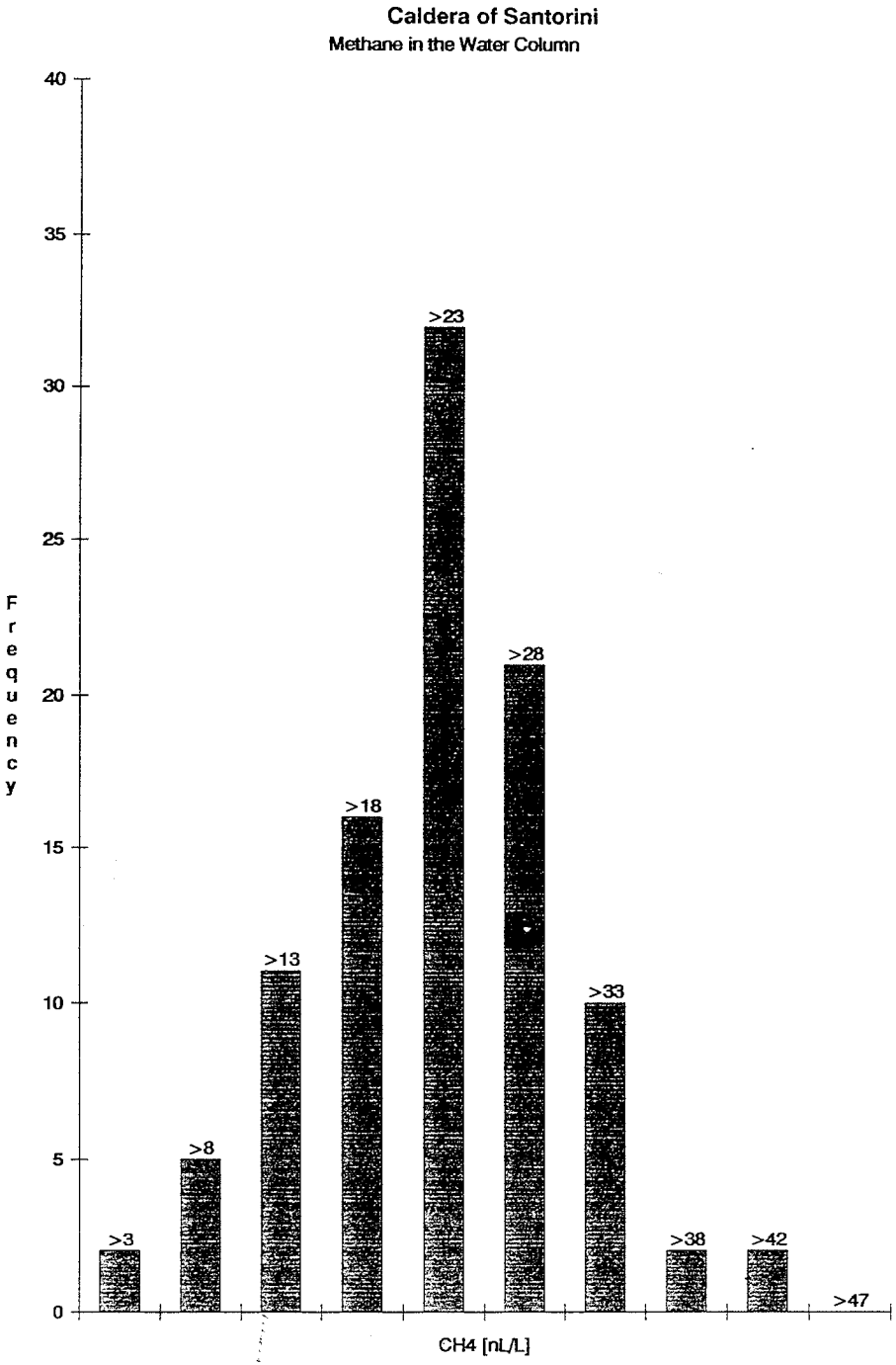


Figure 11.4-19

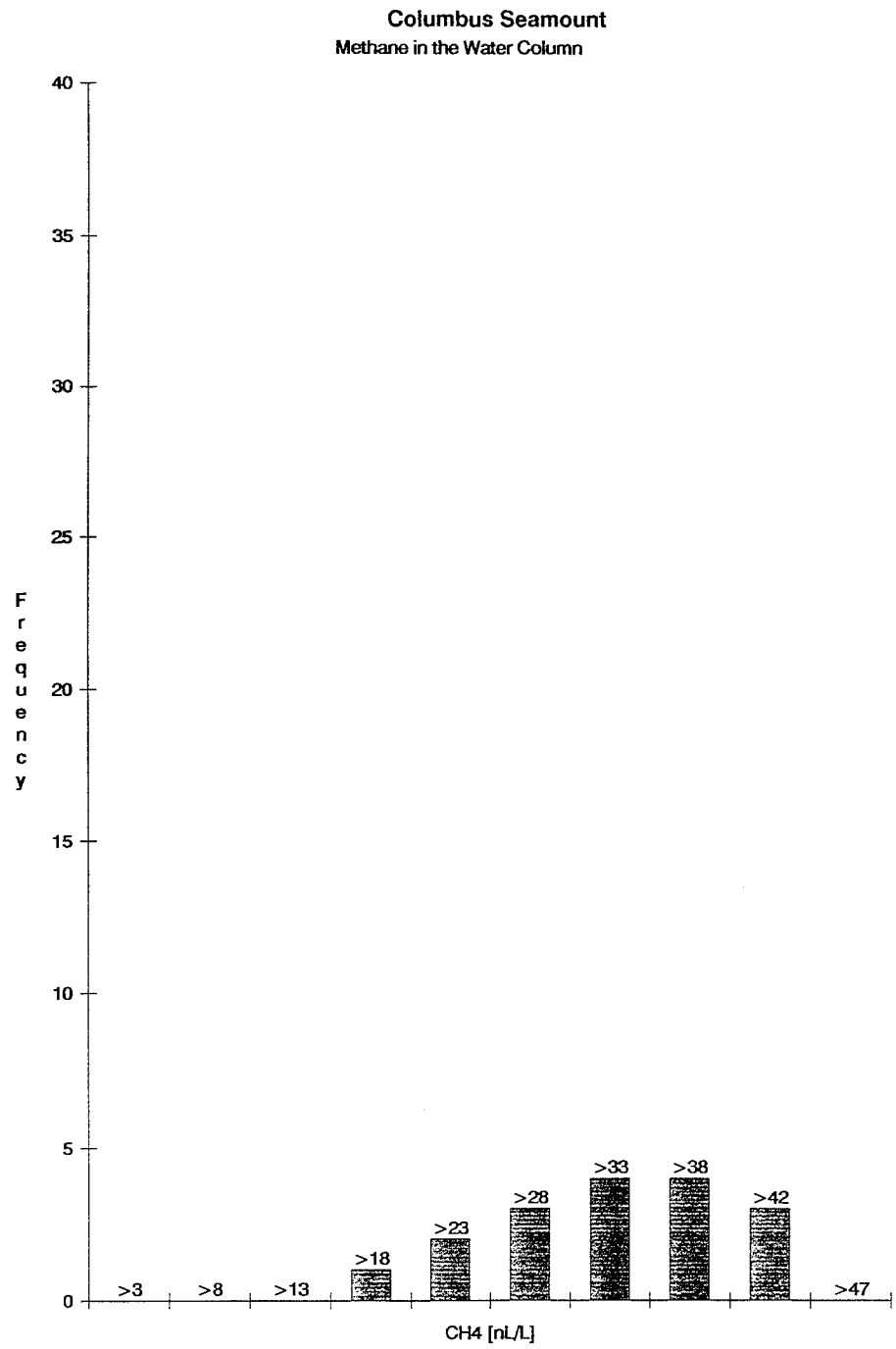


Figure 11.4-20

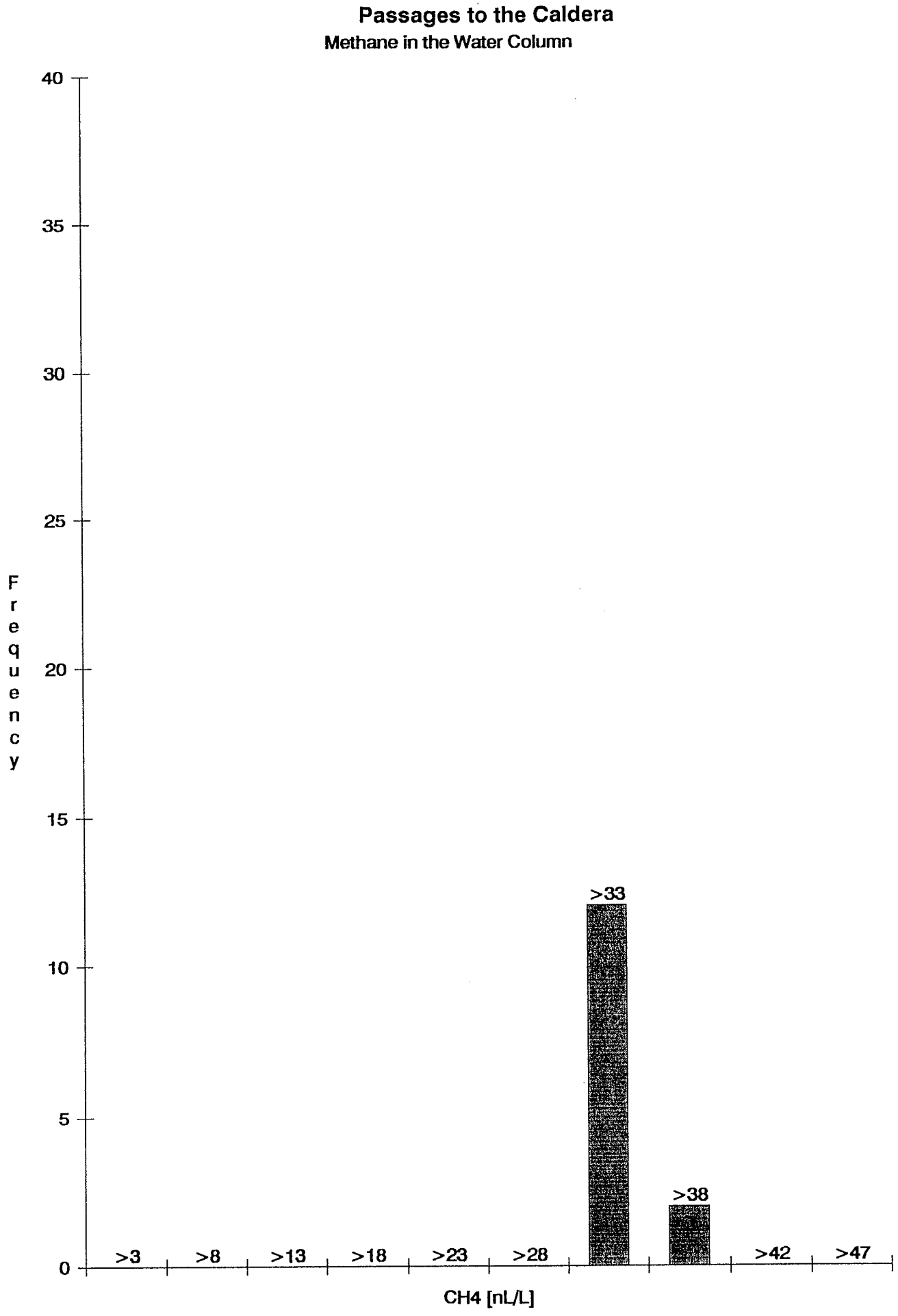
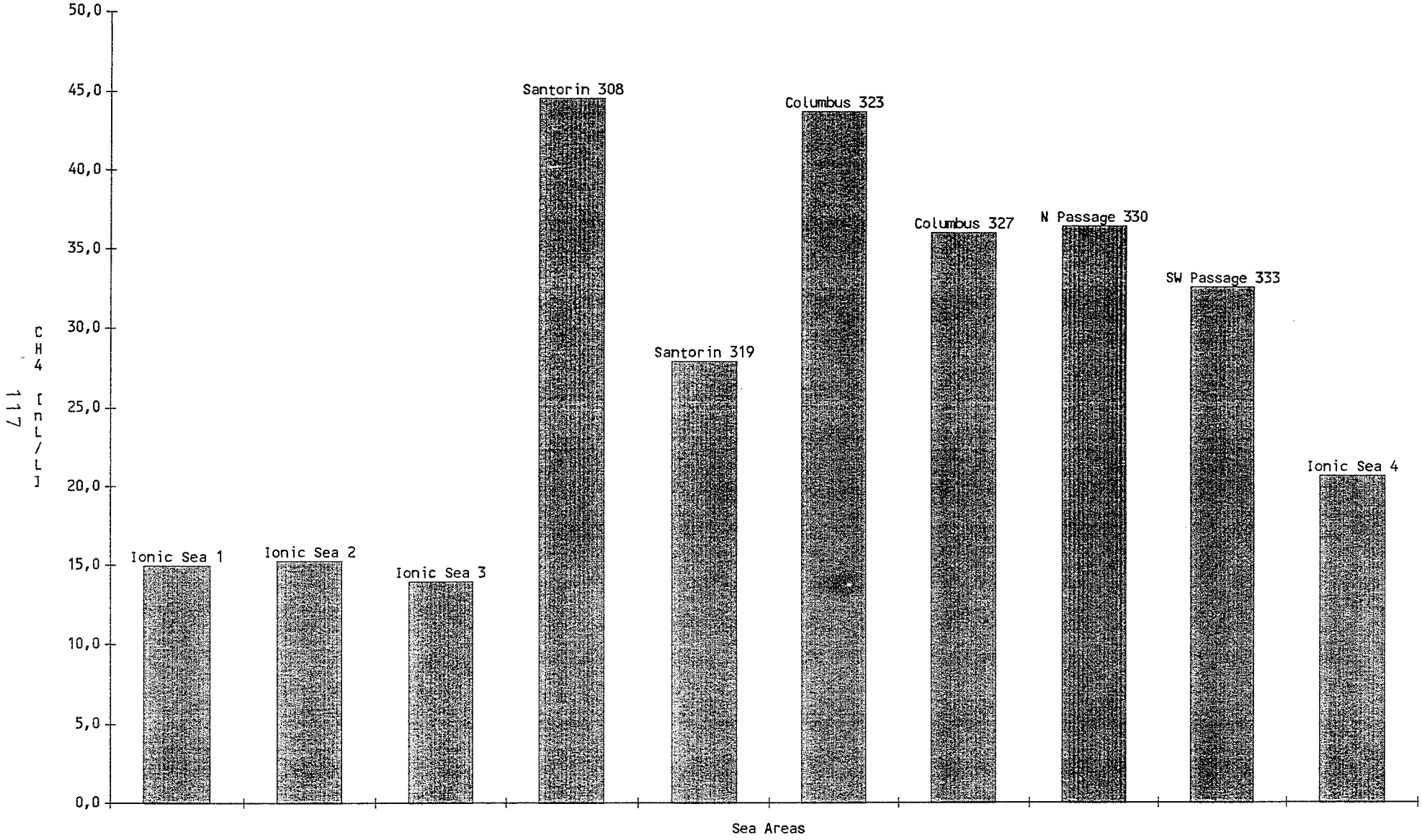


