CSIRO
Marine Laboratories

REPORT 174

M/V 'Anro Australia' Sections: Thermal Profiles in the Eastern Indian Ocean, May 1983 to July 1984

M. A. Greig, K. R. Ridgway, D. J. Vaudrey and J. S. Godfrey

1986

COMMONWEALTH SCIENTIFIC AND INDUSTRIAL RESEARCH ORGANIZATION
MARINE RESEARCH LABORATORIES
GPO BOX 1538, HOBART, TAS. 7001, AUSTRALIA

National Library of Australia Cataloguing-in-Publication Entry

M/V 'Anro Australia' sections: thermal profiles in the eastern Indian Ocean, May 1983 to July 1984.

ISBN 0 643 03961 9.

1. Ocean temperature—Indian Ocean. I. Greig, M. A. (Murray Arthur), 1923– . II. Commonwealth Scientific and Industrial Research Organization, Australia. Marine Laboratories. III. Title. Thermal profiles in the eastern Indian Ocean. (Series: Report (Commonwealth Scientific and Industrial Research Organization, Australia. Marine Laboratories); no. 174).

551.46'01'09165

86.437-550

M/V "ANRO AUSTRALIA" SECTIONS: THERMAL PROFILES IN THE EASTERN INDIAN OCEAN, MAY 1983 TO JULY 1984

M.A. GREIG, K.R. RIDGWAY, D.J. VAUDREY and J.S. GODFREY

Division of Oceanography
CSIRO Marine Laboratories
GPO Box 1538, Hobart, Tasmania 7001,
Australia

CSIRO Marine Laboratories Report No. 174

ABSTRACT

The methods used to monitor the temperature profile between the central coast of Western Australia and Sunda Strait using expendable bathythermographs (XBTs) dropped by the officers of M/V "Anro Australia" are described in this report. In addition maps showing the position of each profile, the steric height, and the sea-surface temperature are presented together with a vertical temperature section for each voyage.

INTRODUCTION

The container vessel M/V "Anro Australia" of the Australian National Line completes a round voyage from Sydney to Singapore via Australian ports, which include Burnie in Tasmania, every six weeks. The route taken by this ship from near Shark Bay on the coast of Western Australia to Sunda Strait in Indonesia (Figs 1a-9a), provided an opportunity to monitor the circulation in a little studied area of the eastern Indian Ocean.

The Master and officers of M/V "Anro Australia" agreed to drop expendable bathythermographs (XBTs) every six hours along their route. The XBTs were provided by the Royal Australian Navy Hydrographic Office; CSIRO provided the equipment, and is responsible for data processing. This report summarises the results obtained from nine voyages during the first year of operation.

METHOD

The XBTs are launched from the bridge, which is situated well forward, with a Sippican LM-3A hand-held launcher. Because of the great length of the ship, some of the initial launchers were unsuccessful when the XBT wires fouled the side, but such failures are now rare, as the ship's officers have developed techniques to ensure clean launches (Fig. 10).

From the first voyage in May-June of 1983 to the fifth voyage in November 1983, a Sippican MK-2A Recorder provided a plot of each probe launched, this analogue trace being subsequently digitized at the CSIRO Marine Laboratories.

A Sippican MK-9 digital XBT/XSV system was installed in December 1983. This system records temperature at intervals of 0.6-0.7 metres on magnetic cassette tape in an HP-85 desk-top computer on board, as well as plotting temperature against depth on the computer printer. The plots and cassettes are collected and the XBT supplies replenished whenever the ship calls at the Tasmanian port of Burnie, its closest port of call to Hobart, headquarters of the CSIRO Division of Oceanography. Officers of the Division also inspect the equipment and correct faults during these calls.

DATA PROCESSING

(a) Sippican MK-2 System

The analogue traces were carefully inspected, using as a standard the "Guide to Common Shipboard Expendable Bathythermograph (SXBT) Recording Malfunctions" (Kroner & Blumenthal, 1978). Traces with obvious faults (fouling, insulation penetration, poor grounding or wire stretch) were rejected from the point where these faults occurred. The remainder of the trace and the traces without fault were digitized, using a Summagraphics Data Tablet Digitizer* which, after the initial tablet coordinates were transformed in the CSIRO Cyber76 computer, gave us a file of temperatures at 5-metre intervals. The station details were entered with the digitizer keyboard. This file was stored in Hobart on disc in a VAX 11/750 for later processing to produce plots of station position, surface temperature, steric height, and the temperature profile.

The chart drive motor of the Sippican MK-2 recorder sometimes ran slowly or erratically, producing incorrect depth-temperature relationships and traces that did not finish at the usual 500 metres. The resulting digitized temperatures were thus too cold, an error that was not immediately obvious because of the very strong El Nino-Southern Oscillation event which was affecting the seas north of Australia at the time. When the results of several voyages were available the error became apparent and all traces where the finish depth was less than 500 metres were rejected, except for those in shallow water or those where the short trace could be attributed to a fault such as a wire break or insulation breakdown.

(b) Sippican MK-9 System

The MK-9 system replaced the MK-2 system after the fifth voyage. The recorder processor in the MK-9 stores, processes, and prints a plot of water temperatures measured by the probe during its fall. When the station is complete, the data are transferred to magnetic tape, which is collected each time the ship visits Tasmania during the round voyage. The cassettes and plots of each probe are processed further in the Hobart laboratories.

The data stored on magnetic tape - the station details and temperature at approximately 0.6 metre intervals - are transferred to disc in a VAX 11/750 computer, which reformats the data as temperatures at 5-metre intervals for analogue processing. It also computes and plots the steric height, and plots the station position, surface temperature and temperature against depth (Figs 1-9).

* Made by Summagraphics Corporation, Connecticut, U.S.A.

RESULTS

The series of plots below summarize the data received during the first year of operation from M/V "Anro Australia". For the first voyage, Fig. 1a gives the station number for each probe, Fig. 1b the steric height at each station relative to 400 db, Fig. 1c the surface temperature and Fig. 1d a vertical section of temperature against depth on the voyage northward. Similar plots are given in Figs 2-9 for subsequent voyages. It should be noted that severe editing of the MK-2 data has resulted in large gaps in the data in some of the early voyages.

The steric heights given in Figs 1b-9b were computed from tables in Ridgway and Loch (1986), who give mean salinities at 2.5°C intervals from 5°C to 27.5°C for rectangles of 2.5° (latitude) by 5° (longitude) in the eastern Indian Ocean. From their tables we have obtained mean salinities at these temperatures at intervals of 2.5° latitude along the ship's track from Shark Bay to Sunda Strait. Ridgway and Loch (1986) also showed that the RMS error in steric height introduced by use of the temperature-salinity relationship is less than or equal to 0.04 m anywhere along the ship's track.

These results from the voyages will be used in scientific papers on the Western Australian circulation regime.

ACKNOWLEDGEMENTS

We are very grateful to the Master and officers of M/V "Anro Australia", who not only cheerfully accepted the additional task of dropping the XBTs, but also displayed great interest in the program.

REFERENCES

Kroner, S.M. and B.P. Blumenthal (1978). Guide to Common Shipboard Expendable Bathythermograph (SXBT) Recording Malfunctions, Report NOO RP-21, Naval Oceanographic Office, NSTL Station, Bay Street, St Louis, MS 39522.

Ridgway, K.R. and R.G. Loch (1986). Mean TS Relationships and their application to computing steric height from temperature profiles around Australia. *Australian Journal of Marine and Freshwater Research* (in press).