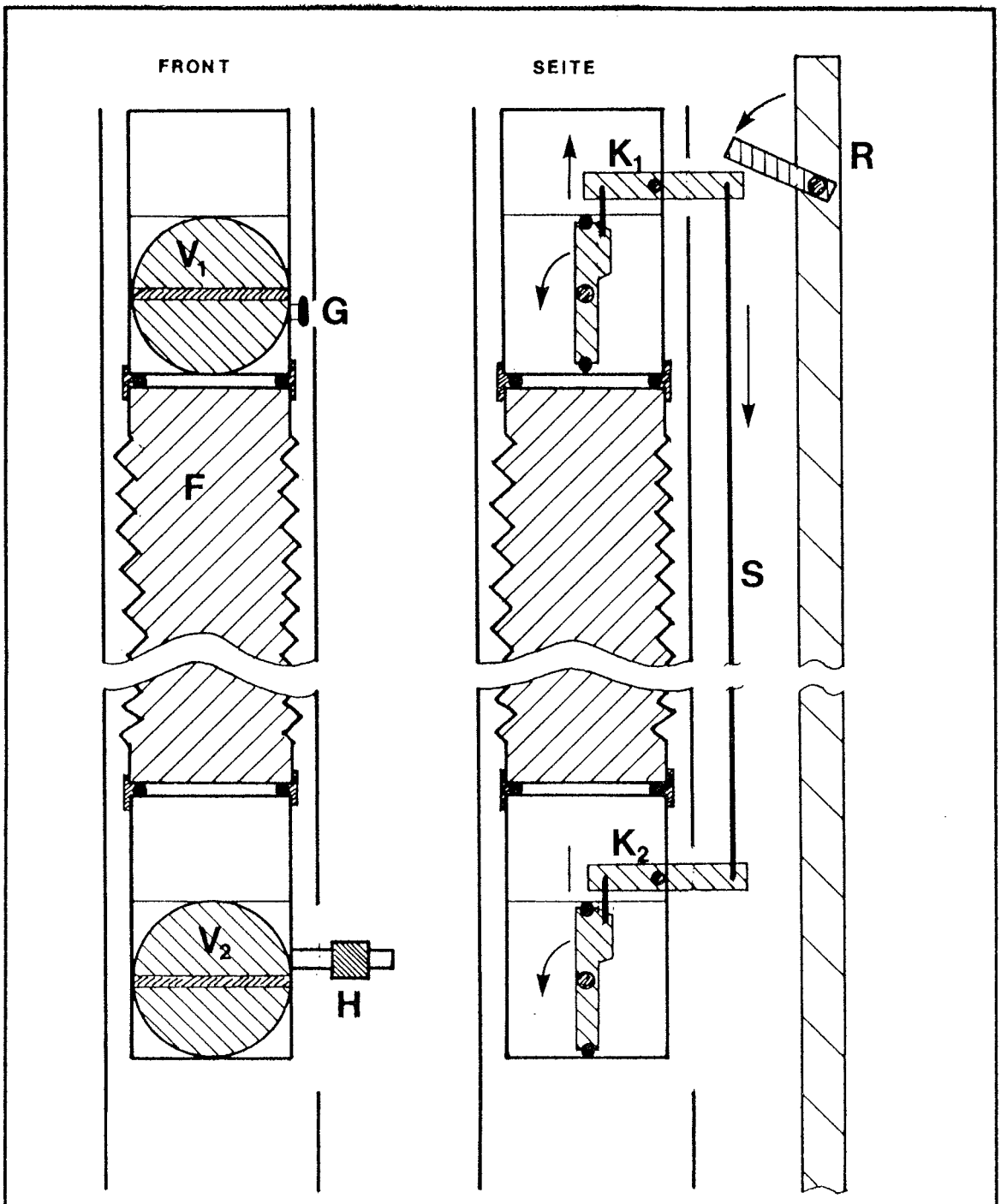
Figure 11.4-21

Figure 11.4-22 : Surface Water

Methane concentration

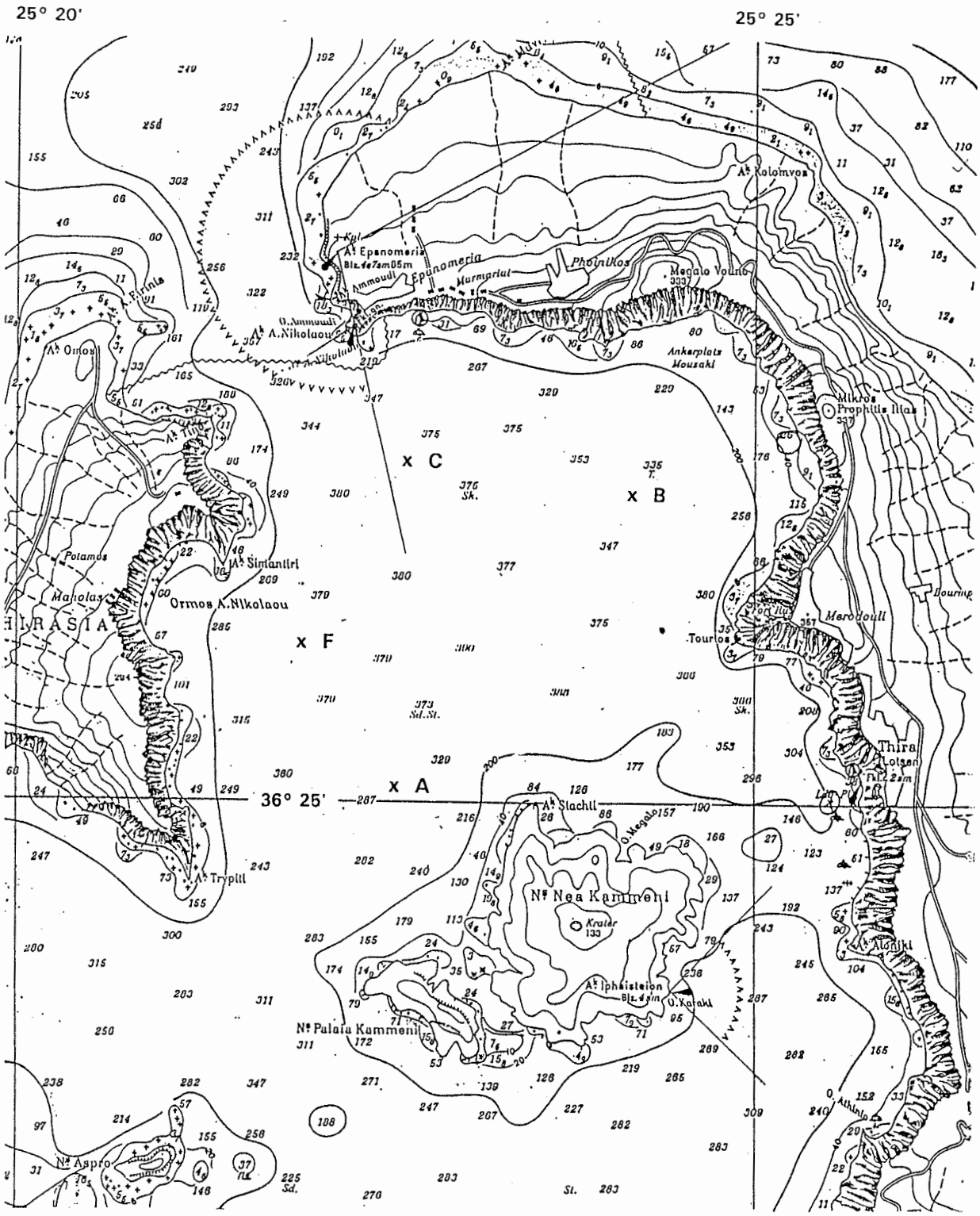


Appendix 11.4-C: Dissolved Methane

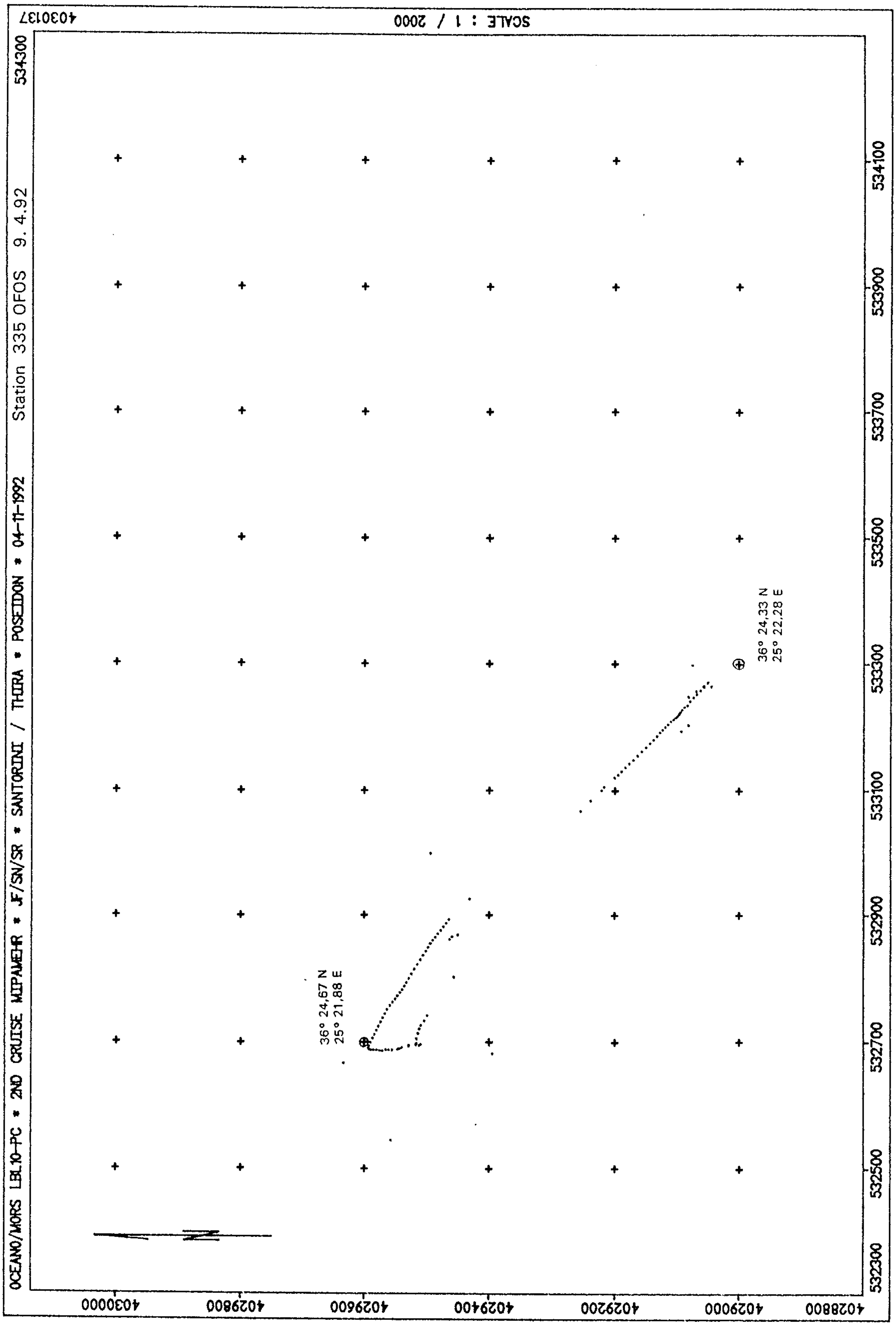


GEOCHEMISCHE ANALYSEN DIPL.-ING. M. SCHMITT Wilhelmstr. 36 · 3160 Lehrte/Hannover Tel. 05132/5[illegible]		Maßstab Skizze	
		FIG.: 1	
	Datum / Name Bearb 30.6.90 Schmitt Gepr Norm	FALTENBALG SCHÖPFER	
Zust / Änderung / Datum / Name			Blatt Bl

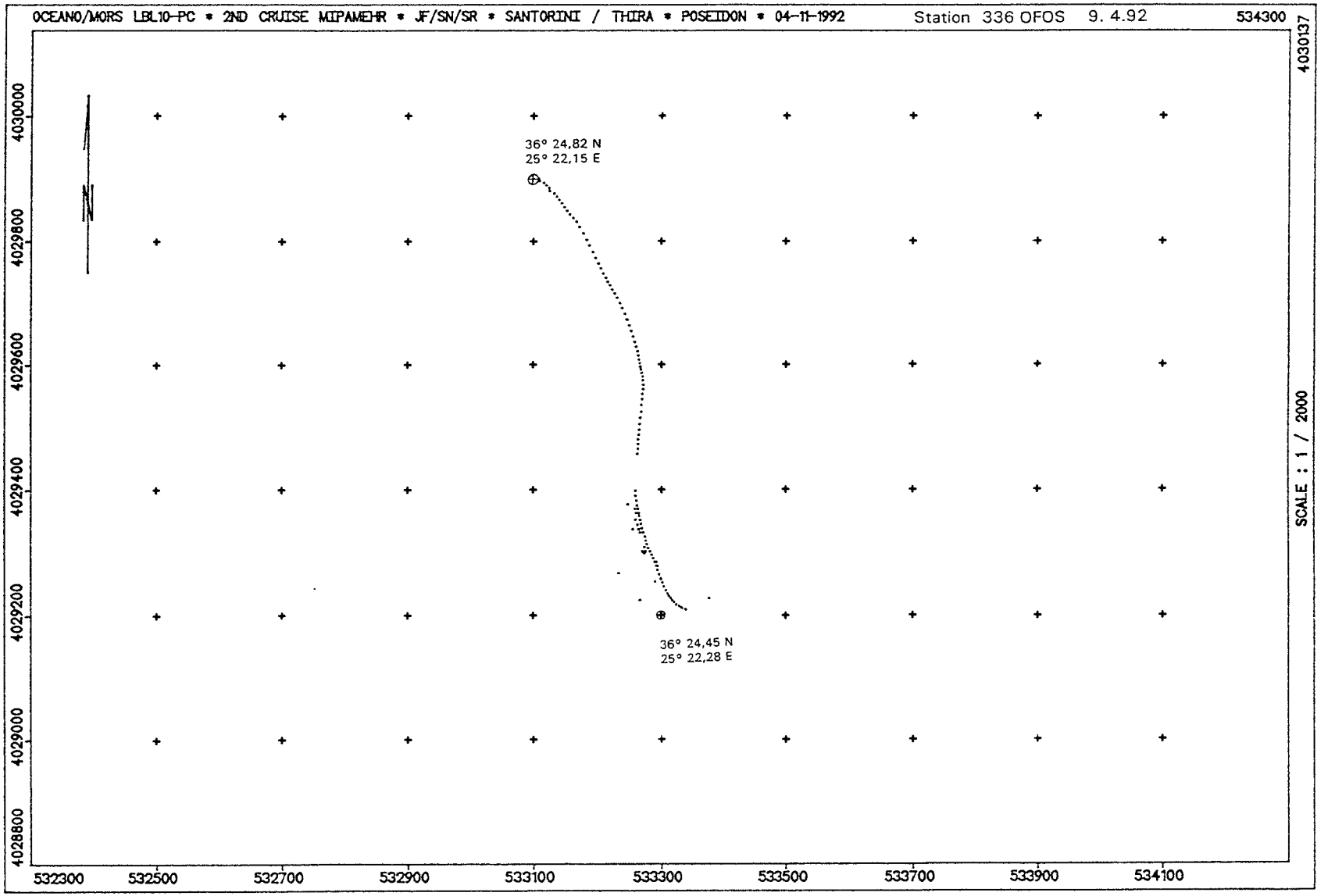
Bestell Nr. 643 311 80185 gl qm



Appendix 11.5: Scetch map of the bottom transponder positions



Appendix 11.6: Plots of OFOS tracks


OCEANO/MORS LBL10-PC * 2ND CRUISE MIPAMEHR * JF/SN/SR * SANTORINI / THIRA * POSEIDON * 04-11-1992
Station 336 OFOS 9. 4.92
534300
4030137
4030000
4029800
4029600
4029400
4029200
4029000
4028800
36° 24,82 N
25° 22,15 E
36° 24,45 N
25° 22,28 E
SCALE : 1 / 2000
532300
532500
532700
532900
533100
533300
533500
533700
533900
534100