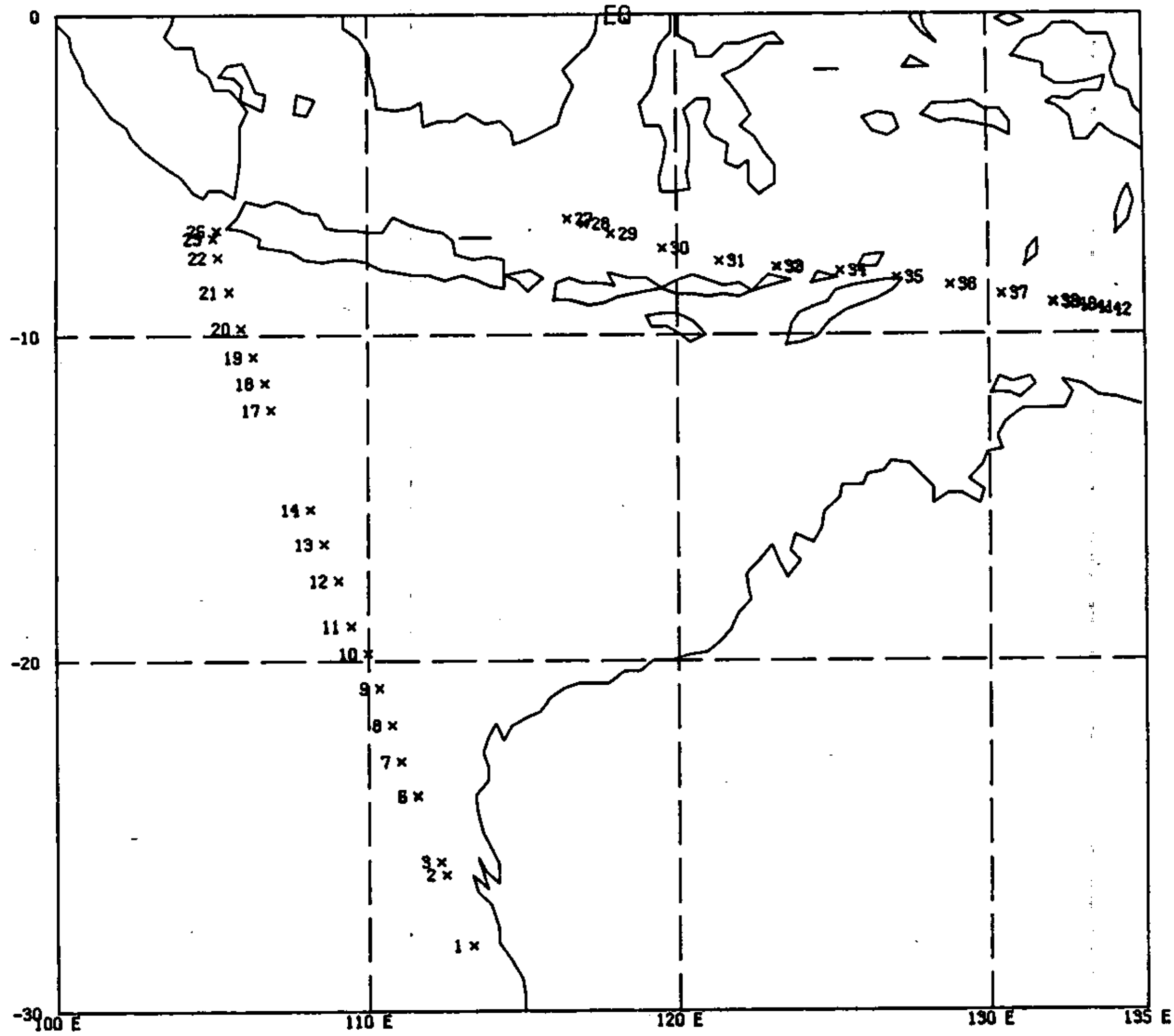

Fig. 1a: Station Positions 31 May-20 June 1983

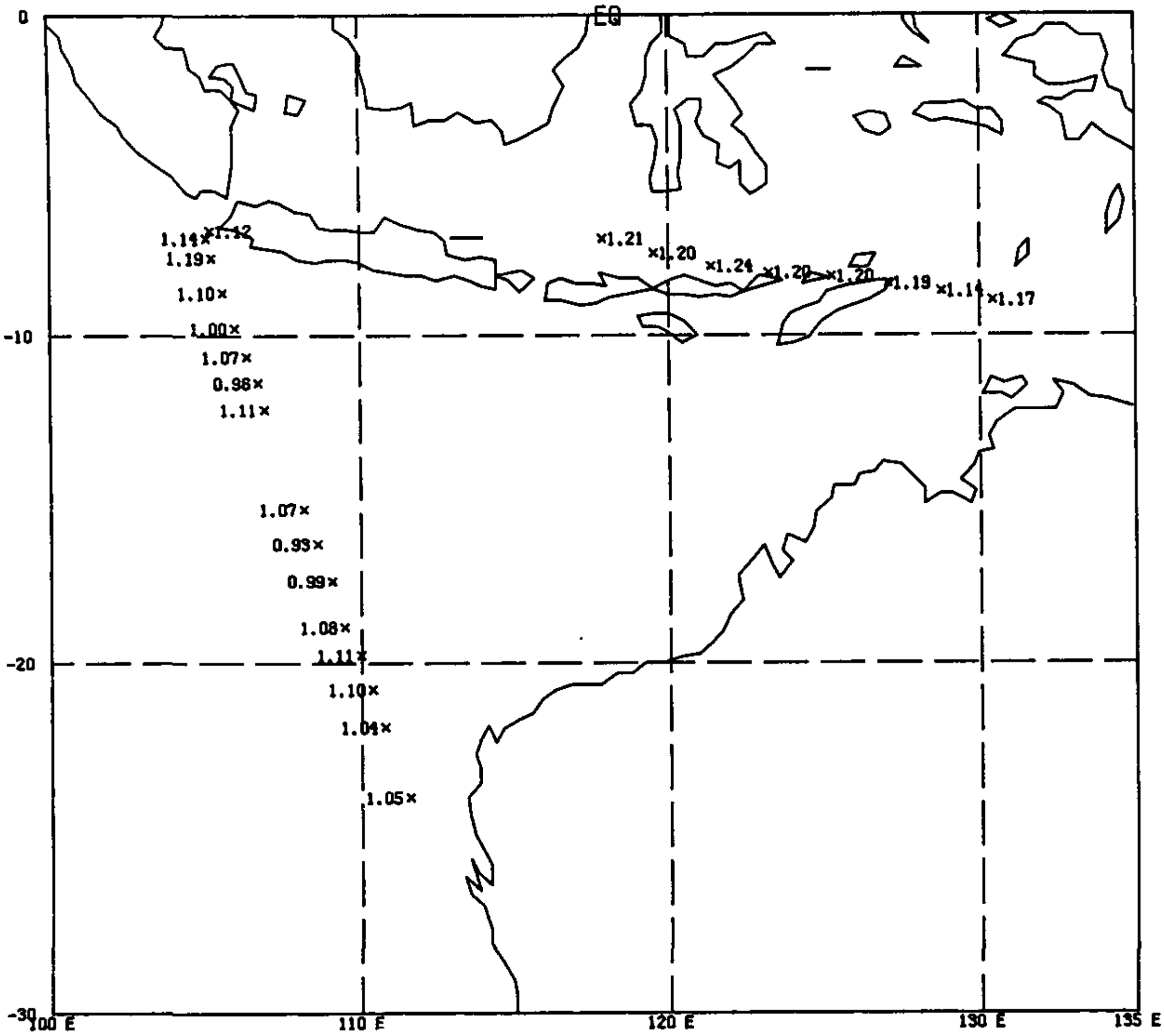

Fig. 1b: Steric height relative to 400 db 31 May–20 June 1983

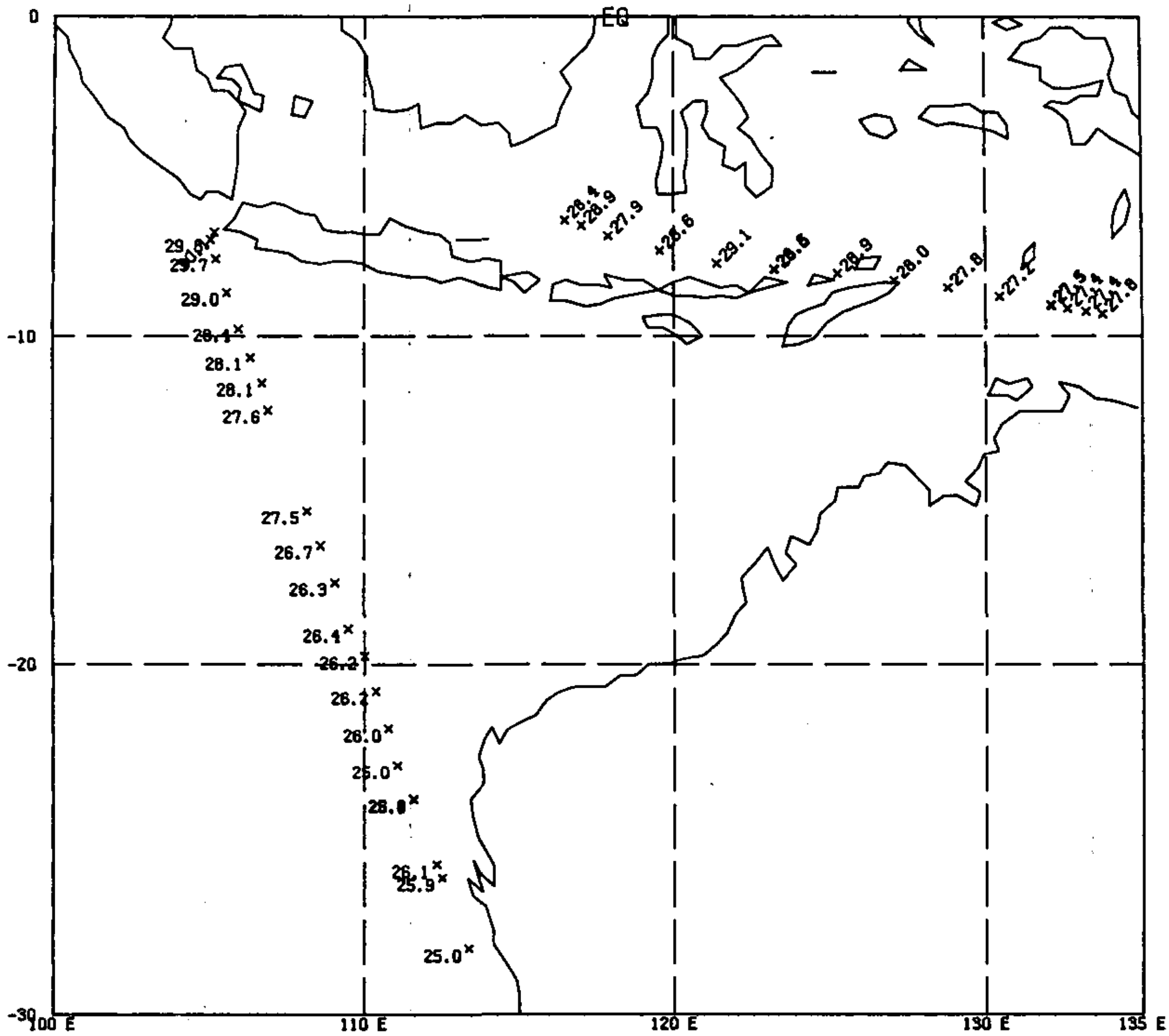

Fig. 1c: Sea-surface temperature - 31 May-20 June 1983

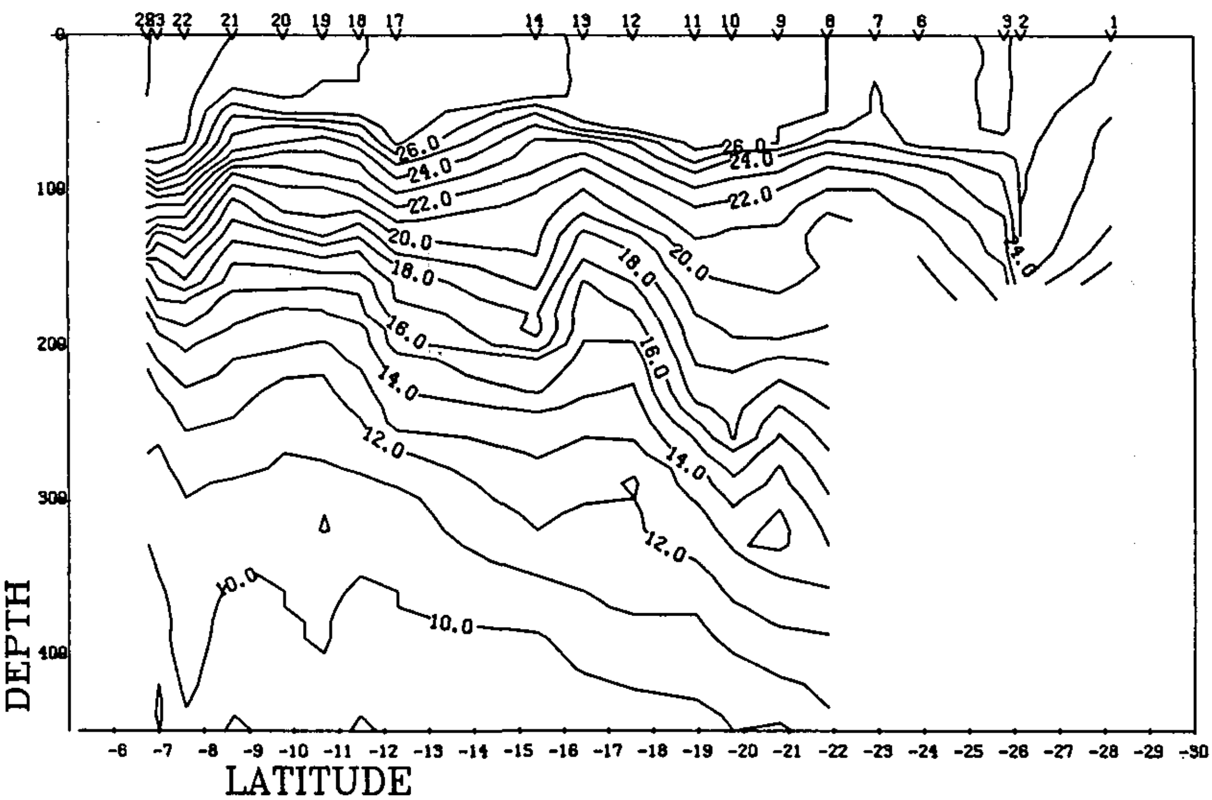

Fig. 1d: Vertical section, Stations 1-25, 31 May-5 June 1983

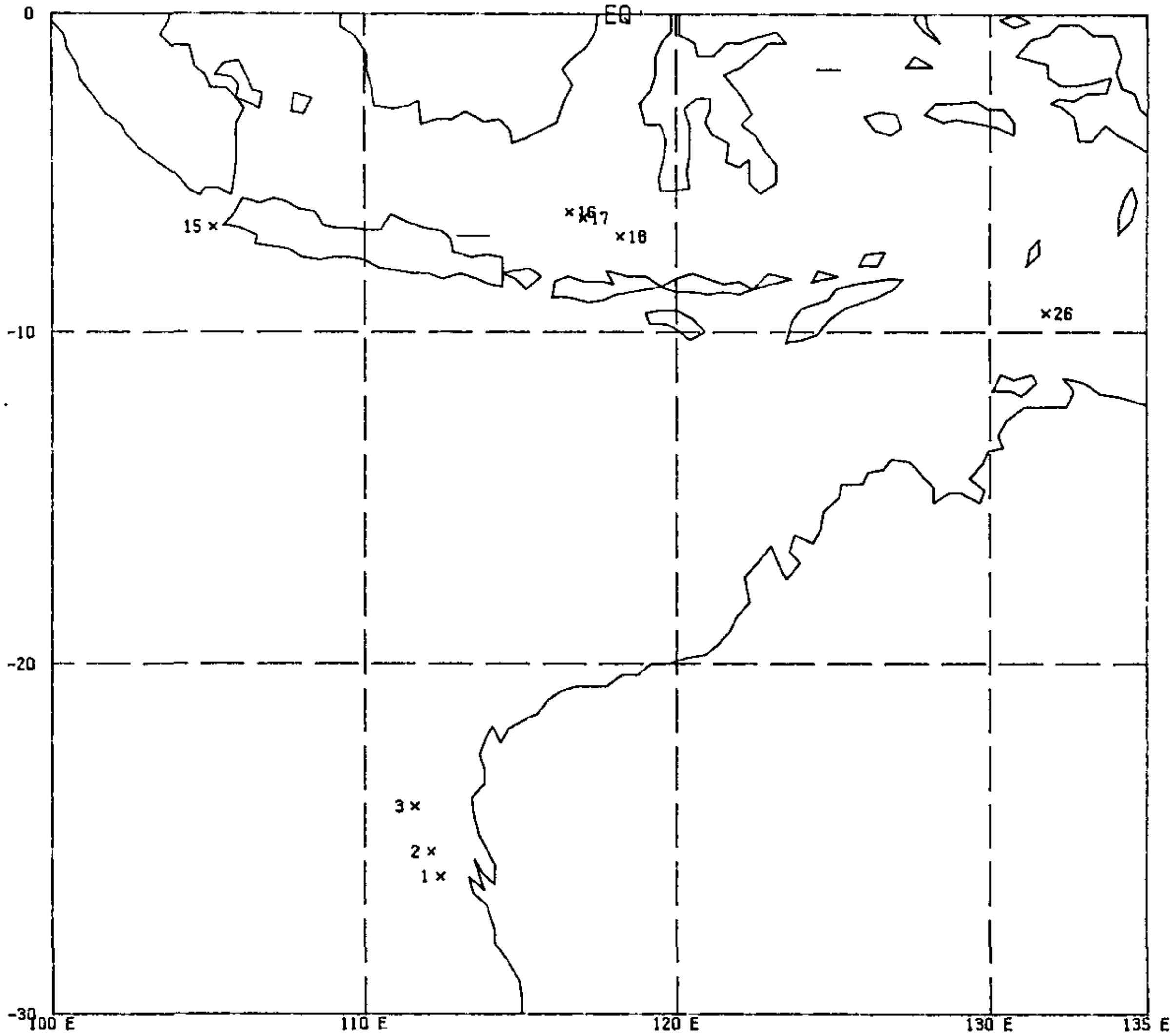

Fig. 2a: As for Fig. 1a, 10-27 July 1983

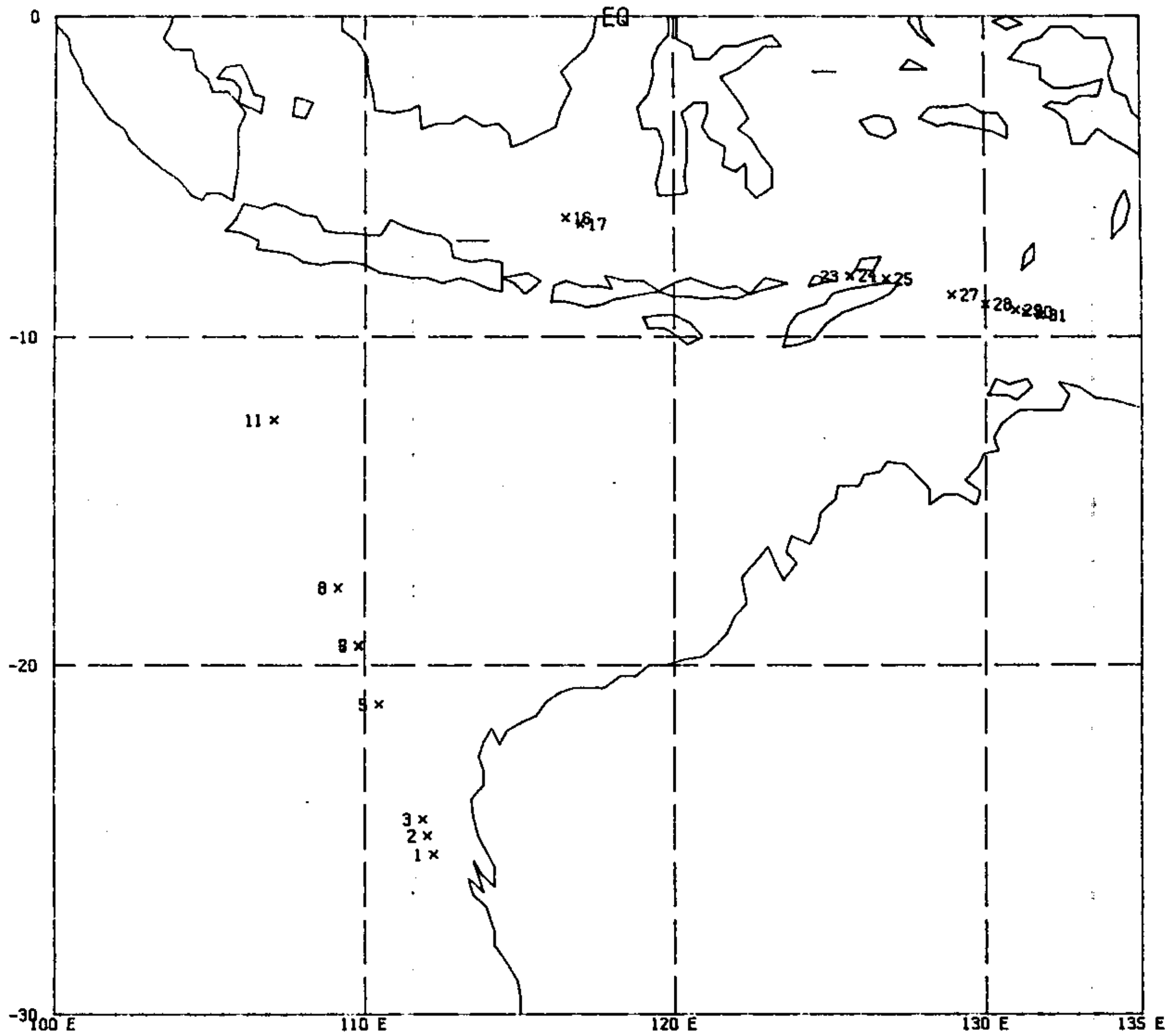