Appendix 11.7: Plots of signals from the UNT chemical sensor unit

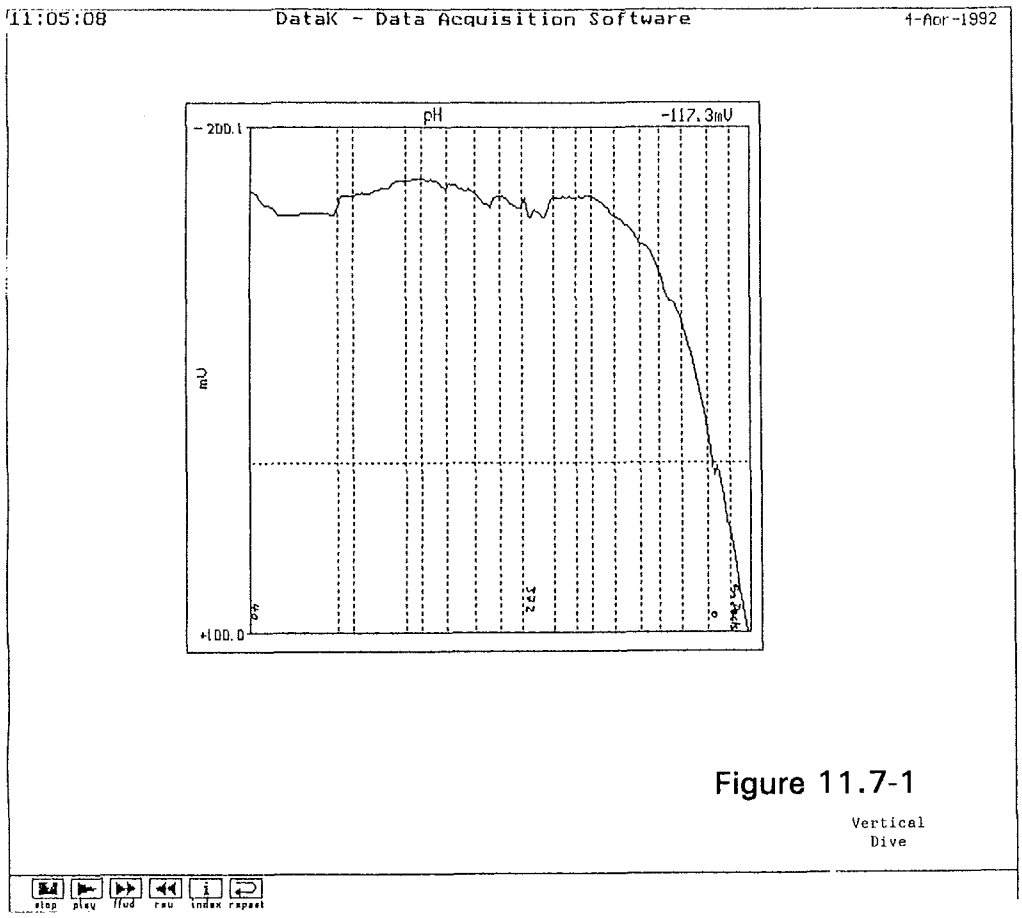


Figure 11.7-1

Vertical
Dive

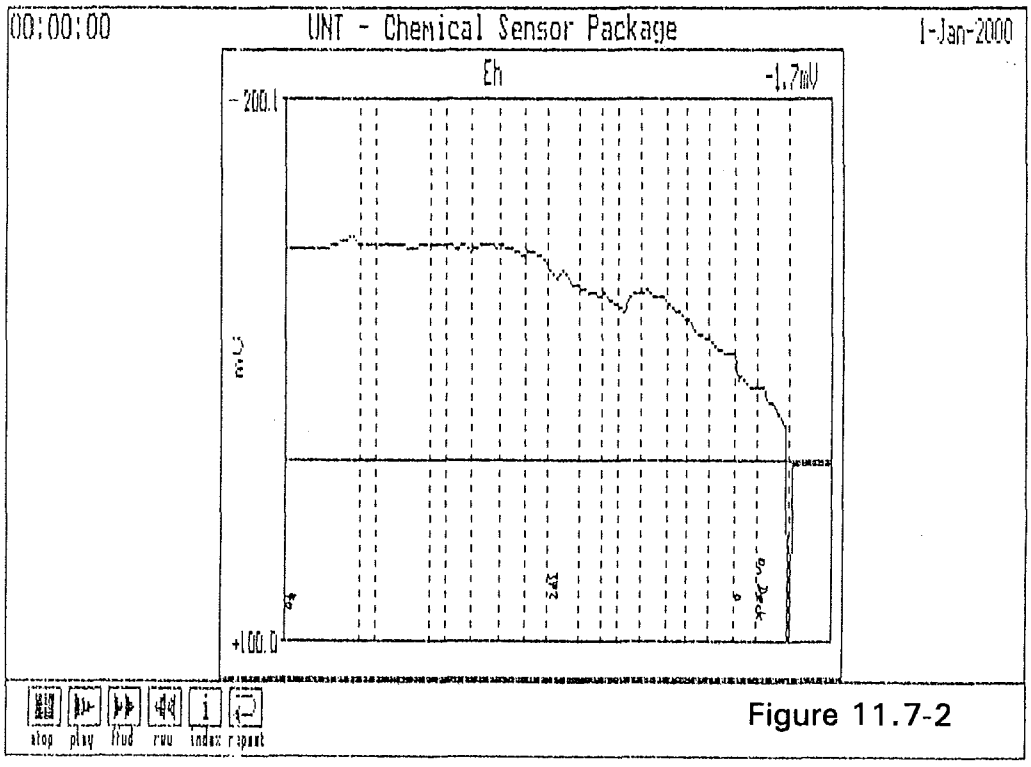


Figure 11.7-2

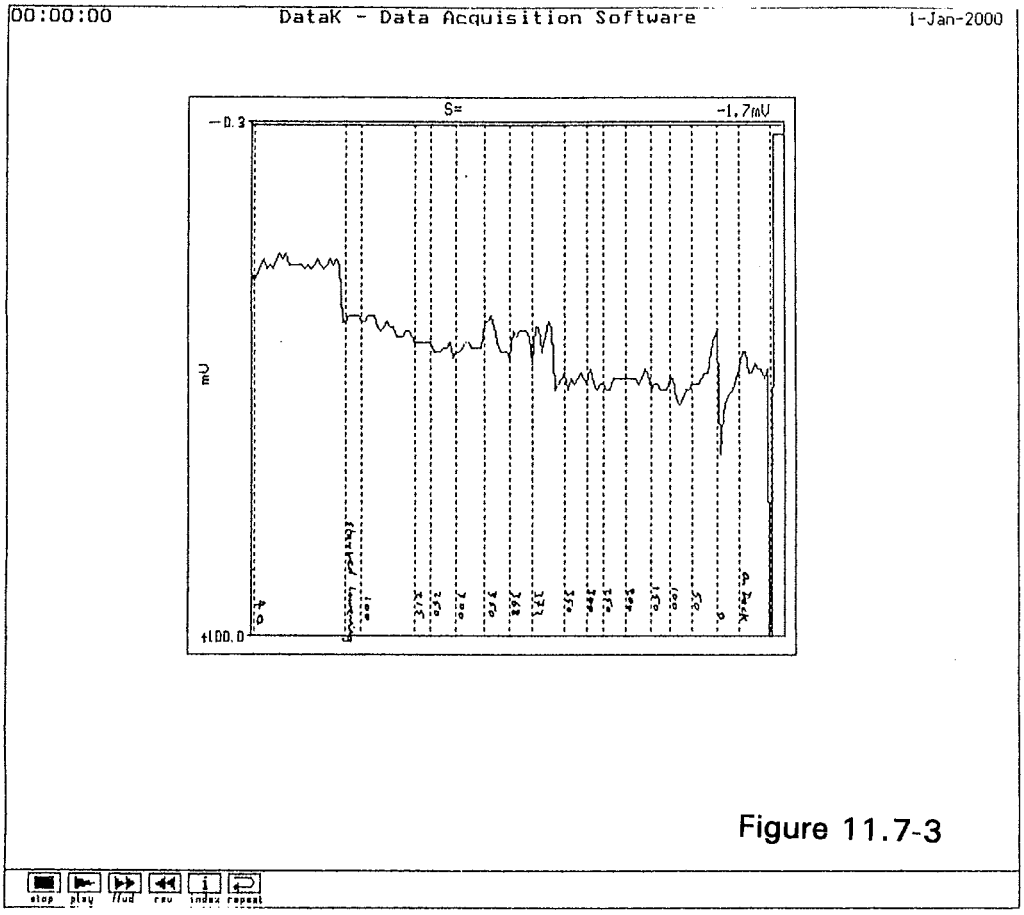


Figure 11.7-3

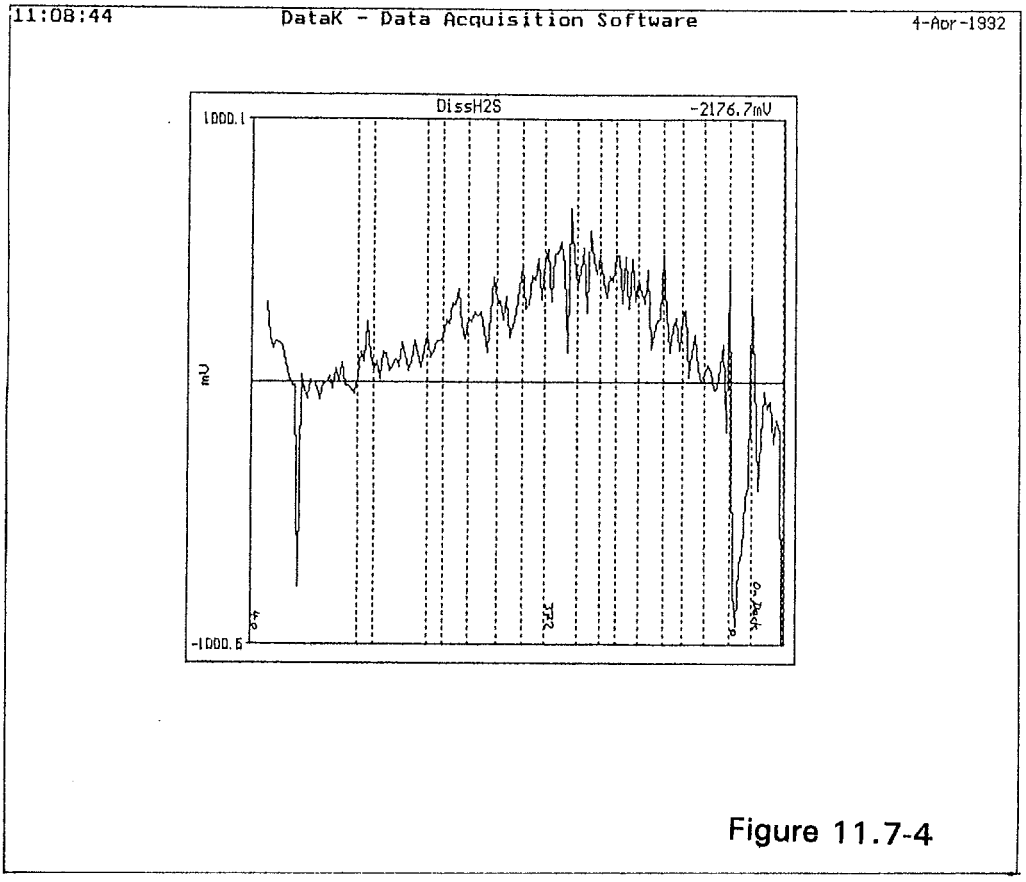


Figure 11.7-4

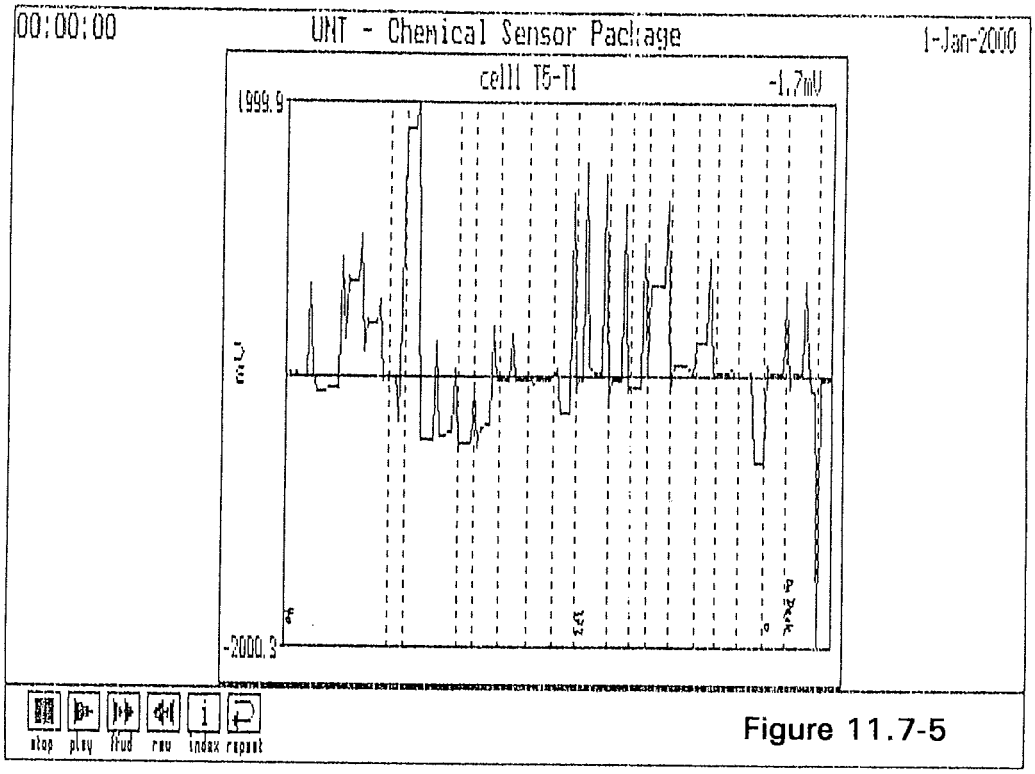


Figure 11.7-5

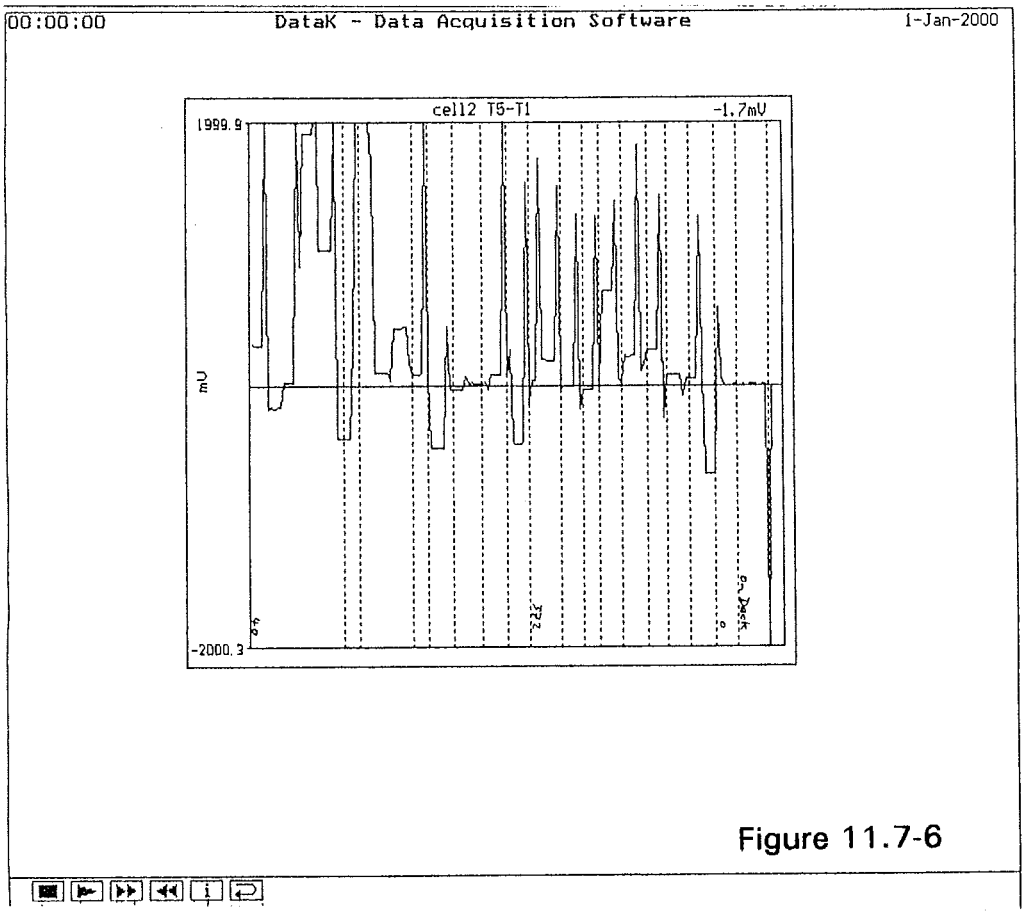


Figure 11.7-6

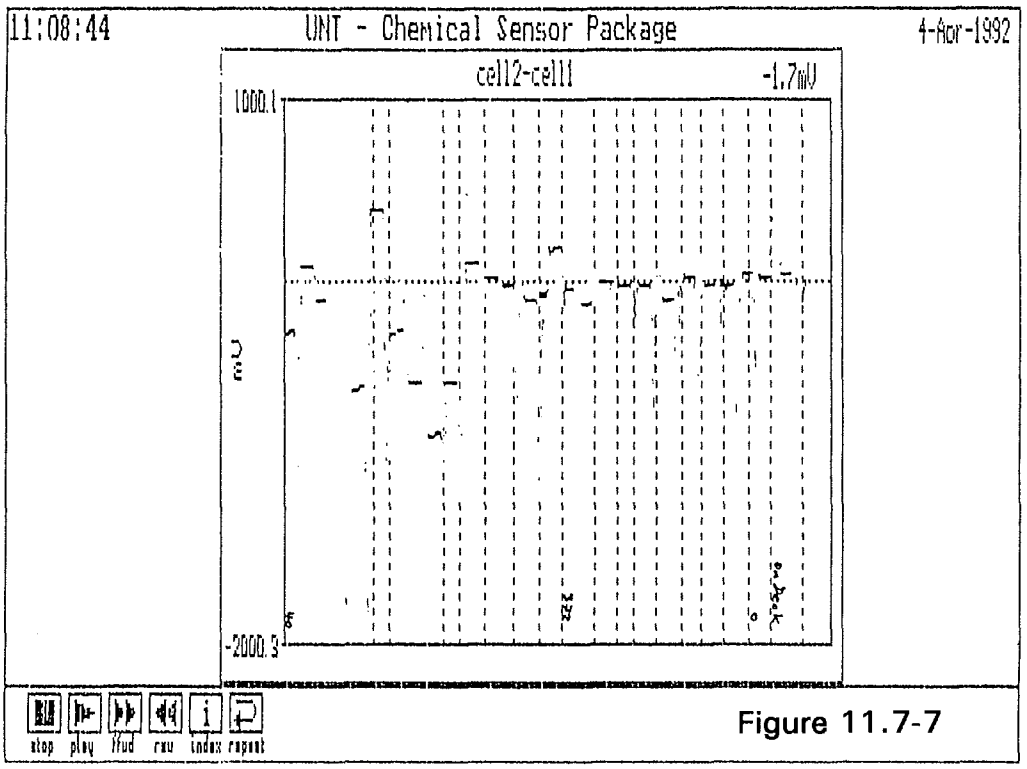