Fig. 3a As for Fig. 1, 16-31 August 1983

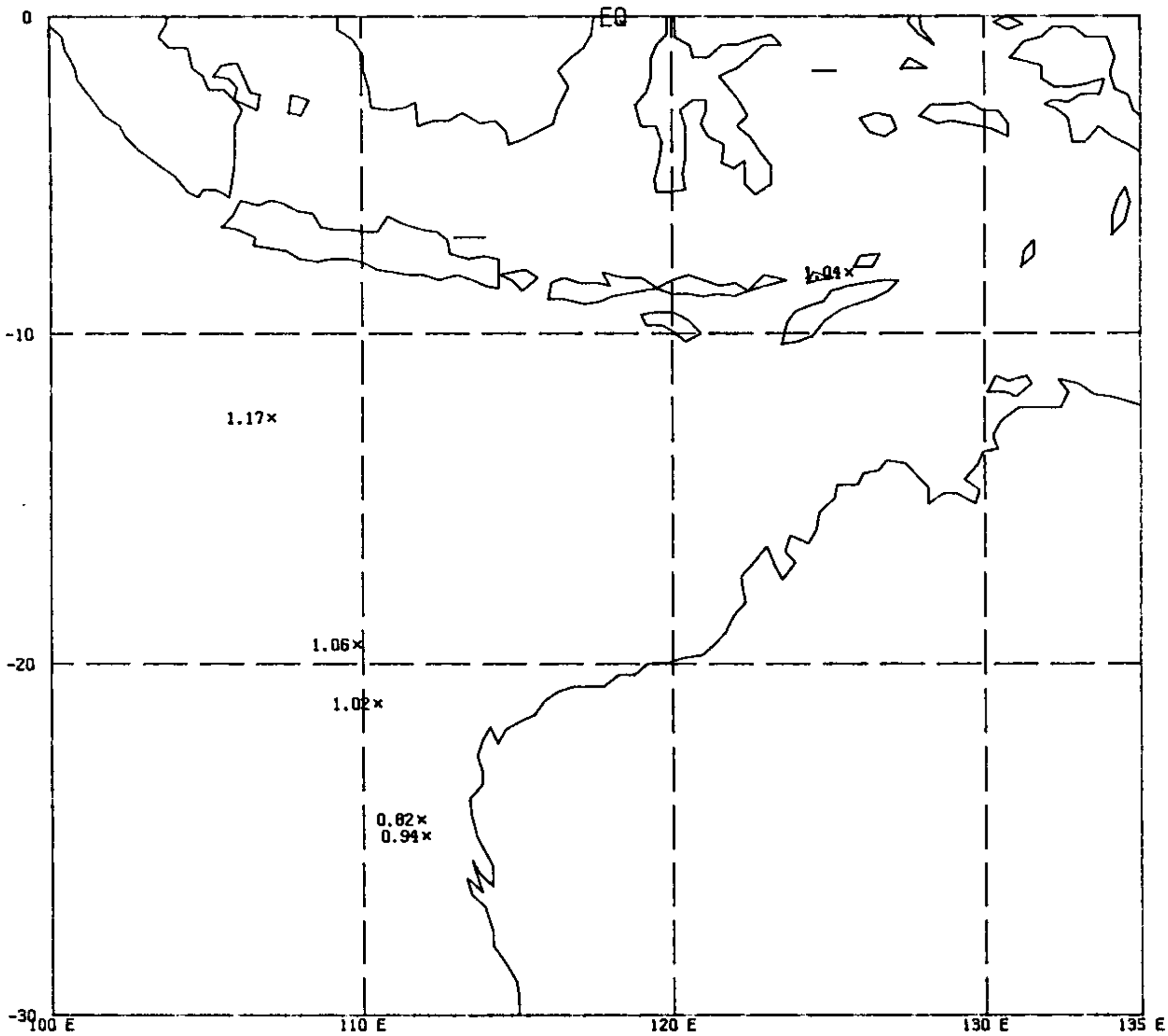

Fig. 3b: **As for Fig. 1, 16-31 August 1983**

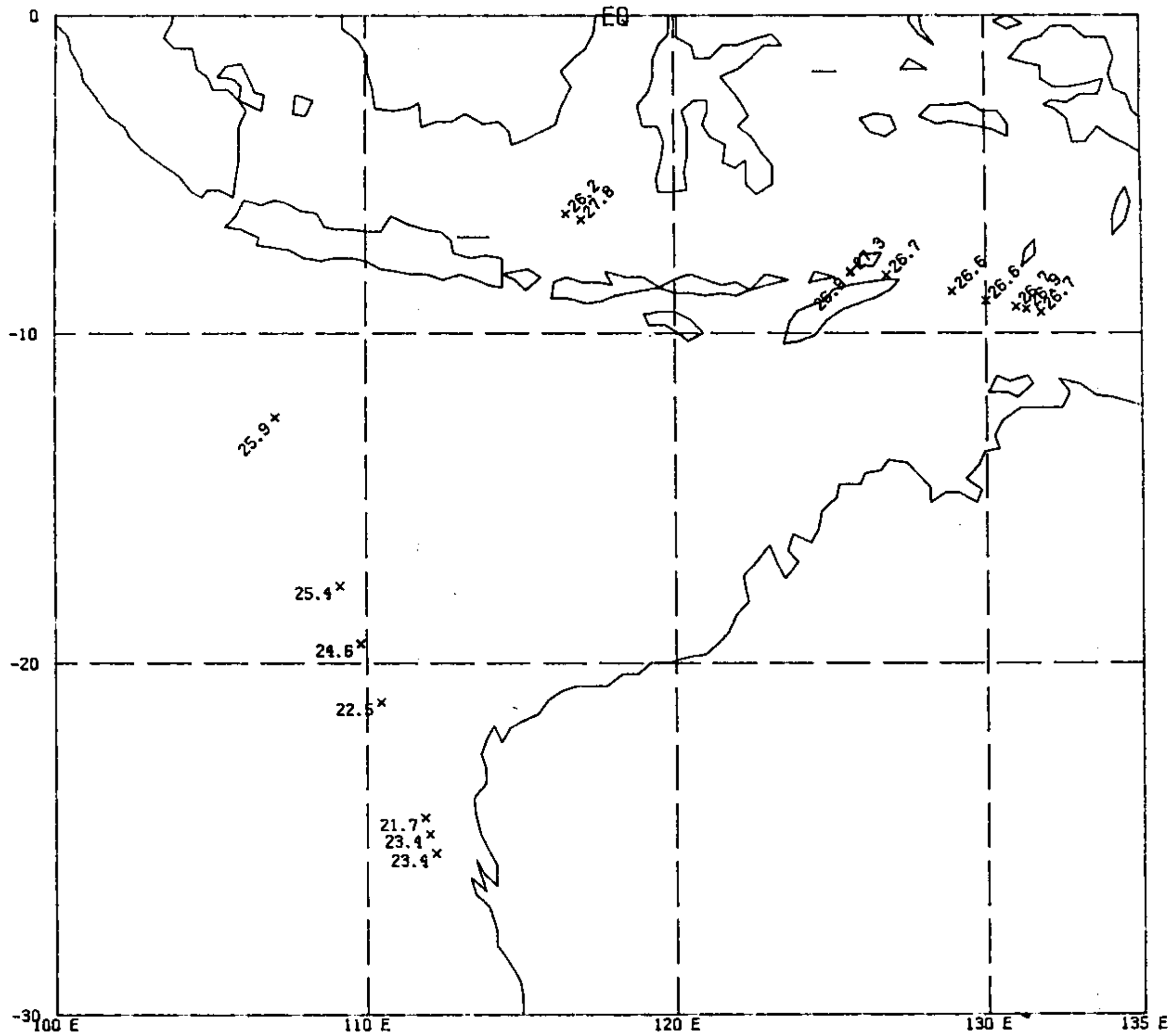

Fig. 3c: As for Fig. 1, 16-31 August 1983

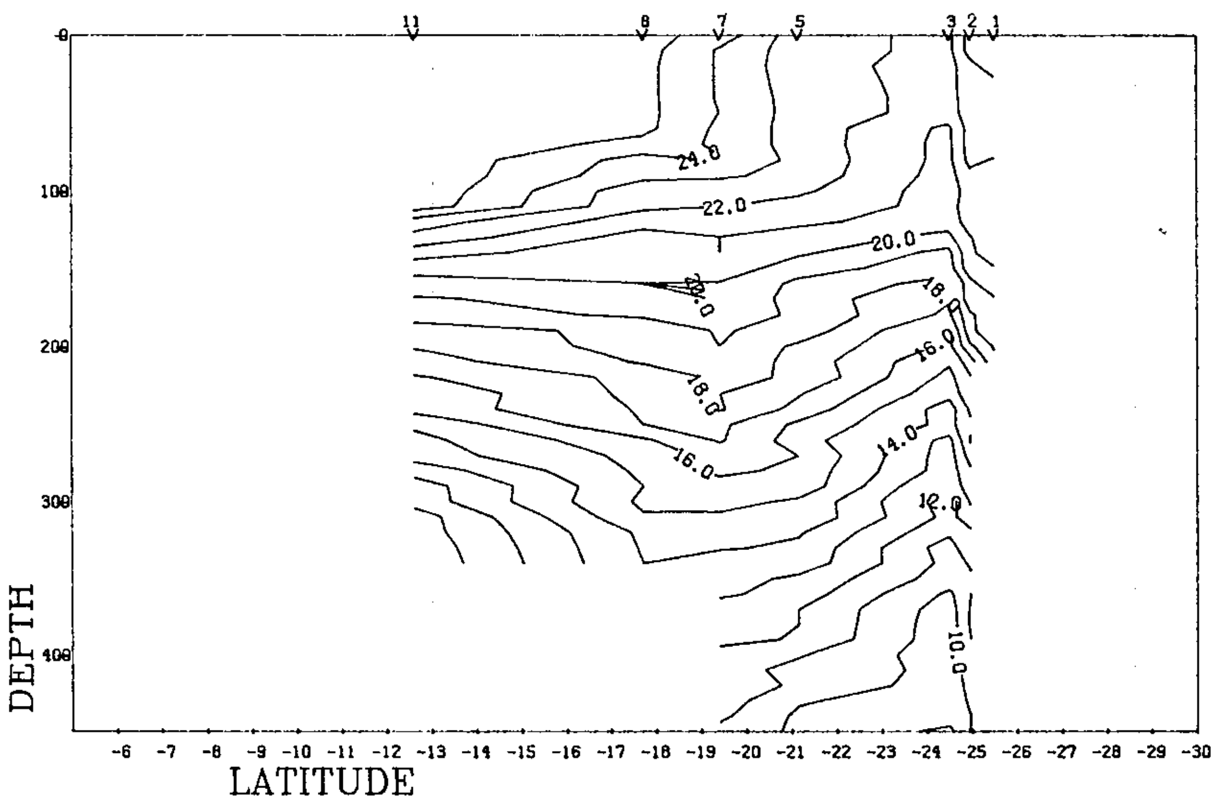

Fig. 3d: Vertical section, Stations 1-11, 16-18 August 1983

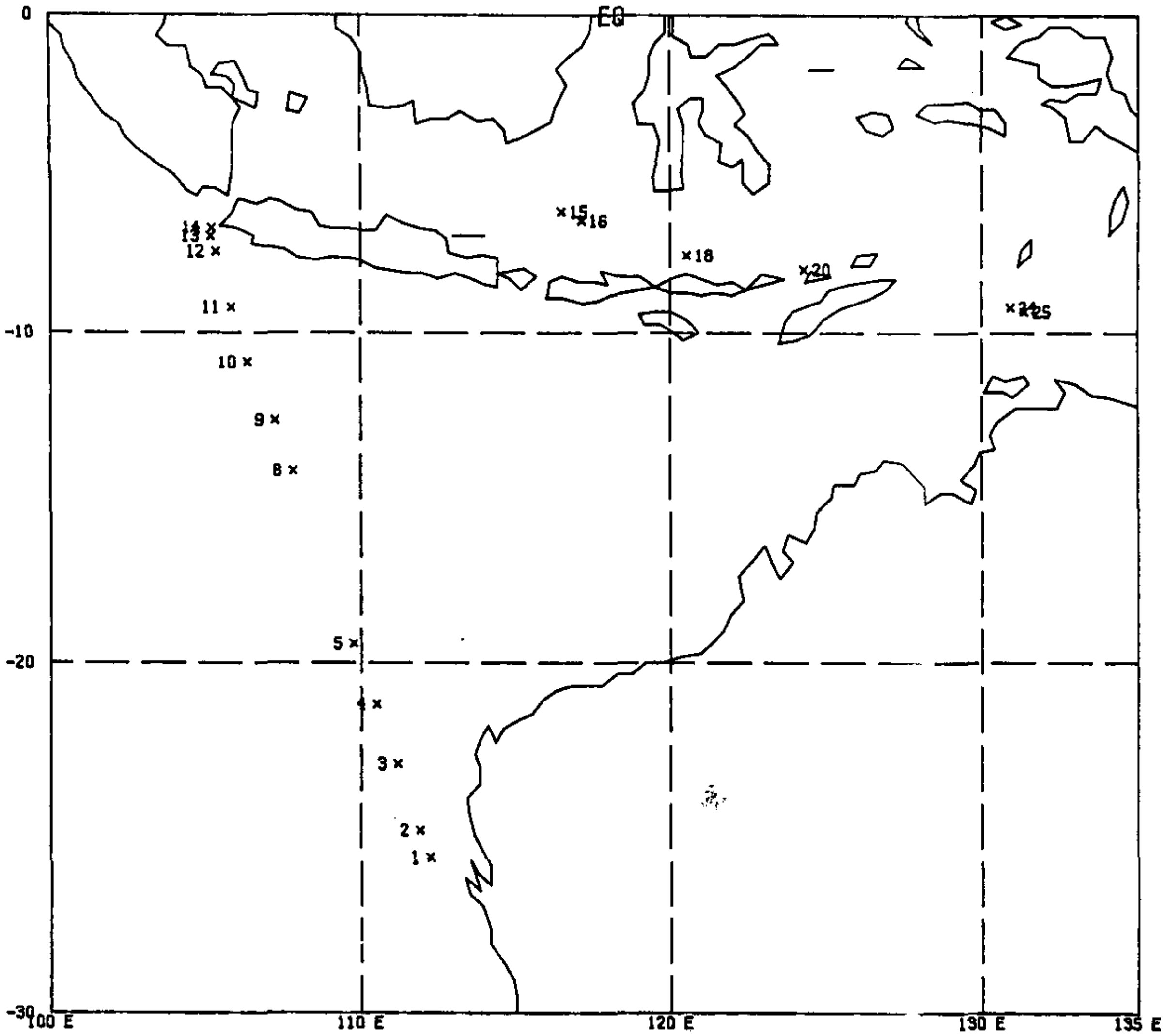

Fig. 4a As for Fig. 1, 25 September-11 October 1983

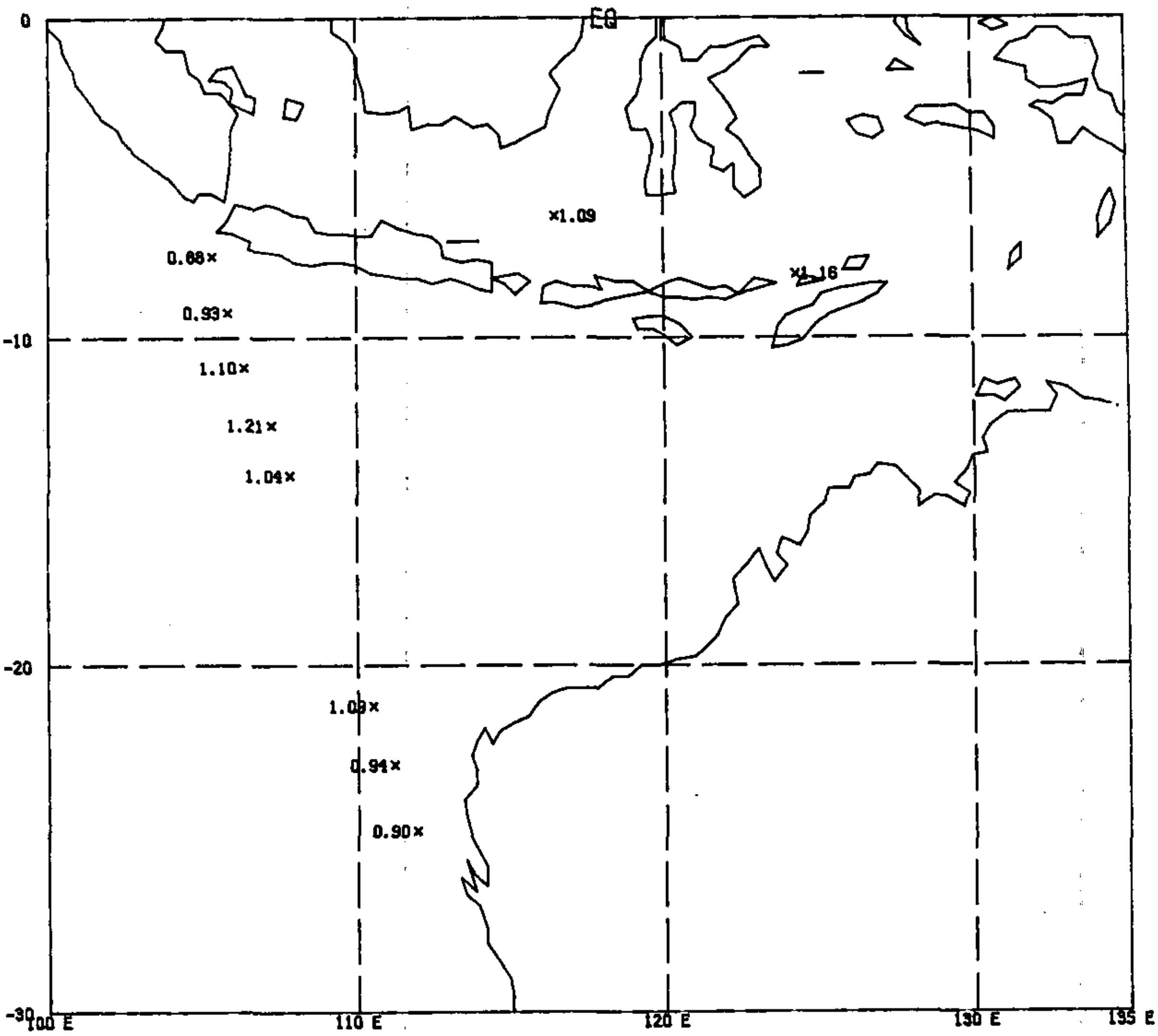

Fig. 4b: As for Fig. 1, 25 September-11 October 1983