Figure 11.7-7

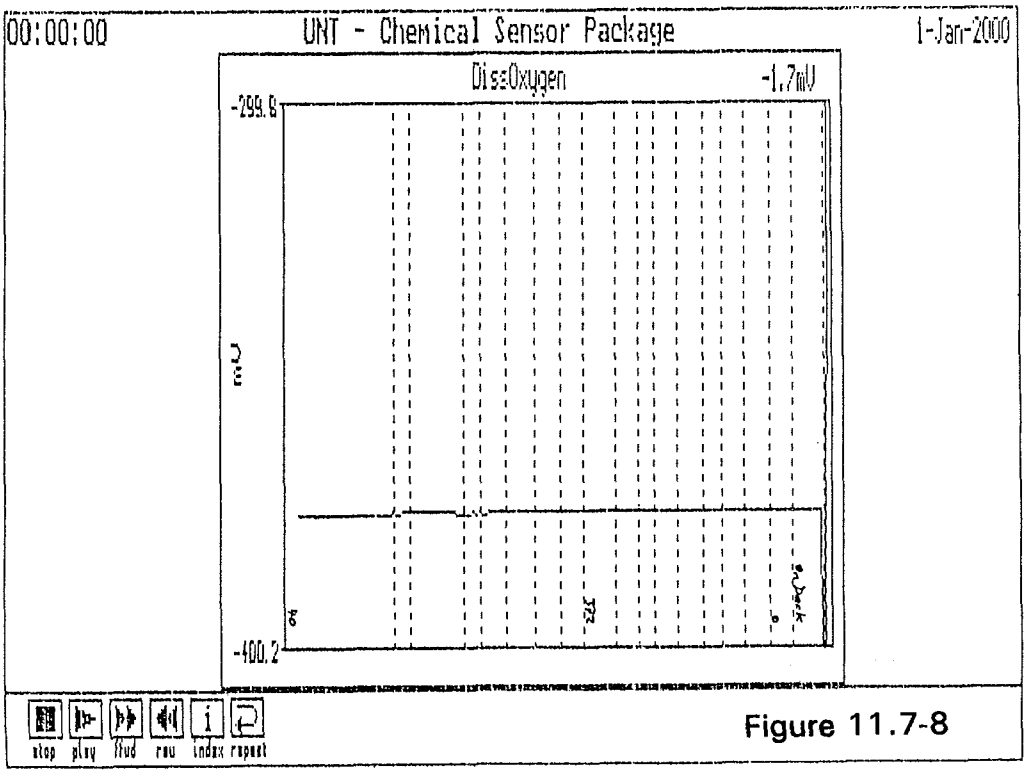


Figure 11.7-8

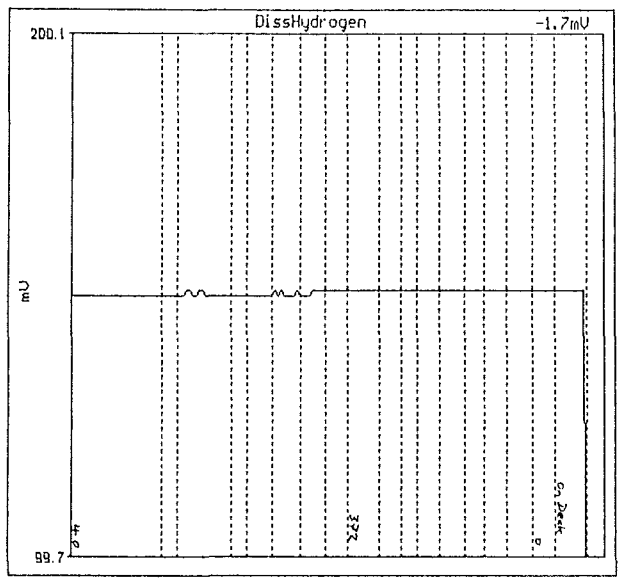


Figure 11.7-9

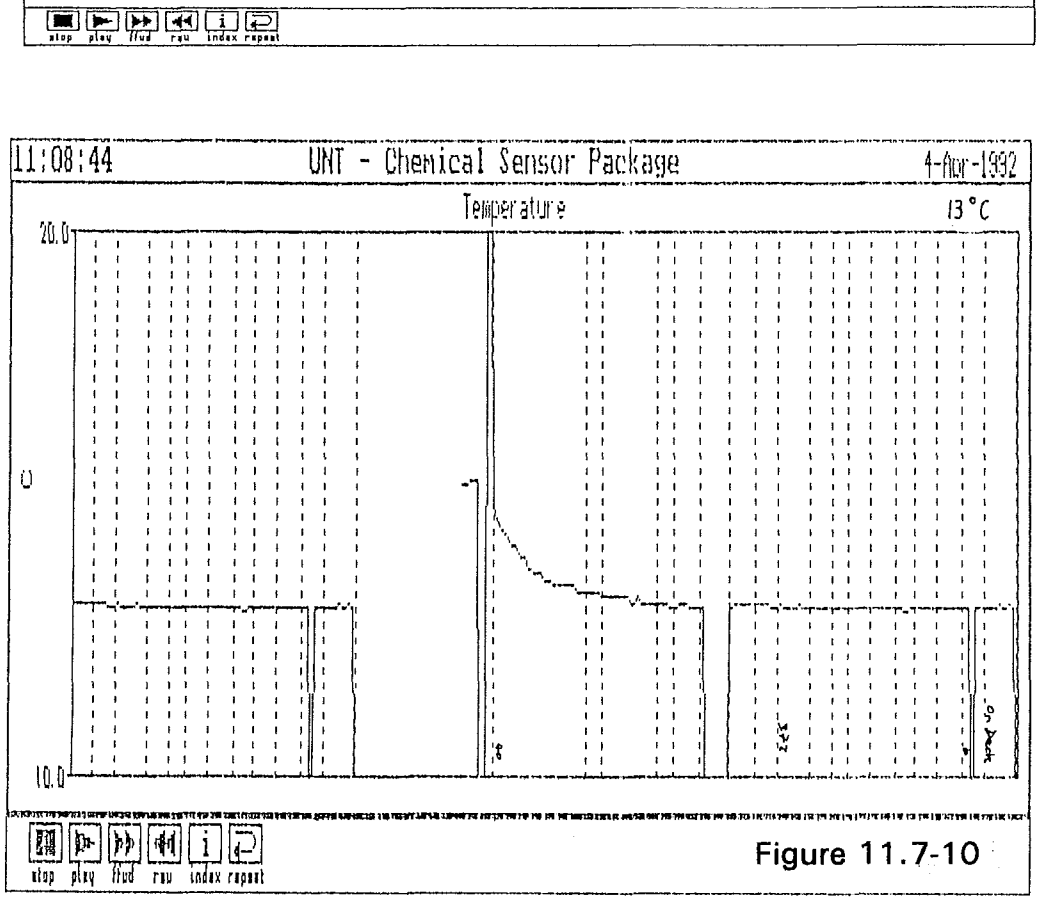


Figure 11.7-10

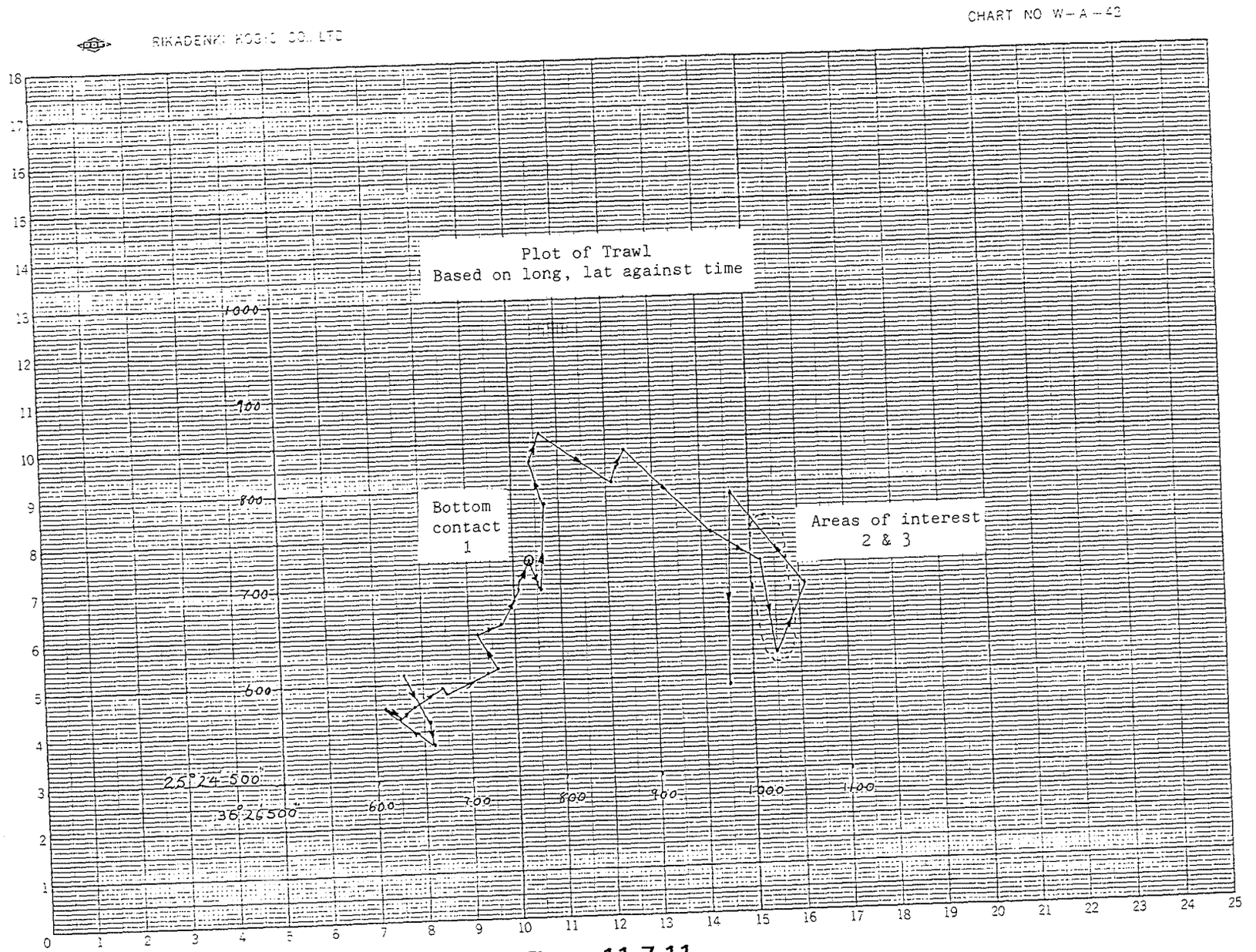


Figure 11.7-11