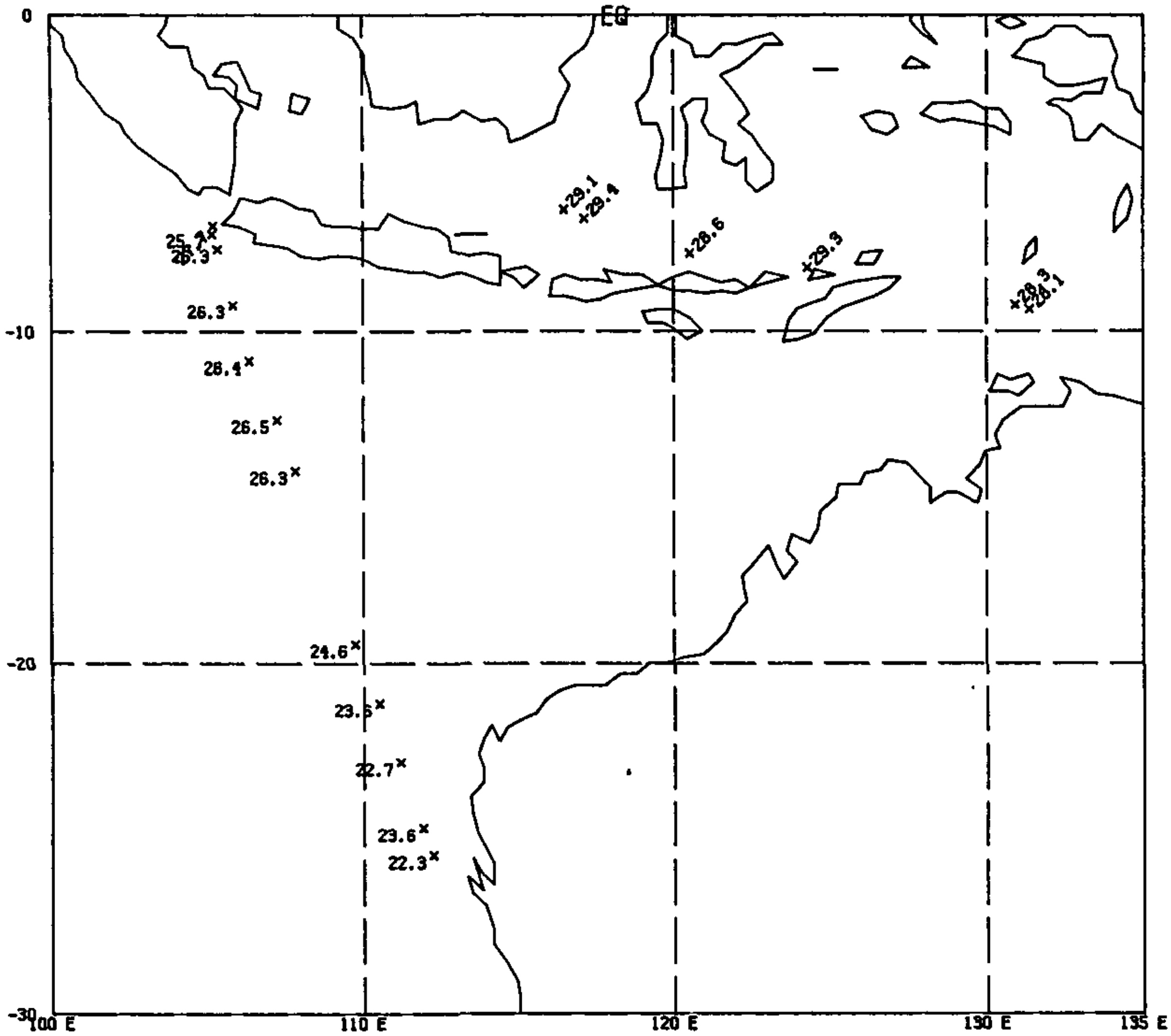

Fig. 4c: As for Fig. 1, 25 September-11 October 1983

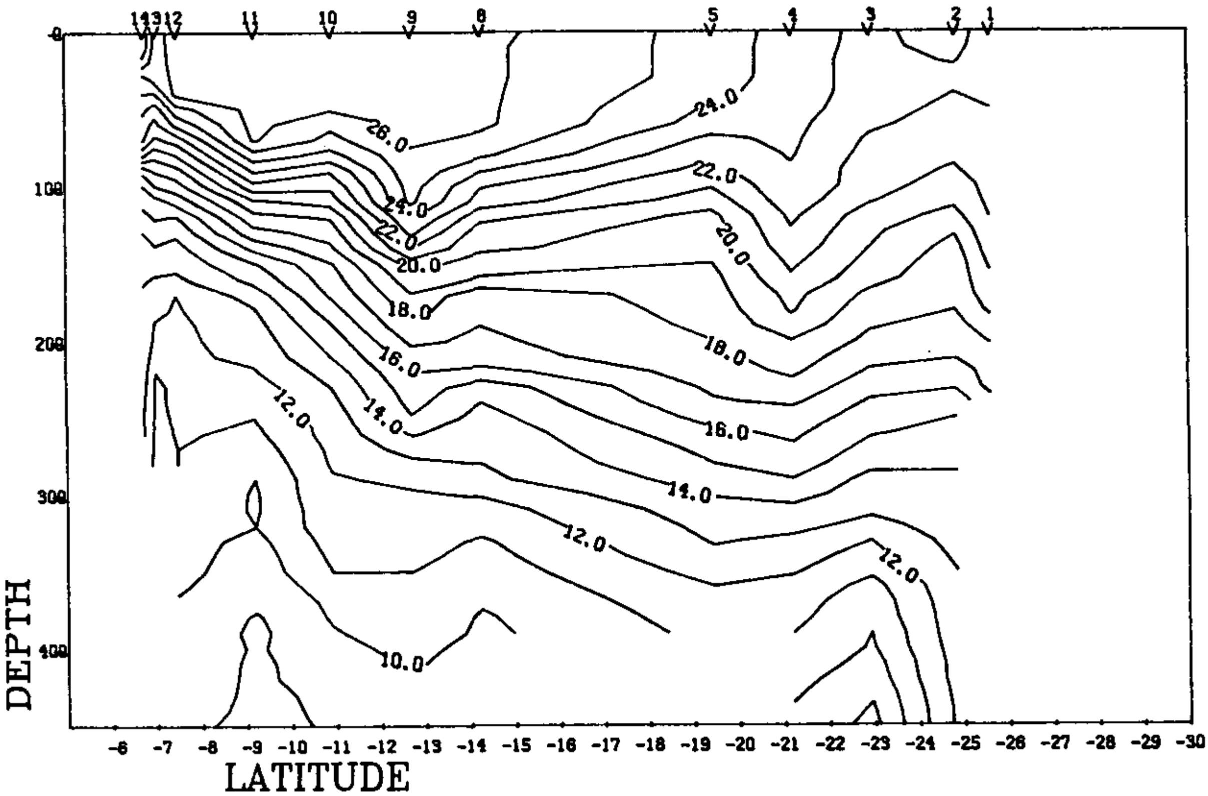

Fig. 4d: Vertical section, Stations 1-14, 25-28 September 1983

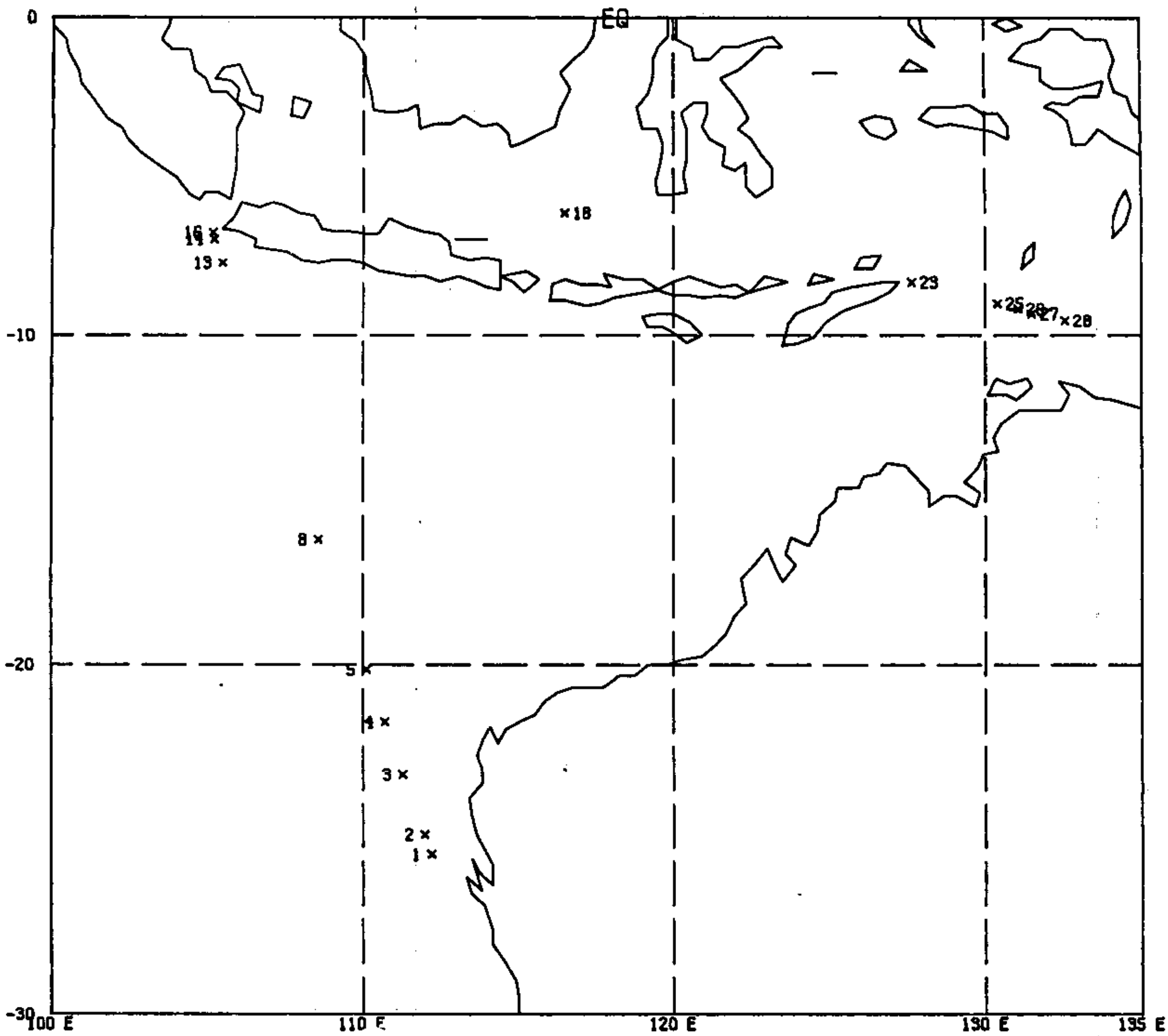

Fig. 5a As for Fig. 1, 15 December 1983-4 January 1984

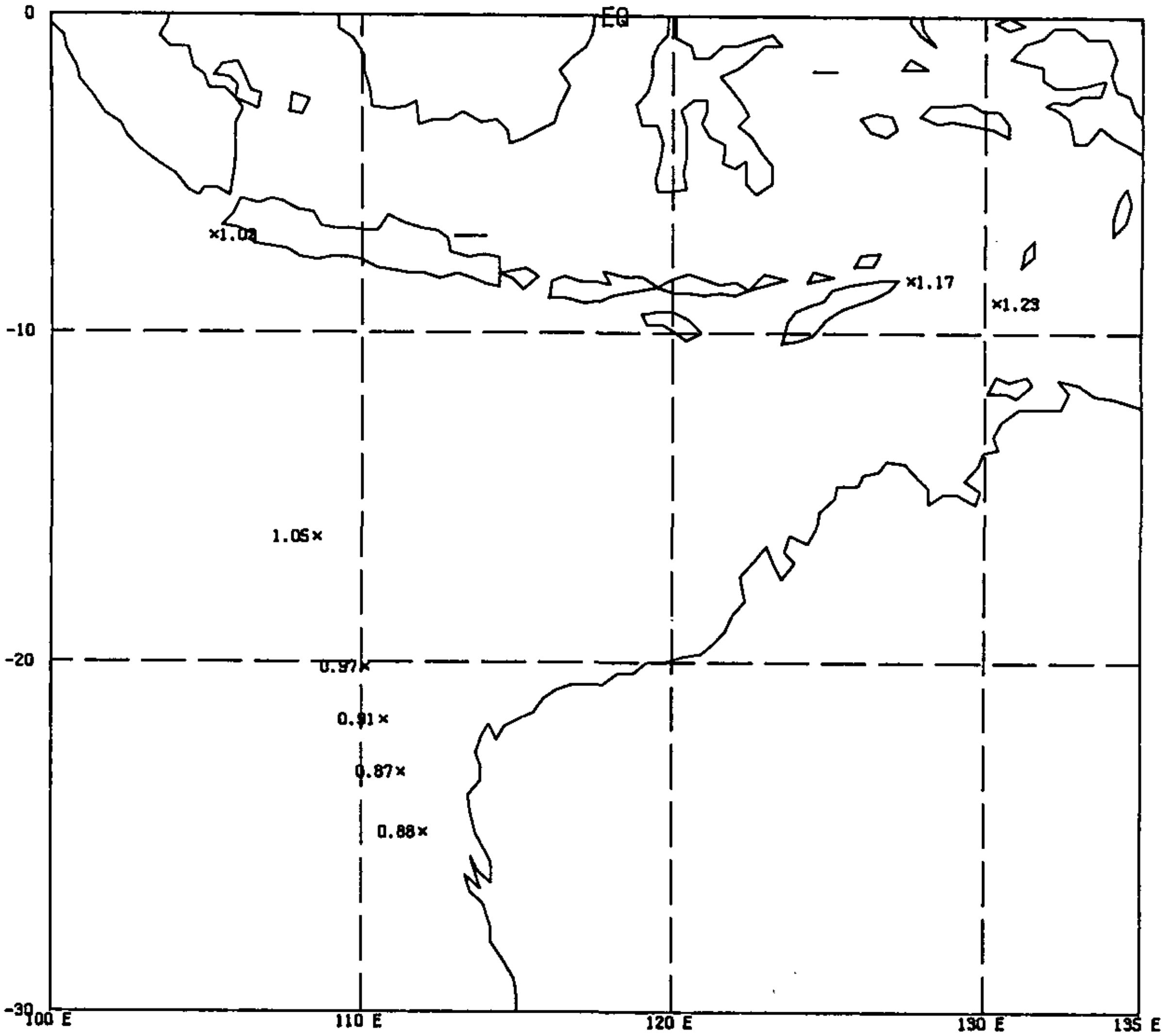

Fig. 5b: **As for Fig. 1, 15 December 1983-4 January 1984**

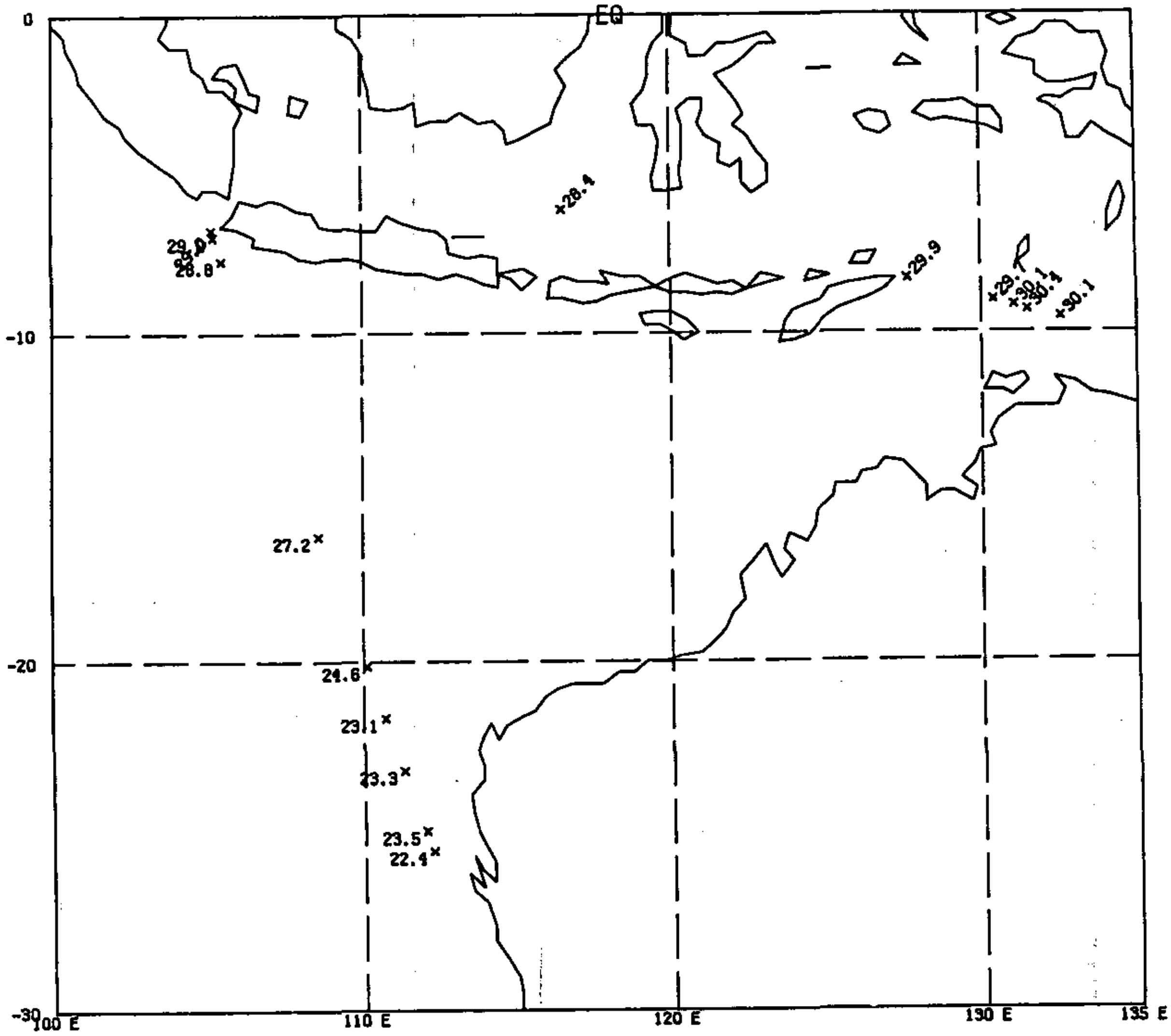

Fig. 5c: As for Fig. 1, 15 December 1983-4 January 1984