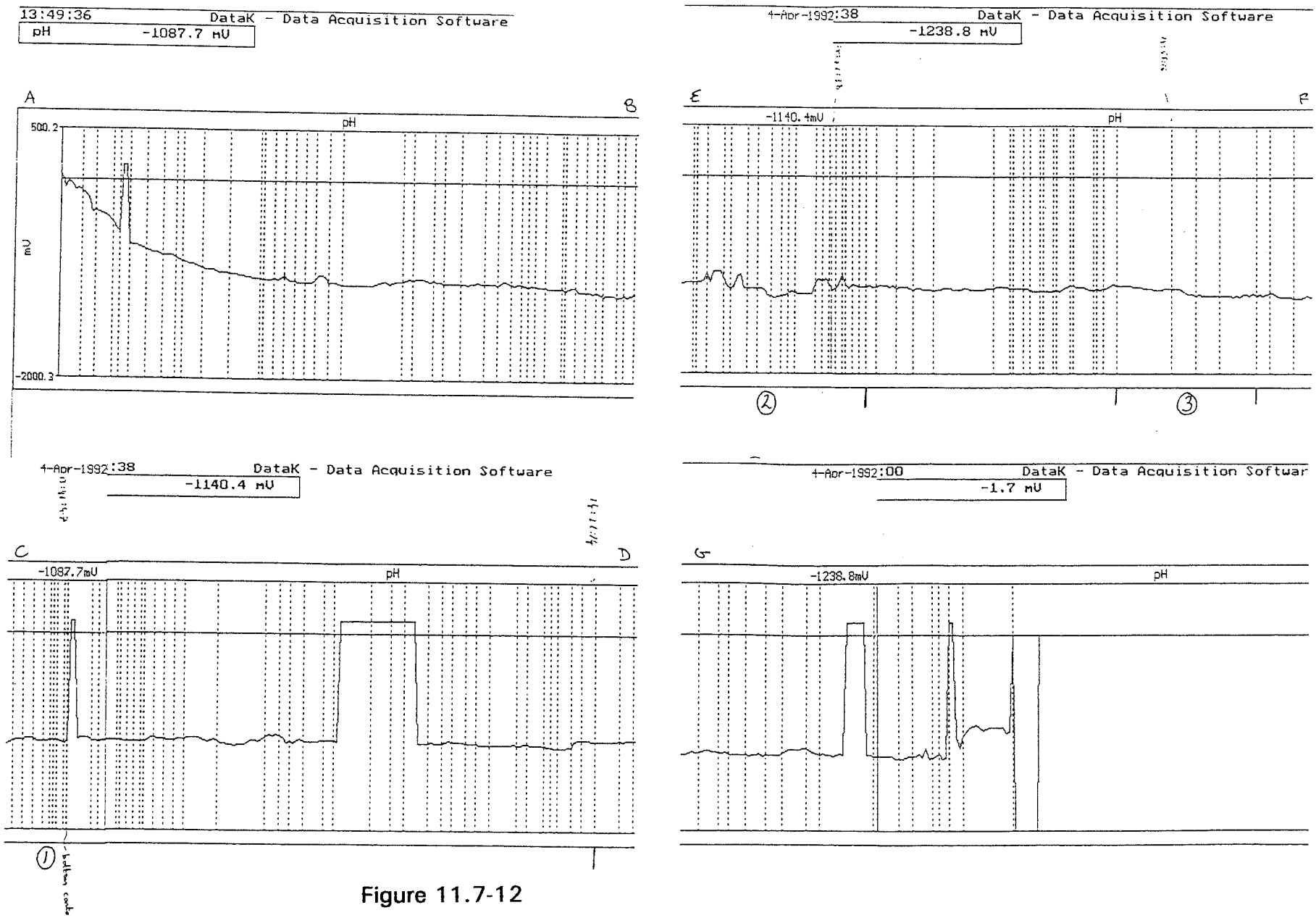


Figure 11.7-12

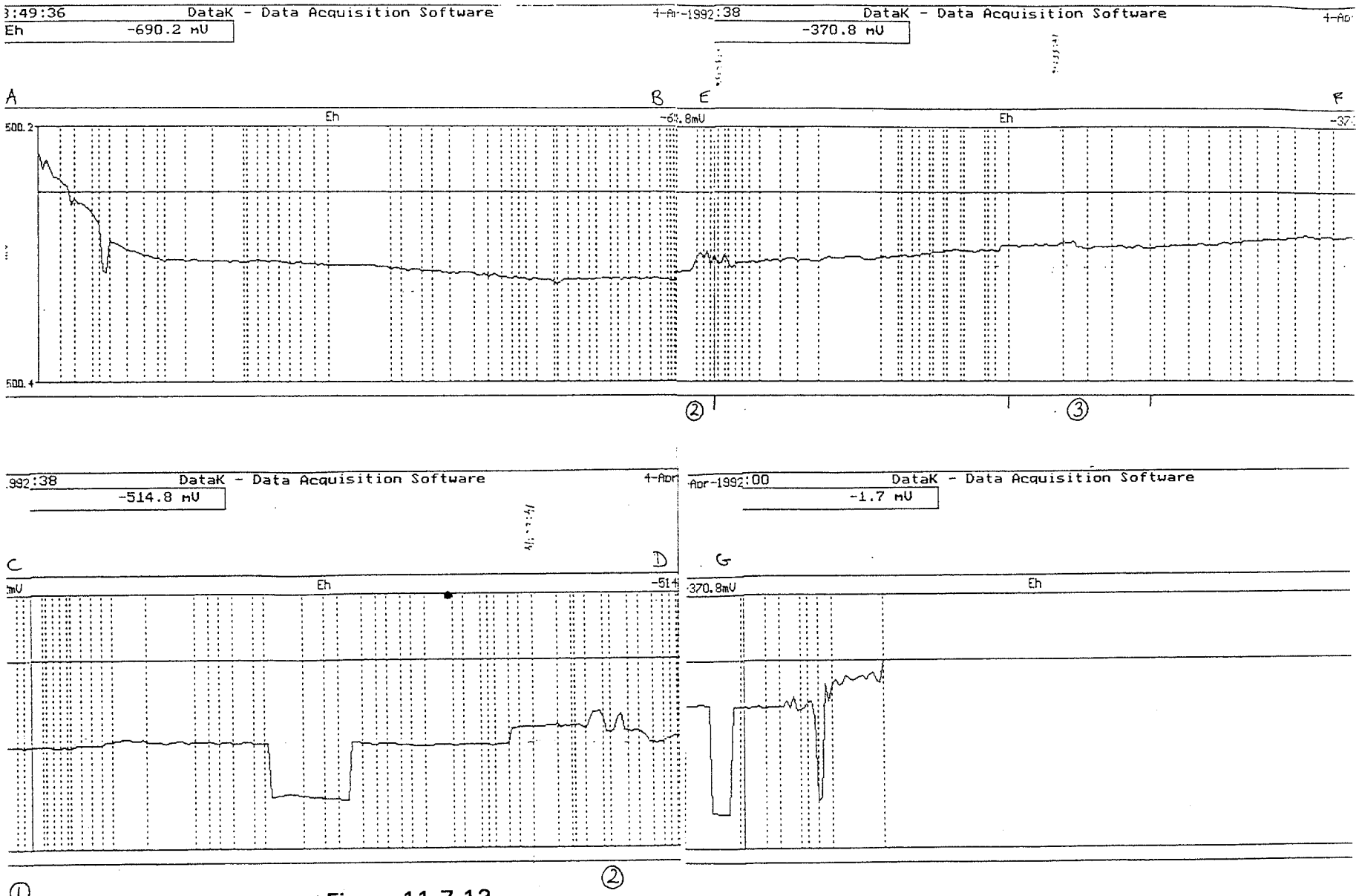


Figure 11.7-13

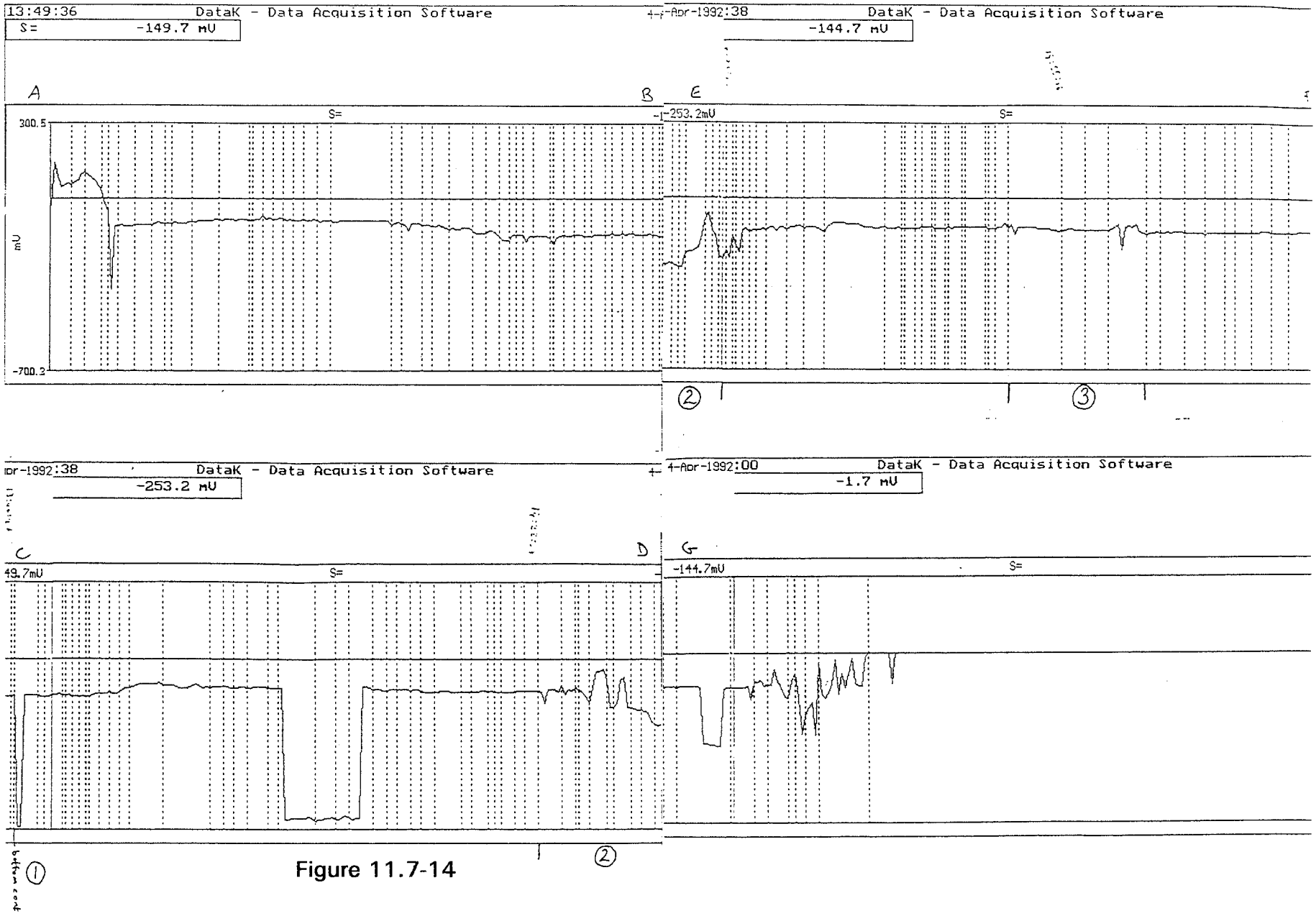


Figure 11.7-14

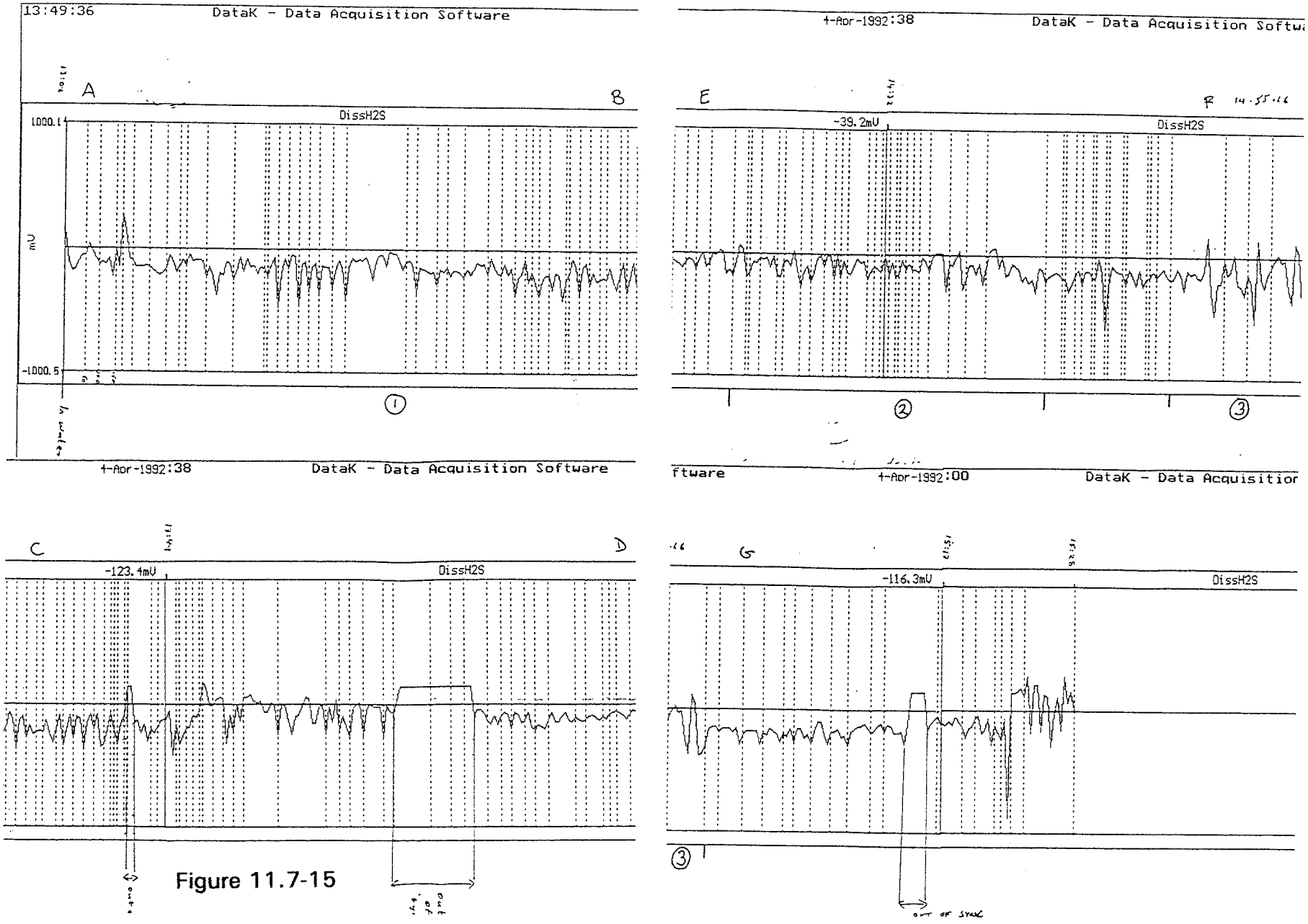


Figure 11.7-15