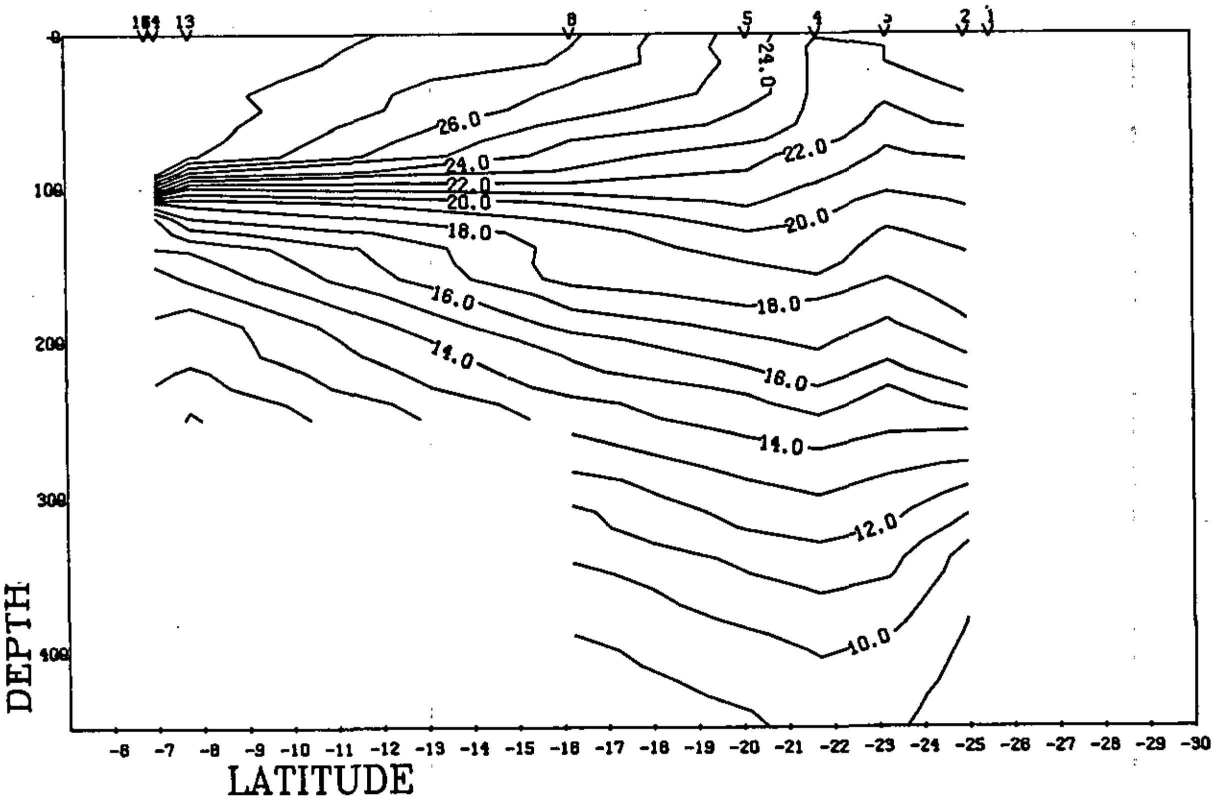

Fig. 5d: Vertical section, Stations 1-16, 18-21 December 1983

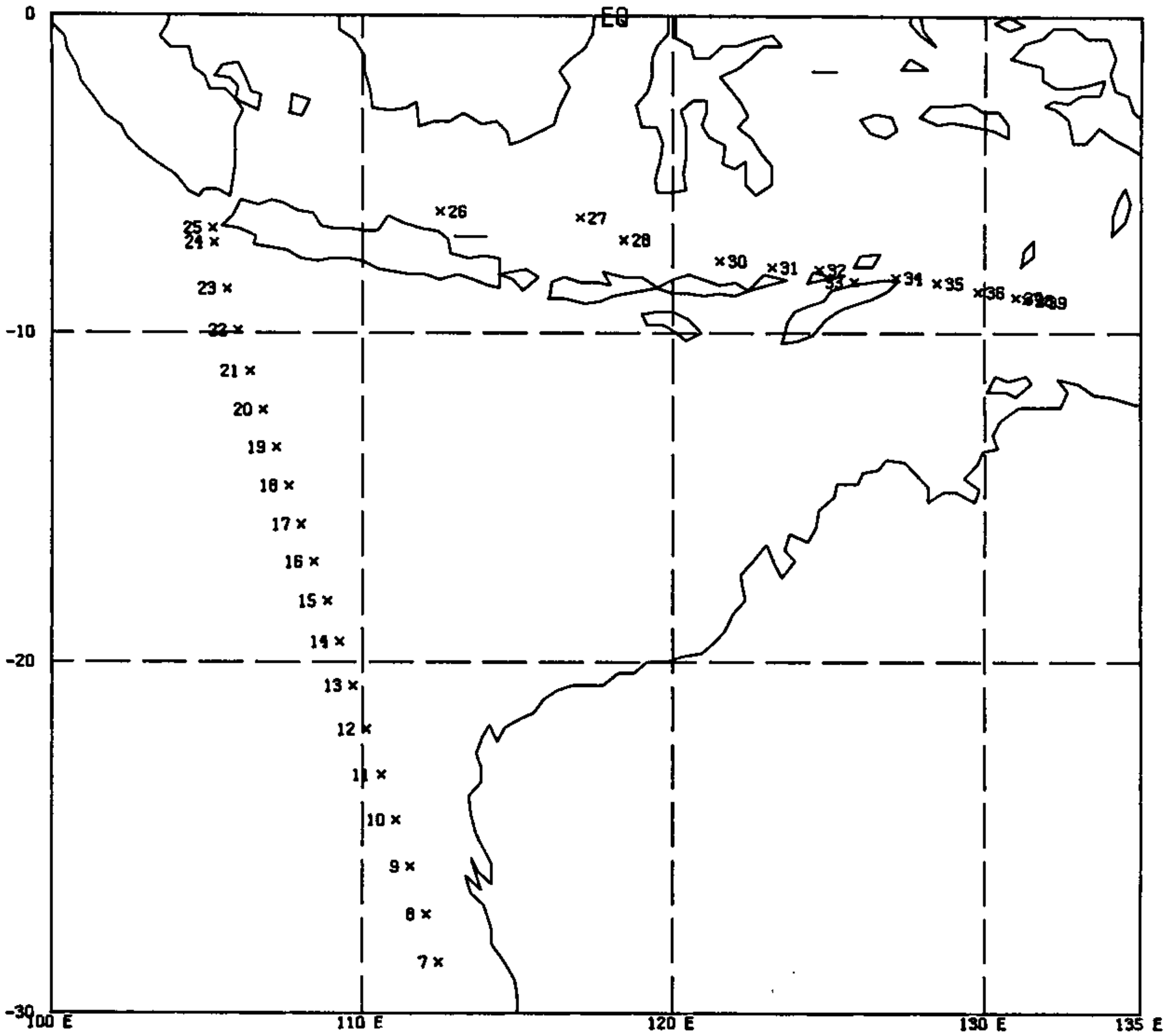

Fig. 6a As for Fig. 1, 26 January-14 February 1984

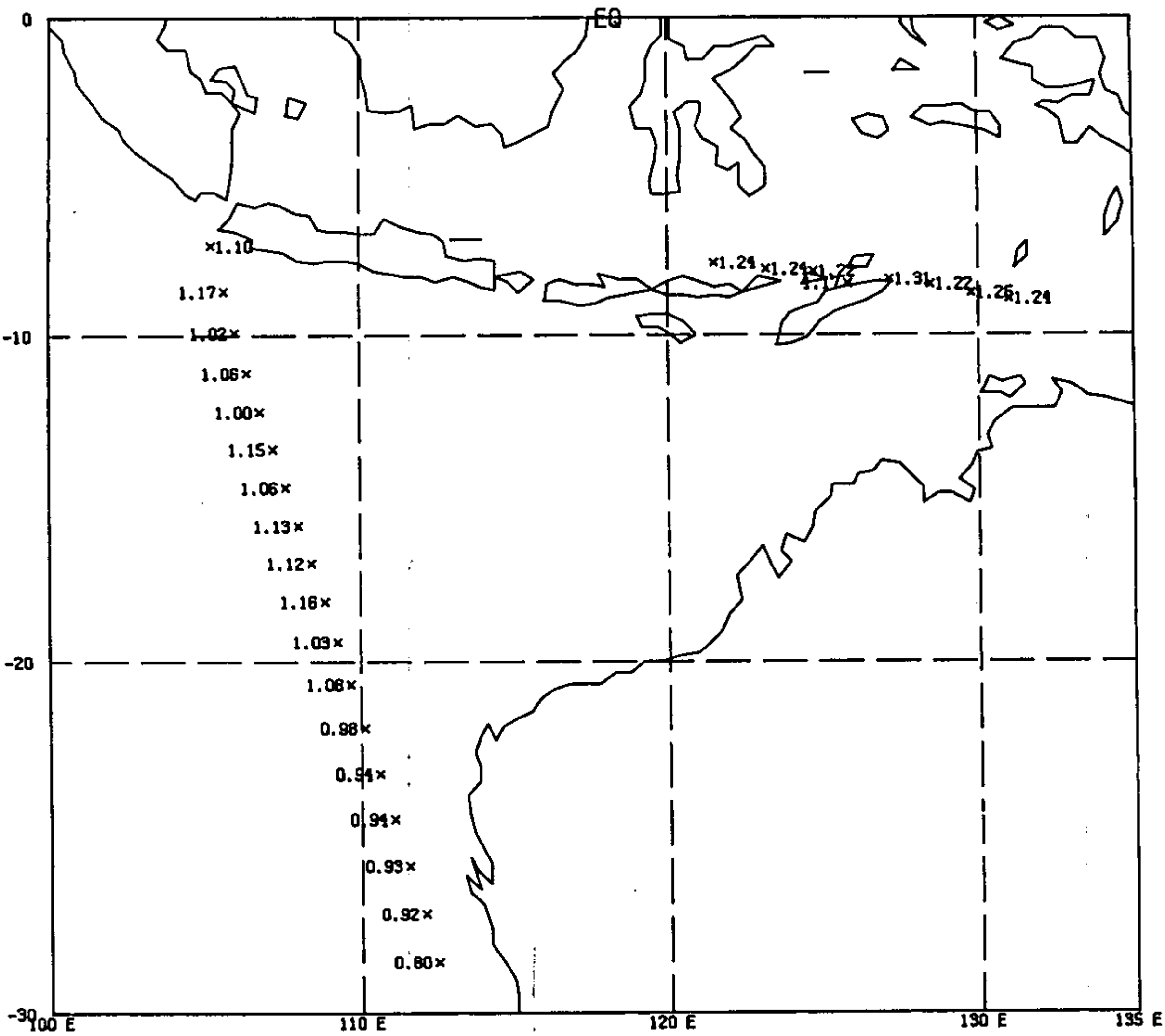

Fig. 6b: **As for Fig. 1, 26 January-14 February 1984**

0.71×

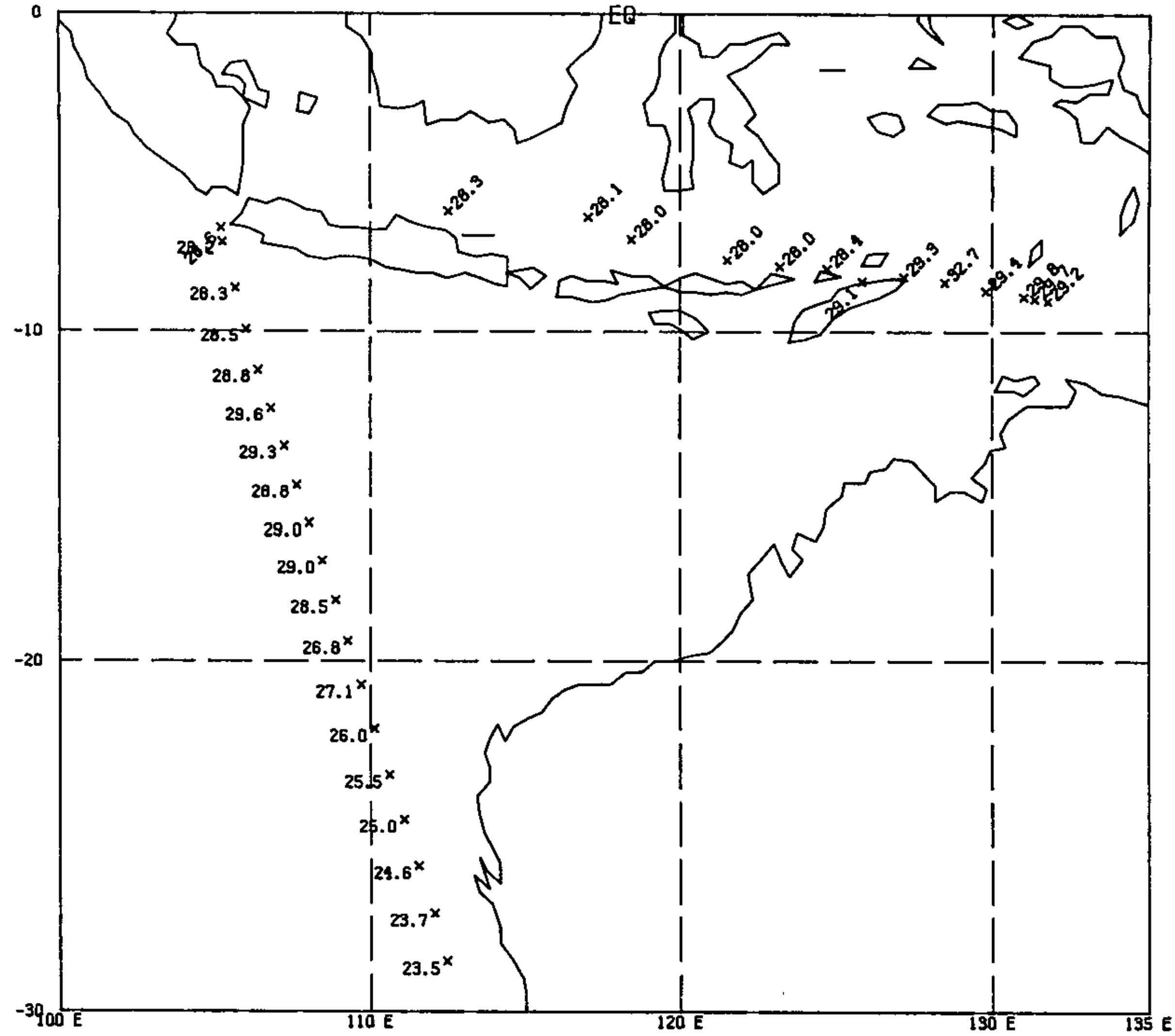

Fig. 6c: As for Fig. 1, 26 January-14 February 1984

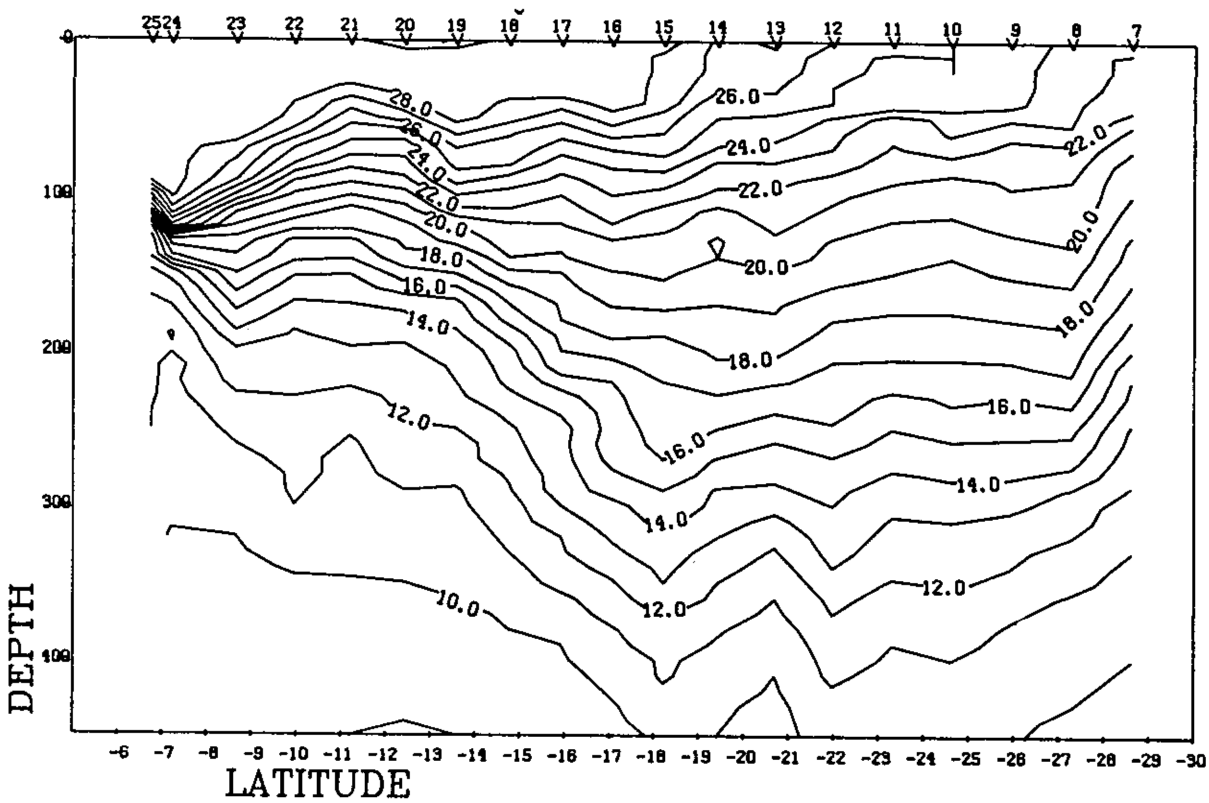

Fig. 6d: Vertical section, Stations 7-25, 27-31 January 1984

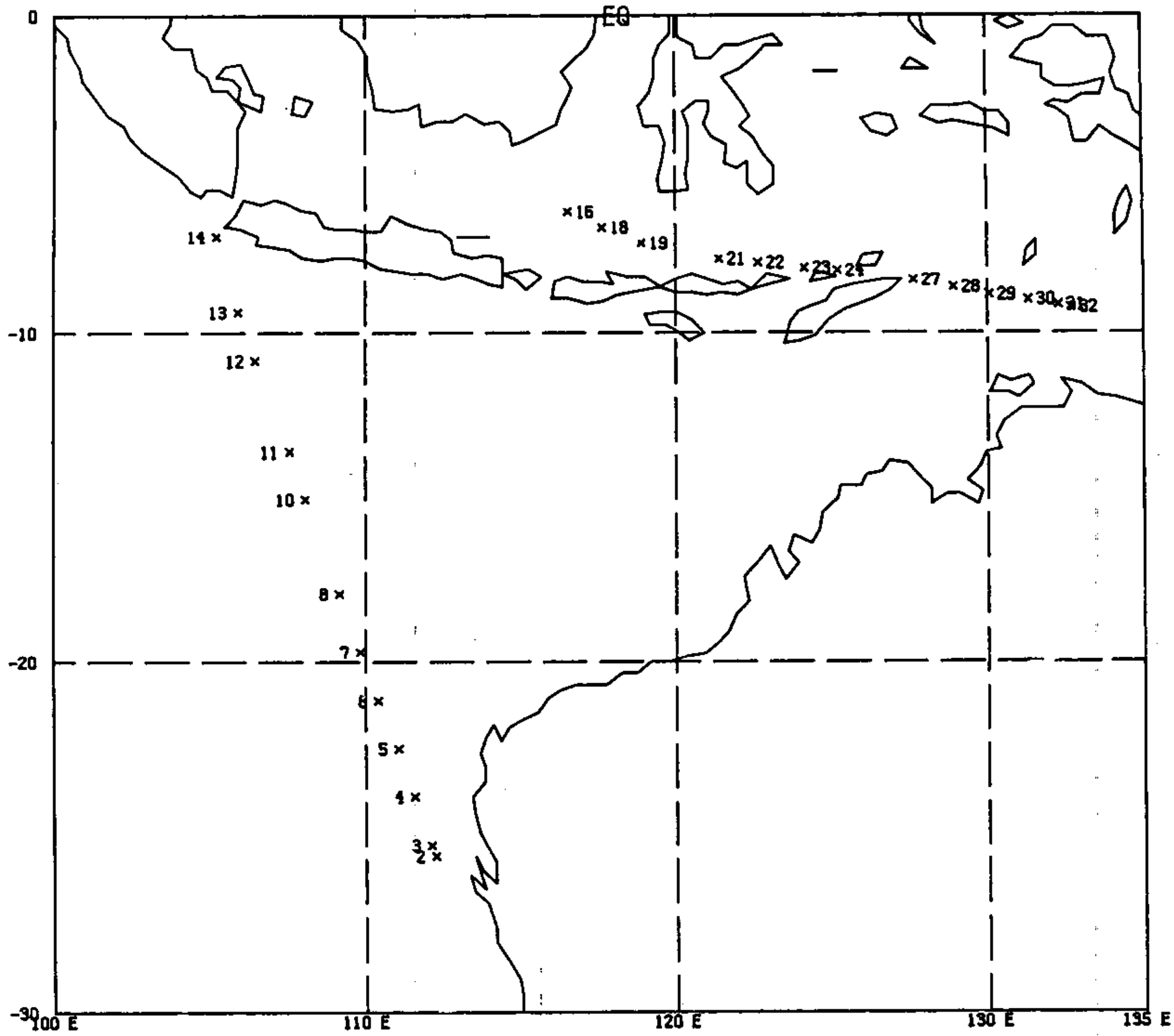

Fig. 7a As for Fig. 1, 12-30 March 1984

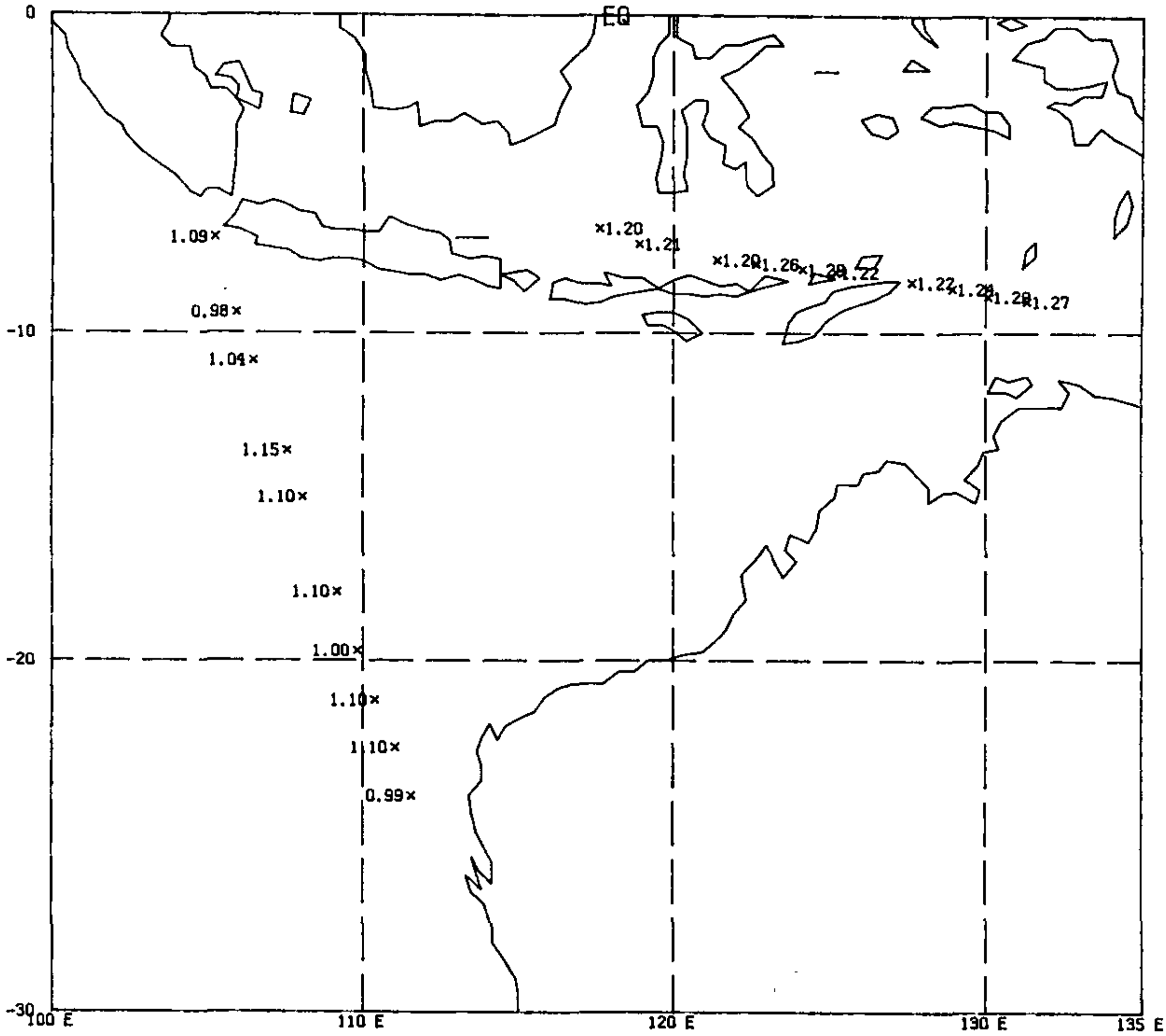

Fig. 7b: **As for Fig. 1, 12-30 March 1984**

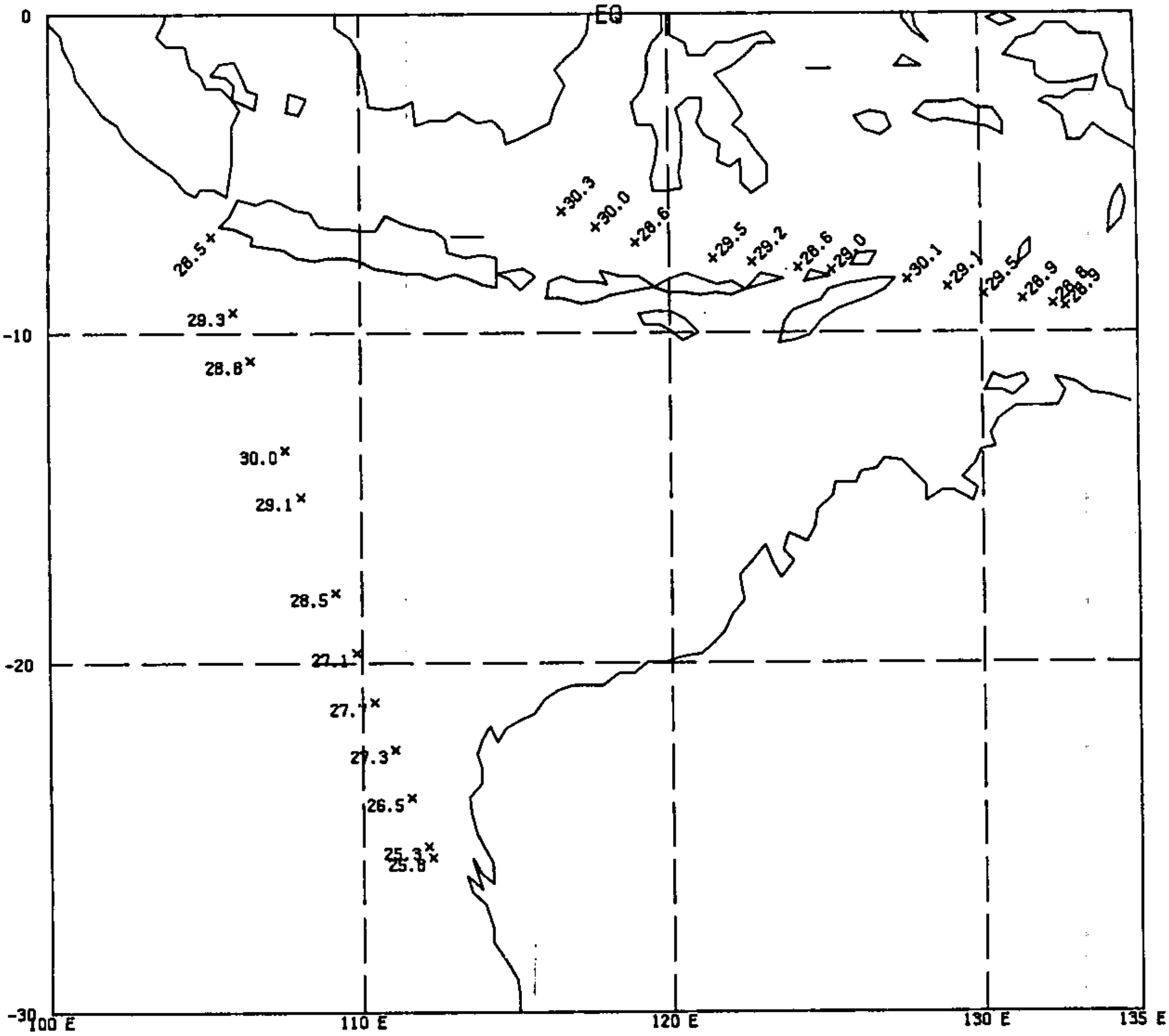

Fig. 7c: As for Fig. 1, 12-30 March 1984

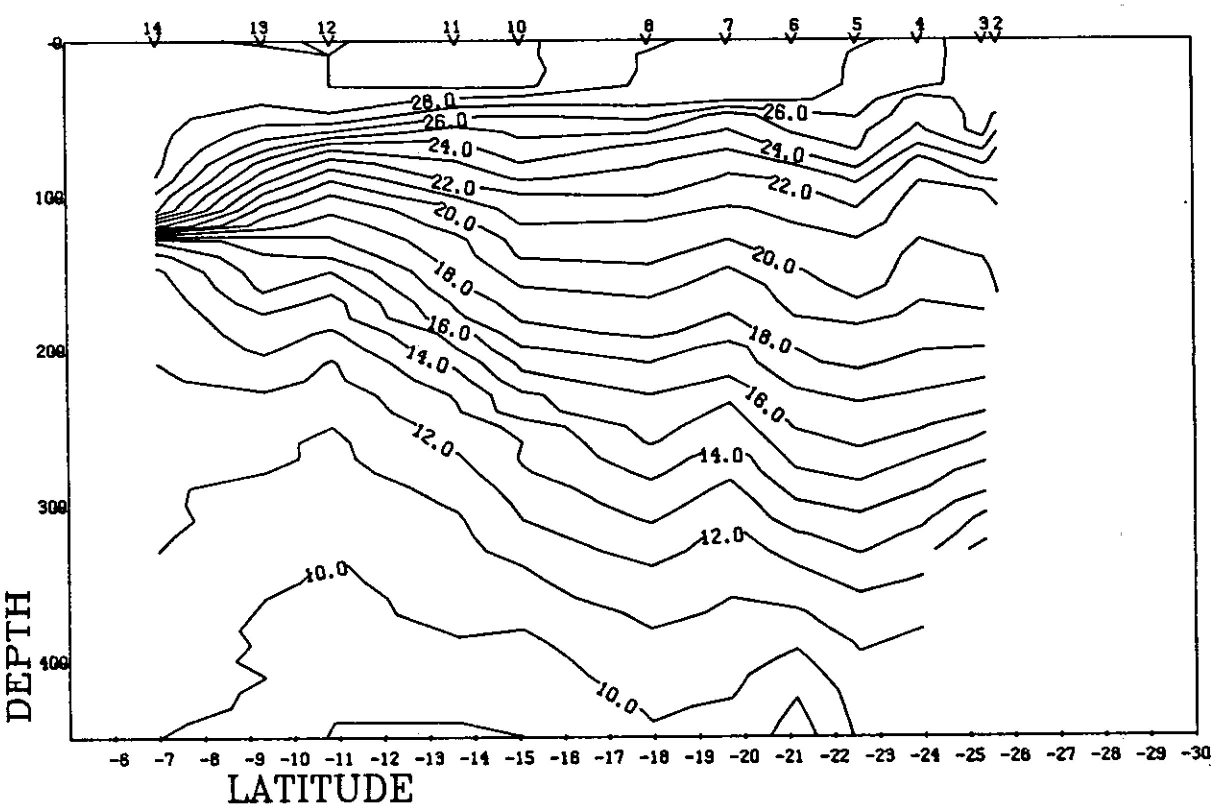

Fig. 7d: Vertical section, Stations 2-14, 12-16 March 1984

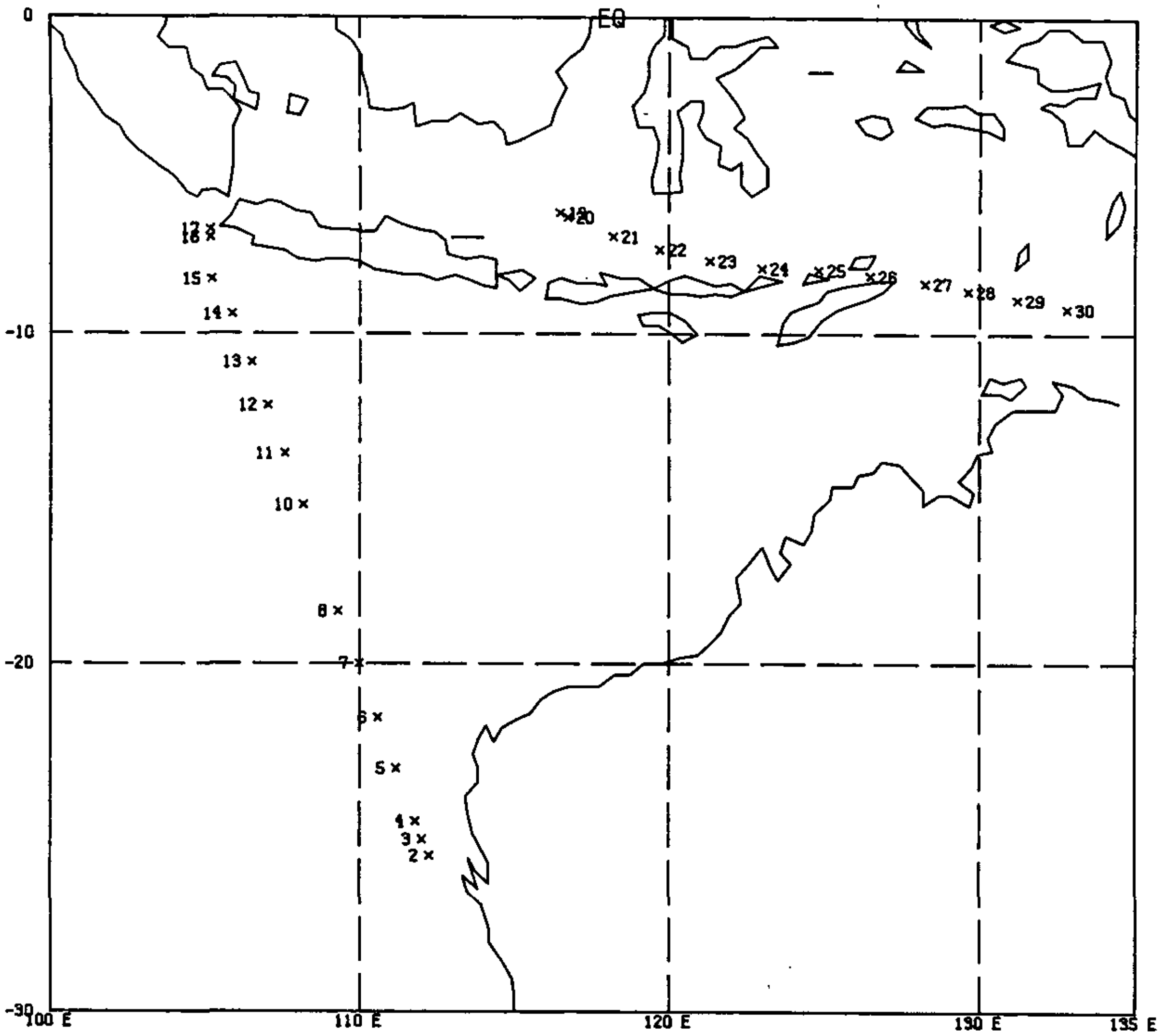

Fig. 8a As for Fig. 1, 20 May-6 June 1984

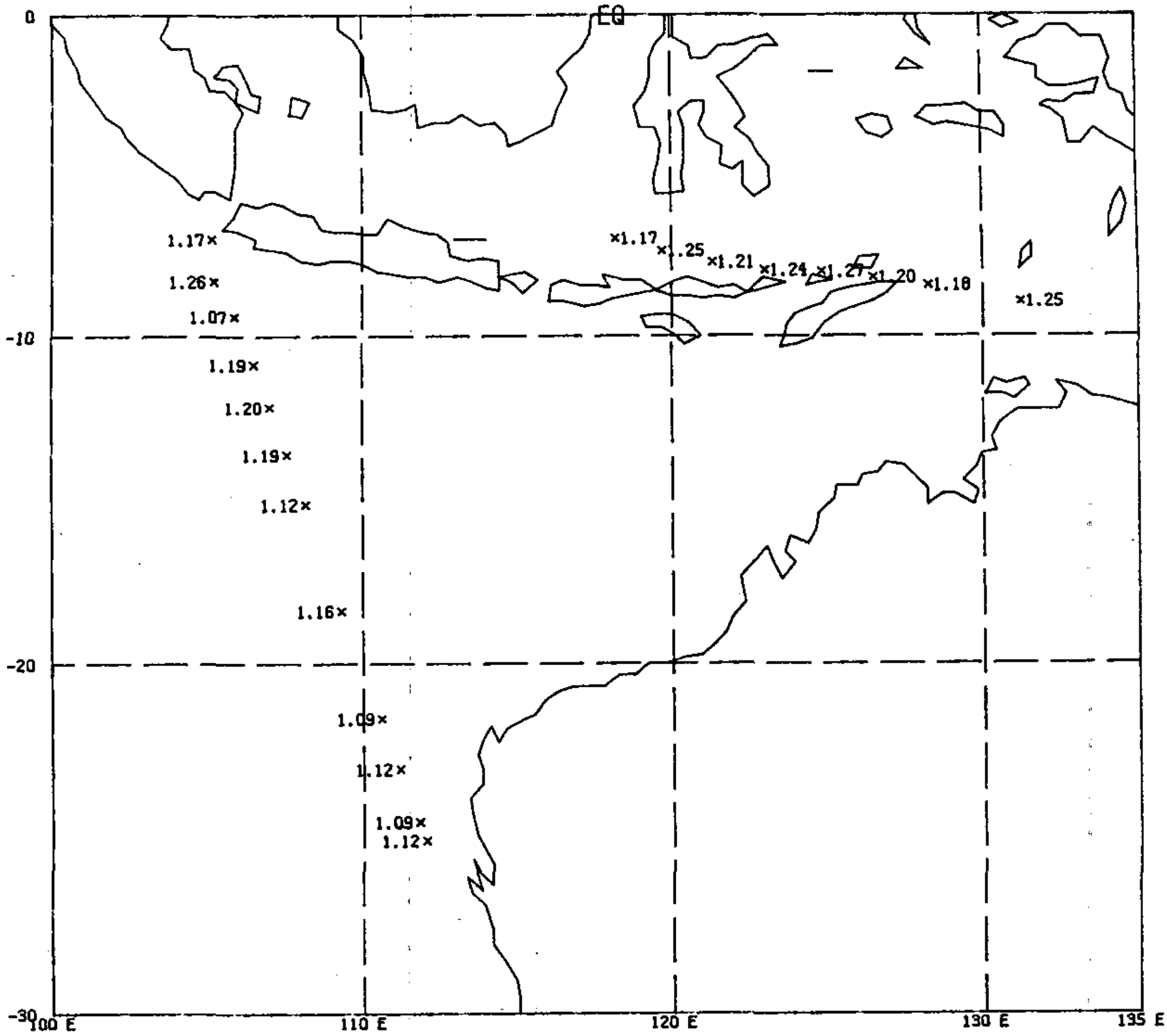

Fig. 8b: **As for Fig. 1, 20 May-6 June 1984**