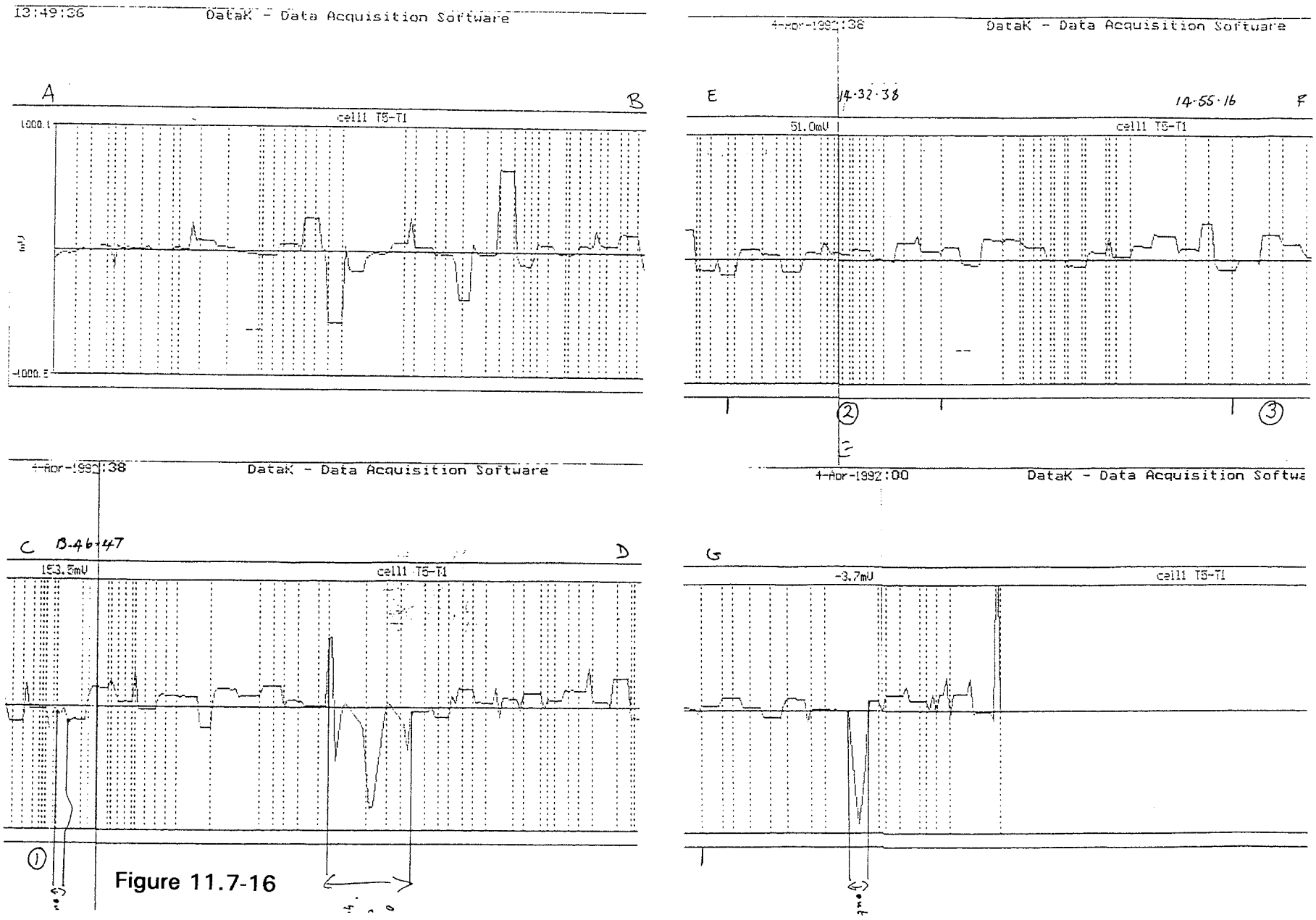


Figure 11.7-16

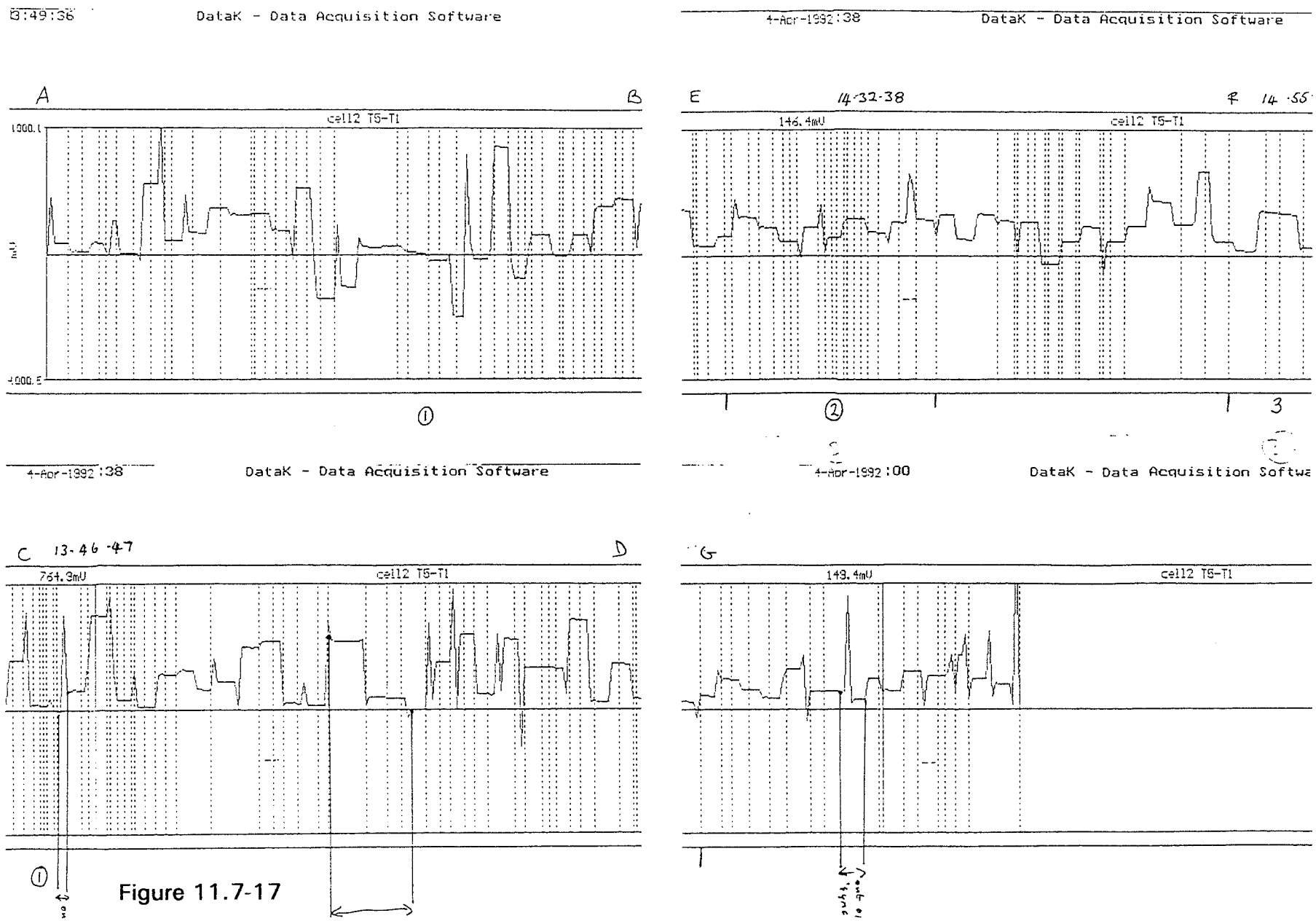


Figure 11.7-17

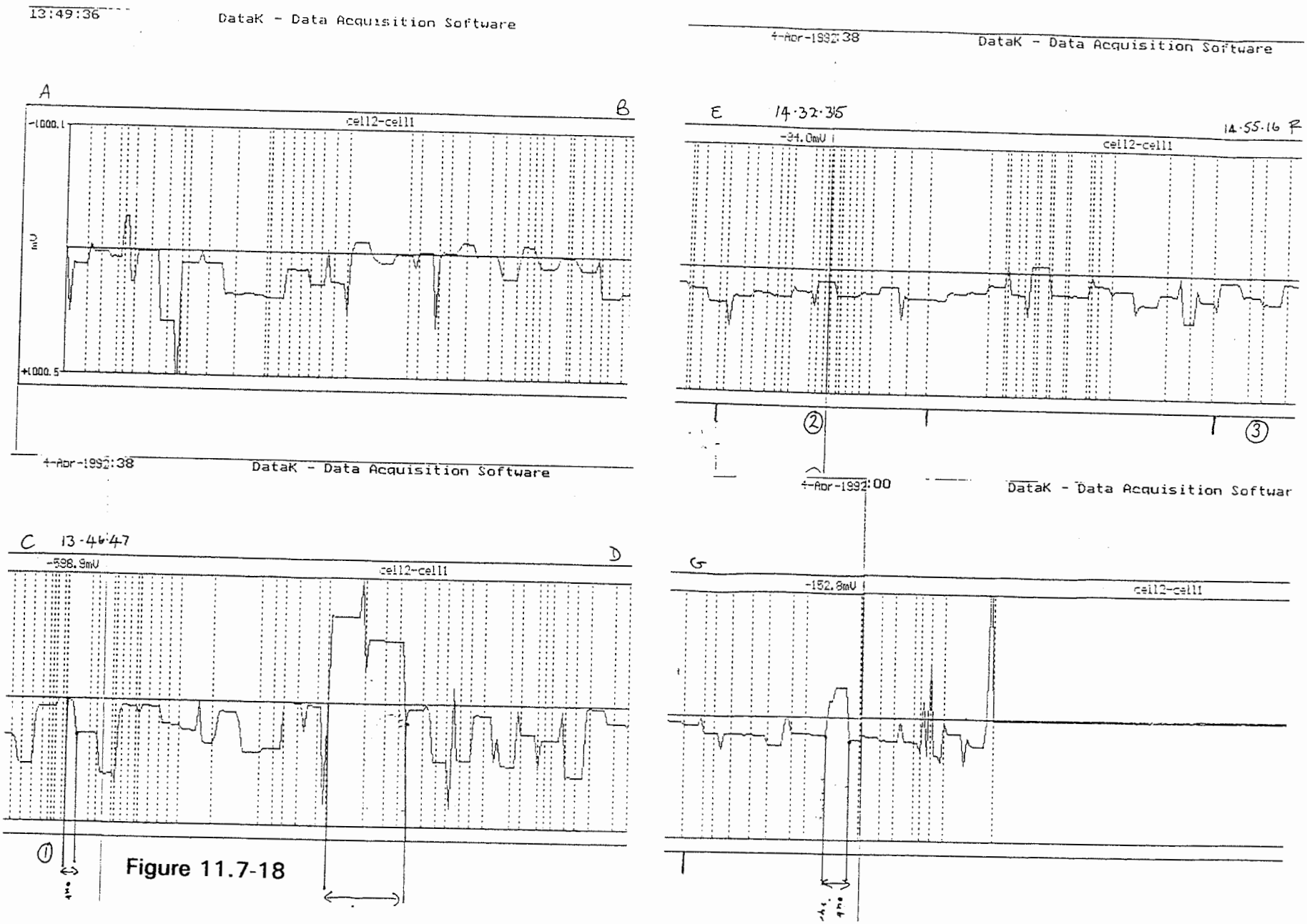


Figure 11.7-18

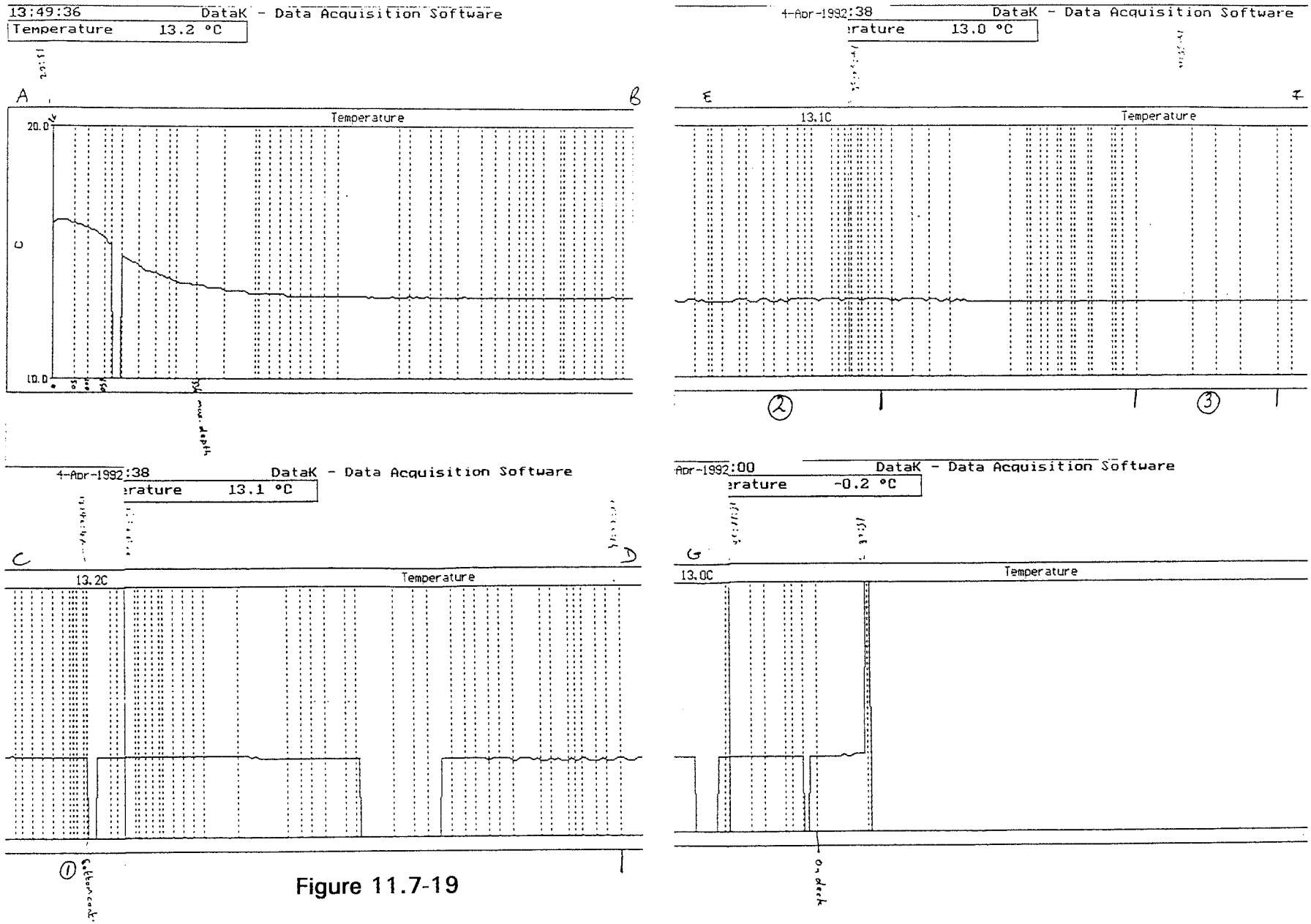


Figure 11.7-19