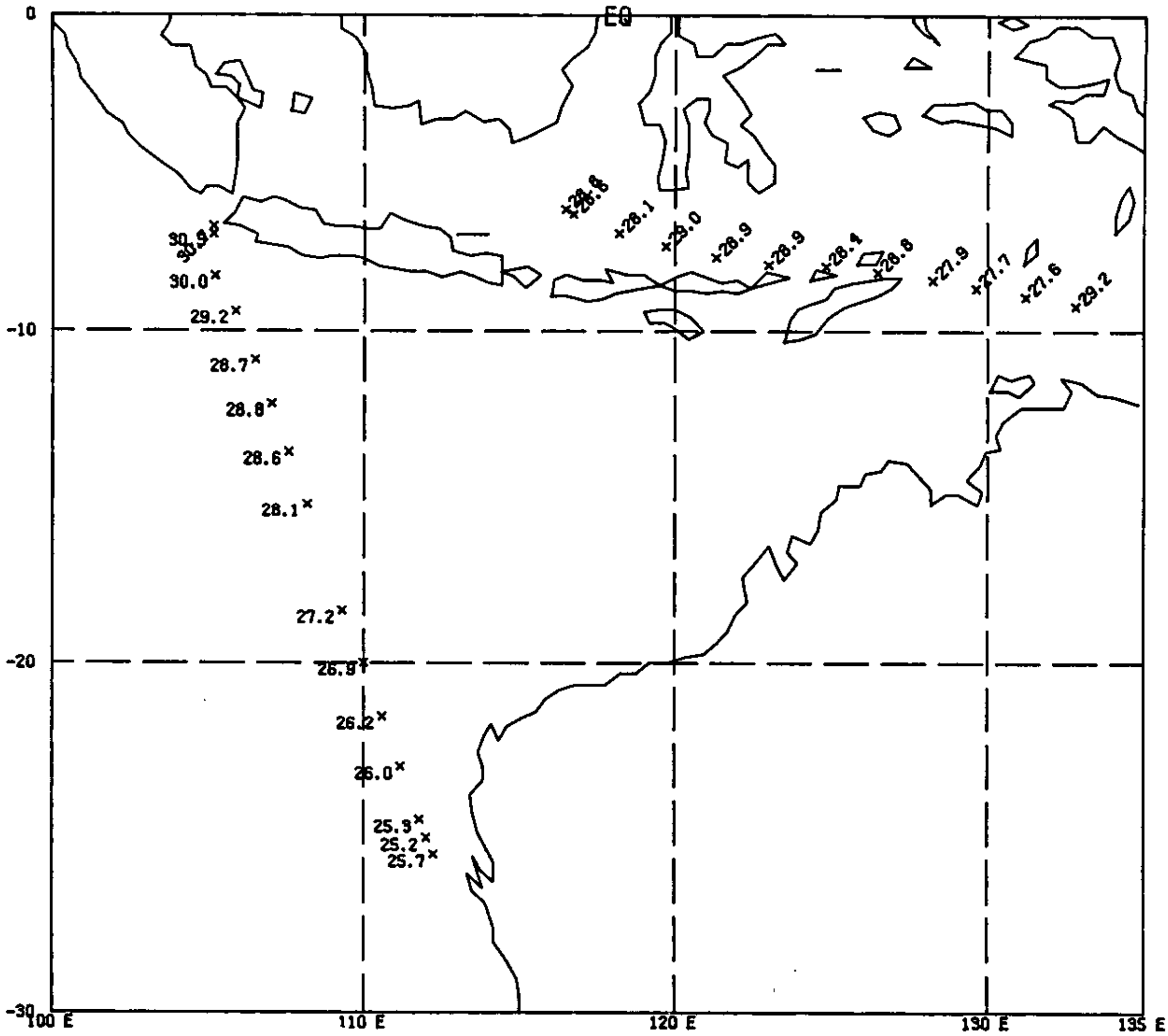

Fig. 8c: As for Fig. 1, 20 May-6 June 1984

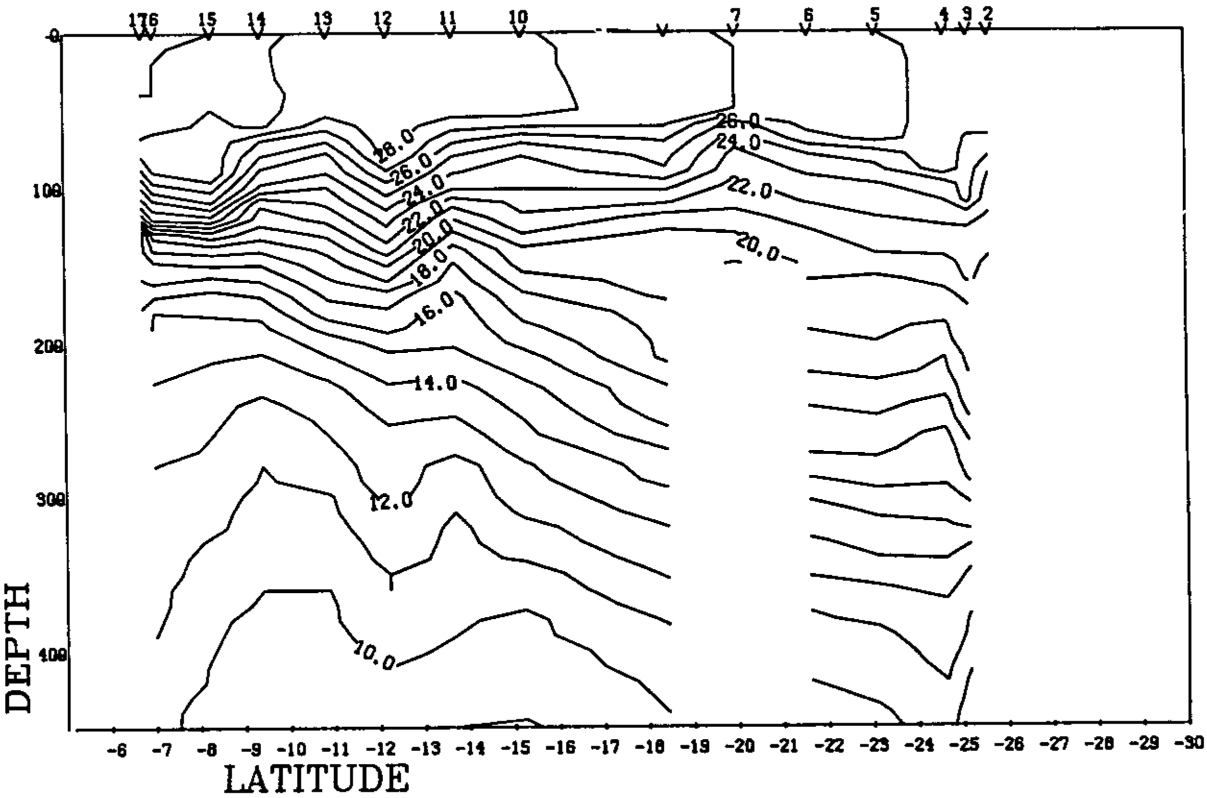

Fig. 8d: Vertical section, Stations 2-17, 20-23 May 1984

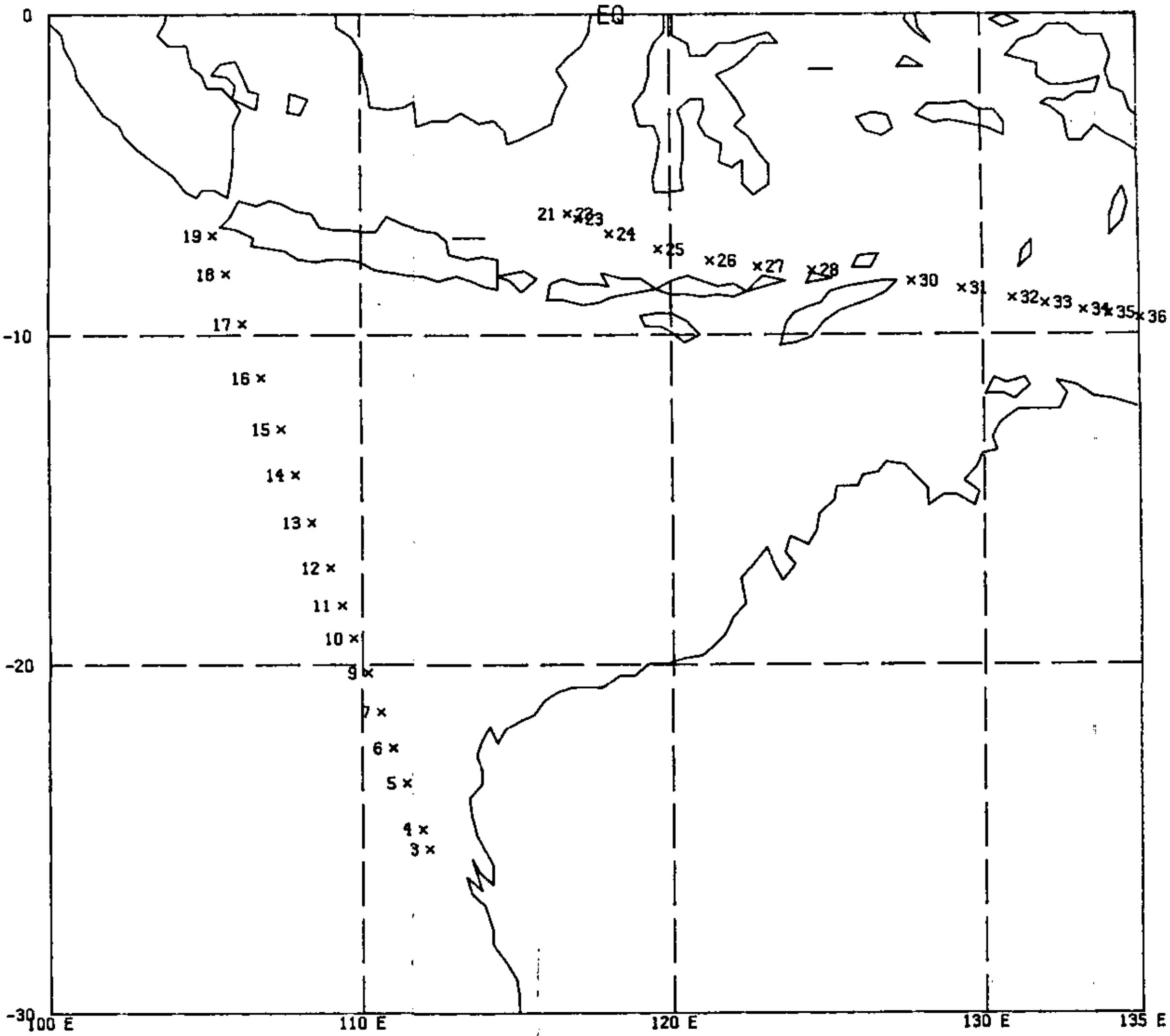

Fig. 9a As for Fig. 1, 5-24 July 1984

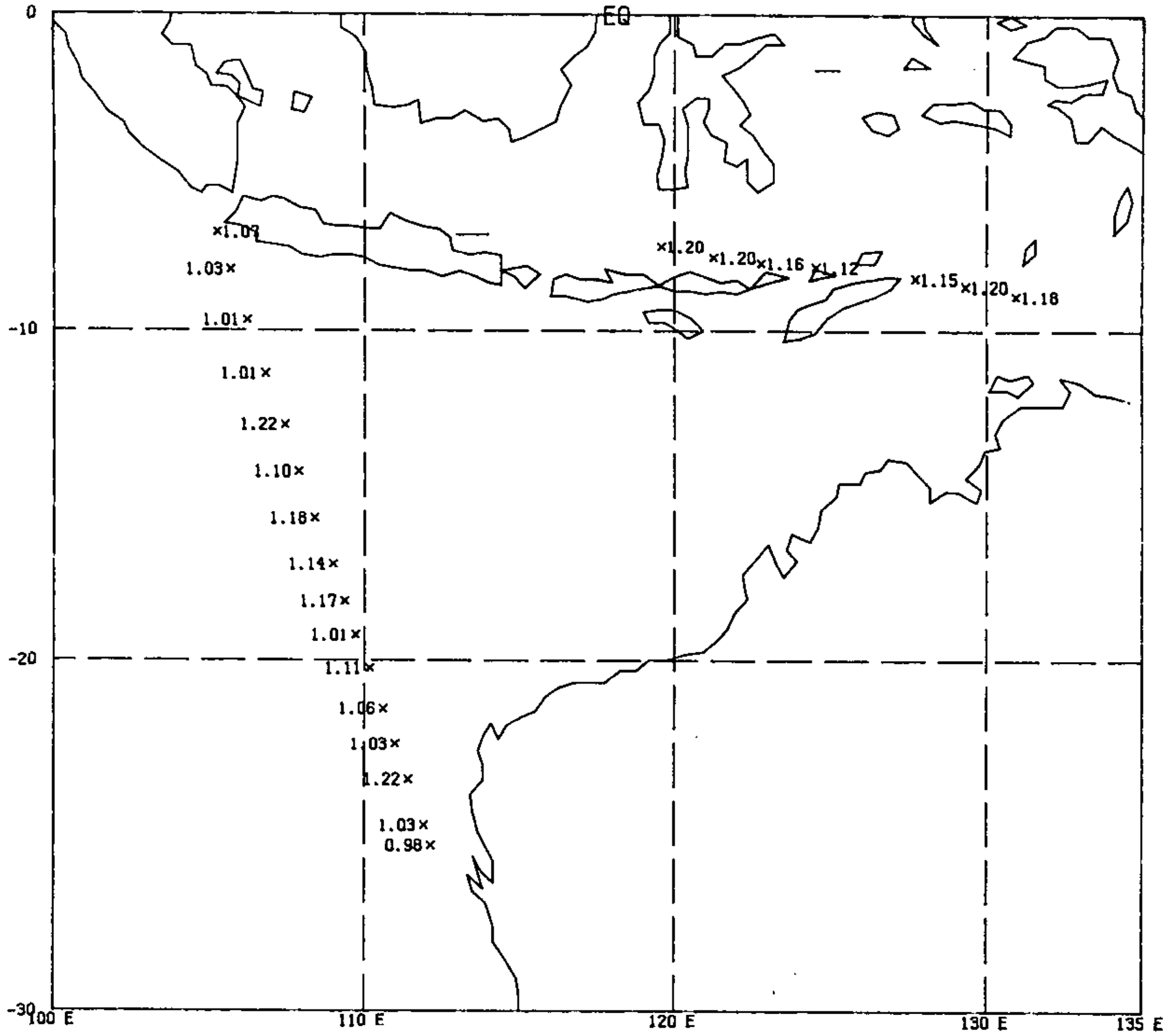

Fig. 9b: **As for Fig. 1, 5-24 July 1984**

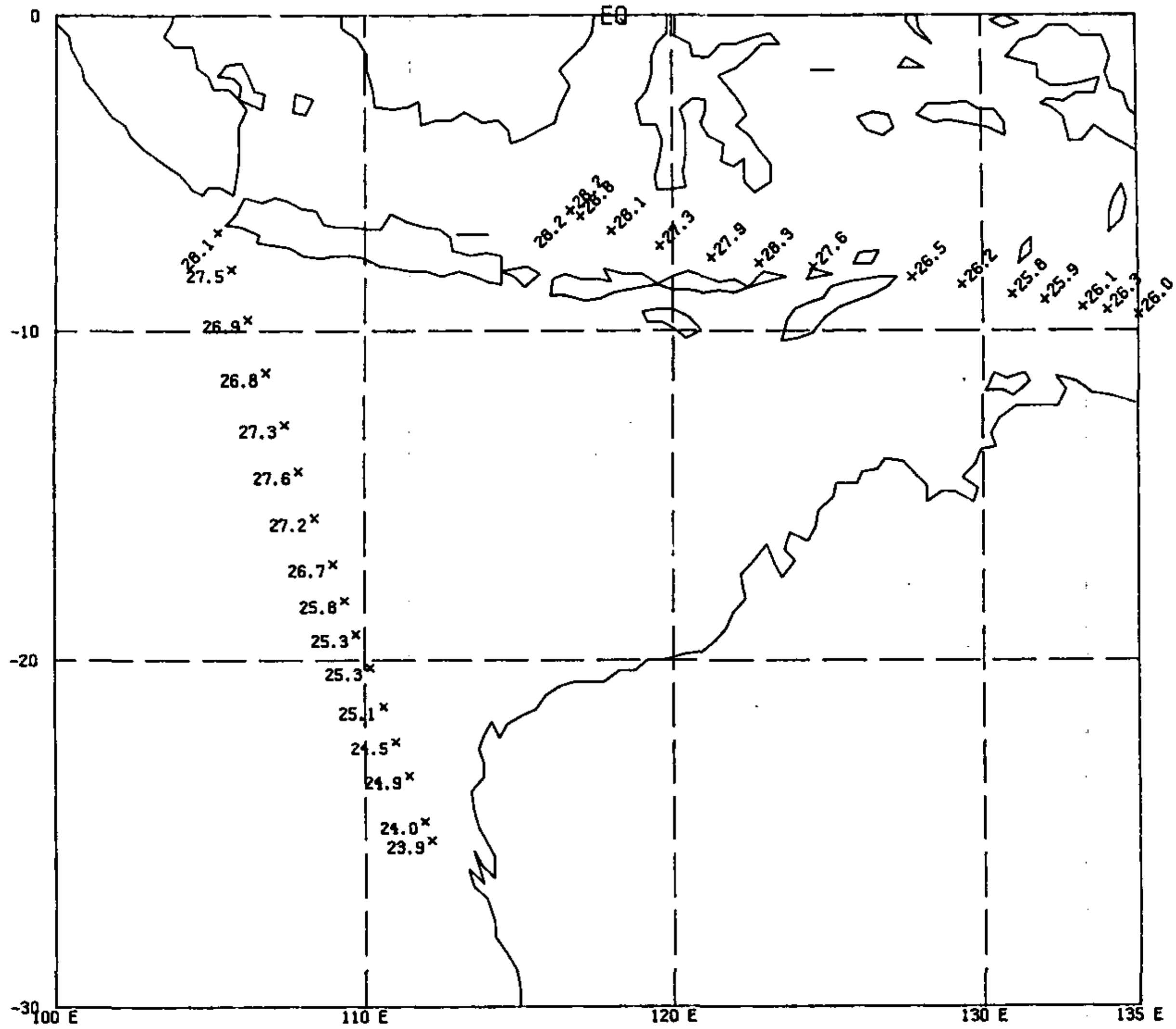

Fig. 9c: As for Fig. 1, 5-24 July 1984

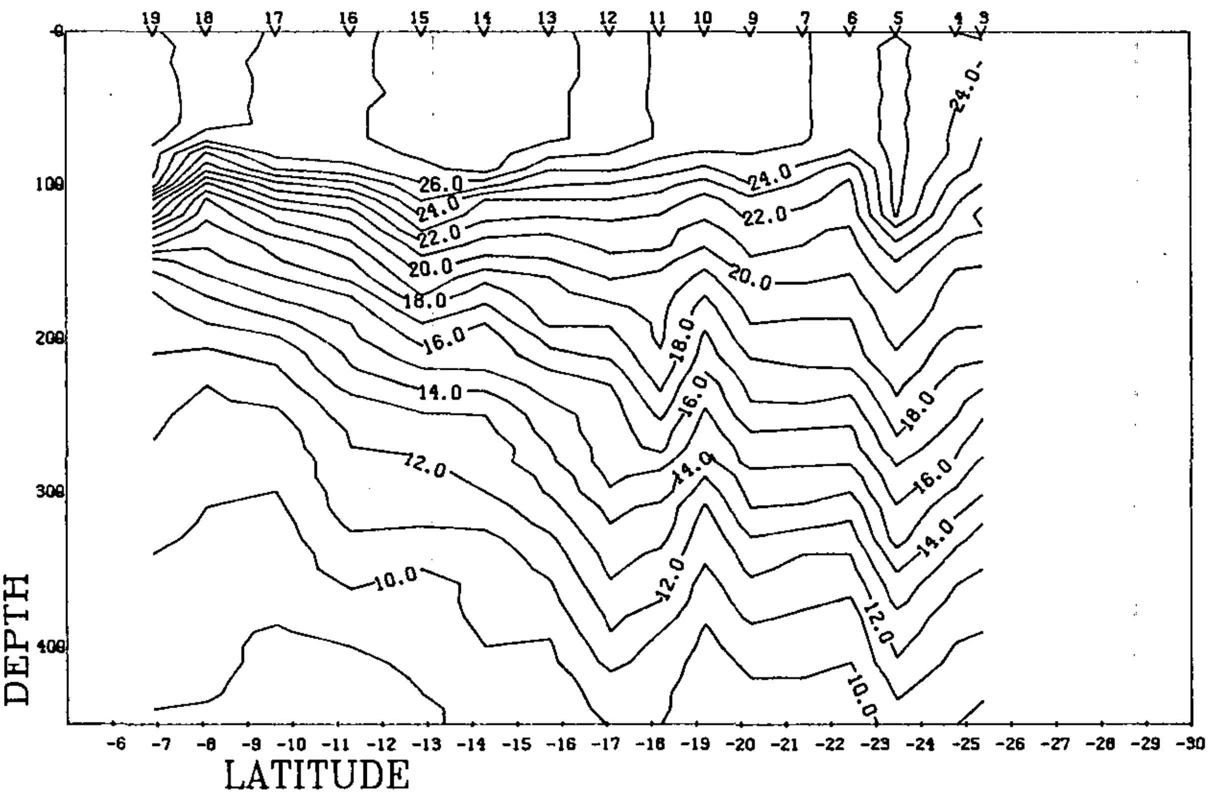

Fig. 9d: Vertical section, Stations 3-19, 5-8 July 1984

Fig. 10: An XBT launch, showing aluminium extension used to keep wire clear of ship's hull

CSIRO
Marine Laboratories

comprises

Division of Oceanography
Division of Fisheries Research

HEADQUARTERS
Castray Esplanade, Hobart, Tas
G.P.O. Box 1538, Hobart, Tas 7001,
Australia

QUEENSLAND LABORATORY
233 Middle Street, Cleveland, Qld
P.O. Box 120, Cleveland, Qld 4163

WESTERN AUSTRALIAN LABORATORY
Leach Street, Marmion, WA
P.O. Box 20, North Beach, WA 6020

ISSN 0725-4598